Effect of Variety and organic Manure on the Growth and Yield of Pepper Grown Makurdi Benue State, Nigeria

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Abstract
The experiment aimed to evaluate the effect of variety and organic manure on the growth and yield of pepper grown in Makurdi Benue State, Nigeria. 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 treatments used were variety of pepper (sweet and Atarogu) and Organic manure sources (Poultry dropping (20t/ha), Compost (20t/ha), Goat manure (20t/ha) and control (zero application) and the spacing used between plants and rows were 15 and 75cm, respectively. The experiment was laid in a randomized complete block design with three replications. During the investigation, some physiological variables, such as plant height and the number of leaves number of branches were measured. Other characteristics like number of flowers, number of 50% flowering, fruits weight, fruits length, fruit diameter and over-all yield were also recorded. The data were analysed using (ANOVA) Gensat version 17. Results indicated that both in growth, yield and yield related characters. 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 sweet pepper recorded high in plant height, number of leaves and atarogu pepper 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. Based on the results obtained it could be suggested that the use atarogu and poultry dropping which is better in both growth and yield characteristics be recommended for optimum yield in pepper production in the study areas

Keywords: *Pepper, Manure, growth, Organic nutrient and yield*

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 color. 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 sweet pepper (*Capsicum annuum*) 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 it 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

i. To determine the effects of different nutrients sources on the growth and yield of pepper
ii. 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. The treatments used were variety of pepper (sweet and Atarogu) and Organic manure sources (Poultry dropping (20t/ha), Compost (20t/ha), Goat manure (20t/ha) and control (zero application). During the investigation, some physiological variables, such as plant height and the number of leaves number of branches were measured. Other characteristics like number of flowers, number of 50% flowering, fruits weight, fruits length, fruit diameter and over-all yield were also recorded. Results indicated that both in growth, yield and yield related characters. 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 sweet pepper recorded high in plant height, number of leaves and atarogu pepper 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 8 plots each within a block which gave the total number of 16 plots for the study, an inter-row and intra-row spacing of 15cm x 75cm was adopted for the research., Weeding was done manually at 2 and 6 weeks after transplanting to ensure weed free plots, all the data were collected within the net plot of 4m2, where a total of 5 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

Table 1: Effect of variety and Organic nutrients on Plant height of pepper grown in Makurdi, Nigeria

	Weeks after transplanting (WAT)						
	2	4	6	8	10	12	14
Variety (V)							
Sweet pepper	4.32	8.23	12.83	18.15	25.43	37.23	40.23
Atarogu	3.00	7.92	10.32	15.43	21.65	30.12	35.54
F-LSD (0.05)	1.01	1.03	1.21	1.91	2.01	2.98	3.49
Nutrient source (N)							
Compost	3.00	3.78	11.34	16.70	21.12	31.21	33.12

Poultry dropping	5.67	8.10	13.82	19.23	26.34	37.34	41.23
Goat manure	4.10	5.00	12.65	17.34	23.43	34.12	35.65
Control	2.24	4.12	10.12	13.21	17.11	28.12	30.12
F-LSD (0.05)	1.02	1.07	1.09	1.00	2.10	2.19	2.21
Interaction							
VXN	NS	NS	NS	NS	NS	NS	NS

LSD= Least Significant Differences at 5% Level of Probability

This study investigated the effect of variety and organic nutrient sources on the plant height of lettuce varieties (Sweet pepper and Atarogu) in Makurdi, Nigeria, at different weeks after transplanting (WAT). The experimental design included a control group with no added nutrients. Plant height measurements were recorded at 2, 4, 6, 8, 10, 12, and 14 WAT. The results revealed significant variations in plant height among the different varieties and nutrient sources. Sweet pepper consistently exhibited greater heights compared to Atarogu across all weeks, this variability could be link to the genetic make-up and ability to adopt to the cultivating environment, this finding collaborate to the work of Abu–Zahra (2012) who reported that genetic make-up brings about vegetative variability in crops, notably, poultry dropping and goat manure application led to increased plant height compared to the control, with poultry dropping generally outperforming compost. The findings suggest that both poultry dropping and goat manure positively influence the growth of pepper, with poultry dropping showing a more pronounced effect, this could attributed to the ability of poultry dropping release its nutrients faster than other organic nutrient leading to taller plant, this result agrees with the finding of Akinfasoye (2019) who reported that poultry dropping have ability to release its nutrient fast and affect plant growth positively. These results contribute to understanding the impact of organic nutrients on pepper growth in the specific agro-climatic conditions of Makurdi, Nigeria..

Table 2: Effect of variety and Organic nutrients on number of leaves of pepper grown in Makurdi, Nigeria

	Weeks after transplanting (WAT)						
	2	4	6	8	10	12	14
Variety (V)							
Sweet pepper	4.12	8.26	12.23	16.15	18.13	22.63	26.12
Atarogu	3.10	6.22	10.21	12.03	16.15	20.02	22.90
F-LSD (0.05)	0.92	1.00	1.11	1.21	1.01	1.98	1.49
Nutrient source (N)							
Compost	3.11	4.70	11.84	14.71	16.02	20.01	23.22
Poultry dropping	4.37	6.12	14.92	16.26	19.14	23.14	27.24
Goat manure	3.54	5.21	13.23	15.23	17.21	22.12	25.12
Control	2.14	4.11	10.42	12.20	14.01	17.92	20.11
F-LSD (0.05)	0.22	1.00	1.09	1.10	1.12	1.00	1.21
Interaction							
VXN	NS	NS	NS	NS	NS	NS	NS

LSD= Least Significant Differences at 5% Level of Probability

The table presents the effects of variety and organic nutrient sources on the number of leaves of pepper varieties (Sweet pepper and Atarogu) in Makurdi, Nigeria, at different weeks after transplanting (WAT). A control group with no added nutrients was also included in the study. The number of leaves was recorded at 2, 4, 6, 8, 10, 12, and 14 WAT. Varietal Differences: Sweet pepper consistently exhibited a higher number of leaves compared to Atarogu across all weeks. This suggests that Sweet pepper generally produces more leaves during the specified growth period, which could be as a result of genetic inherent ability, this result agrees with finding of Walsh and Hoot (2001) who reported that inherent genetic make-up, environmental factor and cultural practice, organic nutrients source resulted in an increase in the number of leaves compared to the control. 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 findings contribute valuable information for pepper cultivation in Makurdi, Nigeria, emphasizing the importance of nutrient management for optimal leaf growth as reported by Sonar (2020).

Table 3: Effect of variety and Organic nutrients on number of reproductive parameters of pepper grown in Makurdi, Nigeria

Variety (V)	No. of flowers	No. of branches	Days to 50% flowering	Days to 50% maturity
Sweet pepper	20.12	5.26	45.66	124.15
Atarogu	23.10	6.22	48.06	128.03
F-LSD (0.05)	2.02	1.00	1.11	2.21
Nutrient source (N)				
Compost	21.11	5.70	46.84	126.71
Poultry dropping	24.37	6.12	49.92	128.26
Goat manure	22.12	5.00	45.23	127.32
Control	20.14	4.11	42.42	122.20
F-LSD (0.05)	1.22	0.20	1.09	1.10
Interaction				
VXN	NS	NS	NS	*

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

The table 3 presents the effects of variety and organic nutrient sources on various reproductive aspects of pepper growth, including the number of flowers, number of branches, days to 50% flowering, and days to 50% maturity. The study was conducted in Makurdi, Nigeria, with two pepper varieties (Sweet pepper and Atarogu), and a control group with no added nutrients. Number of Flowers: Both varieties, Sweet pepper and Atarogu, showed differences in the number of flowers. Atarogu had a higher number of flowers compared to Sweet pepper. The nutrient source also influenced the number of flowers, with poultry droppings resulting in a

higher number compared to goat manure, Compost and the control. Number of Branches: Atarogu exhibited a greater number of branches compared to Sweet pepper. The nutrient source, particularly poultry dropping, led to a higher number of branches compared to goat manure, Compost and the control. Days to 50% Flowering: Atarogu took longer to reach 50% flowering compared to Sweet pepper. The application of poultry dropping extended the days to 50% flowering, while Compost and the control had relatively shorter durations. Days to 50% Maturity: Atarogu also took longer to reach 50% maturity compared to Sweet pepper. The nutrient source did not show a consistent effect on the days to 50% maturity plots with poultry dropping took longer days to reach 50% maturity.

The result suggests that both pepper varieties respond differently to nutrient sources. Atarogu tends to have more flowers and branches but takes longer to reach flowering and maturity compared to Sweet pepper which is not far from the fact that plant inherent ability could cause such variability Chatterjee et al (2013) lend support to this finding. Poultry dropping generally resulted in higher values for the number of flowers and branches. These findings contribute valuable insights for pepper cultivation in study area emphasizing the need for tailored nutrient management strategies based on specific pepper varieties and growth stages, 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.

Table 4: Effect of variety and Organic nutrients on yield and yield related parameters of pepper grown in Makurdi, Nigeria

Variety (V)	No. Fruits/plant	Fruit Diameter (cm)	Fruit Length (cm)	Fruit weight (g)	Fruit yield (t/ha)
Sweet pepper	42.18	2.13	8.12	17.65	2.87
Atarogu	50.12	1.01	6.32	13.23	1.22
F-LSD (0.05)	10.14	0.01	2.01	3.01	0.11
Nutrient source (N)					
Compost	43.01	1.84	6.01	15.98	1.71
Poultry	54.17	2.92	8.89	18.11	2.26
Goat manure	49.21	2.01	7.23	16.21	1.23
Control	32.04	1.02	5.32	13.01	1.00
F-LSD (0.05)	10.02	0.03	0.21	2.67	0.09
Interaction					
VXN	*	NS	NS	*	*

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

Table 4 presents the effects of variety and organic nutrient sources on various fruit-related parameters of lettuce varieties (Sweet pepper and Atarogu) grown in Makurdi, Nigeria. Number of Fruits per Plant: Atarogu had a significantly higher number of fruits per plant compared to Sweet pepper. The nutrient source also influenced the number of fruits, with poultry dropping resulting in a significantly higher number compared to other organic nutrient sources Zamil et al. (2004) reported that poultry manure has more nitrogen in form of uric acids mostly found in birds' droppings since they don't urinate, this content in poultry dropping influences fruit formation. Fruit Diameter: Sweet pepper had a larger fruit diameter compared to Atarogu, this finding agrees with the work of Ekpo et al., (2016) who reported same in tomatoes production stating that yield and yield related characters are products or are mostly influenced by the plants genetic make-up, nutrient, cultural practice and environmental factors. The nutrient source, particularly poultry dropping, led to a significantly larger fruit diameter compared to Compost and the control. Atarogu had shorter fruits compared to Sweet pepper. The nutrient source did not show a consistent effect on fruit length, but poultry dropping shows some significant longer pepper fruits when compared with other treatment used. Fruit Weight: Sweet pepper had significantly heavier fruits compared to Atarogu. Poultry dropping resulted in significantly heavier fruits compared to goat manure, Compost and the control. Fruit Yield (tonnes per hectare): Atarogu had a lower fruit yield compared to Sweet pepper. Poultry dropping significantly increased the fruit yield compared to Compost, goat manure and the control. The data suggests that both pepper varieties respond differently to nutrient sources in terms of fruit-related parameters. Atarogu tends to produce more fruits per plant but with smaller fruit size and lower yield compared to Sweet pepper. Poultry dropping generally resulted in higher values for the number of fruits per plant, fruit diameter, fruit weight, and fruit yield. This result is similar to Santos et al., (1994) who reported that organic sources particularly poultry droppings and climatic condition not only improve soil structure, soil colour, moisture conservation but also improves microbial activities and crop yield, in terms of quality and quantity (Rodriguez-Amaya et al., 2008).

Table 5: interaction between variety and Organic nutrients on yield and yield related parameters of pepper grown in Makurdi, Nigeria.

		Days to 50% maturity		
	Compost	**Poultry dropping**	**Goat manure**	**Control**
Sweet pepper	126.23	127.02	126.21	122.76
Atarogu	125.01	130.34	127.91	124.08
F-LSD (0.05)	1.09	1.01	1.21	2.02
		Number of fruits/plant		
Sweet pepper	44.78	54.03	50.12	33.32
Atarogu	46.89	5623	52.33	35.23
F-LSD (0.05)	1.18	2.02	1.21	1.31
		Fruit weight		
Sweet pepper	16.23	19.23	17.78	14.11
Atarogu	14.35	17.12	15.65	13.23
F-LSD (0.05)	1.00	1.01	1.00	1.00
		Fruit yield		

Sweet pepper	1.56	2.12	1.87	1.11
Atarogu	1.12	2.95	2.00	1.00
F-LSD (0.05)	0.21	0.56	0.23	0.03

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

This study explores the interaction between pepper varieties (Sweet pepper and Atarogu) and organic nutrients application on various growth parameters, including number of fruits per plant, fruit weight, and fruit yield in Makurdi, Nigeria. Days to 50% Maturity: The interaction between variety and nutrient source had a significant effect only on the days to 50% maturity, denoted by '*'. Table 3 Sweet pepper exhibited a range of days to 50% maturity from 122.76 to 127.02, while Atarogu ranged from 124.01 to 130.34, This suggests that the combined influence of variety and nutrient source affected the time taken for 50% maturity.

Number of Fruits per Plant: Both Sweet pepper and Atarogu showed variability in the number of fruits per plant, with Sweet pepper ranging from 33.32 to 54.03, and Atarogu from 35.23 to 56.23. The interaction effect was significant, suggesting that the combination of variety and compost had an impact on the number of fruits per plant; this is similar to the work of Carrizo et al (2016) who started that a combination of improve variety and nutrient sources particularly from organic sources lead to fruit initiation and increase in fruits number.

Fruit Weight: Sweet pepper exhibited variations in fruit weight, ranging from 14.11 to 19.23, while Atarogu showed a range from 13.23 to 17.12. this is true because fruit weight is a products of variety and nutrient assimilation as reported by Barbosa et al (2003)

Fruit Yield: The interaction between variety and nutrient source had significant effects on the number of fruits per plant, fruit weight, and fruit yield, denoted by '*'.table 4 Both varieties displayed variations in fruit yield, with Sweet pepper ranging from 1.11 to 2.12, and Atarogu from 1.00 to 2.65. The interaction effect was significant, indicating that the combination of variety and compost application influenced fruit yield. The interaction effect highlights the importance of considering both variety and nutrient source, especially in relation to the number of fruits per plant, fruit weight, and overall fruit yield, the findings highlight the complex interplay between pepper varieties and compost application, impacting key yield parameters. The significant interaction effects emphasize the need for tailored cultivation practices based on both variety and nutrient source. This result is similar to Santos et al., (1994) who reported that organic sources particularly poultry droppings 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 (Rodriguez-Amaya et al., 2008).

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