Journal of Multidisciplinary Innovations and Perspectives (JMIP)
Maiden Edition
www.fedpodjournal.com
Volume 1; Issue 1; November 2024; Page No. 104-116.

OPTIMIZING GROWTH, YIELD AND YIELD COMPONENTS OF MUSTARD (*BRASSICA NIGRA* L.) USING DIFFERENT LEVELS OF POULTRY MANURE AND ASH MIXTURE IN UNWANA, EBONYI STATE, NIGERIA

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Abstract
Low soil fertility is one of the major constraints in crop production and productivity, including mustard in southeastern Nigeria. The study investigated the growth, yield and yield components of mustard as influenced by different levels of poultry manure and ash of 0, 5 and 10tha^{-1} of poultry manure and 0, 3 and 6tha^{-1} of Ash. The experiment was a 3 x 3 factorial fitted in a randomized complete block design (RCBD) replicated three times. Data were collected on plant height (cm), number of leaves, leaf area (cm^2), total seed weight (kgha^{-1}), straw yield (kgha^{-1}), oil yield (kgha^{-1}) and oil content (%). Data collected were analyzed using ANOVA and significant means were separated with the least significant difference at 5% probability level. The results obtained revealed that the soil of the experimental site was acidic (pH 4.20) and the site was low in fertility (organic carbon - 1.43%, organic matter-1.47%, nitrogen – 0.14%, phosphorus – 18.27mg/kg and potassium – 0.12cmol. the mixtures of the poultry manure and yield improved the soil pH as well as enhanced growth, yield and yield components of mustard. The mixture of 10tha^{-1} poultry manure and 6tha^{-1} Ash significantly (p=0.05) enhanced yield and yield components of mustard in Unwana, Ebonyi State, southeastern Nigeria. The application of poultry manure and ash at 10tha^{-1} and 6tha^{-1} produced the best result and thus has the potential of increasing mustard production in Unwana.

Keywords: Mustard, Organic Manure, Growth, Yield and Unwana.

Introduction

Mustard (*Brassica nigra* L) is one of the most important oilseed crops belonging to the family *Brassicaceae*, formally *Crucifereae*. It is the second most important edible oilseed crop in the world after groundnut (Al-Doori, 2012), and has become a promising oilseed crop. Mustard occupies an area of 6.5 million hectare with the total production of 7.8 million tonnes and productivity of 1208kgha^{-1} in 2013 among the other oilseed crops in India (Annon, 2013). Mustard is used in the production of vegetable oil and bio-diesel (Mao *et a*l, 2012). Mustard oil is dominantly used in the food beverage industry and pharmaceuticals. It also accounts for several applications, such as anti-bacterial agents, anti-fungal agents, and in soap production. The oil is also used in cooking food and to increase the taste. Currently, about 17.84% of annual edible oil in the world comes from mustard crop (Chauhan, 2017).Soil fertility management on small scale farms in the tropics has become a major problem as a result of continued land degradation. Continuous cultivation on the same land has led to soil nutrient exhaustion and low yield. Mustard production is quite low in the study area and in Nigeria at large due to high cost of planting inputs such as fertilizers and availability of land. The quality of mustard oil and its cake is influenced by the mineral

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nutrition available for growth (Tripathi et al, 2010). The demand for mustard oil has overwhelmed its production; therefore, the production needs to be increased for sufficiency. Due to high cost of inorganic fertilizers, its availability and its adverse effects, alternatives to the use chemical fertilizers is a promising strategy for mustard production. Organic manures are cheaper and environmentally friendly. Poultry droppings and Ash could serve as the alternatives of the chemical fertilizers and its adverse conditions, for improving both the crop productivity and sustainability of the system. Poultry manure, an efficient organic fertilizer is an important source of plant nutrient material rich in organic matter which improves soil physical properties (Ayeni 2011). Application of plant ash has been found to improve soil chemical properties such as pH, total nutrient content and availability and subsequently increase in crop yield (Azu et al, 2019), as well as increase microbial activity (Nottidge et al, 2005). Therefore, the present study seek to know the effect of poultry manure and ash on the growth, yield and yield components of mustard planted in Unwana, Southeastern Nigeria.

Materials and Methods

Experimental site

The experiment was conducted at the teaching and research farm of the Department of Horticulture and Landscape Technology, Akanu Ibiam Federal Polytechnic, Unwana, Afikpo, Ebonyi State, Nigeria during 2023 cropping season. The site is situated at the Southeastern part of Nigeria at an altitude of 400m above sea level, at $05^{0}.20^{1}$N latitude and $7^{0}.55^{1}$E longitude. The annual rainfall range of the area is between 1500mm – 3500mm, maximum and minimum temperatures of the area ranged between 21^{0}C – 35^{0}C and 18^{0}C – 32^{0}C, respectively, and a relative humidity range of 89 – 93% (NIMET, 2003). The vegetation is characterized with trees, shrubs and tall grasses of the humid tropical rainforest that is tilted towards derived savanna (Essien et al, 2024). The soil is hydromorphic belonging to the order ultisol classified as clayey-loam (Obasi et al, 2005).

Land preparation

An area of 0.012ha was cleared, packed and marked into three blocks and plots. Each block contains nine plots, measuring 4mx3m with 0.5m inter plot and 1m intra block alleys. Raised beds were constructed and used for the study.

Experimental design and treatments

The experimental design used was a 3x3 factorial in a randomized complete block design (RCBD), replicated three times. The treatments used were three levels of poultry manure (0, 5 and 10tha^{-1}) and three rates of Ash (0, 3, 6tha^{-1}).

Application of the treatments

A well prepared and cured poultry manure and ash were broadcasted uniformly on each treatment plot basis and was incorporated into the soil by manual tilling. The plots were allowed for one week before transplanting mustard seedlings.

Planting/planting methods

The mustard seedlings were raised in the nursery bags for six weeks.The seeds were sown in a nursery medium composed of top soil and river sand in the ratio of 3:1. The established nursery was maintained until the seedlings were due for transplanting. The seedlings were transplanted to the permanent site at a height of 15cm and were planted at a spacing of 20cm x 30cm, giving plant population of 16666.6666 plants per hectare. Transplanting was done in the evening to avoid shock.

Field maintenance

Manual hoe weeding was done at 3, 6 and 9 weeks after transplanting (WAT), and the beds remolded at each weeding period. The plants were generally raised as per recommended practices.

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Data Collection and Analysis

Soil sampling and analysis

Prior to manure incorporation and planting, soil samples were collected from the site at five different points at a depth of 0 – 20cm, and were bulked, air dried and sent to soil laboratory for physico-chemicalanalysis. This was done on both pre-planting and post-harvest soil samples collected from the site.

Growth and yield data collection

Growth and yield data were collected from the selected and tagged plants from each treatment. The selection of the experimental plant was based on 40% sampling criterion. Growth data were collected on plant height (cm), number of leaves, leaf area (cm^2) at 2, 4, 6, 8 and 12 WAT and yield data (total seed weight, straw yield, oil yield and oil content were taken and recorded at harvest.

All data collected were analyzed statistically using Genstat (2012) software model, and means were separated using Fishers Least Significant Difference at 5% probability level.

Results and Discussion

Soil physico-chemical properties of the study area before and after the experiment

The pre-planting and post-harvest physic-chemical soil analysis of the study site showed marked variations (Table 1). The pre-planting soil pH indicated acidity both in water and salt. These results are in corroboration with the findings of Azu et al (2017). The result of the post-harvest soil analysis showed an increase in soil pH in the treatments that received poultry manure and ash when compared with the pH value of pre-planting soil analysis. There were also increases in the percentage organic carbon, organic matter, total N and available P in all the treatments that received poultry manure and ash. Findings from study revealed that the soil was low in fertility with organic carbon (1.43%), organic matter (1.47%), N (0.14%), Av.P (18.27mg/kg), K (0.12cmol/kg), with a pH of 4.20 in water and 3.90 in salt.This agrees with the work of Azu et al, (2017), who reported that soils of Southeastern Nigeria is low in fertility. However, the post-harvest soil analysis revealed that application of $10tha^{-1}$ poultry manure and $6tha^{-1}$ ash was sufficient to raise the pH to a level suitable for mustard production as well as increased the nutrient needed for enhanced growth and yield of mustard plant. The increase in the soil pH could probably be as a result of ions exchange reactions that might have occurred due to decomposition of organic manure. This agrees with the findings of Ogeh (2010), who reported occurrence of exchange reaction when terminal OH^- of Al^{3+} and Fe^{2-} hydroxyl oxides are replaced by organic anions which are products of decomposition of organic manures. Results also (Table 1) showed an increase values of nutrient elements with increased rate of application, hence increased productivity.

Mustard Growth Parameters as Influenced by Poultry manure and Ash Application

Plant height (cm), number of leaves and leaf area (cm^2) as influenced by soil amendments at 2, 4, 6 and 8 weeks after transplanting (WAT) was significant (Table 2). However, mustard plant that received $10tha^{-1}$ poultry manure and $6tha^{-1}$ ash recorded the highest plant height (140.00 – 162.33cm), and number of leaves (69.00 – 101.33) at 6 and 8 WAT. Closely followed by the treatment that received $10tha^{-1}$ poultry manure with $3tha^{-1}$ ash with plant height of 112.70 – 142.33cm, and number of leaves of 42.70 – 90.33 at 6 and 8 WAT. The shortest plant height (24.04 – 31.62cm), and the lowest number of leaves (23.31 – 29.72) were obtained from mustard grown without poultry manure and ash application at 6 and 8 WAT, respectively.

The leaf area index (Table 2) showed that poultry manure and ash application have significant effects on the leaf area (cm^2) of the various treatments. Mustard plant that received $10tha^{-1}$ of poultry manure and $3tha^{-1}$ of ash recorded the highest leaf area ($258.10cm^2$), followed by mustard plant that received $10tha^{-1}$ poultry manure without ash ($237.00cm^2$) application while the least leaf area ($19.00cm^2$) was obtained from mustard plant that received zero poultry manure and ash application.

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Findings from the study showed that mixtures of poultry manure and ash applications had significant effects on plant height and leaf production. The vigorous growth and leaf formation observed on the treatment suggest that poultry manure has positive effects on the leaf formation and growth of mustard due to the high nitrogen content. This agrees with the work of Emma-Okafor et al, (2017) who reported positive effect of poultry manure on plant growth and development as well as its rich nutrient content. However, the significant and vigorous increase in growth parameters of mustard could be attributed to increased and availability of nutrient in the soil due to the fact that nutrients from poultry manure were readily available and in the best form and proportion for easy absorption by the plant roots, hence, the boost in the morphological growth of the plant. The remarkable increase in leaf number could also be as a result of acceleration of cell division and elongation. Moreover, due to the increase in leaf formation per plant across different treatment, the photosynthetic surface area of the leaves per plant might have been high. This shows that irrespective of the treatment, the leaf of mustard is a factory for the conservation of solar energy into chemical energy through the process of photosynthesis as earlier reported by Essien et al (2024).

Table 1: Pre-planting and Post-harvest Soil Physico-chemical properties of the study site

Properties/ Treatment	Texture	pH	pH (H_2O)	OC ($CaCl_2$)	OM (%)	Total (%)	N (%)	Av. P (mg/kg)	Ca	Mg	K (cmol/kg)	Na	Al (H_2O)	Al (100g)
Pre-soil		CL	4.20	3.90	1.43	1.47	0.14	16.27	2.03	1.10	0.12	0.02	0.18	0.12
Post-soil														
PM (tha^{-1})	Ash (tha^{-1})													
	0	CL	4.01	3.42	1.00	1.79	0.23	18.77	1.60	0.99	0.14	0.01	0.18	0.14
0	3	CL	5.08	5.32	2.52	2.38	0.16	18.00	2.80	1.60	0.12	0.04	0.31	0.18
	6	CL	6.11	6.36	2.03	2.62	0.17	22.40	3.20	2.60	0.14	0.02	0.52	0.35
	0	CL	4.03	3.52	2.52	2.50	0.18	19.30	2.32	2.00	0.18	0.06	0.39	0.25
5	3	CL	6.01	5.40	2.93	3.21	0.20	20.73	3.10	2.61	0.16	0.48	0.34	0.20
	6	CL	6.09	6.51	2.62	2.09	0.19	20.10	3.40	2.41	0.18	0.48	0.50	0.30
	0	CL	4.10	3.43	2.45	3.10	0.20	22.30	3.60	2.42	0.19	0.40	0.41	0.22
10	3	CL	6.12	6.60	2.05	3.14	0.16	21.03	3.53	2.44	0.19	0.48	0.52	0.31
	6	CL	6.25	6.58	2.69	3.53	0.24	22.52	3.71	2.20	0.18	0.46	0.38	0.23

CL = clayey-loam, PM = poultry manure, OC = organic carbon, OM = organic matter

Mustard Yield and Yield Components

Results obtained (Table 3) showed the effects of poultry manure and ash application on mustard yields. The results of the findings shows that mustard plant that received 10tha^{-1} poultry manure and 6tha^{-1} ash recorded the highest total seed yield (883.33$kgha^{-1}$), straw yield (208.93$kgha^{-1}$), oil yield (872.65$kgha^{-1}$) and oil content (66.73%), followed by the treatment that received 10tha^{-1} of poultry manure and 3tha^{-1} of ash (679.97$kgha^{-1}$, 101.07$kgha^{-1}$, 612.15$kgha^{-1}$ and 60.90%) of total seed yield, straw yield, oil yield and oil content, respectively. The least yield and yield components (39.40$kgha^{-1}$, 25.30$kgha^{-1}$, 337.70$kgha^{-1}$ and 37.56%) of total seed yield, straw yield, oil yield and oil content, respectively were obtained where plants were grown without poultry manure and ash application. The significant increase in mustard yields confirmed the high nutrient quality of poultry manure and ash which enhances the growth of the plant leading to improvement in its yields. This agrees with the work of Emma-Okafor et al, (2017) on yield enhancement in African eggplant production using poultry manure reported that poultry manure being very rich in nutrient that boost crop yield.

The increase (Table 3) in the yield parameters under increased poultry manure and ash application could also be attributed to easy solubilisation effect of released plant nutrients leading to improved nutrient status and water holding capacity of the soil. The result obtained are in agreement with the findings of Mbah et al, (2010) on pepper reported higher yield response of pepper due to organic manure application and the relative faster decomposition rates of the organic materials used for the study. This could be ascribed to improved physical and

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biological properties deposited in the soil, resulting in better supply of nutrient to the plant. However, the improved physic-chemical properties of the soil might have provided better soil environment for the biological activities and improved microbial population leading to better growth and productivity. This present study is in agreement with the findings of Singh and Pal (2011).

Table 2: Effect of different levels of poultry manure and Ash on Growth parameters of Mustard

Treatments		Plant height (cm)				leaf number				Leaf area (cm^2)
PM (tha^{-1})	Ash (tha^{-1})	2	4	6	8	2	4	6	8	8 (WAT)
	0	3.10	17.34	24.14	31.62	7.40	15.79	23.31	29.72	19.00
0	3	5.39	13.43	24.87	32.13	6.20	14.83	24.62	31.69	45.50
	6	7.76	15.53	24.14	32.65	8.61	16.74	23.96	33.66	165.50
	0	10.00	19.33	40.70	40.67	9.70	20.70	35.70	64.30	105.75
5	3	13.01	28.33	54.70	90.67	41.30	24.30	45.70	96.00	101.80
	6	16.32	36.67	73.70	125.00	48.30	36.30	46.00	96.66	205.80
	0	27.33	39.67	95.30	137.67	19.30	45.00	57.70	98.00	237.00
10	3	66.33	41.00	112.70	142.33	20.70	47.00	42.70	90.33	258.10
	6	71.33	41.06	140.00	162.33	22.70	52.70	69.00	101.33	59.00
$LSD_{0.05}$ Ash		3.31	4.09	5.32	4.15	2.62	4.60	5.97	7.66	4.47
$LSD_{0.05}$ PM		3.31	4.19	5.32	4.15	2.62	4.60	5.97	7.66	4.47
$LSD_{0.05}$ PM x Ash		5.67	7.32	9.42	7.32	5.70	9.90	10.08	13.10	6.00

PM = Poultry manure, WAP = Weeks After Transplanting

Table 3: Effect of different levels of Poultry manure and Ash on Mustard Yield and Yield Components

Treatments		Total seed yield ($kgha^{-1}$)	Straw yield ($kgha^{-1}$)	Oil yield ($kgha^{-1}$)	Oil content (%)
PM (tha^{-1})	Ash (tha^{-1})				
	0	39.40	45.30	337.10	31.56
0	3	71.90	33.70	460.14	42.73
	6	102.90	53.00	487.93	45.90
	0	45.00	40.20	345.20	40.55
5	3	233.75	74.74	565.80	51.50
	6	574.00	79.80	595.00	56.76
	0	40.55	39.00	373.73	40.76
10	3	677.97	101.07	612.15	60.90
	6	883.33	200.93	872.65	66.73
$LSD_{0.05}$ Ash		73.69	41.66	76.00	30.93
$LSD_{0.05}$ PM		80.22	60.23	86.55	42.30
$LSD_{0.05}$ PM x Ash		29.30	25.74	23.01	12.74

The increase in oil content under the treatments might have aided in the availability of sulphur and zinc present in the organic materials, which might have involved in the conversion of fatty acids metabolite to the end products of fatty acids as earlier reported by Tripathi et al, (2010), leading to increase in oil formation. Thus, the increase in the application of poultry and Ash ($10tha^{-1}$ and $6tha^{-1}$) could have attributed to the increased oil content due to the presence of essential and micronutrients that supported oil production and the overall plant growth. These nutrients such as N, P, S and Zn might have enhanced enzymes activity involved in lipid synthesis as well as supports protein synthesis which is crucial for oil formation and accumulation in the seeds od mustard. This result is in close conformity with the findings of Tripathi et al (2010), who reported increased in oil content under farm yard manure (FYM) treatment, attributing it to availability of S and Zn in the organic materials. Also, the increase

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in oil content could be attributed to better growth potential of the plant which had significant role in regulating the photosynthesis enhanced the metabolic activities by promoting chlorophyll formation and photosynthesis, leading to variations in the synthesis of fatty acids due to the presence of and availability of essential and micronutrients responsible for the production of enzymes involved in lipid biosynthesis. This agrees with the work of Essien et al (2024), who reported variation in oil content of grains due to synthesis of fatty acids and their esterification by accelerating biochemical reactions in glyoxalate cycle.

This works concludes that ppropriate nutrient management provides useful indices in soil quality, growth and sustainable crop productivity. The results obtained revealed that mustard responded well to the combined application of poultry manure and Ash. However, mustard grown with mixtures of $10tha^{-1}$ poultry manure and $6tha^{-1}$ Ash gave the best growth, yield and yield components and therefore recommended for adoption by the farmers in Unwana, Southeastern Nigeria.

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