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Effect of fertilizer types on the growth and yield of two cabbage varieties.

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1 SUMMARY

To determine the effect of fertilizer types on the growth and yield of two cabbage (*Brassica oleracea* L.) varieties. The treatments involved 8 fertilizer types (NPK (15:15:15) fertilizer, neem compst, alesinloye organomineral fertilizer, sunshine organomineral fertilizer, sunshine organic fertilizer, cassava peel compost, alesinloye organic fertilizer and pacesetter organomineral fertilizer) applied at two rates (0 and 60kg/ha) each to two cabbage varieties (Copenhagen market and F1 milor). The treatments were laid out in randomized complete block design fitted into split plot with variety as the main plot factor and fertilizer types as sub plot factor, replicated three times. Data were collected on growth parameters and yield attributes of cabbage. The growth parameters and yield attributes were significantly influenced ($P \leq 0.05$) by fertilizer types and variety. At 12 weeks after sowing, Copenhagen market had higher mean number of leaves (17.50), taller plant height (7.39cm) and better yield attributes over F1 milor. The highest growth parameters (number of leaves and plant height) were obtained from plant that received cassava peel compost in Copenhagen while NPK and neem produced the best in F1 milor. Organomineral fertilizers (sunshine, aleshinloye and pacesetter fertilizers) gave the highest head length, diameter, and marketable yield in both varieties. The highest yield (34.8 t/ha) was recorded from plants treated with sunshine fortified fertilizer while control gave the least (14.8 t/ha). Organomineral fertilizers (pacesetter followed by sunshine and alesinloye), compared with NPK (15:15:15) enhanced optimum yield of cabbage varieties. Copenhagen market produced better head yield than F1 milor with or without fertilizer therefore can be recommended as the better variety among the two in Ogbomoso, South West Nigeria.

2 INTRODUCTION

Cabbage (*Brassica oleracea* L.), a member of cruciferae and a useful vegetable, belongs to the genus Brassica. Cabbage and is related to turnips, cauliflowers and brussels sprout (Jim and Tony, 2006) . It is generally believed to have originated from the wild, leafy, non-heading types which are found growing in Europe (Grubben and Denton, 2004) . Cabbage is easily grown under wide range of conditions and is adaptable to most areas of Africa (Smith, 1995). According to Grubben and Denton (2004), it can be grown throughout the year in most parts of Africa. Good performance has been reported in places like Jos Plateau, Nigeria to have the highest cabbage production in Africa (Jim and Tony, 2006).

The food and Agricultural Organisation (FAO,1988) has identified cabbage as one of the top twenty vegetables and an important source of food globally. It has been domesticated and used for human consumption since the earliest antiquity (Smith, 1995). It is a rich source of vitamin A and C. The green outer leaves of cabbage are richer in vitamin A, calcium and iron than the white inner leaves. Headed cabbage are usually consumed as a

cooked vegetable, or eaten fresh as an ingredient of coleslaws and mixed salads (Grubben and Denton,2004). For optimum plant growth, nutrient must be available in sufficient and balanced quantities. Soil contains natural reserve of plant nutrients, but these reserves are largely in forms unavailable to plants, and only a minor portion is released each year through biological activities and chemical processes. Therefore, fertilizers are designed to supplement the nutrients already present in the soil. The type of fertilizer and quantity to apply depends on soil type, initial nutrient reserves in the soil and yield level. A headed cabbage with a yield of 25t/ha approximately absorbs 100kg N, 12kg P and 75kg K (Grubben and Denton,2004). Singh and Naik (1990) reported maximum marketable heads at fertilizer level of 60 to 120kg N and 30-90 kg P_2O_5 per hectare. Similar recommendations were recommended by Morris (1950). Optimally cabbage requires 60-85 kg N/ha; 60-80 kg P_2O_5/ha; and 30-90kg K_2O/ha (Shika and Doug,2001). Also Bhardwaj et al, (2000) reported higher yield and nutritional quality in cabbage, okra and tomato at the rate of 60kg N/ha from organic fertilizer sources (neem, rape seed cake) and NPK. For sustainable crop production integrated use of chemical and organic fertilizer has proved to be highly beneficial. Hence, Cultural practices such as adequate application of fertilizers have to be adhered to in order to obtain good yields in cabbage production. Despite many investigations in area of nutrition and knowledge about how organic, mineral and organomineral fertilizers influence growth and yield of crops, there is need to investigate further on the effect of fertilization on the production of vegetables. Therefore the objective of this study is to determine the best fertilizer type for the maximum growth and yield of cabbage varieties in Ogbomoso, South West, Nigeria.

3 MATERIALS AND METHODS

Field experiments were conducted in 2009 and 2010 at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Ogbomoso is located on longitude 4°10' and latitude 8°10' in the Guinea savanna zone of Southwest Nigeria. The land was prepared and ploughed and raised beds of 4 m² dimension each was made. A total of 54 beds were made for three replicates used, with a replicate having 18 beds. Pre - cropping soil samples were collected randomly from the experimental area at the depth of 0 - 15cm for physico - chemical analysis. Soil samples were bulked, air - dried and ground to pass through a 2 mm by 2 mm sieve. Soil particle size was determined by Bouyoucous method (Bouyoucos, 1962). Soil organic carbon was determined by Walkey black modified method (IITA, 1982). Available phosphorus was determined by Technicon AAII (IITA, 1982) and total nitrogen by Kjeldahl digesting method (AOAC, 1990; 2005). While exchangeable Ca, Mg, Na, K and effective C.E.C in soils by use of atomic absorption spectrophotometer (IITA, 1982). Two cabbage varieties (Copenhagen market and F1 Milor) which are widely cultivated, adapted and consumed in different ecological zones in Nigeria were used. The seeds were collected from the Seed Project Company Limited, Adejia Road, Kano, Nigeria. These were subjected to eight fertilizers types used in the experiment. Four organic fertilizer types: Neem organic fertilizer (NOF), cassava peel compost (CPC), sunshine unfortified fertilizer (SUF) and Alesinloye organic fertilizer; three organomineral fertilizers: Alesinloye organomineral fertilizer, sunshine fortified fertilizer (SFF) and pacesetter fortified fertilizer (PFF) were used. NPK 15:15:15 mineral fertilizer was included as conventional fertilizer. Alesinloye fertilizers were produced by the Fertilizer Factory of Oyo State Government, the SFF and SUF are products of Ondo State Government Waste Fertilizer Firm and Neem organic fertilizer was obtained from Niger State Government Fertilizer Factory while CPC is produced from LAUTECH, Ogbomoso. The N, P and K composition of each fertilizer material as stated by the manufacturer is presented in Table 1.

The eight Fertilizer types were applied to the cabbage varieties as nitrogen sources as: T1 = 0.61 kg N/plot through NPK chemical fertilizer at the rate of 60kg N/ha; T2 = 0.61 kg N/ plot through

of neem organic fertilizer at the rate of 60kg N/ha; T3 = 0.80 kg N/ plot through alesinloye organomineral fertilizer at 60kg N/ha; T4 = 0.69 kgN/ plot through sunshine organomineral fertilizer at 60kg N/ha; T5 = 1.09 kgN/plot through cassava peel compost organic fertilizer at 60kg N/ha; T6 = 2.40 kg N/ plot through alesinloye organic fertilizer at 60kg N/ha; T7 = 0.69 kg N/ plot through pacesetter organomineral fertilizer at 60kg N/ha; T8 = 0.96 kg N/ plot through sunshine unfortified organic fertilizer at60kg N/ha; and T9 = No fertilizer (control). Experiment was laid out in split plot fitted into randomized complete block design, replicated thrice. The two cabbage varieties formed the main plot treatment while nutrient sources were allocated into the subplots. Two seeds were sowed per hole at 0.5cm depth due to the small rounded nature of the seed at 50 cm by 50 cm apart. Water in form of irrigation was provided for seedlings to minimize the environmental stress that occurred during transplanting and to ensure better crop establishment in the first three weeks.

Table 1: Percentage N, P and K compositions of different fertilizer materials used for the experiment.

Treatment	Fertilizer	Type	N	P	K
T1	NPK 15:15:15	Mineral	15.00	15.00	15.00
T2	Neem	Organic	15.00	15.00	15.00
T3	Alesiloye(A)	Organomineral	3.00	2.50	1.50
T4	SFF	Organomineral	3.50	2.50	4.00
T5	CPC	Organic	2.20	0.22	0.51
T6	Alesiloye (B)	Organic	1.00	1.00	1.50
T7	PFF	Organomineral	3.50	2.50	4.00
T8	SUF	Organic	2.50	1.70	2.00

Source: Manufacturer
.Key: SFF = sunshine fortified fertilizer; CPC = cassava peel compost; PFF = pacesetter fortified fertilizer; SUF = sunshine unfortified fertilizer.

Supplying of non-germinated plant stands was carried out on the field 3 - 5 days after sowing while overcrowded plant stands were thinned to one plant per stand. The organic fertilizers were applied 2 weeks after sowing (WAS) while other fertilizers were applied at four weeks after sowing. Treatments were applied to the respective beds randomly. Weeding was carried out every two weeks. Insect control was carried out by spraying fortnightly with neem seeds extract at the rate of 40 ml / 20 L water. Data collection commenced at 2 WAS and continued fortnightly till harvesting of cabbage heads at maturity. Six plants were tagged and assessed on each bed for number of leaves and plant height. Numbers of leaves were obtained by counting each green and functional leaf that existed on the plant at each sampling time. The plant height was measured from ground level to the tip. Yield attributes such as head weight, diameter, length and girth of cabbage were measured and recorded. The head was weighed and recorded using weighing scale. The head diameter was measured using;

$$\text{Diameter} = \frac{\text{Circumference}}{\pi} \quad . \text{ Where } \pi \text{ is } 3.14$$

The data collected were analyzed using Statistical Analysis Software procedure (SAS, 1999) for analysis of variance (ANOVA). Differences among treatment means were computed where applicable, using the Least Significance Differences (LSD) at 0.05 probability level.

4 RESULTS

Soil analysis: The chemical composition of the surface soil (0 - 15 cm) before cropping is shown in Table 2. The soil belongs to the textural class of sandy loam indicating that the soil is low in organic content and high percentage of sand (87 %). The soil is deficient in organic carbon, total N, available P, exchangeable K and cation exchange capacities. The soil is very low in exchangeable acidity (0.01 cmol/kg). The soil pH is of 5.9 which indicates that the soil is moderately acidic and recommendable for cabbage production.

Table 2: Chemical and physical properties of the soil of the experimental site.

Parameters	Values
pH (H_2O)	5.9
Organic carbon (mg/kg)	0.048
Total N (mg/kg)	0.003
Available P (mg/kg)	5.34
Fe (mg/kg)	56.44
Cu (mg/kg)	1.12
Zn (mg/kg)	11.72
Exchangeable K (c mol/kg)	0.10
Exchangeable Na (c mol/kg)	0.14
Exchangeable Ca (c mol/kg)	7.65
Exchangeable Mg (c mol/kg)	0.76
Exchangeable acidity (c mol/kg)	0.01
ECEC (c mol/kg)	8.6
Particle size distribution	
Sand (%)	87
Silt (%)	4
Clay (%)	9
Textural class	sandy loam

5 Growth parameters: The mean height of cabbage plant was influenced by fertilizer types (Table 3). At 12 WAS, cassava peel compost gave the highest height (10.40 cm) followed by neem fertilizer (7.63cm) while NPK had the least (6.46 cm) in Copenhagen market. The use of Neem fertilizer produced the highest plant height in F1 milor (6.57 cm) while control had the least (4.27 cm). Varietal effect was significantly ($P \leq 0.05$) on the vegetative growth parameter (height) of cabbage plant. Copenhagen market responded better without fertilizer compared to F1 milor. Throughout the growing period, the plant height of Copenhagen supersedes F1 milor (7.39cm and 5.63cm respectively). The interactive effect of fertilizer type and variety was significant ($P \leq 0.05$) on plant height of cabbage plant at 12WAS as shown in Table 3. Number of leaves increased with the age of the plant (Table 4). The use of fertilizer had significant effect ($P \leq 0.05$) on the number of leaves of cabbage plant. Cassava peel compost recorded the highest number of leaves at 12 WAS in Copenhagen (22.10) while in F1 milor, the highest was recorded with NPK (21.50) while control had the least for the two varieties. Cabbage variety influenced the number of leaves of cabbage plant. The initial growth of cabbage plant was slow but later increased as from 8 WAS for the two varieties. At 12 WAS, Copenhagen had the higher mean number of leaves (17.50) while F1 milor had the least (16.90). Without fertilizer, Copenhagen variety did better with respect to number of leaves than F1 milor. Interactive effects of fertilizer types and variety significantly affected the number of leaves of cabbage plant at 10 and 12 WAS.

Table 3: Effect of fertilizer types and variety on plant height (cm) of cabbage at different growth stages.

	Plant height (cm)							
	Copenhagen				F1 Milor			
	Weeks after sowing							
Fertilizer types	**4**	**8**	**12**	**mean**	**4**	**8**	**12**	**mean**
NPK	4.37	5.80	6.46	5.54	2.27	4.83	5.96	4.39
Neem	3.23	6.03	7.63	5.63	4.47	5.60	6.57	5.55
AB	3.87	5.17	6.30	5.11	3.17	4.87	5.87	4.64
SFF	4.23	6.03	7.63	5.96	3.37	4.50	5.67	4.51
CPC	4.97	7.70	10.40	7.69	3.13	4.20	5.10	4.14
AB	3.77	5.27	7.10	5.38	3.33	4.73	5.43	4.50
PFF	4.43	6.03	7.47	5.98	3.77	5.10	5.63	4.83
SUF	3.93	5.20	6.67	5.27	2.93	3.90	4.60	3.81
C	3.46	5.57	6.87	5.30	2.70	3.76	4.27	3.58
Mean	4.03	5.87	7.39		3.23	4.61	5.63	
LSD (5%)								
Fertilizer(F).	ns	ns	ns		ns	ns	ns	
Varieties(V)	ns	ns	32.80		ns	ns	28.40	
LSD F x V	ns	ns	4.90		ns	ns	4.58	

Where: NPK = Neem; AA = alesinloye organomineral; SFF = Sunshine organomineral; CPC = cassava peel compost; AB = alesinloye organic; PFF = pacesetter organomineral; SUF = sunshine organic and Control

Table 4 : Effect of fertilizer types and variety on number of leaves of cabbage plant at different growth stages.

	Number of leaves							
	Copenhagen				F1 Milor			
	Weeks after sowing							
Fertilizer types	**4**	**8**	**12**	**Mean**	**4**	**8**	**12**	**Mean**
NPK	15.13	17.97	8.10	13.73	17.03	21.50	21.50	20.01
Neem	8.73	13.97	17.60	13.43	10.90	14.77	18.96	14.87
AB	10.10	15.83	18.10	14.77	8.80	14.03	17.97	13.60
SFF	9.47	14.93	16.83	13.74	9.20	13.53	17.00	13.24
CPC	11.57	18.43	22.10	17.34	7.70	12.63	16.50	12.28
AB	10.13	15.10	17.00	14.08	10.17	13.10	16.57	13.28
PFF	9.67	15.05	16.50	13.74	9.53	12.93	15.67	12.71
SUF	8.03	14.03	16.10	12.72	8.67	13.03	15.13	12.28
Control	6.87	12.83	15.23	11.64	5.40	9.47	12.17	9.01
Means	9.43	15.03	17.50		8.72	13.44	16.90	
LSD(5%)								
LSD fert.	ns	12.00	20.90		ns	10.01	19.92	
LSD var.	ns	ns	ns		ns	ns	ns	
LSD F x V	ns	ns	9.90		ns	ns	9.90	

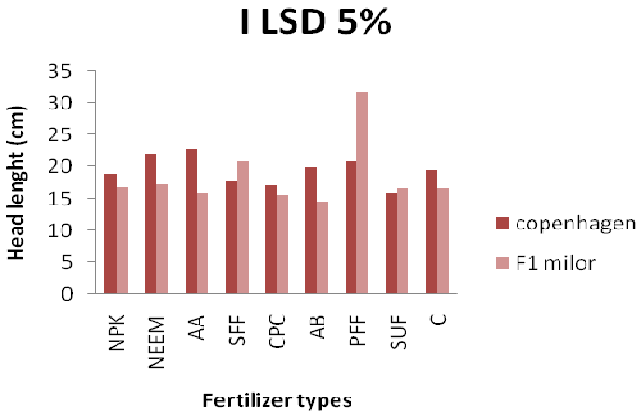
Key: AA = Alesinloye organomineral; SFF = Sunshine organomineral; CPC = Cassava peel compost; AB = Alesinloye organic; PFF = Pacesetter organomineral; SUF = Sunshine organic.

The least growth response of cabbage varieties obtained in this study from unfertilized plot reconfirmed the report of Abey *et al.* (2002), which might be due to low nutrient availability during the growing period. The increased in plant height and number of leaves as the plant aged revealed the existence of genotypic differences among the varieties tested. This reconfirmed the report of

Abey *et al*., (2002), that vegetable crop performance could be linked to both genetic and environmental influences amongst which is nutrient source, climactic condition, soil fertility status etc. Also, IBPGR (1990) reported that cabbage plant exhibited morphotype and shortened non - branching stem that is terminated in the production of leaf rosette as from 6WAS. The significant increased in plant height and number of leaves of cabbage at four to twelve weeks after sowing was in accordance with the work of Olaniyi and Akanbi (2008). The variations obtained among the two cabbage varieties used during their vegetative growth with and without fertilizer application performed are in accordance with the work of other researchers (Olaniyi *et al.,*2010) with the eight fertilizer types during vegetative growth. Copenhagen responded to cassava peel compost during growth while F1 milor was improved with neem organic fertilizer. Manure is generally recommended for cabbage production particularly in the tropics (Tindall, 1983; William *et al.,* 1991).

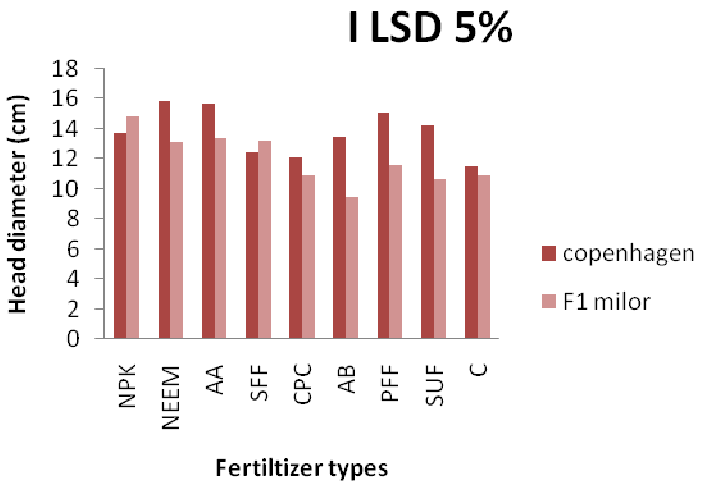
The higher plant growth as a result of organic fertilizer application may be associated with the fact that organic manure releases considerable amount of nutrients for plant use. This is essential for formation of plant essential molecules such as chlorophyll and protoplasm formation. The capability of organic fertilizer to improve soil structure, retain nutrient and water, improves aeration aids better response of crops to fertilizer (Akanbi *et al*, 2006).

5.1 Yield attributes: Fertilizer types and variety had significant effect (P≤0.05) on the length of cabbage head (Figure 1). In Copenhagen, alesinloye organomineral fertilizer recorded the highest (22.81cm), followed by neem organic fertilizer (22.04 cm) while sunshine organic fertilizer had the least (15.90 cm). In F1 milor, pacesetter organmineral fertilizer obtained the head length (31.70 cm) followed by sunshine organomineral fertilizer (20.97 cm) while alesinloye organic fertilizer recorded the least (14.55 cm). Significant difference occured between the mean head length of the two cabbage varieties used in the experiment with Copenhagen (19.36 cm) while F1 milor had (18.43 cm). The interactive effect of fertilizer types and variety is significant on the mean length of cabbage head. Organomineral fertilizers obtained the best result in the tested cabbage varieties; with or without fertilizer, Copenhagen did better than F1 milor.



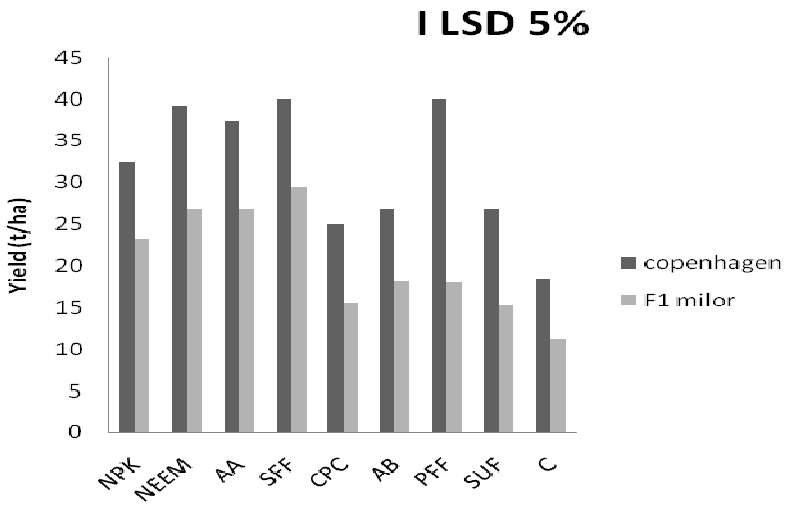
The diameter of cabbage head was significantly influenced (P≤0.05) by fertilizer types (Fig. 1). Neem organic and alesinloye organomineral fertilizers gave the best width of cabbage head followed by NPK fertilizer in both varieties. The least value was recorded from control (non fertilized) in Copenhagen while alesinloye organic fertilizer had the least in F1 milor. Cabbage head diameter gave similar response to applied fertilizer types. Cabbage variety showed difference in the width of cabbage head. Amongst the varieties, F1 milor had the higher mean value for head diameter (18.05 cm) while Copenhagen market had the least (13.80 cm). Fertilizer types had significant effect (P≤0.05) on the yield of cabbage (Figure 2). Sunshine and pacesetter organomineral fertilizers gave the best yield (40.10 t/ha) followed by neem organic fertilizer (39.2 t/ha) while control had the least (18.4 t/ha) in Copenhagen variety. Likewise, sunshine organomineral fertilizer improved the yield

of F1 milor cabbage varieties (29.50 t/ha), followed by neem organic fertilizer (26.90 t/ha) and alesinloye organomineral fertilizer. Varietal influence was observed to be significant in the yield of cabbage. With or without fertilizer, Copenhagen produced better head than F1 milor. Fertilizer types and variety had interactive influence on the yield of cabbage. The application of organomineral fertilizer recorded highest for cabbage yield.



Where: NPK = Neem; AA = alesinloye organomineral; SFF = Sunshine organomineral; CPC = cassava peel compost; AB = alesinloye organic; PFF = pacesetter organomineral; SUF = sunshine organic and Control.
Figure 2: Effect of fertilizer types and variety on lenght and diameter of cabbage head.

Cabbage head yield (t/ha)



Where: NPK = Neem; AA = alesinloye organomineral; SFF = Sunshine organomineral; CPC = cassava peel compost; AB = alesinloye organic; PFF = pacesetter organomineral; SUF = sunshine organic and Control.
Figure 3: Effect of fertilizer types and variety on yield (t/ha)of cabbage.

Table 5: Effect of fertilizer types and variety on dry matter yield (g/ plant) of cabbage head

Fertilizer types	Dry matter yield (g/ plant)	
	Copenhagen market	F1 milor
NPK	11.20	5.90
Neem	4.40	9 30
AB	8.60	6.70
SFF	4.70	6.00
CPC	12.50	7.40
AB	7.00	6.80
PFF	16.00	7.40
SUF	28.00	8.10
Control	8.40	7.70
Mean	9.00	8.15
LSD 5%		
LSD fert.	85.38	85.38
LSD var.	208.86	208.86
LSD F x V	80.19	80.19

Where; AA = Alesinloye organomineral; SFF = Sunshine organomineral; CPC = Cassava peel compost; AB = Alesinloye organic; PFF = Pacesetter organomineral; SUF = Sunshine organic.

Fertilizer types affected the dry matter yield of cabbage head (Table 5). Organic fertilizers (sunshine and cassava peel compost) obtained the highest percentage in Copenhagen (28.0g and 12.0g respectively). In F1 milor, neem organic fertilizer had (9.30g) while NPK had the least. There was interactive significance on the dry content of cabbage head. Organic fertilizers improved the dry matter yield of both varieties.

The variations observed in the dry matter yield as influenced by fertilizer types indicated a better nutrient status in compost amended soil which was supported by the higher nutrient content of plants grown on the soil with manure commendations. Copenhagen market and F1 milor responded to sunshine and neem organic fertilizers respectively. Dry matter yield had been reported to be proportional to the quantity of N in the wastes and to the quantities of inorganic fertilizer applied to the leafy vegetables (AVRDC, 1994).

The best yield attributes obtained from organomineral fertilizers might be attributed to rapid mineralization of N from inorganic fertilizer and steady release of N in organic fertilizer which might have met the N requirement of crop at critical stages. This recomfirms the work of Maheshbabu *et al.*, (2007) who reported that manure acts as nutrient reservoir and upon decomposition are released slowly during entire growth periods leading to higher seed yield and yield components. This result also is in line with that of Aliyu (2002, 2003) who reported significant response in yield to different types of manure rate application and source. The significant response of growth parameters, yield attributes and yield to fertilizer demonstrated the high nutrition demand of cabbage which agrees with the findings of Adeyemi, (1991), and Olaniyi, (2000) for melon that crops responded significantly to applied N rates.

6 CONCLUSION

The main goal of cultivating crops and vegetables is to obtain such quality minerals and chemicals such as protein, N, P, K, Ca, and Mg as man's food. Depending on cropping conditions, the crop quality may vary widely. Numerous agrochemical and biochemical studies indicate that one of the most effective and fast acting factors of variations in the chemical composition of plants and higher crop

quality is fertilizer. Data collected in this experiment on the soil sample, growth and head yield of cabbage showed significant variation in the two cabbage varieties and eight different fertilizer types examined. Pacesetter closely followed by sunshine and alesinloye, compared with NPK (15:15:15) enhanced optimum yield of cabbage varieties. Copenhagen market produced better head yield than F1 milor with or without fertilizer therefore can be recommended as the better variety among the two in Ogbomoso, South West Nigeria

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