

Organic Production of Pepper as Influence by Variety Grown in Makurdi, Benue State, Nigeria

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Abstract

The experiment aimed to investigate the effect of variety and organic nutrients on the growth and yield of pepper grown in Makurdi, Nigeria. The experiment is laid in a complete randomized design with three replications. The treatments used are variety (Red and Green pepper) and organic nutrient source (cow dung, poultry dropping, goat manure and control) the experiment was carried out during the 2023 rainy season. During the investigation, some physiological variables, such as growth, Plant height (cm), Numbers of leaves, Numbers of branches, Other characteristics like Days to first flowering, Number of flowers, Days to first, Number of fruits, Fruit length (cm), Fruits weight/plant (g), Fruits diameter (mm) and overall yield were also recorded. The results of the investigation revealed that pepper generally responded to both variety and organic nutrient. All the parameter studies have significantly ($P \leq 0.05$) responded to the variety with Bell pepper recorded higher in growth parameters and such, as plant height (19.53), the number of leaves (37.73), number of flowers (16.02), number of branches (8.83), with yellow Wanda variety recorded higher days to maturity (48.52), bell pepper also recorded higher number of fruits per plant (12.63), fruit diameter (6.00), fruit length (7.62), fruit weight (72.62g) and over all yield (4.31). On organic nutrient source poultry dropping recorded higher in both growth, yield and yield related characters such as plant height (20.19), number of leaves (40.82), number of branches (8.68), number of flower (17.13), except where control recorded longer maturity days (48.22), while Bell pepper recorded higher in number of fruits per plant (13.12), fruit diameter (6.00), fruit length (6.84), fruit weight (92.41) and over all yield (4.02). Based on the results obtained it can be suggested that pepper farmers use bell variety of pepper and poultry dropping which is better in both growth and yield characteristics leading to optimum yield in pepper cultivation in the study areas.

Keywords: *Pepper, Nutrient, Organic sources and Variety*

Introduction

Sweet pepper popularly known as “King of spices” belongs to family Solanaceae. Beside its value as spice, it has many medicinal properties which are yet to be fully exploited. Sweet pepper is known for its pungency and fascinating natural red or yellow colour. Shafeek et al. (2012) stated that, sweet pepper is being used in food and beverage industries for its oleoresin which imparts characteristic color and flavors to food. Also, maximizing pepper productivity is a crucial goal for farmers, and nutrient management plays a vital role in achieving optimal yields. The cultivation of pepper (*Capsicum annum*) is of great economic significance due to their high demand in the global market and their versatile culinary uses (Smith et al., 2022). According to

Bosland and Votava (2000), pepper production has increased worldwide and this could be ascribed partly to its high nutritional value. As explained by Grubben and Tahir (2004), Food and Agriculture Organization (FAO) statistics estimated world production of Capsicum peppers in 2001 at 21.3 million tonnes from a harvested area of 1.6 million ha (that is, an average yield of 13.4t/ha). The Central Statistical Authority (2005) reported the world average yield of pepper to be 3.75 t/ha. Comparatively, yield in the developing countries is about 10 – 30% of that in developed countries (Grubben and Tahir, 2004). In Nigeria, pepper is known to be the second most cultivated vegetable (Abu et al., 2020), which account almost half of African production (Ayo-John and Oderara, 2017; Mustapha et al., 2015) and its average consumption per person per day is about 20% (Ogunbo et al., 2015). In combination with other agricultural produces, almost 70% of farmers and traders depend on pepper for food security, income generation and employment (World Bank 2017; Opata et al., 2020).

Due to the necessity of pepper in human life, attention has to be drawn to increasing the level of production with functioning market system. The choice of nutrient sources significantly impacts plant growth, development, and fruit production. Nutrition play an important role in the growth and development of any crop including capsicum, because it is known to exhibit positive response to the application of nitrogenous, phosphoric and potassium fertilizers and fertilization is one of the major factors of crop production (Satyanarayana et al., 2002). Application of organic manures to soil not only improves the physical properties but also increases the availability of nutrients. It supplies the plant nutrients including micronutrients to increases the yield of crop (Saravaiya, 2010). To enhance maximal production of vegetable, it is important to use good fertilizers with appropriate nutrients composition. Mathowa et al. (2016) reported that, a variety of fertilizers from different sources are used in the production of vegetables worldwide. Some are natural in origin and others are produced artificially in factories (Olle et al., 2012; Bhat et al., 2013). Although soil nutrients has been reported to be the basic and fundamental determinant in the production and yield of sweet pepper as nutrients deficiency is practically seeing even at early stage of development. Biondo and Noland (2000) stated that, the selected fertilizer should have sufficient nutrient that will stimulate fast growth and high yield. The fertilizer sources should be cheaper and provide a better environment that is not harmful to the crops and environmental friendly. The choice of fertilizer use in sweet pepper production is also largely influenced by costs which may not be a suitable assessment tool for pepper production (Oagile et al., 2016). Pepper, scientifically known as Capsicum, is a diverse and widely cultivated vegetable known for its characteristic pungent flavor. There are numerous varieties of peppers, each offering a unique taste, color, and level of heat. These variations make peppers a versatile ingredient in culinary traditions around the world. It's important to note that the heat level of peppers is measured on the Scoville scale, with higher numbers indicating greater spiciness.

The diversity of pepper varieties allows for a wide range of culinary applications, catering to various taste preferences and cultural cuisines. Whether you're looking to add a mild sweetness or intense heat to your dishes, there's likely a pepper variety that fits the bill. Most varieties are cultivated based on consumer preference and adoptability to cultivating environment FAO (2021). The main objective of the work is to determine the effects of different nutrients sources on the growth and yield of pepper, to determine the effects of variety as influence by organic sources

Materials and Methods

The experiment was carried in the research and teaching farm of Joseph Sarwua Tarka University Makurdi is Located at (Latitude 7°49N, Altitude 07°52N and Longitude 08°36E).The experiment

seeks to investigate the effect of variety and organic nutrients on the growth and yield of pepper at Makurdi, Benue state, a factorial experiment was set out. The treatments used were variety of pepper (Bell pepper and Yellow wander) and Organic manure sources Poultry dropping was applied at the rate of 20 tones/ha and poultry dropping (15t/ha) (100% Dry Matter, Organic Material 55%, Total Nitrogen 6.2%, Total Phosphorus 2.01% and Total Potassium 2.12%), Goat manure (15t/ha) (Dry matter 52%, Organic Material 31%, Total Nitrogen 4.5%, Total Phosphorus 1.0% and Total Potassium 1.3%), and compost(15t/ha) (Dry matter 32%, Organic Material 20%, Total Nitrogen 18.0%, Total Phosphorus 0.9% and Total Potassium 1.2%). All the organic manure are kept under intensive care and was allowed to undergo partial decomposition for three months following the recommendation of Bello (2015) before it was used for the experiment. During the investigation, some physiological variables, such as plant height as taken (with the aid of measuring tape from the base of the plant to the tip), number of leaves (were counted), number of branches (were counted) were measured. Other characteristics like number of flowers (were counted), number of 50% flowering (were counted from flower initiation to last flower), fruits weight (with digital weighing scale), fruits length (measured with a ruler), fruit diameter (measured with a vainer calliper) and over-all yield (converted to t/ha) were also recorded. The results of the investigation revealed that pepper responded to variety and nutrient sources in both growth and yield parameters. All the parameters studied significantly ($P \leq 0.05$) responded to variety with bell pepper recorded high in plant height, number of leaves, recorded higher number of fruits, days to 50% flowering, fruit length, fruits diameter, fruit weight and over-all yield on nutrient source with poultry dropping been superior in both growth and yield-related characters such as plant height, the number of leaves, number of branches, number of fruits, days to 50% flowering, fruit length, fruits diameter, fruit weight and over-all yield The experiment was laid in a randomized complete block design (RCBD) with three replications; a 4m² plot was laid out with 1m between plots and 1m between blocks. There were 10 plots each within a block which gave the total number of 30 plots for the study, an inter-row and intra-row spacing of 15cm x 80cm was adopted for the research., Weeding was done manually at 2 and 6 weeks after transplanting to ensure weed free plots with the aid of simple hoe, all the data were collected within the net plot of 4m², where a total of 3 plants were tagged for data collection within each net plot All data collected were subjected to Analysis of Variance (ANOVA) Genstat version 17, while least significant difference (LSD) at 5% level of probability was used in separating the mean

Result and Discursion

Table 1: Effect of Variety and nutrient source on plant height of pepper grown in Makurdi, Nigeria

Variety (V)	Weeks after transplanting (WAT)			
	2	4	6	8
Bell pepper	4.23	6.72	11.53	19.53
Yellow wander	3.14	7.02	13.82	17.62
F-LSD (0.05)	1.02	1.00	1.13	2.03
Organic nutrient (O)				
Cow dung	3.43	7.73	12.51	18.83
Poultry dropping	4.62	10.63	16.73	20.91
Goat manure	3.00	8.12	14.34	19.11
Control	2.30	5.53	8.12	14.62

F-LSD (0.05)	0.28	1.11	2.23	1.24
Interaction				
VXO	NS	NS	NS	NS

LSD= Least Significant Differences at 5% Level of Probability, * = 95% level of probability

Table 1 study investigates the impact of variety and nutrient source on the plant height of peppers cultivated in Makurdi, Nigeria. Two varieties, namely Bell pepper and Yellow wander, were subjected to different nutrient sources (Cow dung, Poultry dropping, Goat manure and Control) at 2, 4, 6, and 8 weeks after transplanting (WAT). The results revealed that both variety and nutrient source significantly influenced plant height. bell pepper generally exhibited greater heights compared to Yellow wander, with values ranging from 4.23 to 19.53 at different weeks; this variability could be attributed to the plant inherent traits, this is in conformity with the finding of Madina et al (2024) who stated that genetic make-up influence vegetative growth in most plant, he added that cultural practice, spacing (plant population) can also lead to teller plants as they strife for solar radiation.

Among nutrient sources, Poultry dropping consistently promoted the tallest plants, reaching up to 20.91 at 8 WAT. This is true due to its ability to contain various nutrient elements that is need for plant growth, this work agrees with Eche et al., (2020) who linked his finding for plant growth to various nutrient elements in poultry dropping leading to taller plants, he added that other factors that may influence plant height is solar radiation and spacing he added that poultry dropping releases it nutrient fast and through-out the plant cycle in the field, he added that residual effects could be experience if plant are planted in the same land in subsequent year. The findings provide valuable insights into the cultivation practices for enhancing pepper plant growth in the specific agro-climatic conditions of Makurdi, Nigeria.

Table 2: Effect of Variety and nutrient source on number of leaves of pepper grown in Makurdi, Nigeria

	Weeks after transplanting (WAT)			
	2	4	6	8
Variety (V)				
Bell pepper	4.13	10.02	17.72	37.73
Yellow wander	3.04	8.12	14.22	33.64
F-LSD (0.05)	1.00	1.20	1.13	2.03
Organic nutrient (O)				
Cow dung	4.03	8.83	19.92	36.43
Poultry dropping	5.02	12.13	26.74	40.82
Goat manure	4.83	9.21	22.23	38.71
Control	3.30	6.89	12.82	24.93
F-LSD (0.05)	0.31	1.21	2.81	2.36
Interaction				
VXO	NS	NS	NS	NS

LSD= Least Significant Differences at 5% Level of Probability, * = 95% level of probability

Table 2 study investigates the influence of pepper variety and nutrient source on the number of leaves in plants cultivated in Makurdi, Nigeria. Two pepper varieties, Bell pepper and Yellow wander, were subjected to different nutrient sources (Cow dung, Goat manure Poultry dropping, and Control) at 2, 4, 6, and 8 weeks after transplanting (WAT). The results demonstrated a

significant impact of both variety and nutrient source on the number of leaves. Bell pepper consistently exhibited a higher leaf count compared to Yellow wander, with values ranging from 4.13 to 37.73 across different weeks. Poultry dropping emerged as the most effective nutrient source, promoting the maximum number of leaves (40.82) at 8 WAT. The results reveal distinct patterns in leaf development influenced by variety as reported by Danlingi et al., (2022) he added that variation could be varietal and environmental. These findings provide valuable insights into optimizing cultivation practices for enhancing leaf development in pepper plants under the specific agro-climatic conditions of Makurdi, Nigeria.

In the context of pepper cultivation in Makurdi, Nigeria, this research explores the effects of nutrient sources (Cow dung, Goat manure Poultry dropping, and Control) and pepper varieties (Bell pepper and Yellow wander) on the number of leaves at 2, 4, 6, and 8 weeks after transplanting (WAT). The study revealed significant variations in leaf count influenced by both variety and nutrient source. Notably, Bell pepper consistently exhibited a higher number of leaves compared to Yellow wander, reaching a maximum of 37.73 at 8 WAT. Poultry dropping emerged as the most effective nutrient source, fostering the highest number of leaves (40.82) at 8 WAT. Poultry dropping consistently outperformed other organic source, which could be as result of fast mineralization, nutrient release and also ability of the plant to absorb and utilized the nutrient for leaf initiation this work is not a par with the work of Thangarajan et al., (2013) who recorded same on his work on tomatoes, time-dependent effects also shows that number of leaves generally increased as the weeks progressed, indicating a positive correlation between time and leaf development. The interaction between variety and nutrient source did not yield significant effects on the number of leaves. These findings contribute to optimizing agricultural practices for pepper cultivation, emphasizing the importance of nutrient selection for enhanced leaf development in the region

Table 3: Effect of Variety and nutrient source on number of branches of pepper grown in Makurdi, Nigeria

	Weeks after transplanting (WAT)		
	4	6	8
Variety (V)			
Bell pepper	3.12	8.72	8.83
Yellow wander	2.22	6.22	7.14
F-LSD (0.05)	1.21	1.03	1.01
Organic nutrient (O)			
Cow dung	2.00	6.92	7.63
Poultry dropping	3.65	7.74	8.62
Goat manure	2.34	5.00	6.21
Control	1.20	3.82	4.13
F-LSD (0.05)	0.11	1.01	1.16
Interaction			
VXO	NS	NS	NS

LSD= Least Significant Differences at 5% Level of Probability, * = 95% level of probability

Table 3 investigates the impact of pepper variety and nutrient source on the number of branches in plants cultivated in Makurdi, Nigeria. Bell pepper and Yellow wander varieties were subjected

to different nutrient sources (Cow dung, Poultry dropping, Goat manure and Control) at 4, 6, and 8 weeks after transplanting (WAT). The results indicated significant effects of both variety and nutrient source on the number of branches. Bell pepper consistently displayed fewer branches compared to Yellow wander across different weeks, with values ranging from 2.12 to 7.83. Among nutrient sources, Control exhibited the lowest number of branches, while NPK and Poultry dropping contributed to increased branch development. These findings provide insights into optimizing cultivation practices for pepper plants, emphasizing the importance of nutrient management for enhanced branch formation in the specific agro-climatic conditions of Makurdi, Nigeria.

In the context of pepper cultivation in Makurdi, Nigeria, this study explores the effects of nutrient sources (Cow dung, Poultry dropping, Goat manure and Control) and pepper varieties (Bell pepper and Yellow wander) on the number of branches at 4, 6, and 8 weeks after transplanting (WAT). The results revealed significant variations in the number of branches influenced by both variety and nutrient source. Notably, Bell pepper consistently displayed a higher number of branches compared to Yellow wander, with values ranging from 3.22 to 8.14 across different weeks. Poultry dropping contributed to increased branch development, with Control exhibiting the lowest number of branches these finding collaborate with the findings of Yusuf and Paul (2018) who reported same trend in his work on ginger he added that beside fast release of nutrient in poultry dropping it has ability to improve soil organic matter, binding soil colloids for sustainable cultivation of crops The interaction between variety and nutrient source did not yield significant effects on the number of branches. These findings contribute to optimizing agricultural practices for pepper cultivation, highlighting the importance of nutrient management for enhanced branch development in the region.

Table 4: Effect of Variety and nutrient source on number of flowers, days to maturity, and number of fruits per plant of pepper grown in Makurdi, Nigeria

Variety (V)	Number of flowers	Days to maturity	Number of fruits/plant
Bell pepper	16.02	36.12	12.63
Yellow wander	13.12	48.52	10.04
F-LSD (0.05)	1.10	10.13	2.01
Organic nutrient (O)			
Cow dung	13.83	45.42	10.62
Poultry dropping	17.13	38.14	13.12
Goat manure	15.12	40.32	12.23
Control	10.89	48.22	7.23
F-LSD (0.05)	2.21	2.02	1.16
Interaction			
VXO	NS	NS	*

LSD= Least Significant Differences at 5% Level of Probability, * = 95% level of probability

This research investigates the impact of pepper variety and nutrient source on crucial growth parameters, including the number of flowers, days to maturity, and number of fruits per plant, in Makurdi, Nigeria. Bell pepper and Yellow wander varieties were subjected to different nutrient sources (Cow dung, Poultry dropping, Goat manure and Control). The results revealed

significant differences in these growth parameters influenced by both variety and nutrient source. Bell pepper consistently exhibited higher numbers of flowers (16.02), shorter days to maturity (36.12), and a slightly higher in number of fruits per plant (9.63) compared to Yellow wander, this variability could be as result of genetic make which agrees with the work of Ravindra, et al (2020) who reported that poultry droppings have ability to release the needed nutrient fast and consistently at every stage of growth, development and initiating rhizomes production Akinyemi et al., (2024) who reported that variation in crops of the same species in yield and yield related characters is mostly influenced by genetic make-up and the ability of the plant to adopt to the growing environment, in contracts Esang et al., (2022) reported that increase in yield and yield related characters is mostly influence by cultural practices and timely planting

Among nutrient sources, poultry dropping contributed to the highest number of flowers and days to maturity and maximum number of fruits per plant (13.12). this is not far from the facts that poultry dropping release their nutrient faster and through-out the crop growth cycle, this finding collaborate with the work of Madina et al., (2023) who stated that high nitric acid which is utilized for photosynthetic activities in plants with good cultural practice and optimum climatic conditions could lead over all yield. This study emphasizes the need to use poultry nutrient sources on crucial yield-related parameters. Iyough, et al., (2024) stated that manure obtained from birds have high amount of nitric acid which is high in nitrogen when compared with other manure obtained from other animals, he added that poultry dropping have ability to activate some trace element in the soil for plant utilization. These findings provide valuable insights into optimizing cultivation practices for pepper plants, considering both variety and nutrient management, in the specific agro-climatic conditions of Makurdi, Nigeria.

Table 5: Effect of Variety and nutrient source on fruits diameter, fruit length, fruits weight and over all yield of pepper grown in Makurdi, Nigeria

Variety (V)	Fruit diameter (cm)	Fruits length (cm)	Fruits weight (g)	Yield (t/ha)
Bell pepper	6.00	7.62	72.63	4.31
Yellow wander	5.12	6.82	69.04	3.00
F-LSD (0.05)	1.10	1.03	1.00	1.21
Organic nutrient (O)				
Cow dung	5.03	5.22	80.12	2.82
Poultry dropping	6.00	6.84	92.42	4.02
Goat manure	5.43	5.76	85.21	3.31
Control	3.89	4.32	70.02	1.05
F-LSD (0.05)	0.11	0.22	2.65	0.10
Interaction				
VXN	NS	NS	*	*

LSD= Least Significant Differences at 5% Level of Probability, * = 95% level of probability

Table 5 is the effect of variety and nutrient source on fruits diameter, fruit length, fruits weight and over all yield of pepper grown in Makurdi, Nigeria In this context, the study investigates the impact of nutrient sources (Cow dung, Poultry dropping, Goat manure and Control) and pepper varieties (Bell pepper and Yellow wander) on crucial fruit characteristics and overall yield. Significant variations were observed in fruit diameter, fruit length, fruit weight, and overall yield

influenced by both variety and nutrient source. Bell pepper consistently displayed larger fruit diameter (6.00 cm), length (7.62 cm), fruit weight (72.62g) and overall yield (4.31) t/ha). This could be attributed to genetic make-up as reported in the finding FAO (2021) who reported that most varieties are cultivated based on consumer preference and adoptability to cultivating environment they also attributed variation in yield and yield related characters to genetic make-up, acclimatization to environmental factors and cultural practice

On organic nutrients source the use of poultry dropping emerged as the most effective nutrient source, contributing to the highest values for fruit diameter (6.00 cm), fruit length (6.84 cm), fruit weight (92.42 g), and overall yield (4.02 t/ha) and control recording the least. This finding is in conformity with the work of (Saravaiya, 2010) who stated that the application of organic manures to soil not only improves the physical properties but also increases the availability of nutrients. It supplies the plant nutrients including micronutrients to increases the yield of crop Madina et al., (2022) who stated that poultry dropping have ability to release its nutrient faster than other nutrient source leading to increase on vegetative stage of plant and overall yield, with these result Nazifi et al (2023) reported that most organic nutrient source may contain all the needed nutrients for plant growth and yield its release is slow but its release is all through the planting season. Rokonuzzaman (2017) reported that nutrient plays a very important role in both growth, reproductive and yield parameters of plants he added that nutrients gotten from organic source release their nutrient through-out the crop life cycle, improving crop yield and soil organic matter. On the contrary Madina et al. (2021) reported that dung site nutrients recorded the highest in both growths and reproductive characteristics attributing to the fast release of nutrients to plants throughout the growing season, Vishal et al., (2014) also added that poultry dropping affects pepper reproductive stage positively due to nitric acid availability which translate to reproduction and yield characters, this poultry dropping could be needed in appreciable quantity at the growing stage and also reproductive stage.

The interaction between variety and nutrient source had a notable effect on overall yield and fruit weight. These findings contribute to optimizing agricultural practices for pepper cultivation, emphasizing the importance of variety and nutrient selection for specific fruit characteristics and overall yield in the region.

Table 6: interaction between variety and nutrient source on number of fruits per plant, fruit weight and fruit yield of pepper grown in Makurdi, Nigeria.

	Number of fruits/plant			
	Cow dung	Poultry dropping	Goat manure	Control
Bell pepper	10.89	12.13	11.12	7.13
Yellow wander	9.08	11.53	10.93	6.30
F-LSD (0.05)	1.28	1.12	1.03	1.05
	Fruit weight			
Bell pepper	77.75	95.42	90.87	70.13
Yellow wander	72.93	87.13	82.23	67.81
F-LSD (0.05)	2.12	5.13	6.01	2.19
	Fruit yield			
Bell pepper	3.02	4.55	4.01	1.95
Yellow wander	2.56	3.12	3.00	1.21
F-LSD (0.05)	1.11	1.06	1.07	0.33

LSD= Least Significant Differences at 5% Level of Probability, * = 95% level of probability

Table 6 is the interaction between variety and nutrient source on number of fruits per plant, fruit weight and fruit yield of pepper grown in Makurdi, Nigeria, this research focuses on the interactive effects of pepper variety and nutrient source on critical parameters, including the number of fruits per plant, fruit weight, and overall fruit yield in Makurdi, Nigeria. Two pepper varieties, Bell pepper and Yellow wander, were cultivated using different nutrient sources (cow dung, Poultry dropping, goat manure and Control). The results highlighted significant interactions between variety and nutrient source across all measured parameters. Bell pepper consistently exhibited higher numbers of fruits per plant, greater fruit weights, and increased overall fruit yield compared to Yellow wander under all nutrient conditions which could be linked to the facts that genetic make-up and readily available nutrient might have caused the variation, this result is in agreement with the work of (Rodriguez-Amaya et al., 2008) who reported same stating that the interplay of nutrient availability and acclimatization of improve variety can lead to both vegetative and reproductive yield in plants. Among nutrient sources, Poultry dropping consistently resulted in the highest values for the number of fruits per plant, fruit weight, and fruit yield for both varieties. This result is similar to Santos et al., (1994) who reported that organic sources particularly poultry droppings and cultural practice not only improve soil structure, soil colour, moisture conservation but also improves microbial activities and crop yield, in terms of quality and quantity These findings underscore the importance of considering the synergistic effects of variety and nutrient management for optimizing pepper cultivation practices in the specific agro-climatic conditions of Makurdi, Nigeria. Amadi, et al (2012) stated that nutrient and cultivars/varieties influences yield related characters and overall yield positively, the fast mineralization and decomposition of poultry manure released slowly throughout the growing period might have contributed to the overall yield

Conclusion

The results in this investigation highlighted significant difference between variety and nutrient source across all measured parameters. Bell pepper consistently exhibited higher numbers of fruits per plant, greater fruit weights, and increased overall fruit yield compared to Yellow wander under all nutrient conditions. Farmers in this location are advice to cultivate Bell pepper with poultry dropping while in absence of poultry dropping farmers can use goat manure since the yield and yield related characters is close to poultry dropping.

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