ASSOCIATION OF ORGANIC AGRICULTURE PRACTITIONERS OF NIGERIA

ENHANCING ORGANIC & REGENERATIVE AGRICULTURE BUSINESSIN NIGERIA

1st International NOAN AGM/Technical Workshop [Hybrid], Anambra 2023

BOOK OF PROCEEDINGS

Edited By:
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Enhancing Organic and Regenerative Agriculture Business in Nigeria

Proceedings of NOAN AGM/Technical Workshop 2023, Association of Organic Agriculture Practitioners of Nigeria (NOAN).

Held at Chike Okoli Centre for Entrepreneurial Studies (COCES), Nnamdi Azikiwe University,Awka, Anambra State, on 27th-28th April, 2023.

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ABOUT THE ASSOCIATION

Association of Organic Agriculture Practitioners of Nigeria is a non-governmental organization created to serve as an umbrella body for all stakeholders involved in organic agriculture in Nigeria. The National Secretariat is located at the city of Ibadan, Nigeria.

Membership is drawn from farmers, scientists, processors, exporters, individuals, institutions, NGOs and organizations that are key players in the organic agriculture sector in Nigeria. The Association also serves as a link between organic agriculture stakeholders in Nigeria and international bodies interested in organic agriculture. The activities of the Association are hinged on the following thematic areas:

- Advocacy
- Capacity Building
- Standards and Certification
- Marketing
- Production and Processing
- Research

These areas are managed by a committee which is well experienced in such matters.

Our Vision: To improve the quality of urban and rural livelihoods through the adoption of organic agriculture in Nigeria.

Our Mission: The mission of the Association of Organic Agriculture Practitioners of Nigeria is to coordinate and facilitate the development of sustainable organic Agriculture related activities in Nigeria.

Our Objectives:

a. To vigorously create and increase awareness of organic agriculture in Nigeria
b. To enhance capacity building of all stakeholders involved in organic agriculture in Nigeria
c. To assist local producers who desire to convert to organic agriculture
d. To facilitate the process of setting local standards and local certification or organic produce/products in Nigeria
e. To link farmers to local and international organic produce markets
f. To assist all stakeholders in developing viable organic agriculture industry in Nigeria
g. To interact with international bodies on organic agriculture related issues.

A BRIEF HISTORY OF THE ASSOCIATION

The Association of Organic Agriculture Practitioners of Nigeria, formerly known as Nigeria Organic Agriculture Network (NOAN) gradually evolved as far back as 2008 when some concerned academics (Profs. J.A Omueti, Prof. G.O Adeoye, Dr. O.O. Adeoluwa from University of Ibadan, Prof. Odeyemi from Obafemi Awolowo University, Prof. Jonathan Babatola (Olusegun Obasanjo Centre for Organic Research and Development (OOCORD) and Prof. J.A Adediran (IAR&T, Ibadan) met on several occasions at Ibadan to deliberate on the relevance of the newly emerging production system referred to as organic agriculture to agriculture in Nigeria. The Association was thereafter adopted as a national movement to coordinate organic agriculture activities in Nigeria at a meeting held on September 05, 2008 at Ibadan. The Association finally got registered (RC 529446) with the Corporate Affairs Commission (CAC), Abuja in 2010 under the name of Association of Organic Agriculture Practitioners of Nigeria. The Association is actively involved in on-going continental projects such as the Ecological Agriculture Project Initiative (EOA-1) and Forum for Agricultural Research in Africa (FARA) Organic Agriculture Innovation Platform, and as well aligned to the AU-Department of Rural Economy and Agriculture (DREA) agenda, the Comprehensive African Agriculture Development Plan (CAADP) Results framework, the Malabo declaration and Agenda 2036.

ORGANIC AGRICULTURE ANTHEM

Organic is life
Organic is life
Using organic standards organic is life.

Organic is life
Organic is life
Farming without synthetics organic is life.

Organic is life
Organic is life
For healthy farmers organic is life.

Organic is life
Organic is life
For healthy consumers organic is life.

Organic is life
Organic is life
For healthy environment organic is life.

Organic is life
Organic is life
That is why I'm saying that organic is life. (*Composed by Prof. N.T. Meludu*)

PRESIDENT'S WELCOME ADDRESS

Welcome Address from the President, Association of Organic Agriculture Practitioners of Nigeria

PROTOCOL
The First Lady and Wife of the Governor of Anambra State
The Honourable Commissioner for Agriculture, Anambra State
The Honourable Commissioner for Business, Trade & Cooperatives, Edo State
The Chief Host and Vice Chancellor, Nnamdi Azikiwe Univerity, Awka
The Awardees of Ambassadors of Organic Agriculture in Nigeria
Keynote Speaker, Prof. Ike Nwachukwu
Members of the Board of Trustees
Members of the Governing Board
Corporate Members
Farmers' Groups
Regular Members
Students
Gentlemen of the Press
Ladies and Gentlemen

The leadership of the Association is highly honoured to host the guests and participants in this year's AGM. The Annual General Meeting of 2022 is organized in a special way adding Technical Workshop and Exhibition / Trade Fair together in a single two-day event. This is the first edition of its kind in the history of the Association. This is a bold effort to live out the main objective of the Association "To develop a unique organic agriculture sector based on the principles of ecology, health, fairness and care that guarantee food security, food sovereignty, organic cosmetic and sustainable development along the organic agriculture value chain".

The current event is designed to bring together the entire value chain actors in the same environment for effective interaction. This interaction will provide the opportunity for actors of the value chain to interact and exchange ideas. It is very pertinent that with the sustenance of this arrangement as an annual event, will provide sustainable process for actors of the value chain including the farmers to effectively share experiences with the researchers and benefit from the findings of research. These will be repeated in subsequent years to the extent that there will be a continuous annual exchange of ideas and these exchanges will be compiled as a repository of knowledge as organic agriculture is knowledge intensive.

The awardees of Ambassadors of Organic Agriculture in Nigeria are equally dear to the Association main objective. One of the major challenges of organic agriculture in Africa and Nigeria is awareness. There is need for increased advocacy and the voice of the Ambassadors based on their personalities and achievement will give a boost to the acceptance of organic agriculture as the way to go.

It is important to note that currently the Association is coordinating two projects including Ecological organic Agriculture Initiative (EOA-i) and Knowledge Centre for Organic Agriculture (KCOA) in Africa. These two project has significantly impacted the growth and development of organic agriculture in Nigeria and it should be sustained. We count on the members and most importantly the awardees to use their influence and give louder voice to the advocacy.

I wish you a successful deliberations and interactions. Thank you and welcome.

Signed
Dr. Jude C. Obi
(*NOAN, President*)
April, Anambra 2023.

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Enhancing Organic and Regenerative Agriculture Business in Nigeria

Professor Ike Nwachukwu

Michael Okpara University of Agriculture, Umudike

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(*Being a keynote address, presented at the Association of Organic Agriculture Practitioners of Nigeria (NOAN), 2023 Annual General Meeting (AGM). 27th and 28th April, 2023 held at Chike Okoli Centre for Entrepreneurial Studies(COCES), Nnamdi Azikiwe University, Awka, Anambra State*).

INTRODUCTION

Two major global events have helped in shifting attention to the importance of organic and regenerative agriculture. The incidence of climate change has affected the environment in some negative ways, and this calls for a regenerative agricultural practice. The economic downturn and the war between Russia and Ukraine, have combined to shoot up the prices of inorganic fertilizer. The price of a bag of fertilizer in Nigerian market now, ranges from N25, 000-N 30,000. This obviously is beyond the reach of most Nigerian farmers. The inevitability of organic farming is now imperative.

Organic agriculture has been defined as a system that relies on ecosystem management, rather than external agricultural inputs. Organic agriculture includes the whole value chain production system from production to processing and marketing. Organic agriculture is also a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects (IFOAM, 2021).

The objective of organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people. The specific objectives are to; use energy and natural resources, maintain biodiversity, protect animal welfare and to conserve the regional ecological balance (https://www.iberdrola.com).

IMPORTANCE OF ORGANIC AGRICULTURE

The practice of organic agriculture in Nigeria has become so inevitable, as global events have made it imperative. The vast majority of our farmers are low scale producers who cannot afford the high price of inorganic fertilizers. As Nigerians face health challenges, organic agriculture ensures the production of high-quality food that is nutritious and prevents sickness. The harmful effect of the use of inorganic fertilizer on the health of the people and the environment, have been well documented. Organic agriculture has been noted to create the ecosystem that achieves sustainable productivity and promotes weed and pest control. Organic agriculture produces certified products that meet the strict standards set by regulatory agencies. It is a holistic approach to food production that prioritizes natural processes and environmental sustainability. Organic agriculture provides a wholesome and responsible choice for your table (Ellen Van, 2020). The author maintains that, it provides environmental conservation, economic self-reliance, increases fertility and prevention of soil erosion. In addition to that, it protects the human and animal kingdom from the side-effects of chemicals and synthetic agriculture, thereby promoting long life.

Indeed, in a study it carried out some years ago in Benue State, the Women Environmental Programme, a gender-focused indigenous non-governmental organization, found that the chemicals have also contributed to deformities in infants, an emerging prenatal condition which most rural dwellers ignorantly attribute to witchcraft. Odogwu (2021)

ORGANIC AGRICULTURE IN NIGERIA

The National Dialogue on Organic Agriculture Policy was held in 2012 and the then Minister of Agriculture and Rural development stated that the practice of organic agriculture in an organized manner was relatively new in the country and that about 70 % of the Nigerian farmers think they practice organic agriculture but true organics is a certified production method that is yet to be widely understood by Nigerian farmers. With a vast landmass, conducive climate, and large population of over 200 million, Nigeria is well-suited to excel in organic agriculture, especially as the major natural input needed, including plant residues, poultry, and livestock waste, biogas residue, and agricultural by-products, are readily available locally.

Organic agriculture is increasingly gaining popularity in Nigeria. More farmers are going into its production, and consumers are also getting aware of the benefits of organic products. It is now possible for consumers in the local markets to seek for organic products, and reject inorganic fertilizer infested products. Due to the activities of NOAN, organic agriculture is being popularized in Nigeria.

Nigerian producers are seeking to be part of the organic food market that is expected to reach $437.36 billion by 2026 with a compounded annual growth rate of 14 % (FAO, 2022). In the last five years, African farmers, including those from Nigeria, have been making money producing organically grown crops for European markets, where demand for healthier food is growing. FAO renewed its partnership agreement with the International Federation of Organic Agriculture Movements (IFOAM) – Organics International, till next year to enable smallholder farmers access international market. More than 5,000 farmers in West Africa are exporting organically-grown produce to Europe, after gaining organic and fair-trade certification with help from FAO.

Unfortunately, Nigeria is not producing enough of organic products, even to meet its quota in the international market. Igoh (2021) reported that there is an organic market in Abuja, but products are brought from Ghana, to meet the market demand. It is rather surprising that Nigeria, with the number of farmers that we have, will depend on other smaller African nations, to meet our demand.

REGENERATIVE AGRICULTURE

Regenerative agriculture is often associated with agroecology, soil and ecosystem restoration, reliance on biological interactions and ecosystem services, integration of domestic plants and animals, and efficient use of the photosynthetic potential of annual and perennial combinations (Giller, Hijbeek, Andersson, and Sumberg, 2021).

There are various regenerative farming practices; they include no-till farming and pasture cropping, organic annual cropping, compost, holistically managed grazing, animal integration, ecological aquaculture, perennial crops, silvopasture, and agroforestry. These different regenerative farming practices are all underpinned by a common set of principles. These principles are (Giller, Hijbeek, Andersson, and Sumberg, 2021);

- Minimizing soil disturbance will benefit the soil and the climate. The practice here involves no or reduced land tillage techniques, which are employed to improve the soil's ability to retain water and soil nutrients.
- Year-round planting of coverage crops to prevent soil erosion and increase carbon inputs. Planting cover crops will help improve the health of the soil and soil moisture.
- Diversifying crops in space and time will support resilience, productivity, and diversity. This entails practicing crop rotation, interseeding, relay planting, and biodiversity strips, or

agroforestry, to help increase the soils nutrients, fight pests and weeds, thereby limiting pest infestations, and nourish beneficial microbes in the soil with a more diverse diet.

- Reducing biological and chemical inputs. This principle encourages the farmers to practice precision agriculture/farming which will help them only apply the optimal amount and type of product needed for a productive crop.
- Integration of livestock when possible since livestock-managed grazing can help create a virtuous circle of soil health.

The definition of regenerative agriculture allows for a diversity of interpretations because they are often based on practices, yet its theme is dynamic and holistic in the sense that it adopts permaculture and organic farming practices, including conservation tillage, cover crops, crop rotation, traditional compost manure, mobile animal shelters, and pasture cropping, so that the farmers can not only increase agriculture productivity but also raise their income and the quality of the top soil. This simply means that regenerative agriculture blends sustainable innovation with traditional agricultural practises used earlier by our forefathers to promote their yield. According to Drawin *et al*. (2021), the concept of regenerative agriculture is to improve the fertility of the soil, that can produce high-quality, nutrient-dense food while simultaneously improving rather than degrading the land, ultimately leading to productive farms, healthy communities, and thriving economies, and that it operates under some basic principles which promotes sustainable environment for the future.

ORGANIC AGRICULTURE BUSINESS IN NIGERIA

The major focus of organic agribusiness is self-sufficiency versus market-oriented farming. Farmers need to produce for their own needs and to care about what the market needs.

Organic farming in an organized manner is still young in the country. The practitioners are mostly a few farmers and some NGOs. Organic farmers in Nigeria currently sell organic lemongrass tea, turmeric and other produce in the local market with few certified products for export, a situation many regards as under-maximization of the premium benefits of organic farming where several agribusiness opportunities abound (GAIN REPORT, 2014).

Job Opportunities in Organic Agriculture include crop production, animal production, wildlife (beekeeping, mushroom, games, forestry products, etc), fisheries production, inputs (fertilizers, pesticides, colourant, etc.), handling (middlemen), processing (fibre, drinks, foods, etc.) and certification and accreditation. All these areas when harmonized through proper agribusiness management and organic labels can contribute to increased livelihood and national GPD. (NOAN website provides more information on this)

Most Nigeria market are priced markets which do not support premium price for organic produces, consequently, farmers' income cannot appreciate to compensate for the much labor required in organic farming. There should be organized standard sales outlets for organic products to bring producers closer to potential buyers, and consumers should be well informed on the health values of organic through advertisement and other means. Regulations and quality control measures should be developed and strictly followed to conform to international standards to attract foreign trade and streamline market requirements (GAIN REPORT, 2014).

ESTABLISHMENT OF ORGANIC MARKETS

Markets for organically produced crops are strongest in North America, Europe, and Japan. Countries according to their areas of comparative advantage strive to meet up with legislation and regulations to guide the activities responsible for movement of organic agricultural products across national and international boundaries. Global revenues have increased over several folds from 18 billion US dollars in 2000 and double-digit growth rates were observed each year. (AdeOluwa, 2017). Price premiums are important for the profitability of small organic farmers. Organic food is widely believed by the lay public to be healthier than conventional food. Participation in markets holds the potential for sustained and continuous improvement of incomes of rural poor (NATUR, 2014). Farmers selling directly to consumers at farmers' markets have continued to achieve these higher returns.

In 2021, Michael Okpara University of Agriculture's organic market was established, sponsored by EOA project from NOAN. Small holder organic farmers within the university community and environs bring their produce for sale and also receive trainings on organic principles and practice to improve production. Earlier, lack of organized market had posed limitations on the potential for improvement within this production system. Significant, continuous and sustained improvement in people's income can only be achieved through a shift from a subsistence economy to a market economy (NATUR, 2014). Replication of such premium market outlets can stirrup vibrant agribusiness enterprises in organic agriculture.

CHALLENGES OF ORGANIC AGRICULTURE

The challenges of organic agriculture have been highlighted by USDA Gains Report No 18 (2014)

1. **Lack of Awareness**

It is a fact that many farmers in the country have only vague ideas about organic farming and its advantages as compared to conventional farming methods. Use of bio-fertilizers and bio-pesticides requires awareness and willingness on the part of the farming community. Knowledge about the availability and usefulness of supplementary nutrients to enrich the soil is also vital to increase productivity.

2. **Output Marketing**

Organic farmers are of the opinion that marketing and distribution of organic produce is challenging, unlike in the developed countries. It is found that before the beginning of the cultivation of organic crops, their marketability and distribution at a premium over the conventional produce has to be assured. One has to get certification before his good is sold. Inability to obtain a premium price, at least during the period required to achieve the productivity levels of the conventional crop will be a setback. More emphasis is usually placed, by government on policies to increase food production with little or no consideration on how to distribute the food produced efficiently and in a manner that will enhance increased productivity. In other words, food marketing by farmers and their families, mostly in the immediate post-harvest period usually involves a lot of costs and in Nigeria these costs are so high that lowering the costs through efficient marketing system may be as important as increasing agricultural production.

3. **Shortage of Bio-mass**

Many experts and well-informed farmers are not sure if all the nutrients with the required quantities can be made available by the organic materials. They are also of the view that the available organic matter is not simply enough to meet the requirements. The crop residues useful to prepare a high grade natural, organic fertilizer are removed after harvest from the farms. And they are used as fodder and fuel. Even if some are left out on the farms termites and other insects destroy them. The small and marginal cultivators have difficulties in getting the organic manures compared to the chemical fertilizers, which can be bought easily, if they have the financial ability to procure them. However, they have to either produce the organic manures by utilizing the bio-mass they have or they have to be collected from the locality with a minimum effort and cost. Increasing pressure of population and the disappearance of the common lands including the wastes and government lands make the task difficult (WWOOF NEWS, 2012).

4. **Inadequate Supporting Infrastructure**

In spite of the recent pronouncement by the African Union to assist in the development of organic agriculture in the continent, the Federal and state governments are yet to formulate policies and a credible mechanism to implement them. NOAN is sensitizing the Nigerian Government to produce policy on Organic Agriculture, accreditation and certification for organic produce. No Certifying agency yet to regulate and ensure compliance with international organic production system. The trade channels are yet to be formed and the infrastructure facilities for verification leading to certification of the farms are inadequate.

5. **High Input Costs**

The small and marginal farmers in Nigeria have been practicing a sort of pre organic farming in the form of the traditional farming system. They use local or own farm renewable resources and carry on the agricultural practices in an ecologically friendly environment. However, the costs of the organic input are now higher than those of industrially produced chemical fertilizers and pesticides including other input used in the conventional farming system. According to an industry source, groundnut cake, neem seed and cake, organic fertilizer, silt, cow dung, other manures, etc. applied as organic manure are increasingly becoming costly, making them unaffordable to the small cultivators.

6. **Non-availability of farm Input**

Bio-fertilizers and bio-pesticides are yet to become popular in the country. There is a lack of marketing and distribution network for them because the retailers are not interested to deal in these products, as the demand is low. Biofertilizers are not marketed by retailers in most parts of Nigeria. The erratic supplies and the low level of awareness of the cultivators also add to the problem. Higher margins of profit for chemical fertilizers and pesticides for retailing, heavy advertisement campaigns by the manufacturers and dealers are other major problems affecting the markets for organic inputs in Nigeria.

7. **Lack of appropriate Agriculture Policy**

Promotion of organic agriculture both for export and domestic consumption, the requirements of food security for millions of the poor, national self-sufficiency in food production, product and input supplies, etc. are vital issues which will have to be dealt with in an appropriate agricultural policy in Nigeria. These are serious issues that need to be resolved with consistent efforts. Formulation of an appropriate agricultural policy that will take care of these complexities is essential to promote organic agriculture in a big way.

8. **Lack of Financial Support**

The developing countries like Nigeria need to design a plethora of national and regional standards in tune with those of the developed countries. The adoption and maintenance of such regulatory framework and its implementation will be costly. The cost of certification, a major component of which is the periodical inspections carried out by the certifying agencies, which have freedom to fix the timing, type and number of such inspections appears to be burdensome for the small and marginal farmers. Despite contributing 45 per cent to Nigeria’s Gross Domestic Product, agriculture, which before the discovery of oil was the country’s highest revenue earner, is still plagued by funding issues. Supports from the States and the Federal government for the marketing of the organic products are not forthcoming.

9. **Low production**

Conventional agriculture has shown to produce more yield than organic agriculture. A 2006 study suggested that converted organic farms have lower pre-harvest yields than their conventional counterparts in developed countries (92%) and those organic farms have higher pre-harvest yields than their low-intensity counterparts in developing countries (132%) (Stanhil, 1990 cited in Oyewole G (Ed.) 2015). In many cases the farmers experience some loss in yields on discarding synthetic inputs during conversion of their farming methods from conventional to organic. Restoration of full biological activity in terms of growth of beneficial insect populations, nitrogen fixation from legumes, pest suppression and fertility problems will take some time and the reduction in the yield rates is the result during the changeover period. It may also be possible that it will take years to make organic production possible on the Nigerian farms. Small and marginal farmers cannot take the risk of low yields for the initial 2-3 years during the conversion to organic farming. There are no schemes to compensate them during the adjustment period.

10. **Inability to Meet the Export Demand**

The demand for organic products is high in the advanced countries like United States of America (US), the European Union (EU) and Japan. It is reported that US consumers are ready to pay a premium price of 60 to 100% for organic products. The upper classes in Nigeria are beginning to follow this trend.

11. **Lack of Quality Standards for Bio-manures**

The need for fixing standards and quality parameters for bio-fertilizers and bio-manures has arisen with the increasing popularity of organic farming in the country. There are a very large number of brands of organic manures, claiming high levels of natural nutrients and essential elements. But most farmers are not aware of the pitfalls of using the commercially available bio-manure products. While the concept of organic farming itself lays great stress on the manures produced on the farm and the farmers' household, many of the branded products available in the market may not be really organic. Elements of chemicals slipping into the manures through faulty production methods could make the product not certifiable as organic. Most farmers are still unaware of the difference between bio-manure and bio-fertilizer. While biomanure contains organic matter, which improves the soil quality, biofertilizers are nutritional additives separated from the organic material, which could be added to the soil, much like taking vitamin pills. Bio-fertilizers do nothing to enhance soil quality while the loss of soil quality has been the major problem faced by farmers these days.

12. **Political and Social Factors**

Agriculture in Nigeria is subject to political interventions with the objectives of dispensing favors for electoral benefits. Subsidies and other supports from both the Federal and state governments, government-controlled prices of input like chemical fertilizers, the public sector units' dominant role in the production of fertilizers, government support/floor prices for many agricultural products. Similarly, supply of inputs like power and water either without cost or at a subsidized rate, etc. are the tools often used to achieve political objectives. Any movement for the promotion of organic farming in Nigeria will have to counter opposition from the sections who benefit from such policies in the conventional farming system.

ENHANCING ORGANIC AND REGENERATIVE AGRICULTURE IN NIGERIA (RECOMMENDATIONS)

Having reviewed the problems of organic agriculture in Nigeria, I now make the following recommendations for enhanced organic and regenerative agriculture in Nigeria.

1. **Improved advocacy programme**

NOAN has been doing a great job in its advocacy campaigns; however, it is obvious that more needs to be done.

Youth. For the youth, specific programmes should be designed to popularize both the production and consumption of organic products. Efforts should be made to form clubs in such schools

Government agencies. Agencies of government that are relevant to the advancement of organic agriculture, should be approached. Such include; Federal and States Ministries of Agriculture, National Agricultural Land Development Agency, and others.

Policy makers. The National and States' Assemblies are key stakeholders that should be reached out to.

There is no doubt that advocacy campaigns are very expensive, but much attempts should be made.

2. Collaboration and Partnership

NOAN cannot achieve its goal of advocacy alone. There is the need to partner and collaborate with both National and International organizations. The followings are suggested;

a. Nigerian Forum for Agricultural and Advisory Services (NIFAAS). This is the affiliate of African Forum for Agricultural and Advisory Services (AFAAS)

In November, 2023, NIFAAS, in collaboration with the Federal Ministry of Agriculture and Rural Development, will be hosting the 6th African Agricultural Extension Week. The theme for the conference is "**Harnessing Agricultural Extension & Advisory Services in Scaling Regenerative Agriculture and Nature Based Solutions for Food System Transformation in Africa**"

I invite NOAN to participate in this all-important conference.

b. AFAAS (as mentioned above

c. Forum for Agricultural Research in Africa (FARA), based in Ghana

3. Publicity

Publicity materials should be produced and deployed to the public. Messages should be for both farmers and consumers. In this case, it is always good to use professional advertisers to develop appropriate campaign materials. The strategic selling points must be properly identified and used in order to achieve maximum success

4. Graduate trainee program

Graduate trainee program can be established for farmers. The project aims to build capacity of young Nigerian graduates in organic agriculture and equip them with entrepreneurial skills, which enable them to start their organic businesses, thus becoming job creators rather than job seekers. The programme will make a positive difference in food security and improved livelihoods in Nigeria.

5. Research funding

A lot of research needs to be carried out on organic farming. Funding is usually the limiting factor. I will recommend that NOAN develops research proposals and approach

Tetfund for funding. TETFUND has a lot of budgets for research. If approached as a group, we may be more successful.

The National Agricultural Extension Research and Liaison Services (NAERLS) should be contacted for collaboration in research and extension.

Also, all the organizations mentioned in no 2, applies here.

6. **Enhanced extension services**. Specialized extension services on organic agriculture for public extension system is almost nonexistent. There is the need to train some extension agents in the various Agricultural Development Projects (ADPs) in the country. To achieve this, the apex coordinating executive of the ADPs should be contacted.

The National Policy on Agricultural Extension in Nigeria has just been approved by the Federal executive Council. I recommend a collaboration between NOAN and the Federal Department of Agricultural Extension, in the Ministry of Agriculture and Rural Development, will be very beneficial.

7. Market

The development of market, both physical and virtual is very crucial in enhancing organic farming in Nigeria. Physical markets should be established in various parts of the country. The example of Michael Okpara University of Agriculture, Umudike, where they have a physical market for organic products, should be replicated by all the institution present here.

Of course, the issue of standard, certification and packaging must be strictly adhered to in the markets.

8. Export Market.

This is a huge market waiting to be tapped into. The level of export of organic products is abysmally low in Nigeria. Efforts should be made to increase organic products for export market. However, strict international standards must be observed

9. Cooperativeness

There is the need to get a census of actual organic farmers from each Local Government Area, and each state. They will now be formed into cooperative societies. With the economy of scale, farmers would be able to gain access to input and funds, as the case may be.

10. **Funds.** There is no doubt that the lack of funds has been a limiting factor in agrobusiness, especially organic farming business. Obtaining fund from conventional institutions has always been difficult. However, farmers cooperative organizations have greater chances of obtaining loans from financial organizations. This makes the formation of cooperative societies, imperative

11. Policy formulation and Implementation

The formulation and implementation of a national Policy on organic and regenerative agriculture is very crucial to the future of organic agriculture. I know that much efforts have been put into realizing this goal. Much efforts should still be put in place. The policy will outline all the stakeholders in the business and how it will be regulated. It will also establish the certifying agency for organic products in Nigeria.

CONCLUSION

It is my belief, that if the recommendations stated above are implemented, the practice of organic and regenerative agriculture in Nigeria will be greatly enhanced.

It is not going to be an easy road. However, with the enthusiasm and dogged determination of all practitioners in Nigeria, will bring about the desired goal.

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Growth And Yield Response of Fluted Pumpkin (*Telfairia occidentalis*) as Influenced by Tillage Practices

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ABSTRACT

The study assessed the effect of tillage practices on the growth and yield of *Telfairia occidentalis.* The experiment was laid out in a Randomized Complete Block Design (RCBD) having four (4) treatments replicated three (3) times. The treatments were zero tillage (T1), sunken bed (T2), manual ridges (T3), and raised beds (T4) respectively. Seedlings of *Telfairia occidentalis* were transplanted to the experimental field four weeks after sowing in polythene pots filled with *Gmelina* sawdust in the nursery. Data collection started two weeks after transplanting and parameters assessed were vine length, stem girth, leaf number, branch count and foliar yield. Data was subjected to Analysis of Variance (ANOVA) using Statistical Package for Social Sciences (SPSS) and significant means separated using Duncan Multiple Range Test (DMRT) at 5% probability level. Although, the results showed no significant difference in all the parameters but manual ridges recorded best in vine length having 153.3cm while raised bed plots had the least of115.7cm. However, sunken bed plots had the highest values in stem girth of 7.30mm while the least performance was observed on zero tillage plots with 6.67mm. Similar results was observed in number of leaves where sunken bed plots recorded best having 82.67 and the least was observed on raised bed plots recording 69.67. In addition, manual ridges plots recorded best in number of branches having 5.67 while zero tillage plots recorded the least value of 3.67. Manual ridges showed best results for foliar yield having 0.075kg and the least performance was observed in raised beds plots recording 0.045kg. Best results were obtained from manual ridges over other tillage practices and therefore recommended for the growth and yield of fluted pumpkin in the study area.

Keywords: fluted pumpkin, tillage practices, growth and yield

INTRODUCTION

Tillage systems play important role in the maintenance of soil productivity, the choice of which could depend on soil characteristics, type of crops grown, prevailing agro-ecological conditions and socio-economic status of farmers. Primarily, tillage practices are carried out to control weed infestation, improve soil conservation, water infiltration hence provide optimum soil conditions for planting. It also improves the physical conditions of the soil through the breaking of hardpans, increase root penetrability and exploratory tendencies in available soil medium which consequents upon crop yield (Uwah *et al.*, 2013). Tillage is often carried out for one or a combination of the following purposes including raised bed preparation, control of weeds and incorporation of organic matter into the soil, soil and water conservation as well as improvement of soil's physical condition (Ndaeyo, 2003). Farmers prefer to have a wide choice of tillage alternatives to enhance selection of an appropriate seedbed preparation method that satisfies the specific management challenges.

Tillage practices are integral to soil conservation and management (Kuku, 2012). Tillage creates soil environment favorable for plant growth (Klute, 1982) and is also reported to have profound changes in soil fertility status and such changes may be manifested in good or poor performance of crops (Ohiri and Ezumah, 1990; Ojeniyi and Agboola, 1995; Aiyelari *et al*., 2001).

Sustainable vegetable production is the production of vegetables using a system that increases inherent productive capacity of natural and biological resources in step with demand. At the same time, it must allow farmers to earn adequate profit, provide consumers with wholesome safe food and minimize adverse effect impact on the environment (National Research Council, 1991). Fluted pumpkin is cultivated across lowland humid tropics of West Africa including Ghana and Sierra Leone (Bologi, 2012). It is widely grown in many nations of West Africa and it is a popular vegetable among the southern eastern Nigerian people (Burkul, 2004), where it has the widest diversity and for its edible leaves and seed. Fluted pumpkin production remains entrenched in Nigerian agriculture and forms an important condiment in the national diet (Ibekwe and Adesope, 2010). Fluted pumpkin leaves are picked continually as the plant grows and are used in soups and porridges as the vegetative parts of the crop make excellent vegetable rich in vitamins. These vegetable has 37.3% protein content on a dry weight basis (Schippers, 2002). The leaves are rich sources of protein, oil, vitamins and minerals (Aregheore, 2007). The leaves have medicinal values and are used for the treatment of anemia and diabetes (Akanbi *et al*., 2007). Sap from the leaves because of its high chlorophyll content finds usefulness in medicinal or herbal compositions as blood tonic for anemic or weak patients (Akoroda, 1990). The tender vine and foliage are eaten as potherb, while the seed is consumed as a nut (Akoroda, 1990). The oily seeds according to Schippers (2000) have lactating properties and are widely consumed by nursing mothers. The seeds which can be boiled, roasted and eaten or ground into paste could be used for thickening soup (Fashina *et al*., 2002). The seed contains 20% protein, 45% fat, 23% carbohydrate, 2.2% fibers and 1.8% total ash. The oil in the seeds is non-drying and contains lactating properties which are of high demand by nursing mothers (Akanbi *et al*., 2007). The oleic and linoleic acid constitute over 63% of the fatty acids and that makes the oil useful in soup making and cooking, suitable for use in the manufacturing of pomade, margarine and as well as being carrier for certain drugs (Asiegbu, 1987; Akanbi *et al*., 2007).

Fluted pumpkin grows well in fertile well drained loamy soil with a high water holding capacity when grown under rain-fed conditions. The plants are tolerant to elevation up to 1000 m and a wide range of soil condition. Although fertile soils with good moisture retaining capacity are preferable, it is partially drought resistant, growing in shade or full sun. The plant is dioecious perennial and normally grown trellised. The seedling of fluted pumpkin is very tender, and as such it is usually grown on soils cultivated into raised bed, ridges or sunken bed to ensure good soil tilth for easy root penetration, aeration and infiltration of water, hence, the need to understand the available tillage options and consider the best of them.

MATERIALS AND METHODS

Experimental Location: The experiment was carried out at the Research plot of The Department of Agricultural Technology, Federal College of Forestry, Ibadan which is located within the Government Reserved Area (GRA) Jericho Ibadan, Oyo state. The area lies between latitude 7º26N and longitude 3º51E. The climate pattern of the area is typically dominated by annual rainfall ranging from 1300- 1500mm and average relative humidity of about 65%. The average temperature is about 26ºC. Ecoclimate of dry season usually commence from November to March while the raining season is usually April to October. (FRIN, 2019).

Procurement of Materials: Planting materials (*Telfairia occidentalis pods*) for the experiment was obtained from Crop Production Technology Department, Federal College of Forestry. The measuring tape, ropes used as trellises were procured and other farm tools were collected from the Agricultural Technology Department, Federal College of Forestry, Ibadan.

Method of Sowing *Telfairia occidentalis* In the Nursery: Sawdust of *Gmelina* was collected from Forestry Research Institute of Nigeria (FRIN) saw mill. 80 polythene pots were filled up with *Gmelina* sawdust using the hand trowel. Seeds of *Telfairiaoccidentalis* were extracted from the pod, depulped and sundried to reduce the moisture content before sowing into the polythene pots filled with *Gmelina* sawdust and watering was carried out in the morning and evening for four (4) weeks.

Land Preparation and Seedling Transplanting: The experimental field was cleared of bushes using farm implements such as hoe, cutlass and the debris were taken out of the field. Mapping out was done and the tillage methods were prepared as treatments. The experimental area was mapped into 11m by 12.5m while each plot size separatedby a furrow path of 0.5m apart measured 3m by 2.5m. Seedlings were transplanted at a spacing of0.7m by 0.5m. The plots were marked out using measuring tape, pegs and ropes.

Experimental Design: The experiment was laid out in a Randomized Complete Block Design (RCBD) having four (4) treatments replicated three (3) times which include: Zero Tillage, sunken beds, manual ridges andraised beds.

Agronomic Practices: Agronomic practices such as watering and weeding was carried out. Manual weeding was done by hand at 2, 4, 6, 8, 10 weeks after transplanting using hoe and cutlass. The commonly found weeds at the experimental site were *Centrosema pubescens, Panicum maximum, Commelina benghalensis*, *Caladium bicolor, Axonopus compressus,* and *Talinum triangulare.* Staking using ropes as trellises was also carried out.

Data Collection: Data collection on vegetative parameters such as vine length (cm), number of leaves, number of branches and stem girth started two (2) weeks after transplanting while total foliar yield (kg) where leaves were harvested, bulked together and weighed for each treatment using weighing balance was taken at the 9th week after transplanting.

Data Analysis: Data obtained was subjected to Analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS) and significant means separated using Duncan Multiple Range Test (DMRT) at 5% probability level.

RESULTS

Table 1: Physical and Chemical Properties of the Soil in the Study Area

Soil properties	Content in soil

pH (H_2O)	6.30
Organic carbon (%)	0.58
Total Nitrogen (%)	0.06
Available Phosphorus (mg/kg)	2.40
Exchangeable Acidity (cmol/kg)	0.40
Exchangeable Bases (cmol/kg)	
Ca(cmol/kg)	2.85
Mg(cmol/kg)	0.83
K (mol/kg)	0.26
Na (cmol/kg)	0.20
Extractable Micro Nutrient (mg/kg)	
Mn (mg/kg)	85.00
Fe (mg/kg)	96.00
Cu (mg/kg)	1.10
Zn (mg/kg)	1.21

Source: DE-IMAGE Laboratory Service, Oyo State.

Table 1 shows the result for the analysis of soil sample in the experimental site. It shows the composition and structure of the soil which consist of nutrients both at large and small quantity and its pH level. The analysis carried out shows that the soil is Loamy sand in texture and with seemingly low fertility as reflected by low organic carbon, total nitrogen, available phosphorus and exchangeable bases. The result as compared with the USDA Handbook (1993) indicated low nutrient capacity with abysmal organic carbon content. This may be due to the exhaustive use of the land for a prolonged period of time with little or no soil management and conservation practice (Edna and Ime, 2017). This indicates that the soil has some fertility constraints for crop production, consequently optimum crop growth yield cannot be achieved without supplement through soil amendment. NPK fertilizer 20:10:10 was added to the soil. Nitrogen is a constituent of all proteinand chlorophyll and produces rapid vegetative growth in vegetables (Ojetayo *et al.*, 2011).

Table 2: Influence of tillage practices on the vine length of fluted pumpkin (*Telfairia occidentalis*).

	Vine Length (cm) *Weeks After Transplanting*						
Treatments	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Zero tillage	64.17[a]	68.75[a]	74.33[a]	85.50[a]	101.33[a]	118.00[a]	124.83[a]
Sunken Bed	58.00[a]	60.16[a]	70.17[a]	92.83[a]	117.33[a]	128.83[a]	137.17[a]
Manual Ridges	64.67[a]	77.92[a]	92.83[a]	104.17[a]	125.83[a]	142.83[a]	153.30[a]
Raised Bed	57.17[a]	58.33[a]	68.83[a]	77.67[a]	95.50[a]	108.50[a]	115.17[a]

Means in the same column having the same subscript are not significantly different from each other at 5% level of significance (p>0.05) according to Duncan (1955)

The vine length of fluted pumpkin as influenced by the different tillage methods as shown in the table above. The result showed no significant difference ($p>0.05$) in vine length among the tillage methods. However, at the 8th week after transplanting (WATP), manual ridges plots recorded the highest vine length followed by sunken beds while raised beds produced the least vine length. The increase in vine length was of the order; Manual Ridges>Sunken Beds>Zero Tillage>Raised beds at 8 WATP. This result, therefore supports the study of (Edna and Ime, 2017) who reported the evaluation of different tillage practices on growth and yield of fluted pumpkin (*Telfairia occidentalis*) in which manual ridges recorded the highest vine length among other tillage practices. This may be as a result of roots of *Telfairia occidentalis* being able to reach out to nutrients and water for development when compared with other treatments.

Table 3: Influence of tillage practices on stem girth of fluted pumpkin (*Telfairia occidentalis*).

	Stem Girth (mm)						
	Weeks After Transplanting						
Treatments	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Zero tillage	5.38[a]	5.33[a]	5.75[a]	6.25[a]	6.42[a]	6.53[a]	6.67[a]
Sunken Bed	5.93[a]	6.18[a]	6.43[a]	6.93[a]	7.02[a]	7.17[a]	7.30[a]
Manual Ridges	5.80[a]	6.00[a]	6.23[a]	6.33[a]	6.50[a]	6.67[a]	6.87[a]
Raised Bed	5.63[a]	5.90[a]	6.15[a]	6.62[a]	6.73[a]	6.93[a]	7.18[a]

Means in the same column having the same subscript are not significantly different from each other at 5% level of significance (p>0.05) according to Duncan (1955)

Stem girth is usually a good index of plant vigor, which may contribute towards greater productivity. From the above table, no significant difference (p>0.05) was observed in stem girth among other tillage methods but at the 8th week after transplanting (WATP), sunken beds had the highest stem girth, followed by raised beds while the least stem girth recorded was on zero tillage. This supports the findings of Akata *et al.*, (2017) who worked on effect of tillage practices on growth and yield of fluted pumpkin on an ultisol and stated that sunken bed improves water retention and evaporation, and keeps the soil cooler.

Table 4: Influence of tillage practices on the number of leaves of fluted pumpkin (*Telfairia occidentalis*).

	Number of Leaves						
	Weeks After Transplanting						
Treatments	2	3	4	5	6	7	8
Zero Tillage	28.17[a]	30.67[a]	34.67[a]	45.33[a]	55.33[a]	62.83[a]	77.33[a]
Sunken Bed	35.33[a]	38.00[a]	42.67[a]	50.00[a]	57.83[a]	64.83[a]	82.67[a]
Manual Ridges	26.17[a]	31.83[a]	38.00[a]	46.50[a]	50.83[a]	58.67[a]	75.83[a]
Raised Bed	30.00[a]	30.33[a]	35.50[a]	45.33[a]	50.83[a]	57.83[a]	69.67[a]

Means in the same column having the same subscript are not significantly different from each other at 5% level of significance (p>0.05) according to Duncan (1955)

Table 4 shows the influence of different tillage practice on the number of leaves of fluted pumpkin (*Telfairia occidentalis*). No significant difference (p>0.05) was observed in number of leaves among the tillage methods assessed throughout the weeks after transplanting (WATP), but at the 8th week, sunken beds had the highest number of leaves followed by manual ridges while raised beds recorded the least. The highest number observed may probably be because of how tillage exert significant influence on plant parameters and may also be due to the ample root zone that encouraged vibrant growth in the sunken bed plots against other tillage plots. This disagrees with the work of (Uwah *et al.,* 2013) who reported highest number of leaves on flat tilled tillage.

Table 5: Influence of tillage practices on the numbers of branches of fluted pumpkin (*Telfairia occidentalis*).

	Numbers of Branches						
	Weeks After Transplanting						
Treatments	2	3	4	5	6	7	8
Zero Tillage	0.33[a]	0.67[a]	1.50[a]	2.00[a]	2.50[a]	3.17[a]	3.67[a]
Sunken Bed	0.67[a]	1.50[a]	1.50[a]	2.33[a]	3.83[a]	4.50[a]	4.83[a]
Manual Ridges	0.50[a]	0.83[a]	1.67[a]	3.17[a]	3.83[a]	5.00[a]	5.67[a]
Raised Bed	0.50[a]	0.67[a]	1.67[a]	2.33[a]	3.17[a]	4.17[a]	4.67[a]

Means in the same column having the same subscript are not significantly different from each other at 5% level of significance (p>0.05) according to Duncan (1955)

Influence of tillage practices on the numbers of branches of *Telfairia occidentalis* as presented in table 5 above. At the 8th WATP, manual ridges had the highest numbers of branches, followed by sunken beds while the least was recorded on Zero tillage practice. This further reveals that *Telfairia occidentalis* will grow well to produce more branches on manual ridges similar to the study of (Akata *et al*. 2017) who researched on effect of tillage practices on growth and yield productivity of fluted pumpkin on an ultisol. The result from the table also revealed that there was no significant difference (p>0.05) observed in number of branches produced by *Telfairia occidentalis* among the different tillage methods.

Table 6: Influence of tillage practices on the foliar yield of fluted pumpkin (*Telfairia occidentalis*).

	Foliar Yield (kg)		
	Weeks After Transplanting		
Treatments	9	11	13
Zero Tillage	0.158[a]	0.032[a]	0.047[a]
Sunken Bed	0.225[a]	0.043[a]	0.047[a]
Manual Ridges	0.387[a]	0.058[a]	0.075[a]
Raised Bed	0.192[a]	0.055[a]	0.045[a]

Means in the same column having the same subscript are not significantly different from each other at 5% level of significance (p>0.05) according to Duncan (1955)

The table above shows the influence of tillage methods on foliar yield of *Telfairia occidentalis* No significant difference was observed among the treatments assessed, however manual ridges produced best all through the weeks of harvest as compared with other tillage practices followed by sunken beds, similar results was observed on zero tillage while raised beds had the least result in the thirteenth week after transplanting . This result also supports the findings of (Edna and Ime, 2017) who evaluated the different tillage practices on growth and yield of fluted pumpkin (*Telfairia occidentalis*) in which manual ridges had the highest foliar yield among other tillage practices.

DISCUSSION

Selecting the right tillage method for plant growth and yield production is among the most significant parameters affecting the productivity of agricultural fields. Tillage becomes imperative after land clearing before crops are planted even though, various forms of tillage may also be carried out while the crop is growing on the field. These could be possible through ploughing and harrowing where soils are collected into mounds, ridges and beds. The study therefore revealed manual ridges performed best in the foliar yield among the tillage practices assessed. Awe and Abegunrin (2009) reported that tillage practices have significant impact on crop production. Khurshid *et al.,* (2006) reported that among crop production factors, tillage contributes up to 20% of total crop yield. Appropriate soil tillage is considered necessary for enhanced crop production since it creates a greater soil volume for seed germination and emergence, seedling establishment and root growth (Aiyelari *et al.,* 2001). According to Keshavarpan and Rashidi (2008), soil tillage is a major cultural practice that affects soil physical properties and yield of crops. Reddy *et al.* (2007) reported that continuous tillage results in an annual disturbance and pulverization which produces finer and loose soil structure as compared to conservation and no-tillage methods whichleave soil intact.

CONCLUSION AND RECOMMENDATION

The experiment examines the influence of tillage practices on the growth and yield performance of fluted pumpkin (*Telfairia occidentalis*). The data obtained from the parameters assessed, showed manual ridges performed best in vine length and numbers of branches, while sunken bed performed best in stem girth and numbers of leaves. Although there was no significant difference ($p>0.05$) in the foliar yield of *Telfairia occidentalis*, manual ridges however recorded highest values and was therefore concluded to be the best among the tillage practices. Based on the result, it was therefore recommended that manual Ridges should be adopted by farmers on the growth and yield of *Telfairia occidentalis*. However, further studies should be conducted to fully comprehend and ascertain the effects of tillage on growth and yield of *Telfairia occidentalis* since the results obtained were not significantly different from each other.

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ABSTRACT

The main threat to food and nutrition security are climate change, world population growth, conflict and displacement, increase in demand for food, ever increasing food prices, disappearance of the variety of agriculture plant species, increase in scarcity of water, limitation of available land, food losses and food waste. The focus of this paper is on how to leverage on organic production system for sustainability of Okra consumption for improved nutrition and health. Organic agriculture generates significant environmental and developmental benefits which contributes to meaningful socioeconomic and ecologically development without compromising the health of the future generation. This is due on one hand to the application of organic principles for plant production. The consumers are desiring fewer synthetic ingredients in food which may favour Okra/plant-based products, which are usually recognized as safe/healthy in eco-friendly management. There is the need for market intervention for organic Okra at the local and international market which offers excellent advancement for enhanced livelihoods.

Keywords: Nutrition, Okra, green, organic farming, livelihoods.

INTRODUCTION

Okra is a popular vegetable with a high demand in various cuisines across the world. However, conventional methods of production, such as the use of synthetic fertilizers and pesticides, have been associated with negative environmental and health impacts. Organic farming, on the other hand, offers an alternative method of production that promotes sustainability and ecological balance. Out of the ground made the Lord God to grow every tree that is pleasant to the sight and good for food (Genesis 2: 9a.) There was no mention of any fertilizer use in fruit and tree production by God, therefore, the issue of inorganic should be ruled out in God's plant and animal production. According to Hippocrates who is considered the father of Western medicine, let food be thy medicine and medicine be thy food (Wegener, 2014).

Plants are one of the significant economic and health resources of human in most countries of the world. According to WHO (2008), more than 74% of pharmaceuticals in Africa are plant-based. Foods are the basic building blocks of living things that is required for growth, yet they may pose a threat and become harmful to human health in some situations. Several people throughout the world become ill because of the food they eat. These diseases associated with food consumption are referred to as foodborne diseases and the consequence may be from dangerous microorganisms. Foods often become harmful to human health or even fatal when combined with bacteria, mold, viruses, parasites and chemical toxins. Therefore, it is essential that consumers be provided with a safe food supply, from the farm until consumption. The factors involved in the potential threat caused by foods are inappropriate agricultural practices, poor hygiene at any stage of the food chain, lack of preventive controls during processing and preparation of the food, incorrect use of the chemical materials, contaminated raw materials, food and water and inappropriate storage. The issues of food safety are classified into three categories: food hygiene, personal hygiene of food handlers and kitchen sanitation (Uçar, Yilmaz and Çakiroglu, 2016).

Food hygiene: Several factors attend to undermine food hygiene. The hygienic quality of the foods is negatively influenced by purchasing low-quality or stale foods, storing food in inappropriate conditions, cooking large amounts of food, more than is necessary, and letting it stay in inappropriate environments, storing raw and cooked foods together and preparing, cooking and storing food using incorrect methods Meludu, (2010). When foods are contaminated at any stage, from production to consumption, the hygiene of the food is compromised, depending on the temperature, humidity and pH values of the environment it is stored in, and the food then becomes potentially harmful to human health. Infection or intoxication caused by the consumption of a contaminated food or drink is referred to as food poisoning. The causes of food poisoning are classified as microorganisms, parasites, chemicals, naturally created food toxins, naturally created fish toxins, metabolic disorders, allergic reactions and radioactive substances. More will be discussed on how to use organic system in okra production to reduce food toxin from inorganic chemical fertilizer.

Personal Hygiene of Food Handlers

The food processing stage is one of the most important stages in the food chain and those responsible for handling food in this stage assume major responsibilities in the prevention of food poisoning. The food processing staff should include healthy individuals who do not have any diseases, and they should undergo regular medical check-ups. In addition to being healthy, it is also important that the workers take particular care for their personal hygiene and execute proper food handling behaviour. This is especially important because food handlers can cause cross-contamination between raw and cooked foods, and often endanger food hygiene by improper preparation, cooking and storage of foods. Importantly, food workers may have the power to make a remarkable impact on public health. In reducing the foodborne diseases or food poisoning, the personal hygiene practices of workers at food production sites are a key factor. Proper personal hygiene is the best way to lessen the risks associated with contamination by most of the bacteria commonly considered as being responsible for foodborne diseases.

Conceptualization of Okra

Okra (*Abelmoschus esculentus)* is a member of the Malvaceae family known in many English-speaking countries as ladies' fingers or okro. It has edible green seed pods. The geographical origin of okra is disputed, with supporters of West African, Ethiopian, Southeast Asian, and South Asian origins. Cultivated in tropical, subtropical, and warm temperate regions around the world, okra is used in the cuisines of many countries (Farooq et. al., 2010).

Okra is an annual, warm-season crop that grows best in tropical and subtropical regions with temperatures between 20 and 35 °C. . It grows best in well-drained soil with a pH between 6.0 and 7.0 and requires full sun exposure to thrive. Okra plants can grow up to 2 meters tall and have a taproot system with numerous lateral roots that help them absorb nutrients and water from the soil (Singh, 2018).

The leaves of the okra plant are large and heart-shaped, with a pointed tip and a serrated margin. They are arranged alternately on the stem and can grow up to 20 cm in length. The leaves are dark green in color and have small, fine hairs on the upper and lower surfaces (Sagonoy, 2022).

The flowers of the okra plant are large and showy, with five petals that are typically yellow in color. They are about 5 cm in diameter and have a prominent central stamen with a yellow anther. The flowers are borne singly or in clusters at the axils of the leaves and are pollinated by bees and other insects.

The fruit of the okra plant is a long, narrow, tapered pod that resembles a finger or a cone. It can grow up to 25 cm in length and is green when immature, turning reddish-brown or purple as it matures. The pod is covered in small, soft spines that can cause skin irritation, and contains numerous small, round seeds.

Okra is a self-pollinating crop, meaning that it can produce viable seeds without the need for cross-pollination. The seeds are typically planted directly in the field and take 7 to 14 days to germinate. Okra plants require regular watering and fertilization throughout the growing season and are ready for harvest about 50 to 60 days after planting (Swamy, 2023)

Nutrient and medicinal value

Okra is a versatile vegetable that is used in many different cuisines around the world. It is commonly used in stews, soups, and curries, and can also be pickled or fried. It is a good source of vitamins C and K, as well as fiber, and has been shown to have potential health benefits, such as improving digestion and lowering cholesterol levels. Okra is a highly nutritious vegetable that contains a range of important vitamins and minerals, as well as other beneficial compounds. According to Gemede, *et. al*., (2015), some of the key nutrients found in okra include:

1. Fiber: Okra is a good source of dietary fiber, which is important for digestive health and canhelp to lower cholesterol levels.

2. Vitamin C: Okra is a good source of vitamin C, an antioxidant that is important for immunefunction, skin health, and wound healing.

3. Vitamin K: Okra is also a good source of vitamin K, which is important for blood clotting andbone health.

4. Folate: Okra contains folate, a B-vitamin that is important for fetal development and may helpto reduce the risk of certain types of cancer.

5. Potassium: Okra is a good source of potassium, an essential mineral that is important for bloodpressure regulation and heart health.

In addition to these important nutrients, okra also contains a range of beneficial compounds, including antioxidants and anti-inflammatory compounds. Some studies have suggested that okra may have potential health benefits, such as:

1. Lowering cholesterol levels: Some studies have suggested that okra may be able to help lower cholesterol levels, which could reduce the risk of heart disease.

2. Improving digestion: Okra contains a type of fiber called mucilage, which can help to improvedigestion and relieve constipation.

3. Supporting immune function: The vitamin C in okra can help to support immune function and reduce the risk of infections.

4. Reducing inflammation: Okra contains anti-inflammatory compounds that may help to

reduce inflammation throughout the body, which could help to reduce the risk of chronic diseases such asarthritis and diabetes.

Overall, okra is a highly nutritious vegetable that can provide a range of health benefits when consumed as part of a balanced diet.

Why Organic Okra Production

Organic okra production refers to the process of growing okra without the use of synthetic fertilizers, pesticides, or other chemicals. Instead, organic farmers use natural methods to control pests and fertilize the soil, such as crop rotation, composting, and the use of natural predators. There are several reasons why organic okra production may be beneficial:

1. Health benefits: Organic okra is free from synthetic chemicals, which means that it is healthierfor both the consumer and the environment. Studies have shown that organic foods are generally higher in nutrients and lower in toxins compared to conventionally grown foods.

2. Environmental benefits: Organic farming practices help to promote biodiversity and reduce thenegative impact of farming on the environment. Organic farmers use techniques such as crop rotation and natural pest control to promote healthy soil and reduce erosion.

3. Better taste: Some people believe that organic okra has a better taste than conventionally grownokra. This may be due to the fact that organic farming practices promote healthier soil, which canlead to better flavour and nutrient content in the produce.

4. Support for small farmers: Organic farming often involves smaller-scale operations, which canhelp to support local economies and provide income for small farmers. By choosing organic okra,consumers can help to support small farmers who are using sustainable farming practices.

Organic farming is considered one of the most consistent approaches in the family of sustainable production systems (Willer and Lernoud, 2017). Organic agriculture is a production system that aims at sustaining the health of soils, ecosystems and people. It relies on ecological processes, biodiversity, cycles adapted to local conditions, and the use of on farm and local inputs. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved. Organic agriculture is a holistic production management system that enhances the agroecosystem and people’s health, utilizing both traditional, innovative and scientific knowledge. To benefit the shared environment and promote fair relationships and good quality of life for all involved. Organic agricultural system relies on biodiversity for ecosystem management rather than the use of external agricultural inputs (IFOAM, 2016). Biological diversity is the variability of life on earth.

Works with nature to create a healthy balance between naturally available resources and farming while increasing the resilience of food systems (Obiesie *et al.*, 2022). Organic agriculture is concerned with the following:

1. Does not use chemical-synthetic pesticides and fertilizers.
2. Renounces livestock feed additives and minimizes synthetic animal drugs.
3. Excludes genetically modified organisms including seeds, plants or animals.
4. Makes best use of both traditional and new scientific knowledge to come up with the bestfarming practices that are adaptable to the local conditions and opportunities.

5. Relies on ecologically sustainable practices such as feeding the soil with organic material to improve and maintain its productivity, maximal possible disease prevention by the use of tolerant cultivars and appropriate system design and enhancement of beneficial insects to control pests.

6. Wherever possible, establishment of integrated market chains from field to fork that guarantee a fair share of the benefits of organic products to all partners in the food chain.

The principles of the International Federation of Organic Movement (IFOAM) standards are explained in detail as regards to:

1. **Health**: Organic agriculture, whether in farming, processing, distribution, or consumption, seeks to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. In particular, organic agriculture intends to produce high quality,nutritious food that contributes to preventive health care and well-being. As such, health starts with balanced nutrition that avoids or eliminates the use of chemical-synthetic fertilizers, pesticides, animal drugs and food additives that may have an adverse side effecton health and wellbeing.

2. **Ecology**: Organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature. These cycles are universal, but their operation is site-specific. Organic management must be adapted to local conditions, ecology, culture and scale. Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources. Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

3. **Fairness**: This principle emphasizes involvement in greater communities. In organic agriculture human relationships should be conducted in a manner that ensures fairness at all levels and to all parties - farmers, workers, processors, distributors, traders and consumers. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products. This principle also insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behaviour and well-being. Finally, natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations.

4. **Care**: This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture. Given the incomplete understanding of ecosystems and agriculture, care must be taken. Consequently, new technologies need to be assessed and existing methods reviewed. Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time. Organic agriculture aims at preventing significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering. Decisions should reflect the values and needs of all who might be affected through transparent and participatory processes.

ORGANIC PRACTICES IN OKRA PRODUCTION

Organic practices in okra production involve the use of natural methods for fertilization, pest control, and disease prevention. Some of the organic practices used in okra production include:

1. Composting: Composting is the process of decomposing organic matter, such as food waste and plant material, to create a nutrient-rich soil amendment. Organic farmers use compost to fertilize their crops instead of synthetic fertilizers.

2. Crop rotation: Rotating okra with other crops can help reduce pest and disease pressure, as wellas maintain soil health. Ideally, okra should be rotated with non-host crops, such as legumes, grains, or brassicas

3. Natural pest control: Organic farmers use natural methods to control pests, such as planting pest-resistant varieties, using beneficial insects to control pests, and using natural repellents such as garlic and neem oil.

4. Cover crops: Cover crops are plants that are grown to protect the soil and improve soil health. Organic farmers plant cover crops between growing seasons to prevent erosion and improve soil fertility.

5. Mulching: Mulching involves covering the soil around the okra plants with a layer of organic material, such as straw or leaves. This helps to conserve moisture, suppress weeds, and improve soil health.

6. Avoiding synthetic chemicals: Organic farmers do not use synthetic fertilizers, pesticides, or herbicides in their production of okra. Instead, they use natural methods to control pests and fertilize the soil.

These organic practices help to promote healthy soil and a healthy environment, which in turn leads to healthier, more nutritious okra. By using these practices, organic farmers can produce high-quality okra without compromising the health of the environment or the consumer.

CONCLUSION AND RECOMMENDATIONS

There is no doubt on whether organic agriculture is a viable alternative to poor environmental management/pollution and conventional farming to reduce harmful toxins in foods. It is an alternative for the domestication of medicinal plants. Organic agriculture generates significant environmental and developmental benefits. It can contribute to meaningful socioeconomic and ecologically sustainable development, especially in poorer countries. This is due on one hand to the application of organic principles, which means efficient management of local resources effectiveness. At the same time, the market for organic products – at the local and international level – has tremendous growth prospects and offers excellent opportunities to improve livelihoods for farmers all over the world. The consumers are desiring fewer synthetic ingredients in food which may favour Okra/plant-based products, which are usually recognized as safe/healthy in eco-friendly management. There is the need for market intervention for organic Okra at the local and international market which offers excellent advancement for enhanced livelihoods.

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Comparative Study of Liquid Organic Fertilizer Effect on the Growth and Yield of Sweet Potato *ipomea batata (l.) Lam.* In Ozoro, Nigeria

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ABSTRACT

An experiment was conducted at the Delta State University of Science and Technology Ozoro, Faculty of Agriculture organic research farm to examine different levels of liquid organic fertilizers (sweedga) on the growth and yield of Butter milk sweet potato Ipomea batata. The levels were 0ml (control), 15mls, 30mls and 45mls replicated four times in a randomized complete block design within an area of 15m x 15m making a total of 225m^2. Stem girth, number of leaves, length of vines and number of branches were taken at 2 weeks interval from 4 weeks, 6 weeks and 8 weeksafter planting, while the yield of tubers was measured at the 16th week after planting. All the parameters observed were subjected to Analysis of Variance (ANOVA). There was no significant difference (P> 0.05) in tuber yield among the four levels of liquid organic fertilizer used. But therewas a significant difference (P< 0.05) in the stem girth, number of leaves, length of vines and number of branches among the four levels of liquid organic fertilizer used. On the growth parameters, 30mls liquid organic fertilizer proved highest among the other levels in girth thickness 2.0cm, number of leave 116, length of vine 150cm and number of branches 12; therefore it is recommended for use by farmers.

Keywords*:* Liquid organic Fertilizer (sweedga)

INTRODUCTION

Sweet potato is one of the most important root tubers produced throughout the world today, with china being the largest producer of 788 million tonnes per year with an average yield of 22 tonnes per hectare. While Nigeria is the highest producer in Africa with an annual output of 3.45 millions tonnes and globally the largest producer after China and Malawi (FAO STAT 2017). Sweet potato is so important because all the plant parts which includes leaves, vines and root tubers are used as food, for humans, feeds for animals raw materials for industrial purposes, and as medicines. (Nebunchezhiyan, Byju and Dash 2010). It is relatively drought-resistant, high yield potential, wide adaptability and low input requirement. (Nhanala and Yencho 2021).

Musenbi, Githiri, Yencho and Sibiya 2015). Belongs to the botanical family of convolvulaceae commonly called morning glory and the only member of the genus *Ipomoea* (Wardell, 2006).

According to Somasundaram and Udhaya (2018) Organic manures are the materials derived from animal, human and plant residues which contain plants nutrients in complex forms. Manures with low nutrient content per unit quantity have longer residual effect besides improving soil physical properties compared to fertilizer with high nutrient content.

The liquid organic fertilizer used in this case is called the sweedga a herbal plant growth regulator made from sea weed (*sargassum*) formulated to help the plant enhance its growth and floral initiation, induce resistance against pests and diseases, promote new roots and leave development. Therefore the objective of the study is to determine the quantity and level of liquid organic fertilizer used in producing the best growth and yield of sweet potato variety.

MATERIALS AND METHOD

Site of Experiment: The research work was conducted at the Faculty of Agriculture Organic Research Farm, Delta State University of Science and Technology Ozoro, under ram fed condition during the 2022 planting season. Ozoro is located at latitude 5^{o}30'N and longitude 6^{o}50'E lying immediately Northof the coastal swamp regions of West Niger Delta. The climatic condition is humid with a mean annual rainfall of between 2000 – 3000 mm. The mean annual temperature is between 25^{o}C – 30^{o}C and a relative humidity range of 75 – 100% with dry and rainy seasons (NIMET 2019). The soil of the area is a well drained acidic loamy soil.

Land Preparation and Duration: The field experiment was carried out in one cropping season approximately 16 weeks in acleared and ridged heap of 1mx1m distance each.

Layout size of the Experiment: The area size of the experiment was 15m x15m giving a total of 225m^2. The plot size was 2m x 3m for each four levels of the required organic fertilizer used replicated four times giving a totalof 16 plots.

Preparation procurement (vine cuttings): Improved variety of sweet potato cultivars was purchased and obtained from the National Root Crop Research Institute (NRCRI) Umudike Abia State. The variety being Butter milk (milk colourskin and flesh).

Planting Method: A vine cutting of 20cm containing 3 nodes were used for the planting.

Data Collection

Girth Size: This was measurement using vernier calliper at 4 weeks after planting and subsequently taken forth nightly, that is every 2 weeks at 1cm above the ground level.

Length of Vines: This was obtained by measuring the sampled plant vine length with a tape rule at 4, 6 and 8 weeks interval.

Number of Branches: Done by counting the branches per plant.

Number of Leaves: Taken by counting the number of leave present in each stand.

Tuber Yield: This was determined by weighing the tubers after harvesting at 16 weeks after planting with a camry sensitive scale.

Experimental Design: A Randomized Complete Block Design was used.

Statistical Analysis: Data collected was subjected to the Analysis of Variance (ANOVA)

RESULTS AND DISCUSSION

Stem Girth Thickness

The stem girth thickness at various weeks after planting at two weeks interval, are show in table 1 below within a progressive increase in liquid organic manure levels. The 30mls was highest atthe eight week with 2cm thick.

Table1: Stem Girth Thickness (cm) of sweet potato at various weeks after planting.

Treatment	4WAP	6WAP	8WAP
0ml	0.2	0.6	1.2
15mls	0.2	0.3	0.9
30mls	0.2	0.5	2.0
45mls	0.2	0.7	1.2

Number of Leaves
The number of leaves with liquid organic fertilizer was highest at level 30mls having 116 at the eight weeks.

Table 2: numbers of leaves of sweet potato at various weeks after planting

Treatment	4WAP	6WAP	8WAP
0ml	24	52	37
15mls	19	51	66
30mls	26	59	116
45mls	30	54	110

Length of Vines
The length of vine at various weeks after planting was highest at 30mls level of liquid organic manure of 150cm as shown in table 3 below.

Table 3: length of vines (cm) of sweet potato at various weeks after planting.

Treatment	4WAP	6WAP	8WAP
0ml	40	86	111
15mls	39	79	128
30mls	43	75	150
45mls	52	72	133

Number of Branches
The number of branches was highest with 30mls levels of liquid organic manure application as shows in table 4 below.

Table 4: Number of branches of sweet potato at various weeks after planting.

Treatment	4WAP	6WAP	8WAP

0ml	3	5	8
15mls	4	6	10
30mls	3	7	12
45mls	3	6	10

Tuber Weight in (kg) of Sweet Potato at 16 weeks

At 16 weeks after planting, sweet potato tubers were harvest, the least were already yellowish and reducing in numbers, vines looking old and branches harder in texture. The 45mls level of liquid organic fertilizer proved superior having 4.3kg followed by 15mls 4.2kg, 30mls 3.3kg and 0ml 2.6kg respectively as shown in table 5 below.

Table 5: Weight of Sweet Potato Tuber at 16 weeks after planting

Treatment	0ml	15ms	30mls	45mls
Rep 1	1	0.5	0.7	1.5
Rep 2	0.6	3.3	0.7	0.7
Rep 3	0.7	0.3	1.4	0.3
Rep 4	0.3	0.1	0.5	1.8
Total	**2.6**	**4.2**	**3.3**	**4.3**

Table 6: Effect of Liquid Organic Fertilizer Levels on the Growth and Yield Parameters of Sweet Potato after 16 Weeks Planting

Treatment	Stain Girth	Number of Leaves	Length of Vines	Number of Branches
0ml	**0.5^{c}**	**37^{c}**	**79^{c}**	**5^{b}**
15ml	**0.7 ^{bc}**	**45^{bc}**	**82^{bc}**	**6^{ab}**
30ml	**0.9^{a}**	**67^{a}**	**89^{a}**	**7^{a}**
45ml	**0.9^{a}**	**64^{ab}**	**86^{ab}**	**6^{ab}**

Leaves having the same letter along the columns indicates no significant difference using theLeast Significant Difference of 5% probability level.

DISCUSSION / RECOMMENDATION

There was a steady increase from 2 weeks after planting to 8 weeks between the four different levels of liquid organic fertilizer as was shown in the tables of the parameters taken which are stem girth thickness, number of leaves, length of vines, and the number of branches. When subjected to analysis of variance there was a significant difference ($P<0.05$) among the four levels of liquid organic fertilizer application. But at 16weeks harvest of the tubers, there was no significant difference ($P>0.05$) among the liquid organic fertilizer used. But the weight in kg was highest in 45mls application (4.3 kg) followed by 15mls application (4.2 kg), 30mls application (3.3 kg) and 0.ml (control) 2.6kg. Therefore, all levels did well in tuberization but in stem girth thickness, number of leaves, length of vines and number of branches, 30mls was highest among the four levels of liquid organic fertilizer used. By this 30mls level of liquid organic fertilizer (sweedga) is recommended for use by farmers.

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Evaluation of Cowpea Genotypes for Drought Tolerance Using Seedling Survivability and Growth Response as Selection Criteria for Breeding

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ABSTRACT

Drought is one of the key constraints to cowpea production. This is further aggravated by the ever-changing global climate and the concomitant effects such as erratic rainfall pattern. Among abiotic stresses, drought is the most important. It has a great impact on crop growth and productivity worldwide. However, little is known about the drought-tolerant genes in cowpea. Hence, this study aimed at providing information on the performance of cowpea genotypes under drought stress with a view to identify genotypes that are tolerant as well as to identify selection criteria for easy identification of drought tolerance under drought-stressed conditions. The experiment was carried out at two locations: screen houses of the Department of Crop, Soil and Pest Management, The Federal University of Technology Akure (FUTA) and Department of Crop Science, University of Nigeria, Nsukka, from January 2019 to April 2019. The experimental design was a split-plot in completely randomized design with three replications. Watering regimes (well-watered and drought-stressed) were placed in the main plots and genotypes (fifteen cowpea genotypes) in the subplots. Data were collected on the number of yellow or green leaves, plant height, number of leaves, wilted leaves, and dead plants. The results indicated that seedling survivability, plant height, number of leaves, and leaf water potential were the most important traits for screening drought tolerance at the seedling stage. On the basis of these indices, FUTA MT/ABL 04, FUTA MT/ABL 02, FUTA MT/BROWN 02, FUTA MT/ABL 06, FUTA MT/ABL 08, ZARIA, FUTA MT/ABL 07 and FUTA MT/WHITE W1 were identified as the most drought-tolerant. Collectively, results suggested that selection by combining seedling survivability, growth response, and leaf water potential can be efficiently used for rapid evaluation of drought tolerance in cowpea breeding.

Keywords: Drought stress, Genotypes, Survivability, Watering regimes, cowpea

INTRODUCTION

According to Rogério (2010), the genetic potential for drought tolerance in cowpea within Nigeria's smallholder sector is yet to be fully exploited. As a cheap source of protein, vitamins, and minerals, cowpea enhances the quality of cereal-based diets with its high lysine content combined with cereals' high content of methionine and cysteine (Boukar *et al*., 2018). Cowpea grain is an important source of protein (23.4%) and is commonly used to prepare various snacks and meals, making it a staple in the Nigerian diet (Osho and Olasanmi, 2019). The crop also provides a vital source of income for farmers and seed traders in drought-prone areas (Boukar *et al*., 2018). In developing countries in the tropics, cowpea is also a source of employment for many people.

To create drought-tolerant genotypes, a thorough understanding of plants' mechanisms and responses to water-deficient conditions is essential. The mechanism of drought tolerance is complex and depends on factors such as crop species, drought intensity, duration, and growth stage

(Mir *et al*., 2012). The survival of plants under drought stress involves three mechanisms: escape, tolerance, and resistance (Ahmad *et al*., 2015, 2017). In the escape mechanism, the plant completes its life cycle before drought sets in. Tolerance mechanisms involve plants competing with drought by reducing transpiration rate and closing stomata, while resistance mechanisms involve the plant sustaining normal growth by increasing photosynthetic pigments and maintaining root-to-shoot ratios for optimal distribution of assimilates (Ashfaq *et al*., 2016).
The vigor of seedlings is a crucial index in determining a plant's yield in a short time (Noorka *et al*., 2013). A genotype with drought tolerance has more impermeable roots that help conserve soil moisture and minimize the impact of drought during growth (Zhang and Wang, 2012). The root and first dicotyledonous leaves of the cowpea plant are mainly affected by water shortage. Maximum root length indicates the availability of moisture from deeper soil layers and contributes to adaptation to water-deficient conditions. Root length in the seedling stage is a key genetic trait for increasing yield under drought. Seedling growth under drought stress can vary among varieties (Ahmed *et al*., 2019).
The selection of cowpea varieties with the best performance under water stress environments can increase production in rainfed areas. Various methods have been designed for screening cowpea genotypes for drought tolerance, including root-to-shoot ratio and relative water content as selection criteria (Slabbert *et al*., 2004). The relative water content (RWC) is a good criterion for selecting drought-tolerant cowpea varieties, as it shows the balance between water absorbed by the plant and water lost through transpiration (Souza *et al*., 2004). Both normal and water-deficient conditions were evaluated for cowpea genotypes, and those with optimum RWC and root/shoot length performed best and were considered drought-tolerant genotypes (Slabbert *et al*., 2004). Selecting cowpea varieties based on seedling traits is easy, cheap, and requires less labor.
In the present work, the combination of seedling survivability and seedling growth response was tested as a screening criterion for drought tolerance in cowpea. The objective was to evaluate fifteen genotypes of cowpea for drought tolerance at the seedling and vegetative stages.

MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research Farms of the Department of Crop, Soil and Pest management, The Federal University of Technology Akure (FUTA) and Department of Crop Science, University of Nigeria, Nsukka (UNN) during the 2019 dry seasons. The farms were located at an altitude of 332 m above sea level, latitude $07^{0}16^{1}$N, longitude $05^{0}12^{1}$E in rainforest southwestern region, and at 447.2 m above sea level, latitude $06^{0}52^{1}$N, longitude $07°24^{1}$E in the derived savannah agro-ecological zone of Nigeria respectively. Fifteen cowpea genotypes were used for this study. The experiment was a split-plot in randomized complete block design arrangement with three replications. Watering regimes (well-watered and drought-stressed) as the main plot treatment and genotypes (fifteen cowpea genotypes) as the subplot treatment. The experiment is grouped into two. Seeds were sown in pots filled with topsoil and water was applied in line with experimental design.
Experiment 1 evaluated the genotypes for drought stress tolerance at seedlings stage. After sowing the pots were well-watered, thereafter no water was applied again. Seedling survivability was used as a criterion for evaluation in this stage.
Experiment 2 evaluated the genotypes for drought stress tolerance at the vegetative stage. The pots were watered twice daily (morning and evening) for 2 weeks until the seedlings were well established. Thereafter, no watering was done for 30 days. Data were collected on the number of yellow leaves, the number of green leaves, number of wilted leaves and the number of dead plants.

Statistical Analysis

Descriptive statistics were applied to analyze and organize the resulting data. All the statistical calculations were performed using GraphPad Prism Version 6.01.

RESULTS

Seedling survivability as selection criteria for drought

Seedling survivability as a selection criterion for drought tolerance among cowpea genotypes at Nsukka and Akure is shown in Figures 1 and 2, respectively. In the seedling survivability experiment, the stress effect (wilting) started a few days after sowing. The withering of the leaves progressed from the top to the bottom, starting with yellow tips, turning brown and eventually drying out completely. This process advanced from older to younger leaves. Genotypic differences became more prominent with increasing days of water stress.

The contour line was used to explore the percentage survivability of the genotypes. Percentage survivability ranges from 33% to 100%. OLOYIN, ZARIA, FUTA MT/BROWN 02, FUTA MT/ABL 05, FUTA MT/ABL 03, genotypes had 100% survivability at 1WAP while FUTA MT/ABL 02 and FUTA MT/ABL 07 had 0% survivability. At 2 WAP only ZARIA and FUTA MT/BROWN 02 had over 60% survivability at Akure (Figure 1). At Nsukka (Figure 2), percentage survivability showed that all the cowpea genotypes had 100% survivability except for FUTA MT/ABL 08 that had the lowest percentage survivability of 30% and OLOYIN, IFE BROWN, FUTA MT/BROWN 01, FUTA MT/BROWN 02, and FUTA MT/ABL 05 which genotypes recorded over 60% survivability. It was recorded that across these two genotypes ZARIA and FUTA MT/BROWN 02 had higher survivability and performance better, follow by genotype FUTA MT/WHITE W1, FUTA MT/BROWN 01,03,04, and 06.

Cowpea Responses to Drought Stress at Vegetative Stage

Survivability of the cowpea genotypes at vegetative stage, as selection criteria for drought among genotypes at Nsukka and Akure are shown in Figures 3 and 4 respectively. At Nsukka, substantial variation in response to water stress at the vegetative stage was observed among the cowpea genotypes. Percentage survivability ranged from 33% to 100%. ZARIA, FUTA MT/ABL 06, FUTA MT/ABL 04 and FUTA MT/ABL 01 genotypes had 100% survivability while IFE BROWN, FUTA MT/BROWN 01 and FUTA MT/ABL 05 had 0% survivability. FUTA MT/ABL 02, FUTA MT/BROWN 02, FUTA MT/White W1, FUTA MT/ABL 07, and FUTA MT/ABL 08 genotypes had over 60% survivability (Figure 3).

The effects of water stress on the number of leaves and plant height at the vegetative stage, as selection criteria for drought among genotypes at Akure, are shown in Figure 4. Under stressed water conditions, all the stressed cowpea genotypes had about one leaf in the first week. In the second week, IFE BROWN had the highest number of leaves with a mean of 3.8, while FUTA MT/ABL 04 had the lowest number of leaves (less than 2). FUTA MT/BROWN 03 and FUTA MT/ABL 07 had the highest plant height at both first and second weeks (8 and above). OLOYIN, IFE BROWN, FUTA MT/BROWN 01, FUTA MT/WHITE W1, FUTA MT/ABL 05, FUTA MT/ABL 06, FUTA MT/ABL 03, FUTA MT/ABL 04, and FUTA MT/ABL 08 had plant heights above 6 cm at both first and second weeks, while ZARIA and FUTA MT/BROWN 02 had the shortest plant heights of less than 6 cm at the second week.

Meanwhile, under unstressed water conditions, OLOYIN, FUTA MT/BROWN 03, FUTA MT/ABL 06, and FUTA MT/ABL 03 gave the lowest number of leaves (2) at the first week, while IFE BROWN had the highest number of leaves (3 and 4) at the first and second weeks, respectively. Meanwhile, the ZARIA genotype gave the lowest number of leaves (less than 2) at the second week. The genotypes showed a similar trend in plant height at both the first and second weeks, which were significantly higher than the stressed plants. FUTA MT/ABL 02 had the highest plant height (12 cm), while OLOYIN had the shortest plant height (8.2 cm) at the first week.

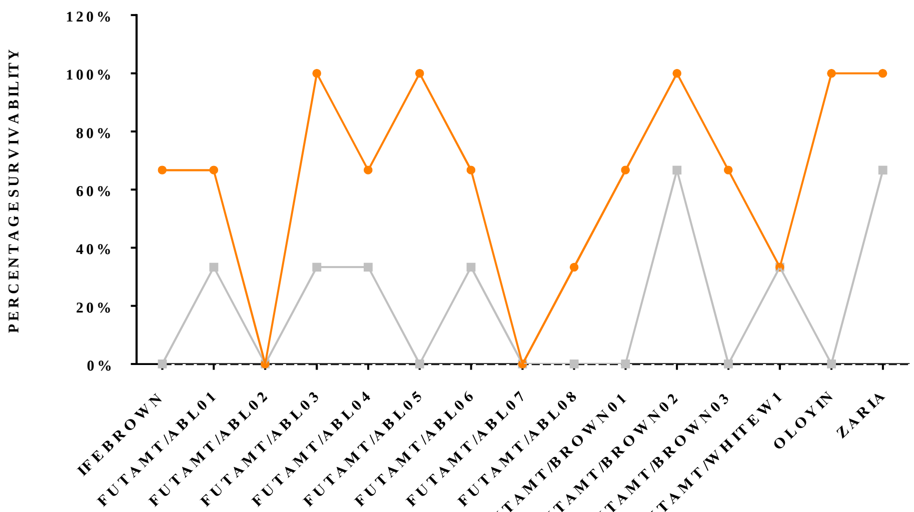

Figure 1: Percentage survivability in different cowpea genotypes subjected to Drought stressed at seedling stage in Nsukka

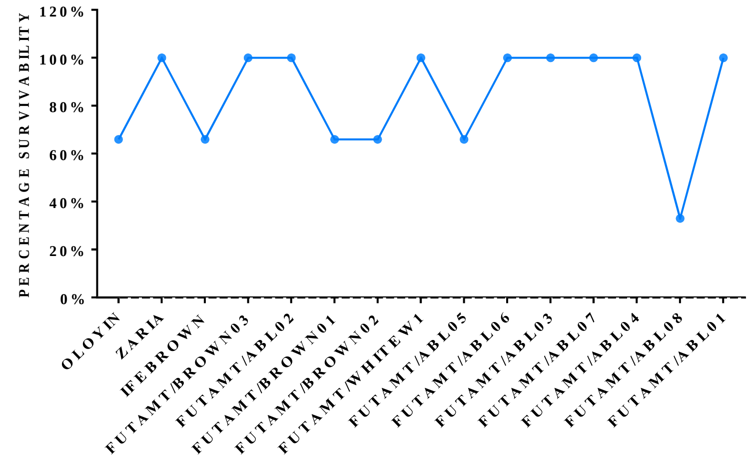

Figure 2: Percentage survivability in different cowpea genotypes subjected to Drought stressed at seedling stage in Akure

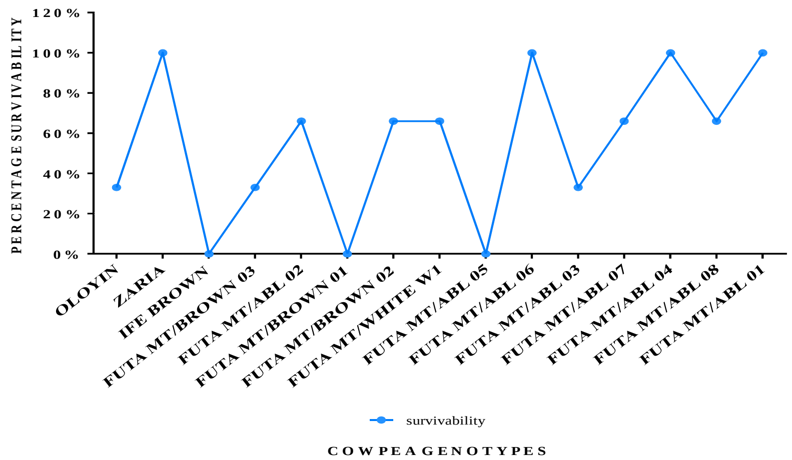

Figure 3: Percentage survivability in different cowpea genotypes subjected to Drought Stressed at vegetative Stage in Nsukka

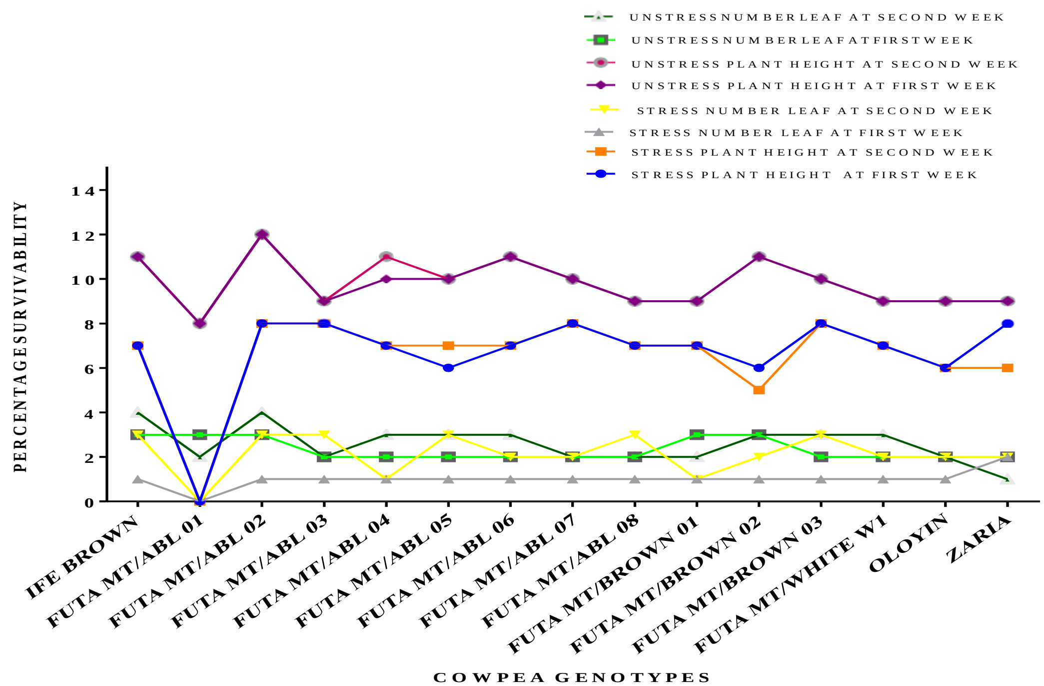

Figure 4: Percentage survivability in different cowpea genotypes subjected to Drought stressed at vegetative stage in Akure

DISCUSSION

The need for drought resistance crop with good yield and less water requirement is important due to global warming and climatic change. The survivability rate of cowpea seedlings is an important criterion for the selection of drought-tolerant genotypes for different locations. The results of the study implied that there was 100% seedling survival of the cowpea genotypes at one week after planting. This may be attributed to soil water reserve after initial watering and smaller transpiring leaf area of the germinated seedlings. This finding provides evidence for the usability of seedling survivability as selection criteria for drought tolerance, which is in accordance with the reported works on high efficacy of seedling survivability as a screening method for selecting drought-tolerant cowpea (Singh *et al*., 1999a) and wheat (Tomar and Kumar, 2004) varieties (Kaium, *et al*, 2021). At two weeks after planting, ZARIA and FUTA MT/BROWN 02 genotypes maintained high survival rates, indicating genotypic differences with increasing days of water stress. Genotypes that withered earlier also showed poor seedling survivability. Based on high seedling survival, seven cowpea genotypes, i.e. ZARIA, FUTA MT/WHITE W1, FUTA MT/ABL 06, FUTA MT/ABL 03, FUTA MT/ABL 04, FUTA MT/ABL 01, FUTA MT/BROWN 03 and FUTA MT/BROWN 02, showed better drought tolerance, which was further confirmed by seedling growth response studies. Similarly, the leaf death score of seedlings has also been used in rice breeding programs as a selection index for drought resistance (Mitchell *et al*., 1998, Binodh Asish, *et al*., 2023). Hameed *et al*. (2010) reported seedling and vegetative survivability as selection criteria for drought resistance in wheat. Watanabe *et al*. (1999) reported screening of accessions in pots at the seedling stage as a viable and effective means of identifying drought-tolerant varieties, which is confirmed by this study. The decrease in the percentage survivability rate from one week to two weeks suggested that cowpea seedlings, especially the most susceptible ones, would find it difficult to regrow and recover. They also indicated that seedlings must maintain stem greenness to be able to recover from drought and resume growth. A similar conclusion was reached by Muchero *et al*. (2018) and Ajayi *et al*. (2017), who maintained that stem greenness is a trait of importance in screening for drought tolerance in cowpea. Drought stress induces differential physiological, morphological, biochemical, and gene expression responses in crops (Wang and Huang, 2004; Dai Maohua *et al.*, 2023).

During the vegetative stage, the percentage survivability of cowpea genotypes ranged from 33% to 100%, indicating substantial variation in response to water stress.

There was variability in the percentage survivability rate during the vegetative stage among genotypes. Sapaki *et al* (2013) and Kerbauy (2004) reported that leaf and plant growth reductions during the vegetative phase were due to water deficit in the soil. The number of leaves of cowpea genotypes grown under unstressed water conditions was significantly higher than that of stressed water conditions. The responses of plant growth parameters to soil moisture stress in the study showed that plant height and the number of leaves were significantly decreased with increasing soil moisture stress. However, cowpea genotypes cultivated under stressed conditions compared to irrigated conditions were shown to have substantial resistance to vegetative-stage drought, with the IFE BROWN producing the highest number of leaves. The virtual reduction in the use of water by plants for processes such as leaf production after the suspension of irrigation is a strategy to conserve water since stomatal closure prevents photosynthesis and, therefore, plant growth. During this occasion, there is a slowdown of the actions toward photoassimilates to form new leaves (source), and the reproductive structures become the main sink. However, the following genotypes showed a higher survivability rate and a low number of leaves during the vegetative stress period at both locations: ZARIA, FUTA MT/WHITE W1, FUTA MT/ABL 02, FUTA MT/BROWN 02,

FUTA MT/ABL 06, FUTA MT/ABL 07, FUTA MT/ABL 04, FUTA MT/ABL 08, and FUTA MT/ABL 06. The results were consistent with previous studies in cowpea, which also identified leaf wilting within the first week of water stress (Mwale *et al*., 2017; Singh *et al*., 2023). Although some genotypes had an average but low survivability rate, they were able to fully recover after rehydration. This was attributed to Type 2 drought tolerance mechanisms that most genotypes had (Pungulani, 2014). These genotypes derived water from their lower canopies to support apical meristematic growth during water stress. Similarly, a reduction in leaf production and/or an increase in leaf senescence and abscission due to water stress have been reported (Abidoye, 2004).The reduction in leaf production and/or increased leaf senescence results in the decreased numberof the leaf, which might be a drought avoidance mechanism.

There was a significant reduction in plant height in all genotypes grown under stressed conditions compared with their corresponding genotypes under unstressed conditions during the vegetative stage. Similar results have shown that plant height in cowpea decreases under water stress (Abayomi and Abidoye, 2009). Other researchers have also demonstrated that water deficit during the vegetative phase causes reductions in leaf and plant growth (Kerbauy, 2004). Del Rosario *et al*. (2003) reported a similar reduction in plant height in maize seedlings due to drought. The reduction in plant height of the cowpea genotypes under extreme moisture stress may have been due to reduced turgor, which affected cell division and expansion, as growth involves both cell growth and development. The reduction in leaf and plant growth has been attributed to a decrease in cellular expansion resulting from a decrease in plant water content and turgor due to water stress (Kramer and Boyer, 1995; Shravani, and Bhandari, 2023).

These simple physiological traits deserve attention while screening cowpea for drought tolerance. In conclusion, this study proves that seedling survivability, plant height, number of leaves, and leaf water potential are useful indices for the rapid evaluation of drought response in cowpea breeding.

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Control of fungal wilts of pepper (*Capsicum annuum* L.) caused by *(Fusarium oxysporumf.sp capsici*) using different organic amendments in Umudike, Abia-state, Nigeria.

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ABSTRACT

The research study was conducted in the screen house of the Crop and Soil Sciences, Michael Okpara University of Agriculture, and the Plant Pathology Unit of the National Root Crops Research Institute, Umudike both in Abia-state, Nigeria on the Control of fungal wilt of pepper (*Capsicum annuum* L.) incited by (*Fusarium oxysporum f.sp capsici*) using four different organic amendments namely; goat manure, poultry droppings, saw dust and wood ash. The experiment was laid out in a Completely Randomized Design (CRD) with five (5) treatments and three (3) concentrations replicated three times and the data collected was analysed using Anova with Genstat 2007 version. The effect of the various concentrations (100,200, 300 g/ml) of the treatments, showed that saw dust and wood ash most significantly (P>0.05) reduced the radial mycelial growth of the test organism *in-vitro* when compared to the poultry droppings, goat manure and the control. The result also showed that saw dust (100mg/l) and goat manure at (200mg/l) concentrations were more effective in inhibiting the radial mycelial growth of the pathogen in culture than the other treatments. It was also revealed from the result that pepper seedlings treated with wood ash 1-4 weeks after inoculation significantly inhibited the radial growth of the pathogen. Poultry manure(18.00cm,19.00cm) gave the highest maximum number of leaves at week 1and 2 as well as plant heights (23.10cm,26.30cm) at week 3 and 4 respectively when compared with others treatments. Therefore, these organic materials (poultry droppings, wood ash, saw dust) which are eco-friendly, cheap, easy to prepare and readily available to poor resource farmers proved potent in controlling the wilt disease in the screen house and also reduced effectively the radial mycelia growth of the test pathogen *in-vitro*.

Keywords: Pepper, organic amendments, *Fusarium oxsporum, wilt, concentrations*

INTRODUCTION

Pepper (*Capsicum annuum* L.) is one of the most economically vegetable crops in Nigeria and in the world, belonging to the family Solanaceae. Pepper is also important because of the nutritional value of its fruits, it is an excellent source of natural colours and antioxidant compounds (Nevarro *et al.*, 2006). In many Nigerian diets, pepper accounts for a large source of vitamins A and C which is responsible for red colour in mature fruit, it could be utilized in the dry state as spice, and it contains an alkaloid, a digestive stimulant that is used in ointment treatment of arthritic and neuropathic pains (Grubben and Tahir, 2004). In 2003, FAO estimated pepper production in Nigeria at 715,000 metric tons from total area of about 90,000 hectares.

The major limiting diseases of most peppers in the world are the phytopathogenic fungi, (Melanie and Sally, 2004). Grubben and Tahir (2004) reported fungi which cause wilt and are associated with fruits of pepper which also limits its production in the world includes *Fusarium* spp, *Verticillium dahliae,* other fungal pathogens are *Aspergillus niger, Aspergillus flavus, Penicillium digitatum* and etc (Balogun *et al*., 2005). The *Fusarium* wilt disease, caused by the soil-borne fungus, *F. oxysporum* f. sp. *capsici* is the most important disease on pepper plants which reduces growth, fruit yield, quality, and production (Wongpia & Lomthaisong, 2010). *F. oxysporum* is difficult to control as it survives in the field soil for several years. Commercial fungicides used to control outbreaks of most crop disease have been studied to be hazardous to humans, animals and the environment (Nevarroet *et al*., 2007). Organic amendments, such as animal manures and composts, were commonly used in the past for agricultural production due to their value as fertilizers and for their ability to improve plant health. The widespread availability of chemical fertilizers and pesticides led to the replacement of those organic materials by these highly effective and inexpensive synthetic agrochemicals (Lazarovits, 2001). At present, however, there is an increasing interest, intensified by environmental concern, in the replacement of synthetic agrochemicals with organic amendments, which are experiencing resurgence in popularity as efficient and environmentally friendly alternatives to chemical fertilizers and pesticides (Lazarovits, 2001). The effect of the organic amendments on soil physical, chemical and biological parameters has been widely studied. The improvement of soil quality through organic amendments has also proved effective on crop production and plant health, and some of these effects have been related to the enhancement of soil suppressiveness against soil-borne pathogens. However, the beneficial effects of organic materials on different aspects of plant health have been widely reviewed by several authors (Bailey *et al., 2003*; VanElsas*et al., 2007*; Noble *et al*., 2005). Different works have shown that organic amendments to crop soils can increase plant growth, reduce disease incidence and severity and also crop yield both in herbaceous and woody plants such as pepper, maize, wheat and avocado (Roy *et al., 2010;* Yan *et al.,2010;*Hermoso *et al., 2011*). The objectives of the study therefore were to**;** isolate and identify fungal pathogens associated with pepper wilt in Umudike, **t**o determine the effect of the different organic amendments sources against the isolated pathogens *in-vitro* and *in-vivo* **a**nd also to evaluate the effect of the different sources of organic amendments on the two growth parameters of the pepper seedlings.

MATERIALS AND METHODS

The experiment was conducted in the screen house of the Michael Okpara University of Agriculture Umudike, Abia State, Nigeria. Umudike located at latitude 5° 28¹ north and longitude 7° 35¹ and an altitude of 112m above sea level with an annual rainfall of 1916m, and relative humidity of 76% and temperature range of 25-35°C. With an annual rainfall of about 2200mm distributed over eight month period (March – November) an evaporation rate of 1531mm and the soil type is sandy loamy soil. (NRCRI, Umudike Meteorological Station, 2020).

Poultry and goat manures were sourced from the animal rearing unit of the Michael Okpara University of Agriculture, Umudike, saw dust from the timber market Ahiaeke, Umuahia, while the wood ash was collected from the local community in Umudike. The manures were air-dried on the laboratory bench for two weeks. Coarse particles were removed, ground with power mill, sieved through a 2mm screen before bagging in polythene bags and kept until required.

The pepperseedlings were first raised in the nursery, which consisted of top soil, organic manure and river sand.

The topsoil was sterilized using heat method for 45 minutes at a temperature of about 60◦c, and allowed for two weeks to cool before being mixed with other components. The pepper seedlings were sown to a depth of about 4mm, the seeds were drilled at about 5cm apart, and thenthe drills were covered with a thin layer of sandy soil and highly watered. Transplanting was doneearly in the morning at 4 weeks after sowing and well watered.

The experiment was arranged in a Completely Randomized Design (CRD) with each treatment replicated four (4) times, the different treatments assayed were; poultry manure, goat manure, wood ash, saw dust and control. Goat and poultry manure, saw dust and ash were applied three (3) times at two (2) weeks intervals at the rate of 50g/stand in a ring form.

Data collected included; plant height (cm), number of leaves, radial mycelia growth and percentage inhibition of the test fungi.

Effect of plant extract on mycelia growth on the test fungi was studied using the food poisoning technique (Songoyomi, 2004). One milliliter of each plant extract concentrations (25%, 50%, 75% and 100%) was dispensed per Petri dishes and 9ml of the media (PDA) was added to each of the Petri dishes containing extract and carefully spread evenly over the plate, this gave rise to PDA extract mixture with corresponding 250mg/ml, 500mg/ml, 750mg/ml and 1000mg/ml extract concentrations. These were used for the inhibition of mycelia growth. The plates were gently swirled for even dispersion of the extract. The agar extract mixture were allowed to solidify and then inoculated at the centre with a 4mm diameter mycelia disc obtained from colony edge of 7 days old pure cultures of test fungi. Each treatment consists of four replications. The negative control set up consists of blank agar plate (no extract) as described above. Petri dishes dispensed with (PDA) and one ml of sterilized distilled water inoculated with each test fungi is served as the control. All plates were incubated at 28±2°C for five days and examined daily for growth and presence of inhibition. Colony diameter was taken as mean growth along two direction on the reverse side of the plates. The effectiveness of the different organic materials was recorded.

Pathogenicity test

Spore suspension of *Fusarium oxysporium* f. sp *capsici*) isolated from wilt infected pepper from the Research farm was prepared and adjusted to 1.0 x 10^6 spore/ml (Amini, 2005). The spore suspension was used to inoculate the healthy seedlings of pepper seedlings which were susceptible to the *form species* (Bost, 2005). Inoculation was done by inflicting wounds with a sterile needle at the base of the healthy transplanted pepper seedlings and kept well watered. The poly bags were maintained in a screen-house at about 70% relative humidity and $28^0 \pm 2^0$C. Symptom of the disease after 4 weeks showed successive yellowing of the lower leaves, abscission, drooping, wilt and death of seedlings. The infected seedlings (roots, leaves and stems) were later cut, washed severally and plated on fresh molten PDA and incubated at 28^0C. The identity of the isolate, re-isolated from the infected tissues were confirmed after slides of the isolates were mounted and viewed using a compound microscope; and ascertained to have the same characteristics with the ones previously isolated from the research farm specimens.

***In Vitro* Experiment**

One (1) grams of each organic sources namely; (poultry waste, wood ash, saw dust, goat waste and control (sterile water) were soaked in 10mls of sterile distilled water in a sterile conical flasks and well covered. Each suspension was hand shaken intermittently and allowed to stand for 6 hoursOne (1) ml of each suspension was dispersed into sterile Petri plates containing 9 ml of molten PDA media and carefully swirled for even distribution. The organic waste mixture was allowed tosolidify and then inoculated at the centre with 4 mm mycelial disc of a 7 day old pure culture of the test fungi (*Fusarium oxysporum*). Each treatment was replicated three (3) times. The control plate had no treatment but was only added sterile water. After inoculation, plates were incubated at 28^0C for 5 days and examined daily for radial growth of the pathogen. Colony diameter was taken as mean growth along two perpendicular directions.

The effectiveness of the organic amendment sources in retarding the growth of the pathogen were recorded in terms of percentage growth inhibition which was calculated according to the formulaadopted by Amadioha and Enyiukwu (2006) as:

$$\% \text{ inhibition} = \frac{dc - dt}{dc} \times \frac{100}{1}$$

Where:

dc is the average radial distance of pathogen in control plate
dt is the average radial distances of pathogen in extract incorporated agar plates.

In Vivo Experiment

Preparation of fungal suspension

The spores of the pathogen *Fusarium oxysporum f.sp capsici*) were collected from a day old culture- agar stock in Petri dishes by lifting 60 cm^2 pieces into a beaker containing 200 ml of sterile distilled water. This was sieved through a 4-folds of sterile cheese cloth to remove agar and fungal mycelia fragments and the filtrate centrifuged for ten (10) minutes. The spores suspension was standardized using a heamocytometer counting slide to 10^5 spores/ml of sterile distilled water. Thereafter it was poured into a round-bottomed flask, stoppered and used to inoculate the relativelydisease pepper seedlings to run-off.

Field evaluation of different organic amendments for antifungal activity

This experiment was conducted at the screen-house of Michael Okpara University of Agriculture,Umudike. The pepper seeds obtained from the Research and Training (R&T) Unit of the College of Crop and Soil Sciences of the University were used for the study. A well sterilized garden soil was poured into nursery trays of about 90 cm × 60 cm. The pepper seeds were sown in drills in the nursery trays kept under shade and watered as when necessary. Three (3) weeks after planting (WAP), the germinated seedlings were transplanted into poly bags of about 17 cm diameter filledwith 20 kg of the sterilized soil. The seedlings were watered daily.

At 8 WAP, the transplanted pepper seedlings were inoculated with the fungal spores suspension as afore-prepared, by making grooves around the base of each seedling and using a sterile inoculation needle, wounds were mildly inflicted around the bases of the seedlings before gently pouring the suspension into the grooved area made around the seedlings. Then thirty grams (30 g) of each organic sources (poultry waste, wood ash, saw dust, goat waste and control (sterile water) were separately soaked in 100 ml of sterile distilled water in sterile test tubers and covered with foiled cotton wool. Each solution was hand shaken intermittently and allowed to stand for 6 h; thereafter, the suspension was sieved through 2-folds of sterile cheese cloth. The organic waste suspensions thus obtained were poured separately into a small hand sprayer and used to spray-inoculated the leaves surfaces of the seedlings; afterwards, the inoculated plant were covered with transparent light-weight polyethylene bags to provide humid condition for 24 hrs. The seedlings used as control were set up in a similar manner with the application of sterile distilled water. A high relative humidity was maintained around the inoculated plants by continuous watering while the experiment lasted. Records on the number of emerged and established pepper seedlings from 2 weeks after planting (WAP), as well as the vine length, number of leaves and plants were taken per plant per treatment.

DATA ANALYSIS

The experiment was laid out in a Completely Randomized Design (CRD) with 5 treatments replicated 3 times. All data were subjected to Analysis of Variance (ANOVA) using SAS (2001 Version) and the means separated using Least Significant Difference (LSD) at 5% level of probability.

Plate1: Transverse section of an infected root of a pepper seedling by Fusarium oxsporum.

Plate 2: Secondary roots of a pepper seedling infected by *Fusarium oxsporum*

Plate 3: Pure culture of *Fusarium oxysporum f.sp capsicum* grown in PDA media

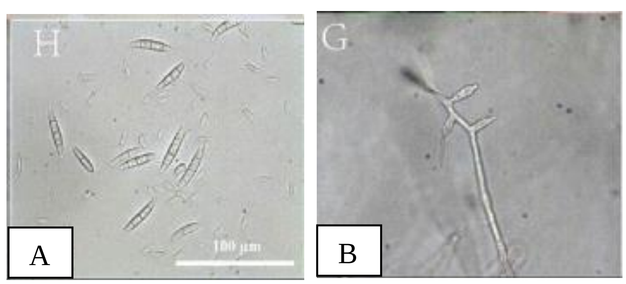

Plate 4 and 5 (A and B): Spores and hyphal strand of *Fusarium oxsporum* viewed on a light microscope.

RESULTS AND DISCUSSION

The result obtained from the study in Table 1 above showed that saw dust (1.86mm) at 100 mg/l significantly (P =0.05%) reduced the radial growth of the test pathogen followed by the goat manure (2.37mm) and poultry droppings (2.77mm) which were significantly (P=0.05%) different from the control (17.67mm). Also, saw dust (2.16mm) and goat manure (2.60mm) at 200mg/l concentrations showed higher potency in reducing the radial mycelial growth of the fungal pathogen when compared with the control (3.15mm) and poultry droppings (3.72mm) respectively, thus wood ash recorded the least mycelial growth. Similarly saw dust (3.63mm) and goat manure (4.3mm) at 300 mg/l concentration significantly ($P \geq 0.05$) were the most effective in decreasing the radial mycelial growth of the isolate however, this was in contrast with poultry droppings (15.91 mm) and the control (16.19mm).

TABLE 1: Effects of different concentrations of the organic amendments on the radialmycelial growth of *F. oxysporum in-vitro.*

Treatments	100mg/L (mm)	200mg/L (mm)	300mg/L (mm)
Goat manure	2.37	2.60	4.33
Poultry droppings	2.77	3.72	15.91
Saw dust	1.86	2.16	3.63
Wood ash	3.47	4.77	6.27
Control	17.67	13.15	16.19
LSD (0.05)	2.21	2.93	2.95

The result could be due effect of the abiotic factors sucha s temperature , light within the culture medium, the essential nutrient contained in the organic sources. Therefore, the result revealed that saw dust and goat manure at 100- 300 mg/l concentrations studied were the most effective in reducing the radial mycelial growth of the test fungi in culture.

The result in Table 2 showed varied effects of the different organic amendments assayed on % inhibition of *F. oxysporum* in culture. The result showed that plates applied with goat manure at week 1 recorded the lowest % inhibition by (38.18%) followed by the control (35.02 %), while the wood ash recorded highest by (14.53%). Poultry dropping (34.77 %) and saw dust (34.79 %) hada closely similar % inhibition which were slightly significant ($P \geq 0.05$) from the control (35.02 %).The reason for thse result could also be the enzymatic reactions within the fungal pathogen in culture, differences in the abiotic factors such as; light, temperature in the culture medium which indirectly affected fungi growth.

TABLE 2: Effect of different organic amendments on the % growth inhibition of *F. oxysporum* inciting wilt on pepper seedlings 4 wks after inoculation *in culture***.**

Treatments	Week 1 (%)	Week 2 (%)	Week 3 (%)	Week 4 (%)
Goat manure	38.18	34.02	33.92	27.96
Poultry droppings	34.77	30.86	32.30	28.52
Saw dust	34.79	34.85	39.36	30.63
Wood ash	14.53	24.31	20.15	24.57
Control	*35.02*	32.59	27.18	28.04
LSD (0.05)	13.20	14.09	11.38	10.65

The result further showed that at 2 weeks after inoculation saw dust (34.85%), goat manure (34.02%) also were lower in inhibiting the radial mycelial growth of the pathogen followed by the control (32.59 %) and poultry dropping (30.86%) respectively. However, there were significant difference (P≥0.05) between the plates inoculated with wood ash which effectively controlled the radial growth of the test fungi by (24.31 %).The also result showed that wood ash was more effective when compared to other treatment in inhibiting the radial mycelia growth of the pathogen. Therefore, result in Table 2,revealed that 1-4 weeks after inoculation wood ash proved more effective in inhibiting the radial mycelia growth of the fungi more than the other treatments; poultry manure, saw dust and goat manure.

The result in Table 3, showed that one (1) week after inoculation, pepper seedlings treated with poultry droppings (18.00 cm) recorded the highest maximum number of leaves and plant heights (17.00 cm) respectively, this could be due to the presence of nitrogen element contained in poultry droppings which has been studied to support vegetative growths of crop plant, this was then followed by saw dust (11.40 cm) wood ash (11.00 cm) and goat manure (10.00 cm) which were significantly different from poultry droppings. Furthermore, at the first week saw dust supported the highest plant height of (19.30cm), followed by goat manure (19.00), poultry dropping (17.00), and lowest was the control (16.30) which could be lack of nutrient unavailable in sterile distilled water.

TABLE 3: Effect of different organic amendments on the number of leaves, plant height of pepper seedlings 4 weeks after inoculation.

	Week 1		Week 2		Week 3		Week 4	
Treatments	Number of leaves	Plant height (cm)	Number of leaves	Plant height (cm)	Number of leaves	Plant height (cm)	Number of leaves	Plant height (cm)
Goat manure	10.00	19.00	11.20	15.40	13.20	18.60	15.60	21.30
Poultry droppings	18.00	17.00	19.90	19.40	11.80	23.10	14.00	26.80
Saw dust	11.40	19.30	11.90	13.60	13.80	16.70	13.20	17.30
Wood ash	11.00	16.30	11.00	18.40	13.20	20.80	13.00	22.00
Control	8.00	14.00	9.00	10.40	11.80	18.40	13.00	21.50
LSD (0.05)	2.38	3.65	2.56	10.50	2.95	4.56	3.02	15.31

In a similar trend, the result in table 3 at four weeks (4) after inoculation showed that poultry droppings had the highest number of leaves (19.90 cm) relative to other organic amendment whilecontrol recorded the lowest number of leaves (9.00 cm). This result may also be as result of higher percentage of the macro elements like nitrogen usually present in poultry droppings which supportsplants vegetative growth. On the contrary, at the 3-4th week of the study the poultry droppings gave the highest maximum plant heights of (23.10 cm) and (26.80 cm), followed by wood ash (20.80 cm) and (22.00 cm).While saw dust (13.80 cm) and poultry droppings (15.60 cm) recorded the highest production of leaves at 3-4th week after inoculation. This result may be a proof of the percentage concentration of the essential elements available in the inoculated soil which helps supports both microbial presence and crop growth.

DISCUSSION

Fusarium wilt caused by *Fusarium oxysporum* f. sp. *capsici* is a potential threat in pepper growingareas in the tropics, causing above 70-100% yield losses during an unfavourable environmental conditions (Ashfaq *et al.,* 2014). There are sufficient data to indicate that organic materials reduce microbial population of various soil borne phytopathogenic fungi causing diseases of mostvegetable crops. 6). The result in Table 1 revealed that saw dust and goat manure at 100- 300 mg/l concentrations studied were the most effective in reducing the radial mycelial growth of the test fungi in culture. This was in agreement with previous reports that organic amendments have been proved to be effective in reducing the incidence of wilt disease, and microbial pathogens necessary for crop growth, and also supports % growth inhibition of most fungal pathogens (Muhammad *et al.,* 2018).Organic amendments are known to affect soil aeration, structure, drainage, moisture holding capacity, nutrient availability and microbial ecology (Davey, 1996). These practices influence pathogen viability and distribution, nutrient availability and the release of biologically active substances from both crop residues and soil microorganisms. Developing disease suppressive soils by introducing organic amendments and crop residue management takestime, but the benefits accumulate across successive years by increasing beneficial soil microorganism population and structure. *Fusarium* crown and root rot in tomato plants has been controlled by the addition of poultry manure and wheat straw (Bettiol *et al*., 1997) or pine bark compost (Zhang *et al*., 1996). Outcomes of this study in Table 2 also revealed that 1-4 weeks after inoculation wood ash proved more effective in inhibiting the radial mycelia growth of the fungi more than the other treatments; poultry manure, saw dust and goat manure. This result may be due to the nutrient contents available in the treatments or the suppressive effect due to biotic and abiotic factors in the culture media. According to Oghebode and Shehu (1999) ina study revealed that kitchen ash also known as wood ash and poultry droppings were able to suppress the disease incidence of phytopathogens. Bailey and Lazarolits (2002) also stated that organic amendment and nitrogen may have effect on soil-borne disease by releasing allelochemicals generated during product storage, while saw dust and goat manure promoted disease incidence and severity despite the fact that they have good number of leaves and plant height in the study. Furthermore, results from previous authors have proven that poultry manure naturally contains all mineral constituent including trace element, while wood ash contains liming agent which helped to reduce severity occurrence of some soil microbes thus helping to suppress the growth of *Fusarium oxysporum f. sp. capsici.*

In a similar trend, in Table 3, the result further showed that one (1) week after inoculation, pepper seedlings treated with poultry droppings (18.00 cm) recorded the highest maximum numberof leaves and plant heights (17.00 cm) respectively. In contrast, after 3-4th week of the study the poultry droppings gave the highest maximum plant heights of (23.10 cm) and (26.80 cm), followed by wood ash (20.80 cm) and (22.00 cm).While saw dust (13.80 cm) and poultry droppings (15.60 cm) recorded the highest production of leaves at 3-4th week after inoculation. The decline in the number of leaves produced and plant heights of the pepper seedlings inoculated with the test pathogen and the various organic amendments could be predicted to some extent based on the heat generation activity of soil and its ammonium ion content, also some residual levels of suppressiveness could also be attributed to the abiotic factors such as pH and carbon sources.Research revealed that application of organic amendments in soil helps in improving physical (water holding capacity, aeration and nutrient uptake) and chemical properties of soil which not only enhanced crop growth but also suppress soil borne pathogens like *Fusarium oxysporum* (Bonanomi *et al*., 2010; Gotora *et al.,*2014).

CONCLUSION

The various organic amendments studied ; poultry droppings, goat manure, wood ash and saw dustvaried in their activity on the radial mycelia growth and the % inhibition of the test fungi (*Fusariumoxysporum f.sp capsici)*, both *in vitro* and in the screen house. However**,** poultry droppings and wood ash performed better than the other treatments and therefore could be applied to control pepper wilt caused by the pathogen, Also, these organic amendments could be incorporated into the soil to control *Fusarium oxysporu*m which will directly help to reduce the incidence and severity of infection, and also indirectly improve crop growth, I recommend that these organic sources could be further researched on the active principles present in them which acts on the pathogen, and formulated for commercial production of pepper and other vegetable crops that are susceptible to its fungal pathogens.

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Comparative assessment of the nutritional and phytochemical compositions of threecommonly consumed fruits in Abia State, Nigeria

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ABSTRACT

Food self-sufficiency is an important goal for Nigeria due to its rapidly growing population and a high level of food insecurity. This study seeks to enhance Nigeria's food self-sufficiency by minimizing the reliance of imported apple (*Malus domestica*) to meet the nutritional needs of the people. The experimental design used was completely randomized design. The proximate, minerals, vitamins and phytochemicals contents of local apple (*Syzygium jambos)*, imported apple, and banana (*Musa sapientum*) were analyzed in the laboratory. Result of nutritional analysis revealed significant variation in all the traits assayed among the fruits except the dry matter content. Banana had highest protein content of 4.28 %, followed by 1.02 % for pink apple and least 0.85 % for rose apple. Carbohydrate content also ranged between 5.14% for pink apple, 2.99% for rose apple and 22.56 for banana. Furthermore, banana also indicated higher contents of ash of 2.17, fibre of 1.89 % for rose apple and fat of 1.79% for rose apple but lower moisture content of 67.19(%). Banana fruit had vitamin A 15.67 IU, 12.74mg for rose apple and 10.68mg for pink apple, vitamin C 15.84 mg/100g for banana, 12.77 mg/100g for rose apple and 10.63 mg/100g for pink apple. Calcium content had 19.55mg, 21.30 and 25.86mg, for rose, pink apples and banana, respectively, potassium 25.82mg/100g, 28.69mg/100g and 52.76mg/100g for rose, pink apples and banana, respectively. Zinc content was 0.76mg/100g, 0.84mg/100g and 1.36mg/100g for, pink, rose apples and banana, respectively. Phytochemical content also showed alkaloid 0.65, 0.63 and 0.74 for rose, pink and banana, phenol 35.86, 36.72 and 49.41 for rose, pink and banana. Banana had highest concentrations of nutritional qualities examined and can play a vital role in reducing the dependence on imported apple.

Keywords: Rose apple (*Syzygium jambos*), pink apple (*Malus domestica*), Banana (*Musa sapientum*), food security, minerals, and vitamins.

INTRODUCTION

Food self-sufficiency is an important goal for Nigeria, as the country has a rapidly growing population and a high level of food insecurity. Achieving food self-sufficiency in Nigeria would mean that the country is able to produce enough food to feed its population without relying on imports. Nigeria can leverage its diverse agro-ecological zones to promote the cultivation of crops that are well-suited to local conditions, which can help increase the value of Nigeria's agricultural exports and reduce dependence on imports.

According to the National Bureau of Statistics, Nigeria imported 1.9 billion Naira ($4.9 million USD) worth of apples (*Malus domestica*) in the fourth quarter of 2020, making it one of the top fruits imported into the country. Apple importation and consumption in Nigeria has been on the rise in recent years due to changing lifestyles and preferences, as well as an increase in disposable income. Apples are not grown in Nigeria due to the country's tropical climate, so they are imported from countries such as South Africa, the United States, and China.

However, the high cost of imported apples can make them inaccessible to many Nigerians, especially those in rural areas and with lower incomes. Therefore, there is need to promote the cultivation and consumption of other fruits, which are better suited to Nigeria's climate and can be grown locally.

Banana (*Musa sapientum*) is grown across Nigeria and is readily available and accessible. Rose apple (*Syzygium jambos*), is a fruit that is growing in popularity in the southeast Nigeria and it is readily available and affordable. However, imported apples (*Malus domestica*) commands premium price in the market than banana and local apple (*Syzygium jambos*). Both imported apples and bananas are nutritious fruits that can be part of a healthy diet as well as provide a range of vitamins and minerals, and is good sources of fiber, calories and carbohydrates.

The high demand for imported apples in Nigeria is due to the popularity of the fruit among the Nigerian population, who perceived imported apple as a healthy and nutritious fruit and consumed it as a snack and as an ingredient in cooking. While these healthy perceptions about imported apple is true, continued importation of apples to the detriment of locally produced fruits will not improve food security in Nigeria. FAO (2021) reported the prevalence of severe food insecurity and malnutrition in Nigeria.

Achieving food self-sufficiency in Nigeria is essential for the country's long-term food security and economic growth. This requires a concerted effort from the government, farmers, and other stakeholders to address the challenges and promote sustainable agriculture practices. To achieve food self-sufficiency, Nigeria needs to invest in agriculture and prioritize policies that support small-scale farmers. This can include increasing access to credit and technology, improving infrastructure such as roads and irrigation systems, and providing training and education to farmers.

The objective of this study is to compare the nutritional, minerals, vitamins and phytochemical constituents of imported apples (Malus domestica), local apple (Syzygium jambos) and banana (Musa sapientum).

MATERIALS AND METHODS

Experimental site

The study was carried out at Department of Agronomy, Michael Okpara University of Agriculture, Umudike. Umudike is located on latitudes 5^{o} 24$^{!}$ N of the equator and longitudes 7^{o} 32$^{!}$ E, with an altitude of 122m above sea level.

Treatment and experimental layout

The three fruits pink apple, rose apple and banana used in this experiment were sourced from Abia Shopping Mall in Umuahia, Abia State. The samples were taken to National Root Crop Research Institute's laboratory for proximate, minerals and vitamins and phytochemicals analyses. The experiment design used was completely randomized design with three replications. The proximate, minerals and vitamins contents were determined by standard procedure described by AOAC (2010), while the phytochemicals analysis was performed according to Pearson (1976).

Data analysis

The collected data were subjected to one-way analysis of variance using GenStat software version 12 according to the procedure for completely randomized design.

RESULTS

Proximate, vitamins, minerals and phytochemical contents of Rose apple, Pink apple and Banana mature fruits were explored in this study. The results in table 1, indicated significant ($P<0.05$) variation among the traits assayed. Banana had the highest ash, fat, fibre, crude protein, carbohydrate and dry matter contents 2.17%, 1.79%, 1.89%, 4.28%, 22.56% and 22.8%, respectively with exception of moisture content. Rose apple showed highest moisture content (94.28%), as against other fruits, whereas, banana had the least (67.19%).

The result of the ANOVA in Table 2 showed significant ($P<0.05$) variation in all the vitamins determined. Banana fruit had the highest concentration of Beta carotene, ascorbic acid and vitamin E compared to other fruit species, 15.67 IU, 15.84 mg/100g, and 2.64 mg/100g, respectively. Rose apple showed the lowest vitamin E concentration of 1.49 mg/100g; while Pink apple showed the least Beta carotene 10.68 IU and ascorbic acid 10.63 mg/100g concentration, respectively.

As shown in Table 3, all the traits determined were significant ($P<0.05$). Banana indicated highest concentration of Ca, Mg, K, P, Na, Zn and Fe, thus. 25.86, 19.54, 52.76, 23.53, 20.57, 1.36 and 2.78 mg/100g, respectively. Rose apple showed lowest concentration of Ca, K, and Na, 19.55, 25.82, 12.85 mg/100g, respectively, whereas Pink apple had least Mg, P, Zn and Fe content, 16.33,15.88, 0.76 and 0.87 mg/100g , respectively.

Results on Table 4 showed that Banana fruit had significantly ($P<0.05$) highest alkaloid, flavonoid, terpernoid, total phenol and tannin content, 0.74, 65.79, 3.18, 49.41 and 1.06, respectively compared to apple fruit species. More so, Pink apple had lowest alkaloids, flavonoid, and terpernoid contents, 0.63 mg/100g, 43.86 QE/g and 1.66 %, respectively, while Rose apple had least total phenol and tannin content, 35.86 GAE/g and 0.73 mg/100g, respectively.

Table 1: Proximate composition and dry matter analysis as influenced by fruit species.

Fruit species	Ash (%)	Fat (%)	Fibre (%)	Protein (%)	CHO (%)	DM (%)	MC (%)
Rose apple	0.57	0.10	1.04	0.85	2.99	5.7	94.28
Pink apple	0.64	0.55	1.10	1.02	5.14	8.5	91.54
Banana	2.17	1.79	1.89	4.28	22.56	22.8	67.19
LSD (0.05)	0.03	0.35	0.03	0.03	0.14	n.s	0.23

Note: n.s = not significant, CHO = carbohydrate, DM=Dry matter, MC= Moisture content

Table 2: Variability in some Vitamin concentration of different fruits species

Fruits	Beta carotene (IU)	Ascorbic acid (mg/100g)	Vitamin E (mg/100g)
Rose apple	12.74	12.77	1.49
Pink apple	10.68	10.63	1.86
Banana	15.67	15.84	2.64
LSD (0.05)	0.33	0.06	0.04

Table 3: Minerals composition as influenced by different fruit species

Fruit species	Calcium (mg/100g)	Magnesium (mg/100g)	Potassium (mg/100g)	Phosphorus (mg/100g)	Sodium (mg/100g)	Zinc (mg/100g)	Iron (mg/100g)
Rose apple	19.55	17.56	25.82	16.79	12.85	0.84	0.93
Pink apple	21.30	16.33	28.69	15.88	13.86	0.76	0.87
Banana	25.86	19.54	52.76	23.53	20.57	1.36	2.78
LSD (0.05)	0.11	0.19	0.04	0.17	0.18	0.03	0.04

Table 4: Variability in phytochemical composition of different fruit species.

Fruit species	Alkaloid (mg/100g)	Flavonoid QE/g	Terpernoid (%)	Total phenol GAE/g	Tannin (mg/100g)
Rose apple	0.65	45.57	1.79	35.86	0.73
Pink apple	0.63	43.86	1.66	36.72	0.78
Banana	0.74	65.79	3.18	49.41	1.06
LSD (0.05)	0.01	0.06	0.04	0.18	0.01

DISCUSSION

This findings demonstrated that rose apple, pink apple and banana fruits were packed with enormous proximate, vitamins, minerals and phytochemical contents. In general, variation in chemical composition are reported to be dependent on soil (habitat), climatic variations, genetic factors, maturity and the storage conditions of the samples as reported elsewhere by Chadare *et al*. (2009); Diop *et al*. (2005); Osman (2004). The protein content of banana 4.28 % in this study was not similar to the findings of (Aurore, *et al*. 2009) 1.10 % and (USDA, 2021) 1.09 %. The fibre content in the current study (1.89 %) were in consonant with earlier findings of (Aurore *et al*. 2009) 2.0 % and (USDA, 2021) 2.6 %. It was also observed that carbohydrate 22.56 % concentration of this study were similar to the findings reported by (Aurore, *et al*. 2009) 21.8 %, (USAD, 2021) 22.84 % and phosphorus content 23.53 mg as reported by (Aurore *et al* 2009) and (USDA, 2021) 22mg, 22mg. The report of (Aurore, *et al*. 2009) 0.30 %, (USAD, 2021) 0.33 % on fat content of banana was not in agreement with the result of this findings 1.79 %. The magnesium content 19.54 mg/100 g of the current research was not similar to the findings of (USDA, 2021) of 30 mg/100 g and (Aurore *et al*, 2009) of 27 mg/100 g. Furthermore, (USDA, 2021) reported that Iron content 2mg/100g of banana was in agreement with the findings of this work, but was not in agreement with the earlier report of (Aurore *et al*. 2009) of 0.4 mg/100 g. The earlier report of Ascorbic acid (Vitamin C) content by (Aurore *et al*. 2009) was 11.7 mg/100 g and (USDA, 2021) 10 mg/100 g were in close range with findings of this work (15.84). The B-carotene content of 15.67 IU of this findings was not in consonant with result of (Aurore *et al*. 2009) (68 µg).

The USDA, (2021) reported carbohydrate concentration of rose and pink apple as 5.7 g and

13.81%, while the current research showed 2.99 % and 5.14 %, respectively. It obviously showed variation. The fat and protein content of both apples earlier reported by (USDA, 2021) showed 0.3 g, 0.60 g and 0.17 %, 0.26 %, respectively were closely related to the result of the current findings thus: 0.10 %, 0.55 % and 0.85 %, 1.02 %, respectively. Fibre content was not similar to the resultof this work 1.10 % as reported by (USDA, 2021) 2.4 %. Rose apple moisture content of 94.28 %of this work was in agreement with the report of (USDA, 2021) of 93g. The B-carotene content ofrose apple as reported by (USDA, 2021), was 17 mg/100 g, while the findings of this work indicated 12.74 IU. The vitamin C content of Rose apple 12.77 mg/100 g and pink apple 10.63 mg/100 g of this work was not similar to the report of (USDA, 2021) findings in rose apple 22.3 mg/100 g and pink 4.6 mg/100 g fruit species. The Calcium content Rose and Pink apple fruits as reported by (USDA, 2021) 29 mg and 6 mg, respectively, were in disagreement with the current findings of 19.55 mg/100 g and 21.30 mg/100 g, respectively. The fruit of Rose apple and Pink apple as earlier reported by (USDA, 2021) showed that magnesium content were 0.02mg and 5mg as against the result of this work 17.56 mg and 16.33mg. Moreso, potassium concentration of the current work had rose and pink apple fruits of 25.82mg and 28.69mg as against earlier report by (USDA,2021) (123mg) and 107mg.Okudu and Ahara, (2018) reported that alkaloid, flavonoid, tannin and phenol content in pink apple fruit assayed were less than 1mg/100 g. The report was similar to the result of this findings with respect to alkaloid and tannin, table 4.

CONCLUSION

The study on the proximate, vitamin, mineral and phytochemical composition of three fruits species indicated banana is very rich source of proximate, minerals, vitamins and a number of phytochemicals assayed in this work. Banana fruit showed highest concentration of almost all the traits determined with the exception of moisture. This study recommends that banana fruit should be promoted over the imported pink apple as it is even cheaper than that of apple counterpart and is readily available. Rose apple that compared favourably with pink apple can be taken as a substitutes where available.

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Effect of Biochar and NPK 15:15:15 on Selected Soil Properties and *Celosia Argentea* Growth and Yield Performance in Southwest Nigeria

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ABSTRACT

Biochar is a carbonaceous recalcitrant product of biomass produced through the process of pyrolysis. This study examined the effect of biochar and inorganic fertilizer on selected soil properties, growth and yield of *Celosia argentea*. The experiment was laid out in a Randomized Complete Block Design (RCBD). Four treatments used were; Control (i.e no fertilizer application), 20 t/ha biochar from *Gliricidia sepium*, 20 t/ha biochar from sawdust and 150 kg NPK 15:15:15 with two (2) seedlings per treatment, replicate four times. Data collected were plants height (cm), number of leaves, stem diameter (cm) and yield of *Celosia*. The result of the post harvest soil properties analysis showed that exchangeable potassium, Na and Available P ranged from 0.45, 0.22 cmol/kg and 16.76 mg/kg in the control plot to 0.73, 0.29 cmol/kg and 28.40 mg/kg respectively in the plot where 20t/ha *Gliricidia sepium* biochar was applied. Bulk density ranged from 1.13 to 1.24 g cm^{-3} which is in the range of fine texture soil indicated a well drained soil. At 5th week after treatment application (5WATA), 150 kg/ha NPK15:15:15 had the highest plant height (34.22cm) followed by 20t/ha biochar from *Gliricidia sepium* (32.99cm) and least by Control (13.11cm). This result suggests that the incorporation of fertilizer was effective in improving the soil properties and yield (kg/ha) of *Celosia argentea*. Application of 150 kg/ha NPK 15:15:15 is recommended for the yield of *Celosia argentea* especially in the study area.

KEYWORDS: Biochar, NPK 15:15:15, Soil, *Celosia argentea*, Fertilizer.

INTRODUCTION

Biochar is a carbon-rich material produced during pyrolysis process that is a thermochemical decomposition of biomass with a temperature about ≤700 °C in the absence or limited supply of oxygen (Lehmann and Joseph, 2015). It has higher pore space, negative surface charge and surface area (Lehmann and Joseph, 2015), higher water holding capacity, reduced soil bulk density (Adekiya *et al*., 2019) and reduced nutrients losses, thereby offering the possibility of improving yields (Adekiya *et al*. 2019, 2020). Nguyen *et al*. (2017) reported that through pyrolysis process, pure organic waste/material is converted into a valuable product with distinctive physicochemical properties that can contribute to good soil environment for better crop performance. According to Domingues *et al*. (2017), pyrolysis leads to high aromaticity of carbon, which makes biochar more recalcitrant to biodegradation. Hence, biochar-treated soils have high carbon residence time compared with non-treated soils. Furthermore, biochar was reported to have high cation exchange capacity, with diverse acidic and basic functional groups, which helps to adsorb nutrients on its surface and better synchronize their release with plant uptake (Mandal *et al.*, 2016; Esfandbod *et al.*, 2017). Application of biochar could improve soil physical, chemical and biological properties, addition to affecting soil carbon and nitrogen cycles (Sadaf *et al.*, 2017). Biochar contains macronutrients and increases soils nutrient availability, thus improving plant growth and grain yield. Celosia is primarily used as a leafy vegetable. The leaves and tender stems are cooked as soups, sauce or stews with various ingredients including other vegetables such as onions, hot pepper and tomato, with meat or fish and palm oil. Celosia leaves are tender and break down easily when cooked for a short time (Nwafor, 2019). An experiment in Nigeria showed that, the yield of a well-managed crop harvest by uprooting was 47t/ha, while repeated cuttings was 57t/ha. Repeated cuttings also led to a better quality of the produce and higher economic return. Although celosia is a productive leafy vegetable, its yields are lower than those of amaranth (Denton, 2004). Makinde *et al*., (2011), reported that *Celosia argentea* and *Corchorus olitorus* responded differently to the treatments in relation to growth parameters with NPK fertilizer having the highest agronomic parameters while cow dung and poultry manure had the highest agronomic parameters in Celosia argentea. The vegetables fertilized with urea have the highest plant height and least stem girth compared with cow dung, poultry manure and NPK fertilizer. The *Celosia* and *Corhorus* treated with poultry manure had better yields, higher moisture contents in plants tissue than vegetables that were fertilized with urea. Poultry manure had the highest leaf, stem and root moisture. Urea also had the highest plant height compared with the control, and all the treatments significantly increased number of nodes, leaves, height and plant girth. The soil samples treated with cow dung had the highest number of nodes and plant height while poultry manure had the highest number of leaves, branches and girth.Most previous studies on soil properties, growth and crop yields have evaluated the benefits of biochar alone and not the combination of biochar and other amendments. Combining biochar with other amendments could improve the effectiveness of biochar for improving soil properties. To this end, the objective of this study was toexamine the effect of biochar and inorganic fertilizer on soil properties, growth and yield of *Celosia argentea*.

MATERIALS AND METHODS

The experiment was conducted at the Teaching and Research farm of Federal College of Forestry, Ibadan, located on latitude $7^{0}23^{1}$N and longitude $3^{0}51^{1}$E. The pattern of rainfall is bimodal, with the average annual rainfall estimated to about 1400 mm. The average temperature is about 32^0C and relative humidity of about 80-85% (FRIN, 2020). The experiment was laid out in a Randomized Complete Block Design replicated four times resulting into sixteen (16) experimental units. There Four (4) treatments namely: control (i.eno fertilizer application), 20 t/ha biochar from *Gliricidia sepium*, 20 t/ha biochar from sawdust and 150 kg NPK 15:15:15. The biochar used for this study were produced from Sawdust gotten from Forestry Research Institute of Nigeria (FRIN) Sawmill and *Gliricidia sepium* was gotten from the Teaching and Research farm of Federal College of Forestry Ibadan. They were air dried at a room temperature before taken to National Institute of Horticulture Research for pyrolysis at a temperature of 400^0c. The biochar produced were grinded into fine particles to increase its surface area and mixed thoroughly with thesoil at two weeks before planting. Application of NPK 15:15:15 fertilizer was applied as two weeks after planting and water was applied to 70% field moisture capacity.Soil samples (0-15 cm) were collected from unfertilized plots at the Teaching and Research farm of the College Subsample of the soil was air-dried, crushed in an agate mortar, passed through a 2-mm sieve before laboratory analysis. Exchangeable K, Na, Ca, and Mg were extracted with neutral (pH 7) solution of 1N NH_4OAc solution. K and Na were determined using the flame photometer while Ca and Mg concentrations were determined by atomic absorption spectrophotomer. Particle size distribution was determined by the modified hydrometer method by Oyebiyi *et al*. (2018), while the soil textural triangle was used to classify the soils into textural classes. Soil pH was determined using a glass electrode pH meter in both distilled water and 0.01 M $CaCl_2$ solution. Soil organic carbon was determined by walkey-black method using potassium dichromate ($K_2Cr_2O_7$) as oxidizing agent in the presence of concentrated sulphuric acid (H_2SO_4) while available P was extracted using the Bray-1 method and determined using a Visible Spectrophotometer.Seeds of Celosiawere planted by mixing a spoon of the seed with sand and the mixture was evenly spread on germination trays. At two weeks after planting, germinated seedlings of uniform height weretransplanted on the field. Plant height, number of leaves and stem girth were recorded at 2, 3, 4, and 5 weeks after transplanting (WATA). Plant height was determined using a measuring tape; stem girth was determined using venier caliper while number of healthy leaves was counted visually and recorded per experimental unit. The duration of the experiment was five (5) weeks.Harvesting was done at 6th week after planting. *Celosia argentea* was uprooted from the soil with the use of hand. *Celosia argentea* was weighed and recorded after harvesting.Soil samples were later collected from each experimental unit at post-harvest, air-dried, and analyzed for pH, total carbon, available P, exchangeable cations (Mg, Ca, K and Na), extractable micro nutrients (Mn, Zn, Cu and Fe) and particle size distribution using the same methods stated above. Data collected were statistically analysed using Genstat Statistical software package. Means was separated using Duncan Multiple Range Test (DMRT) at 5% level of significance.

RESULT AND DISCUSSION

Physical and chemical properties of the soil

Pre-planting physical and chemical properties of soil sample from the experimental site is as presented in Table 1. The analysis reveals that the soil is low in and total nitrogen (1.3 g/kg), Organic carbon (9.5 g/kg) which is below the critical range of (1.6 – 2.0 g/kg) for total nitrogen and (10 – 14 g/kg) for organic carbon (Adeoye and Agboola, 1985). The soil is moderate in exchangeable potassium (0.40cmol/kg), phosphorus (14.52 mg/kg) and zinc content (1.04 mg/kg)which is within the critical range of (0.31 cmol/kg – 0.61 cmol/kg) for exchangeable potassium, (7 – 20 mg/kg) for available phosphorus and (1 – 5 mg/kg) for organic carbon (Adeoye and Agboola, 1985). The pH of the soil was 5.81 which is slightly acidic. The textural class of this soil is loamysand.Soils at the sampling site were classified as Iwo series (Smyth & Montgomery, 1962) which is said to be the typical soil for vegetable cultivation in the region.

Table 1: Pre Planting Physical and Chemical Properties of the Soil Sample from the Experimental Site

Parameters Determined	Value
pH (H_20)	5.81
Organic carbon (g/kg)	9.50
Total nitrogen (g/kg)	1.30
Available phosphorus (mg/kg)	14.52
Exchangeable bases (cmol/kg)	
Na	0.32
K	0.40
Ca	1.13
Mg	0.27
Extractable micro nutrient (mg/kg)	
Fe	200.00
Zn	1.04
Mn	130.00
Cu	2.60
Particle size distribution (g/kg)	
Silt	45.00
Sand	865.00
Clay	90.00
Textural class	Loamy sand

Bulk density (g cm^{-3})	1.22
Saturated hydraulic conductivity (cm hr^{-1})	12.8

Gliricidia sepium biochar and sawdust biochar analysis is as presented in Table 2. It shows the chemical composition which consist of nutrient in low, moderate, and high quantity. The result in *Gliricidia* biochar is low in zinc, moderate in total nitrogen and high in potassium and total organic carbon respectively. While in sawdust biochar the total nitrogen and zinc content is low, potassium and total organic carbon is moderate.

Table 2: Analysis on *Gliricidia sepium* and Sawdust Biochar used

Parameters determined	Gliricidia biochar (%)	Sawdust biochar (%)
N	1.59	0.03
P	0.63	0.18
K	0.48	0.21
Ca	0.37	0.13
Mg	0.33	0.05
Zn	0.26	0.07
Fe	0.18	0.04

Effect of biochar type and inorganic fertilizer on plant height of *Celosia argentea* is as presented in table 3. There was significant difference among the fertilizer types used. At 5weeks after treatment application, Inorganic fertilizer plot (34.22cm) had the highest plant height, followed by the *Giliricidia sepium* plot (32.39cm) and the least by control plot (13.11cm).The result obtained in plant height in this study experiment agrees with the findings of Omotoso and Shittu (2007) who reported increase in *Abelmoschus esculentus* (L) growth parameters when NPK fertilizer was applied by ring method of application.

TABLE 3: Effect Biochar and Inorganic Fertilizer on Plant Height at Weeks after planting.

	Weeks after treatment application			
Treatment	2	3	4	5
20t/ha GSB	6.23b	15.49c	23.44c	32.39
20t/ha SDB	2.31a	6.89a	10.11a	13.28a
150kg/ha IF	7.06b	11.30b	15.79b	34.22b
Control	2.43b	6.63a	9.11a	13.11a

Means in the same column having the same alphabet are not significantly different from each other at 5%level of significant.

Effect of biochar types and inorganic fertilizer on stem diameter of *Celosia argentea* is presented in table 4. There was significant difference among the fertilizer types used. At 5 weeks after treatment application, inorganic fertilizer plot (8.78cm) had the highest stem diameter followed by *Gliricidia sepium* biochar plot (4.02cm) and least by control (1.98cm).

The result obtained in stem diameter in this study experiment agrees with the findings of Omotoso and Shittu (2007) who reported increase in *Abelmoschus esculentus* (L) growth parameters when NPK fertilizer was applied by ring method of application

TABLE 4: Effect of Biochar types and Inorganic Fertilizer on Stem Diameter of *Celosia argentea*

	Weeks after treatment application			
Treatment	2	3	4	5
20t/ha GSB	1.41b	2.29b	2.86b	4.02b
20t/ha SDB	0.71	1.10a	1.55a	2.19a
150kg/ha IF	1.4ab	2.10b	2.66b	8.78b
CONTROL	.92a	1.38	1.60a	1.98a

Means in the same column having the same alphabet are not significantly different from each other at 5%level of significant.

Effect of biochar types and inorganic fertilizer on number of leaves of *Celosia argentea* is presented in table 5. There was significant difference among the fertilizer types used. At 5weeks after treatment application,, inorganic fertilizer plot (55cm) had the highest number of leaves followed by *Gliricidia sepium* biochar plot (46cm) and the least by control plot (17cm). The result obtained in number of leaves in this experiment is in line with the submission of (Olufolaji *et al*., 2002) where they recorded an increase in growth parameter with the application of NPK fertilizer by ring method.

TABLE 5: EFFECT of Biochar types and Inorganic Fertilizer on Number of leaves of *Celosia argentea*.

	Weeks after treatment application			
Treatment	2	3	4	5
20t/ha GSB	8a	14b	21b	46b
20t/ha SDB	6a	11a	13a	18a
150kg/ha IF	10c	20c	27c	55c
CONTROL	6	10a	12a	17a

Means in the same column having the same alphabet are not significantly different from each other at 5%level of significant.

Effect of biochar types and organic fertilizer on yield of *Celosia argentea* is presented in Table 6.

There was significant differences among the fertilizer types used after planting plot inorganic fertilizer (9650.00kg) had the highest number of yield followed by *Gliricidia* biochar plot (8460.00 g) and the least by control plot 2866.67 g). The result obtained in this experiment is in line with the submission of (Olufolaji *et al*., 2002) where they recorded an increase in growth and yield parameter with the application of NPK fertilizer by ring method.

TABLE 6: Effect of biochar types and organic fertilizer on yield of *Celosia argentea*

Treatment	Yields (kg/ha)
20 ta/ha GSB	8460.00c
20 ta/ha SDB	4053.33b
150 kg/ha IF	9650.00d
CONTROL	2866.67a

Means in the same column having the same alphabet are not significantly different from each other at 5%level of significant.

Effect of biochar on selected soil properties

The effect of biocharon some selected soil properties in the post-harvest soil is as presented in Table 7. Exchangeable potassium (K, Na) and Available P ranged from 0.45, 0.22 cmol/kg and 16.76 mg/kg in the control plot to 0.73, 0.29 cmol/kg and 28.40 mg/kg respectively in the plot where 20t/ha *Gliricidia sepium* biochar was applied. Organic carbon and total nitrogen ranged from 8.70 g/kg and 1.62 g/kg in the control plot to 18.24 g/kg and 1.84 g/kg respectively in the plot where 20t/ha *Gliricidia sepium* biochar was applied. This is in line with the report of Lehmann *et al.*, (2002), that the amount of exchangeable K increased with increasing application of biochar. According to Olakayode *et al*., (2019), who reported that biochar addition increases soil available P in soils of Iwo series. Laird *et al*., (2010), also reported that biochar has the ability to absorb nutrients, such as P, to its surface.The soil pH increased considerably, which is in line with Biederman and Harpole (2013) and Prakriti *et al.*, (2019) that soil pH tends to increase and become less acidic, following the addition of biochar. The soil bulk density was ranged from 1.13 to 1.24 g cm^{-3} which is in the range of fine texture soil. Particle size distribution was sandy loam. Saturated hydraulic conductivity ranged of 11.80 to 12.84 cm hr^{-1} indicated a well drained soil.

TABLE 7: POST HARVEST TYPICAL PHYSICAL AND CHEMICAL ANALYSIS SOIL PROPERTIES

PARAMETERS DETERMINED	Control plot	GSD	SDB	NPK 15:15:15
pH(H_2O)	6.60	6.50	6.40	6.66
Total Organic Carbon (g/kg)	18.75	10.24	18.11	11.93
Total Nitrogen (g/kg)	1.62	1.84	1.67	1.90
Available phosphorus Mg/kg	16.76	27.83	26.24	28.40
Exchangeable Acidity	0.080	0.085	0.90	0.22
Exchangeable Bases (Cmol/kg)				
Na	0.29	0.32	0.29	0.35
K	0.45	0.73	0.72	0.66
Ca	1.44	1.66	1.48	1.67
Mg	0.36	0.38	0.34	0.32
Extractable Micro Nutrient (mg/kg)				
Fe	209.15	269.17	261.10	266.18
Zn	1.16	1.20	1.14	1.21
Mn	136.03	141.30	146.04	143.03
Cu	3.02	3.39	3.36	3.42
Particle size distribution (%)				
Silt	24.64	24.71	23.98	25.65
Sand	69.71	68.23	70.15	67.11
Clay	5.65	7.06	5.87	7.24
Textural class	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Bulk density	1.20	1.23	1.13	1.24
Saturated hydraulic conductivity	12.44	12.84	12.63	11.80

CONCLUSION AND RECOMMENDATION

Poor soil structure is the main cause of soil degradation; however, Biochar is a carbonaceous recalcitrant product of biomass produced through the process of pyrolysis. It can be used as a tool to improve the soil properties for a long period of time as compared to other organic amendments. This study investigates the effect of biochar types and inorganic fertilizer on the yield of *Celosia argentea* as influenced by soil properties. The result of the study showed that the various treatment applications had significant effect on soil properties. However there was an effect on growth parameters as well as yield of *Celosia argentea.* It can be concluded that all the fertilizer may be adopted or utilized for *Celosia argentea* production. Hence, it can be recommended that application of 150kg/ha NPK15:15:15 can be utilized by most farmers to increase *Celosia argentea* yield production since it gave the highest *Celosia argentea* yield

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Evaluation of Growth and Yield Parameters of *Sesame radiatum* (Schuach and Thonn) Vegetable in Response to Application of Compost and Bat Manure in Mokwa Southern Guinea Savannah Zone of Nigeria.

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ABSTRACT

Farmers in Nigeria have realized the yield and health potentials of using organic resources for sustainable crop production. An experiment was carried out under irrigation during the 2022 cropping season at the Niger State College of Agriculture, Mokwa Research Orchard to investigate the yield and growth responses of *Sesame vegetable* to compost (CPM) and little brown bat (LBBM amendments in the Southern Guinea Savanah zone of Nigeria. The treatments comprised of soil amended with three levels (0, 15, 30, 45 and 60 kg N ha^{-1}) each of compost and little brown bat manures. Treatments were arranged in a Complete Randomized Design (CRD) and replicated three times. Growth parameters were collected at 2, 4, and 6 WAP on plant height, number of leaves, leaf area (LA), leaf area index (LAI) while, yields of fresh leaf and shoot biomass were weighed at 8 weeks after planting (WAP). Data collected were subjected to Analysis of Variance (ANOVA). The results showed that the application of bat and compost manures influenced Sesame growth and yield parameters. Generally, as the rates of compost and bats manure rates increased, the growth and yields parameters of Sesame vegetable also increased. The significantly ($P \leq 0.05$) largest fresh shoot biomass, number of leaves and number of branches as well as tallest plants were observed in pots treated with 60 kg N ha^{-1} in bat manure. The lowest values of growth parameters were recorded in the control Sesame plants. The highest yields of shoot biomass (69.24 g) and fresh leaf (24.65) were observed in pots treated with 60 kg N ha^{-1} bat manure compared to those of the untreated control (0 kg N ha^{-1}). It is hereby suggested that 45 kg N ha^{-1} bat manure that produce 49.88 g fresh shoot biomass and 19.46 g fresh leaf weights, which, were not significantly

different from the 60 kg N ha^{-1} yield be adopted by smallholder farmers in the agro-ecological zone for the cultivation Sesame vegetable.

Key words: Compost, Bat manure, Sesame vegetable, Amendments, Growth and Yield.

INTRODUCTION

Sesame S*esame radiatum* (Schuach and Thonn), is a member of the family *Pedaliaceae.* It is an erect annual herb between with simple stem or branched and leaves arranged alternately or opposite positions on the shoot of the plant. It is a common plant in West Africa and Central Africa where it is gathered in the wild and is used as a pot herb. It is an important vegetable commonly consumed in Nigeria and many other parts of the tropics. *Sesamum radiatum* is referred to as Beniseed or Black Beniseed or Black Sesame or Vegetable sesame in English, Ewe Atura in Yoruba, Karkashi in Hausa while the Nupes call it Nimbolo. They are rich in protein, vitamins and minerals (Naloh *et al.,* 2015 ; Gills,1992). Sesame has many medicinal and cosmetic uses. It has shown to improve fertility, ease child birth, antimicrobial activities, effective against many forms of intestinal disorder especially diarrhoea and dysentery. It is effective as hair shampoo (Oduntan, 2014). It is one of the many neglected leafy vegetables of the tropics despite its nutritional and non-nutritional values. Sesame grows well on a variety of soils but thrives best on those, which are moderately fertile with good internal drainage. Soils with neutral reaction are preferred. The problem of low soil fertility is common in Africa (Lynam *et al.,* 1998). The soils at the study area were reported to be low (Mohammed *et al.,* 2020). Therefore, there is need for nutrient supplementation for optimal performance of *Sesame radiatum* at the study area. According to Obatolu (1995), organic fertilizer is an alternative to inorganic fertilizer for economic, health and environmental reasons. Organic manure amendments help to replenish soil nutrients, improve soil texture and structure, water retention capacity, activation of soil microbial activities etc (Crow, 2009). Poultry and bat manures were reported to increase N, P and K contents of soil which in turn enhanced significantly the growth characters of vegetable plants (Law - Ogbomo and Oseigbovo, 2**017; Mohammed *et al.,* 2020).**

However, there is very little or no information on the response of Beniseed (*Sesamum . radiatum L.*) growth and yield parameters to application of compost and little brown bat droppings in Mokwa

Southern Guinea Savanah. The aim of the study is therefore, to evaluate the growth and yield parameters of *Sesame radiatum* vegetable in response to application of compost and bat manures in Mokwa Southern Guinea Savannah zone of Nigeria.

MATERIALS AND METHODS.

Site description

The trial was conducted in the 2022 growing season at the College Orchard, a subsidiary unit of the Teaching and Research Farm of Niger State College of Agriculture, Mokwa (09°-18 N and 05° 4'E) situated in the Southern Guinea Agro-Ecological zone of Nigeria. The Research was carried out between 17/08/22 and 01/10/2022 under irrigation system. Mokwa is characterized by a unimodal rainfall distribution with a mean annual rainfall of 1179.5 mm and a mean average temperature of 33.6. This was based on the data collected from the College of Agriculture Metrological Station (CAMET, 2022).

Treatment and Experimental Design.

The pots were laid out in Complete Randomized Design (CRD) consisting of nine treatments and replicated three times. *Sesbania radiatum* was used as the experimental plant, while Compost Manure (CPM) and Little Brown Bat Manure (LLBM) were used to amend the soil. . Four rates each of the Compost manure (15, 30, 45 and 60 kg N ha^{-1}) and Little Brown Bat Manure (15, 30, 45 and 60 Kg N ha^{-1}) as well as Control (0 kg N ha^{-1}) were applied.

Soil Preparation and Amendments

The land was cleared of debris, Soil samples were then collected from 0 - 15 cm depth and put in a pan. The soil was thoroughly mixed together and 4 kg of the soil were weighed into each of the treatment pots. The soils in the pots were either amended with little brown bat manure or compost manure. 2 kg of the 4 kg soil was mixed thoroughly with the corresponding rate of compost and bat manures and was applied at the top soil of in the container. The little brown bat treated pots were watered for two weeks to allow for curing of the bat manure. The compost on the hand was applied on the day of sowing Sesame seed. The soil was adequately moisture through pre sowing irrigation. The soil in the pots had sufficient moisture throughout the period of the experiment.

Compost preparation

A 3 x 3 m (9 m^2) pit was dug out under a tree to provide shade. Poultry droppings and *Centrosema pubens* legume shoot were alternately arranged in layers in that order until the pit was filled. Water was applied on each layer to provide adequate moisture. The pit was covered with palm fronds. The compost was turned and mixed at intervals of 5 or 6 days until the compost is mature for harvest.

Soil and compost analysis

Soil samples were collected, bulked and mixed thoroughly to obtain a composite soil sample. A Sub sample of the composite sample which was obtained through coning and quartering was air dried, gently crushed and passed through a 2mm sieve for physical and chemical analysis in accordance with standard procedures described by IITA, (1979) and Anderson and Ingram, (1993). After air drying, the chemical properties of the compost and bat manures were determined using the standard methods described by Anderson and Ingram, (1993). The particle size distribution was determined using hydrometer method. Soil pH was measured in 1;1 (soil : water) suspension using a glass electrode pH meter. Organic carbon was determined by Wet Oxidation method. Micro-Kjeldahl method was used to determine the total Nitrogen of the soil samples. Available Phosphorus was determined by Bray No. 1 method. Exchangeable cations were extracted with 1N ammonium acetate at pH 7.0. The concentrations of Ca and Mg were determined on an Atomic Absorption Spectrophotometer (AAS) and the concentrations of Na and K on a Flame Photometer. Cation Exchange Capacity (CEC) was extracted using the leachate from the washed soil sample with neutral ammonium acetate.

Manure Analysis

The standard methods described by Anderson and Ingram (1993) and IITA (1979) were also used to determine the chemical properties. The pH, OC, N, P, Ca, Mg, K and Na contents in poultry and bat manures were measured.

Agronomic practice

Improved seed of Sesame was obtained from the College Horticultural Unit. Five (5) seeds were planted at the centre of the pots. Thinning was carried out two (2) weeks after planting to three (3) plants per pot. Weeds were controlled manually by hand pulling when the need arose**.**

Pests were controlled by preparing a combination of 1 kg each of ground garlic and ginger, and 500 g chili pepper in water, allowing he mixture to soaked for 24 hours before decanting into 3 litters of water. 5 ml of neem oil was added to the decanted solution and mixed thoroughly. The plants were sprayed thrice weekly early in the morning.

Data collection

Data were collected from each of the three plants in each of the treatment pots.

At 2, 4 and 6 weeks after planting (WAP) plant height was measured using ruler from the ground level to the tip of the apical leaves, Number of Leaves was determined by counting of fully expanded leaves, Leaf Area (LA) was carried out by measuring the length and maximum width (breath) of the leaves multiplied by a factor of 0.43 (Remison 1997) and Leaf Area Index computed as LAI = Leaf Area (m^2/Ground cover (m^2). At 8 WAP, Number of Branches was determined by visual counting, while, Shoot Biomass and Fresh Leaf Weights were carried using digital measuring scale.

Data analysis

All data collected were subjected to the analysis of variance (ANOVA) and where significant. were separated using Duncan Multiple Range Test (DMRT) at 5% level of probability using the General Linear Model (GLM) procedure of Version 9.3 (SAS, 2010).

Results

Soil Chemical and Physical Properties

The physical and chemical properties of the soil before the commencement of the experiment are presented in Table 1. The soil at the site was sandy loam and slightly acidic. The OC, P, N, Ca,Mg, K, Na and CEC with values of 11.40,13.23, 0.11, 2,69, 1.25, 0.24 and 6.60 were obtained respectively.

Table 1: Physical and chemical properties of the soil of experimental site prior to the commencement of the experiment.

Parameter	Value
SOIL PARTICLE SIZE	
Sand (%)	92
Silt (%)	4
Clay (%)	4
TEXTURAL CLASS	Sandy loam
pH (H_20)	6.5
Organic carbon g kg^{-1}	11.40
Available P mg kg^{-1}	13.23

Total N g kg^{-1}	0.11
EXCHANGEABLE CATIONS	
Ca (cmol kg^{-1})	2.69
Mg (cmol kg^{-1})	1.25
K (cmol kg^{-1})	0.24
Na (cmol kg^{-1})	0.32
Exchangeable acidity (EA) (cmol kg^{-1})	0.30
CEC (cmol kg^{-1})	6.60

Values represent means of triplicate determination.

Chemical Properties of organic manures

Table 2 shows the chemical characteristics of the Compost and Little brown bat manures used to amend the soil. The N, P, K and Exchangeable bases contents of Little Brown Bat manure were numerically higher than those of the Compost manure.

Table 2: Chemical properties of compost and little brown bat manures

Parameter	Value	
	Compost Manure	Little Brown Bat Manure
	(CPM)	(LBBM)
pH (H_20)	5.8	8.0
Organic carbon (OC) (%)	0.89	31.43
Organic matter (OM) (%)	1.03	54.34
Available P (%)	25.0	2.29
Total N (%)	0.12	7.99
Exchangeable Cations		
Ca (%)	2.96	2.08
Mg (%)	7.99	2.37
K (%)	0.13	1.85
Na (%)	0.10	0.95
Exch. Acidity (EA) (%)	0.04	0.78

Values represent means of triplicate determination.

Effects of N – levels in Compost and Little Brown Bat manures on Plant Height of Sesame vegetable.

Tables 3, 4 and 5 shows the effects of organic manure on plant heights of Sesame. The application of organic manure was significant ($P \leq 0.05$) at 2 and 6 WAP (Table 3). LBBM treatments significantly ($P \leq 0.05$) increased the plant height than those of the CPM treatments. The control had the lowest plant height. At 4 WAP, manure treatments gave plant heights that were only numerically different. Among the treatments, the plant heights consistently increased from 10.00 cm at 2 WAP to 45.67 cm at 6 WAP.

The 60 kg N ha^{-1} LBBM treatments recorded significantly the highest plant height among treatments at 2 WAP (12.33 cm) and 4 WAP (45.67 cm) WAP (Table 3). At 2 WAP, the 11.00 cm plant height obtained in 60 kg N ha^{-1} CPM treatments pots was statistically similar 0 and 45 kg N ha^{-1} CPM but significantly ($P \leq 0.05$) higher than the 0 and 15 kg N ha^{-1} CPM treatments, while, 60 kg N ha^{-1} LLBM treatments gave plant height value of 36.33 cm that was significantly highest at 6 WAP but statistically ($P \geq 0.05$) similar to 30 and 45 kg N ha^{-1} LLBM.

Generally, 60 kg N ha^{-1} LBBM significantly ($P \leq 0.05$) recorded the highest plant height (53.33 cm) among the organic manure amendments. Also,60 kg N ha^{-1} CMP gave the highest plant height values among CPM treatments (Table 5), this was, however, not significantly ($P \geq 0.05$) different from the 15, 30 and 45 kg N ha^{-1} CPM treatments pots (Table 5).

Table 3: Sesame plant height as affected by N - levels in Compost and Little Brown Bat manure application at 2, 4 and 6 Weeks After Planting.

Manure rate	Plant height at 2 WAP (cm)	Plant height at 4 WAP (cm)	Plant height at 6 WAP (cm)
0 kg N ha^{-1} (control)	10.00b	20.67	24.67b
15kg N ha^{-1} CPM	10.33b	21.00	26.33b
30 kg N ha^{-1} CPM	10.67ab	21.33	31.67ab
45 kg N ha^{-1} CPM	10.67ab	21.33	35.33ab
60 kg N ha^{-1} CPM	11.00ab	21.67	36.67ab
15 kg N ha^{-1} LBBM	11.00ab	22.00	39.67ab
30 kg N ha^{-1} LBBM	11.67ab	22.00	41.67a
45 kg N ha^{-1} LBBM	11.67ab	22.67	43.33a

60 kg N ha^{-1} LBBM	12.33a	22.67	45.67a
Significance	*	NS	*
SE	0.52	0.70	3.01
DMRT	1.55	2.11	9.03

* = Significance at 5%, SE = Standard Error and DMRT = Duncan's Multiple Range Test.
Means with the same letter are not significantly different.

On the whole, irrespective of N – rates, the LLBM treatments plots recorded significantly ($P \leq 0.05$) taller plants (46.52 cm) than the CPM (37.11 cm). The control had significantly ($P \leq 0.05$) the lowest plant height value of 26.74 cm (Table 4)

Table 4: Comparative effect organic manure types on Sesame plant height, shoot biomass, fresh leaf weight and leaf number.

Manure Type	Plant height (cm)	Shoot biomass (g)	Fresh leaf weight (g)	Number of Leaves
Control	26.74c	16.93	8.90	44.11c
Compost manure	37.11b	29.70	12.74	71.52b
Little Brown Bat manure	46.52a	43.61	16.04	102.48a
Significance	*	NS	NS	*
SE	2.21	7.46	2.75	6.92
DMRT	6.27	21.14	7.79	19.60

* = Significance at 5%, SE = Standard Error and DMRT = Duncan's Multiple Range Test
Means with the same letter are not significantly different.

Effects of Organic Manure on Sesame Shoot Biomass

Tables 4 and 5 shows the effects of organic manures on the shoot biomass of sesame. The application of organic manure had significant ($P \leq 0.05$) effect on the shoot biomass (Table 4 and 5).

Significantly ($P \leq 0.05$) the highest shoot biomass was observed in the LBBM 60 kg N ha^{-1} treatments. This was statistically ($P \leq 0.05$) similar to the 30 and 45 kg N ha^{-1} treatments (Table 5). Similarly, the 60 kg N ha^{-1} CPM treated pot gave significantly the highest shoot biomass among the compost treatments (Table 5).

The 60 kg N ha^{-1} LBBM treatment significantly ($P \leq 0.05$) recorded the highest shoot biomass value of 43.61 g than those of the CPM manure treatments that had 29.70 g. Significantly the lowest shoot biomass of 16.93 g was obtained in the Control treatments (Table 4).

Table 5: Response of plant height, shoot biomass, fresh leaf weight and Number of leaves of Sesame to different rates of N in Compost and Little Brown Bat manures.

Manure rate	Plant Height (cm)	Fresh Shoot Biomass yield (g)	Fresh Leaf Weight (g)	Number of Leaves	Number of Branches (g)
0 kg N ha^{-1} (Control)	21.44c	6.49d	6.01	25.67d	4.89d
15 kg N ha^{-1} CPM	29.33bc	12.49d	6.48	44.33d	6.67abc
30 kg N ha^{-1} CPM	29.89bc	18.23cd	8.19	44.67bcd	9.78abc
45 kg N ha^{-1} CPM	33.44bc	19.96bcd	8.72	49.44bcd	9.00ab
60 kg N ha^{-1} CPM	35.11bc	22.06bcd	9.80	68.00cd	9.67abc
15 kg N ha^{-1} LBBM	42.00ab	28.20bcd	13.74	73.78abc	10.00ab
30 kg N ha^{-1} LBBM	43.44ab	44.15abc	15.98	94.67ab	10.22ab
45 kg N ha^{-1} LBBM	44.22ab	49.88ab	19.46	112.00ab	10.67ab
60 kg N ha^{-1} LBBM	53.33a	69.24a	24.65	120.78ab	11.67a
Significance	*	*	*	*	*
SE	4.65747	9.77	3.11	15.22	1.57
DMRT	13.1355	27.53	8.77	42.93	4.42

* = Significance at 5%, SE = Standard Error and DMRT = Duncan's Multiple Range Test

Means with the same letter are not significantly different.

Effects of Organic Manures on Fresh Leaf Weight of Sesame

Effects of organic manure on the fresh leaves weight are presented in Table 4 and 5. The application of organic manure did not affect fresh leaf weight significantly ($P \leq 0.05$) (Table 5). Numerically the highest fresh Leaf weight was recorded in 60 kg N ha^{-1} of LLBM (24.65 g) and CPM (9.80 g) treated plots (Table 5).

Irrespective of N rate treatments, the 60 kg N/ha LBBM treatments significantly ($P \leq 0.05$) had the highest fresh leaves weight (16.04 g) than those of the CPM treatment which recorded (12.74 g) and the control pots had (8.90 g) recorded the lowest fresh leaves weight.

Effects of Organic Manures on Number of Branches

Table 5 and 7 shows the effect of organic manure on the number of branches. The application of both organics manures were significant ($P \leq 0.05$) (Table 5 and 7). Significantly ($P \leq 0.05$) the highest number of branches was observed in the 60 kg N ha^{-1} LBBM treatments (Table 5). This did not differ statistically ($P \geq 0.05$) from the other rates of N - levels in both LBBM and CPM. Significantly ($P \leq 0.05$) the lowest number of branches was in the control treatments (Table 5). The 60 kg N ha^{-1} LBB had significantly the highest number of branches (11.67) than those of the CPM 60 kg N/ha treated pots (9.20) (Table 7). Control pots had 4.89 branches which was significantly the lowest. The bat manure performed better than the compost (Table 7).

Effects of Organic Manures on Number of Leaves of Sesame vegetable

Tables 4, 5, 6 and 7 reveals the effects of organic manure on number of leaves There was no significant different ($P \geq 0.05$) in number of leaves at 2, 4 and 6 WAP (Table 6). The 60 kg N ha^{-1} LLBM treatments had higher number of leaves (13.56) at 6 WAP. Compost manure with 60 kg N ha^{-1} rate recorded 13.11 while the control recorded 2.89 number of leaves (Table 6). Table 7 shows comparism of Compost and bat manure treatments irrespective of rates of application at 2, 4, and 6 weeks. The LLBM produced numerically higher leaf number than the CPM treatments. Number of leaves obtained was significant ($P \leq 0.05$) among the N – rates of both manure amendments (Table 5). The 60 kg N ha^{-1} LBBM treated pots recorded significantly ($P \leq 0.05$) the highest number of leaves (120.78) among treatments which was marginally higher than the 112.00 leaf number obtained in 45 kg N ha^{-1} LBBM treated plots. Among compost treatments, the highest number of leaves was also recorded in the 60 kg N ha^{-1} CPM treatments (Table 5). Table 4 shows the difference in number of leaves between compost and bat manures amended pots. The difference was statistically significant ($P \leq 0.05$). The LLBM plots produced significantly ($P \leq 0.05$) higher number of leaves (102.48) than the CPM (71.52) treatments (Table 4).

Table 6: Number of leaves of Sesame at 2, 4 and 6 weeks after planting as affected by N contents of Compost and Little Brown Bat manure amendments.

Manure rate	Number of leaves at 2 WAP	Number of leaves at 4 WAP	Number of leaves at 6 WAP
0 kg N ha^{-1} (control)	2.87	7.44	12.56
15kg N ha^{-1} CPM	2.89	7.56	13.11
30 kg N ha^{-1} CPM	3.00	7.56	13.11
45 kg N ha^{-1} CPM	3.11	7.44	13.22
60 kg N ha^{-1} CPM	3.22	7.56	13.11
15 kg N ha^{-1} LBBM	3.3	7.67	13.22
30 kg N ha^{-1} LBBM	3.44	7.78	13.22
45 kg N ha^{-1} LBBM	3.44	7.89	13.56
60 kg N ha^{-1} LBBM	3.44	7.89	13.56
Significance	NS	NS	NS
SE	0.18	0.18	0.28
DMRT	0.51	0.51	0.79

* = Significance at 5%, SE = Standard Error and DMRT = Duncan's Multiple Range Test. Means with the same letter are not significantly different.

Table 7: Comparative effects of Compost and Little Brown Bat manures amendment on number of leaves and branches of Sesame.

Manure type	Number of leaves at 2 WAP	Number of leaves at 4 WAP	Number of leaves at 6 WAP	Number of branches
Control	3.15	7.96a	13.11	6.44b
Compost manure	3.07	7.59b	13.44	8.78b
Bat manure	3.19	7.49b	12.82	11.11a
Significance	NS	*	NS	*
SE	0.11	0.11	0.16	0.88
DMRT	0.29	0.29	0.46	2.49

* = Significance at 5%, SE = Standard Error and DMRT = Duncan's Multiple Range Test. Means with the same letter are not significantly different.

Effects of Organic Manure N - rates on Leaf Area (LA).

Table 8 showed the effects of organic manure on leaf area at 2, 4 and 6 WAP. Except for leaf area values observed at 6 WAP that differed significantly, there was no significant difference in leaf areas at 2 and 4 WAP (Table 8). Generally, as N – rates increased the leaf area also increased in both LBBM and CPM treatments (Table 8).

The LBB at 60 kg N ha^{-1} recorded had 37.00 m^2, while CMP recorded 34.33 m^2 while the control pots recorded lowest leaf area value of 32.00 m^2 at 6 WAP. These values were only marginally different from those values obtained in 30 and 45 kg N ha^{-1} treated pots.

Table 8: Influence of N – rates in Compost and Little Brown Bat manures on leaf area index and leaf area at 2, 4 and 6 weeks after planting.

Manure rate	LAI at 2 WAP	LAI at 4 WAP	LAI at 6 WAP	LA (cm^2) at 2 WAP	LA (cm^2) 4 WAP	LA (cm^2) 6 WAP
0 kg N ha^{-1} (control)	8.00b	11.00b	13.67b	18.67	26.33	32.00ab
15kg N ha^{-1} CPM	8.17b	11.67ab	14.50ab	19.60	26.67	32.33ab
30 kg N ha^{-1} CPM	8.17b	11.67ab	14.50ab	19.00	26.67	32.67ab
45 kg N ha^{-1} CPM	8.37ab	11.67ab	15.17ab	19.00	26.67	34.33a
60 kg N ha^{-1} CPM	8.33ab	11.67ab	15.83ab	19.00	27.00	34.33a
15 kg N ha^{-1} LBBM	8.33ab	11.83ab	16.00ab	19.00	27.00	34.33a
30 kg N ha^{-1} LBBM	8.33ab	12.00ab	16.17ab	19.00	27.67	36.00a
45 kg N ha^{-1} LBBM	8.67ab	12.067ab	17.00a	19.33	28.33	`36.33a
60 kg N ha^{-1} LBBM	9.50a	13.67a	17.33a	20.00	28.67	37.00a
Significance	*	NS	*	NS	NS	NS
SE	0.24	0.44	0.60	0.71	0.99	1.42508
DMRT	0.73	1.33	1.79	2.13	2.97	4.27242

* = Significance at 5%, SE = Standard Error and DMRT = Duncan's Multiple Range Test. Means with the same letter are not significantly different.

Effects of Organic Manures application on Leaf Area Index (LAI) of Sesame.

Table 8 also reveals the effect of organic manure on the leaf area index of Sesame. The organic manure applied significantly ($P \leq 0.05$) affected the leaf area index at 2, 4 and 6 WAP

The 60 kg N ha^{-1} LBBM recorded significantly the highest leaf area index (17.33) among the organic manure amendments. The CMP 60 kg N ha^{-1} had 15.83. These values were very similar to those obtained in 15, 30 and 45 kg N ha^{-1} treatments in each of the amendment types. The control pots recorded 13.67 which was the lowest leaf area index obtained at 6 WAP.

DISCUSSIONS

The soil was of medium fertility **with Ca and Mg dominating the exchange complex**. It has N, P, OC, CEC, exchangeable cations contents that were generally of medium nutrient rating according to Esu (1991) nutrient levels categorization. This corroborates the findings of Mohammed *et. al.* (2020). They reported medium soil fertility at the study area.Thus, the need for fertilizer amendment to the soil in order to produce optimum yield of Sesame vegetable. The high nutrient contents of the organic manures indicated that they can be made available to crops on mineralization. Atoleye *et al.* (2014) recorded 6.1, 4 %, 0.56 %, 0.22 %, 2.25 % and 0.32 % values in pH, OC, N, P, K and Na, respectively which, were similar to those obtained in compost manure used in this work. The nutrient contents of LLBM were higher than those of the CPM. On the other hand, Nikki (2018) reported 10, 3 and 1 percent N, P and K respectively in little brown bat dropping because they are insectivorous. This work corroborates the findings of Musa *et. al.* (2016). They reported OC, N, P, CEC, K and Ca in insectivorous Bumblebee bat droppings that were comparable to medium to high nutrient critical levels reported by Esu (1991). The application of theses organic manure is thus, a viable strategy to enhancing soil nutrient status and sesame vegetable production. The use of organic amendments applied to soil not only enhances its nutrient status but also improve crop yield and quality (Abdulmaliq *et al.*, 2017). The general increase in plant growth parameters in response to manure types in this study were in agreement with the report of the studies conducted on Amaranthus by (Abdulmaliq *et al.*, 2017). The result revealed that Amaranthus treated with the highest poultry manure rate of 18 t ha^{-1} attained the highest plant height of 99.45 cm in the two years combined while those that received no manure treatment reached a highest height of 69.18 cm. Also, Shehu, *et al.* (2006) reported increased growth parameters in *Sesame indicum* as the N rates increased from37.5 to 112.5 kg ha^{-1}. Auwalu (2007) observed similar responses of Sesame vegetable growth parameters to application fertilizer application. The difference among the Bat manure and compost could be attributed to the larger N, P and K, bat contents when compare with those the compost used in this experiment. This probably explained the higher growth values recorded in the LBBM treatments than the compost. Control treatments recorded the lowest yield values among treatments. This corroborates the findings of Mohammed *et al.* (2020). They reported relative herbage yield increase in poultry and little brown bat droppings in 6 t ha^{-1} treated soils when compared with control.

CONCLUSION AND RECOMMENDATIONS

Conclusion

All the growth and yield parameters investigated in this work were highest with manure rates of 60 kg N ha^{-1} than the other treatments in both amended manures. Although these values were generally similar to those obtained in 45 kg N ha^{-1} treatments in both treatments. Also parameters investigated increased numerically from 2 to 6 weeks after planting.

Recommendation

From the result obtained in this study, cultivation of vegetable Sesame with the application of 45 kg N ha^{-1} of little brown bat manure and 60 kg N ha^{-1} of compost are hereby recommended to farmers in Mokwa Southern Guinea Savannah Agro-ecological zone of Nigeria.

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Evaluation of Weight Loss Caused By *Prostephanus Trucatus* on Two Processed Forms of Cassava Chips Treated With *Zingiber Officinale* and Deltamethrin

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ABSTRACT

In Africa, *Prostephanus truncatus* is a destructive pest of economic importance which has deteriorative effects on dry cassava chips in storage. The present study investigates the effects of *Zingiber officinale* on *P.truncatus* on dried cassava chips processed in two methods. Deltamethrin was used as the reference insecticide. The plant extract was used at different concentrations (500ul/ml, 250ul/ml, 125ul/ml, 62.5ul/ml, 0ul/ml (control) and 0.05ul/ml (reference)). The cassava variety used is TME 419. The cassava variety was cut into cubes and subjected to two processing methods, parboiling and unparboiling (plain). Percentage emergence was assesed as thus; 100g of cassava chips were put in a plastic plate. 10 unsexed adult of *P.truncatus* were introduced into each plate and left for 14days to oviposit, after which the insects were removed, the chips were thereafter treated with *Z.officinale* at (500ul/ml, 250ul/ml, 125ul/ml, 62.5ul/ml, 0ul/ml (control) and 0.05ul/l (Deltamethrin). The plates were covered with muslin cloth held with a rubber band and left to stand for 25 days. After which the percentage emergence was assessed, by counting. All the data generated were subjected to one-way analysis of variance (ANOVA) in Genstat package 9.2 (9th edition). Difference between mean values were separated using least significant difference (LSD) at $P<0.05$ (Finney 1971). The result of the experiment showed that *Z.officinale* conferred greaterprotection to the chips at higher concentrations of 250ul/ml and 500ul/ml, its effects were similar to the reference insecticide. Processing methods recorded a great significance ($P <0.05$).

Key words: *Z. officinale*, Deltamethin, P.*truncatus*, Cassava chips

1. INTRODUCTION

Cassava *(Manihot esculentus)* is a staple food crop in Africa, produced in large quantity by peasant and commercial farmers with Nigeria being the highest producer in the world. (FAO, 2013). In order to prevent its deterioration and wastage, fresh roots of cassava are converted into dried chips. The process of conversion into chips, is achieved by drying and subsequent storage for long periods until needed.however during this storage period, dry cassava chips are exposed to attack by insect pests, thus threatening food security in sub-Saharan Africa. Parker and Booth. (1979) reported thatcassava chips are heavily infested during sun drying and when in store by a number of stored product pests including the larger grain borer *P. truncatus* (GASGA, 1993).

The Larger Grain Borer (LGB), Prostephanus *truncatus* (Horn) (Coleoptera: Bostrichidae), is a stored product pest beetle indigenous to Central America (Chittedon, 1911), where it has spread to many countries (Eppo, 2013) . In Africa, it was accidentally introduced through Tabora region of Tanzania in the late 1970s the capacity to exploit a new environment (Dick, Ress, Lay and Ofusu 1989). This pest has become a serious pest of stored maize and dried cassava in part of east, South and West Africa (Eppo, 2013). In, Southwestern part of Nigeria, the earliest reports of *P. truncatus* indicated its presence in areas of Oyo, Ogun and Lagos States, mostly in areas near the border with the Republic of Benin (Pike, Akinnibagbe and Bosque-Peres 1992) . However, Echendu and Ojo (1997) reported that *P. truncatus* has moved out of the border areas of the south-west from where it probably entered into the country but extent of spread is yet unknown. According to Espinal , Markham and Wright *(*1996), adult and larval stages of *P. truncatus* has ability to damage wide range of commodities including some roots and tubers, cereals, pulses, cocoa, coffee, groundnut and wooden structures.

Ginger [*Zingiber officinale* (Rosc.)] is a perennial root crop that is cultivated in almost all the tropical and subtropical regions of the world (Kannan and Nair, 1965).Nigeria is currently the world's fifth largest producer and exporter of ginger especially the split-dried ginger (Arene, Okwor and Okwuowulu 1986). The bio-activities of Zingiber officinale rhizome (Ginger), was investigated in the laboratory against P. truncatus at different proportions (25%, 20%, 15%, 10% and 5% wt/wt) with Actellic dust insecticide as a reference insecticide. The highest proportions (25% wt/wt) of Z. officinale powder significantly reduced the survival of P. truncatus to 0% after 12 days of treatment (Ogbonna *et al.*, 2014).

The pesticide effect of ginger essential oil was confirmed against adults and larva of *Dermestes maculatus* De Geer (adult and larva). 1.33 µl/ml essential oil exposure of adult pest for 6 h caused 36.2% mortality. The larva was more sensitive than that of adults. The percentage of mortality increased with time exposure of pest with essential oil. The LD_{90}(lethal dose) of ginger essential oil were 12.92, 5.14 and 3.06 after 6, 12 and 18 h exposure of *D. maculatus* larva. The corresponding LD_{90} were 6.52, 4.64 and 4.64 on adults of *D. maculatus* (Babarinde *et al*, 2016).

2. MATERIALS AND METHODS

2.1 STUDY AREA

The study was carried out in the Department of Parasitology and Entomology, at the Science Village of the Faculty of Bioscience Nnamdi Azikiwe University Awka (6°14'N ,6°14.5'N to 7°8, 6°E, 7°9'E) Anambra State (6°25'N, 7°12'E) The annual rainfall of the area ranges from 1,000mm

- 1,500mm with 2 seasons – dry and rainy.

2.2 EXPERIMENTAL DESIGN

The experiment was laid out in 5x2(concentration and processing methods) factorial experiment in Completely Randomized Design (CRD) with each treatment repeated 3 times.

2.3 EXPERIMENTAL INSECT COLLECTION AND CULTURE

The adult larger grain borer, *P.truncatus* that was used for the study was obtained from commercial produce stores in Eke Awka market. One kilogram (1kg) of the dried cassava chips containing both lavae and adult was weighed into a transparent 2kg bucket. Prior to the culturing. One kg of the dried cassava in a sealed polythene bag was refrigerated for 3 days at 4^{o}C to kill any hidden infestation. Thereafter, it was infested with the pest. The Culturing lasted for a period of 40 days under ambient laboratory temperature and humidity conditions. The newly emerged F1 adults was used for the experiment.

2.4. COLLECTION OF CASSAVA VARIETIES AND PROCESSING

Genetically improved cassava variety TME 419 was used for the study; which was collected from National Root Crop Research Institute substation at Igbariam Anambra State. Fifty kg of the cassava was peeled, washed and cut into sizes of approximately 2 to 5cm and subjected into two processing methods, which were:

a) Parboiling for 2minutes at the boiling point of water (100°C) and continuous stirring of the mixture .the ratio of cassava chips(kilogram) to volume of water(liters)used was 1:3 w/v (modification method by Rajamma, Padmaja and Lakshmi,1994).
b) Oven drying at 70°C for 24hrs immediately after peeling without any pre-treatment.

The dried samples were later conditioned for 2 weeks under room temperature before use. This was done to equilibrate the chips with experimental room temperature (Chijindu *et al.,* 2008).

2.5. SOURCE AND EXTRACTION OF Z.OFFICINALE

Z.officinale rhizome was sourced from Eke Awka market. Two kg each of these plant products were peeled, sliced, and dried under shade for 12days at 65^{o}C, it was thereafter pulverized. The crude extracts were extracted using n-hexane in Soxhlet apparatus. The n-hexane was removed with rotary evaporator. The extraction was carried out in Botany laboratory in the Department of

Botany, Nnamdi Azikiwe University, Awka.

2.6 SOURCE OF DELTAMETHRIN

Deltamethrin 12.5 EC equivalent of 15.5g/l of active ingredient was sourced from Comfort Agro Chemical Nigeria Limited Onitsha, Anambra State,

0.005ul/ml of Deltamethrin was used for the experiment as a reference. Several studies have shown the effectiveness of Deltamethrin at rate varying from 0.0005 – 0.005ul/ml (Daglish 1998; Athanassiou *et al.,* 2004).

2.7 **Serial Dilution of** ***Z. Officinale***

The serial dilution of the crude extract was prepared in acetone using 20ml syringe to obtain 50%, 25%, 12.5% and 6.25% thus obtaining 500 ul/ml, 250 ul/ml, 125 ul/ml and 62.5 ul/ml of oil per 1 ml respectively.

2.8 EFFECT OF PLANT EXTRACT ON PROGENY DEVELOPMENT AND ADULT EMERGENCE

The effect of the crude extract on progeny was determined by modifying the method used by Eziah , Buxton and Owusu (2013). Each of the different forms of the processed chips of 100 g each were weighed and put into separate plastic plates, which were infested with 10 unsexed adults of *P.trucatus* . The cups were covered with a muslin cloth and held with a rubber-band to aid ventilation and prevent the escape of the insects. The set up were allowed to stand in the laboratory for 2wks to allow oviposition. Thereafter, the adult insects were sieved out and the set up were treated with different concentrations of *Z.officinale* at (500 ul/ml, 250 ul/ml, 125 ul/ml and 62.5 ul/ml) and Deltamethrin at 0.005ul/ml .The applications were done with the aid of a syringe and mixed thoroughly. The set up were monitored for 25 days for larval and pupal development (Okonkwo, Nwankwo and Uko 2014). Deltamethrin insecticide was used as a standard reference while acetone was used as the control, each treatment was replicated 3 times. The number of adults that emerged after the 25 days were counted and recorded

2.9 DATA ANALYSIS

The data collected on insect mortality, damage and loss was subjected to one-way analysis of variance (ANOVA) in Genstat package 9.2 (9^{th} edition). Difference between mean values were separated using least significant difference (LSD) at $P<0.05$ (Finney 1971).

3. RESULTS

3.1 Evaluation of emergence of *P. truncatus* cassava chips with *Z. officinale*

The effect of concentration, variety and processing method on emergence of *P. truncatus* on cassava chips is shown in Table 1. The result obtained shows that there was a significant difference in the concentration levels and processing methods, whereas there was no significant difference in the varieties. Deltamethrin (0.005 ul/ml), *Z. officinale* (500 ul/ml and 250 ul/ml) recorded the same(zero) emergence, followed by 125ul/ml. the highest emergence was recorded at 0 ul/ml. TME 419recorded lesser emergences, whereas the parboiled chips recorded a significantly lesser emergence.

The interaction effect of concentration and processing method on emergence of *P. truncatus* on cassava chips is shown in Table 2. There was a significant difference in the concentration and processing method interaction. The two processing methods recorded zero emergence at 500 ul/ml, 250 ul/ml and Deltamethrin (0.005 ul/ml). Parboiled chips recorded a significant lesser emergence at 125 ul/ml, 62.5 ul/ml and 0 ul/ml.

Table 1: Main effect of Concentration and Processing method on emergence with *Z. officinale*

Concentration (ul/ml)	Emergence
Z. officinale (500)	0.00
Z. officinale (250)	0.00
Z. officinale (125)	27.75
Z. officinale (62.5)	40.67
Z. officinale (0.00)	122.08
Deltamethrin (0.005)	0.00
$LSD_{(0.05)}$	7.09
P.M	
Plain	26.37
Parboiled	20.57
$LSD_{(0.05)}$	5.05

Table 2: Effect of Concentration and Processing method interaction on emergence with *Z. officinale*

Concentration(ul/ml)	Processing method	Emergence
Z. officinale (500)	Plain	0.00
	Parboiled	0.00
Z. officinale (250)	Plain	0.00
	Parboiled	0.00
Z. officinale (125)	Plain	27.33
	Parboiled	20.66
Z. officinale (62.5)	Plain	38.67
	Parboiled	32.83
Z. officinale (0.00)	Plain	123.17
	Parboiled	111.00
Deltamethrin (0.005)	Plain	0.00
	Parboiled	0.00
LSD(0.05)		2.89

4. DISCUSSION

The research was carried out at Parasitology and Entomology laboratory Nnamdi Azikiwe Unuversity and Maeve Scientific Laboratory Awka, Anambra state to investigate comparative performance of *prostephanus truncatus*(horn) (coleoptera:bostrichidae) on cassava (*manihot esculenta(crantz))* chips treated with plant extracts

The chips were subjected to 2 processing methods – parboiled and unparboiled (plain) before the infestation of *P.truncatus*. The two insecticides used for the experiment are *Z.officinale* and deltamethrin

In emergence assessment for *Z.officinale*, there was a significant difference ($P < 0.05$) in the concentrations. 500ul/ml and 250ul/ml recorded no emergence which is same as the reference. The processing methods have significant ($P < 0.05$) effect on the emergence. In a similar work by Chijindu *et al.*, (2008), he also reported that parboiled cassava chips recorded the least number of

P.truncatus. The effect of processing method wasn't significant (P > 0.05) at higher concentrations (250ul/ml and 500ul/ml).

4.2 CONCLUSION AND RECOMMENDATION

Z.officinale was effective as the reference insecticide at higher concentration. If the concentration of *Z.officinale* used was higher than 500ul/ml, it would have achieved same result as the reference. The two processing methods showed great effect on all the assessments, parboiling confers greater protection to chips in respect to pest attacks, therefore it is highly recommended

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Response of Mungbean (*Vigna Radiata* L Wilczek) Genotypes to Different Spacing Types in Derived Savanna Agroecology of Southeast Nigeria

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ABSTRACT

Population density is an important determinant of crop yield. For optimum crop production, the best spacing requirement must be adopted. Although the recommended spacing requirement of mungbean is abundant in literature globally, there is no such information on studies conducted within derived savanna agro-ecological zone of southeast Nigeria, despite the crop's usefulness as food, green manure and nitrogen fixer. We hypothesized that spacing requirement of mungbean may vary with genotype. Hence, this study was conducted to evaluate the response of three mungbean genotypes to four spacing types in derived savanna agroecology. The experiment was a split-plot design with genotype (Tvr18, Tvr65, and Tvr83) as the main plot treatment and plant spacing (30x10, 40x10, 30x15 and 40x15 cm) as the sub-plot treatment. Data were collected on 19 agronomic traits. Analysis of variance (ANOVA) showed that plant spacing of 30x10 cm influenced significantly higher ($p<0.05$) values in most agronomic traits measured while Tvr18 was higher in pod and seed attributes with higher seed-yield (0.80 t/ha) compared to Tvr83 (0.52 t/ha) which was the least. Interaction effect of Tvr18 by 30x10 cm gave higher seed yield of (1.37) t/ha compared to Tvr83 by 30x10 cm (0.62 t/ha) which was the least.

Keywords: mungbean, spacing requirement, genotype effect, growth, seed-yield

INTRODUCTION

The spacing requirement of a crop is a critical component of crop productivity. Crop growth and yield are often influenced by the area of space available to a plant (Rafiei, 2009). Although several reports have recommended a spacing of 30x10 cm as optimum for mungbean production across several regions of the world (Sarkar *et al*., 2004; Kassaye *et al*., 2020), report on plant spacing recommendation in derived savanna agroecology of southeast Nigeria is non-existent in literature. Plant spacing could vary with genotype (Sekhon *et al*., 2002). We hypothesized that spacing requirement of mungbean may vary with genotype. As an introduced crop in the agroecology, it is necessary to investigate its response to different plant spacing.

Mungbean ranks top as the most economically important crop of the vigna group and also doubles as the most nutritious pulse in existence (Anjum, 2011), with over 30% protein, 45% carbohydrate, 65% fiber and substantial concentrations of vitamins and minerals (Hueze *et al*., 2015; Ihejiofor *et al*., 2022). The seeds are reservoirs of digestible proteins for man in regions where animal protein is expensive, scarce or lacking, and where people are mostly vegetarian (AVRDC, 2012). Due to its diverse use, it could be eaten fresh as vegetable (Mogotsi, 2006), cooked to porridge or soups or processed into noodles, flour, bread and ice-cream. Mungbean could provide an alternative and cheap source of plant based non-flatulence proteins, essential minerals and vitamins especially in areas where soybean and cowpea are not readily available.

Mungbean can fix atmospheric nitrogen up to 109 kg per ha in symbiotic association with rhizobium bacteria (Mehandi *et al.*, 2019) which enables them to meet their own nitrogen requirement and also benefit the succeeding crops as well as companion crops when intercropped.

Genotype (Ukwu and Olasanmi, 2018) and population density (Mondal *et al.*, 2012) are key determinants of crop yield. Determining the genotype and corresponding population density with the highest yield could lead to a significant breakthrough in the struggle for discovering cheap alternative plant derived protein sources. Hence, this study was therefore carried out to investigate the response of mungbean genotypes to different spacing treatments.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at the Teaching and Research Farm of the Department of Crop Science, Faculty of Agriculture, University of Nigeria, Nsukka. The University is situated in the derived savanna agro ecological zone of Nigeria, at latitude 06°52'N, longitude 07°24'E and 447 altitudes.

Experimental Materials and Treatments

Three (3) accessions of Mungbean (Vigna radiata (L) R Wilczek) sourced from the Genetic Resource Centre, International Institute of Tropical Agriculture (IITA), Ibadan were used for this study. The accessions include:

i. $TVR_{18}(A_1)$
ii. $TVR_{65}(A_2)$
iii. $TVR_{83}(A_3)$

Four plant spacing types including 30×10 (S_1), 40×10 (S_2), 30×15 (S_3), and 40×15 (S_4), corresponding to population densities of 333 333, 250 000, 222 222 and 166 667 plants per hectare were used for the study.

Experimental Design

The experiment was laid out in a split plot design with three replications. Three accessions of mungbean ($A_{1,}$ $A_{2,\ and}$ A_3) and four plant spacing types (S_1, S_2, S_3 S_4) constituted the main and sub-plot treatments, respectively.

Field Establishment

The study was a field experiment carried out between June to October 2021. Thirty six (36) beds were made on a land area measuring 20 × 30 m^2. The land was cleared and beds made manually using hoe. The land was divided into three blocks. Each block was partitioned into twelve (12) plots, each measuring 1.2 m × 1 m with spacing of 1 m between plots. A blanket dose of 10 t/ha poultry manure was applied 2 weeks before planting. Two seeds were sown per stand at a depth of 1.5 cm, and later thinned to one at 2 weeks after planting (WAP). Weeding was done manually using hoe as at when due. Seeds were primed by soaking in water for 12 hours the night preceding the date of planting to accelerate germination and to ensure that only viable seeds aresown.

Data Collection

Data were collected number of days to first seed emergence (NODTFSE), plant height (PHt), leaf area (LA), stem diameter (SD), number of branches (NOB) $plant^{-1}$, number of pods (NOP) $plant^{-1}$, number of seeds (NOS) pod^{-1}, pod length (PL), pod width (PW), seed length (SL), seed width (SW), seed thickness (ST), average seed weight (ASW), 100 seed weight (100-SW), seed yield (SY). All data were measured following the standard procedures used by Ihejiofor *et al*. (2020, 2022).

Statistical Analysis

Data were tested for significance using analysis of variance (ANOVA) and significant treatment means were separated using LSD at $p<0.05$. GenStat 12.0 version was used for analysis.

RESULTS

Effects of Accession and Plant Spacing on Phenology and Growth Traits of Mungbean

The result presented in Tables 1 and 2 showed significant difference ($p<0.05$) for accession, plant spacing, and accession by plant spacing interaction in most of the growth traits measured.

The effect of accession on number of days to emergence was significant ($p<0.05$). Accessions Tvr18 and Tvr65 emerged earlier at 2 days after planting compared to Tvr83 that emerged after 4 days. Plant spacing did not significantly ($p>0.05$) influence number of days to emergence as the four plant spacing were comparable a mean of 2 DAP.

The effect of accession on plant height, leaf area, number of branches and stem diameter was significant ($p<0.05$) at 6, 8 and 10 weeks after planting (WAP). Accessions Tvr65 and Tvr18 were significantly higher in plant height, leaf area and stem diameter than Tvr83. However, Tvr83 produced higher number of branches than TVR65 and Tvr18 (Table 1).

The effect of spacing on plant height was significant ($p<0.05$) at 8 and 10 WAP. Plant spacing 30x10 cm and 40x10 cm significantly influenced taller plants than 30x15 cm and 40x15 cm. Plant spacing did not significantly influence ($p>0.05$) number of branches, leaf area and stem diameter at 6,8 and 10 weeks as all plant spacing produced similar result (Table 1).

Table 1: Main Effect of Accession and Plant Spacing on Growth Parameters of Mungbean in the Field

Treatment	Days to emergence	Plant height (cm)			No of Branches			Leaf Area (cm^2)			Stem Diameter (cm)		
		Weeks After Planting											
		6	8	10	6	8	10	6	8	10	6	8	10
Accession													
TVR18	2.00	32.59	47.78	67.61	6.86	7.94	9.39	120.06	145.43	197.60	0.62	0.76	0.94
TVR65	2.00	36.54	53.86	74.17	7.03	8.06	9.42	144.33	162.07	177.34	0.69	0.81	0.96
TVR83	4.00	21.32	26.75	33.94	8.39	8.69	9.03	64.26	62.80	58.84	0.50	0.55	0.57
$LSD_{(0.05)}$	0.460	5.962	7.315	8.030	0.844	0.599	NS	24.550	23.772	61.536	O.11	0.095	0.080
Spacing													
S_1	2.20	34.15	49.63	65.67	7.33	8.63	9.81	117.77	131.62	146.06	0.67	0.79	0.89
S_2	2.40	32.72	45.96	60.85	7.67	8.37	9.41	120.24	129.74	139.35	0.61	0.71	0.83
S_3	2.20	25.80	40.19	57.59	7.22	7.96	9.22	91.05	114.34	137.00	0.55	0.65	0.81
S_4	2.25	27.93	35.41	50.19	7.48	7.96	8.67	109.14	118.04	155.96	0.58	0.67	0.78
$LSD_{(0.05)}$	NS	NS	8.447	9.273	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS = non-significant; S_1 = 30x10cm; S_2 = 40x10cm; S_3 = 30x15cm; S_4 = 40x15cm; Ac. = Accession; Sp. = Spacing

Table 2: Interaction Effect of Accession and Plant Spacing on Growth Parameters of Mungbean in the Field

Treatment Combination		Days to emergence	Plant Height(cm)			No. of Branches			Leaf Area(cm^2)			Stem Diameter (cm)		
Spacing	Accession		6	8	10	6	8	10	6	8	10	6	8	10
S_1	TVR18	2.00	38.79	58.44	78.67	7.00	8.33	9.78	128.94	171.56	191.78	0.69	0.83	1.03
	TVR65	2.10	42.78	64.00	84.56	7.00	8.67	10.44	161.06	162.66	189.84	0.72	0.87	1.02
	TVR83	4.30	20.89	26.44	33.78	8.00	8.89	9.22	63.31	60.64	56.57	0.59	0.67	0.60
S_2	TVR18	2.10	34.33	50.56	71.11	7.56	8.44	9.33	156.46	164.72	169.55	0.66	0.79	0.96
	TVR65	2.15	39.11	58.22	76.78	7.56	8.33	9.89	132.72	161.33	189.06	0.69	0.83	0.97
	TVR83	4.10	24.72	29.11	34.67	7.89	8.33	9.00	71.54	63.18	59.44	0.5	0.5	0.57
S_3	TVR18	2.20	25.78	45.56	67.44	5.89	7.56	10.11	66.46	113.83	165.01	0.5	0.67	0.93
	TVR65	2.35	31.94	47.89	68.89	7.00	7.67	8.67	146.14	165.89	185.22	0.7	0.79	0.97
	TVR83	4.00	19.67	27.11	36.44	8.78	8.67	8.89	60.56	63.31	60.76	0.46	0.5	0.53
S_4	TVR18	2.30	31.44	36.56	53.22	7.00	7.44	8.33	128.38	131.62	264.06	0.63	0.73	0.86
	TVR65	2.20	32.33	45.33	66.44	6.56	7.56	8.67	137.40	158.42	145.24	0.64	0.76	0.90
	TVR83	4.15	20.00	24.33	30.89	8.89	8.89	9.00	61.64	64.08	58.59	0.47	0.53	0.58
$LSD_{(0.005)}$		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS = non-significant; S_1 = 30x10cm; S_2 = 40x10cm; S_3 = 30x15cm; S_4 = 40x15cm

Effect of Accession and Plant Spacing on Yield Parameters of Mungbean

The main effect and interaction effect of accession and plant spacing on yield traits are shown in Tables 3 and 4 respectively.

The effect of accession on number of pods per plant (NOP plant^{-1}), number of seeds per pod (NOS pod^{-1}), number of seeds per plot (NOS plot^{-1}), pod length (PL), pod width (PW), seed length (SL), seed thickness (ST) and 100 seed weight (100-SW) was significant ($p<0.05$). Accessions Tvr18 and Tvr65 significantly produced higher NOS pod^{-1}, higher NOS plot^{-1}, longer pods, wider pods and longer seeds than Tvr83. However, Tvr83 produced higher NOP plant^{-1}, thicker seeds and higher 100-SW than Tvr18 and Tvr65.

NOS plant^{-1}, SW, PW and SY were not significant ($p>0.05$) as the three accessions recorded comparable results.

The main effect of plant spacing on NOP plant^{-1}, NOS plot^{-1}, PW, SW, and SY per hectare was significant ($p<0.05$). Plant spacing 30x10 cm and 40x10 cm produced significantly higher NOP plant^{-1}, higher NOS plot^{-1}, wider pods and higher SY than 30x15 cm and 40x15 cm. However, plant spacing 40x10 cm and 30x15 cm produced significantly wider seeds compared to 30x10 cm and 40x15 cm. The plant spacing 40x10 cm and 40x15 cm influenced significantly the highest PW than 30x10 cm and 30x15 cm.

NOS pod^{-1}, NOS plant^{-1}, PL, SL, ST, 100-SW and PW were not significantly influenced ($p>0.05$) by plant spacing as all plants spacing produced similar results (Table 3).

Table 3:Main Effect of Accession and Plant Spacing on Yield Parameters of Mungbean in the Field

Treatment	No. of pods /plant	No. of seeds /pod	No. of seeds /plant	No. of seeds /plot	Pod length (cm)	Pod width (cm)	Seed length (cm)	Seed width (cm)	Seed thickness (cm)	Avr. pod weight (kg)	Plot weight (kg)	100 seed weight (g)	Pod weight (t/ha)	Seed yield (t/ha)
Accession														
TVR18	68.90	11.16	757.00	22876	8.52	0.17	0.42	0.36	0.35	15.60	0.44	42.00	3.68	0.80
TVR65	56.90	10.30	585.00	17165	8.38	0.19	0.44	0.35	0.35	14.50	0.43	43.00	3.54	0.61
TVR83	75.10	6.88	517.00	14102	4.67	0.11	0.46	0.34	0.38	18.00	0.53	45.00	4.38	0.52
$LSD_{(0.05)}$	15.10	1.699	NS	7079	0.32	0.03	0.03	NS	0.014	NS	NS	1.674	NS	NS
Spacing														
S_1	80.50	8.04	680.00	27192	7.19	0.16	0.43	0.34	0.36	13.10	0.52	43.33	4.35	0.96
S_2	63.70	9.64	606.00	18182	7.21	0.19	0.46	0.37	0.37	19.30	0.58	43.33	4.82	0.65
S_3	50.20	9.38	495.00	12865	7.17	0.14	0.45	0.36	0.38	12.30	0.34	43.33	2.87	0.46
S_4	73.40	10.73	698.00	13951	7.18	0.15	0.44	0.33	0.36	19.60	0.41	43.33	3.43	0.51
$LSD_{(0.05)}$	17.440	NS	NS	8174.6	NS	0.032	NS	0.025	NS	6.360	NS	NS	NS	0.283

NS = non-significant; S_1 = 30x10cm; S_2 = 40x10cm; S_3 = 30x15cm; S_4 = 40x15cm

Table 4: Interaction Effect of Accession and Plant Spacing on Yield Parameters of Mungbean in the Field

Spacing	Accession	No. of pods/ Plant	No. of seeds/pod	No. of seeds /plant	No. of seeds /plot	Pod length (cm)	Pod width (cm)	Seed length (cm)	Seed width (cm)	Seed thickness (cm)	Avr. Pod Weight (g)	Plot weight (kg)	100 seed weight (g)	Pod Weight (t/ha)	Seed yield (t/ha)
S_1	TVR18	104.80	9.07	977.00	39087.00	8.71	0.21	0.41	0.35	0.33	10.00	0.40	42.00	3.33	1.37
	TVR65	72.80	8.48	643.00	25717.00	8.18	0.16	0.41	0.33	0.33	13.30	0.53	43.00	4.44	0.91
	TVR83	64.00	6.57	419.00	16771.00	4.65	0.12	0.46	0.33	0.39	15.80	0.63	45.00	5.27	0.62
S_2	TVR18	69.90	11.47	758.00	22739.00	8.58	0.20	0.41	0.40	0.35	20.00	0.60	42.00	5.00	0.81
	TVR65	59.80	10.19	612.00	18362.00	8.51	0.24	0.51	0.36	0.35	16.70	0.50	43.00	4.17	0.65
	TVR83	61.60	7.27	448.00	13445.00	4.52	0.11	0.46	0.35	0.39	21.10	0.63	45.00	5.28	0.50
S_3	TVR18	50.30	11.21	640.00	16650.00	8.39	0.12	0.47	0.37	0.38	11.90	0.33	42.00	2.78	0.58
	TVR65	45.60	10.21	477.00	12395.00	8.42	0.18	0.42	0.36	0.37	10.70	0.30	43.00	2.50	0.44
	TVR83	54.80	6.72	367.00	9550.00	4.70	0.11	0.46	0.36	0.37	14.30	0.40	45.00	3.33	0.36
S_4	TVR18	50.40	12.90	651.00	13028.00	8.37	0.14	0.40	0.32	0.34	20.60	0.43	42.00	3.61	0.46
	TVR65	49.70	12.31	609.00	12184.00	8.39	0.19	0.44	0.33	0.34	17.50	0.37	43.00	3.06	0.44
	TVR83	120.20	6.98	832.00	16642.00	4.77	0.12	0.49	0.34	0.38	20.60	0.43	45.00	3.61	0.62
	$LSD_{(0.05)}$	30.210	NS	NS	NS	NS	0.056	0.051	NS	0.014	NS	NS	NS	NS	NS

NS = non-significant; S_1 = 30x10cm; S_2 = 40x10cm; S_3 = 30x15cm; S_4 = 40x15cm

DISCUSSION

Two accessions Tvr65 and Tvr18 showed similarity in the number of days to emergence, emerging after two days in contrast to Tvr83 that emerged after 4 days. This similarity in days of emergence for Tvr65 and Tvr18 could be as a result of the similarity in their genetic constitution which differed from a distant relation like Tvr83. This report is in agreement with Dauda *et al*. (2023). Plant spacing did not significantly influence days to emergence indicating that all plant spacing responded comparably to number of days to emergence.

Genotypes from same parent tend to have similar genetic traits which will differ from a distant relation. In respect to that Tvr65 and Tvr18 showed similarity in their growth and yield traits compared to Tvr83 which recorded thinner leaves, shorter pods, shorter plants, more branches and brighter colored seeds in contrast to Tvr65 and Tvr18 which possessed broader leaves, longer pods, taller plants etc. (Tables 3 and 4). Variation in the growth and yield characteristics such as plant height, leaf area, stem diameter, NOS plant^{-1}, pod length, seed yield as a function of genotype has also been reported by Yimram *et al*. (2009), Sultana (2014), and Dauda *et al*. (2023).

Plant spacing significantly influenced some growth and yield parameters like plant height, NOP plant^{-1}, NOS plant^{-1}, pod width, seed width, and seed yield with the plant spacing 30x10 cm and 40x10 cm producing significantly taller plants, higher NOP plant^{-1}, higher NOS, wider pods, higher pod weight and higher seed yield. The plant spacing 30x10 cm was superior in most growth and yield traits in contrast to the plant spacing 40x10 cm, 30x15 cm, 40x15 cm. This is in agreement with Sarkar *et al*. (2004) and Kassaye *et al*. (2020) who reported higher growth and yield traits of mungbean with plant spacing of 30x10 cm.

CONCLUSION

The study showed that accession, plant spacing and accession by plant spacing interaction significantly influenced growth and yield attributes of mungbean. The accessions Tvr65 and Tvr18 yielded higher than Tvr83, while 30x10 cm plant spacing gave higher seed yield than the other treatments.

Interaction effects of Trv65, Tvr18 with plant spacing 30x10 cm produced significantly higher growth and yield attributes than the other interactions.

RECOMMENDATION

The accessions Trv65 and Tvr18 were the best yielding accessions while 30x10 cm was the best plant spacing; and were therefore recommended for mungbean production for higher yield in the study area.

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Evaluation of the Efficacy of Some Botanical Insecticides against Okro (*Abelmoschus esculentus* L. Moench) Leaf Beetle (*podagrica* spp.) In Umudike, South Eastern Nigeria

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ABSTRACT

Field studies was conducted in 2022 cropping season (May – August) at Michael Okpara University of Agriculture to evaluate the pesticidal effect of neem ash and pepper fruit extracts in the management of two species of okro flea beetle (*Podagrica sjostedti* and *Podagrica uniforme*r) on okro (*Abelmoschus esculentus*) and to compare the performance of the extracts with a synthetic insecticide (Cypermethrin). Okro variety Clemson spineless was used for the experiment. The study was laid out in a Randomized Complete Block Design with 8 treatments replicated 3 times and planted at a distance of 50 x 25 cm. The treatments included: Neem ash powder applied at 1 week interval (NAIWAP), Neem ash powder applied at 2 weeks interval (NA2WAP), *Capsicum frutescens* extract applied at 1week interval (PE1WAP), *Capsicum frutescens* extract applied at 2weeks interval (PE2WAP), Neem ash powder + *Capsicum frutescens* applied at 1week interval (NA+PE1WAP), Neem ash powder + *Capsicum frutescens* applied at 2weeks interval, Control and a synthetic chemical. Data were collected on number pests, percentage leaf defoliation, weight and number of pods/fruits per plot and percentage damaged pods/fruits per plot. Data collected were subjected to analysis of variance and means were separated using fisher's least significant difference at 5 % level of probability. Results obtained from the experiment proved the efficacy of these plant extracts in the management of the okro flea beetle. The plant extracts were able to significantly ($P \geq 0.05$) lower the population of the two flea beetles with the highest percentage efficacy of 1.14 and the least percentage efficacy of 5.00 compared with the control that recorded 8.16. The plant extracts were also able to reduce leaf defoliation, pod damage and increased the yield of okro. Neem ash+ *Capsicum frutescens* extracts combination applied weekly was the most effective among the extracts in reducing the population of the beetles This was followed by Neem ash liquid (1WAP), and *Capsicum frutescens* extract (1WAP), and all were significantly different from the control and compared very effectively with the synthetic chemical.These results are indicative of the potential of these plant extracts in the management of okro leaf beetle and is therefore highly recommended to farmers as a good alternative in the management of okro leaf beetles (*Podagrica sjostedti* and *Podagrica uniforme*r) .

Keywords: Extracts, *Capsicum frutescens* (pepper), Neem ash (*Azadirachta indica*), *Abelmoschus esculentus, Podagrica spp*

INTRODUCTION

Okra, *Abelmoschus esculentus* L) is a warm season crop belonging to the family Malvaceae and is widely grown in the tropics and subtropics for its succulent green pods (Obeng-Ofori, D and SacKey J. 2003). Okra plants are presently grown commercially in many countries such as India, Japan, Turkey, Iran, West African countries, Malaysia, Cyprus, Southern United States etc (Benjawan *et al.*, 2017; Qhureshi, 2018) It is cultivated in tropical, sub-tropical and warm temperate regions around the world including Nigeria (National Research Council, 2016). Nigeria produced 2.1 million tonnes of okra in 2017 (21.4 % of world production) making it second to India (FAOSTAT, 2018). In Nigeria, okro ranks third in terms of consumption and production area following tomato and pepper.(Ibeawuchi, 2007)

Okra *(Abelmoschus esculentus*), is an important vegetable crop that is utilized by humans in households almost on daily basis especially in sub-saharan Africa (Obopile *et al*, 2008). Their cultivation and production has been widely practiced due to their importance to the development of the economy and can be seen in every market in Africa especially Nigeria. (Udo *et al* 2005). Despite the economic importance of this plant to humans, the cultivation is heavily affected by insect pests attack which affects their growth and development, yield performance and also their market value. Schrippers (2011) reported 25-40 t/ha as the expected yield of okra depending on the variety, prevalence environmental conditions and agronomic practices. Okra yield of 15 t/ha and 16.8 t/ha have also been reported in the lowland humid tropical soils of southern Nigeria and in the West Indies respectively. The occurrence and intensity of damage caused by insect pests varies from different crop growth stages, regions and seasons. Again, infestations by sucking insect pests not only affect the crop but also hamper the crop health by transmitting pathogenic diseases (Grubben and Denton, 2014). Flea beetles (*Podagrica* spp.) which is a major pest of okro has been reported to be more predominate and destructive in Nigeria (Epidi, 2016; Akinlosotu, 2013). Flea beetles feed on the okra leaves and create numerous holes thereby reducing the plant yield, delay plant development and delay occurrence of photosynthesis (NRI, 2013). *Podagrica spp.* not only cause direct damage to okra plants but also serves as vector of okra mosaic virus (Emeasor *et al.*, 2017; Isman, 2016). It has also being implicated to have caused premature falling of pods (Asawalam and Constance, 2018; Uddin, and Odebiyi, 2011).

The use of synthetic insecticides in the control of this destructive pest of okro has become a common practice in developing countries due to their quick effectiveness (Alao, 2011), but most of these synthetic insecticides have been implicated to have caused environmental hazard, insect pests resistance and resurgence and some have been proved as carcinogenic (Ahmed *et al.,* 2016). These problems have necessitated the need for using medicinal plant extracts as an alternative in the management of this pest. (Alao and Adebayo, 2015; Asawalam and Osondu, 2013). Botanical insecticides are naturally occurring chemicals extracted from plants and are available as an alternative to synthetic chemical formulations but they are less toxic to human (Musa *et al.,* 2013). This study was therefore carried out to evaluate the efficacy of Neem ash powder extract and Pepper fruits liquid extracts in the management of Okra flea beetle (*Podagrica spp*).

MATERIALS AND METHODS

Experimental location and field layout

The experiment was conducted from May to August 2022 at the Teaching and Research Farm of the College of Crop and Soil Sciences, Michael Okpara University of Agriculture, Umudike Nigeria. The study area was characterized by (longitude $07^0$33E, latitude $05^0$29N, and altitude 122m) with annual rainfall of 2177mm, 27% relative humidity, and ambient temperature of 17^0C to 36^0C. The plot was ploughed harrowed and beds were made manually and divided into three blocks and each block was further divided into 8 plots with each plot measuring 4 m x 2 m ($8m^2$) with an inter-plot space of 1m and intra plot spacing of 0.5m. Okro seeds variety Clemson Spineless which was obtained from one of the agrochemical stores around the area were directly sown on the beds, two seeds of Okra per hole at a spacing of 50cm × 25cm and this was later thinned down to one seedling per stand at two weeks after emergence. Weeding was manually done at 3 weekly intervals and poultry manure was applied at 2 weeks and 7 weeks after planting.

Experimental design

The experiment consisted of eight treatments; Neem ash powder applied at 1 week interval (NAIWAP), Neem ash powder applied at 2 weeks interval (NA2WAP), *Capsicum frutescens* extract applied at 1week interval (PE1WAP), *Capsicum frutescens* extract applied at 2weeks interval (PE2WAP), Neem ash powder + *Capsicum frutescens* applied at 1week interval (NA+PE1WAP), Neem ash powder + *Capsicum frutescens* applied at 2weeks interval, Control and a synthetic chemical. The experiment was a randomized complete block design (RCBD) and was replicated 3 times.

Preparation and application of treatments

The plant materials that were evaluated for insecticidal activities were *Azadirachta indica* (Neem leaf ash powder extracts) which was obtained from Michael Okpara University premises and *Capsicum frutescens* (hot pepper fruit liquid extracts) which was obtained from one of the agrochemical stores around the environment.

Fresh and matured leaves of *Azadirachta indica* (Neem) were plucked and air dried to a very low moisture level so as to make sure that the process of drying did not affect the potency of the active ingredients. Fresh fruits of *Capsicum frutescens* were blended, while the leaves of Neem were burnt to ashes sieved and kept for use. 100g of these treatments were placed separately into plastic cans containing one litter of water each and allowed to stand overnight to allow the active ingredients to be extracted. The solutions were filtered with muslin cloth into separately labeled clean cans to obtain a homogenous substance that were used for spraying. This procedure was repeated at every application. The cans containing the aqueous solutions were taken to the field for spraying using a hand sprayer. Field application of the treatments commenced 14 days after planting (DAP) and were applied at 2 weeks intervals.

DATA COLLECTION

Data collection started 2 weeks after crop emergence and continued after every 2 weeks. Samplin**g** of the beetles was conducted by visual count which commenced 2 weeks after planting (WAP) in the morning hours between 6 - 8am when the insects were still inactive The numbers of *Podagrica* spp were counted after each spray at 2 weekly intervals from 6 plants selected from the middle row of the plot and tagged as sample plants. Populations of the pest species were estimated by visual counting on selected plants in each plot. This was carried out by gently observing the selected plants by carefully turning the leaves for correct assessment of the number of the test insect present on each of the okra plants. The collected data were pooled and mean population of the pest was worked out separately. Data on percentage defoliation was carried out by counting the number of defoliated leaves. Percentage defoliation was calculated using the formular;

$$\text{Percentage Defoliation (PD)} = \frac{\text{Total number of leaves defoliated}}{\text{Total number of leaves in a sample}} \times 100$$

Pod yield:

Harvesting of fresh pods started when they were due and continued until senescence set in and the plants stopped producing pods. For pod yield, fresh pods from the plants were harvested on weekly basis and the cumulative weight of harvested pods were determined using Kitchen Scale Electronic SF-400, at the end of the final harvest total number of pods per plot were recorded

STATISTICAL ANALYSIS

All data collected were subjected to Analysis of Variance (ANOVA) and significant means were separated by Fisher's Least Significance Difference Test (LSD) at 5% level of probability.

RESULTS

Table 1 shows the effect of Neem Ash, Pepper Extract and Synthetic Pesticide on Insect Pest of Okra **(***Podagrica sjostedti*)**.** Results from the experiment showed that generally all the plant extracts performed excellently well in reducing the population of *Podagrica sjostedti***,** reduced defoliation and pod damage and also increased the yield of the okro plant. Neem ash+pepper extracts combination at weekly application was the most effective among the extracts and compared very effectively with the synthetic chemical and gave significantly ($P \geq 0.05$) lower pest population when applied at 2WAP (1.28), 4WAP (2.46), 6WAP (2.30), 8WAP (3.05) and 10 WAP (3.50)) compared with the control which recorded (1.96), (5.88), (6.49, (7.00) and (8.10) at 2, 4, 6, 8, and 10 WAP Respectively. This was followed by pepper extracts at weekly application which gave a mean population density of (2.7) and this was also significantly different from the control which recorded a mean pest population of (5.89). The synthetic insecticide (cypermethrin) recorded the lowest insect count (2.02). while the untreated plots had the highest number of insect count.

Table 2 shows the effect of the plant extracts and synthetic pesticide on the population of *Podagrica uniformer*. Results from the experiment indicated that the plots treated with the plant extracts were also statistically ($P \geq 0.05$) similar to that of the synthetic chemical in reducing the pest population. A highly significant difference in the pest population was recorded between the extract treated plots and the control. Generally the plots treated with the plant extracts gave significantly (P ≥ 0.05) lower pest population than the control which recorded higher pest population count. All the plant extracts consistently recorded lower pest population a 2, 4, 6, 8, and 10 WAP than the control that recorded higher population of this pest at the same weeks. Neem ash and pepper extract combination at weekly application was the most effective and recorded (1.40), (1.00), (1.28), (1.14) and (1.96) of the pest population at 2, 4, 6, 8 and 10 WAP respectively and was significantly different (P ≥ 0.05) from the control which recorded (1.81), (2.05), (3.30), (3.69) and (4.61) at 2, 4, 6, 8 and 10WAP respectively. The trend was that as the application continues, the pest population in the treated keeps reducing while that of the control keeps increasing. Significant difference (P ≥ 0.05) was recorded from 2weeks of treatment application in all the plots until the 10th week in all the treated plots

Table 1. Effect of Neem ash, Pepper extract and Synthetic Pesticide on field insect pest of Okra (*Podagrica sjostedti*) .

TREATMENT	2WAP	4WAP	6WAP	8WAP	10WAP	MEAN
NA 1WAP	1.33	2.96	2.32	3.24	3.90	2.75
PE 1WAP	1.28	2.47	2.31	3.16	3.64	2.57
NA 2 WAP	1.47	2.93	2.47	3.35	4.82	3.01
PE 2 WAP	1.28	3.36	3.15	3.55	4.59	3.19
NA+PE 1WAP	1.14	2.46	2.30	3.05	3.54	2.49
NA+PE 2WAP	1.48	3.20	3.09	3.16	3.90	2.96
CYPERMETHRIN	1.28	1.67	1.33	2.00	2.02	1.66
CONTROL	1.96	5.86	6.49	7.00	8.16	5.89
LSD 0.05	**0.55**	**1.15**	**0.92**	**0.80**	**0.58**	

Footnote: Data values were transformed values. WAP= Weeks after planting, NA= Neem ash, PE= Pepper extract,

Table 2. Effect of Neem ash, Pepper extract and Synthetic Pesticide on field insect pest of Okra (*Podagrica uniforma*)

	2WAP	4WAP	6WAP	8WAP	10WAP	MEAN
TREATMENT						
NA 1WAP	1.14	1.00	1.28	2.16	2.28	1.57
PE 1WAP	1.14	1.00	1.28	2.15	2.43	1.6
NA 2WAP	1.00	1.14	1.62	2.28	2.10	1.61
PE 2WAP	1.28	1.14	1.41	2.15	2.23	1.64
NA+PE 1WAP	1.47	1.34	1.28	1.61	1.96	1.53
NA+PE 2WAP	1.28	1.33	1.28	2.43	2.58	1.78
CYPERMETHRIN	1.00	1.14	1.14	1.28	1.41	1.19
CONTROL	1.81	2.05	3.30	3.69	4.61	3.09
LSD (0.05)	**0.38**	**0.64**	**0.67**	**0.85**	**0.68**	

Footnote: Data values were transformed values. WAP= Weeks after planting, NA= Neem ash, PE= Pepper extract,.

Table 3 recorded the effect of plant extract (Neem ash and Pepper extract on the number of leaves defoliated by *podagrica* spp. The results from the treated plots were significantly lower ($P \geq 0.05$) in reducing the leaf damaged by the insect pests compared with the control with higher percentage of leaf damage. Leaf damage assessment showed that plots treated with Neem ash+Pepper extract at weekly application also had the lowest number of damaged leaves of (5.8, 6.18, 8.04, 7.71 and 10.1) at 2, 4, 6, 8 and 10 WAP and this was followed by plots treated with Pepper extract weekly application which recorded (7.3), (7.93), (8.80), (9.21) and (10.1) at 2, 4, 6, 8 and 10 WAP respectively while the control plots recorded the highest leaf damage of (21.20), (45.08), (50.10), (53.40) and (65.5) at 2, 4, 6, 8 and 10 WAP respectively. However the synthetic chemical (Cypermethrin) maintained the most effective among all the treated plots. Though was not significantly different from the plots treated with the extracts. .

Table 4 shows the effect of plant extract and chemical pesticide on the pod damage, number and weight of okra pods. There was a significant different at ($P \geq 0.05$) in the number, weight and pod damage on the okro plants treated with the extracts when compared with the untreated plots (control). On the number of pods, the highest number was recorded when Neem ash was applied at 2weekly interval (82.0) and this was followed by Neem ash and Pepper extract combination at 1weekly interval (79.3) and these were not significantly different from the chemical pesticide which recorded (84.0). On the pod weight among the extracts, the highest pod weight was recorded when Neem+Pepper extracts combination was applied at 2weekly interval (2.09) while the lowest pod weight was recorded on the control plots (0.97). However the plots treated with synthetic insecticide was the best among all the treatments. On pod damage the lowest pod damage was recorded on plot treated with chemical pesticides (3.87) and this was followed by Neem + Pepper extracts application on weekly interval which recorded (5.87) and this was signicantly different ($P \geq 0.05$) from the control that recorded (21.67) pod damage. All the other plant extracts also recorded lower pod damage when compared with control and these were all significantly different ($P \geq 0.05$) from the control. .All the treated pods gave significantly higher pod weight, pod number and lower pod damage than the untreated plots (Control plots).

Table 3. Effect of Neem ash and Pepper extract on the number of leaves defoliated.

TREATMENTS	WK2	WK4	WK6	WK8	WK10	MEAN
NA 1WAP	18.80	11.66	10.57	9.84	13.00	12.77
PE 1WAP	7.30	7.93	8.80	9.21	10.10	8.67
NA 2WAP	16.7	10.88	10.32	10.07	11.5	11.89
PE 2WAP	12.8	8.76	9.91	9.85	11.9	10.64
NA+PE 1WAP	5.80	6.18	8.04	7.71	10.10	7.57
NA+PE 2WAP	11.10	10.21	10.74	11.19	11.80	11.01
CYPERMETHRIN	2.70	5.26	4.21	4.11	6.50	5.54
CONTROL	21.2	45.08	50.10	53.40	65.50	47.06
LSD (0.05)	**21.95**	**7.22**	**6.64**	**7.69**	**9.14**	

Footnote: NA= Neem ash, PE= Pepper extract, WAP = Weeks After Planting.

Table 4. Effect of plant extract (Neem ash and Pepper extracts) on the number of fresh pods, pod weight and pod damage

TREATMENT	NUMBER OF PODS	WEIGHTOF PODS(kg)	DAMAGED PODS (%)
NA 1WAP	71.30	1.97	7.53
PE 1WAP	72.70	1.28	9.23
NA 2WAP	82.00	1.83	10.57
PE 2WAP	45.30	1.26	13.27
NA+PE 1WAP	79.30	1.97	5.87
NA+PE 2WAP	76.00	2.09	9.65
CYPERMETHRIN	84.00	2.18	3.87
CONTROL	39.7 0	0.97	21.67
LSD(0.05)	**13.19**	**0.93**	**0.37**

Footnote: NA= Neem ash, PE= Pepper extract, WAP = Weeks After Planting.

DISCUSSION

From the study carried out it was observed that all the plant extracts used were effective in reducing the okro pest population, number of damaged leaves and pods and at the same time increased the yield of okro. The result indicated that the combination of the two plant extracts (Neem + Pepper extracts application on weekly interval) was the most effective in reducing the pest population from 2WAP to 10WAP and compared very effectively with the synthetic chemical used.. These plant extracts has earlier been recorded to exhibit antifeedant, repellent, pesticidal and inner growth disruption abilities. Krause (2002) reported that these plant extracts can incite sterility in some insects, impair egg fertility, repels the insects and also deter oviposition.

Results from this experiment supports the findings of Basedow *et al* (2002) who reported that *A. indica* based-products were effective in the control of aphids and white flies. The result also is in line with Efurumibe and okoko (2016) who reported that liquid extracts of *C. frutescence*, *Allium sativum*, *Allium cepa* and *Vernonia amagdalina* were able to effectively manage the okro leaf beetle (*Podagrica* spp). The protective effect shown by neem ash in the study also agrees with Wini *et al* (2015) who reported that wood ash successfully controlled *Sitophillus zeamais* in stored maize. The protective effect from the neem ash could be as a result of the presence of potash which contains potassium. The neem ash contains insecticidal active ingredient calcium carbornate as reported by Moyin-Jesu (2010). Ashes make it difficult for the pests to breathe and eat, unable to take in enough moisture from their food, the insects dry out and die from suffocation before they are able to reproduce.

In this study, Cypermethrin proved to be the most effective in all the treatment. The high effectiveness of Cypermethrin compared to Neem ash+Pepper extract could also be associated with its standardized active ingredient formulations that have a "knockdown"; effect on pests immediately on exposure, like all Pyrethroids do (Hills and Waller, 1988), The plant materials reduced population of insect pest mainly due to contact toxicity and acting upon the nervous system of the insects. The effectiveness of the synthetic insecticide is a confirmation of the report of Brooke and Hines (1999), that chemical insecticides have been the primary control agent of agricultural pests.

The highest number of pests in okro plants under the control treatment might be responsible for the the increased damage of foliar parts which led to high economic injury level in the okro plant and reduced yield of the plant . This could be as a result of the non application of the treatments hence the more a farmer neglects the use of insecticidal solution on his or her farm, the more exposure to high insect infestation

CONCLUSION AND RECOMMENDATION

The results of this experiment has shown that the application of plant derived insecticides significantly reduced the population of field insect pest of okra (*Podagrica sjostedti* and *Podagrica uniforma),* thereby minimizing leaf defoliation and increased yield compared to untreated okra plants. The study showed that number and weight of pods were significantly higher in treated plots than in the control plots. These plant extracts can be suitable alternative to synthetic insecticides for insect pest management hence farmers are strongly encourage to adopt the use of medicinal plant extracts and their ashes to help alleviate growing public concerns regarding the effect of synthetic insecticide on human health and environment since these plant products are easily accessible, friendly, cheap and easy to apply by non-professionals. To this effect I strongly recommend the use of Neem ash powder and Pepper fruit extract to the local farmers in the management of okra flea beetle (*Podagrica spp*). Further research should be carried out on how these extracts can be used on larger scale basis to increase crop productivity

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Contribution of Organic Agriculture to Foreign Exchange, Food Security and Climate Change

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ABSTRACT

Organic agriculture is a production system that sustains the health of soils, ecosystems and people. As a means of improving foreign exchange, the world is now drifting towards organic farming after considering the adverse effect synthetic fertilizer has on the body, soil and environment. So, most countries prefer foods produced organically and organic production of food for export will attract high revenue. Apart from being environmentally friendly, organic agriculture improves the quality of agricultural products. It is known for boasting the agricultural yield which in turn ensures food security within an environment. Organic agriculture also reduces the greenhouse gas effect. A study reviewed that the elimination of synthetic nitrogen fertilizers alone, as is required in organic systems, could lower direct global agricultural greenhouse gas emissions by about 20%. It is highly recommended that practice of organic agriculture be spread across the agricultural space so that we can save our environment and still have quality food in large quantity.

INTRODUCTION

According to the USDA National Organic Standards Board (NOSB), organic agriculture is "an ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain, or enhance ecological harmony. It is an environmentally friendly response to traditional agriculture. Here, the treatments used are made from natural ingredients, and the use of petrochemicals is forbidden (Bodin, 2020).

Organic agriculture follow the principles and logic of a living organism, in which all elements (soil, plant, farm animals, insects, the farmer, local conditions) are closely linked to each other. This is accomplished by using, where possible, agronomic, biological and mechanical methods, following the principles of these interactions, using natural ecosystem as a model. Organic agriculture eliminates everything that is synthetic and adopts practices that are strictly organic i.e utilizing natural means for agricultural production and processing. After reviewing the adverse effect synthetic means of agricultural production has affect humanity and the environment, the world is making deliberate effort to migrate production and processing of agricultural produce from synthetic to organic. Farmers in different spheres of agriculture are gradually adopting organic means of production to help salvage our ecosystem.

Organic methods can increase farm productivity, repair decades of environmental damage and knit small farm families into more sustainable distribution networks leading to improved food security if they organize themselves in production, certification and marketing (Vikaspedia, 2019). Economically , a number of factors such as yields, prices, and production costs (including cost for inputs, labour and certification) have been termed as important indices to measure productivity in organic agriculture costs (IFOAM, 2006; Seufert, 2012; FAO, 2017). First; yields can be influenced by variables such as production system characteristics, organic nutrient management, farmer's level of knowledge among others (Forster *et al.*, 2013; Sarma, 2015; Morshedi *et al.*, 2017).

Apex Publishers (2020) noted that organic farming is a system for crops that emphasizes environmental protection and the use of natural farming techniques. It is concerned not only with the end-product, but with the entire system used to produce and deliver the agricultural product. To this end, the entire farm cycle, from production and processing, to handling and delivery, excludes the use of artificial products such as genetically modified organisms (GMOs) and certain external agricultural inputs such as pesticides and synthetic fertilizers (Apex Publisher, 2020). Organic farmers rely on natural farming methods and modern scientific ecological knowledge in order to maximize the long-term health and productivity of the ecosystem, enhance the quality of the products, and protect the environment. Proponents of organic methods believe that it is a more sustainable and less damaging approach to the environment (Apex Publisher, 2020).

ORGANIC AGRICULTURE AND FOREIGN EXCHANGE

Organic agriculture has come to be accepted across the world having proven to be environmentally friendly, healthy and sustainable but in Nigeria, this brand of farming is still lagging behind, as only an insignificant percentage of farmers practice it in the country (Agbota, 2017) due to the crude state of agricultural technologies available within the country. Another reason is the poor attention of the government to education, effective extensive service and unfavourable policies. African countries like Kenya that started producing organically are benefiting from it both locally and internationally which is because the adverse effect to synthetic means of production is constantly been unveiled as time goes on. With this discovery the foreign market has proposed that only organic products can be imported into their country. Aguta, (2017) also emphasis that developed nations are said to prefer organic foods to the inorganically produced ones for goods and stable health, among other reasons, because organic agriculture is a system that relies on ecosystem management rather than external agricultural inputs.

In the last 20 years, a lucrative international market for organic cocoa, spices, vegetables and coffee has attracted more farmers into organic farming. This is because the demand for such produce in the United States, Europe and Asia far outstrips domestic supply. The major organic produce importing countries are the United States, the United Kingdom, China, India, Germany and the Netherlands. It was revealed that, so far, Germany is Europe's largest market for organic products, with a sales volume of €5.8 billion and an average growth of 15 per cent yearly (Aguta, 2017).

It will be a good idea if the country, Nigeria, will invest in promoting technologies that will support the farming population to properly adopt organic farming into their various agricultural practices so as to increase the countries chances of having a share in the foreign market there generating revenue and reducing the countries' dependence on revenue from crude oil.

ORGANIC AGRICULTURE AND FOOD SECURITY

Food security means having, at all times, both physical and economic access to sufficient food to meet dietary needs for a productive and healthy life. A family is food secure when its members do not live in hunger or fear of hunger (USAID, 2022). Ekweanya, Aguiyi, Obinna and Odoh (2021) also defined food security as the relationship between the total number of people as against food available at a particular people on a time. The world is faced with limited access to quality food especially the rural people. Globally, more than 800 million people go to bed hungry every night, most of them smallholder farmers who depend on agriculture to make a living and feed their families (USAID, 2022) and in Nigeria, there is high risk of about 25 million people facing hunger between June and August if nothing significant is done (UNICEF, 2023). With over 200 million people, Nigeria is the most populated country in Africa and the seventh in the world. The annual growth rate of the population is approximately 2.7 per cent, and more than half are under 30 years of age (World Food Programme, 2022). So, it's important to pay more attention to agricultural productivity so as to meet the demand of the growing population. While thinking of improving productivity, the health and environment should be put into consideration.

Organic farming is considered a viable choice for small farmers seeking to improve food security and farm income performance in the long term (Morshedi *et al*, 2017). It is also viewed as a sustainable farming method that has been shown to help accomplish the Sustainable Development Goals (Willer *et al*, 2019). In 2017, 181 countries were involved in organic operations, with the organic market valued at 90 billion euros. The global organic portion of total agricultural land was 1.4%, with 2.9 million organic growers around the globe. Asia has 40% of the world's organic producers (IFOAM, 2018). Organic food is increasing in popularity. The growing demand is mainly attributable to consumer concerns about negative implications of conventional agriculture for human health and the environment. Especially in developed countries, most consumers consider organic food to be safer and healthier than conventionally produced food (Funk & Kennedy 2016).

ORGANIC AGRICULTURE AND CLIMATE CHANGE

Climate change is already making farming more challenging with an increase in frequency and severity of extreme weather events, such as floods, heat waves and droughts. Harvest losses, biodiversity loss, soil quality deterioration and other irredeemable damage to natural resources and the destruction of farmers' economic viability are among the most serious effects (Winkler, 2023). It is becoming a threat to sustainable agricultural production and food security in Nigeria (Ekweanya, Anyanwu, Onuoha, and Onu, 2021).

According to Organic without Boundaries (OWB) (2018), global emissions from crop and livestock agriculture have risen from 4.7 billion tonnes CO2 equivalent in 2001 to more than 5.3

billion today, an increase of more than 14%. Organic agriculture can help to tackle climate change by reducing greenhouse gas emissions. There is a direct correlation between nitrous oxide emissions and the amount of nitrogen fertilizer applied to agricultural land.

Nitrous oxide emissions from managed soils account for almost 40% of agricultural emissions. This is particularly important because the impact of 1 kilo of nitrous oxide on warming the atmosphere is about 300 times greater than the impact of 1 kilo of carbon dioxide (OWB, 2018). Because organic farming does not allow the use of synthetic nitrogen fertilizers, focusing instead on establishing closed nutrient cycles, minimising losses via runoff, volatilization, and emissions, nitrogen levels on organic farms tend to be lower per hectare than on conventional farms which can contribute to a sustainable climate-friendly production system that delivers enough food (OWB, 2018),

Also, because fossil fuel-based fertilizers and most synthetic pesticides are prohibited in organic farming, it has a significantly lower carbon footprint. The production of these farm chemicals are energy intensive. Studies show that the elimination of synthetic nitrogen fertilizers alone, as is required in organic systems, could lower direct global agricultural greenhouse gas emissions by about 20% (Brook, 2022). Brook (2022) reported that a forty-year study conducted by the Rodale Institute also showed that organic farms use 45% less energy compared to conventional farms (while maintaining or even exceeding yields after a 5-year transition period.) Meanwhile, fumigant pesticides - commonly used on crops like strawberries and injected into soil - emit nitrous oxide (N_2O), the most potent greenhouse gas. Research indicates that one commonly used fumigant pesticides, chloropicrin, can increase N_2O emissions by 700-800%. Two other fumigants (metam sodium and dazomet) are also known to significantly increase N2O output. To the end, organic agriculture plays a vital role in mitigating the adverse effect of climate change, helping to preserve the climate for sustainability.

CONCLUSION

The importance of organic agriculture can not be overemphasized as it has become a major focus in the field of agriculture. There is no aspect of agriculture that organic farming can not be used to replace synthetic farming. The Student Industrial Work Experience Scheme (SIWES) students in Michael Okpara University of Agriculture Umudike, Abia State adopted the use of Neem extract to prevent army worm infestation on maize plant. Some of the students even explored other option by mixing it with pepper to improve it's efficiency and the result was amazing. No side effect on the user and plant and there was tremendous growth. So, to save the human race and environment we need to adopt organic farming into the agricultural system specifically in Nigeria.

RECOMMENDATIONS

Having gone through some of the benefits of organic agriculture, it necessary that the country pays adequate attention to this area in agriculture. Hence, it's essential that organic practices be taught, starting from agricultural departments and schools. The agricultural curriculum should be reviewed and organic practices be amplified more alongside the adverse effect of using fertilizer. SIWES programs in agricultural universities should be a platform for inventing and utilizing organic farming practices so as to gradually delete the mindset of synthetic farm from the younger generation.

Seeing that the rural communities produce about 70% of the food consumed in the country, it will be important that extension services in Nigeria be upgraded and properly empowered with skill, facilities and trainings that will enable them disseminate information on organic agriculture in rural communities. This will improve the quality and quantity of food produced from the rural communities.

The government and NGOs should sponsor research that will develop more organic materials that will aid in the production and processing of agricultural produce. For examples, using Neem as a case study, Neem oil can be rubbed on any storage material to prevent pest infestation during storage. There are leaves, plants and fruit extract that can be traditionally extracted and utilized in agriculture all that is needed is research, discovery and application. It's very possible for Agricultural production and process to solely rest on organic materials.

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Effect of Some Organic Amendments on Soil Physico-Chemical Properties, Growh andYield Parameters of Sweet Melon (*cucumis melo* l.) In Awka, Southeast Nigeria

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ABSTRACT

The effect of some organic amendments on soil physicochemical properties, growth and yield parameters of sweet melon (*Cucumis melo* L.) was studied at the Soil Science and Land Resources Management Research Farm, Faculty of Agriculture, Nnamdi Azikiwe University, Awka. The experiment was laid out in randomized complete block design (RCBD) with five treatments, replicated three times. The treatments were: Bat (guano) manure, Pig waste (PW), Dry neem leaves, Poultry droppings (PD) applied at 15t/ha, and a control (0t/ha). Data collected were subjected to analysis of variance (ANOVA) using Genstat 4th edition statistical software. Means were separated using Fisher's Least Significant Difference (F-LSD) at 5% probability level. The results obtained showed that the application of the organic amendments had no significant effects on the soil physical properties evaluated but had significant affect on most of the chemical parameters tested. Some growth parameters as well as yield component studied, showed significant differences among the various treatments at 3, 6 and 9 weeks after planting (WAP). At 15t/ha rate of amendment application, PW recorded the highest values for most chemical properties, closely followed by PD but for the growth and yield parameters, bat guano recorded highest and closely followed by poultry manure. Though soil physical properties did not show statistical significant differences, application of organic amendments resulted to increased value of soil moisture content, hydraulic conductivity and porosity. Bat Guano though scarce, is recommended for farmers to be used in the production of Sweet Melon in the study area for higher yield and as an alternative manure source for sustainable soil fertility management. On the other hand, from this study, PD and PW could be used to substitute for bat guano.

Keywords: Sweet Melon; Bat Guano; Neem Leaves; Organic Amendments; Soil Physicochemical Properties.

INTRODUCTION

Organic farming has become an essential priority worldwide in view of the growing demand for healthy and safe food, long-term sustainability and concerns regarding the environmental pollution related to the indistinctive utilization of chemical fertilizers, (Al-Erwy *et al*., 2016). Over the years, use of synthetic materials in crop production has been a common practice globally. The attendant detrimental effects of the chemicals used in the formulation of these synthetics on animal and human health as well as the environment has made researchers to look out for a better agronomic practice that would not only improve productivity but at the same time sustain a healthy environment (Onunwa, *et al*., 2021). Organic materials are very important soil amendments that sustain the productivity of soils in tropical and subtropical areas where there is low soil organic carbon (SOC) content and lower input of organic materials (Zheng *et al*., 2016). Using organic wastes including Poultry manure, Bat guano (bat droppings), Pig waste and dry neem leaf as soil amendments is an ideal way to maintain soil organic matter, improve soil quality and provide nutrients essential to plants (Ghasem *et al*., 2014).

Sweet melon (*Cucumis melo* L.) fruit is one of the most important and popular fruit vegetables grown in Egypt; it is used mainly as a desert and refreshing fruit. It is rich in bioactive compounds such as phenolics, flavonoids and vitamins as well as carbohydrates and minerals (especially potassium). In addition, it is low in fat and calories (about 17 kcal/100g). It has a large amount of dietary fiber (Tamer *et al*., 2010). This study was designed to investigate the effect of selected organic amendments on soil physicochemical properties as well as the growth and yield parameters of sweet melon (*C. melo* L.). The specific objectives were to determine: the effect of organic amendments on soil physical and chemical properties; the effect of organic amendments on the growth and yield parameters of sweet melon '*C. melo* L*'*.

MATERIALS AND METHODS

This study was carried out at the Soil Science and Land Resources Management Research

Farm, Faculty of Agriculture, Nnamdi Azikiwe University, Awka, Anambra state. Awka is located withinLatitudes 06°14'N – 06°15'N, and Longitudes 07°6'E – 07°7'E; with a bimodal rainfall system that lasts between March and October, with a short August break. The rainfall ranges from 1,500 to 2,000mm per annum. The temperature ranges from 25 to 35°C, while the relative humidity rangesfrom 63% to 88% (Ezenwaji *et al*., 2014).

Sweet melon *(C. melo* L.*)* was imported from East-West Seed International ltd, Thailand. Guano was collected from bat infested buildings at Ifite-Ogwari, Anambra State. Poultry manure (deep litre) was collected from Food Soldiers Farms, Awka; Pig waste was collected from Animal Science Research farm, NAU; Neem leaves were harvested fresh from neem plants within the campus (and dried properly under sunlight).

The experiment was laid out in randomized complete block design (RCBD) with five treatments,replicated three times. The treatments were: Bat guano manure, Pig waste, Dry neem leaves, Poultry manure applied at 15t/ha and a control (0t/ha).

Land area of about 0.49ha was mapped out using measuring tape, rope and pegs. The site previously cropped to corn, was cleared manually and the residue worked into the soil. Melon seeds were planted directly at the rate of one seed/hole and at a spacing distance of 30cm x 45cm.Weeds were controlled by hand picking every two weeks.

Soil Sampling and Analysis

A total of 6 disturbed and 6 undisturbed soil samples were collected at a depth of 0-15cm from different location at the experimental field using auger and core samplers. The disturbed samples were bulked together to obtain a composite sample while the 6 undisturbed samples were used forthe determination of bulk density, moisture content and hydraulic conductivity. Post harvest soil samples were collected at designated points. The samples were air dried and passed through a 2mmsieve, ready for analysis.

The following soil parameters were analyzed for:

Moisture content was determined using gravimetric method (Jalota *et al*., 1998); Particle size analysis was done using Bouyoucos hydrometer method as described by Gee and Bauder (1986);Soil **bulk density** was determined using core method as described by Blake and Hartage (1986); **Organic carbon** was determined by Walkley and Black wet oxidation method as outlined by Nelson and Sommers (1982); **Exchangeable bases** (K, Ca, Na, and Mg) were extracted with 1N NH_4OAC buffered at pH 7.0 (Thomas, 1982). The amount of **Ca and Mg** were determined using Ethylene Diamine Tetra-Acetic (EDTA) titration method while **potassium and sodium** were determined by flame photometer (Rhoades, 1982); **Available P** was determined using Bray 2 extraction method (Bray and Kurtz, 1945); **Exchangeable acidity** was extracted with 1N KCL (Thomas 1982) and was determined by titration method using 0.005N NaOH and phenolphthaleinas indicator; **Total nitrogen** was determined using macro kjedahl method (Bremer and Mulvancy, 1982); **Soil pH** was determined using an electronic pH meter (Mclean 1982); The base saturation was calculated mathematically as: TEB/ECEC × 100/1

Where TEB = Total Exchangeable Bases (Ca, Mg, K and Na); and ECEC = effective cation exchange capacity

Effective Cation Exchange Capacity (ECEC) was calculated as the summation of the exchangeable bases (Ca, Mg, K, and Na) and exchangeable acidity.

Plant growth and yield parameters data (vine length, number of leaves and number of branches) were collected from the experimental unit at 3, 6 and 9WAP.

Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA) using Genstat 4th edition (2011); means were separated using Fishers Least Significant Difference (F-LSD) at 0.05 probability level.

RESULTS AND DISCUSSION

Effect of Organic Amendments on the soil physical properties

Table 1 showed the effects of organic amendments on the physical properties of the soil. Observedresult indicated that there was no significant difference in the physical parameters tested. It was however observed that bulk density in the control plot was the highest (1.52) while the least was observed in the plot treated with Neem leaves. For porosity, the highest was in neem leaves while the least was observed in the control. This observation actually followed the general rule for BD and porosity that the higher the BD, the lower the porosity. For Moisture content, the highest was observed in Guano manure while the least was observed in the control. Generally, there was an increase in the value of the soil physical parameters as against control except for BD which reduced for the treatments instead. The result obtained could be attributed to the addition of organic matter to the soil as a result of the amendments used. This corroborates the finding of Eilín and McDonnell (2012), who observed that organic amendments played important and multi-faceted role in soil by influencing soil structure and all its associated properties. Eloi *et al*. (2022) also reported that *Tithonia diversifolia* fresh biomass and poultry manure (PM) lowered the soil bulk density, increased soil total porosity and water holding capacity.

Table 1: Effect of organic Amendments at 15t/ha on Soil Physical Properties.

	Physical properties			
Manure type (MT)	**BD g cm^{-3}**	**Porosity**	**MC (%)**	**K_{sat} mm hr**
Bat Guano	1.49	43.90	45.83	79.90
Neem Leaves	1.45	45.28	45.65	82.60
Pig Waste	1.47	44.47	45.65	83.10
Poultry manure	1.46	44.78	45.65	78.50
Control	1.52	42.61	45.24	68.20
LSD (0.05)	NS	NS	NS	NS

BD = Bulk Density
MC= Moisture Content
Ksat = Saturated Hydraulic Conductivity

Table 2 showed the result of the chemical parameters tested. Most of the parameters tested showedsignificant differences/variations at 5% probability level except for %BS and Al^{3+}.
For Na^{+}, the order was: Neem (0.99)>Guano (0.42)>poultry (0.39)>Pig (0.17) = control (0.13). For Ca^{2+}, it is Pig (5.11)>poultry (4.56) = Guano (4.55)>Neem (4.15)>control (4.09). For Mg^{2+}, Pig (1.9)>poultry (1.71)>Guano (1.67)>Neem (1.32) = control (1.32). The order for K^{+} was: Pig (2.31)>poultry (1.82)>Neem (1.47)>Guano (1.25)>control (0.51). TEA had significant variation possibly because of the influence of H^{+} concentration which varied significantly among the treatments and was in the order: Neem (0.05) = control (0.049)>poultry (0.043)>Guano (0.040)>pig (0.37). CEC followed this order: Pig (10.12)>poultry (8.57)>Neem (8.3)>Guano (6.94)>control (5.38). For pH, the order was: Pig (6.1)>poultry (6.07)>Guano (6.05) = Neem (6.05)>Control (5.97). It could be observed that the application of organic amendments had apositive effect on the soil pH. It made the soil move from strongly acidic to slightly acidic.
Total nitrogen followed this order: Guano (0.27)>pig (0.25)>poultry (0.22)>Neem (0.11)>control (0.09) and organic carbon was in the order: Guano (2.40)>poultry

(1.90)>Neem (0.90) > control (0.80). However, it was observed that application of organic amendments increased the value of most chemical parameters measured as against the control. This observation is in agreement with the findings of Kaur *et al*. (2005) who reported that the application of organic manures improved soil organic carbon content.

Table 2: Effect of organic Amendment on soil chemical properties

	Soil Chemical Properties (cmol/kg)											
Manure type (MT)	**Na^+**	**Ca^{2+}**	**Mg^{2+}**	**K^+**	**TEA**	**CEC**	**%BS**	**Al^{3+}**	**H^+**	**pH**	**%TN**	**%**
Guano	0.42	4.55	1.67	1.25	0.06	6.94	99.10	0.012	0.040	6.05	0.27	2.
Neem	0.99	4.15	1.32	1.47	0.07	8.03	99.10	0.015	0.050	6.05	0.11	0.
Pig	0.17	5.11	1.97	2.31	0.05	10.12	82.90	0.012	0.037	6.10	0.25	1.
Poultry	0.39	4.56	1.71	1.82	0.05	8.57	99.30	0.011	0.043	6.07	0.22	1.
Control	0.13	4.09	1.32	0.51	0.07	5.38	98.80	0.021	0.049	5.98	0.09	0.
LSD ($_{0.05}$)	0.05	0.08	0.04	0.05	0.01	0.03	NS	NS	0.008	NS	0.05	0.7

NS = Not Significant

Table 3 showed the effect of organic amendments on the plant growth parameters. Observed data indicated that for the number of leaves, all the treatments showed significant difference/variations at the various weeks of evaluation. At 3 weeks after planting (WAP), the order was: Guano (44.50)>poultry (44.0)>Neem (43.17)>pig (41.33)>control (33.58).

At 6WAP, number of leaves followed the order: Guano (63.83)>poultry (63.00)>Neem (55.33)>pig (54.33) and then control (46.08). At 9WAP, the order was: Guano (116.17)>poultry (113.83)>Neem (110.83)>pig (107.0)>control (78.92). It could be observed that for the three weeks of evaluation, the number of leaves kept increasing systematically in a particular pattern.

For vine length, at 3WAP, there was no significant difference among the treatments, nevertheless, the highest value was recorded at the plot treated with bat guano (38.50) while the least value was for poultry (38.00). At 6WAP and 9WAP,the treatments showed significant differences among themselves. At 6WAP, the order was: Guano (125.67)>poultry (121.17)>Neem (119.17)>pig (106.83)>control (84.08). At 9WAP, the order was: Guano (171.67)>poultry (170.17)>neem (156.00)>pig (144.5)>control (141.33).

For the number of branches, at 3WAP, there was no significant difference recorded among the treatments. Noticeably, all the treatments gave the same value. At 6WAP, the treatments followed the order: Neem (5) = Poultry (5)>Guano (4.67)>pig (4.17)>control (3.67). There was a change in pattern at this level. At 9WAP, the order reversed to: Guano (9)>poultry (8.33)>Neem (7.83)>pig (6.83)>control (6.75). A consistent increase was observed in all the growth parameters as the plants aged. The result obtained which indicated that guano manure had the highest values among other treatments could be as a result of higher solubility of the guano amendment in the soil where mineralization takes place as compared to the other soil amendment studied. These results corroborated the reports by Mlay and Sagamiko (2008) and Thi *et al*. (2014) that the use of bat guano had a positive influence on plant growth.

Table 3: Effect of Organic Amendments on plant Growth Parameters at 3, 6 and 9 weeks after Planting (WAP)

	Sweet melon										
Treatments	**Number of leaves**				**Vine length (cm)**				**Number of branches**		
Organic Amend.	**3 WAP**	**6 WAP**	**9 WAP**	**Mean**	**3 WAP**	**6 WAP**	**9 WAP**	**Mean**	**3 WAP**	**6 WAP**	**9 W**
Guano	44.50	63.83	116.17		38.50	125.67	171.67		2.00	4.67	9.0
Neem	43.17	55.33	110.83		38.33	119.17	156.00		2.00	5.00	7.8
Pig	41.33	54.33	107.00		38.33	106.83	144.50		2.00	4.17	6.8
Poultry	44.00	63.00	113.83		38.00	121.17	170.17		2.00	5.00	8.3
Control	33.58	46.08	78.92		38.08	84.08	141.33		2.00	3.67	6.7
LSD ($_{0.05}$)	2.09	2.29	1.94		NS	3.46	1.03		NS	0.33	0.4

NS = Not significant
WAP = Weeks After Planting

Table 4 showed the effect organic amendments on sweet melon yield parameters. It was observed that fruit circumference (FC), fruit length (FL), number of fruits and days to edible maturity were not significantly affected by the organic amendments applied. Nonetheless, percentage emergence and yield (fruit weight) significantly varied among the treatments. Fruit weight which could be said to be the yield was in this order: Guano (13.17t/ha) >Poultry (13.08t/ha)>Neem (11.83t/ha)>Pig waste (11.65t/ha)>Control (10.15t/ha). It could readily be observed that the performance of the plant growth and yield parameters followed almost the same pattern of Guano>Poultry>Neem>Pig>control except in few cases. This could be an indication that the yield parameters measured were not significantly affected by the various organic amendments. This result corroborates with the observation of Ambouta *et al.* (2020) that bat guano essentially improved the availability of nutrients in the soil and increased the growth and yield of vegetable crops. They also opined that plots treated with bat guano gave the highest yields compare to the control.

Table 4: Effect of organic Amendments on Sweet Melon Yield Parameters

	Sweet melon					
Manure type (MT)	**FC (cm)**	**FL (cm)**	**% EM**	**FW (t/ha)**	**NF**	**DEM**
Guano	35.50	20.50	89.83	13.17	4.17	83.33
Neem	38.50	20.00	74.00	11.83	3.83	83.83
Pig	36.50	19.00	89.83	11.65	3.50	84.67
Poultry	36.50	22.50	89.83	13.08	3.83	85.17
Control	36.75	18.25	89.08	10.15	3.83	84.08
LSD (0.05)	NS	NS	4.71	0.99	NS	NS

NS = Not Significant
FC = fruit circumference
FL = fruit length
%EM = percentage emergence
FW = fruit weight
NF = number of fruits per plant
DEM = days to edible maturity

CONCLUSION AND RECOMMENDATION

The application of selected organic amendments at 15t/ha had no significant influence on Soil physical properties but, had significant effect on most of the chemical parameters evaluated. This could possibly be due to the short period the experiment or the rate of amendment application was high enough to affect the chemical parameters. The selected Organic amendments used, positively influenced some of the plant growth and yield parameters of Sweet Melon assessed. It could therefore be recommended that Sweet Melon farmers in the study area should farm with Bat Guano at 15t/ha for higher yield and sustainable soil fertility management.

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Effect of Palm Kernel Cake on Haematology and Serum Biochemistry of DifferentNigerian Breeds of Cattle Grazed In Awka, Southeast Nigeria

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ABSTRACT

A 2 x 4 factorial experiment was conducted in a completely randomized design to investigate the haematological and serum biochemical parameters of four Nigerian breeds of cattle grazed and supplemented with palm kernel cake (PKC). Twenty-four yearling cattle consisting of six animals from each of Adamawa Gudali (AG), White Fulani (WF), Sokoto Gudali (SG) and Red Bororo (RB) breed were randomly assigned to two feeding patterns: PKC with grazing (PKC + G) and only grazing (G) and replicated three times with one animal per replicate in each treatment combination. At the end of eight weeks feeding trial, 5 ml of blood sample were collected from one animal in each experimental unit via jugular vein puncture using sterilized disposable syringe and analysed for the parameters studied. Data were subjected to two-way analysis of variance. Results revealed that, although the interaction of breed and feeding pattern had significant effect ($p<0.05$) on all the haematological parameters except the mean corpuscular volume, the parameters were within the normal range reported for Nigerian breeds of cattle. The SG × (PKC + G) interaction gave comparatively higher haemoglobin (Hb) (10.15 g/dl), packed cell volume (PCV) (31.10%), red blood cell (7.08 $x10^6/\mu L$) and lower platelet (403.00 $x10^3/\mu L$) means. This was followed by the WF × PKC + G interaction for same parameters except for platelet which was as high as 731.50 $x10^3/\mu L$. The white blood cell count ranged from 3.85 $x10^6/\mu L$ in SG × G to 9.60 $x10^6/\mu L$ in SG × (PKC + G). The means of biochemical parameters were also within the normal range reported for cattle. The results indicated that the feeding pattern, interacting with breed, did not exert any deleterious effect on the cattle. Breeds fed on PKC and grazing, however, recorded better values for most parameters. Supplementing PKC with natural grazing is therefore recommended for healthy physiological responses of the Nigerian indigenous cattle breeds.

Keywords: Grazing, Palm kernel cake, Haematology, Serum biochemistry.

INTRODUCTION

Cattle are the most common type of large domesticated animals *(*www.agriculturwnigeria.com*)*. They command a prominent position in our meat and livestock industry. Cattle are also utilized for milk, hides and skin which is processed into leather, its by-products such as dung is utilized as manure and fuel. RangelandsRangelands for animals to graze only blossom in the rainy season while in the dry season, they become standing hay (Bamigboye *et al.*, 2013).Feed accounts forward about two- third of the cost of meat production (Vecchiettin and Giardini, 2000) which is about 70-90% of total cost of fattening cattle (Lamidi, 2005).High cost of conventional feedstuffs have made research efforts to be directed towards harnessing and enhancing the utilization of agricultural by products and crop residues for livestock feeding.

Palm kernel cake is highly fibrous and has a medium grade protein content which is more suitable in feeding of ruminants and rabbits (Pichard, 2005).protein content of palm kernel cake is between 18-25% (Onwuka et al.,2014).Palm kernel cake is deficient in lysine, methionine, histidine and threonine. Palm kernel is gritty and high in fibre content.

The health status of animals maintained under different feeding conditions is one of the criteria for welfare assessment. The assessment is through the haematology and serum biochemistry of the animal. The need to observe the changes taking place in the animal's body in response to external factors such as nutrition as it affects haematological and biochemical parameters cannot be over emphasized (Scamell, 2006). When haematological and serum biochemical values fall within the normal range established for the animal, it is an indication that the diet does not show adverse effect on the animal. Haematological and serum biochemical components are valuable in monitoring feed toxicity especially with feed constituents that affect the blood as well as health status of farm animal. Haematology and serum biochemistry assay of livestock determine the physiological disposition of the animals to their nutrition (Menon *et al*., 2013). Haematological traits especially PCV and Hb are correlated with the nutritional status of animals PCV and other haematological parameters are useful aids to prognosis and may reveal adverse condition even when the animal does not display obvious clinical signs of ill health. Thus biochemical determination of serum constituents and blood examination can provide valuable information regarding nutrition, and other environmental factors that influence the performance and wellbeing of animals (Ate *et al*., 2009; Al-Fartosi *et al*., 2010; Diostanzo and Gill, 2012).Serum vitamin, protein and lipid concentrations are affected by diet/nutrition(Swanson *et al*., 2004). Diet is therefore an important factor influencing rumen environment and blood metabolite. This study was carried out to evaluate the effect of palm kernel cake on haematology and serum biochemistry of four breeds of cattle.

MATERIALS AND METHODS

Experimental Site

This experiment was carried out at the ruminant section of the department of animal science and technology research farm, Nnamdi Azikiwe University Awka, Anambra state. The location is situated on lat 6.24◦N, 6.28◦N and a longitude of 7.00◦E, 7.04◦E of the equator on the southern part of Nigeria. The climate is the tropical wet and dry with clear season. The mean daily temperature is usually about 27◦c-34◦c in March and lowest during harmattan month of December and January (*Ezenwaj 2013*). The annual temperature and rainfall are 26.8◦c and 1589mm respectively.

Experimental Animal and Management

A total of twenty four yearlings of four different breeds of cattle was used for this experiment. The breeds include; White Fulani, Red bororo, Adamawa gudali and Sokoto gudali. They were purchased from cattle markets in Adamawa state.

Experimental Diet

Palm kernel cake used for experiment was purchased from a known palm kernel cake processing factory at Amansea Awka.

Management of Experimental Animals

On arrival, the animals were weighed, tagged and kept in pens for proper routine maintenance. All animals were given antibiotics injection (oxytetracycline) while Ivomec injection was administered to control both endo and ecto-parasites. Animals were acclimatized for two weeks before commencement of feeding trial. The feed given was a PKC and salt was provided free choice for the animals. The diet was given to the animals in the morning before they go to graze. Water was also supplied ad-libitium. Feeding trial lasted for eight weeks excluding two weeks of adjustment period.

Experimental Design

A total of twenty-four yearlings from four Nigerian cattle breeds, namely Adamawa Gudali, White Fulani, Sokoto Gudali and Red Bororo, were randomly assigned to two feeding patterns – palm kernel cake (PKC) with grazing and grazing only. The experiment was replicated three times in each experimental unit with one animal per treatment combination. Thus, twelve animals from the four breeds were allotted to grazing supplemented with PKC and another twelve to grazing alone. into two groups, twelve animals per breed. The experiment was a 2 x 4 factorial arrangement in a completely randomized design. The model of the design is provided below.

$$Y_{ijk} = \mu + B_i + F_j + (B\times F)_{ij} + E_{ijk}$$

where

Y_{ijk} = Observation made on k^{th} cattle of i^{th} breed alloted to j^{th} feeding pattern.

μ = Overall

B_i = Effect of breed (i = 1, 2, 3, 4)

F_j = Effect of feeding pattern.

$(B\times F)_{ij}$ = Interaction effect of breed and feeding pattern

E_{ijk} = Random error

Data Collection

At the end of eight weeks feeding phase, blood samples were collected from four animals from each group making a total of eight animals. 5ml of blood was collected from each animal via jugular vein puncture using sterilized disposal syringe and needle. Blood samples were drawn into vials containing Ethylene-Diamine-Tetra-Acetic acid (EDTA) as anticoagulant. This was used to determine the following haematological and serum parameters Red blood count (RBC), pack cell volume (PCV), white blood cell (WBC), platelets, haemoglobin concentration (HC), mean corpuscular valve (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC), total protein globulin, glucose, albumin, cholesterol, creatinine, urea, amino transferase and alaninetransferase. Haematological parameters were analysed using rinse, diluents and M-30Cfl lyse reagents in a haematology auto analyser. Serum was analysed using a serum auto analyzer.

Statistical Analysis

Data were analysed by two-way analysis of variance according to the General Linear Model procedure of IBM SPSS Statistics (2011). Significant interaction means were separated by Duncan Multiple Range Test (Duncan, 1955)

RESULTS AND DISCUSSION

Haematological profile of four breeds of cattle (Adamawa gudali, White Fulani, sokoto gudali and Red bororo)

Table 1 presents the Interaction effect of breed and feeding pattern on the haematological profile of the Nigerian. The hematological status of cattle grazed and also fed supplement (pkc) and those grazed alone were similar but significantly different ($p<0.05$) as shown in all tables. The Hb for the animals grazed and also supplemented with concentrate fell within the range of (8.25-10.15 g/dl) and those that grazed alone ranged between (6.75-7.45g/dl). Though the values for supplemented animals were higher, they all fell with the normal range for healthy cattle as reported by (RAR, 2009).

Table 1. Interaction effect of breed and feeding pattern on the haematological profile of the Nigerian cattle.

Parameter	Interactions means									
	A	B	C	D	E	F	G	H	P-value	SEM
Hb (g/dl)	8.25	6.90	9.15	7.45	10.15	6.75	9.60	7.10	0.001	0.16
PCV (%)	22.30	17.25	26.65	22.10	31.10	17.20	23.60	15.50	0.000	0.48
RBC ($\times10^6$/µL)	5.61	5.13	6.59	5.02	7.08	4.78	6.30	5.21	0.001	0.15
WBC($\times10^6$/µL)	9.45	4.40	9.85	7.55	9.60	3.85	8.25	5.02	0.000	0.22
MCV(fl)	37.70	22.10	38.90	25.90	44.40	21.10	39.40	21.15	0.978	12.44
MCH (Pg)	13.80	14.20	13.25	14.60	14.40	14.10	13.80	13.70	0.001	0.14
MCHC (g/dl)	36.10	35.35	34.50	33.70	32.50	35.95	36.90	34.35	0.000	0.15
PLT($\times10^3$/µL)	623.50	472.50	731.50	603.50	403.00	504.00	603.00	425.00	0.000	2.35

A = Adamawa Gudali × (PKC + Grazing), B= Adamawa Gudali × Grazing, C = White Fulani × (PKC + Grazing), D = White Fulani × Grazing, E = Sokoto Gudali × (PKC + Grazing), F= Sokoto Gudali × Grazing, G = Red Bororo × (PKC + Grazing), H = Red Bororo × Grazing
Hb = Haemoglobin, PCV=Packed cell volume, RBC= Red blood cell, WBC= White blood cell, MCV= Mean corpuscular volume, MCH= Mean corpuscular haemoglobin, MCHC= Mean corpuscular haemoglobin concentration, PLT= Platelets.

PCV for animals grazed and fed supplement were within the ranges of 22.30-31,10g/dl while animals that only grazed were between 15.50-22.10 g/dl. Theses' values obtained all fell within the range for healthy cattle as reported by (RAR, 2009). This suggests that PKC in cattle ration does not induce reduction in PCV.

RBC for grazed and supplemented cattle and those grazed alone were similar but significantly different. The RBC values obtained for grazed and supplemented cattle were between the ranges of (5.61-7.08×10^6×µ/l) and (5.02-5.21×10^6µ/l) respectively but still fell within the range for cattle as reported by (MVM, 2012).

The WBC counts were similar among breeds and agrees with the normal value of WBC that ranged between 4-12×10^3µ/l as stated by(RAR,2009) but higher WBC values was observed in breeds grazed and fed supplement. This indicates that animals were capable of generating antibodies in the process of phagocytosis and have high resistance to diseases (Soetan *et al*, 2013). The MCV however was not significantly different (p>0.05). Breeds grazed and fed supplement ranged between (37.7-44.40 fl) which fell within range for healthy cattle according to (RAR, 2009) but animals that only grazed had values between (21.15-25.90fl) these values were below the established range for healthy animals. This could be as a result of anemic condition and on deficiency in diet.

MCHC were similar but significantly different among breeds of grazed and supplemented and only grazed cattle. The range however was normal for healthy cattle reported by (RAR, 2009). This shows that blood level condition of animals was stable and was not affected by feeding pattern. Platelet count of animals both grazed alone and supplemented with concentrate (pkc) were all similar and within range for healthy cattle as reported by (RAR, 2009). Platelets were unaffected by feeding pattern.

Serum biochemistry of four breeds of cattle (Adamawa Gudali, Sokoto Gudali, White Fulani and Red Bororo) grazed and supplemented with palm kernel cake.

Table 2 presents the serum biochemical indices of indigenous cattle grazed and supplemented with palm kernel results showed that there was significant difference ($p<0.05$) among parameters measured for different breeds except globulin and AST which were not significantly different ($p>0.05$).

The total protein of experimental animals fell within range normal range of 6.7- 8.8 g/dl (Gleghorn et.al, 2004). Although SG, AG, WF and RB grazed and also supplemented with had highest values of 8.25, 8.06, 6.53 and 8.27g/dl respectively compared to animals grazed alone but were within range for healthy cattle as reported (msdvet manual.com). This could mean that those animals received adequate levels of protein from the diet and this translated into adequate production of microbial protein by the microbes to the animal.

Total cholesterol and albumin values for different breeds were significant ($p>0.05$) and fell within range for healthy cattle as reported by (msdvet manual.com) though values carried with some breeds fed supplement with AG having highest values (15.50mg/dl) for cholesterol and (5.53g/dl) and albumin. WF also recorded 153.00 for cholesterol and 3.53 for albumin, SG and RB also recorded highest for cholesterol (5.48mg/dl) and (3.63g/dl) for albumin compared to the animals grazed alone. Total cholesterol however, were high in some breeds only grazed this included SG which recorded (148.00mg/dl) and RB (146.50 mg/dl). All values gotten did not exceed the range for healthy cattle.

Table 2: Serum biochemical indices of indigenous cattle grazed and supplemented withpalm kernel cake

Parameters	Interactions means									
	A	B	C	D	E	F	G	H	P-Value	SEM
TP(mg/dl)	8.06	7.07	6.53	7.04	8.52	8.29	8.27	7.32	0.000	0.10
Globulin(mg/dl)	2.53	3.65	3.03	4.06	3.04	3.55	3.03	3.23	0.077	0.17
Albumin(g/dl)	5.53	2.52	3.53	2.98	5.48	3.02	3.63	2.73	0.000	0.02
TC (mg/dl)	151.5	149.0	153.0	138.00	136.0	148.0	139.5	146.50	0.000	1.49
Creatinine (mg/dl)	0.95	1.03	0.90	1.04	1.25	1.03	0.75	1.06	0.003	0.05
AST(iu/l)	65.40	73.25	67.40	80.40	71.50	75.45	69.40	74.40	0.087	1.61
ALT(iu/l)	73.30	62.20	70.40	60.25	66.20	63.25	68.30	61.60	0.000	0.20
Urea(mg/dl)	40.00	39.04	37.04	38.06	39.07	40.65	38.20	39.02	0.000	0.13

A = Adamawa Gudali × (PKC + Grazing), B= Adamawa Gudali × Grazing, C = White Fulani × (PKC + Grazing), D = White Fulani × Grazing, E = Sokoto Gudali × (PKC + Grazing), F= Sokoto Gudali × Grazing, G = Red Bororo × (PKC + Grazing), H = Red Bororo × Grazing
Tp=Total protein, Tc= Total creatinine, AST= Aspartate aminotransferase, ALT=Alanine aminotransferase

Thus, PKC has no adverse effect on cholesterol and albumin of animals. Values of grazed animals which recorded high vales for total cholesterol could be due to influence of selectivity preference of forage by animals when they go on grazing.

It was observed that AST was not significantly different ($p>0.05$) among breeds but fell within normal range for healthy cattle as reported by (msdvetmanual.com). Result showed that AST values were highest in breeds grazed and supplemented with pkc. AST activities increased above normal range in pathological situations that cause cell necrosis such as liver damage to liver cells (Klinkon and Jezek, 2012) but AST in this study was within range.

Creatinine and urea were significant ($p<0.05$) among breeds. Klinkon and Jezek stated that increased urea concentration in serum of values is indicative of increased protein catabolism. On the other hand, creatinine is synthesized during endogenous metabolism in muscles and do not depend on nutrition (Klinkon and Jezek, 2012) the values reported for the various variables fell within ranges reported for apparently healthy subjects by other studies. For instance, Mahima *et al*. (2013) reported reference values for urea as 34.26 ± 0.90g/dl, creatinine (0.93 ± 0.03g/dl), total protein (5.34 ± 0.10g/dl), globulin (1.94 ± 0.31g/dl), ALT (29.58 ± 1.08iu/l), and AST (66.63 ± 2.38 iu/l) in healthy Hariana cattle. Omer *et al.* (2009) reported values of 26.78 ± 1.77mg/100ml, 1.33 ± 0.20mg/100ml, 7.24 ± 0.20g/100ml, 9.74 ± 1.98iu/l, and 25.24 ± 2.27iu/l for urea, creatinine, total protein, ALT and AST, respectively in suckling and yearling Sudanese carmels (Camelusdromedarius). In cattle breeds of Saudi Arabia, Al-Shami (2003) reported values of serum urea as 24.1 ± 2.1mg/dl, 1.3 ± 0.01mg/dl for creatinine, 7.4 ± 0.62g/dl for total serum protein, 270 ± 20.1iu/l for AST and 0.1 ± 1.4 for ALT. These values substantially agree with the values reported in the present study and this showed that both natural forages and the formulated rations were well tolerated by the animals and that supplementation of diet with palm kernel cake has no adverse effect on pathology of animals.

CONCLUSION AND RECOMMENDATION

From the results obtained in this study, it was concluded that the use of palm kernel cake as supplement to cattle did not have any adverse effect on hematology and serum biochemistry of the different breeds of cattle rather all parameters were within the normal range for healthy cattle.

Farmers should use palm kernel cake in fattening their cattle as it has no negative effects on the health of animals.

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Assessment of the Level of Adoption of Organic Agricultural Practices among Vegetable Farmers in the Agricultural Zones of Abia State, Nigeria

(Sub-theme: Advocacy and Extension)

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ABSTRACT

The study assessed level of adoption of organic agricultural practices among vegetable farmers in the Agricultural Zones of Abia State, Nigeria. Five objectives were used to guide the study. A total of 90 respondents were selected using multistage sampling procedure. Primary data were collected and analyzed with appropriate descriptive and inferential statistics such as frequency counts, percentages, mean ($\underline{x}$), multiple regression at 5% level of significance. Findings show that most (66.70%) participated in extension trainings while 53.30% participated in organic trainings in the past. Most (96.70% and 93.30%) of the respondents got information on organic practices from their family and friends and fellow farmers, internet (84.40%), respectively. However, most of the farmers' organic practices assessed showed that they are still at the awareness and trial level of the adoption process while respondents highly agreed with perceived effect of organic vegetable production on their livelihood. Difficult to maintain or continue practice (x = 3.55) and low quality organic matter (x = 3.06) were identified as major constraints. Significant relationship between selected socio-economic characteristics of the farmers and their level of adoption was rejected at 5% level of significance. Though farmers were aware of most of the organic farming practices, there is till need for actual practice in their farm. The study therefore recommends massive advocacy and skill-based training on promotion and adoption of organic farming practices among vegetable farmers through extension services.

Keywords: vegetable production, organic practices, skilled training**.**

INTRODUCTION

Agricultural activities provide a livelihood for many Nigerians. Agriculture is a key activity for Nigeria's economy after oil. In 2021, the agricultural sector generated about 24 percent of Nigeria's Gross Domestic Product. The largest contribution was from crop production, which covered nearly 21 percent of the GDP. The population of Nigeria is growing at very high rates and the food demand is rising accordingly (STATISTA (2021). However, the sector is thus characterized by low yields, low level of inputs and limited areas under cultivation (Izuchukwu, 2011). It involves small scale farmers scattered over wide expanse of land area, with small holding ranging from 0.5 to 3.0 hectare per farm land. Environment-friendly agricultural systems for food security and safety are appropriate farming partway which do not assault the nature, plays the key roles of ensuring food security, improving human health as well as rehabilitating and conserving the environment safeguards the wellbeing (FAO, 2015).

FAO, (2013), observed that farmers in Africa have often resisted “inorganic farming practices” viewing them not only as unsuitable but also risky and inaccessible. Organic farming in an organized manner is still young in the country. The practitioners are mostly a few farmers and some NGO’s, Organic farmers in Nigeria currently sells organic lemongrass tea, turmeric and other produce in the local market with few certified products for export, a situation many regard as under-maximization of the premium benefits of organic farming where several agribusiness opportunities abound (GAIN REPORT, 2014). Farmers adopt a wide range of indigenous agricultural practices based on experiences, informal experiments and good understanding of their environment. Many of these indigenous knowledge and approaches to environmental conservation include technologies and practices such as; shifting cultivation, mixed cropping or intercropping, minimum tillage and agro-forestry as well as ethno-veterinary. Some of the advantages of these technologies and practices are reduction in susceptibility of the crops to pests and diseases, and better utilization of the environmental (Yekinni, 2012).

Organic farming practices are based upon traditional agricultural practices, farmers' innovations and the results of scientific research (Adeoluwa, 2017 and IFOAM, 2011). Organic farming systems are embedded in local cultures, ethical values and beliefs. It gives rural farmers renewed possibilities for maintaining and developing their local sustainable farming systems. Organic agriculture as a production system and distinguished practices which involve being deliberate in planning, organizing, and compliance with standards from seed selection to marketing. Currently, there is Organic Agriculture Standard to enhance; compliance to principles of organic agriculture, adoption of organic practices by farmers, access to local and international market, and stimulate engagement of policy makers in Nigeria. The promotion of organic farming practices has largely been initiated by government and non-governmental organizations. Recent years have also seen initiatives carried forward and developed by an increasing number of agribusiness firms.

In another definition FAO (2014) suggested that “Organic agriculture is a unique production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity, and this is accomplished by using on farm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs". According to Mgbenka, et., al (2015) In Nigeria, certified organic farming (OF) is still in its infancy, hence there is need for its popularization and policy. Organic farming is therefore a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. Its major aim is for the production of safe, highly nutritious food and long-term sustainability of the environment. Researchers have discovered that chemical fertilizers and other agro-chemicals used in conventional agriculture destroy the environment by altering the natural balance of the ecosystem and in many cases affect food quality with the intake of minerals such as lead or excess copper by crops which are dangerous for human consumption. This leads to deadly terminal diseases. The truth is that organic farming has a whole lot of benefits. However, most Nigerian farmers have not wholly taken up organic farming practices.

Vegetables are common crop grown and consumed by many Nigerians. However, the use of chemicals in vegetable production has been identified as a major source of health problems and a cause of extensive environmental damage to the populace. According to Lumpkin (2012) reported that food safety is a major concern as many of today's vegetable farmers inappropriately use toxic pesticides at pre and post-harvest stages and this threatens the health of the farmers and consumers as well as posing hazards to the environment. The reduction if not total elimination of the use of synthetic inputs through the adoption of organic agricultural production methods will help enhance the potentials of organic agriculture and the production of healthy vegetable crops (FAO, 2014). Adoption is regarded as a decision to make full use of an innovation or technology as the best course of action available. Adoption of an innovation is the decision of an individual or group to use or apply an innovation (Adekoya and Tologbonse, 2011). The importance of the adoption of organic farming practices among vegetable farmers cannot be overemphasized as its advantages are numerous. Owing to the knowledge of these benefits, it is expedient to access the extent of adoption of organic agricultural practices among vegetable farmers in agricultural zones of Abia State

OBJECTIVE OF THE STUDY

The broad objective of the study was to ascertain the level of adoption of organic agricultural practices among vegetable farmers in agricultural zones of Abia state. Specifically, the objectives of the study were to:

i. describe socio-economic characteristics of the farmers in the study area;
ii. identify available channels used in disseminating organic practices to the farmers;
iii. ascertain level of adoption of the organic practices among vegetable farmers in the study area;
iv. ascertain effect of organic vegetable production on the livelihood of the farmers and
v. ascertain constraints faced by the farmers in adopting the organic practices in the study area.

1.5 HYPOTHESES OF THE STUDY

The following null hypotheses were tested:

Ho_1: There is no significant relationship between selected socio-economic characteristics of the farmers and their level of adoption.

METHODOLOGY

STUDY AREA

The study was carried out in Abia State. Abia state is one of the thirty-six states of the Federal Republic of Nigeria. The state is located in the South East agro-ecological zones of Nigeria. Abia State lies between longitudes 7^o00E and 8^o00E and latitude 4^o451N and 6^o171N of the equator. The climate is tropical and humid all the year round. The rainy season ranges from March to October. The dry season occurs from November to February. The State has a population of about 4,112,230 as at 2006. The projected population growth of Abia State at 2.6% from 2006 population figure is 10,3157 people (National Population Commission (NPC), 2020).

Abia State comprises 17 Local Government Areas (L.G.A's) divided into three agricultural zones namely, Aba, Ohafia and Umuahia. In Aba zone, there are seven L.G.A's namely: Aba North, Aba South, Osisioma Ngwa, Obioma Ngwa North, Ukwa East, Ukwa West and Ugwunagbo. In Ohafia zone, there are five L.G.A's namely: Isuiukwuato, Ohafia, Bende, Arochukwu and Umunneochi. In Umuahia Zone, there are five L.G. A's namely: Umuahia North, Umuahia-South, Ikwuano, Isiala Ngwa North and Isiala Ngwa South. Umuahia however is the state capital. There is high production and consumption of agricultural produce such as poultry and poultry products (both local and exotic) (Onumadu *et al*. 2014)

SAMPLE/SAMPLING PROCEDURE

The study adopted a multi-stage sampling procedure. In the first stage, Aba and Ohafia agricultural zones were randomly selected for the study. In the second stage, three out of the seven local government areas that make up Aba agricultural zone and three from Ohafia agricultural zone were randomly selected. Osisioma Ngwa, Obioma Ngwa and Ukwa East were randomly selected from Aba agricultural zone while Isuiukwuato, Ohafia and Bende were selected from Ohafia agricultural zone. In the third stage, one village each were selected from the six selected local government areas to give a total of six villages under study. In the final stage, 15 vegetable crop farmers were randomly selected from each of the six villages to have a total of 90 respondents. Therefore, the sample size of the study is 90 respondents

METHODS OF DATA ANALYSIS

Objective i which seeks to describe socioeconomic characteristics of the farmers was achieved using descriptive statistics such as frequency tables, percentages.

Objective ii which seeks to identify the available channels used in disseminating the organic practices was realized using percentages and frequencies.

Objective iii which seeks to ascertain the level of adoption of the organic practices in the study area was realized using mean counts. Responses from five-point rating scale were used to calculate the mean scores. Level of adoption among the organic vegetable farmers was determined by categorizing the mean into insignificant, low, moderate and high level of adoption using a decision rule.

Objective iv which seeks to ascertain effect of organic vegetable production on the livelihood of the farmers was realized using mean counts. Responses from Five-point Likert scale was used to calculate the mean scores. Variables with mean score of 3.0 and above imply that they are positive while those with mean score of less than 3.0 are negative.

Objective v which seeks to ascertain the constraints faced by the farmers in adopting the organic practices in the study area was realized using mean counts. Responses from Five-point Likert scale was used to calculate the mean scores. Variables with mean score of 3.0 and above imply that they are positive while those with mean score of less than 3.0 are negative.

TEST OF HYPOTHESES

Hypotheses 1: which states that there is no significant relationship between selected socio-economic characteristics of the farmers and their level off adoption was tested using Ordinary

Least Square regression analysis. The four functional forms of regression model viz: linear, semi-log, exponential and Cobb-douglas will be tried. The best fit was chosen as the lead equation based on its conformity with econometric and statistical criteria such as the magnitude of R^2, F-ratio and number of significant variables.

MODEL SPECIFICATION

Mean Score Model

To determine the mean $(\bar{x})$

$\bar{X} = \sum fx/n.$

Mean of each item was computed by multiplying the frequency of each response pattern with its appropriate nominal value and dividing the sum with the number of beneficiaries to the items. This can be summarized with the equation below.

Mean = $\sum fx/n$...(1)

Where:

$\sum$ = Summation

F= frequency

X = Scores to response category

n = Number of beneficiaries

X = Arithmetic mean

3.9.2 Ordinary Least Squares Regression Model (OLS)

The four functional forms are expressed as follows:

Linear Function

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} + ei$$

Semi – log function

$$Y = L_nb_0 + b_1L_nx_1 + b_2L_nx_2 + b_3L_nx_3 + b_4L_nx_4 + b_5L_nx_5 + b_6L_{nX6} + b_7L_{nX7} + b_8L_{nX8} + b_9L_{nX9} + b_{10}L_{nX10} + b_{11}L_{nX11} + ei$$

Exponential function

$$LnY = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} + ei$$

Cobb Douglas Function

$$LnY = L_nb_0 + b_1L_nx_1 + b_2L_nx_2 + b_3L_nx_3 + b_4L_nx_4 + b_5L_nx_5 + b_6L_{nX6} + b_7L_{nX7} + b_8L_{nX8} + b_9L_{nX9} + b_{10}L_{nX10} + b_{11}L_{nX11} + ei$$

Y= farmers' level of adoption (provided by the mean score of 4 point weighing scale).

X_1 = Age (years)

X_2 = Education (years)
X_3 = Farming experience (years)
X_4= Farm size (hectare)
X_5 = Farming pattern (sole cropping =1, missed cropping =2)
X_6 = Access to land (hectares)
X_7 = Cooperative membership (yes =1, No = 0)
X_8 = Extension visit (Number of times)
X_9 = participated in trainings on organic agriculture standards (yes=1, no=0)
X_{10} = easy access to organic planting resources (yes=1, no=0)
ei = error term

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Respondents

The results showed the mean value of age (43.7788), household size (5.910) and farming experience (5.611) of the respondents. This indicate that the farmers were still young, active, agile and within their economically active stage with a moderate household size and farming experience. Ugbajah, *et al*., (2015) reported that age is regarded as an important variable because it influences people's attitude, skill and aspiration especially towards activity such as organic production while large household size eases labour constraints leading to increase in production. The moderate farming experience of about 6 years as found in the study is an indication of how equip the farmers are towards organic vegetable production. Farming experience enhances output performance and also affords farmers wide opportunities to master the skill required in any chosen farm enterprise (Adamu *et al*., 2015).

The results revealed that more than half (58.90%) of the respondents were female farmers, majority (83.30% and 75.60%) were married and have access to organic planting resources and also participated in extension and organic trainings in the past. This implied that the type and quality of work carried out for vegetable production were been done by more than half of the farmers. Vegetable production is not tedious; this could be the reason why women are more than the male in the study. Although Nenna & Ugwumba (2014) added that women dominated the farming population in crop production, they also are aware of the nutritional health benefits of organic vegetables. Again, access to organic planting materials and resources can also increase the level of adoption and vice versa.

Table 1: Socio-Economic Characteristics of the Farmers

Variables	Mean	Std. dev	Minimum	Maximum
Age	43.7788	10.0546	29.00	73.00
Household size	5.910	6.0031	0.00	7.00
Farming Experience	5.6111	3.1859	1.00	15.00
Monthly income	29,422.2220	25710.1290	5000.000	180,000.00
Dummy				
Gender (female)	53(58.90)			
Marital status (married)	75(83.30)			
Mixed cropping	84 (93.30)			
Participated in extension training	60(66.70)			
Participated in organic training	48(53.30)			
Access to organic planting resources	68(75.60)			
Membership of cooperative (yes)	19(21.10)			
Access to agricultural credit(yes)	26(28.90)			

Source: Field survey, 2022

The study also showed that few (21.10% and 28.90%) of the vegetable farmers in the study area were members of cooperative and had access to agricultural credit. The poor percentage of those that belonged to cooperative might affect the level of adoption of organic practices. Co-operative society serves as a bolster for the respondents in accessing farm resources like agro-inputs, credits that could boost their timely adoption of improved vegetable practices following Adamu *et al.*, (2015). Membership of famer's organization will enable the farmers to train and understand the benefits of technology acquisition for high yield and profitability.

Available channels used in disseminating organic practices to the farmers

The results in Figure 2 indicate that most (96.70% and 93.30%) of the respondents got information on organic practices from the family and friends and fellow farmers respectively. Majority also sourced information from internet (84.40%), television (72.20%), and extension agents from the ADP (70.00%). However, the high record of information dissemination through the known sources (family and friends and fellow farmers) as seen in the study. This implied that family and friends and fellow farmers are the major farmer's sources of information on organic – based vegetable production in the study area. Adesope *et al.* (2012) reported that majority of the farmers knew about organic farming practices through friends/relatives/neighbours.

However, the result show the need to provide more verified and precise information on organic farming through extension services, radio and internet handles than allowing farmers to pick random information from friends and fellow farmers.

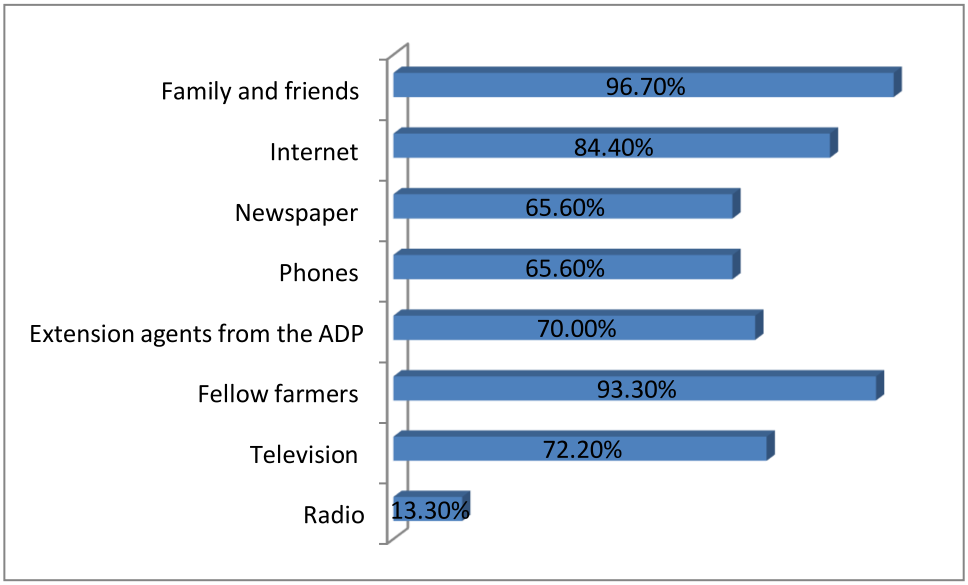

Figure 2: Percentage Distribution of Respondents according to channels sourced Information on Organic Practices
Source: Field survey, 2022

Level of Adoption of the Organic Practices among Vegetable Farmers in the Study Area

Responses in Table 3 showed that most (58.41%) of the organic practices were at the awareness stage, 8.94% were at the trial stage while only about 7.88% are finally at adoption stage.

Specifically, organic practices such as use of use of organic resource (3.04), Farm terracing (3.01), use of Off-farm organic manure (3.11) and Application of compost manure (3.03) were mostly adopted by the vegetable farmers. The high awareness rate of the organic practices found among the farmers high interest in organic farming yet inability to apply most of the indigenous organic practices in the study area. The trend of adoption also indicates high use of external organic substances as indicated by the variables "use of use of organic resource (3.04)", and "use of Off-farm organic manure (3.11)". However, organic farming practices are based upon traditional agricultural practices, farmers' innovations and the results of scientific research (Adeoluwa, 2017and IFOAM, (2011) stressed that organic farming systems are embedded in local cultures, ethical values and beliefs. It gives rural farmers renewed possibilities for maintaining and developing their local sustainable farming systems. Therefore, the vegetable farmers need more information and skill based trainings to enhance their level of adoption of organic cultural practices such as crop rotation, minimum tillage, bush fallow, planting of cover crop, multiple cropping among others no matter their environment and location. Similarly, FAO (2010) added that farmers adopt a wide range of indigenous agricultural practices based on experiences, informal experiments and good understanding of their environment. Many of these indigenous knowledge and approaches to environmental conservation include technologies and practices such as; shifting cultivation, mixed cropping or intercropping, minimum tillage and agro-forestry as well as ethno-veterinary. Some of the advantages of these technologies and practices are reduction in susceptibility of the crops to pests and diseases, and better utilization of the environmental (Mgbenka *et al,* (2015).

Table 3: Level of Adoption of the Organic Practices among Vegetable Farmers in the Study Area

Organic practices	Awareness	Interest	Evaluation	Trial	Adoption	Mean
Mixed cropping	65(65)	5(10)	2(6)	11(44)	7(35)	**2.00**
Mulching of crop	60(60)	16(32)	8(24)	0(0)	6(30)	**2.02**
Crop rotation	60(60)	16(32)	8(24)	0(0)	6(30)	**2.02**
Minimum tillage	60(60)	15(30)	7(21)	0(0)	8(40)	**2.00**
Planting of cover crop	60(60)	6(12)	20(60)	0(0)	4(20)	**2.00**
*Use of organic resource	40(40)	5(10)	9(27)	10(40)	26(130)	**3.04**
Bush fallow	58(58)	13(26)	9(27)	6(24)	4(20)	**2.02**
Use of neem as pesticides	60(60)	6(12)	9(27)	11(44)	4(20)	**2.01**
Use of ash as pesticide and in disease control	60(60)	2(4)	9(27)	15(60)	4(20)	**2.00**
Natural control of weeds	59(59)	8(16)	12(36)	7(28)	4(20)	**2.00**
*Farm terracing	41(41)	5(10)	10(30)	7(28)	27(135)	**3.01**
Shifting cultivation	55(55)	10(20)	16(48)	3(12)	6(30)	**2.03**
Multiple cropping	59(59)	15(30)	12(36)	0(0)	4(20)	**2.01**
*Off-farm organic manure	23(23)	13(26)	4(12)	16(64)	31(155)	**3.11**
Farm sanitization	56(56)	10(20)	13(39)	5(20)	6(30)	**2.01**

Animal manure	75(75)	2(4)	3(9)	4(16)	6(30)	**2.00**
*Application of compost manure	37(37)	5(10)	16(48)	9(36)	23(115)	**3.03**
Mean (%)	**58.41**	**8.94**	**9.82**	**4.94**	**7.88**	

Source: Field survey, 2022

Values in parenthesis are the lickert frequency values

Perceived Effect of Organic Vegetable Production on the Livelihood of the Farmers

The results showed that out of 10 variables examined, eight (8) were agreed by the respondents to have effect on their livelihood. The variables with the mean score agreed with the acceptable mean of 3.00 were; increase productivity (4.80), increased income (4.24), increase business cooperative (4.75), increased access to food (4.48), increased access to healthcare (4.74), better access to education (4.31), improved health/longevity (4.83), and improved access to water (3.05) and thus, were areas of effect on the livelihood of vegetable farmers in the study area. This implied that there was an understanding among the farmers that the practice of organic vegetable production will have positive effect on the productivity, increased income, increase business cooperative, increased access to food, increased access to healthcare, better access to education, improved health/longevity, and as well improved access to water and other areas of their lives.

Food and Agriculture Organization (2010) and Atoma *et al.*, (2018) also agreed that organic agriculture promotes ecological resilience, improves bio-diversity, healthy management of the farm and surrounding environment and building community knowledge and strength. Furthermore, organic products are lower in water content, reserving higher nutrient density richer in iron, magnesium, vitamin C, antioxidants and more balanced with essential amino acids than conventional products (IFOAM, 2013).

Table 4: Likert Scale Analysis on the perceived effect of Organic Vegetable Production on the Livelihood of the Farmers

Variables	**SA**	**A**	**U**	**D**	**SD**	**Mean**
Increase productivity	73(365)	16(64)	1(3)	0(0)	0(0)	**4.80**
Increased income	63(315)	16(64)	1(3)	0(0)	0(0)	**4.24**
Increase agribusiness cooperative	73(365)	14(56)	1(3)	2(4)	0(0)	**4.75**
Increased access to food	63(315)	10(40)	15(45)	2(4)	0(0)	**4.48**
Improved health/longevity	75(375)	13(52)	0(0)	4(8)	0(0)	**4.83**
Improved access to water	18(90)	4(16)	38(114)	25(50)	5(5)	**3.05**
Grand Mean						**4.04**

Source: Field survey, 2022

Values in parenthesis are the lickert frequency values

Strongly Agree SA = 5, Agree A= 4, Undecided U=3, Disagree D=2 and Strongly Disagree SD

Constraints Militating Against Farmers adoption of Organic Practices in the Study Area

Constraints such as high cost (3.55), Difficult to maintain or continue practice (3.12), inadequate extension contact (3.06), inconsistent agricultural polices (3.48) and lack of technical knowhow (3.00) is major constraints identified.

Table 4.5: Likert Scale Analysis of Constraints Militating against Farmers adoption of Organic Practices in the Study Area

Constraints	SA	A	U	D	SD	Mean
Difficult to understand	13(65)	15(60)	11(33)	3(6)	48(48)	2.35
High cost	28(140)	20(80)	16(48)	26(52)	0(0)	**3.55**
Difficult to maintain or continue practice	26(130)	26(104)	4(12)	7(14)	27(27)	**3.12**
Not socially acceptable	2(10)	11(44)	13(39)	8(16)	56(56)	1.83
Technologies disagree with culture	5(25)	11(11)	12(36)	6(12)	56(56)	1.92
Low quality organic matter	11(55)	8(32)	7()21	8(16)	56(56)	2.00
Offensive smell	11(55)	25(100)	2(6)	5(10)	47(47)	2.42
Inadequate extension contact	26(130)	25(100)	1(3)	5(10)	33(33)	**3.06**
Lack of technical know how	32(160)	6(24)	14(21)	6(12)	32(32)	**3.00**
Control of pest and disease attack	26(130)	25(100)	7(21)	7(14)	25(25)	**3.22**
Unavailability of manufactured organic fertilizer	22(110)	3(12)	6(18)	55(110)	4(4)	2.82
Slow decomposition	9(45)	16(64)	2(6)	7(14)	56(56)	2.06
Grand mean						

Source: Field survey, 2022
Values in parenthesis are the lickert frequency values
Strongly Agree SA = 5, Agree A= 4, Undecided U=3, Disagree D=2 and Strongly Disagree SD

Relationship between selected socio-economic characteristics of the farmers and their level of adoption

Ho$_1$: There is no significant relationship between selected socio-economic characteristics of the farmers and their level off adoption.

Regression estimates indicate that among the four functional forms estimated, the semi-log was chosen as the lead equation based on a high R^2 value, number of significant factors and agreement with a priori expectations. The F-value was highly significant at 1% level indicating a regression of best fit. The R^2 value of 0.5398 showed that 53.98% of the variability in level of adoption was explained by the independent variables.

Table 6: Regression Estimates of socio-economic characteristics of the farmers on the level of adoption of Organic practices among Vegetable Farmers in the Study Area

Variables	Parameter	Linear	Exponential +	Double log	Semi-log +
Age	X_1	-0.2338(-1.57)	-0.0795(-1.54)	0.0971(1.88)*	**0.2834(1.91)***
Farm size	X_2	-0.0046(-0.01)	0.0055(0.04)	-0.5522(-0.38)	-0.1505(-0.36)
Educational level	X_3	0.0044(0.02)	0.0217(0.33)	0.0276(0.43)	0.1516(0.08)
Access to land	X_4	0.0111(0.19)	0.0033(0.16)	0.0056(0.06)	0.0064(0.03)
Crop planting pattern	X_5	0.7165(0.19)	0.1982(1.22)	0.1714(1.05)	0.6466(1.38)
Farming experience	X_6	-0.1283(-3.19)**	-0.0504(-3.59)**	-0.0475(-3.43)**	**-0.118(-2.98)****
Income	X_7	1.76e-06(0.37)	5.25e-07(0.31)	-0.0710(-1.10)	-0.1846(-1.01)
Attended organic training	X_8	-0.1441(-0.78)	-0.0519(-0.81)	-0.0599(-0.96)	-0.1604(-0.89)
Member of cooperative	X_9	1.4565(4.94)***	0.3734(3.63)**	0.3658(3.54)**	**1.4411(4.85)*****
Extension visit	X_{10}	-0.0017(-0.13)	0 .0012(0.27)	0.1745(0.77)	0.2311(0.35)
Constant	b_0	1.7180(1.27)	0.7485(1.58)	0.9862(0.99)	2.9753(1.04)
No of observation		90	90	90	90
F value		7.93	6.26	6.51	8.10
R squared		0.5343	0.4755	0.4853	0.5398
Adj. R-squared		0.4669	0.3996	0.4107	0.4732

Source: STATA 13 Results. *, ** and * = Significant at 10%, 5% and 1% respectively. Figures in parenthesis are t-values**

The study found that coefficient of age was positive and significantly related with the level of adoption of organic practice among the vegetable farmers in the study area at 10% level of probability. This implied that increase in age of the farmers will increase level of adoption on organic practice among the vegetable farmers; this means the aged tends to adopt the organic practices than the young. This result disagrees with the findings of Odendo *et al*. (2009) who discovered that age of household heads was negatively associated with the adoption of innovations.

This could be that, the older farmers are already used to the organic materials, its generation and source which make it easy for adoption.

Coefficient for farming experience was also significant and negatively related with the level of adoption of organic practice among the vegetable farmers in the study area at 5% level of probability. This indicated that farmers that are new entrants into farming system tend to adopt organic practices faster than their counterparts with more number of farming experience. Coefficient of membership of cooperative organization was highly positive at 1% level and significantly related with the level of adoption of organic practice among the vegetable farmers in the study area. This implied increase in number of farmers who are members of cooperative will probably increase level of adoption of organic practice among the vegetable farmers in the study area. Membership of cooperative association provides capacity building and exchange of knowledge opportunities among the farmers. It also enhances the capacity of farmers to access credit facilities and government assistance (Umeh, Agu-Aguiyi, & Ekumankama, 2017). Organic vegetable farmers can assess skill based training in organic farming through membership of cooperative societies. .

CONCLUSION

Farmers were highly aware of most of the organic farming practices yet unable to adopt and implement most of the organic cultural practices in their farming operations. The trend of adoption indicates high use of external organic substances which may invariably raise cost of production and other constraints.

Organic farming practices are based upon traditional agricultural practices, farmers' innovations and the results of scientific research. Therefore, organic farming systems are embedded in local cultures, ethical values and beliefs, the vegetable farmers need more information and skill based trainings and capacity building to enhance their level of adoption of organic cultural practices. It gives rural farmers good understanding of their environment, renewed possibilities for maintaining and developing their local sustainable farming systems as well as their income from vegetable production.

RECOMMENDATIONS

1. Skill-based training on how to make compost, farm yard manure, correct implementation cultural practices and general principles of organic farming should be organized for the

farmers on intervals. This will update their knowledge in global best practices in organic farming constantly.

2. Extension organizations, especially Agricultural Development Programmes' (ADPs) staff should ensure regular contacts with farmers to keep them abreast of available innovations on organic farming and also take their farm challenges back to further research.
3. Government and non- governmental organizations should organize projects and programs aimed to support organic agriculture. This should target groups of farmers and cooperatives to encourage easy certification of organic produce and agribusiness.

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Nematicidal Potentials of *Vernonia amygdalina* and *Chromolaena odorata* In the Management of Root-Knot Nematode (*Meloidogyne* spp.) ON *Amaranthus hybridus* L.

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ABSTRACT

A Field experiment was carried out in 2021 at the Faculty of Agriculture Teaching and Research Farm, Nnamdi Azikiwe University Awka, Anambra state, Nigeria, to study the nematicidal potentials of *Vernonia amygdalina* and *Chromolaena odorata* as an alternative to synthetic pesticide in the management of root-knot nematodes on *Amaranthus hybridus* (amaranth). The experiment was set up in a Randomized Completely Block Design (RCBD) comprising five botanical treatments and replicated three times. Treatments include an aqueous extract of *V. amygdalina*, aqueous extract of *C. odorata*, *V. amygdalina* powder, *C. odorata* powder, and the control. Data were collected on the number of leaves, plant height, initial nematode population, nematode population after 1 week after planting, final nematode population at harvest, the reproductive rate of root-knot nematode, and the galling index. All numerical data collected were subjected to analysis of variance (ANOVA) using SPSS statistical package and significant means were separated using Duncan's multiple range test at 5% level of significance. Results showed that the application *Vernonia amygdalina* and *Chromolaena odorata* lead to a significant increase in the growth of amaranth. The botanicals also cause a remarkable reduction in the population of

root-knot nematode. Findings from the study revealed that *Vernonia amygdalina* and *Chromolaena odorata* are effective in managing root-knot nematode infecting *Amaranthus hybridus*.

Keywords: Amaranth, *Chromolaena odorata*, nematode, root-knot, *Vernonia amygdalina*

INTRODUCTION

Amaranthus hybridus L. is a herbaceous plant in the family Amaranthaceae. It is also known as amaranth, pigweed, efo-tete in Yoruba, and Inine in Igbo. Amaranth is a multipurpose crop that is cultivated for its high nutritional value (Venskutonis and Kraujalis, 2013). In Nigeria, it is cultivated as a leafy vegetable used in making dishes such as soup, stew, salad porridge, and garnish (Alegbejo, 2013). It is also one of the cheaper sources of protein, vitamin A, and minerals to prevent malnutrition and maintenance of good health (Owombo *et al*., 2012). *A. hybridus* is associated with a large amount of squalene (Bawa *et al*., 2016); a natural antioxidant that lubricates and protects the skin, making up 10 to 12 percent of the skin oil (Lexy and Chaves, 2022). It is also has a short cycle of two to three months which makes it possible for it to be cultivated several times in a year in locations where there is irrigation, thereby raising the potential income of vegetable farmers.

Plant parasitic nematodes (PPN) are roundworms that infect their host, leading to reduced growth and yield. Yield loss from PPNs can range from 20 to 60%, depending on the severity. Some of the PPN also cause indirect damage to plants by acting as hosts for plant viruses. Earlier reports indicate the common PPN associated with *A. hybridus* were *Meloidogyne, Helicotylenchus, Pratylenchus, Heterodera, Paratrichodorus, Xiphinema,* and *Aphelenchoides*. Among the nematodes, the root-knot nematode (*Meloidogyne* spp.) was also reported to be the most parasitic to the plant, causing root-knot disease (Bawa *et al*., 2016). Root-knot nematodes (RKN) are regarded as the most damaging with the widest host range among plant nematodes. Amaranths are very susceptible to the nematode (Steyn *et al*., 2012; Data, 2006). Once root-knot nematodes become established in plant roots, control is always difficult.

Management strategies for root-knot nematodes include the application of chemical pesticides, crop rotation, use of good planting materials, and adequate soil treatment before planting (Nwanguma and Fawole, 2004). Chemical control has proven to be the most effective method but the high cost and health hazards associated with their use are a source of concern. Recently, the use of botanicals is been explored as a good alternative to the chemical pesticide. Botanicals are plants or parts of a plant that contain antimicrobial properties. They are environmentally safe and easily affordable for poor farmers.

Therefore the aim of this research is to determine the efficacy of *Vernonia amygdalina (*bitter leaf) and *Chromolaena odorata* (Siam weed) in the management of root-knot nematodes infecting amaranth

MATERIALS AND METHODS

Experimental location

The experiment was carried out between April and May 2021, at the Faculty of Agriculture Teaching and Research Farm, Nnamdi Azikiwe University Awka, Anambra state, Nigeria. Awka is located in the tropical rainforest zone of Nigeria. The state has two main climatic seasons; the dry and rainy seasons. The research farm lies on a latitude of 6.2497N and a longitude of 7.116E with an average temperature of 27°C and annual rainfall of 1828mm. The soil texture of the farm was clay-loam.

Collection of Materials

Two varieties of amaranth were used for the experiment and were sourced from two different locations at Awka. The local variety of amaranth used for the experiment was collected from the Agriculture Development Programme (ADP) office, Awka. The botanicals were collected within Nnamdi Azikiwe University environment.

Experimental Design and planting operations

The experimental design used for this experiment was a Randomized Completely Block Design (RCBD) comprising five botanical treatments. Each treatment was replicated three times. The botanicals treatments were; aqueous extract of *V. amygdalina* (*V. amygdalina* Aq.), aqueous extract of *C. odorata* (*C. odorata* Aq.), *V. amygdalina* powder (*V. amygdalina* Pw.), *C. odorata* powder (*C. odorata* Pw.), and the control.

The field was cleared and tilled under a shade for broadcasting of the seeds. A space measuring 10m x 6m was cleared and tilled with hoe to 1.5m x 0.5m bed dimension and 1m spacing between the beds. Seedlings were planted at the rate of four seedlings per hole and later thinned to two. The field also had a previous history of root-knot nematodes.

Preparation and application of botanicals

The leaves of *V. amygdalina* and *C. odorata* botanicals were collected and separately air-dried for fourteen days at room temperature. The treatments were prepared using the method described by Izuogu *et al.*, (2012). Treatments were applied two times during the experiment; 24 hours, and 1 week after planting at the rate of 250 ml and 25g for aqueous extract and powder respectively, per plant stand.

Nematode Extraction and data collection

Data were collected on the number of leaves, plant height, initial nematode population, nematode population after 1 week after planting, final nematode population at harvest, the reproductive rate of root-knot nematode, and the galling index. Nematode extraction was done using the modified Berman's extraction tray method as described by Coyne *et al.*, (2018). Root galling index was scored using Bridge and Page, 1980 method; 0 = Root has no knots; 1 = Scanty little knots, difficult to discover; 2 = Little but visible knots; 3 = Larger knots more easily seen and noticeable; 4 = Large, knots predominant but main root clean; 5 = Approximately half of the roots are affected by knots on some main roots; 6 = Knots on the main roots; 7 = Most of the main roots have knot; 8 = Every part of the roots have knots. Only small parts are clean; 9 = Every part of the roots is extremely knotted; 10 = Every part of the root system is knotted. It usually results in the death of a plant

The reproductive factor was determined by; R=Pf/Pi, where Pf = represents final while Pi= initial population of nematode**.**

Data Analysis

All numerical data collected were subjected to analysis of variance (ANOVA) using SPSS statistical package and significant means were separated using Duncan’s multiple range test at 5% level of significance.

RESULTS

Table 1 shows the effect of the five botanical treatments on the number of leaf of *Amaranthus hybridus*. At 2 WAP, there was no significant difference between the treatments. At 5 WAP, the number of leaf in plants treated with botanicals was significantly higher than the control.

Table 1: Effect of botanicals on the number of leaf of *Amaranthus hybridus*

Treatment	2 WAP	3 WAP	4 WAP	5 WAP
V. amygdalina Aq.	6.83	8.50	14.17	16.00[a]
V. amygdalina Pw.	6.50	8.00	13.83	18.83[a]
C. odorata Aq.	8.67	10.00	12.17	17.00[a]
C. odorata Pw.	8.33	9.33	14.67	17.33[a]
Control	6.50	8.83	10.67	9.33[b]
SEM	0.345	0.347	0.404	0.945

Means within a column followed by the same letter(s)are not significantly different P=0.05; WAP= weeks after planting; SEM= standard error mean; *V. amygdalina* Aq. = aqueous extract of *V. amygdalina*, *V. amygdalina* Pw. = *V. amygdalina* powder, *C. odorata* Aq. = aqueous extract of *C. odorata*, *C. odorata* Pw. = *C. odorata* powder and the control.

Table 2 shows the effect of botanic treatments on the plant height of *Amaranthus hybridus*. At 2 and 3 WAP, there were no significant differences in the height of all the treatments. At 4 WAP, the height of *V. amygdalina* Pw. was significantly than other treatments. At the end of the experiment (5 WAP), all botanicals were significantly higher than the control but *V. amygdalina* Pw. had the highest weight which was remarkably higher than others

Table 2: Effect of botanicals on plant height of *Amaranthus hybridus*

Treatment	2 WAP	3 WAP	4 WAP	5 WAP
V. amygdalina Aq.	14.950	17.300	30.7[b]	33. 417[b]
V. amygdalina Pw.	15.617	18.217	41.27[a]	47.267[a]
C. odorata Aq.	15.500	18.717	30.50[b]	34.850[b]

C. odorata Pw.	15.383	18.300	29.66[b]	34.817[b]
Control	14.93	15.083	18.40[a]	19.783[c]
SEM	0.853	0.828	0.982	1.657

Means within column followed by the same letter(s) are not significantly different P=0.05; SEM= standard error mean;

Table 3 shows the effect of treatments on root-knot nematode population, reproductive rate, and the gall rating of *Amaranthus hybridus* root. The initial nematode population was 610, however at the final nematode count, root-knot nematode reduced significantly in plants treated with botanicals while it increased in the control. *V. amygdalina* Pw. also had the least nematode population among the botanical treatments. The reproduction rate was highest in the control while there was no significant difference in the gall rating of the roots.

Table 3: Effect of treatments on root-knot nematode population, reproductive rate, and galling index of *Amaranthus hybridus*

Treatment	Initial nematode pop.	Nematode pop. at 1 week	Final nematode po.	Reproductive rate	Gall rating
V. amygdalina Aq.	610	570.34[b]	183.1[b]	0.3	1.01
V. amygdalina Pw.	610	421.26[a]	63.9[a]	0.1	1
C. odorata Aq.	610	541.92[b]	172.2[b]	0.28	1.02
C. odorata Pw.	610	526.01[b]	168.9[b]	0.28	1
Control	610	1278.54[c]	1502.01[c]	2.46	1.05
SEM		7.276	7.172		0.21

DISCUSSION

Previous investigation revealed that different species of amaranths are susceptible to root-knot nematodes. However, their level of susceptibility differs according to the plant and the RKN species (Vaingankar *et al*., 2018). In the current research, higher growth and leaf yield was observed in amaranth that was treated with botanicals. The degree of damage by nematodes in plants depends on population density with high population density leading to high disease severity and yield loss. This was also the case in this study where plants with lower nematode populations also had the highest performance. The reduction in the nematode population in this study could be attributed to the *V. amygdalina* and *C. odorata* botanicals. This further showed the importance of botanicals in the management of root-knot nematodes. RKN damages their host by redirecting nutrients from plant cells into their own special feeding sites for developmental activities. This eventually leads to disruption in the distribution of water and useful nutrients in the vascular tissue that ought to go to different parts of plants (Escobar *et al*., 2015).

This study conforms with the reports of Apalowo *et al*. (2021), and Abolusoro *et al* (2010), on the nematicidal importance of *V. amygdalina* in the management of RKN. In their reports, Abolusoro (2006), showed the ovicidal action of *V. amygdalina* leaf extract which may be related to low nematode population build-up in the field. Apalowo *et al*. (2021), also revealed the phytochemicals present in the plant and their antimicrobial properties against RKN. This is also similar to the observation of Abolusoro *et al.* (2020), that *C. odorata* has a nemato-toxic substance to RKN.

Among the botanicals, *V. amygdalina* powder had the least nematode population and the highest growth. This is understandable as powders could also be a source of organic matter to the soil where the plants are planted, thereby enhancing the soil nutrients available for the plants (Aboyeji, 2019) which could help them to tolerate RKN infections. Notwithstanding, all botanical treatments were effective in reducing the nematode population.

CONCLUSION

The result from the study revealed that the use of these botanicals (*V. amygdalina* and *C. odorata*) was effective in the management of root-knot nematode (*Meloidogyne* spp.) by suppressing the nematode population and also help to improve yield. Therefore, these two botanicals are recommended for the effective management of root-knot nematodes in the field where *Amaranthus hybridus* is planted. They are also environmentally safe, require little or no skill to use, and are not dangerous to non-target organisms

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Ethical Implications of Social Media Marketing for Organic Food in Nigeria

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ABSTRACT

More than ever before, Nigerian consumers are showing interest in organic food and the recent popularity can be credited to the brands and retailers who are increasingly turning to social media platforms to promote their products. However, this approach raises a number of ethical questions, particularly around transparency in labelling and the potential for misleading claims or "greenwashing" by brands. This article explores the ethical implications of social media marketing for organic food in Nigeria. The potential of social media for promoting organic food is discussed, with a focus on the opportunities and challenges. The article then tackles ethical considerations of social media marketing, including transparency and authenticity, sustainability, and collaboration and innovation. The need for transparency and authenticity in social media marketing is highlighted, as well as the importance of promoting sustainability in the organic food industry. The role of collaboration and innovation in driving sustainability, as well as the importance of the certification of organic food and farms is also discussed. While social media can be a powerful tool for promoting organic food in Nigeria, ethical considerations must be taken into account to ensure that marketing practices align with sustainability and transparency, for the benefit of the producers and consumers.

1.0 INTRODUCTION

There is a surge in the demand for organic food in Nigeria, as consumers become more health-conscious and concerned about the environmental impact of conventional farming practices. As a result, social media has become a platform of choice for the promotion of organic foods and related products by producers and retailers. The use of social media platforms like Facebook, Instagram, and Twitter has been identified as a low-cost way for reaching a wider audience, especially for small businesses and start-ups. While social media can be a powerful tool for marketing organic food, it also raises ethical concerns about transparency, accountability, and authenticity (Banterle and Cavaliere, 2020; Anand and Shrivastava, 2021). In this article, we will explore the ethical implications of social media marketing of organic food in Nigeria, and examine the challenges and opportunities for promoting ethical marketing practices.

2.0 ETHICAL IMPLICATIONS OF SOCIAL MEDIA MARKETING FOR ORGANIC FOOD

2.1 Misleading advertising of produce as organic

Misleading advertising is one of the biggest challenges of social media marketing of organic food in Nigeria. There is a high risk of greenwashing, which is the practice of making false or exaggerated claims about a product's environmental or health benefits. This can mislead consumers and erode trust in organic food, and it can also undermine the credibility of the organic food industry as a whole. Adeoye *et al*. (2021) observed that social media platforms such as Facebook and Instagram have made it easier for companies to engage in greenwashing, by allowing them to create attractive and persuasive advertisements that appeal to consumers' desire for natural and healthy products. The study concludes that there is a need for stricter regulations and enforcement to prevent companies from making false or misleading claims about their products on social media.

Many conventional foods have false labelling and certification slapped on to make them appear organic. Olawumi *et al*. (2015) pointed out that producers and distributors have been found to use the "organic" label on products that have not been grown or processed according to organic standards. This is a serious issue as it can mislead consumers into thinking that they are buying a product that is healthier, more sustainable, and free from harmful chemicals when in reality, it is not.

Additionally, some producers may use marketing language that implies a product is organic when it is not. For example, a producer may use the term "natural" or "eco-friendly" to suggest that a product is organic when it is not (Adeniyi *et al*., 2018).

The study by Ibiyemi *et al*. (2016) shows that these misleading practices are harmful to consumers who are trying to make informed choices about the food they buy. They also undermine the efforts of legitimate organic producers who follow strict standards and invest in sustainable farming practices.

2.2 Implications for consumer trust and authenticity

Repeated purchase of organic food in Nigeria is largely trust-based and when that trust is breached, it makes the consumers question their decision to eat right. Although social media marketing can be an effective way to build trust and authenticity by providing consumers with information about the production and sourcing of organic food, if social media marketing is perceived as deceptive or manipulative, it can erode consumer trust and damage the reputation of the organic food industry Olugbenga (2020).

Authentic social media promotion of organic produce can help build trust with consumers who are looking for sustainable and ethical food options. Certified and practicing organic farmers can leverage this to provide transparent information about their production practices, certifications, and supply chain. This will help to establish them as trustworthy sources of organic food. This can create a positive association between organic food and authenticity in the minds of consumers.

Olatoye (2021) noted that false claims and misleading information in social media promotion of organic produce can harm consumer trust and authenticity. If consumers believe that a product is organic when it is not, they may become sceptical of organic food and lose trust in the organic industry. This can lead to a decrease in demand for organic products and ultimately harm the growth of the organic sector in Nigeria.

Therefore, it is crucial for producers, marketers, and social media influencers to promote organic produce based on accurate information and transparent communication (Agbonlahor, 2021). By doing so, they can build trust with consumers and contribute to the growth of the organic industry in Nigeria while ensuring the authenticity of organic food (Olatoye 2021).

2.3 Transparency and accountability issues

Transparency is a key component of ethical social media marketing of organic food, as consumers are increasingly demanding information about the production process, certification standards, and sourcing of organic food. Organic food businesses that are transparent about their practices can build trust and credibility with consumers, and demonstrate their commitment to the health of their consumers and the environmental. Transparency should not be challenging for companies that are willing and able to disclose information about their production processes.

Transparency and accountability can be seen in the activities of some organic farmers and producers who use social media platforms such as Instagram and Facebook to showcase their farming practices and production processes (Dada, 2019). For instance, some organic farmers in Nigeria share pictures and videos of their farms, production processes, and organic certification on social media to create awareness and educate consumers about their transparent and accountable farming practices. These farmers use social media as a tool for promoting transparency and accountability in the organic industry by sharing information about the origin and quality of their produce, as well as their farming techniques and environmental impact (Olugbenga, 2020). This helps to build trust with consumers who are concerned about the authenticity and transparency of organic food. . If more organic farmers do this, the effect will be much more significant.

In addition, some organic food retailers and cooperatives in Nigeria use social media to provide information about the sources and supply chain of their products. They share pictures and videos of their organic suppliers and provide details about the farmers, their locations, and their farming practices. This helps to create transparency in the organic supply chain and build accountability among organic food stakeholders (Agbonlahor, 2021).

2.4 Environmental and social responsibility implications

The use of social media marketing for the promotion of organic food can also have environmental and social implications, as it can promote sustainable and responsible farming practices (Agbolahor, 2021), and support local communities and economies. Companies that prioritize environmental and social responsibility can use social media to highlight their efforts and engage with consumers who share their values. However, companies that prioritize profit over social and environmental responsibility can also use social media to promote unsustainable or exploitative practices, and undermine the credibility of the organic food industry (Dada, 2019).

It is important to note that the effect of social media promotion of organic produce on environmental and social responsibility in Nigeria is largely positive. Social media provides a platform for organic farmers and retailers to showcase their commitment to sustainable and ethical farming practices, which can help to raise awareness and create demand for environmentally and socially responsible food production.

Through social media, organic farmers can share information about their farming practices, such as crop rotation, composting, and natural pest control, which are more environmentally sustainable than conventional farming methods. Social media can also be used to promote the use of renewable energy sources and eco-friendly farming techniques that reduce carbon emissions and promote biodiversity.

In addition, social media can be used to promote the social responsibility aspect of organic farming in Nigeria, including fair labour practices and support for local communities (Olugbenga, 2020).

Some farmers also showcase how they recruit and involve members of their farming communities for their production processes. Sharing information about the impact of their farming practices on local communities, can attract socially conscious consumers who are interested in supporting ethical and sustainable farming practices (Asare, 2021). This can encourage consumers to make more environmentally and socially responsible choices, not only in their food consumption but in other aspects of their lives as well.

3.0 CHALLENGES AND OPPORTUNITIES FOR ETHICAL SOCIAL MEDIA MARKETING IN NIGERIA

3.1 Lack of regulation and enforcement

One of the main challenges to promoting ethical social media marketing of organic food in Nigeria is lack of regulation and enforcement (Oyewole and Yusuf, 2021). The organic food industry in Nigeria is still in its early stages, and there is little government oversight or industry standards for certification and labelling. This creates a risk of greenwashing and deceptive marketing practices, as companies may make false or exaggerated claims about their products without facing consequences (Eze *et al*., 2020)

3.2 Limited consumer awareness and education

Another challenge is the limited consumer awareness and education about organic food and ethical marketing practices. Many consumers in Nigeria are not familiar with the concept of organic food, or the fact that standards and certifications are used to ensure its quality and safety. The general assumption is that this makes it difficult for companies to communicate the value and benefits of organic food, and to differentiate themselves from conventional food products. Education and awareness efforts are needed to raise consumer awareness and understanding of organic food, and to promote ethical marketing practices that prioritize transparency, authenticity, and sustainability (Adeoye *et al*., 2020).

3.3 Opportunities for collaboration and innovation

Despite these challenges, there are also opportunities for collaboration and innovation in promoting ethical social media marketing for organic food in Nigeria. Companies that prioritize social and environmental responsibility can work together to establish industry standards and certifications, and to advocate for government regulation and enforcement. They can also collaborate with farmers, suppliers, and other stakeholders to promote sustainable and responsible farming practices, and to support local communities and economies. Additionally, companies can use social media to innovate and differentiate themselves from competitors, by highlighting their unique value proposition and engaging with consumers who share their values (Nwankwo *et al*., 2021).

4.0 CONCLUSION AND RECOMMENDATION

Evidently, social media marketing is a powerful tool for promoting the consumption of organic food in Nigeria, but it also raises ethical concerns about transparency, authenticity, and sustainability. Organic certification, supported with quality assurance framework within the organic food industry, will play a critical role in establishing trust between the producers and consumers. The Association of Organic Agriculture Practitioners of Nigeria, as the umbrella body for organic related issues in the country, can covert these challenges on ethical issues to opportunities, using instruments and support within the body to provide private quality assurance systems that takes care of the transparency issues and also improves the productivity of the producers.

In addition, capacity building in the areas of dissemination of information, extension services, business and technical assistance leveraging technology and various digital marketing tools, will support a robust quality assurance system that guarantees the integrity of organic production systems.

Consumers, as the most important stakeholders, can also play a role in promoting ethical marketing practices, by seeking information about organic food and demanding transparency, authenticity, and accountability from companies and social media marketers.

With the right approach, social media can be a force for positive change in the organic food industry in Nigeria, promoting transparency, authenticity, and sustainability, and supporting the health and wellbeing of consumers and the environment.

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Effects of Soilless Organic Growth Media on the Performance of Tomatoe (*lycopersicon lycopersicon, l.*) In Ile-Oluji, South Western Nigeria.

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ABSTRACT

A nursery experiment was conducted at Teaching and Research Farm, Federal Polytechnic, Ile-Oluji, Ondo State to investigate the effects of soilless organic growth media on the performance of tomatoe (*Lycopersicon lycopersicon, L.*). The experiment involved mixing of soilless materials such as: Cocoa pod husk (CPH) 50%, Stone dust (SD) 5%, cocoa dry leaves (CDL) 10%, poultry manure biochar (PMB) 20%, and pig biochar (PB) at 15%. All these materials were milled and made up to 25kg. The mixture was mixed and allowed to stay for twenty one days before it was used to fill the seed trays. Two varieties of tomatoe was used in this experiment (Diva F1 and Presido F1) with the control. These combinations gave four treatments of; SMD, SMP, CD, and CP. All spread out in a Completely Randomized Design (CRD). The project cell arrangement area in the nursery is (3x1) m^2. There were twelve (12) cells used for this project with six hundred seedlings (600) representing one treatment combination. The total seedlings used were two thousand four hundred (2,400) (12 Seed trays with 200 cells each). Data were collected on growth characters of tomatoe from twenty (20) plants in each cell given a total of two hundred and forty (240) plants sampled. Data collected were subjected to analysis of variance (ANOVA) while significant treatment means were separated using Least Significance Difference (LSD) test at 5% level of probability using Gentstat software. The result of the experiment shown that soilless organic growth media promotes growth and yield characters of tomatoe and is recommended for peasant farmers in Ile-Oluji and South Western Nigeria.

Keywords: Tomatoe, Soilless substrates, growth media, inorganic materials, and organic farming.

INTRODUCTION

Soilless is the practice of growing crops without using soil. The practice is used to control soil related problems emanated from agricultural land use. Some of the soilless materials that can be used as organic substrates for growing crops are; sawdust, coco peat, peat moss, woodchips, fleece, marc, bark etc. whereas, inorganic substrate of natural origin are perlite, vermiculite, zeolite, gravel, rockwool, sand, glass wool, pumice, sepiolite, expanded clay, volcanic tuff and synthetically produced substrates are hydrogel, foam mates (polyurethane), oasis (plastic foam), nylon materials etc (Ehret and Helmer, 2009).

Organic farming entails the use of various raw materials to produce growing media for vegetable production throughout the world. This practice is not new, it is an age long which is used to raise the potential of compost for use in soilless culture of horticultural crops have also been confirmed in a number of scientific studies (Olle, 2012; Urrestarazu *et al*,2002).

The world prefers nowadays organic crops which are products of Organic Farming. This is now being advocating for and it is one of the holistic approaches in agricultural systems, utilizing both traditional and scientific knowledge to improve the agroecosystem health and a save environment (Reddy, 2017). In conventional cultivation methods, tomato plants absorb easily assailable nitrogen from the substrates and use it for its metabolic activities. A large concentration of this macro element results in increased synthesis of proteins in the fruit, which also affect the synthesis of carbon-based compounds such as vitamin C. In effect, plant products from organic farming are higher in vitamin C compared to conventional system (Rihali *et al*, 2009).

Efficient management of organic waste utilization in tomatoe nursery produces healthy seedlings also, high cost of growth media leads to high cost of seedlings and increased in the cost of production. Soilless culture in bags, pots or trays with light weight medium is the simplest, easiest and economical way of growing crops. Researchers reported that soilless culture can provide more efficient use of water and fertilizers, (Riviere and Caron, 2001). Reduce root diseases (Reed, 1996 as cited by Asaduzzaman, 2014), and facilitate cultivation of crops in areas where normal cultivation is not possible such as water and high altitude. Thus (Jensen,1999 as cited by Asaduzzaman, 2014) soil has been replacing by many organic and inorganic substrates, since they are disease and pest free inert material capable of holding required sufficient moisture needed for uptimum growth and can be reused year after year with minimum improvement (Asaduzzaman, 2014). The physical and hydraulic properties of soilless culture substrate is better that those of soil medium. In soil culture plant root get higher water availability just after irrigation which cause lower oxygen content to be used by plant root and micro flora but in substrates optimum aeration is possible due to its leaching or pulling capacity by capillary action (Asaduzzaman, 2014).

The problems in agricultural land use worldwide are; soil exhaustion, pest infestation, chemical interference, toxicity, diseases etc are increasing greatly due to intensive cropping, injudicious application of pesticides or continuous monoculture (Asaduzzaman, 2013). In this regard, soilless culture can avoid problems with monoculture of plants in the same land for years and help to reduce non availability of land for cultivation (Asaduzzaman,2014) Research studies reported that commercial production of greenhouse vegetables with soilless media adopted to reduce economic losses caused by soil-borne pathogens. (Riviere and Caron, 2001). This research work aimed to formulate organic package that will be cheap and affordable to farmers in raising tomatoe seedlings in the nursery than imported coco products that is expensive.

MATERIALS AND METHODS

Source of organic waste

The organic waste used for this Research project was sourced from Teaching and Research Farm, Federal Polytechnic, Ile-Oluji, Ondo State. The waste was from the piggery pen that have been left to ferment for six months. Similarly, dried cocoa pod husk and leaves was from Ondo State Ministry of Agriculture cocoa Breeding plot, Agricultural Village, Ile-Oluji.

Procurement and sorting of seeds

The seeds used for this experiment was sourced from Agro-allied shop located in Ondo City. The varieties used for the experiment are: Diva, and Presido F1. The two varieties of tomatoe were placed on a seed sourcer, dressed with Dress Seed Fungicide/Insecticideb which contains Metalaxy

20%, Carbonxin 15% and imideacloprid 10% at 4kg per 3kg of seed. The seed is later sprinkled with moderate water to give the seeds damp condition for quick germination. However, bad seeds from the seedlot were removed. (Agbona *et al*, 2020).

Preparation of experimental site

The nursery for the experiment was cleared, and fumigated to prevent insect attack on the seedlings. The seed trays and other necessary equipment needed for the experiment were washed and dried in the sun three days before the commencement of the project.

Preparation of soilless materials and filling of seed trays

The soilless materials (cocoa pod husk) CPH, (stone dust) SD, (cocoa dry leaves) CDL, (pig biochar) PB, and (poultry manure biochar) PMB. All were milled separately and allowed to stay for three days before been mixed together in the ratios below:

Table 1; soilless materials in different mixing ratios in 25kg bag

S/N	Soiless Materials	Percentage (%)	Mixing ratio	Quantity (Kg)
1	CPH	50	50/100 x 25	12.5
2	SD	5	5/100 x 100	1.25
3	CDL	10	10/100 x 25	2.5
4	PB	20	20/100 x 25	5
5	PMB	15	15/100 x 25	3.75
Total				25

The materials were later allowed to stay in a mildly perforated rice bag covered completely for 21 days. This is to allow all the micro-organisms in the materials to mix and react together. Later, the materials gave rise to soilless organic material formulated for this trial experiment. A total of six seed trays were filled with the soilless materials and wetted to field capacity after standing in the bag for 21 days. The seed trays were left to stand for 14 days to allow the micro-organisms full establishment under irrigation for the two weeks. Water was applied every three days for three times before planting of seeds.

Treatments, experimental design and allotted technique

The treatments used in the experiment incudes (cocoa pod husk) CPH, (stone dust) SD, (cocoa dry leaves) CDL, (pig biochar) PB, and (poultry manure biochar) PMB. And two varieties of tomatoe Diva and Presido F1. Each of the tomatoe variety was replicated three times given a total of nine replications. A set of seed trays contained 200 cells and three trays wich give rise to 600 cells for each treatment variety. A total of 40 seedlings was sampled randomly from each seed tray which was arranged in Completely Randomnized Design (CRD) in the nursery. For each variety of tomatoe, a total of 120 seedlings were sampled.

Crop establishment

The following procedures were taken in the course of this research project.

Planting

The Tomatoe seeds were placed on a seed sourcer wetted lightly and planted in the seed trays in the evening and they were placed on two days wetting regime (Oyewusi *et al*, 2020). The seed trays were later arranged in their respective plots for the commencement of the research.

Other agronomic practices

Watering was done twice a week throughout the period of the experiment. Weeds were controlled through the hand picking. Karate was used to control mites and Basudin for caterpillar. Also kaocide was used to control leaf rot, a fungus and nematicide for soiless materials treatment before planting of the seedlings.

Growth parameters measured

The parameters measured in the course of this experiment are; Germination count, germination percentage, plant height, numbers of leaves, stem girth, and fresh shoot weight.

Chemical analysis of the soil.

Soil samples were for the experiment were collected from the field using soil auger. The soil was sieved with 2mm sieved range before being subject to laboratory analysis. The samples were collected and analyzed for routine chemical analysis as described by Carter (1993). The samples were air dried and sieved using a 2mm sieve before making the determinations. Soil organic matter was determined by the procedure of Walkley and Black using the dichromate wet oxidation method (Nelson and Sommers, 1996)., total N was determined by micro-Kjeldahl digestion method (Bremner, 1996)., Available P was determined by Bray-1 extraction followed by molybdenum blue colorimetry (Frank *et al*, 1998). Exchangeable K, Ca, Mg were extracted using 1.0N ammonium acetate. Thereafter, K was determined using a flame photometer and Ca Mg were determined by EDTA titration method (Hendershot and Lalande, 1993). The pH was determined in water (1/2) medium using the digital electronic pH meter.

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) while significant treatment means were separated using the Least Significance Difference (LSD) test at 5% level of probability using Genstat software.

Result and discussion

Chemical composition of the soiless materials

The result of the chemical composition of Soilless materials (Table 2) shows that the materials contains essential elements (N,P,K,Ca), Ash and moderate pH. (5.57)which fell between the range of 5.5 and 7 recommended by (FAO, 1975 as cited by Adebisi and Agbona, 2019) for tomatoe plant cultivation. Table 2 shows the chemical composition of stone dust used for the experiment the pH is moderate (5.67) with all other elements (N,P,K,Na, Ca, and Mg.) available for raising soilless crops.

Table 2: Chemical composition of the soilless materials

S/N	Soiless materials	1:50 H_20 pH	ASH	% C	N	Mg/100g				
						P	K	Na	Ca	Mg
1	Substrate organic materials formulated	5.57	14.530	85.470	1.68	25.78	9.43	7.52	8.24	3.96
2	Cocoa dry leaves	3.80	17.822	82.178	1.16	51.89	0.80	0.60	6.02	2.84
3	Pig biochar	3.81	31.357	68.421	1.50	17.53	1.12	0.70	7.38	3.14
4	Ficus leaves	5.27	14.286	85.714	1.46	6.00	7.80	6.66	19.56	8.94
5	Poultry biochar	5.71	2.326	97.674	1.58	45.79	9.90	0.4	31.36	12.96
6	Stone dust	5.67	97.976	2.024	0.11	1.32	0.10	0.02	1.26	0.72

Table 3: Chemical composition of stone dust

1:2 1:H_2O pH	(%)			mg/ kg	Cmol / kg			
5.67	Oc	om	N	P	K	Na	Ca	Mg
	0.10	0.17	0.11	2.33	1.03	1.36	3.00	1.20

Effects of soilless organic substrates on growth c haracters of tomatoe

Percentage germination of tomatoe in the nursery

Germination percentage of tomatoe was taken at the beginning of the experiment between seven to nine days after sowing (Table 4). The result shown that the organic substrates have effects on the germination of tomatoe. Presido variety has the highest germination (Fig. 1).

Table 4: Percentage germination of the tomatoe seeds

TREATMENTS	PERCENTAGE GERMINATION
SMDR1	75.3
SMDR2	78.4
SMDR3	80.9
SMPR1	74.8
SMPR2	76.8
SMPR3	77.6
CONTD1	71.4
CONTD2	69.8
CONTD3	74.5
CONTP1	76.4
CONTP2	72.1
CONTP3	67.8

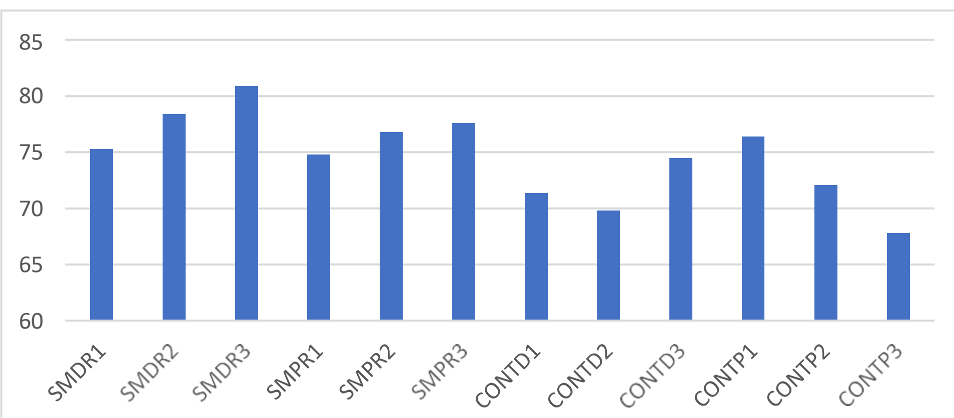

Fig. 1: Mean effects of the treatments at 9 DAP for percentage germination

Plant height, numbers of leaves and stem girth

Table 5,6 and 7 shows the growth characters of tomatoe in response to the effects of soilless organic substrates (SM). Plant height at 9, 16 and 23 days after planting was not significant across all the treatments however, the trends was higher at 23 DAP. (Fig. 2) with Diva F1 variety having the best performance at 9,16 and 23 DAP. Similarly, numbers of leaves were not significantly different from each other in all the stages and in all the varieties. On stem girth, at 9 DAP, there was no significant difference in the varieties but however, this trend change as the days progresses with the highest value recorded at 23 DAP. (Fig. 2 and 3).

Table 5: Mean effect of plant height, Numbers of leaves and Stem girth at 9DAP, 16 DAP and 23 DAP

TREATMENTS	**Mean Plant Height**	**Mean effects of Plant Height**	**Mean effects of Stem Girth**
SMDR1	6.67	2.00	2.00
SMDR2	6.30	2.00	2.00
SMDR3	6.60	2.00	2.00
SMPR1	6.20	2.33	2.33
SMPR2	6.30	2.00	2.00
SMPR3	6.07	2.00	2.00
CONTD1	5.60	2.33	2.33
CONTD2	5.17	2.00	2.00
CONTD3	4.60	2.00	2.00
CONTP1	5.37	2.00	2.00
CONTP2	5.57	2.00	2.00
CONTP3	5.07	2.00	2.00
F-test	**	**	**
F-test (Plant height)	0.086 (NS)	0.000 (Significant)	0.001 (Significant)
CV%	12.300	4.620	4.610
LSD (0.05)	0.802	0.118	0.128

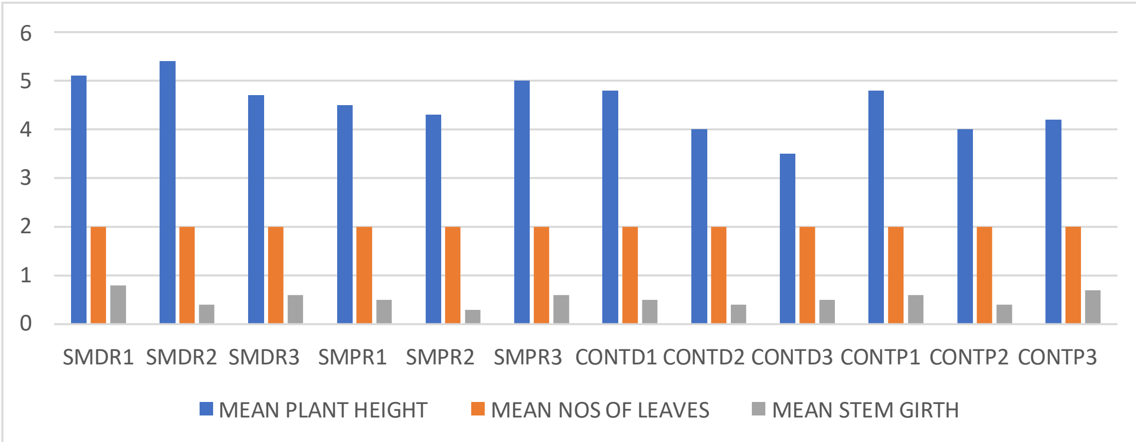

Fig. 2: Mean effects of the soilless materials on growth characters of tomatoe varieties at 9 DAP.

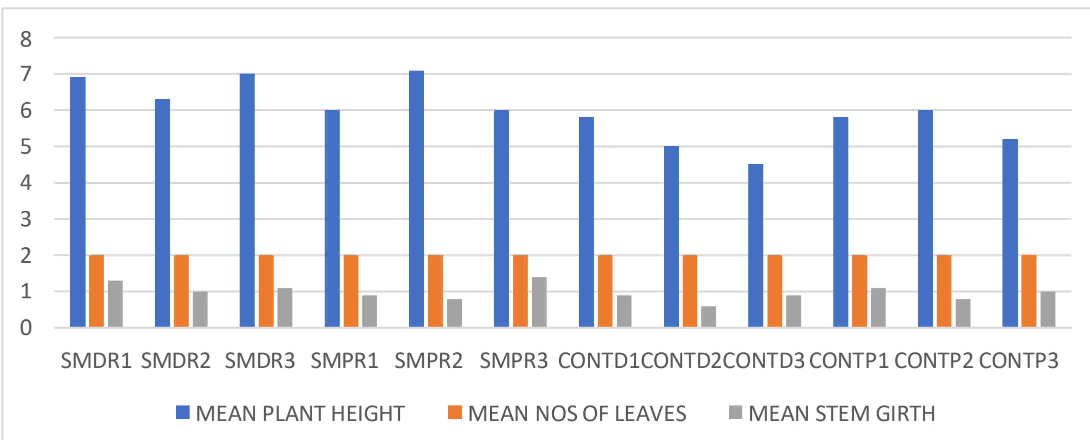

Fig. 3: Mean effects of soilless organic materials on growth characters of tomatoe at 16 DAP

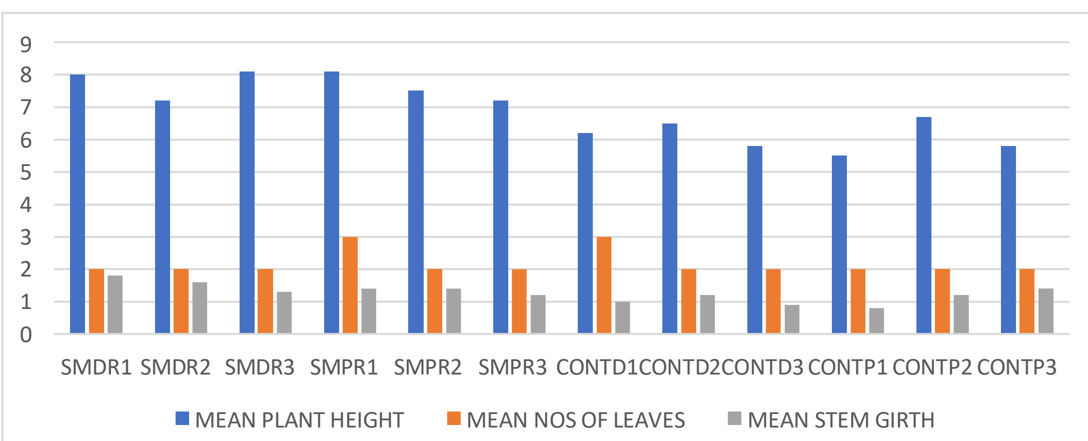

Fig. 4: Mean effects of soilless organic materials on growth characters of tomatoe at 23 days after planting.

Effect of soilless organic media on yield of tomatoe

At termination of the experiment, the means of fresh shoot weight, root length and stem girth is as presented on table 8, Diva F1 variety gave the best performance and the effect was much on tomatoes grown on soilless organic media.

Table 6: Mean effect of organic soilless materials on fresh shoot weight at 30dap (termination of experiment)

TREATMENTS	**Mean**
SMDR1	2.78
SMDR2	2.50
SMDR3	2.93
SMPR1	2.88
SMPR2	2.45
SMPR3	2.53
CONTD1	2.25
CONTD2	2.40
CONTD3	1.83
CONTP1	1.70
CONTP2	2.18
CONTP3	2.03
F-test	**
F-test (Soilless Materials)	0.010 (Significant)
CV%	5.410
LSD (0.05)	0.108

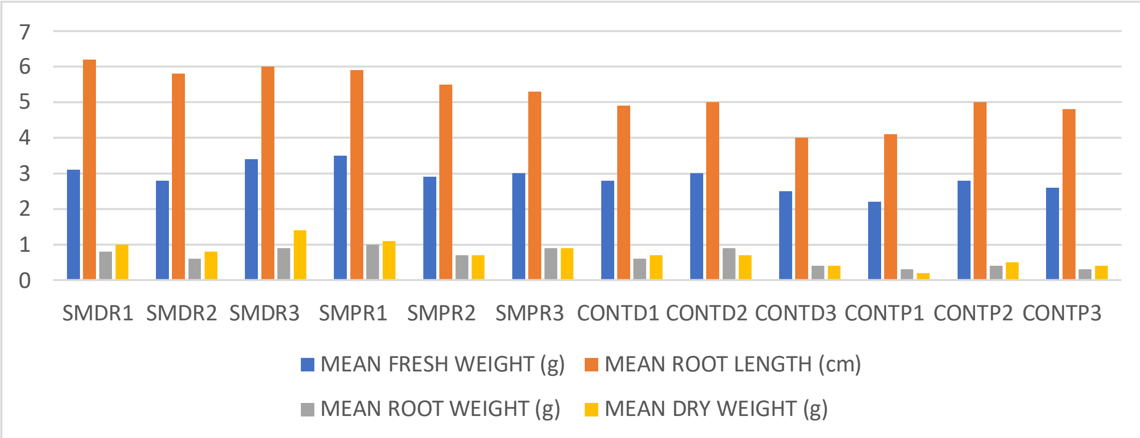

Fig. 5: Mean effects of soilless organic media on yield of tomatoe 23 days after planting.

CONCLUSION AND RECOMMENDATION

Conclusion

It is concluded that soilless organic substrates is good for raising seedlings in the nursery as it enhanced growth, fresh and dry matter yield of tomatoe this was in line with Agbona *et al*, 2020 that stated that organic substrates promotes the growth of tomatoe in the nursery.It is therefore recommended that soilless organic package using the proportions as presented on table 1 is affirmed for sustainable organic tomatoe production in Ile-Oluji. This will enable the farmer to reduce the cost of production of tomatoe seedlings for planting.

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Production of Organic Amendments from Sustainable Plant Sources Using Eco friendly Agricultural Technology

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Workshop Expectations

The expectations of this workshop include the following:

- The participants to know micro organisms as natural sources of soil health and plant fertility
- The participants to identify other sources of natural organic amendments to save our environment
- The participants to understand how plant residues can be used in the preparation of organic amendment to enrich our soil and plant health organically
- The participants to understand how to use organic amendments to improve soil fertility

Our Environment

In our environment you can see mountains of heaps of garbage, degradable dirt, domestic and industrial wastes stinking and smelling. Our farms are full of agricultural wastes. All these if not properly harnessed contribute to climate change and pollution and directly affect many ecosystems and spies, which results to poor agricultural yields and impacting negatively to our environment as well. What is the solution to the above wastes? The solution to this problem is use of eco-friendly agricultural technology to transform this waste to organic amendments for soil fertility/health improvement.

Status of Animal and Domestic Waste

1. Animal wastes management Practice in Nigeria is very poor.
2. Current management in livestock production in peri-urban areas of Nigeria consists of confinement in moderate flocks (8-12) within small areas.
3. The wastes from poultry and ruminants are heaped and they constitute environmental nuisance in Nigeria
4. They constitute health challenges; emit harmful gas like methane and carbon.
5. Cause greenhouse gas emissions and ***Climate Change***

The waste from Poultry or Ruminants is managed in these ways:

1. Is either stored in bags or piled up.
2. Sweeping off and heaping on farm.
3. The confined cow lives in slurried dung waste without evacuation and is animal welfare abuse.
4. The manure from slaughtered ruminants are flushed or discharged into water stream or piled up, Where it typically releases a lot of Ammonia {NH3}, when the manure get wet.

Solution

The solution to this problem is the use of eco-friendly agricultural technology, it involves Recycling, recyclable biodegradable content such as Plant-based materials into organic amendments.

Reduction of polluting substances into landfill dump like domesticwaste, animal dung and agricultural wastes that may trigger greenhouse gas emissions into organic amendments

Organic Amendments

They occur naturally with or without the help of humankind — it's happening right now on forest floors, in farmers' fields, and in our yards. But oftentimes it's a slow process and we can speed it up using the right combination of water, oxygen, heat, and organic material.

Organic amendments are **fertilizers derived from organic sources, including organic compost, cattle manures, poultry droppings and domestic sewage**. It means *fertilizer derived from or made of organic materials which are produced through methodologies* such as moistening, chopping and fermenting. Examples of naturally occurring organic amendments include **slurry, worm castings, peat, seaweed dead wood, failing leaves and animal droppings etc.**. Green manure crops are also grown to add nutrients to the soil. Naturally occurring minerals such as mine rock phosphate, sulfate of potash and limestone are also considered organic amendments.

In Nigeria intensive cropping is gradually replacing the traditional shifting cultivation that is associated with the long period of fallow to resuscitate soil fertility. The resultant effect of this intensive cropping is low crop yield (Onyekwere *et al*., 2020). The steady decline in soil fertility due to reduced fallow regime as a result of population increase and urbanization, has compelled farmers to amend the soil with different fertilizer (Organic and in-organic) in other to enhance plant growth and increase soil productivity. It has been observed that the use of organic materials as soil amendments, improves environmental condition, public health as well as the quality of the crop. The fertility status of the soil is also improved by the activities of soil micro- organisms. (Agboola and Omueti 1982))

Consequently, Abuo El-magd *et al*., (2006) reported that the application of organic amendments play vital roles in plant growth and also as source of all essential macro and micro nutrients in available forms during mineralization, thereby improving both physical and biological properties of the soil. This enhances soil productivity and increases crop yield.

Organic amendments produce nutrient rich, fertile soil that nourishes the plants, through the action of microorganisms, by solubilization of nutrient that get attached to soil glomalin and is actively released slowly to provide nutrients to plants continuously and sustainably (Roddy and Reddi, 1992)

Benefits of Organic Amendments

You would be hard-pressed to think of anything else you can use in crop production that does more than organic amendments to improve growth and yield of crops. If you ever needed a list of some their most beneficial attributes, here it is:

• Enhances soil tilth (the physical condition of the soil)

• Improves soil structure and porosity (creating a better plant root environment)

• Increases moisture infiltration and permeability

• Reduces erosion and runoff

• Filters out and/or binds contaminants that might be contained in surface water

• Improves the moisture-holding capacity of light soils

• Supplies organic matter

• Supplies and aids the proliferation of microorganisms

• Encourages vigorous root growth

• Allows plants to more effectively utilize nutrients

• Reduces nutrient loss by leaching and enables soils to retain nutrients longer

• Improves soil fertility

• Destroys or suppresses many soil pathogens

• Neutralizes toxins (soil organic matter can chemically bind, or lock up, heavy metals)

• Reduces the amount of solid waste going to landfills

• Reduces greenhouse gas emission

Eco friendly Agricultural Technology

Eco- friendly technology can be referred to as clean technology that uses green renewable energy to convert plant residues to organic amendments at zero carbon emission.
Eco-friendly technology can help preserve the environment through energy efficiency and reduction of harmful waste.
Eco-friendly agricultural technology often involves some of the following:

Recycling, renewing and reusing biodegradable content waste such as plant-based materials to decompose and convert to organic amendments

Reduction of polluting substances

Reduction of greenhouse gas emissions

Renewable energy for Energy-efficiency

Why Eco-friendly Agricultural Technology

The world is turning to eco- friendly technology driven by the following reasons

1) The consumer's desire to obtain safe food that does not contain chemical residues calls for this technology.
2) Reducing environmental degradation: The current agricultural practices have led to the use of chemical inputs in our farming activities, which pollute and harm the soil ecosystem, water and degrade farmland.
3) Preserving the fertility and vitality of the soil by repeatedly using organic amendments and not using chemical inputs.
4) Preserving biological diversity and microbe.
5) Gives natural healthy rich dense food.
6) Human health and vitality are maintained through the consumption of food grown withorganic amendment that is healthy rich dense.

List of material that can be used for Organic Amendments production using Eco-friendly Agricultural Technology

MATERIAL	BROWN OR GREEN	COMMENTS
Grass clippings	Green	When saturated, fresh clippings will clump and emit an unpleasant odor temporarily
Leaves	Brown	Shred or chop first for faster breakdown. A mulching mower works great for this.
Sticks and twigs	Brown	The smaller the better. Slow to break down.
Yard debris	Brown & Green	Cut or chop into small pieces
Maize stalk	Brown	Make sure you use the one that was not treated with herbicides and break them down into pieces
Rice mill waste	Brown	Make sure you use the one that was not treated with herbicides
Sawdust	Brown	
Wood mulch (natural)	Brown	
Manure	Green	High in nitrogen. Use caution when using horse manure due to risk of persistent herbicides that can survive organic fertilizer process.
Pet bedding	Green	Small animals (hamsters, rabbits, guinea pigs, etc.)

		Herbivorous animal bedding only.
Vegetable scraps	Green	
Citrus and fruit waste	Brown	Rinds, seeds, fruit, peelings
Corncobs	Brown	Slow to break down.
Eggshells	n/a	Crush first for faster breakdown.
Breads	Brown	
Cereal (hot or cold)	Brown	
Coffee grounds (and filters)	Green	
Popcorn	Brown	
Pasta	Brown	Cooked or uncooked
Tea leaves/tea bags	Green	
Cardboard	Brown	The smaller the better
Egg cartons	Brown	Cardboard only
Wine corks	Brown	Natural cork only.
Hair	Brown	Human or animal is fine.
Paper (plain)	Brown	Shred first if possible. Avoid glossy.
Paper towel	Brown	Without grease or oil.
Envelopes	Brown	Avoid window envelopes.
Pet food–dry only	Brown	
Seaweed/kelp	Green	
Wood ash	Brown	Use very sparingly (raises pH).
Nutshells	Brown	Crush if possible.
Natural twine	Brown	
Natural fiber material	Brown	Cotton, burlap, bamboo, wool.
Palm bunch	Brown	Break them down into pieces
Other crop residue	Brown	Break them down into pieces

Materials that should not be used for Organic Amendments production using Eco-friendly Agricultural Technology

The following materials should not be used in the production of organic amendments

- Plastics
- Metals
- Chemicals
- Weeds
- Diseased plants
- Glossy magazines
- Gum leaves

- Treated pine saw dust
- Dog and cat droppings(they are acidic)
- Meat, bones and diary product (they attract rodents, pests and pathogens)
- Grease
- Chemically-treated plants and grass

The following materials should be added in small quantity

- Onion
- Lemons

Acidic materials should be added sparingly, as these can be difficult to break down and affect the pH of the organic amendments

The two major Eco- friendly Agricultural Technologies involved in Organic Amendments production

1. Aerobic fermentation

2. Pyrolysis

Aerobic fermentation

Aerobic fermentation is a metabolic process by which cells metabolize sugars via fermentation in the presence of oxygen and occurs through the repression of normal respiratory metabolism.

Basic requirement for organic amendments production using Aerobic fermentation process

Five Basic Ingredients are needed for this process. They include:

- Air
- Water
- Carbon (browns)
- Nitrogen (greens)
- Animal manure
- Biofertilizer

When you understand that organic amendments are made up of billions of beneficial microscopic living organisms, it's easy to see why air and water would be key ingredients to sustaining life, even for the smallest forms of life. Yet it's this oxygen and moisture that allows them, and other organisms in the process, to utilize the other two ingredients -- carbon and nitrogen -- to biodegrade the raw material into finished product.

- **AIR (OXYGEN**, REALLY): Microorganisms can't live without it. It's that simple.
- **WATER**: When it comes to remembering how wet your organic amendments should be, think in terms of making and keeping it at the moisture level of a damp sponge. Now. The organisms consuming the organic material in your organic amendments pile cannot survive

without moisture. It's also responsible for providing the medium for the chemical reactions and the mode of transport for both the nutrients and the microorganisms. If you had a way of knowing the moisture content in your pile was between 40 and 65%, you'd be in the ideal range for water content. But in the real world, that's easier said than done. A simple way of knowing is to take a handful of organic amendments and squeeze it. If water drains from your hand, it's too wet. Conversely, if it does not feel moist or bind together when squeezed, it's too dry. Greens and browns (reduced to small pieces), kept moist, and aerated by turning once a week or so goes a long way to making organic amendments quickly. Keeping your material consistently moist is a major factor in making organic amendments faster.

RAW MATERIAL: Fortunately, you don't have to know anything about science to figure out how to get a reasonable balance of the carbon (browns) and nitrogen (greens) into the mix. I think in terms of anything that came from the earth originally in some living plant form (no matter what it is today) is biodegradable and can be added into the system. And that's pretty much your guide for considering what you put into your organic amendments. It also helps to know that all organic matter has varying amounts of both brown (carbon) and green (nitrogen) matter. Common examples of brown waste ingredients include dried leaves, small twigs, yard debris, coffee grounds, shredded paper and newspapers, paper towel rolls and brown paper bags. Common examples of green waste include fresh grass clippings, plant trimmings and food scraps such as vegetables and salad greens. Animal manure is also added as a source of nitrogen, before it is added it is usually sprayed with biofertilizer to reduce the odour.

Production process

With organic amendments being so well-known as the key input to a thriving farm, one should often wonder why more people don't produce organic amendments at home. Even a small backyard pile will go a long way. I believe a big reason is that people don't know where to start or become quickly overwhelmed. In nature, organic amendments happen without any help from us. It's simply the natural decomposition of organic matter over time by billions of microorganisms (bacteria and fungi mostly). To be sure, converting organic matter from its initial form to finished product can be a very slow process. But we farmers are generally very impatient. We want it immediately. Fortunately, there are a few simple things we can do to speed up the process. While the science behind production of organic amendments can get quite heady, producers just don't need to get bogged down in such details. Information abounds about the optimal carbon-to-nitrogen ratio (a.k.a., the brown-to-green ratio) to accelerate the process, for example. This is one of the biggest impediments to getting started with home made organic amendments. Having a good balance of brown to green is indeed important for producing good organic amendments quicker. Think of it like us having a balanced diet of nutrients in our body. Too much of one type, while not enough of the other can have an impact on how our bodies function and how healthy we are. The same is true during the process of making organic amendments. The stars of the show in making organic amendments are the billions of microorganisms breaking down all the raw inputs that consist of carbon and nitrogen. The microbes need some of both. The closer you are to the proper ratio, combined with sufficient oxygen and moisture, and the billions of soil microbes will work fast and furious to break down the organic material as they consume the carbon and nitrogen. It's this activity that generates the heat found in an organic amendments heap during the fermentation process. The hotter the heap, the more in-balance your material is, and the faster it breaks down. So what is the ideal carbon-to-nitrogen ratio? I will reluctantly tell you it's about 25:1. But don't glaze over here. While it does absolutely help in the speed of decomposition, your organic amendment will eventually break down anyway.

A simple heap of organic matter from inside and outside the house can create the most amazing organic amendments that are ready to use in only a matter of months. This pile lived in shade and reached sustained temperatures of 65 degrees C. for several weeks. You don't need anything fancy to make amazing organic amendments.

More on Temperature

So how hot is hot enough for organic amendments to happen, even a little? While the process does take place down to as low as 10 degrees C (the lower end of the mesophilic range, 10 - 45 degrees C), you'll be waiting a long time for the finished product. The fastest process takes place above 50 degrees C (the lower end of the thermophilic range, 50 – 70 degrees C). In addition, higher sustained temperatures are necessary to destroy many of the undesirable

elements in organic amendments, such as pathogens, weed seed, and fly larvae. So here's the best news: making organic amendments is not rocket science. In fact, producing organic amendments might be the easiest thing you do when it comes to farming. So don't burden yourself with the science behind the details.

To prepare:

1. The first step is to find the right location for your organic amendment chamber. To make it convenient to use, position your chamber so that you have easy access to it. It can be placed both in the sun or the shade; the warmer the location, the faster the organic amendments will work.

2. Get your rice mill waste , this 'brown ingredients' should be placed at the bottom of your organic amendments chamber

3. Your second layer should include 'green ingredients'. Add a layer of clippings, plant scraps or other green materials so that it's roughly the same thickness as your first brown layer.

4. The next thing is to get your animal manure sprayed thoroughly with bioferlizer at a ratio of 1:50 then mix them together and allow to stay for one week this reduces the ordure . This is about kick starting the process by introducing ingredients rich in useful microorganisms.

5. You can put the mixture inside the chamber as the next layer and water thoroughly. This water encourages bacterial growth which allows your organic amendments to start breaking down.

6. Mix often (every week is good) and add water to moisten (about like a damp sponge). The amendment is ready to serve when the ingredients are unrecognizable, the internal temperature is ambient, and the contents smell rich and earthy.

Maturity period of organic fertilizer produced using Eco-friendly Agricultural Technology

The process of converting raw material to finished organic amendments does not stop until all sources of available carbon have been exhausted. While you won't be able to know when this happens, you can safely assume organic amendments is ready to use is once two things have occurred: First, you can no longer recognize any of the original ingredients. It should look and smell rich and earthy, rather than any distinctive or offensive odor. However, this alone is not a sufficient indicator Ingredients during the process can achieve this stage well before stability is reached? Second, the sustained temperature of the ingredients has reached ambient levels at the core, even after turning and sufficient moisture is present. It should be noted that even though a pile can smell and look earthy, and temperatures are sustained near ambient levels, that does not ensure it's finished if moisture is absent from the pile. The best way to know organic amendment has stabilized is to turn the pile again while ensuring it has sufficient moisture. Then re-check the internal temperature after about a day. If the reading is close to ambient temperature, stability has been reached and you can start using your organic amendments. Now, if you're a very patient farmer, allowing your organic amendments to rest for about a month beyond this point can have added benefits including more beneficial and disease-fighting microorganisms and humus (the star ingredient of organic amendments)

Optimum conditions of Organic Amendment produced from aerobic fermentation

- Carbon-to-Nitrogen Ratio (C:N) - Good: 20:1 – 40:1, Better: 25:1 – 30:1
- Moisture Content - Good: 40-65%, Better: 50-60%
- Oxygen concentration - Good: Greater than 5%, Better: Much greater than 5%
- Temperature - Good: 43-66 degrees C., Better: 54 -66 degrees C

How to store finished Organic Amendments produced from aerobic fermentation

Once the initial activity of the organic amendments production has subsided and the internal temperatures have cooled, it's best to keep it relatively dry and in piles small enough to allow aerobic respiration throughout

Challenges involve in Organic Amendments production using aerobic fermentation

- Production harmatan
- Space(for urban dwellers)
- Odor
- Rodent control
- Deterring ants
- Dealing with flies

Pyrolysis

Pyrolysis is **the heating of an organic material, such as biomass, in the absence of oxygen**. Biomass pyrolysis is usually conducted at or above 500 °C, providing enough heat to deconstruct the strong bio-polymers,and the end product is known as biochar. Biochar, which is produced through pyrolysis of feedstocks can be used to replenish soil nutrients, especially in acidic condition where it acts as a liming material (Onwuka *et al.*, 2015). It can also improve soil fertility (Biederman and Harpole, 2013); reduce gaseous and leaching losses of nutrients such as carbon and nitrogen from the soil (Zhang *et al.*, 2010). Biochar can be produced from diverse feedstocks and each of these feedstocks has different nutrient contents which affect the soil fertility and crop yields

Basic requirements for Organic Amendments production using pyrolysis process

Three basic Ingredients are needed for this process. They include:

- Heat
- Carbon (browns)
- Nitrogen (greens)

Production process

This process can take place, using the following facilities; metal burning chamber, drums, dishes even by digging hole in the ground. Make sure that the hole will be strong enough to withstand pressure. The major end product of this process is soil amendment known as **biochar**.

Making biochar in a drum, dish or earthen pit is a very simple way to start making charcoal and learn the process. From there it can become as elaborate or large as needed or wanted. The important part is to burn from the top down.

Procedure

1. Get evenly sized (feedstocks) biomass, (sticks, twigs, off cuts or other agricultural waste.),make sure that they are dried because it saves time and energy.
2. Put them into your pyrolysis drum. If it is a mixed biochar that you aimed at producing put the feedstocks at layers one after the other..
3. Ignite the feedstocks with matches alone .Kerosene is usually avoided to prevent introduction of contaminants,
4. Allow it to burn for few minutes (10 to 20 mins) and cover with the lid.
5. Monitor the burning and when the smoke coming out has reduced open and check.
6. Drum is designed with holes that will limit the oxygen,heat up the system and increase the temperature. For the drum, the temperature is always between 450 – 550 ^{o}C.
7. Once all the feedstock has been burnt and turned into charcoal, quench the charcoal by tipping liquid over it. If you’re game, urine is the best as it fills the charcoal with valuable nutrients, if not available use water.
8. Crush the charcoal to a fine dust while still wet.
9. You can mix it with your fermented organic amendments to charge it with microbial life

Use of Organic Amendments produced using Eco-friendly Agricultural Technology

It is advisable to use organic amendments for crop production, based on its numerous benefits. In doing this, the first step is to establish the nutrient requirement for the establishment, growth and yield of such crop. Followed by laboratory analysis of the organic amendments and soil that the crop will be grown, after which the quantity to be applied based on the requirement will be determined before application. These steps will give excellent results for sustainable soil fertility and enhanced crop yield.

Benefits of the these Organic Amendments

1) They are free of methane
2) They are free of plant disease causing pathogens
3) They act as buffer against drought and flood
4) They scavenge unwanted chemical residues and entrains them in insoluble forms.
5) They work as a sponge for water, nitrogen and many trace elements.
6) They resist combination of carbon with oxygen to become carbon monoxide or carbon. It just remains in the soil for a very long time.

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The Place of Agricultural Extension in Developing Organic Agriculture in Nigeria

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ABSTRACT

The challenge of developing organic agriculture, producing healthy food and ensuring sustainable livelihood for organic farmers in Nigeria is enormous. This is largely due to lack of awareness of organic farming and its advantages as compared to conventional farming method and inadequate extension services. There is therefore need for extension to bridge the gap in organic agriculture technology development and dissemination. The paper discuss the place of agricultural extension in developing organic agriculture, producing healthy food and ensuring sustainable livelihood for organic farmers. Specifically, it examine the concepts of agricultural extension, organic agricultural extension, organic agriculture producers and the challenges of organic farming in Nigeria. It further elucidated what Nigeria should do to maximize the advantages of organic farming as compared to conventional farming method. The study submitted that organic agriculture practices should be properly coordinated and regulated by bringing all organic agricultural technology transfer agencies on board. The paper concluded that extension should not only bridge the gap between organic farmers and research, they should also bridge the gap between organic farmers and consumers. It was recommended that extension workers' capacity in organic agriculture and its benefits to farmers and society at large should be built up by extension agencies through training.

INTRODUCTION

Over sixty percent of sub-sahara Africa population lives in rural areas and depends on agriculture as the main source of livelihood. The dominance of agriculture in Africa's economies make its performance a major determinant of the continent economic development. Despite the vast arable land with potential to feed Africans and produce surpluses for export, the continent is still battling with hunger and food insecurity. Africa remains a net importer of food with a widening food trade deficit. This is largely due to poorly developed agricultural extension system and the untapped potentials of Africa's farm and farmers.

In Nigeria, over seventy percent of the population are engaged in one form of agricultural production or the other. Yet, Nigeria is not food sufficient. Food importation still take a large chunk of our annual budget. This is an indication that agriculture is still underdeveloped, lack of extension service and lacked inadequate supporting infrastructure. In developing organic agriculture in Nigeria, the extension component should be adequately addressed.

Agricultural extension is central in the agricultural development process both in terms of technology transfer and human resource development. Agricultural extension is the core of agricultural development because of extension primary responsibility of improving farmers productivity and income. Until farmers productivity and income is optimum, agricultural development has not taken place. For farmers production to be optimum, extension must connect farmers to adequate, current and relevant information that will help in greatly improving the production level of organic agriculture products. There is a wide gap between what researchers have found out to be possible on the field in terms of yield potentials through innovations and what the practitioners are doing in their farms (Nwachukwu, 2019). While researchers are developing new technologies and recipes, these are largely not known to the farmers. This is largely due to lack of proper linkages in the value chain of organic agricultural practice in Nigeria. It was against this background that this paper examine the role of agricultural extension in developing organic agriculture in Nigeria.

THE CONCEPT OF AGRICULTURAL EXTENSION

The main thrust of agricultural extension is to have competent, well informed extension workers who will have contact with farmers frequently and regularly with relevant technical information and bring farmers problem to research. Although the method to achieve this may vary from place to place to suit different environments, the main focus is on farmers and information. Agricultural extension is not static but moving in pattern and shades. The over reaching objective of agricultural extension service globally remains the development of the rural areas and raising the standard of living of the farmers through increased farm production and income. It relays farmers problems and information needs to researchers and in turn transfers technical information to farmers for implementation or formation of sound opinion which allows them make good decision in selecting probable solution from alternatives. Agricultural extension is globally acknowledged as information and knowledge sharing for agricultural and rural development purpose.

Agricultural extension was defined as an ongoing process of getting useful information to farmers and assisting farmers to have necessary knowledge, skills and attitude to effectively utilize information or technology (Yahaya, 2011). It also involves teaching, research and the transfer of new farming technologies and information to farmers and feedback from farmers. Abdul-Aziz etel (2013) noted that agricultural extension is the prime vehicle for bringing technological innovations to farmers for sustainable development and improved quality of life.

THE CONCEPT OF ORGANIC AGRICULTURE

Organic agriculture represents a deliberate attempt to make the best use of local natural resources and is an environmental system of farming. It relies much on ecosystem management which excludes external inputs especially the synthetic one. According to IFOAM (2014) organic agriculture is a holist system’s health, biodiversity, biological cycle and biological activities without the external inputs of synthetic chemicals, such as fertilizers, pesticides, hormones and feed addictives. Thus, organic system which promotes and enhances agro-ecosystem’s health including increased functional activities. It emphasize the use of management practices in preference to the use of off farm inputs, taking into account that regional conditions requires locally adapted systems. This is accomplished by using where possible, cultural, biological and mechanical method, as opposed to using synthetic materials to fulfil any specific function within the system.

ORGANIC AGRICULTURAL EXTENSION

The challenge of developing organic agriculture in Nigeria is in the ineffective communication of research findings to organic farmers. There are many current technological developments that are capable of doubtling organic farmers production, there are also traditional organic practices that are documented and seen to be effective; these findings have not been well communicated in an effective and sustainable way. Effective dissemination is when stakeholders are properly linked in a channel that ensures that whatever is communicated get to the intended beneficiaries as intended by the source of the message (Nwachukwu, 2017). Information dissemination to farmers is the cardinal objective of agricultural extension. Extension every where in the world is saddled with the responsibility of effective dissemination of recent and relevant agricultural information to farmers with the aim of improving farmers productivity and income. Agricultural extension is critical to developing organic agriculture. Although, organic agriculture is relatively new and an emerging player in the Nigeria agricultural space, there is need to deeply involve extension in its development, considering the critical role it can play in order to sustain its growth.

ORGANIC AGRICULTURAL MARKETING

Marketing is as critical to better performance in organic agriculture as farming itself. Marketing failures have been identified to exist in the form of fragmented supply chains which reduces the competitiveness of local producers (World Bank, 2010). Over the years, agricultural extension has concentrated effort in bridging the gap between research and farmers. Thus leaving the farmers with the sole responsibility of marketing their agricultural produce. One of the area where agricultural extension will play a critical role in the development of organic agriculture is in bridging the gap between farmers and consumers. One of the greatest challenge faced by farmers is the inability to sell farm produce. This has led to glut and demoralizes farmers drive to increase productivity. Of what benefit is a production technology that will increase farmers output that the farmer cannot sell. The essence of extension service is to help farmers improve their farm productivity and their income by providing relevant and up to date farming information. Extension market information is the core of farmers income because it provide farmers with information that will support their marketing effort. While traditional extension services provide production advice to farmers' extension marketing will provide market information for farmers produce. The information to be provided will include; who and where the buyers are and how they can be contacted, current prices which will help farmers to decide whether to sell or not, produce price trend which will help farmers to decide whether to produce new crops, higher quality or not and organic market within farmers neighbourhood and farther markets and the prevailing market prices for farmers produce in their markets. Marketing information can be used by farmers to make decision about what to plant and about out of season production (FAO, 2015).

Another prominence role extension will play in developing organic agriculture in Nigeria is linking organic farmers with organic certificating agencies and ensuring that farmers truly practice organic farming principles. Thus agricultural extension could be a pointer to identifying genuine organic farmers and true organic produce in a locality and support periodic inspection of organic farms.

ORGANIC AGRICULTURE PRODUCER

These are organic farmers who produce organic products. Over seventy percent of these organic farmers are peasants who produce at subsistence level. These farmers have little or no access to extension services. Due to lack of finance, they are forced to practice traditional organic farming. Majority of these farmers have little or no idea about modern organic farming practices. Stakeholders in organic agriculture practice in Nigeria (USAD Gains Report, 2014) observed that many farmers in the country have vague ideas as compared to conventional farming method.

For organic agriculture to develop and grow in Nigeria, extension must play a prominent role of disseminating recent, relevant and up to date information in organic farming. The farmer is the focus of every agricultural development process. Until the farmer is adequately equipped with the necessary information that can lead to improved productivity, no meaningful development can be said to have taken place. And this can only be achieved by extension effectively taken up their traditional role of supporting farmers to change their attitude, improve their productivity and their standard of living.

CHALLENGES OF ORGANIC FARMING IN NIGERIA

Lack of awareness, high input cost, inadequate supporting infrastructure, lack of financial support, non availability of farm input, product marketing problem, lack of appropriate agricultural policy and low production have been identified as some of the challenges facing organic farming in Nigeria. A high percentage of so called organic farmers do not have adequate and up to date knowledge about modern organic farming. What majority of the farmers practice is traditional organic farming devoid of modern knowledge in organic farming. On the part of extension, most technology transfer agencies especially government technology transfer agencies seemed not to have adequate knowledge on modern organic farming practices. The very few extension services provided for organic farmers seemed to come from private technology transfer agencies. The agricultural sector in Nigeria is dominated by peasant farmers who produce at subsistence level. Their only hope of extension service is the government own extension agency: Agricultural Development Programme (ADP). The ADP which is the extension arm of the ministry of agriculture saddled with the responsibility of implementing the unified agricultural extension system through the training and visit technique are not sufficiently informed and adequately equipped for modern organic farming practices. The lack of extension services to a higher percentage of the organic farming population is a major drawback in the development and growth of organic farming in Nigeria.

WHAT NIGERIA SHOULD DO TO MAXIMIZE THE BENEFIT

There is a growing consciousness between what we eat and our health status, thus the awareness of the importance of organic agriculture is increasing on daily basis. There is need for government to drive this emerging subsectors of our agriculture.

- ✓ Federal and state government should formulate policies and create mechanism to implement these policies
- ✓ Government of all level should set up regulatory agency that will be responsible for farm certification, regular inspection of farmers, issuing certificate and enforcing the regulation guiding the sector
- ✓ Federal and state government should provide the necessary funding and infrastructure necessary for effective development and dissemination of organic farming technologies
- ✓ Government should adequately train public extension agents in organic crop production, organic post harvest handling of produce, organic livestock production, organic trade and other subsectors including conservation of biodiversity, aquaculture and apiculture.
- ✓ All technology transfer agencies should collaborate to develop and grow organic farming in Nigeria.
- ✓ NOAN should do more of advocacy visit to policy makers, federal and state ministry of agriculture, and technology transfer agencies especially government owned and create awareness on organic agriculture for easy buy-in.

CONCLUSION

Organic agriculture which is define as a production system that exclude the use of synthetic chemical inputs is an emerging production system in Nigeria. The development of organic agriculture in Nigeria will be subject to so many factors among which is the deep involvement of agricultural extension. Agricultural extension which is responsible for the dissemination of recent, relevant and up to date information to farmers to improve farmers productivity and income is critical to any agricultural development project. Farmers are the core of every agricultural development process and agricultural extension is the only body that directly interface with practicing farmers. Agricultural extension will play a critical role in the development of organic agriculture. Extension will create awareness of organic farming practices and it numerous advantages among farmers, assist farmers to obtain recent, relevant and up to date production information and also bridge the gap between organic farmers and consumers of organic products. To develop organic agriculture in Nigeria, the country need to have a clear vision at the national level, state level, research institutes, training institutes, formulate implementable policy and deeply engage both public and private technology transfer agencies.

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Diversity in Amino acids of seeds of *Plukenetia conophora* Mull Arg from Southern Nigeria.

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ABSTRACT

Seeds of *Plukenetia conophora* Mull Arg (African walnut) obtained from ten locations-Ndorlu, Ikot-ekpene, Akwu-ukwu, Ibagwa, Okigwe, Ogbe, Igbatoro, Irun-Akoko, Apomu-Osun and Ile-Ife in southern Nigeria were assayed for amino acid contents of raw seeds using Applied Biosystems PTH Amino Acid Analyzer in laboratory by OTO Consults in Murtala Mohamed way Jos, Plateau state. All the analysis was in triplicate. Results indicated significant ($p<0.05$) variation for both essential and non-essential amino acid contents across the locations. Among the essential amino acids, Okigwe accession had higher concentration of arginine, Histidine, Isoleucine, leucine, methionine, phenylalanine, tryptophan and valine, whereas Ibagwa-Nkwo accession had higher lysine and threonine contents. Apomu-Osun accession had the least Histidine, leucine and lysine contents, while Ogbe accession had the least tryptophan. Among the non-essential amino acids, alanine, aspartic acid, cysteine, glutamic acid, serine and proline, glycine and tyrosine responded significantly ($p<0.05$) to locations. Okigwe accession had higher contents of the following non-essential amino acids and total amino acid; Alanine, aspartic acid, cysteine, glutamic acid, serine and proline, whereas glycine and tyrosine were higher in Ibagwa accession. Pearson's correlations matrix among essential and non-essential amino acid showed that all the amino acids correlated with each other. Alanine showed a very high positive and significant correlation with arginine, aspartic acid, cysteine, glutamic acid, glycine, tyrosine, proline, histidine, isoleucine, leucine, lysine, methionine, threonine and valine. Arginine had a very high positive and significant correlation with aspartic acid, glutamic acid, glycine, proline, histidine, isoleucine, leucine, and lysine. It was further shown in GGE Biplot analysis that most of the essential amino and non-essential amino acids fall within one of the quadrant where Okigwe accession occupied the vertex indicating higher concentration, figure 1 and 2. It was observed from the study that seeds of this under-utilized forest species (African walnut) have full complement of the essential amino acids in sufficient amounts to meet the amino acid requirements of the teeming population.

Keywords: African walnut, *Plukenetia conophora*, location, accession and amino acids.

INTRODUCTION

Amino acids are integral units of proteins and pioneer for the formation of secondary metabolites in gene expression, homeostasis, hormone synthesis etc. (Graça et, al.2010, Perex *et al*, 2009 and Cuin; S Shabala, 2007) Amino acids are grouped into essential and non-essential amino acids.

While essential amino acids are synthesized only by plants. Non-essential amino acids were synthesized by plants as well as human beings. Proteins are molecules with great complexity and diversity that play an important role in maintaining the structure and function of the living form (Sa, *et al* 2020). As a results proteins are being used for many application; such as for food, medicine and feed.

By 2050 according to United Nation, the world ‘total population is expected to grow or might exceed 9 billion, and, hence the demand for food, feed, and fibre around the globe is expected to increase by 70% (FAO, 2009). To meet this increasing demand a new sources must be explored. Currently, food derived from plant origin plays an important role in human diet. For meeting protein requirements, generally, animal are considered perfect. However, due to many diseases in animals, their consumption is not safer for human health. Also, it replaces animal-based proteins with plant-based due to various limitations, such as increased cost, limited supply of nutrients and hazard for human health (Sun-Waterhouse *et al*., 2014; Sabute and Soret 2014 and Pojic *et al*, 2018). Plant-based proteins are considered vegan food, provide an ample number of amino acids, are directly absorbed by the body, and helped in treating various disease ailments.

Plukenetia conophora Mull Arg (African walnut) a forest plant according to Akintayo and Bayer (2002) reported that it yielded 25.65% crude protein, at 8% moisture content, while oil yield of seeds was 49.58%. The value of protein content of *T. conophorum* fall within the range of 3.2 – 43.1% for fruits and nuts. Any plant food that provides more than 12% of its energy from protein is considered a good source of protein (Kanu and Okorie, 2015). As investigated by Okafor (1991) and Udeala *et al*. (1984), the fruits yield 47.72% crude protein and 50% fats and oil (*Conophor* oil). Generally, it is noteworthy that seeds of this species have full complement of both essential and non-essential amino acid according to (Gbadamosi *et al*., 2012). This means that *Plukenetia* nut, has the potential to meet the amino acid requirement of both rural and urban dwellers who consume the nut, in the southern part of the country. Proteins are very essential nutrients for human beings. Quality and quantity of proteins are basic factors in the selection of plants for nutritive value (Chandrachood, 2011). Therefore, this study explores the diversity of amino acids in ten accessions of African walnut

RESULTS.

Amino acid profiling of seeds of ten accessions of *Plukenetia conophora* Mull Arg.

The result in (Table 1) revealed significant ($p<0.05$) variation in all the essential amino acid tested across the accessions. Okigwe accession had higher concentration of arginine, histidine, Isoleucine, leucine, methionine, phenylalanine, tryptophan and valine, whereas Ndorlu recorded least concentration of Arginie, Isoleucine, leucine, threonine and valine. Ibagwa-Nkwo accession had higher lysine and threonine contents but was statistically similar with Okigwe accession on lysine. Apomu-Osun accession had least concentration of Histidine and Lysine and also Leucine.

In (Table 2), it was observed that Okigwe accession had the higher concentration of some non-essential amino acids such as; alanine, aspartic acid, cysteine, glutamic acid, serine and proline but glycine and tyrosine concentration were higher in Ibagwa-Nkwo accession.

Pearson's correlations matrix among different amino acid are shown in (Table 3). It was observed that all the amino acids correlated with each other. Alanine showed a very high positive and significant correlation with arginine, aspartic acid, cysteine, glutamic acid, glycine, tyrosine, proline, histidine, isoleucine, leucine, lysine, methionine, threonine and valine. Arginine had a very high positive and significant correlation with aspartic acid, glutamic acid, glycine, proline, histidine, isoleucine, leucine, and lysine. The GGE-Biplot in (Figure 1) showed that most of the essential amino acids fall within one of the quadrant where Okigwe accession occupied the vertex indicating higher concentration.

DISCUSSION

Amino Acid Profiling

Proteins are very essential nutrients for human beings. Quality and quantity of proteins are basic factors in the selection of plants for nutritive value (Chandrahood, 2011). Variation in amino acid content of ten *Plukenetia* nut across the accessions agrees with findings by Udeonyia *et al*. (2013) and Kumar *et al*. (2015) who reported that amino acid content varied across four states of southern Nigeria and twenty plant leaves species near river Beas India, respectively. However, these findings disagrees with the report of Oyenuga *et al*. (1971) who found high levels of cysteine (4.9%) and tryptophan (4.45%) and abundance of glutamic, aspartic acids and arginine in conophor nut. Changes in amino acid contents in different plants depend on numerous factors such as source of nutrition, nutritional requirement, biotic and abiotic factors (Chandrachood, 2011).

Moreso, soil fertility could influence amino acid distribution (Bell *et al*., 2000). This has been amply demonstrated by Thanapornpoonspong *et al*. (2005) in a study involving *Amaranthus species* and *Chemopodium quinoa*. Different rates of nitrogen fertilizer were found to influence the protein fractions and amino acid content of the two species. Thus in general, higher rates of nitrogen reduced lysine and increased arginine content in the seeds. Similarly, sulphur fertilization of winter wheat increased the amino acid content of the sulphur containing amino acids – cysteine, methionine, threonine and lysine – in magnitudes ranging from 7.7 to 35.3% (Järvan *et al*., 2008). In the report of Bell *et al*. (2000), environment rather than genetics, was more highly implicated in observed differences in amino acid composition of tested species. In this study, samples used were sourced from different agro ecological zones in southern Nigeria, (Table 1). Apart from the above, it is probable that differences in amino acid content of provenances could be as a result of the genetic factor (Meredith and Gaskin, 1984). In seeds of the family Brassiceae, variation in amino acid and protein content has been partly linked with the relative proportions of protein fractions in the seeds (Mossé and Baudet, 1983).

Generally, it is noteworthy that seeds of this species have full complement of both essential and non-essential amino acid according to (Gbadamosi *et al*., 2012). This means that *Plukenetia* nut, has the potential to meet the amino acid requirement of both rural and urban dwellers who consume the nut in the country. When compared with amino acid values of cultivated oilseeds, this species shows impressive rating. For instance, amino acid values of cultivars of sunflower and groundnut as reported by Ingale and Shrivastava (2011) do not seem to be superior to those of *Plukenetia* nut except in one or two cases. This is credible considering the fact that *Plukenetia conophora* is yet a neglected species (Gbadamosi *et al*., 2012), with a dearth of scientific intervention in form of genetic improvement and/or improved agronomic practices. The plant has mostly been maintained by cultural preferences and traditional practices, as a result it remained inadequately characterized and neglected by research and conservation. On the contrary, oilseed crops cited above have enjoyed several improvement interventions over the years. This is a reinforced conviction that this forest species has great potentials for utilization as a food and industrial crop. Evidence from the present study suggests that accessions studied has considerable amount of amino acid profile

Table 1. Influence of accession on essential Amino Acid concentration (g amino acid/100g protein) of African walnut (*Plukenetia conophora* Mull Arg.) sourced from ten different locations.

Traits/ Accession	Arg	Hist	Iso	Leu	Lys	Met	Phe	Thr	Try	Val
Igb	6.87	2.41	3.68	7.34	2.86	1.36	4.07	3.33	1.22	3.55
Iru	6.59	2.33	3.47	6.80	2.59	1.12	3.77	3.26	1.16	3.36
Ife	7.10	2.57	3.71	7.58	3.03	1.31	4.20	3.45	1.29	3.68
Apo	6.37	2,24	3.33	6.75	2.43	1.21	3.68	3.21	1.17	3.19
Ogb	6.83	2.45	3.36	7.05	2.56	1.26	3.94	3.04	1.10	3.35
Oki	7.73	3.21	4.46	8.39	3.58	2.23	4.56	3.82	1.48	4.49
Ndo	6.24	2.30	3.07	6.75	2.53	1.19	3.69	3.03	1.16	3.15
Iko	7.15	2.87	3.54	7.86	3.40	1.42	3.73	3.66	1.31	4.01
Iba	7.48	3.10	4.11	8.25	3.59	2.04	4.48	4.06	1.34	4.37
Akw	6.93	2.65	3.56	7.71	3.13	1.46	3.86	3.54	1.34	3.73
LSD (0.05)	0.071	0.053	0.063	0.075	0.166	0.034	0.068	0.265	0.043	0.084

Note: Igb=Igbatoro; Iru=Irun-Akoko; Ife=Ile-Ife; Apo=Apomu-Osun; Ogb=Ogbe-Mbaise; Oki=Okigwe; Ndo=Ndorlu; Iko=Ikot- Ekpene; Iba=Ibagwa-Nkwo; Akw=Akwa-Ukwu, Arg=Arginie, Hist=Histidine, Iso=Isoleucine, Leu=Leucine, Lys=Lysine, Met=Methionine, Phe=Phenylalanine, Thr=Threonine, Try=Tryptophan and Val=Valine.

Table 2. Influence of accession on non-essential amino acid concentration (g amino acid/100g protein) of ten accessions of African walnut (*Plukenetia conophora* Mull Arg.).

Traits/ Accession	Alanine	Aspartic Acid	Cysteine	Glutamic Acid	Glycine	Serine	Tyrosine	Proline	Total amino acid
Igb	4.94	7.55	0.83	13.23	4.20	4.37	2.56	3.48	77.85
Iru	4.53	7.18	0.79	12.85	3.97	4.23	2.59	3.45	74.04
Ife	5.02	7.49	0.78	13.72	4.52	4.02	2.92	3.65	80.04
Apo	4.58	**6.35**	0.73	12.43	3.90	4.14	**2.41**	**3.25**	71.37
Ogb	4.73	7.39	0.66	13.04	4.05	3.57	2.58	3.35	74.31
Oki	**5.64**	**8.74**	**1.32**	**15.03**	4.89	**5.04**	3.86	**4.31**	**92.78**
Ndo	**4.42**	6.49	**0.64**	**12.12**	**3.72**	**2.85**	**2.41**	**3.25**	**69.01**
Iko	5.09	8.24	0.97	14.23	4.61	4.40	3.53	3.76	83.78
Iba	5.50	8.62	1.30	14.75	**5.06**	4.75	**4.04**	4.26	91.10
Akw	4.94	7.88	0.91	14.01	4.47	3.85	3.40	3.71	81.08
LSD (0.05)	0.079	0.095	0.043	0.105	0.059	0.826	0.125	0.051	0.256

Note: Igb=Igbatoro; Iru=Irun-Akoko; Ife=Ile-Ife; Apo=Apomu-Osun; Ogb=Ogbe-Mbaise; Oki=Okigwe; Ndo=Ndorlu; Iko=Ikot-Ekpene; Iba=Ibagwa-Nkwo; Akw=Akwa-Ukwu.

Table 3. Pearson's correlation matrix showing relationship between amino acid concentration (g amino acid/100g protein) of ten accessions of African walnut *Plukenetia conophora* Mull Arg.)

Traits	Ala	Arg	Asp	Cys	Glu	Gly	Ser	Tyr	Pro	His	Iso	Leu	Lys	Met	Phe	Thr	Try	Val
Alanine	1																	
Arginine	.977**	1																
Asp-A	.928**	.958**	1															
Cysteine	.930**	.882**	.882**	1														
Glut-A	.961**	.973**	.973**	.907**	1													
Glycine	.963**	.954**	.938**	.907**	.979**	1												
Serine	.792**	.778**	.728*	.820**	.761*	.754*	1											
Tyrosine	.905**	.887**	.924**	.929**	.955**	.953**	.670*	1										
Proline	.960**	.941**	.927**	.975**	.956**	.956**	.764*	.956**	1									
Histidine	.953**	.943**	.942**	.940**	.961**	.945**	.700*	.968**	.973**	1								
Isoleucine	.945**	.929**	.849**	.917**	.884**	.873**	.858**	.800**	.930**	.867**	1							
Leucine	.975**	.960**	.953**	.908**	.985**	.977**	.711*	.953**	.956**	.967**	.877**	1						
Lysine	.941**	.924**	.946**	.912**	.969**	.968**	.703*	.967**	.951**	.963**	.832**	.984**	1					
Methionine	.934**	.878**	.835**	.955**	.865**	.860**	.709*	.874**	.947**	.929**	.921**	.892**	.856**	1				
Phenyl-A	.877**	.861**	.745*	.787**	.767**	.797**	.658*	.678*	.841**	.769**	.922**	.788**	.717*	.865**	1			
Threonine	.910**	.867**	.879**	.948**	.925**	.961**	.789**	.954**	.949**	.914**	.841**	.927**	.951**	.854**	.716*	1		
Tryptophan	.884**	.846**	.817**	.870**	.898**	.867**	.681*	.877**	.899**	.881**	.850**	.919**	.910**	.848**	.694*	.863**	1	
Valine	.976**	.962**	.956**	.962**	.977**	.969**	.783**	.961**	.986**	.987**	.913**	.979**	.977**	.926**	.801**	.948**	.903**	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Arg=Arginie, Hist=Histidine, Iso=Isoleucine, Leu=Leucine, Lys=Lysine, Met=Methionine, Phe=Phenylalanine, Thr=Threonine, Try=Tryonine and Val=Valine, Pro=Proline, Tyr=Tyrosine, Ser=Serine, Gly=Glycine, Glu-A=Glutamic acid, Cys=Cysteine, Asp-A=Aspartic acid, Ala=Alanine.

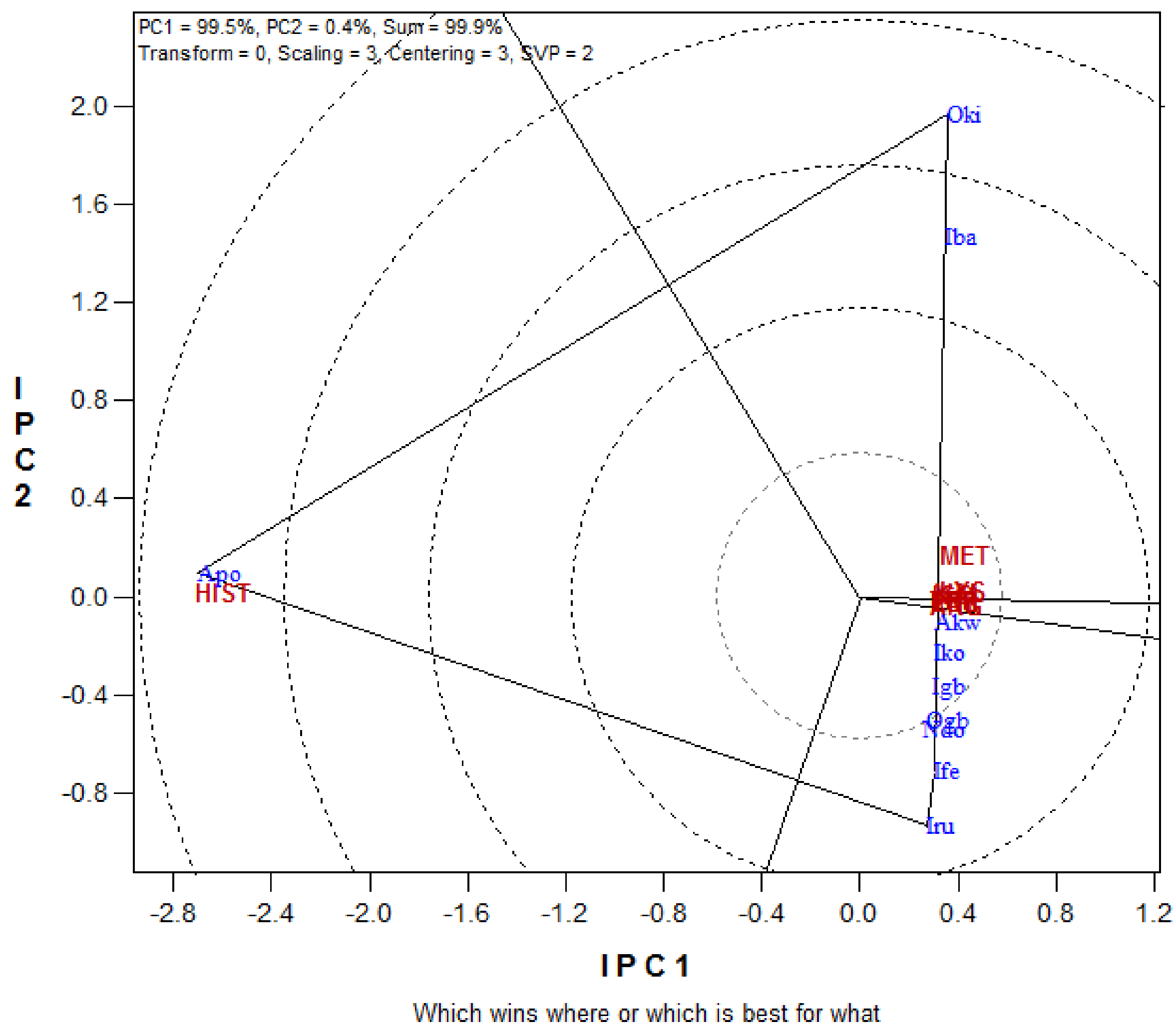

Figure 1: Interaction between Essential Amino acid and 10 accessions African walnut.

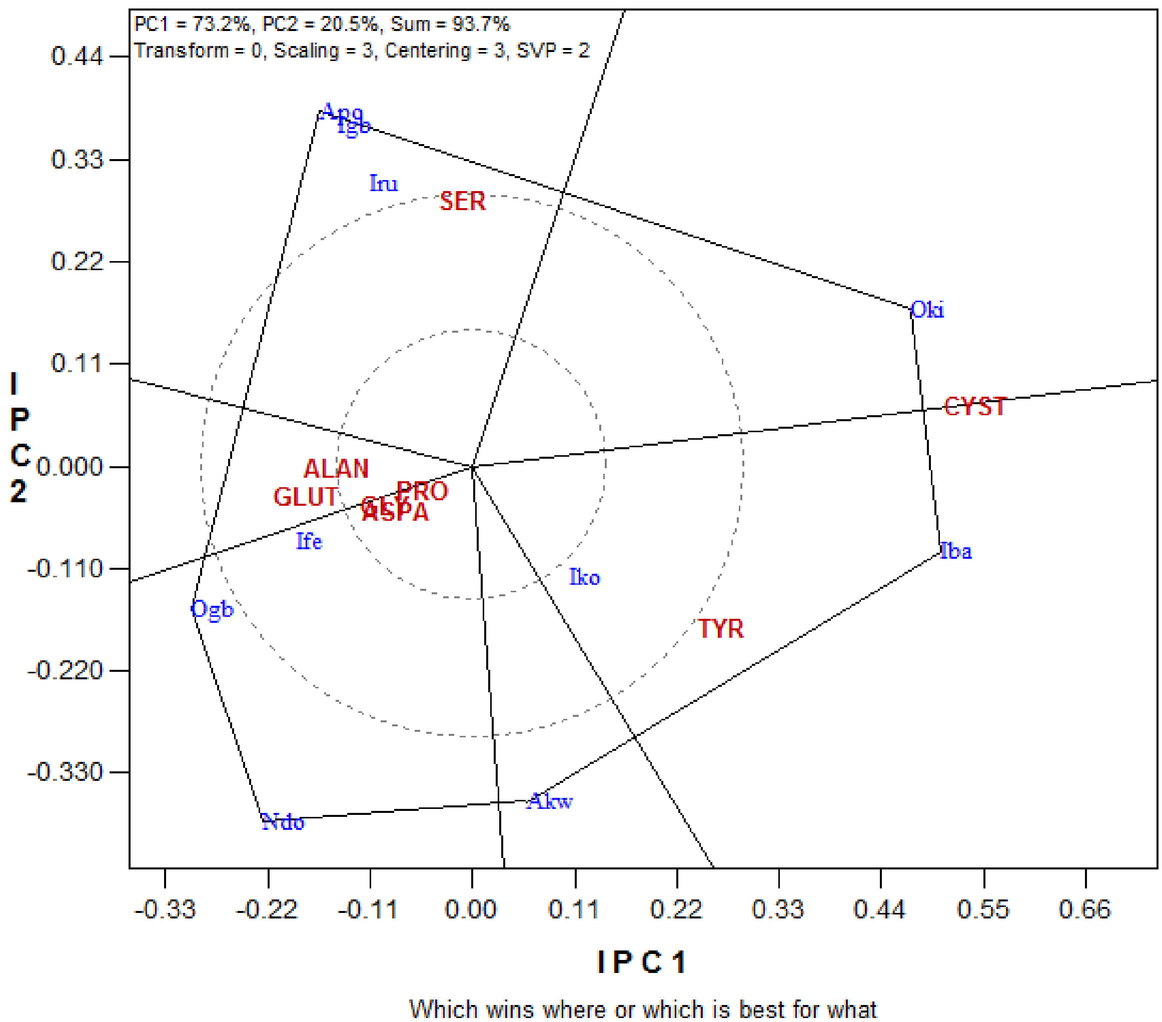

Figure 2**:** Interaction between Non-essential Amino acid and 10 accessions of African walnut.

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Substrates Effects on the Yield Potentials of *Pleurotus pulmonarius* in a Humid Tropical Environment

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ABSTRACT

Substrate effects on the yield potentials and nutrient compositions of *Pleurotus pulmonarius* in a humid tropical environment was evaluated in the Department of Crop Science Teaching and Biotechnology Laboratories, Faculty of Agriculture, University of Nigeria, Nsukka from July 2021 to March 2022. The experiment was laid out in Completely Randomized Design (CRD) with four treatments replicated nine times. The data were collected on morphological, proximate, vitamin and phytochemical attributes of the mushrooms grown on the four substrates formulated with maize kernel (K), empty palm fruit bunch (P), dry banana leaf (B) and the Control (C) which was the conventional substrate. All the treatments produced mushrooms with variable attributes that were significantly different ($P<0.05$) from the other. The mushroom grown in the substrate formulated with banana leaf was significantly higher ($P<0.05$) in morphological attributes: pileus circumference (39.07cm), pileus area (124.6cm), length of stipe (6.37cm) and pileus diameter (12.43cm) and percentage moisture content while mushroom grown in the substrate formulated with maize kernel had significantly higher ($P<0.05$) protein (4.6%) and flavonoids contents (14.42%) when compared with other substrates. Mushroom grown in the substrate formulated with empty palm fruit bunch was significantly higher ($P<0.05$) in vitamin B1 (3.8mg/100g), vitamin B2 (5.7mg/100g), vitamin C (114mg/100g) and vitamin E (17.4mg/100g). Thus, mushroom grown in the substrate formulated with empty palm fruit bunch could be harnessed for dietary supplementation and for enhanced antioxidant activity in human nutrition. Mushroom grown in the substrate formulated with maize kernel could serve as an alternative for animal protein because of the high protein content while mushrooms produced with the dry banana leaf substrate with higher morphological attributes is of high recommendation for commercial cultivation of *P. pulmanorious* due its high marketable attributes.

Keywords: Substrate effects, yield potentials, *Pleurotus pulmonarius*

INTRODUCTION

Pleurotus pulmonarius is a nutrient-rich mushroom of cosmopolitan status with a lot of therapeutic benefits (Correa *et al*., 2016). It contains dietary fiber, essential minerals, trace elements, favourable organoleptic properties, proteins, and other healthy nutrients that are comparable to those in meat (Gregori*et al*., 2007; Rahman *et al*., 2012; Guinard *et al*., 2016). indicated that *P. pulmonarius* contains antioxidants necessary for the prevention of cancer and free radical generation in human and animal cells (Rahi and Malik, 2016; Carrasco-González *et al*., 2017). The regular consumption of *P. pulmonarius* can have therapeutic effects in humans by preventing some dietary aliments associated with deficiency of food nutrients (Valverde *et al*., 2015).

Mushrooms are naturally harvested from the forest but can be cultivated. *Pleurotus pulmonarius* is an edible mushroom naturally found in both tropical and subtropical rainforests at favourable conditions that support its growth. Chang and Miles (2004) observed that *P.pulmonarius* can also be cultivated artificially, using a variety of agricultural wastes. Thus, the use of agro-waste substrate as the raw material in *P. pulmonarius* production provides not only a solution to the nation's waste management problems and pollution challenges but also helps in combating poverty and the rising youth unemployment (Okhuoya *et al*., 2010).

Successful cultivation of *P. pulmonarius* with different agro waste materials can help increase food security and solve some critical challenges such as malnutrition, economic depression, unemployment and poverty (Osemwegie *et al*., 2014). The availability of agro waste materials such as maize kernel, empty palm fruit bunch fiber, banana leaves and wood dust can be harnessed as substrates for mushroom cultivation. Eze and Agbo (2020) reported that substrates can influence the yield quality and quantity of mushrooms. Therefore, selection of appropriate substrate for specific mushrooms is a fundamental step for successful and adequate mushroom production. Interestingly, the mushroom-substrate-production research area is still developing in Nigeria. Although, there are rich sources of substrates for the cultivation of edible mushrooms like *P. pulmonarius*, little is known about their effects.

This study therefore investigated substrate effects on the yield potential of *P. pulmonarius* in a humid tropical environment. The finding of the research could be beneficial to mushroom farmers, health professionals and environmental protection personnel since regular consumption of different edible and medicinal mushrooms prevents some dietary ailments associated with a deficiency of food nutrients (Valverde *et al*., 2015).The objective of this study was to compare the effect of substrate made from readily available agricultural waste (maize kernel and empty palm fruit bunch fiber) with the yield of *P. pulmonarius* grown on conventional substrate. Besides, proper utilization of agro-industrial based wastes could stop inappropriate disposal of wastes, which is threatening environment and public health of developing countries such as Nigeria.

MATERIALS AND METHODS

Materials

The materials that were used for the experiments were: mushroom spores, mushroom spawns, sawdust, polyethylene bags, autoclave, cotton wool, potato dextrose agar (PDA), hot air oven, UV-Visible spectrophotometer and chemicals (Analar grade).

Sources of Materials

The mushrooms used for this study was *P. pulmonarius* obtained from the Department of Crop Science, University of Nigeria, Nsukka.

Methodology

The conduct of Experiment was in the Department of Crop Science Teaching and Pathology Laboratories, Faculty of Agriculture, University of Nigeria, Nsukka. Nsukka is located in the derived savannah ecological zone on the latitude 06^{o} 52' North, longitude 07 ^{0} East and altitude 447.26 m above sea level.

Culture of Mushrooms

Fresh mushrooms were taken and the surfaces sterilized. Then, a small piece of the mushrooms inner tissues containing the spores were placed on potato dextrose agar (PDA) medium using sterile forceps. The inoculated dishes were incubated at 27 ^oC for four days. Three sub-culturing were produced.

Spawn Preparation

The spawn preparation was carried out as described by Nwanze *et al*. (2005). About 250 g of red sorghum will be washed in clean water three times to remove chaff, dust and other particles. The grains will be boiled in clean water for 45 min and allowed to stay for 24 hours for maximum absorption of water. Soaked grains were washed in water, drained and put into spawn bottles. Two third (2/3) of each spawn bottle was filled with grains and mixed with 5 g of calcium carbonate ($CaCO_3$), thereafter they were autoclaved at 121 ^oC (at a pressure of 1kg/cm^2) for 2 hours each day, for 3 consecutive days. The grains in the bottles were inoculated with three 9 mm mycelium discs per bottle (in triplicate of each grain type) under aseptic condition as described by Fasidi and Kadiri (1993).

Mushroom cultivation from spawns

The mushrooms were cultivated from the spawns as described by Bram (2007). Ten kilogram of sawdust will be mixed with 3 kg of rice bran and 2 kg of wheat bran. The mixture was served as mushroom substrate and was made wet with about 25.2 L of distilled water containing 200 g of lime ($CaCO_3$) and 30 g of gypsum ($CaSO_4$). The substrate was sterilized at 121 ^oC for 15 minutes in an autoclave. After the sterilization, mushroom spawn was introduced into 12 x 24 cm polypropylene bags containing 170 g of the substrate. The spawns was spread over the substrate. Small holes were perforated on the bags for aeration. The bag and its content was placed in the dark room and maintained at moist condition until the mushrooms were matured for harvest.

Determination of the Effects of Banana Leaves Substrates on the Marketable Yield Attributes of *P. pulmonarius*

The experiment was carried out to determine the effect of four different substrates on the *P. pulmonarius* mushrooms. The substrates formulations included: Control (10 kg of *Gmelina arborea* saw dust mixed with 3 kg of rice bran, 2 kg of wheat bran, 200 g of lime ($CaCO_3$) and 30 g of gypsum ($CaSO_4$) substrates), A (10 kg of *Gmelina arborea* saw dust mixed with 3 kg of rice bran, 2 kg of dry banana leaves,200 g of lime ($CaCO_3$) and 30 g of gypsum ($CaSO_4$) substrates), B (10 kg of *Gmelina arborea* saw dust mixed with 3 kg of rice bran, 2 kg of Maize,200 g of lime ($CaCO_3$) and 30 g of gypsum ($CaSO_4$) substrates) and C (10 kg of *Gmelina arborea* saw dust mixed with 3 kg of rice bran, 2 kg of empty palm fruit bunch,200 g of lime ($CaCO_3$) and 30 g of gypsum ($CaSO_4$) substrates). The experiment determined the effect of the four substrates on the marketable yield attributes of *P. pulmonarius.* It was a CRD experiment with four treatments replicated nine times and randomized in the experimental units. The data were collected on the morphological, nutritional and phytochemical qualities.

Statistical Analysis:

The data collected were subjected to analysis of variance (ANOVA) using GenStat Release 10.3DE (2011) statistical software.

Determination of the Proximate, Flavonoids and Vitamin Compositions of *P. pulmonarius* Produced with Banana Leaves.

Proximate Analysis

The proximate content of the *P. pulmonarius* was done following the standard method of the Association of Official Analytical Chemists (AOAC, 2010). The proximate compositions comprised of percentage ash, protein, fibre, moisture, fat and carbohydrate contents.

Determination of Flavonoids

Flavonoids were determined using the method described by Bhoham and Kocipai (1974). Five gram of the mushroom was weighed into flask and the flavonoids were extracted repeatedly with 100 ml of 80 % aqueous methanol at room temperature. Thereafter, it was filtered with Whatman filter paper No 43 (125 mm) and the filtrate transferred into weighed beaker and evaporated to dryness to get the weight of the flavonoids. The percentage flavonoids were calculated.

$$\text{Flavonoid (\%)} = \frac{(weightofbeaker + flavonoid) - (weightofbeakeronly)}{Weightofsampleused} x \frac{100}{1}$$

Determination of Vitamins in the *P. pulmonarius* Mushrooms

The vitamin contents of the *P. pulmonarius* were determined quantitatively using standard spectrophotometric methods. The thiamin content of the mushrooms was determined as described by Onwuka (2005) while the riboflavin content was determined as described by Onwuka (2005).The procedure of Jakkutowicz *et al*. (1977) was used for the determination of pro-vitamin A. The vitamin content was determined as described by Olokodona (2005) while that of vitamin E was determined as described by Pearson (1976).

Statistical Analysis

The data collected were subjected to analysis of variance (ANOVA) using GenStat Release 10.3 DE (2011) statistical software.

Determination of the Substrate with Optimum Yield and Edibility Potential for Production of *P. pulmonarius.*

RESULTS

Among the substrates used, banana leaf (B) produced mushroom with higher weight, pileus circumference, area, pileus diameter, length of stipe and stipe-pileus ratio while the control substrate was lower in all the morphological attributes measured (Table I). Although the mushroom grown in the substrate formulated with empty palm fruit bunch was higher in weight, the value was statistically the same with that of the other substrates.

Table 1: Mushroom Weight (WT), circumference (CL), area (AR), diameter of pileus (DI), length of stipe (LS) and stipe-pileus ratio (SPR) of the *P. pulmonarius* grown with four different substrates

Trt	WT (g/hypha)	CL (cm)	AR (cm^2)	DI (cm)	LS (cm)	SPR
K	40.40	24.30	56.50	8.40	4.83	0.58
P	54.80	29.52	77.80	9.80	5.20	0.54
B	41.80	39.07	124.6	12.43	6.37	1.09
C	25.60	19.20	32.70	7.00	3.50	0.61
LSD ($p<0.05$)	**30.73**	**11.64**	**58.08**	**3.83**	**1.35**	**0.89**

K=Maize Kernel, P=Empty Palm Fruit Bunch, B=Banana leaf and C=Control Substrates

The mushroom grown in the substrate formulated with banana was significantly higher in percentage moisture content than mushrooms grown in the control and maize kernel substrates but was statistically the same with that of empty palm fruit bunch. Mushroom grown in the maize kernel substrates was significantly higher in percentage protein compared with mushrooms grown with other substrates (Table 2).

Table 2: Proximate compositions of *P. pulmonarius* grown in the four different substrates

Trt	Moisture (%)	Ash (%)	Protein (%)	Fibre (%)	Fat (%)	Carbohydrate (%)
K	76.33	2.80	4.60	1.400	0.321	14.549
P	81.35	2.05	3.50	1.025	0.543	11.532
B	88.73	3.00	2.45	1.500	0.500	3.820
C	79.97	2.55	2.35	1.225	0.200	13.705
LSD ($p<0.05$)	**9.41**	**1.44**	**1.88**	**0.52**	**0.33**	**7.29**

K=Maize Kernel, P=Empty Palm Fruit Bunch, B=Banana leaf and C=Control Substrates

Mushroom grown in the substrate formulated with empty palm fruit bunch (P) was significantly higher in Vitamin B_1, Vitamin B_2, Vitamin C and Vitamin E while mushroom cultivated in the substrate formulated with banana leaves was significantly lower (Table 3). However, the quantities of Vitamin B_1, Vitamin B_2 and Vitamin E found in mushroom cultivated in the substrate formulated with banana leaves were statistically the same with that of maize kernel and the conventional substrate (Control).

Table 3: Vitamin compositions of *P. pulmonarius* grown with four different substrates

Trt	Vitamin B_1 (mg/100g)	Vitamin B_2 (mg/100g)	Vitamin C (mg/100g)	Vitamin E (mg/100g)
K	2.0	3.0	60	8.4
P	3.8	5.7	114	17.4
B	0.8	1.2	24	4.8
C	1.6	2.4	48	6.6
LSD ($p<0.05$)	**1.12**	**1.99**	**7.65**	**4.98**

K=Maize Kernel, P=Empty Palm Fruit Bunch, B=Banana leaf and C=Control Substrates

The mushroom grown in the substrate formulated with maize kernel was significantly higher in percentage flavonoids content when compared with other substrates. Mushroom grown in the conventional substrate (Control) was significantly higher in phenol and alkaloid, saponnin and glycosides when compared with mushrooms grown with other substrates. The tannin content of the mushroom grown in the substrate formulated with empty palm fruit bunch (P) was significantly higher, although statistically the same with that grown with the conventional substrate (Table 4).

Table 4: Phytochemical compositions of *P. pulmonarius* grown with four different substrates

Trt	Flavonoids (%)	Phenol (%)	Tannin (%)	Alkaloid (%)	Saponnin (%)	Glycosides (%)
K	14.42	0.11	0.005	2.5	2.0	0.28
P	3.73	0.23	0.009	2.0	1.5	1.00
B	4.14	0.45	0.003	2.5	2.0	0.65
C	4.00	1.02	0.008	3.0	3.00	1.25
LSD ($p<0.05$)	**4.02**	**0.05**	**0.002**	**1.49**	**1.49**	**0.94**

K=Maize Kernel, P=Empty Palm Fruit Bunch, B=Banana leaf and C=Control Substrates

The correlation coefficients among selected morphological and phytochemical parameters revealed that circumference (CL), area (AR) and diameter of pileus (DI) were positively correlated with the length of stipe (LS). However, the length of stipe was negatively correlated with tannin (r = -0.600) (Table 5).

Table 5: Correlation coefficients among selected morphological and phytochemical parameters of *P. pulmonarius* Grown with Maize Kernel (K), Empty Palm Fruit Bunch (P), Banana leaf (B) and Control (C) Substrates

	FLA	PHE	TAN	ALK	SAP	GLY	WT	CL	AR	DI	LS	SPR
FLA	1											
PHE	-0.526	1										
TAN	-0.396	0.227	1									
ALK	0.126	0.409	-0.285	1								
SAP	-0.212	0.573	0.081	0.168	1							
GLY	-0.537	0.526	0.312	0.513	0.53	1						
WT	-0.028	-0.488	0.073	-0.232	-0.445	-0.108	1					
CL	-0.174	-0.333	-0.548	0.05	-0.187	0.088	0.424	1				
AR	-0.161	-0.322	-0.517	-0.011	-0.208	-0.001	0.397	.969**	1			
DI	-0.162	-0.31	-0.513	0.113	-0.175	0.123	0.404	.948**	.958**	1		
LS	-0.037	-0.508	-.600*	-0.029	-0.252	-0.035	0.443	.822**	.771**	.862**	1	
SPR	-0.144	0.039	-0.365	-0.048	0.033	-0.091	-0.04	0.084	0.02	0.082	0.426	1

** = Correlation is significant at the 0.01 level (2-tailed), * = Correlation is significant at the 0.05 level (2-tailed), Fla = Flavonoid, PHE = Phenol, TAN = Tannin, ALK = Alkaloid, SAP = Saponnin, GLY = Glycosides, WT CL AR DI LS SPR

DISCUSSION

The four different mushroom substrates used in this study had varying effects on the morphological, nutritional, phytochemical and vitamin compositions of their individual harvested mushrooms. This could be attributed to the differences in the substrates' nutrients and chemical constituents. Eze and Agbo (2020) had reported that substrate compositions can influence mushroom quantity and quality. The banana leaf substrate that produced mushrooms with higher weight, pileus circumference, area, pileus diameter, length of stipe and stipe-pileus ratio which are all morphological attributes could give more harvestable yield and even appeal more to the eyes when cultivated for commercial purposes. Eze and Ishiwu (2021) had earlier reported that banana leaf substrate has potentials for better marketable yield. Carvalho *et al*. (2012) had also reported banana tree wastes to be a promising raw material for the cultivation of *P. ostreatus* because of high level of the availability at low or no cost in many localities.

The mushroom grown in the substrate formulated with banana that was significantly higher in percentage moisture content than mushrooms grown in the control and maize kernel substrates can easily be digested when consumed. This agrees with the findings of Belewu and Belewu (2005) who reported that mushroom is easily digested when consumed and has no cholesterol content. The mushroom grown in the substrate formulated with maize kernel that had higher protein composition could be used as an alternative to animal protein. This is in line with the findings of Oei (2003) that edible mushrooms are highly nutritious and can be compared with eggs, milk and meat. Belewu and Belewu (2005) also reported that the content of the essential amino acids in mushroom is high and close to the need of the human body.

Mushroom grown in the substrate formulated with empty palm fruit bunch that was significantly higher in Vitamin B_1, Vitamin B_2, Vitamin C and Vitamin E could be beneficial in dietary supplementation and antioxidant activity. Miles and Chang (1997) reported that mushrooms contain many vitamins such as niacin, riboflavin, vitamin D, C, B1, B5 and B6. Egwim *et al*. (2011) observed that mushrooms contain dietary polyphenols which have high bioavailability and antioxidant effects.

The mushroom grown in the substrate formulated with maize kernel that had higher flavonoids content when compared with other substrates could be harnessed as one of the safe healthy natural sources of spices because of the flavour. Flavonoids are also considered important in the antioxidant activities (Pietta, 2000). Antioxidants are substances that can neutralize oxidative activities in the body by donating an electron or hydrogen atom to the free radicals (Tsao, 2010).

Conclusion

Cultivation of *P. pulmonarius* mushroom with banana substrate is therefore highly recommended to farmer for commercial production because of its high marketable yield potentials. Cultivation of mushroom with empty palm fruit bunch could be recommended for dietary intervention especially in vitamin supplementation while mushrooms grown in maize kernel substrate may be harnessed for use in therapeutic and pharmaceutical applications.

Conflict of Interest

The authors declares no conflict of interest

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Socio-economic determinants of livestock farmers' level of awareness of organic farming practices.

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ABSTRACT

The purpose of the research is to identify the socioeconomic variables that affect how livestock farmers in South-South Nigeria use organic farming methods. The research's specific goals were to identify the socioeconomic traits of livestock farmers in the study area, the extent of their use of organic farming methods, and the socioeconomic factors that affected their use. A structured questionnaire that was given to a sample size of 397 livestock producers was used to collect the study's data. Utilizing inferential statistics like multiple regression, the data gathered were analyzed. The magnitude of the dependent variable varied by28.7 percent as a consequence of the combined effects. This suggests that the farmers' socioeconomic traits were discovered to be highly predictive of their level of knowledge regarding organic farming methods for livestock. The degree of awareness of organic farming was significantly correlated with religion, farm size, and farming expertise. Age, sex, marital status, household size, farmers' organization, extension contact, and income were not statistically different from each other. The regression coefficients of 25.282 show that religion is a significant factor; the t-value was 2.698 and the p-value was 0.008, which is less than 0.05. (level of significance). Religion might be used as a forum to share knowledge about organic farming. Therefore, it is advised that organizations with a religious stance, such as churches and Islamic groups working in Nigeria, act as channels for disseminating information about organic farming. It is also advised that extension employees, who serve as crucial interns in the education of farmers and the adoption of innovations, receive new training and refresher courses in the standards and advantages of organic agriculture.

Keywords: Organic livestock, socioeconomic determinants, awareness.

INTRODUCTION

In order to increase food production to meet the need of the world ever growing population, the use of agro-chemicals was adopted. Despite the apparent boost of crop and animal production by the use of synthetic fertilizers and other agro – chemicals, a number of side effects have been recorded in recent times.

Organic farming represents a deliberate attempt to make the best use of local natural resources and is an environmental friendly system of farming. It relies much on ecosystem management which excludes external input, especially the synthetic ones. Anderson, Jolly & Green (2005) stated that organic farming is a production system that excludes the use of synthetically manufactured fertilizers, pesticides, growth regulators and livestock feed additives. The system relies on crop rotation, crop residues, animal manures, legumes, green manures, off-farm organic wastes, mechanical cultivation and biological pest control to maintain soil nutrient. . Organic farming technology is generally regarded as the solution to environmental problems that are related to agriculture as well as food safety (Agbamu, 2002). Also, Conor (2004) pointed out that organic farming was developed as a response to what was perceived to be polluting food supply by modern farming methods and the ensuing degradation of the environment with chemical and other by-products of the industry

Irrespective of the several benefits of organic farming, the coverage is still low. This may be as a result of lack of awareness of the potentials of organic farming practices. According to Oyekanini, Coyne & Fawole (2008) the poor performance of Nigerian farmers is attributed to their lack of awareness and use of sustainable agricultural practices. There is inadequate awareness of organic production practices, animal welfare issues and the requirements of importing countries, especially by individual organic trainers/advisers and farmers. Organic production calls for an in-depth understanding of the principles, standards, production practices and requirements of the organic certification agencies. Most of the literature on organic farming is available in English, through the print medium and the Internet. Much of this material is inaccessible to small-scale farmers in the South, where illiteracy is common and most do not speak English. Technical knowhow is a production constraint of farmers in developing countries (Twarog & Vossenaar, 2002).

One cogent step to curtail poverty in rural areas is to foster these small-holder farmers into new technological and market participation in order to improve their net returns from agricultural production (World Bank, 2007). But fostering farmers into a technology that does not fit their actual needs will often result in an unsuitable environment. There is a requirement to provide the relevant data needed for incorporating the technology into policy. Therefore, it is relevant to examine the current socioeconomic characteristics of the farmers as it affects their level of awareness in organic farming.

Availability of relevant information on the importance of organic farming practices could enhance its adoption among farmers. There is scarcely any literature on whether or not farmers are aware of the benefits of organic farming. This apparent lack of enough empirical data in organic farming practices by farmers in the study area has created lacuna in knowledge thus culminating in gap that this study intends to fill.

3.0 Material and Method

3.1 The study area

The area of study is South-South, Nigeria which comprises six (6) states namely: Delta, Bayelsa, Edo, Rivers, Cross River and Akwa Ibom. The South-South region of Nigeria is strategically located at the point where the Y tail of the river Niger joins the Atlantic Ocean through the Gulf of Guinea. Though a relatively small stretch of land, the south of the country provides the economic mainstay of the economy: oil. In addition to oil and gas, the region equally contributes other key resources, with potential huge investment opportunities in tourism and agriculture. South-south zone has a population of 21,044,081(National Population Commission, 2006). The region is characterised by the tropical hot monsoon climate and a high annual rainfall which varies within the Delta. Heavy rains begin in January and falls till November with peaks in July and September before the incidence of climate change. The South-south region is endowed with very rich alluvial soil structure that supports swamp agriculture in most cases.

3.2 Sampling Procedures

The prominent agricultural enterprise of livestock was purposively sampled for the study. This was based on their dominance in agricultural production system of the people. The population therefore comprised rural households engaged in livestock production. Multistage random selection technique was employed. The first stage was the random selection of three states out of the six states that make up South-south Nigeria. The states sampled were Bayelsa, Delta and Akwa-Ibom. One-third (33.3%) of the number of agricultural zones in the states sampled were selected. Delta state is divided into three Agricultural zones- Delta North, Delta South and Delta Central out of which Delta central was selected. Bayelsa state is also classified into three Agricultural zones- Brass, Sagbama and Yenogoa out of which Brass zone was sampled. Akwa-Ibom is divided into six Agricultural zones- Eket, Etinan, Oron, Abak, Ikot Ekpene and Uyo zones. Two zones Uyo and Ikot Ekpene were sampled in Akwa- Ibom state. In each zone, three blocks were randomly selected for Delta and Bayelsa while two blocks from each of the two zones sampled in Akwa Ibom state giving a total of ten blocks. Two circles were further sampled from each selected block in Delta and Bayelsa. Twelve circles were thus selected from the two states. Two cells were sampled from each block in Akwa-Ibom. Eight circles were sampled in the state. The total number of circles used was twenty. Two rural communities were then selected from each circle giving a total of forty communities for Delta, Bayelsa and Akwa- Ibom states. Lastly, four farmers (Household heads) for crop, livestock and fish each were randomly sampled from the forty communities giving a total of four hundred and eighty farmers. Of this lot, three hundred and ninety seven respondents (83%) properly filled and had the relevant information for the study. The lists of farmers were gotten from the Zonal Managers in charge of each zone.

Data for this study were gathered from both primary and secondary sources. Research reports, proceedings, journals, books, internet and information from the ministry of Agriculture in the various states made up the secondary sources while information generated with semi structured questionnaire from farmers constituted the primary data. The questions in the questionnaire were structured to capture and elicit information from the respondents based on Socio economic characteristics of the respondents, awareness of organic farming practices, organic farming practices by livestock farmers. The researcher with the assistance of three trained enumerators administered and retrieved the research instrument from the respondents in the three states used for the study.

Data obtained were analysed using descriptive namely frequency table, percentages, charts, mean, and inferential statistics such as ordinary least square multiple regression (OLS),

The variables of the study were measured as follows:

Section A: Socio-economic characteristics

Age: The chronological years of life indicated by the respondents was measured in years

Level of education: (no formal education (1), primary (2), secondary (3), tertiary (4).

Sex: (dummy variables; male (1), female (0)

Marital status: (Single (0), Married (1), Widowed (2), Separated (3), Divorced (4)

Farming experience: (years)

Household size: (number of persons that eat from the same pot)

Farm size: (livestock – no of animals).

Major aim of production: (sale (1), consumption (2), both (3)

Source(s) of information about organic farming practices: (Dummy, yes (1) no (0)

Frequency of use of information sources: (very often (4), often (3), rarely (2), not at all (1)

Information source use factors; Relevance (dummy, relevant (1), not relevant (0), Usefulness: (dummy, useful (1). Not useful (0).

Credibility: (dummy, credible (1) not credible (0)

Farm enterprise characteristics – cost: (dummy, expensive (1), not expensive (0), profitability: (dummy, profitable (1), not profitable (0)

Section B

Respondent awareness was measured by using dummy (aware =1, not aware= 0).

Level of awareness was measured by a response to a 4-point Likert type scale of high (4), moderate (3), low (2) and not at all (1) to the organic farming practices livestock. Level of awareness was analysed using percentages and mean. The mean was computed by adding the weights of the responses to the items using the scale and dividing by the number of scales:

High + Moderate + Low + Not at all/ 4 i.e 4+3+2+1/4=2.5 (Discriminating index) Mean score of 2.5 and above were considered as those that they were aware while those below 2.5 were considered otherwise.

The OLS regression model was explicitly stated as

$Ya = f(X_1X_2X_3X_4X_5X_6X_7X_8X_9.X_{10}\ X_{11}....e)$

Where Ya = pooled index of level of awareness of organic farming practices for each of crop, livestock and fishery

X_1 = Sex (Dummy variable, male = 1, female= 0)

X_2 = Age (years)

X_3 = Marital status (Single (0), Married (1), Widowed (2), Separated (3), Divorced (4)

X_4 = Level of education (no formal education (1), Primary (2), Secondary (3), Tertiary (4)

X_5 = Farming experience (Years)

X_6 = Household size (Number of persons per household that feed from the same pot

X_7 = Farm size (Hectares for crops, number of animals (livestock and fish)

X_8 = Type of farming (Dummy Full time (1) part-time (0)

X_9 = major aim of production. (Measured on a 3 point Likert type scale of consumption = 1, sale = 2, consumption and sale = 3)

X_{10} = Contact with extension agents (Dummy variables, yes = 0, no = 1)

X_{11} = Annual income (Naira)

E = Error term

It is expected a *priori* that the coefficient of $X_1X_2X_3X_4X_5X_6X_7X_8X_9X_{10}X_{11} > 0$

The four functional forms of the model namely linear, double log, exponential and semi-log were tried out. The model with the best fit, highest number of significant variables, highest coefficient of multiple determination R^2 and concurred with a *priori* expectation was used to describe the result.

4.0 Result and Discussion

The findings of the study were presented under the following headings:

a) Socio economic characteristics of respondents

Awareness / level of awareness of organic farming practices among livestock farmers.

Table 4.1: Distribution of Respondents according to their Socio-economic characteristics

_S/N	Socio-economics	Frequency	Mean ($\bar{x}$)
1	**Gender**		
	Male	254 (63.6)	Male
	Female	143(36.4)	
2	**Age**		
	19-32	74(20.0)	
	33-46	173(43.5)	43
	47–60	115(30.39)	
	61-74	24(6.03)	
3	**Marital Status**		
	Single	50(12.7)	
	Married	303(76.3)	Married
	Divorced	21(5.4)	

	Widow	12(3.0)	
		8(2.0)	
4	**Education Level**		
	No formal education	81 (20.5)	
	Primary	58(14.7)	Primary
	Secondary	31(31.9)	
	Tertiary	130 (32.8)	
5	**Religion**		
	Christianity	347(87.3)	
	Islam	22(5.6)	
	Traditional/other religion	28(7.1)	
6	**Farming Experience**		
	1-20	143(36)	Mixed farming
	21-40	254(64)	
	41-50	0(0)	
	51-70	2(0.6)	
7	**Farm size (Livestocks)**		
	Cattle		
	None	97(98)	
	0-5	2(2.0)	
	6-10	0(0)	
	11-15	0(0)	0
	16-20	0(0)	
	Above 20	0(0)	
	Farm size (Poultry)		
	0-500	56(56.6)	
	501-1000	10(10.0)	
	1001-1500	5(5.0)	
	1501-2000	8(3.0)	
	2001-2500	3(5.1)	1223
	2501-3000	6(6.0)	
	3001-3500	1(1.0)	
	3501-4000	5(5.0)	
	4001-4500	0(0)	

Above 4500	5(5.0)	
Farm size (Sheep)		
None	94(94.9)	
1-5	2(2.0)	
6-10	3(3.0)	
11-15	0(0)	0
16-20	0(0)	
Above 20	0(0)	
Farm Goat	80(80.8)	
None	5(5.0)	
1-5	3(3.0)	
6-10	4(4.0)	9
11-15	5(5.0)	
16-20	2(2.0)	
Above 20		
8. Household size		
1-5	288(62.1)	
6-10	167(36.0)	5
11-13	9(1.93)	
9. Farmers' Ass. membership		
Yes	205(51.7)	
No	192(48.3)	
10. Contact with Extension agent		
Yes	273(68.8)	Yes
No	124(31.2)	
11. Frequency of contact		
Not at all	124(31.2)	
Once in a fortnight	181(45.7)	
Once in a month	81(20.5)	Once in a fortnight
Twice in a year	6(1.5)	
Once in a year	4(1.1)	

12. Annual Farmers Income		
0-2,000,000	355(89.4)	
2,000,001-4,000,000	24(6.0)	1,000,000
4,000,001-6,000,000	8(1.9)	
6,000,001-8,000,000	3(0.7)	
8,000,001-10,000,000	3(0.7)	
10,000,001-12,000,000	1(0.2)	
12,000,001-14,000,000	2(0.4)	
16,000,000-18,000,000	1(0.2)	
18,000,001-20,000,000	0(0)	
20,000,001-22,000,000	1(0.2)	

Source: Field survey, 2022

(a) Socio economic characteristics of respondents

Gender

From the results in Table 4.1, the majority (63.6%) of the respondents were male while 36.4 percent were female. It shows that males are more involved in livestock farming in South-South Nigeria. This could be attributed to the socio- cultural advantages in favour of male in the zone. These could include right to land and institutional support services like extension, credit, etc all skewed in support of male. This result is supported by the findings of Nwankwo, Peters & Benkelman (2009) that male gender still dominated farming activities in Nigeria.

Age

Table 4.1 shows that 20.0 percent of the respondents were between the ages of 19-32 years; 43.5 percent were between the ages of 33-46 years; 30 percent were between 47-60 years while 60.3 percent were between 61-72 years. The mean age was 43 years. The result implies that the farmers are young and this is an asset to organic farming practices in livestock. Young farmers are innovative and thus can adopt innovations faster. They are full of energy and as such can withstand the drudgery associated with this farming practice. This agrees with the work of Obi, (2013) which revealed that most farmers in South-south Nigeria fall between ages 41-60 years.

Marital status

Table 4.1 indicates that the married farmers formed the majority with 76.3 percent; 12.7 percent were single, while 10.4 percent were widowed, separated or divorced. Marriage confers legal right to use the services of either of the spouses and the attendant offspring(s). The dominance of the distribution by married farmers could be to ensure food security to the household at easy daily reach.

Level of education

The result in Table 1.0 showed that 20.5 percent of the respondents had no formal education and 14.7 percent had primary education, 31.9 percent had secondary education while 32.8 had tertiary education. The level of education of farmers from this result is high. This is very good because educational status of farmers influence adoption of improved technologies even organic farming practices. This is confirmed by Agwu & Anyanwu (1996) which noted that increase in educational status of farmers positively influence adoption of improved technologies and practices.

Religion

The distribution of farmers by religion showed that 87.3 percent were Christians, 5.6 percent were Muslims, and 7.1 percent practiced traditional or other religions. The majority of farmers in South-South Nigeria are Christians. This may have been facilitated by the missionaries' entry and operations through the route, as well as the riverine surroundings. Religion fosters camaraderie and may serve as a forum for the promotion of organic farming innovations and technologies.

Experience

The farming experience distribution of the farmers, Table 4.1 reveals that 81.7 percent had farming experience ranging between 1 - 20 years. Another 17.1 percent had farming experience ranging from 21-40 years, while 0.6 percent had farming experience ranging from 51-70 years. The mean farming experience was 12 years. Experience is a valuable asset in farming. It shapes a farmer's opinion and guides his decision making prowess. Experience could engender adoption of innovations as the farmer's encounter in his environment directs his will and drive. The use of organic farming practices could be favoured with farmers having several years of farming experience.

Farm size

A number of authors reported that majority of sub-Sahara population living in rural areas can be considered as smallholders mainly because of their limited resources relative to other farmers in the same sector (Dixon Taniguchi, Wattenbach & Tanyeri- Arbur, 2004). For the Livestock farmers, answers to the questions posed during interview revealed that 19.2 percent rear goats, 5 percent rear sheep, 2 percent rear cattle while 80.8 percent were into poultry. average farm / stock size for cattle was 0, poultry was 1223 birds, sheep was 0 and goats was 9. Farm size could be a serious factor in farm decision making. Large farm size could predispose to increased adoption of innovations or high use of organic farming practices. It could also be a pointer to the level of investment and status of operation. This could determine the level of commitment to the business.

Household size

The household distribution of the farmers shows that 62.1 percent had household size of 1-5 persons; 36.0 percent had between 6-10 persons and 1.9 percent had between 11-13 persons. The average household size was 5. Akinnnagbe and Ajayi (2010) in their study revealed that majority of households in rural areas in Nigeria maintain household size of 6-10. The household size is moderate. A large household size could pre- dispose conversion of investible fund to consumptive as the farmer has many mouths to feed. Here the farmer may have less to commit to the farm business and this could degenerate entanglement within the vicious cycle of poverty. However, large household size could furnish farm labour and ensure the receipt of more extension messages. A small household size could culminate in low labour supply and reduced consumption.

Membership of Farmers' association

The result in Table 4.1 shows that 51.7 percent of the livestock farmers indicated that they belonged to farmers' associations and 48.3 percent do not belong to any. The reason for this large percentage in farmers' membership of association is because farmers have always worked in groups in order to enjoy benefits together. Lopez & Reguena (2005) reported that the adopters of organic farming practices in Spanish olive orchard were commonly members of agricultural association and had received more information and trainings about organic practices. The membership of farmers' association could be an asset to the use of organic farming practices. The farmers would be fast in analysing the obvious gains and observe possibly from one another's farms the applicability of the practices.

Annual Farm Income

Most of the farmers 89.4 percent earned annual income less than 2,000.00 while 6 percent earned 2,000,001- 4,000,000. Also 1.9 percent earned between 4,000,001 - 6,000,000. Again 0.7 percent earned 6,000,001 – 8,000,000, and 8,000,001- 10,000.00 respectively. Others included 0.2 percent for 10.000.001 – 12,000.000, 14,000,001 – 16,000,000, 16,000,001 – 18,000,000 and 20,000,001 – 22,000,000 respectively. In the same manner, 0.4 percent had 12,000,001 – 14,000,000. The mean annual income was 1,000,000 naira. (₦1m). This was an average of eighty-four thousand naira monthly and two thousand six hundred naira daily. This implies that more than 50% of the respondents earn $2.25 per day, thereby living above the international poverty line of $2.15 per day, as recommended by United Nation.

Contact with extension agents**.**

Most of the respondents, 68.8 percent had contact with extension agents while 31.2 percent had no contact with extension agents. On the frequency of contact, no contact at all was 31.2 percent, once in a forth-night 45.7 percent, once in a month 20.5 percent, twice a year 1.5 percent, while once in a year 1.1 percent. It is interesting to note that over 50 percent of the farmers had contact with extension agents. This implies that farmers were familiar with extension agents and like anyone else, people believe who they are familiar with. Therefore, any programme geared towards improvement and encouragement of farmers in adopting an innovation like organic farming would be better done through agricultural extension agents.

Section B

Level of awareness of organic farming practices among livestock farmers

Table 4.2: Distribution of livestock farmers by level of awareness of organic farming practices.

Organic Farming Practices for livestock	Not at all	Low	Moderate	High	Mean	Std Deviation
Adequate land holding	33 (33.3)	40 (40.4)	14 (14.1)	12 (12.1)	2.05	0.98
Farm diversification	44 (44.4)	29 (29.3)	25 (25.5)	1 (1.0)	1.82	0.85
Free movement of animals/Provision of fresh air and natural day light	61 (61.6)	6 (6.1)	25 (25.3)	7 (7.1)	1.77	1.05
Protection against adverse weather condition	57 (57.6)	2 (2.0)	30 (30.3)	10 (10.1)	1.92	1.14
Resting areas	57 (57.6)	16 (16.2)	13 (13.1)	13 (13.1)	1.81	1.10
Clean and dry beddings	55 (55.6)	3 (3.0)	29 (29.3)	15 (15.2)	2.09	1.29
Enough space for exercise	52 (52.5)	3 (3.0)	29 (29.3)	15 (15.2)	2.07	1.19
Access to fresh drinking water by livestock	12 (12.1)	1 (1.0)	59 (59.6)	27 (27.3)	3.02	0.88
Allowing livestock to express natural behaviour	29 (29.3)	11 (11.1)	40 (40.1)	19 (19.2)	2.50	1.11
Use of local breed	59 (59.6)	2 (2.0)	26 (26.3)	12 (12.1)	1.90	1.16
Natural reproduction technique	53 (53.6)	11 (11.1)	20 (20.2)	15 (15.2)	1.96	1.16
Produce without genetic engineering , ionising radiation or sewage sludge	51 (51.5)	25 (25.3)	15 (15.2)	8 (8.1)	1.79	0.98
Adequate feeding	16 (16.2)	64 (64.6)	0 (0.0)	19 (19.2)	2.86	0.91
Animal feeding is 100% organic	32 (32.3)	3 (3.0)	24 (24.2)	40 (40.4)	2.72	1.29
Prompt treatment of sick animals	27 (27.3)	10 (10.1)	51 (51.5)	11 (11.1)	1.74	1.01
Manage animals without antibiotics	74 (74.7)	10 (10.1)	7 (7.1)	8 (8.1)	1.48	0.94
Traditional/natural treatment of sick animals	62 (62.6)	11 (11.1)	15 (15.2)	11 (11.1)	1.74	1.08
Vaccinate only during disease outbreak	69 (69.7)	16 (16.2)	8 (8.1)	6 (6.1)	1.50	0.88
Manage without added growth hormones	45 (45.5)	29 (29.3)	15 (15.2)	10 (10.1)	1.89	1.01
Accurate record keeping	33 (33.3)	1 (1.0)	40 (40.4)	25 (25.3)	2.57	1.20

Field survey, 2022.
Mean score ≥ 2.50 = aware (A), mean score < 2.50 = not aware (NA)
Values in parenthesis stand for percentages.

Table 4.2 shows that farmers were adequately aware of allowing livestock access to fresh drinking water $\bar{x}$ =3.02 and SD of 0.86, adequate feeding ($\bar{x}$ = 2.86 and SD of 0.91), animal feeding of 100% organic ($\bar{x}$ =2.72 and SD of 1.27) and accurate record keeping ($\bar{x}$ = 2.57 and SD of 1.20). The four practices above had mean scores above the discriminating index. The other practices were below the discriminating index of 2.50. These included farm diversification with mean of 1.82 and standard deviation of 0.85, free movement of animals / provision of fresh air and natural day light ($\bar{x} = 1.77$ and SD = 1.05), protection against adverse weather condition with mean 1.92 and standard deviation of 1.14, provision of resting areas ($\bar{x} =$ 1.81, SD = 1.10), clean and dry bedding ($\bar{x} =$ 2.09, SD = 1.29), enough space for exercise ($\bar{x} =$ 2.07, SD = 1.19).

In the same manner, use of local breed of livestock had mean of 1.90 and SD of 1.26, natural reproduction technique ($\bar{x}$ =1.96, SD = 1.16, produce without genetic engineering with mean of 1.77 and standard deviation of 0.98, prompt treatment of sick animals with mean of 1.74 and SD of 1.00, managing animals without antibiotics ($\bar{x}$ =1.48, SD = 0.94), traditional / natural treatment of sick animals ($\bar{x} =$ 1.74, SD = 1.08), vaccinate only at disease outbreak ($\bar{x} =$ 1.50, SD = 0.88) and no addition of growth hormones ($\bar{x} =$ 1.89, SD = 1.01). The grand mean was 2.04 which fall below the discriminating index of 2.50. This could be as a result of poor extension campaign in organic livestock practices and this call for increased extension campaign to sensitize people and sustain interest.

Table 4.3: Socio-economic determinants of livestock farmers' level of awareness of organic farming practices

Coefficient	Linear	Exponential	Double	Semilog
Constant	B:43.070 t:4.852 sig:0.000	B:1.691 t:13.198 sig:0.000	B:1.408 t:8.636 sig:0.000	B: 24.045 t:2.135 sig:0.035
Age	B:-0.18 t: -0.153 sig:0.878	B:0.001 t:-0.708 sig:0 480	B:-0.080 t:0.939 sig:0.266	B:7.520 t:1.280 sig:0.203
Sex	B:-1.230 t:-0.777 sig:0.439	B:-0.033 t:-1.451 sig:0.147	B:-0.073 t: -1.117 sig:0.266	B:-4.649 t:-0.807 sig:0.421
Edu. Level	B: 0.239 t:0.739 sig:0.461	B: 0.002 t: 0.495 sig:0.621	B:-0.056 t:0.902 sig:0.369	B: 5.162 t: 1.193 sig:0.235
Marital status	B: 1.959 t: 1.628 sig:0.106	B:0.030 t:1.746 sig:0.083	B:0.107 t: 1.069 sig: 0.287	B:9.045 t: 1.307 sig: 0.194
Religion	B:-4.733 t:-1.857 sig:0.066	B:-0.81 t:-2.197* sig:0.030	B:-0.329 t:-1.676 sig:0.096	B:-19.903 t:-1.469 sig:0.144

Farming Exp	B:-0.105 t:-0.810 sig:0.413	B:-0.001 t:-0.291 sig:0.772	B:-0.005 t:-0.103 sig:0.918	B:-3.011 t:0.903 sig:0.353
Farm size	B:-0.163 t:-1.350 sig:0.179	B:-0.002 t:-1.255 sig:0.212	B:-0.068 t:-1.852 sig:0.066	B:-5.041 t:-1.973* sig:0.051
Household size	B:0.059 t:0.120 sig:0.915	B:0.003 t:0.0450 sig:0.654	B:-0.026 t:-0.442 sig:0.659	B:-1.965 t:-0.478 sig:0.634
Farmers Association	B:7.030 t: 3.475* sig:0.001	B:0.091 t:3.102* sig:0.002	B:-0.026 t:-0.442 sig:0.659	B:-1.965 t:-0.478 sig:0.634
Extension contact	B:-9.376 t:-4.378* sig:0.000	B:-0.113 t:-3.671* sig:0.000	B:-0.274 t:-2.259* sig:0.026	B: 24.209 t:-2.888* sig:0.005
Income	B: 3.027E-00 t: 1.919 sig:0.057	B: 3.08E-09 t:1.355 sig:0.178	B: 0.010 t:1.285 sig:0.201	B: 0.843 t:1.586 sig:0.115
R^2	0.336	0.290	0.259	0.310
Fstart	5.836	4.722	4.030	5.176
P value	0.000	0.000	0.000	0.000

The level of significance: 0.05 t-value significant at 0.05.
Decision Rule: Reject H0 if the P (probability) value is less than 0.05 (level of significance).

Source: Computed from survey data, 2022.

Ordinary least square multiple regression analysis was used to determine the significant relationship between the level of awareness of organic farming practices for livestock and the farmers' socio-economic characteristics. From the SPSS output in Table 4.3 of the four functional models, the semi-log multiple regression produced the best fitted model with the highest coefficient of determination (R^2 = .28.7), which is 28.7 % variation of the data that is explained or accounted for by the regression model Y- (pooled responses on level of awareness of organic farming practices for livestock) F- value of 3.184 and 3 significant variables.

The result shows that the combined effects of the socio-economic characteristics significantly related with level of awareness of organic farming practices for livestock (p-values of 0.001 less than level of significance

0.05). The combined effects resulted in 28.7 percent variation in the magnitude of the dependent variable. This implies that the socio-economic characteristics of the farmers were found to be significant predictors of level of awareness of organic farming practices for livestock.

The result indicates that religion from the regression coefficients of 25.282 had t- value of 2.698 with a p-value of 0.008 which is less than 0.05 (level of significance). This shows that religion is significantly related with the level of awareness of organic farming. Religion could serve as a platform for disseminating information on organic farming. Thus, the more committed the farmers were in religion, the more their level of awareness of organic farming practices. John, Robert and Chris (2003), revealed in their work – improving agricultural extension through Faith-Based Organization that many churches and Islamic organizations operating in Kenya are involved not only in spreading their faith but also in promoting socio-economic development by working with local communities. The case is not different in Nigeria. Most health information are passed through the religious organizations to the populace.

Farming experience from the regression coefficients of 6.694 with t – value of 2.082 showed a p-value of 0.040 which is less than 0.05 (level of significance). This shows that years of experience is significantly related with the level of awareness of organic farming practices for livestock. This is not surprising as it is expected that farmers who have spent more years in farming should be more knowledgeable of farming practices.

Farm size from the regression coefficients of -4.283 had t- value of -2.219 and a p-value of 0.029 which is less than 0.05 (level of significance). This shows that the stock size of a farmer is significantly related with the level of awareness of organic farming practices for livestock. The result implies that farmers who have large farm sizes had low level awareness of organic farming practices for livestock. This could be as a result of stereotype teaching and learning in which they tried to maintain the status quo. The work of Kassie *et al.,* (2009) established a relationship between the farm size of farmers and farming practices.

The other variables of age, sex, marital status, household size, farmers' association, extension contact and income were not significant.

Conclusion

Farmers had a sufficient awareness of the importance of providing livestock with access to clean water for drinking, adequate rations, 100% organic animal feed, and precise record-keeping. There were statistically significant correlations between the impact of religion, farm size, and farm experience on the level of knowledge of organic farming. As a result, programs for educating the farmers and raising awareness can be created in accordance with religious values. Farmers can receive assistance from extension agents and agricultural professionals in the form of technical advice and support. Additionally, giving farmers financial assistance and incentives to adopt methods can raise their level of awareness.

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Resource Use Efficiency in Organically Produced Fluted Pumpkin among Small Holder Farmers in Anambra State, Nigeria

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ABSTRACT
As against conventional produce, certified organic produce gives higher net incomes, but fewer farmers engaged in its production. Efficient allocation of resources at the farm level has implications for investment, as it evaluates the success of production units, thereby enabling the formulation of sound policies. Thus, the Technical and Allocative Efficiency (TAE) of organically produced Fluted Pumpkin farmers was examined in Anambra State, Nigeria. Three-stage sampling technique was used. Awka South, Anaocha, Ogbaru, Anambra west, Idemili North and Ihiala, Local Government Areas (LGAs) were purposively selected due to high number fluted pumpkin producers. From each LGA, three villages were randomly selected. Ten were selected by Snowball sampling technique. Thirty farmers were sampled per LGA, totaling 180 farmers with the aid of structured questionnaire. Ordinary Least squares multiple regression was employed to estimate the Cobb-Douglas Production Function (CPF) from the farm production data. The TAE were estimated. The summation of the CPF factors coefficients (1.90) implied that farmers were operating in the increasing returns to scale stage. Resources were managed inefficiently as underutilization was established. There are gaps in resource use efficiency. Mechanization, access to productive resources, increase land use intensity and training were recommended to improve efficiency.

Key words: Resource use efficiency, Organic, fluted Pumpkin, production efficiency, Nigeria

1.0 INTRODUCTION

Organic farming advocates healthy farm products. It depicts the practices of using green manure, crop rotation, compost, crop rotation technique, biological pest control, and mechanical cultivation in maintaining soil productivity and control pests, excluding the use of inorganic pesticides, fertilizers, plant growth enzymes, genetically modified crops and animals and livestock feed additives, (Toungos and Tanko, 2018).

The goals motivating organic farmers were production of contaminant-free foods, reduce exposure to harmful chemicals, and price incentives. Most studies on farm resource use efficiency contrast the conventional against the organic farming method. Comparing organic farming with conventional farming systems**,** showed organic farming to be more resilient to changes in weather conditions. Meta-analysis studies have shown organic farms to sustain 30% more biodiversity than conventional farms (Tsiafouli et al., 2015). Organic farming produces lower yields and requires larger agricultural land areas Madau, (2005), Wheeler and Crisp (2009), and Charyulu and Biwas (2010). Organically grown crops were more resistance to pests and diseases due to greater soil microbial biomass slower growth of the plants, and improved soil quality. In addition, organic systems enable crops to develop its own chemical defenses against pests and diseases and enhanced biodiversity. Organic agriculture enhances and maintain soil fertility. Reduced phosphorus losses is identified by a met analysis in organic farming systems. In addition, organic farming reduces runoff and increases infiltration and reduces soil erosion and prevents flooding. Certified organic farmers sell their farm produce at higher prices, despite their lower input costs resulting in higher net incomes compared to conventional agriculture. Conventional farmers dependent solely on products supplied by agrochemical companies and are obliged to pay fixed prices, but organic farmers have greater sovereignty and better control on their production processes and the associated costs (Trewavas, 2002; Andres and Bhullar, 2016; Hendrani 2022). Hendrani 2022 Fluted pumpkin (*Telfairia occidentalis*), is an important tropical vine that belong to the family *Cucurbitaceae* (Agatemor, 2006; Time and Chikezie, 2016). It is a very important vegetable crop cultivated in the eastern Nigeria both for its leaves and edible seeds (Annih, Tatiana, Kinge, Mariette, and Kebei, 2020). Fluted pumpkin is highly nutritious and medicinal; it improves blood production, fertility and also useful in the treatment of convulsion (Ibironke and Owotomo, 2019). It contains 39.2 percent crude protein, which is 9.5 percent, 18.11 percent, and 8.2 percent higher than the crude protein in Amaranthus (sp.), Talinum triangulate and Solanum marcrocarpon (L.) (Okyto1997; Ayanwale,2006). It also plays an important role in high income generation and employment generation for the rural farmers (Time and Chikezie.2016). the oil of Fluted Pumpkin oil has high molecular weight fatty acids, therefore it is a good feedstock, and can be used for candle and soap production (Agatemor,2006; Ayanwale,2006). It equally has a high unsaturated fatty acid, therefore its use for cooking-oil or margarine production. Fluted Pumpkin oil is better for human consumption than palm oil because of its lower saponification value and a higher specific gravity. Its richer in iron than other leafy vegetables with dry matter concentration of 969.92 mg·kg_1 (Schippers, 2000; Agatemor,2006; Ayanwale,2006).

Farmers in Nigeria preferred to expand their farm land to achieve their household's food security. This practice is a factor of environmental degradation and weather variability. Farming practices and the use of farming technology in Nigeria is at lower level of development despite the country's potential of producing adequately for her market. This is achievable if proper research-based assistant is provided to the farmers, so as to increase productivity and efficiency of factors of production, Thus, to adequately design better policy measures to increasing productivity, it is important to understand how to efficiently allocate resource in farm enterprises**.**

1.2.1 Theoretical framework for production function, short run output production theory

The firm as a unit of production manage production process by engaging entrepreneur with the objective of profit maximization. In agriculture, the physical inputs are usually land, labour, capital, management and water resources. The production function stipulates that technical relationship between inputs and output in any production process is based on the follow assumptions: Input and output are nonnegative ($q \geq 0$), there is technical efficiency (any combination of inputs generate maximum output possible, a production function is single valued continuous and twice differentiable, a production function is characterized by diminishing marginal productivity. diminishing marginal o technical substitution and increasing rate of product transformation. there is decreasing return to scale ($Eq < 1$), inputs and outputs are perfectly divisible, a production function is chosen (assumed) to be constant overtime and is not random (probability of occurrence is one).

$Q = f(X_i \dots \dots \dots . . X_n)$ ………………….. (1)

$Q =$ output of fluted pumpkin

X_i, i = 1, 2….n where X_i are variable inputs. This shows the path of the locus of maximum output that can be produced at every level of variable inputs

1. 2.2 Factor - product relationship

$Q = f\ (X_1/X_2\ \dots\dots X_n)$………………… (2)
Where is the $Q =$ output of fluted pumpkin
X_i is varied input of capital services
$X_2\ X_3 \dots\dots\dots..X_n$ are fixed amount of inputs
The singular concern of the factor product relationship is essentially that of the transformation of single factor into single product. For practical purpose, therefore the relevant short run production function will be of form
$Q = f(X_i)$ ………………... (1)
$\frac{\partial q}{\partial x} = f(x)$ - Marginal physical product (MPP)
$\frac{Q}{X} = \frac{f(x)}{X}$ – Average product (AP)
If we employ these two measures as the frame of reference, we can undertake a quantitative interpretation of the three stages of production.

1.2.3 Technical efficiency

Efficiency implies the realization of a production goal of output maximization without waste.
The producer production efficiency is of the ratio of observed output, cost or profit to potential output, minimum cost, or maximum profit that a producer can attain (Ferdushi, Abdulbasah-Kamil, Mustafa, and Baten, 2013). Consequently, agricultural sector policies are targeted at eliminating constraints to increased productive efficiency. These constraints among others include: high price and inadequate inputs such as fertilizer (manure), vegetable seeds, herbicides, insecticides, lack/ inadequate access to farm credits, land tenure, extension services, irrigation facilities and poor rural infrastructure, market failures and poor store facilities (Nwinya, Obienusi and Onouha, 2014). Farrell (1957) identified three types of efficiency namely: Technical Efficiency (TE): the ability of an entrepreneur to produce the maximum possible output from a given level inputs, or using the minimum feasible quantity of inputs in producing a given level of output.
Allocative/ Price Efficiency (AE): the ability of a technically efficient an entrepreneur to use inputs in proportions that minimize production costs at a given input price and
Economic Efficiency /Overall Efficiency (EE): an entrepreneur attained both technically and allocative efficiency.
Economists argument is the achievement of greater efficiency from scarce resources therefore, the need for firm's efficiency calculations. Parametric and nonparametric approaches were the two common approaches for estimation of efficiency in the literature. Parametric methods entail ordinary least square(OLS) and the stochastic frontier(SF) models that were components of classical regression estimation procedures (Aigner, Lovell and Schmidt, 1977; Rapu, 2016) unlike commonly used nonparametric approach; data envelopment analysis (DEA) first used by Charnes, Cooper and Rhodes (1978). Data envelopment analysis uses linear programming procedure as its estimation procedure.

2.0 METHODOLOGY

2.1 Sampling technique and sample Size

Multistage sampling technique was adopted for the study. In the first stage, the study purposively selected Ogbaru, Anambra west, Ihiala, Awka South, Idemili North and Anaocha Local Government Areas (LGAs). Enquiries from Anambra State Agricultural Development Program (ASADP, 2019) shows high dominance of organic farmers involve in fluted pumpkin production in these areas. In the second stage, three (3) villages were randomly selected from each LGA and in the third stage, snowball sampling was used to select ten (10) organic pumpkin farmers because the list of these farmers were not available. Total of thirty (30) farmers were sampled per LGA, in all, one hundred and eighty (180) were sampled. Structured questionnaire was used to collect data on farmers' characteristics, farm enterprises and farmers' challenges.

2.2 Analytical Framework

2.2.1 Measurement of Technical efficiency

The production function summarizes the conversion of inputs of land, labour, capital, management and water resources into outputs of goods and services and stipulates that technical relationship between inputs and output in a production process. Technical efficiency depicts ratio of output to the factor inputs Sadhu and Singh (1995; Owusu-Ansah Aneani, 2011)

The production function approach is commonly employed to examining the effect of physical inputs on output. A stochastic frontier model (Cobb-Douglas production function) is specified as Battese and Coelli, (1995; Owusu-Ansah Aneani, 2011)

Yi = Xi β_0 + e_i ……………….. (3)

Where,

Yi = output of Fluted pumpkin farmer

Xi = a (1 x k) vector of farm inputs (in natural logarithm)

β = a (k x 1) vector of parameters to be estimated

e_i error term = vi – ui

vi = the random variation in output (Yi) by factors beyond the control of the farmer examples are weather and natural disasters.

μi = the factors (within the farmer's control) that were responsible for his inefficiency example is management.

vi is assumed to be identically and independently distributed as N (0, δv^2) random variables, independent of ui which is truncated normally at zero. ui is independently, but not identically distributed. The technical inefficiency can only be estimated if and only if the efficiency effects are present. With the absence of one-sided error term in the production function then the model is an ordinary production function, that can only be estimated by Ordinary Least Squares (OLS) regression, but if ui is present it is justifiable to employ the stochastic frontier approach.

A Cobb-Douglas production function was fitted to the stochastic frontier production and estimated. The specified multiplicative production function was:

$Q = A.\ X1^{\beta1}.\ X2^{\beta2}.\ X3^{\beta3}.\ X4^{\beta4}.\ X5^{\beta5}.\ e$ ……………………………. (4)

The linear transformation of equation (4) by taking the natural logarithm of the two sides of the equation (4) to give equation (5).

In Q = β0 + β1 InX1 + β2 InX2 + β3 InX3 + β4 InX4 + β5 InX5 + β6 InX6 + e …………… (5)

Where:

Q_i = Fluted pumpkin output (Kg), X1 = farm size (X_i), Labour-man-days (X_2), organic fertilizer (X_3), Education in years (X_4) , Farming experience(X_5) and Harvesting rate(Counts) (X_6) farm size (X_i), Labour-man-days (X_2), price of organic fertilizer (X_3), Education in years (X_4) , Farming experience(X_5) and Harvesting rate(Counts) (X_6) farm size (X_i), Labour-man-days (X_2), price of organic fertilizer (X_3), Education in years (X_4) , Farming experience(X_5) and Harvesting rate(Counts) (X_6) βi = Parameters (elasticities) to be estimated; e = error term,

defined in equation (1). The technical efficiency of a firm is defined in terms of the observed output (Y_i) to the corresponding frontier output (Y_i*) given the available technology, that is, $TE = Y_i/Y_i*$ (Agom, Ohen, Itam, and Inyang, 2012; Rapu, 2016). In this study, a Cobb-Douglas function was fitted to the production function of the farmers using the Ordinary Least Square model. In this study, with the use of Cobb Douglas ordinary least square (OLS) was used to estimate resource use efficiency in organically produced fluted pumpkin among small holder farmers in Anambra state.

2.2.2 Economies of scale

Increase factors of production, implies a change in the scale of operations (economies of scale). This change in economies of scale would lead to one of these outcomes: For constant returns to scale, $\sum \beta xi$ = 1, implies that increasing all the inputs by a factor of *n*, will increase the output by a factor of *n*. For increasing returns to scale, $\sum \beta xi$ > 1, implies that increasing all the inputs by a factor of *n*, will increase the output by an amount greater than *n*. For decreasing returns to scale, $\sum \beta xi$ < 1 implies that increasing all the inputs by a factor of *n*, will increase the output by an amount less than *n*.

Estimation of allocative efficiency was done by the use of marginal analysis, the ratio of marginal value of product (MVP) and marginal factor cost (MFC). A ratio of each factor indicates an efficient utilization of resource provided its marginal value product (MVP) is equal to its marginal factor cost (MFC) (Sadhu, and Singh, 1995; Ogundari, 2008). MVPi = MFCi = Pxi efficiency utilization of resource was determined by the ratio of MVP to MFC of inputs from the estimated regression coefficients. The efficiency of resource utilization, r, was calculated as Onyenwaku, **(**1994),

r = MVP/MFC ……………………………………… (5)

when r = 1, implied efficient use of a resource; r > 1, implied underutilization; while r < 1, implied over utilization of resource. The values of MVP
and MFC were estimated as follows:

MVP = MPP. PQ
MPP = _Q/Xi
MPP = βi. Qm/Xmi
MFC = Pxi

Where,

r = efficiency ratio
MVP = marginal value product of input
MPP = marginal physical product
MFC = marginal factor cost
Pxi = Unit price of input Xi
Ym = mean value of output
Xmi = mean value of input considered
PQ = unit price of output
βi = output elasticities.

3.0 RESULTS AND DISCUSSIONS

Table 1 presented the result of the Ordinary Least Square (OLS) estimates of Cobb-Douglas production function. Estimation of the stochastic frontier model based on Cobb-Douglas production function failed due to the absence of the one-sided error term, μ_i, in the model. This is shown by sigma-squared (δ^2) and gamma (γ) that were statistically insignificant in (Table 3). Therefore, the ordinary least square model adequately estimated the data (Idiong 2007; Udoh and Etim, 2008; Owusu-Ansah Aneani, 2011).

Table 1: Ordinary Least Square (OLS) estimates of Cobb-Douglas production function

Variable	Coefficient	Standard Error
Intercept	1.24	0.33
Farm size (ha) X_1	0.03***	0.01
Labour(man-days) X_2	2.10***	0.17
Quantity of organic fertilizer (kg) X_3	0.31***	0.10
Education (Years) X_4	0.22	0.03
Farming experience (Years) X_5	0.16*	0.06
Harvesting rate (Counts) X_6	0.50	0.74
R	0.95	
R^2	0.93	
F Ratio	52.76	14.19***
Durbin-Watson	2.48	

**** Sig. at 10 % level, ** sig. at 5% level, ***sig. at 1% level***

Consequently, fluted pumpkin production function was estimated using the OLS regression analysis which is adequate. The F-test was statistically significant at the 1% level, this implied the existence of production function where all the independent variables jointly explained the variations in the output. The R-squared was 0.93, indicating 93% variation in the fluted pumpkin output was explained by the independent variables in the model. Durbin-Watson value of 2.48, it implies the absence of first order serial autocorrelation. Four explanatory variables out of six were significant. These were farm size (X_1), labour (X_2) and price of organic fertilizer (X_3) were statistically significant at the 1% level, but farming experience was statistically significant at the 10% level. education and harvesting rate were positive, but not significant. The equation is presented as: $Y=1.24+0.03\ln X_1+0.32\ln X_2+0.31\ln X_3+0.22\ln X_4+0.16 X_5+0.51 X_6$. The coefficients estimated the elasticity of fluted pumpkin output. For instance, a 1% increase in farm size, labour and organic fertilizer resulted in 3 %, 32 % and 31%, increase in fluted pumpkin output, respectively. All variables had positive relationship with output showed that as their quantity used increase, yield of fluted pumpkin will equally increase. The increased output is assumed to keep the costs and other inputs at their mean levels. Summation of the coefficients gave an estimated return to scale of 1.9 which was greater than one, this implies that as all the variables included were increased, there would be more than a single unit increase in yield (increasing returns to scale).

Table 2: Price Efficiency of Resource Utilization

Resource	MFC	MPP	MVP	Efficiency ratio
Farm size	5000	71.03	689.02	2.3×10^{-5}
Labour X_2 (man-days)	4000	221.02	773554.77	5.17×10^{-3}
Organic fertilizer X_3 /kg	4.31	0.05	3.30	0.77

***Price efficiency of resource utilization**:* The efficiency of resource utilization among farmers was presented in Table 2. The efficiency ratio compares the MVP with the MFC. This gives the opportunity cost of the input. Efficiency ratio of 1 implies efficient producers because the MVP is an indicator of what the use of an additional unit of the input will add to the output. An efficiency ratio of more than 1 implies overutilization, while a value of efficiency ratio less than 1 implies

underutilization. To ascertain if resources were efficiently utilized the marginal value products of land, labour and organic fertilizer were calculated and compared with their marginal factor products. The marginal value product of labour was less than its marginal factor product this showed that labour was under-utilized. This maybe because most of the producers were female, who pampered hired labour that were mostly men, so that they will be ready to work for them any other time their services are needed. Also, the enterprise is labour intensive, without mechanization, therefore the efficiency level is lowered. Equally, female farmers are not in control of the production resources, therefore, they are constrained in transforming the production efficiently. The use of labour for clearing, weed, irrigation and harvesting were inefficient-underutilization. Use of
additional unit of labour will increase the output than the cost of hiring the labour therefore, more labour should be hired since the producer stands to benefit more from additional units of the labour used. The marginal value product of land and organic fertilizer were equally less than their respective marginal factor products this implied that land and organic fertilizer were underutilized in the study area. The use of additional unit of these inputs will increase the output than the cost of the inputs. This agrees with the work of Hendrani Y., Nugraheni S., Karliya N., (2022). The results showed that producers were most efficient in the use of organic fertilizer.

Table 3 Maximum likelihood estimated parameters of the Cobb-Douglas function (stochastic production frontier)

Variable	Coefficient	Standard Error	T- value
Intercept	4.50	0.39	11.6
Ln Farm size β_1	0.45	0.10	4.56***
Ln labour β_2	0.30	0.09	3.33***
Ln Organic Fertilizer β_3	0.33	0.11	2.90***
Ln Weeding rate β_4	0.21	0.17	1.21
Ln Harvesting rate β_5	0.26	0.08	3.25***
Seed β_6	0.32	0.11	2.96***
Inefficiency functions			
Intercept	2.01		36.50
Age	-0.002	0.01	0.27
Farming experience	-0.67	1.0×10^{-3}	2.66
Education	0.03	5.9×10^{-3}	3.60
Sigma square (δ)	0.32	0.30	1.07
Gamma (γ)	0.53	0.91	0.59
Log-likelihood function	-28.592		
L R Value	0.08		
L R Statistic	3.5		

**** Significant at 10 % level, ** sig. at 5% level, ***sig. at 1% level.***

Technical efficiency of fluted pumpkin farmers: The maximum likelihood estimates of the parameters of the stochastic production frontier identified farm size, labour, organic fertilizer, weeding rate, harvesting rate and seed as important variables influencing technical inefficiency. The variance ratio (γ) = 0.53 indicate that farm specific factors contributed to the variation in yield. The (γ) value implies that majority of the total variation in output from the frontier is attributable to technical inefficiency. Fifty-three percent of the difference between the observed and maximum production frontier output were due to difference in producer technical efficiency. Most of the variation in yield was due to factors under the farmers control. To increase technical efficiency of farmers the influence of these variables should be reduced. That the sigma square value of 0.32 is not significantly different from zero signified that Ordinary Least Square (OLS) estimates is adequate for this analysis. The negative sign of the coefficient of inefficiency function implied that as farming experience and farmer's age increases the efficiency level of farmers improves, and that older farmers with enough farming experience were more efficient than young farmers that were just entering into the enterprise this corroborate the work of (Ayanwale, and Abiola, 2008). The positive sign of the coefficient of education implies that with increase in formal education in the efficiency level of farmers decreases. This implies that training is the most important factor rather than formal education. The inferences from these observations were that even the most efficient producer could improve efficiency by training on the job, availability of inputs and returning to improve the allocative efficiency.

CONCLUSION AND RECOMMENDATIONS

The role of organically produced vegetable in the nutrition and health of human cannot be over emphasized. It is therefore important that farmer's production should be efficiently done This study estimated resource use efficiency of organically produced fluted pumpkin in Anambra state, Nigeria. The findings revealed that the resources were inefficiently utilized; labour, land and organic fertilizer were underutilized in the study area. This study established that there is gaps in resource use efficiency in the production of organic fluted pumpkin. The follow recommendations were made to improve resource use efficiency:

i. Mechanization of the enterprise should be encouraged by stakeholders.
ii. Female farmers that were the main producers of fluted pumpkin should be able to access the required production resources through the agencies of government and other stakeholders.
iii. Increase land use intensity by farmers and reduce the long period of land fallowing during raining season because cultivation is majorly in water logged area that can be used only during the dry season.
iv. Notwithstanding the farmer's formal educational level, farmers should be taught better resource management practices to ensure optimal utilization of resources.

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Influence of Spent Mushroom Compost, Poultry Manure and their Combinations on Chemical Properties of a Loamy Clay Soil of Awka and *Telfairia* Leaf Yield.

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ABSTRACT

Mushroom domestication generates a huge quantity of organic waste, which if not properly handled could results in environmental hazard. A field trial was carried out at the Teaching and Research Farm of the Department of Soil Science and Land Resources Management, Nnamdi Azikiwe University, Awka to evaluate the influence of Spent Mushroom Compost (SMC) , Poultry Manure (PM) and their combinations (SMC + PM) on selected soil chemical properties , fresh and dry leaf yield of *Telfairia occidentalis* . The experiment was laid out in randomized complete block design with the treatments consisting of 10tSMC/ha, 10tPM/ha, 5tSMC +5tPM/ha, 7tSMC+ 3tPM/ha, 7tPM + 3tSMC/ha and a control, replicated three times. Soil samples were taken at 12 months after treatment application and analyzed for org.C, total N, available P, pH, exchangeable base and acid cations, while the cation exchange capacity (CEC) and percentage base saturation (BS) were calculated using standard procedures. The result showed positive significant effects of the treatments on the measured soil characteristics. Application 10tSMC /ha and 7tSMC+ 3tPM/ha resulted in a significantly ($P \geq 0.05$) higher soil pH, org. C. available P and exchangeable base and lower exchangeable acid cations, relative to the control and 7tPM +3tSMC/ ha treatments. While highest value of total N was recorded from the plots that had 10tPM/ha, followed by those that received 3tSMC +7tPM/ha. The highest fresh and dry leaf yield were recorded from the plots that had 10tSMC /ha followed by 7tSMC + 3tPM plots. The results suggest that SMC could be a good amendment for soil chemical fertility conservation under telfairia production in acid loamy clay soils.

Keywords: Mushroom domestication, organic waste, fresh and dry leaf yields

INTRODUCTION

Mushroom being a cheap source of rich protein and other food nourishments is in high demand in Nigeria in recent times. Efforts at overcoming the risks associated with its collection from the wild, seasonal availability and bridging the gap between demand and supply have necessitated the domestication and /or cultivation (Oyetayo, 2011).

The cultivation requires the use of substrates as a growth medium. Primarily, such substrates consist of agricultural or farm waste, which include but not limited to cereal straw, cotton waste, maize cob, coffee husk, palm bunches and saw dust (Li Xuemei, 2003). Upon the harvest of the mushroom, the substrates now referred to as Spent Mushroom Compost (Europe) or Spent mushroom substrate (America), constitutes a serious bulky waste, but rich in organic and inorganic nutrients (Li Qiansheng, 2006).

There are numerous report on the potentials mushroom compost waste as a soil amendment for sustainable production of annual crop China (He Guoxiang, 2006) and Netherlands(Oei et al,. 2007) However, the effect varies due to high lignin and cellulose content and cultivated specie (Jay Holcomb , 2006). Mushroom compost waste possesses many beneficial characteristics including a relatively low bulk density, a low level of heavy metals and an absence of plant pathogens and weed seeds relative to some other sources of organic manure (Wang Meiqin, 2006)

Telfaria occidentallis is a leafy vegetable of cucurbitaceae family which is used in Nigeria for both culinary and medicinal purposes (Aderi *et al.*, 2011). The leave is very nutritious and among the most favorite vegetable for many Nigerians due to its high minerals and vitamin content (Akang *et al.*, 2010, Adegunwa, *et al.*, 2014.). The crop requires soil with high level of organic matter for optimum fruit and leave yield (Okore and Ogidi, 2013).

Generally, the crop is fertilized with poultry manure, especially in home gardens. Poultry manure are known for its high nutrient content and fast release compared to most common sources manure in Nigeria (Mba and Mbagwu, 2006). However, due its fast decomposition and mineralization; nutrient releases are not often synchronized with uptake by plants (Okonkwo et al. 2009), especially among long gestation annual crops production.(Okonkwo et al. 2009), which may include telfaria , if seed production is among the targets.

With evidence of spent mushroom compost being an excellent source of phosphorus (P), potassium (K) and trace elements but needs supplementation with nitrogen (N) for sustainable crop production and soil fertility maintenance (Tien- chih and San-Hsien, 1993), the objective this to study is evaluate the response of soil chemical properties and growth and yield characteristics telfaria *occidentalis* to application mushroom compost waste, relative to poultry manure and their combinations.

MATERIALS AND METHODS

Description of experimental site and Design:

The study was conducted at the Teaching and Research Farm of the Department of Soil Science and Land Resources Management, Nnamdi Azikiwe University, Awka. It lies within Latitude 62488°N and Longitude 7.18289°E. The area is characterized by a mean annual rainfall of 1828mm, maximum and minimum temperature of 32°C and 24°C respectively, and a relative humidity of 75-85% on the average of the dry season and raining season with general lower evapotranspiration. The soils are described as Imo Shales formation, characterized by thick clay shales and fine textured surfaces (Nwajide and Reijer. 1996).

The experiment consists of the following treatments: 10t/ha Spent Mushroom Compost (SMC), 10t/ha Poultry Manure (PM), 5t/ha SMC + 5t/ha PM., 7t/ha SMC +3t/ha PM, 3t/haSMC+7.t/ha PM, and a Control; laid-out in randomized complete block design in three replications. Each experimental unit measured 4X4 m with the test crop planted at the spacing of 1X1m 14 day after treatment application.

The spent mushroom compost (SMC) used for the study was obtained from Bio-resource Development Centre mushroom unit Odi, Bayelsa State Nigeria. It was formulated with standard sawdust, empty palm bunch, white lime, rice bran, wheat bran, and used to grow oyster mushroom .(*Pleurotus* spp.) After three mushroom harvests, the fresh SMC was collected from the mushroom houses and kept outside in a pit and covered for two to four months for further composting. While, poultry manure (battery cage) was sourced from Odumegwu Ojukwu University, Igbariam, and poultry farm. Both the SMC and PM were air dried at room temperature for seven days before application.

Data collection:

Two grams (2g) each of the air-dried SMC and PM were crushed and passed through 2mm sieve and analyzed for total N , P, K Ca ,Mg and org.C contents as described by Okalebo et al.(1993) . .

Pre – and post (12 months after) treatment application soil samples were collected at the depth 0-20cm, processed and analyzed for particle size distribution using the hydrometer method (Klute, 1986), total N (Micro Kjeldahl digestion) , org.C (dichromate oxidation) , Bray^{1}P , exchangeable bases cations (Ca^{2+}, Mg^{2+}, K^+ and Na^+) using 1 N NH_4OAC extractant and total exchangeable acid cations (H^+ and Al^{3+}) using 1N KCl (Page *et al.*, 1982). pH was determine both in water and KCl at 1:2.5 (w/v ratio).

The fresh and dry leaf yield response were determined at monthly intervals.

Data analysis:

The data generated from the experiment were subjected to Analysis of Variance (ANOVA) using GenStat Release 10.3DE. Where significantly different, the Means were compared using LSD test ($p \leq 0.05$)

RESULTS AND DISCUSSION

Chemical Composition of Soil, Poultry Manure and Spent Mushroom Compost Used:

The chemical composition of the soil, poultry manure and spent mushroom compost is shown in Table 1. Before treatment application the soil was strongly acid with low organic matter content. However, the available P (Bray-1) content was moderate, while the exchangeable bases (Ca^{2+}, Mg^{2+} and K^+) were very low. These chemical characteristics of the soil are within range reported by FDALR (1999) for typical rainforest Ultisol under anthropogenic influence.

Percentage total N content of the poultry manure was about 35% higher than that of the SMC, but the reverse was the case with their percentage Org. C content. Thus having parallel C:N ration as reported by Xiao Shenggany, (2005) . Except for Ca, the SMC had more mineral nutrients than the PM (Table 1). This result is in line with report of He Guoxiang who observed that the nutrient content SMC is highly influenced by the materials composition.

Effect of treatments on the soil pH, total N, Org.C and available P.

The effect of the treatment on the soil pH, total N, org.C and available P is shown on Table 2. Application of PM and SMC either singly or in combination significantly ($P \leq 0.05$) affected these parameters, relative to the control. The highest pH values were recorded from soils that received 10tSMC/ha, followed by those PM at similar rate. These values were significantly different from those of other treatments. The higher pH values obtained with the single applications at similar rate relative to the combined applications, could be ascribed to complexity of the quality of the mixtures. Okore *et al.* (2015) made similar observation.

Table 1: Chemical composition of the poultry manure, mushroom compost waste and soil used for the study

Soil Properties	Values	Poultry manure properties	Values (%)	Spent Mushroom Compost	Values (%)
Total Nitrogen	0.08%	N	3.89	N	2.38
Soil Organic Carbon	0.95%	Organic Carbon	1.77	Organic Carbon	2.93
Av. P	18.32 (mg/kg)	P	1.44	P	0.59
EXCHANGEABLE CATIONS (cmol/kg)					
Ca^{2+}	3.20	Ca	0.80	Ca	1.49
Mg^{2+}	1.02	Mg	0.32	Mg	0.68
K^{+}	0.27	K	2.18	K	3.45
Na^{+}	0.20	-	-	-	-
Al^{3+}	0.36	-	-	-	-
H^{+}	0.56	-	-	-	-
pH(H2O)	5.23	-	-	-	-

with single and combined application poultry manure and defatted palm kernel cake in a sandy loam ultisol of south eastern Nigeria.

Org.C and available P values mirrored those of the pH. The maximum Org.C and available P values were obtained from plots that single application of 10tSMC (2.01% C and 21.98mg/kg P) and a combination of 7tSMC/ha and 3tPM/ha (1.79% C and 21.37mg/kg P). The values were significantly higher than those of the plots that received 10tPM /ha alone and 3tSMC + 7tPM/ ha. However, the reverse was the case with total N values, with application of PM at 10t/ha giving the highest values. The higher values of Soil organic C SMC treated plots relative to the PM treated ones, is reflection of composition of org. C in the applied material as reported by. (Maher, 1994). Higher values of available P in SMC amended soils could be attributed to the higher P in soil pH and low total exchangeable acid cation in that plot.

Table 2: Effects of poultry manure (PM), Spent Mushroom Compost (SMC) and their combinations on the pH, total N, Org. C and available P, 12 months after application, relative to the control

Treatments	pH (H2O)	pH (HCl)	Total N	0rg.C	AV. P (mg/kg)
			(%)		
10tSMC/ha	6.22	5.63	0.17	2.01	21.98
10tPM/ha	6.06	5.17	0.20	1.71	20.63
5tPM+5t SMC/ha	6.01	5.10	0.18	1.77	20.17
3tSMC+7tPM/ha	5.89	4.97	0.19	1.62	20.23
7tSMC+3tpm/ha	6.15	5.20	0.18	1.79	21.37
Control (No amendment)	4.93	3.90	0.08	0.65	14.77
LSD (0.05)	0.20	0.39	0.01	0.13	0.89

Effect of the treatments on the Soil Exchangeable Base and Acid Cations:

As shown in Table 3, the treatment on the soil exchangeable base cations differed significantly with the plots that had 10tSMC/ha and 3tPM + 7tSMC/ha giving the highest values in that order. These were followed by the plots that received a combination of the amendments at ratio of 1:1 (5tSMC+5tPM/ha) . This report is line with report of Wang Meiqin (2006), who observed higher values of inorganic nutrient upon the application SMC relative other organic inputs. However, the reverse was the case exchangeable acid cations (Al^{3+} and H^{+}) with the lowest values being recorded from plots that had 10tSMC/ha and combination of SMC and PM (7t +3t/ ha in that order). The effect of these treatments on the soil exchangeable base and acid cations could be attributed to is high organic matter content of the applied material. Okore (2003) reported on the positive and negative correlation between organic matter and exchangeable base and acid cations respectively.

Table 3: Effects of spent mushroom compost (SMC), poultry manure (PM) and their combinations on the soil base and acid cation, CEC (Cmol/kg) and Base Saturation (%)

;TREATMENTS	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	Al^{3+}	H^{+}	BS%	CEC
10t/ha SMC	8.07	4.20	0.55	0.46	0.17	0.46	95.44	10.57
10t/ha PM	7.60	3.23	0.63	0.43	0.19	0.53	94.29	12.61
5tPM+5tSMC/ha	8.17	3.77	0.57	0.37	0.26	0.58	93.75	13.45
3tSMC+7tPM/ha	7.33	0.73	0.19	0.21	0.25	0.55	93.44	12.36
7tSMC+3tPM/ha	8.07	3.23	0.59	0.41	0.24	0.54	94.25	13.82
Control (No Amendment)	2.73	0.73	0.19	0.21	0.66	0.55	76.10	5.08
LSD (0. 05)	0.49	3.97	0.56	0.42	0.06	0.03	0.76	3.68

Telfaira Fresh and dry leaf yield response to Spent Mushroom Compost, Poultry Manure and their combinations:

The yield (fresh and dry leaf weight) response of the test crop – *Telfaira occidentaallis* to the applied treatments at 2 and 3 after application is shown in Table 4. At two months after application, the yield

Table 4: Fresh and dry leaf yield (g/ Stand) response of *Telfaira occidentallis at* 2 and 3 months after treatment application (MAP)

Treatments	fresh	dry	fresh	Dry
10tSMC/ha	420	63.40	1760	234.40
10tPM/ha	450	77.20	1660	219.20
5tPM+5tSMC/ha	350	35.10	1610	219.70
7tPM+3SMC/ha	300	68.90	1570	209.60
3PM+7SMC/ha	400	54.00	1540	209.70
Control	250	51.70	1150	187.10
LSD (0.05)	Ns	Ns	181	242.10

differences amongst the treatments did not differ significantly, although the plots that had higher values were those that received 10tPM/ha. Amongst the treatments, significant differences were recorded in these parameters at three months after application with the highest values coming from the plots that had SMC at the rate 10t/ha. This was followed by those that had a combination of 7tSMC and 3tPM/ha.

The higher yields obtained from 10tPM/ha treated plots at 2 months after application, relative other treatments could be attributed to quick nutrient release resulting from its narrow C:N ratio compared to the SMC (Table 1). By the third month, the C in SMC may have reduced through microbial activities, thus resulting to nutrient release that may resulted to the higher yields. This observation is in line with the report of (Ndor *et al.*, 2013).

CONCLUSION:

Generally, the result of this study showed the positive effect of SMC on soil nutrient restoration and conservation under telfaira production in an acid soil. Application of 10tSMC and its combination with PM at the rate of 7SMC and 3PM/ ha out performed every other treatment in terms crop yield and soil fertility improvement. Thus, could be recommended as suitable rates when compared to PM.

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