FEDERAL UNIVERSITY GASHUA

HORTICULTURAL SOCIETY OF NIGERIA (HORTSON)

HORTSON

BOOK OF PROCEEDINGS

Of The

34th ANNUAL CONFERENCE

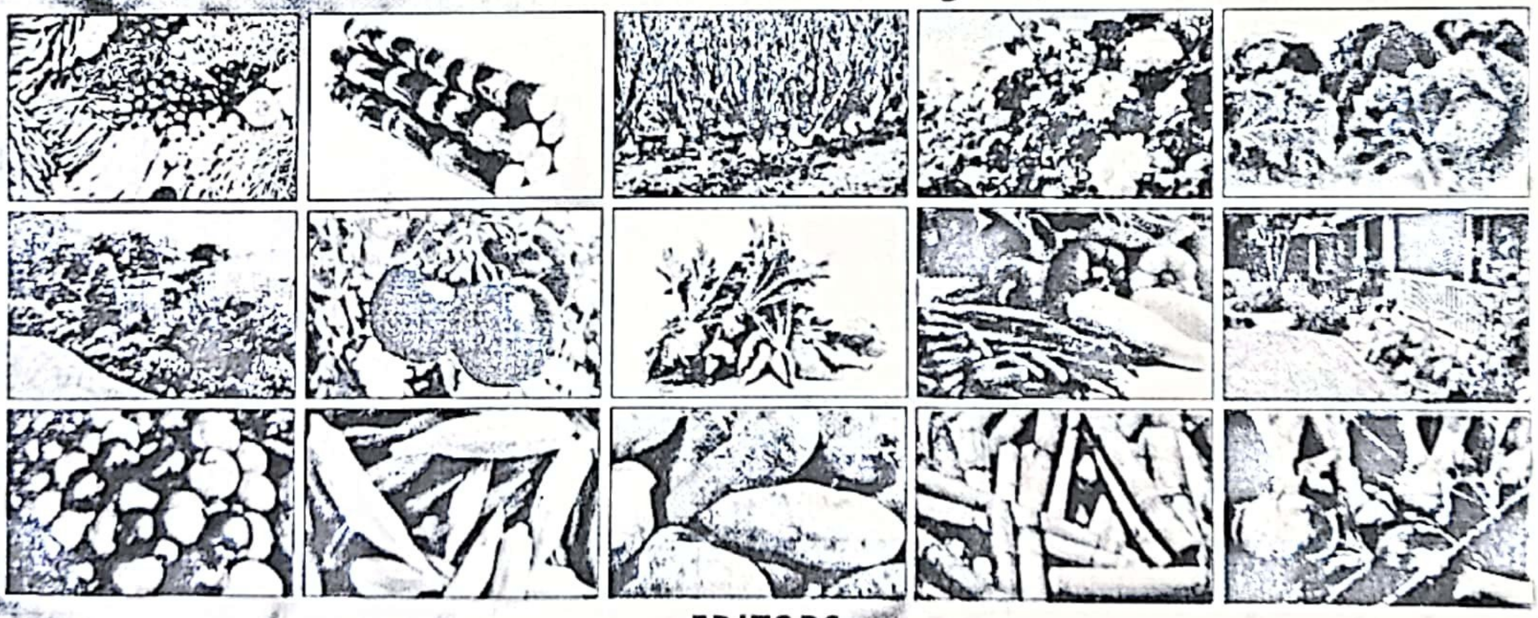
'GASHUA 2016'

Theme:

Horticulture for sustainable nutrition, livelihoods, economic growth, environment and national security

Date: 23rd - 26th October, 2016

Venue: New Lecture Theatre, Federal University, Gashua.



EDITORS:

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HORTICULTURAL SOCIETY OF NIGERIA (HORTSON)

BOOK OF PROCEEDINGS OF THE 34TH ANNUAL CONFERENCE

THEME: HORTICULTURE FOR SUSTAINABLE NUTRITION, LIVELIHOODS, ECONOMIC GROWTH, ENVIRONMENT AND NATIONAL SECURITY

EDITORS:
ISHAYA, D.B., DANTATA, I.J AND TIKU, N.E

Correct Citation:
In: Ishaya, D.B., Dantata, I.J and Tiku, N.E (2016). Horticulture for Sustainable Nutrition, Livelihoods, Economic Growth, Environment and National Security. Book of Proceedings of the 34th Annual Conference of Horticultural Society of Nigeria, Department of Agronomy, Federal University, Gashua, Nigeria, 23rd – 26th October, 2016, 560pp.

ISBN
9789789473069

PROCEEDINGS OF THE 34TH ANNUAL CONFERENCE OF THE HORTICULTURAL SOCIETY OF NIGERIA (HORTSON)
23rd - 26th October, 2016, Department of Agronomy, Federal University, Gashua, Yobe State, Nigeria

PLANT GROWTH AND SEED YIELD RESPONSE OF TWO OKRA (ABELMOSCHUSESCULENTUS (L.)MOENCH) CULTIVARS TO DIFFERENT NUTRIENT SOURCES

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ABSTRACT

This work was undertaken at the Teaching and Research farm of Federal University of Technology, Minna, Nigeria. The objectives was to determine the effects of different levels of poultry droppings and cow dung and recommended dosage of NPK 15-15-15 fertilizer on plant growth andseed yield of two varieties (NHAe47-4 and LD88-1) of okra. The rates of 0, 2, 4, 6 and 8 t ha^{-1} of poultry droppings and cow dung and NPK fertilizer at 100 kg N ha^{-1}, 50 kg P_2O_5 ha^{-1}, 50 kg K_2O ha^{-1} were applied to experimental plots. The control plots received neither organic nor inorganic fertilizers. Ridges were constructed 75 cm apart each measuring 2 m long. Three seeds each were sown into holes made 50 cm apart on the ridges. Following emergence, seedlings were thinned to one per stand two weeks after sowing.Manual weeding was also done at four, seven, and nineweeks after sowing. Combine NPK fertilizer 15:15:15 application was done at two weeks after sowing for the plots concerned at the ratesdescribed above. Data were taken on plant heights at 50% flowering and maturity, number of leaves at maturity, Dry fruit yield per ha, 100-seed weight and seed yield per hectare. The 2 varieties by 10 fertilizer treatment levels resulted in 20 treatment combinations. The field experiment was conducted from 2009 to 2011 using Randomized Complete Block Design in a factorial arrangement with three replicates. Results revealed that plants from plots to which 6 or 8 t of poultry droppings per hectare was applied performed significantly ($p<0.05$) better in final plant height (90.3 cm), number of leaves (21) per plant, dry fruit yield per ha, 100-seed weight and total seed (542 kg ha 1) yield. Results further revealed that greater plant height (101 cm) and seed yield (400 kg ha^{-1}) respectively were recorded in LD88-1compared to the values of 65 cm and 250 kg ha^{-1} for NHAe47-4. It is concluded from this study that application of poultry droppings at 6 or 8 t ha^{-1} to okra (Abelmoschusesculentus L. Moench) mother-plants enhanced growth and seed yield compared to other fertilizer treatments.It is therefore recommended that poultry droppings at 6 to 8 t ha^{-1} should be applied to mother-plants of okra of these varieties for optimum plant growth and seed yield.

Key words:Nutrient sources, plant height, seed yield, poultry droppings and okra

Introduction

Fertilizer from any source is one of the important factors for crops survival and optimum performance. Soil nutrients play significant role in many of the metabolic processes of crop plants and their deficiency may result to stunted growth and yellowish appearance in okra plants. Olaniyiet al. (2010) recommended adequate supply of nitrogen for vigorous vegetative growth and optimum fruit and seed yield in okra. The savannah soils of Nigeria are inherently deficient in essential nutrients like N, P, K, Ca, Mg amongst others (FAO, 1992). The increase in demand for vegetables due to increased population explains the reason for the intensification of production using same land year in year out. Since farmers are working to key in to the economy diversification agenda of the present Nigerian government, production technologythat would ensure high seed yield must be developed. To achieve this, agronomic practices employed should be eco-friendly so that beneficial soil organism population would be safe. Organic manures are not only known to be eco-friendly, they are also reported to be responsible for vigorous and effective plant growth (Oladotun, 2008).The reports of Kale and Banu(2004) in brinjal and Sharma (2005) in tomato showed that nitrogen from poultry manure is superior over inorganic

fertilizers because of the greate
former to conserve N (Olaniy
According to Schutz (2000), organic manure is the most efficient in storing excess N, while conventional inorganic fertilizers were least efficient in soils of the savannah. Ngeze (1999) reported that organic manures serve as storehouse for plant nutrients. The author further observed that organic manures play a major role in boosting cation exchange capacity (CEC) of the soil, improves soil water availability through retention and aeration which promote better crop utilization of nutrients. Tanimuet al. (2007)reported that the beneficial effect of inorganic fertilizers on three cultivars of 'yakuwa' (rossel) was short-lived compared to organic manures. The result of the study of Akanbiet al. (2005) on fluted pumpkin indicated that application of organic manure was found to improve cell activity, enhanced rapid cell multiplication, elongation of stems and enlargement of the fruits over the non-fertilized and those fertilized with inorganic fertilizers. Vigorous plant growth have been reported by the use of organic fertilizers through massive soil buffering and excellent water retention compared to inorganic fertilizers (Spacciniet al., 2002).Plant height have been reported to be responsible for the fruit bearing capacity of okra plant (Akanbiet al., 2005), this was also proportional to the seed yield.Khan et al. (2003) reported that increase in fruit and seed yields of some cultivars of okra was due to greater plant height. Naziret al.(2007) also reported that okra fruit and seed yield is a function of plant height.Several works with encouraging results have been reported on the use of both synthetic and organic manures on the fruit yield in okra. However, there does not seem to be adequate information on the various nutrients and their sources on the yield of the seeds produced.In this context, this work seeks to study the effect of organic (using poultry droppings and cow dung) and inorganic (NPK fertilizer) sources of nutrients on plant growth and seed yield of okra with the principal aim of developing strategies to strengthen okra production amongst the urban and peri-urban growers of the crop.

Materials and methods.

The experiment was carried out in the teaching and research farm of Federal University of Technology, Minna, Niger State, Nigeria. Seeds of two varieties (NHAe 47-4 and LD88-1) of okra were sourced from the National Horticultural Research Institute (NIHORT) sub-station at Bagauda, Kano. Each experimental plot comprised of eight ridgesconstructed 75 cm apart measuring 2 m long.

and organic ferilizers used in the
bined N P K (at 100, 50 and 50 kg ha
), poultry droppings at 2, 4, 6 and 8 t ha^{-1} and cow dung at 2, 4, 6 and 8 t ha^{-1}. Plots to which no fertilizer was applied served as the cotrol. This gave a total of 10 fertilizer treatments factorially combined with two cultivars. Two weeks prior to sowing, the properly cured organic manures were incorporated into the ridges manually.N fertilization was done in two split applications: 333.33kg of NPK 15: 15: 15 fertilizer at first application supplied 50 Kg each of N, P_2O_5 and K_2O at two weeks after sowing. The balance of 50 kg N was supplied by urea fertilizer at fruiting.Three seeds each were sown 50 cm apart along the ridges. Seedlings were thinned to one per stand two weeks after sowing. Manual weeding was also done at four, seven, and nine weeks after sowing. Both soil and manure samples were subjected to routine physical and chemical analysis following the procedures of (Okaleboet al., 1989). Data were collected onplant height at 50% flowering and at maturity. Dry fruits were collected fromplants at 42 days afteranthesis (DAA) for seed yield studies. By this time the fruits had turned brown and therefore ready for harvest (Ibrahim et al., 2013). Following each harvest, the fruits were broken to extract the seeds. The seeds were left to dry further at room temperature (28 °C) for 2 weeks. Total and 100-seed weight per ha were determined. All the data collected were subjected to analysis of variance (ANOVA) using SAS Statistical Package 9.2. Means were separated using the Student-Newman-Keuls (SNK) test.

Results

Table 1 shows the initial physical and chemical properties of the surface soil (0-15 cm) of the study site. It reveals that the soil texture is sandy clay loam and the pH is slightly acidic. Going by the standard prescribed by Esu (1991), the soil of the experimental site is high in organic carbon and total nitrogen content, moderate in available phosphorus and potassium while calcium and magnesium contents are low. Table 2 shows the chemical compositions of poultry manure and cow dung used in the study.

Table 1: Physico-chemical properties of surface soil sample (0-15 cm) from the study site before fertilizer application

Soil properties	Value		
	2009	2010	2011
Sand (g /kg)	630	632	630
Silt (g /kg)	73	73	78
Clay (g /kg)	278	276	281
Textural class	SCL	SCL	SCL
pH (H_2O)	6.4	6.3	6.4
Organic carbon (g /kg)	23.6	23.5	23.1
Total N (g /kg)	0.44	0.46	0.46
Available P (mg/kg)	11.72	12.22	12.25
Exchangeable bases (cmol/kg)			
Ca	2.23	2.25	2.5
Mg	1.38	1.43	1.36
Na	0.62	0.64	0.65
K	0.39	0.40	0.42

SCL= Sandy clay loam

Table 2: Chemical properties of samples of poultry droppings and cow dung used.

Soil properties	Poultry droppings			Cow dung		
	2009	2010	2011	2009	2010	2011
C (g /kg)	32.4	32.4	32.6	28.30	27.92	28.34
N (g /kg)	0.61	0.63	0.61	0.52	0.55	0.51
P (mg/kg)	17.0	17.0	17.2	14.0	14.21	14.11
Na (g/kg)	6.35	6.33	6.33	4.0	4.12	4.15
K „	10.76	10.76	10.66	0.42	0.44	0.44
Mg „	3.70	3.68	3.71	2.80	2.77	2.84
Ca „	4.0	4.0	4.0	3.40	3.46	3.44

Plant height at 50% flowering

Plants height at 50% flowering was significantly affected by variety in 2009 and 2010 with LD88-1 plants being taller than NHAe47-4 (Table 3). Furthermore, significant effect of fertilizer on height at 50% flowering was only recorded in 2010. Increases in the rates of fertilizer application irrespective of fertilizer sources enhanced the growth of plants. Application of 8 t ha^{-1} of poultry droppings produced significantly taller plants (59.0 cm) than any of the other sources of fertilizer and rates usedat 50% flowering. This was closely followed by 53.5 cmrecorded when 6 t ha^{-1} of poultry droppings was applied. Plants grown on control plots produced the shortest plants (38.4 cm) than those treated with any of the fertilizer sources and rates.

Variety×fertilizer interaction effect on this trait was only significant in 2010. Table 4 shows that application of 8 t ha^{-1} of poultry droppings and NPK fertilizer produced significantly taller plants than any of the other fertilizer sources and rates in NHAe47-4 with values ranging between 52 and 54 cm, while the application of poultry droppings at 4, 6 and 8 t ha^{-1}, cow dung at 6 and 8 t ha^{-1} as well as NPK fertilizer resulted in the production of the tallest plants in LD88-1 with height values of between 54 and 60 cm (Table4).

Table 3: Main effects and interaction of variety and fertilizer on plant height at 50% flowering

Factor level/ interaction	Cropping season (years)		
	2009	2010	2011
Variety (V)			
NHAe47-4	55b	41.84b	63.09a
LD88-1	61a	51.95a	58.03a
± SE	1.8	0.6	11.9
Fertilizer (F)			
Control	53.35a	38.38f	39.47a
2 t ha⁻¹ PD	55.68a	44.85de	50.07a
4 t ha⁻¹ PD	62.22a	49.60bcd	55.85a
6 t ha⁻¹ PD	63.35a	53.53b	60.03a
8 t ha⁻¹ PD	64.52a	59.02a	60.98a
2 t ha⁻¹ CD	54.4a	36.45f	44.87a
4 t ha⁻¹ CD	52.98a	40.82ef	45.73a
6t ha⁻¹ CD	56.8a	45.22de	50.08a
8t ha⁻¹ CD	58.53a	48.32cd	53.57a
NPK	57.78a	52.78bc	61.62a
± SE	4.0	1.3	26.5
Interaction			
V × F	NS	**	NS

PD= Poultry droppings; CD= Cow dung; means followed by the same letter(s) for same factor in a column are not significantly different ($p > 0.05$) by Student-Newman-Keuls (SNK) test; NS= Not significant

Table 4 : Interaction effects of Variety × fertilizer on plant height at 50% flowering

Variety	Fertilizer	2010
NHAe47-4	Control	37.3d
	2 t ha⁻¹ PD	39d
	4 t ha⁻¹ PD	45c
	6 t ha⁻¹ PD	47c
	8 t ha⁻¹ PD	53.8ab
	2 t ha⁻¹ CD	32.2e
	4 t ha⁻¹ CD	44c
	6 t ha⁻¹ CD	37.8d
	8 t ha⁻¹ CD	40.1d
	NPK	52.3ab
LD88-1	Control	39.5d
	2 t ha⁻¹ PD	50.7b
	4 t ha⁻¹ PD	54.2a
	6 t ha⁻¹ PD	60a
	8 t ha⁻¹ PD	64.3a
	2 t ha⁻¹ CD	40.7d
	4 t ha⁻¹ CD	47.7c
	6 t ha⁻¹ CD	52.7ab
	8 t ha⁻¹ CD	56.5a
	NPK	53.3ab

PD= Poultry droppings; CD= Cow dung; means followed by the same letter(s) for same factor in a column are not significantly different ($p > 0.05$) by Student -Newman-Keuls (SNK) test; NS= Not significant

Plant height at maturity

Table 5 shows that plant height at maturity was significantly affected by variety in the three cropping seasons with LD88-1 being significantly taller (ranging between about 78and 84 cm) than NHAe47-4 (about 63-66 cm). In all the cropping seasons, plants treated with 6-8 t ha^{-1} of poultry droppings were significantly taller than what was obtained in any of the cow dung plots; and except in 2009, plants from plots that received application of any of the poultry dropping treatments were taller than those that received NPK fertilizer application. Significant height differences were generally not recorded among the plants treated with cow dung in all the cropping seasons. Also plants to which the recommended rate of NPK fertilizer was applied were not superior in height to those that received cow dung manure.

The interaction of variety and fertilizer treatments on plants height at maturity is shown in Table 6. The results show that there were no significant differences in height among the NHAe47-4 plants in 2009 season irrespective of rates and source of fertilizer application. However, application of poultry droppings at 6-8 t ha^{-1} resulted in the production of significantly taller plants of LD88-1 compared to all other treatments. In 2010, significantly taller plants were produced by the application of poultry droppings at 2-6 t ha^{-1} than other treatments in the two varieties. Whereas NHAe47-4 plants treated with poultry droppings at 8 t ha^{-1}, cow dung at 2-8 t ha^{-1} and NPK were similar in height, the LD88-1 plants treated with poultry droppings at 8 t ha^{-1} were significantly shorter than those of all cow dung treatments. Furthermore, plants grown under an application of cow dung at 6 t ha^{-1} were significantly taller than those at other cow dung rates. In 2011, NHAe47-4 plants to which poultry droppings were applied at 8 t ha^{-1}had the greatest height, but the values was similar to those of plants treated with 2-6 t ha^{-1} of poultry droppings, 8 t $ha^{-1}$of cow dung and NPK. LD88-1 plants to which poultry droppings were applied at 4, 6 and 8 t ha^{-1} were significantly taller than plants of all other treatments.

Table 5 : Main effects and interaction of variety and fertilizer on plant height at maturity (cm)

Factor level/ interaction	Cropping season (Years)		
	2009	2010	2011
Variety (V)			
NHAe47-4	62.83b	65.60b	63.20b
LD88-1	78.26a	84.34a	78.08a
± SE	1.0	0.5	0.5
Fertilizer (F)			
Control	60.65c	61.58f	54.90f
2 t ha^{-1} PD	69.05bc	72.51d	71.37d
4 t ha^{-1} PD	74.38b	84.95c	79.37c
6 t ha^{-1} PD	83.03a	90.62b	83.73b
8 t ha^{-1} PD	84.95a	98.87a	89.27a
2 t ha^{-1} CD	66.57bc	67.32e	64.47e
4 t ha^{-1} CD	65.93bc	66.57e	67.08e
6t ha^{-1} CD	67.13bc	69.35de	67.24e
8t ha^{-1} CD	67.43bc	72.07d	68.50de
NPK	66.33bc	60.28e	65.50e
± SE	2.2	1.0	1.1
Interaction			
V × F	**	**	**

PD= Poultry droppings; CD= Cow dung;
means followed by the same letter(s) for same factor in a column are not significantly different (p> 0.05) by Student-Newman-Keuls (SNK) test; NS= Not significant

Table 6: Interaction effects of variety × fertilizer on plant height at maturity (cm)

Variety	Fertilizer	2009	2010	2011
NHAe47-4	Control	58.9d	58.3d	53.7c
	2 t ha^{-1} PD	65.1d	68.9c	64.3bc
	4 t ha^{-1} PD	63.3d	72.7c	63.0bc
	6 t ha^{-1} PD	64.8d	75.4c	69.6b
	8 t ha^{-1} PD	65.1d	63.8d	72.7b
	2 t ha^{-1} CD	61.1d	63.0d	55.0c
	4 t ha^{-1} CD	61.8d	65.9d	61.0c
	6 t ha^{-1} CD	62.1d	63.6d	63.0c
	8 t ha^{-1} CD	61.4d	63.9d	65.0bc
	NPK	64.5d	65.0d	65.0bc
LD88-1	Control	62.3d	76.3c	56.1c
	2 t ha^{-1} PD	73.0c	100.2a	78.4b
	4 t ha^{-1} PD	85.4b	108.5a	95.8a
	6 t ha^{-1} PD	101.2a	122.3a	97.8a
	8 t ha^{-1} PD	104.7a	58.3d	105.8a
	2 t ha^{-1} CD	72.0c	70.1c	73.9b
	4 t ha^{-1} CD	70.0c	72.8	73.1b
	6 t ha^{-1} CD	72.2c	80.5b	71.5b
	8 t ha^{-1} CD	73.4c	68.7c	72.0b
	NPK	68.1c	40.0e	66.3bc

PD= Poultry droppings; CD= Cow dung;
means followed by the same letter(s) for same factor in a column are not significantly different (P>0.05) by Student -Newman-Keuls (SNK) test; NS= Not significant

4.9 Leaf number at maturity

Table 4.13 shows the effect of variety and fertilizer on the number of leaves per plant at maturity. Variety LD88-1 produced significantly higher number of leaves per plant than NHAe47-4 at maturity in the three cropping seasons. Poultry droppings applied at 8 t ha^{-1} resulted in the production of significantly greater leaf numbers than other fertilizer sources and rates in the three cropping seasons. The number of leaves at maturity produced by NPK fertilized plants in 2009 and 2011 cropping seasons did not generally differ significantly from plants to which cow dung were applied. Plants that did not receive any fertilizer (control) treatment produced the fewest number of leaves than all other fertilizer sources and rates throughout the growing seasons.

The interaction effect of fertilizer×variety on this trait is shown on Table 4.14. Application of poultry droppings at 8 t ha^{-1} yielded significantly more leaves in NHAe47-4 against 6 and 8 t ha^{-1} of the same fertilizer source for LD88-1 during the 2009 cropping season. In 2010, the number of leaves at maturity for NHAe47-4 variety was similar for all fertilizer types and rates, except for the 8 t ha^{-1} of poultry droppings which produced significantly fewer leaf number. Similarly, application of 8 t ha^{-1} of poultry droppings resulted in the fewest leaf number among the LD88-1 fertilizer treatments. Leaf number of the NPK treatments was similar to those of cow dung treatments in both varieties. Application of 8 t ha^{-1} of poultry droppings to the two varieties resulted in the production of higher number of leaves in 2011. However, except in the control treatment the values recorded for all treatments in NHAe47-4 were statistically similar.

Table 4.13: Main effects and interaction of variety and fertilizer on number of leaves at maturity

Factor level/ interaction	Cropping season (years)		
	2009	2010	2011
Variety (V)			
NHAe47-4	14b	15b	15b
LD88-1	18a	17a	17a
± SE	0.2	0.2	0.1
Fertilizer (F)			
Control	12f	10e	11e
2 t ha-1 PD	16cd	16bc	16c
4 t ha-1 PD	17c	16bc	16c
6 t ha-1 PD	19b	18b	18b
8 t ha-1 PD	21a	19a	19a
2 t ha-1 CD	13e	15d	14d
4 t ha-1CD	15d	15d	15cd
6t ha-1 CD	15d	16bc	16c
8t ha-1 CD	15d	16bc	16c
NPK	16cd	15d	16c
± SE	0.4	0.4	0.3
Interaction			
V × F	**	**	**

PD= Poultry droppings; CD= Cow dung;
means followed by the same letter(s) for same factor in a column are not significantly different (p>0.05) by Student-Newman-Keuls (SNK) test; NS= Not significant

Dry fruit yield per plant

Table 7 shows that variety LD88-1 produced significantly greater number of dry fruits at harvest than NHAe47-4 throughout the three growing seasons. Significantly greater numbers of dry fruits were obtained with the application of poultry droppings at 6 and 8 t ha^{-1}and cow dung at 8 t ha^{-1} than in other treatments in 2009. Application of 4-8 t ha^{-1} of poultry droppings in 2010 cropping seasons resulted in the production of significantly greater number of dry fruits compared to other fertilizer treatments. In 2011, the greatest number of fruits was recorded under the application of poultry droppings at 8 t ha^{-1}but the values obtained was at per with those for poultry droppings at 4 and 6 t ha^{-1}. There were generally no significant differences between fruit yield of NPK fertilized plants and those treated with cow dung rates of 2-8 t ha^{-1} in 2009, 2-4 t ha^{-1} in 2010 and 4 t ha^{-1} in 2011. The lowest fruit number (2/3) per plant was recorded from unfertilized plots in the three seasons.

The interaction of variety and fertilizer significantly inluenced dry fruit number per plant in 2010 and 2011 (Table 8). In 2010, application of poultry droppings at 8 t ha^{-1} to NHAe47-4 plants resulted in significantly greater number of dry fruits than other fertilizer sources. In LD88-1, significantly greater fruit numbers were recorded in plots to which poultry droppings were applied at 4, 6 and 8 t ha^{-1}. The same trends were recorded in the two okra varieties in 2011 except that variety NHAe47-4 plants to which cow dung at 8 t ha^{-1} was applied produced similar number of dry fruits as those to which poultry droppings were applied at 8 t ha^{-1}.

Table 7 : Main effects and interaction of variety and fertilizer on dry fruit yield per plant

Factor level/ interaction	Cropping season (years)		
	2009	2010	2011
Variety (V)			
NHAe47-4	3b	4b	4b
LD88-1	4a	7a	6a
± SE	0.1	0.1	0.1
Fertilizer (F)			
Control	2c	3d	3d
2 t ha-1 PD	3b	5b	5bc
4 t ha-1 PD	3b	6a	6ab
6 t ha-1 PD	4a	6a	6ab
8 t ha-1 PD	4a	7a	7a
2 t ha-1 CD	3b	4c	3e
4 t ha-1CD	3b	4c	4c
6t ha-1 CD	3b	5b	5b
8t ha-1 CD	4a	5b	5b
NPK	3b	4c	4c
± SE	0.2	0.2	0.2
Interaction			
V × F	NS	**	**

PD= Poultry droppings; CD= Cow dung; means followed by the same letter(s) for same factor in a column are not significantly different (p>0.05) by Student Newman-Keuls (SNK) test; NS= Not significant

Table 8: Interaction effects of variety × fertilizer on dry fruit yield per plant

Variety	Fertilizer	2010	2011
NHAe47-4	Control	2g	2e
	2 t ha-1 PD	2g	3d
	4 t ha-1 PD	4e	4c
	6 t ha-1 PD	4e	4c
	8 t ha-1 PD	5d	5b
	2 t ha-1 CD	3f	3d
	4 t ha-1 CD	2g	3d
	6 t ha-1 CD	4e	4c
	8 t ha-1 CD	4e	5b
	NPK	3f	3d
LD88-1	Control	3f	3d
	2 t ha-1 PD	7b	6b
	4 t ha-1 PD	8a	8a
	6 t ha-1 PD	8a	8a
	8 t ha-1 PD	8a	8a
	2 t ha-1 CD	5d	4c
	4 t ha-1 CD	5d	5b
	6 t ha-1 CD	6c	4c
	8 t ha-1 CD	6c	5b
	NPK	5d	4c

PD= Poultry droppings; CD= Cow dung; means followed by the same letter(s) for same factor in a column are not significantly different (p> 0.05) by Student-Newman-Keuls (SNK) test; NS= Not significant

Seed yield

Significantly higher seed yield per hectare was recorded for LD88-1 than NHAe47-4 in both 2009 and 2011 (Table 9). Although the former yielded higher than the latter in 2010, the difference was insignificant. The effect of fertilizer on seed yield was significant in 2009 and 2011 seasons. Application of poultry droppings at 8 t ha`1 resulted in significantly higher seed yield than the yield at all other treatments in 2009 and 2011. In 2010, application of any of the fertilizer treatments resulted in statistically similar yield values.

The interactionof variety×fertilizer was significant in 2009 and 2011 growing seasons (Table 10). In 2009, the highest seed yield (35 kg ha^{-1}) was achieved in NHAe47-4 with the application of 8 t of poultry droppings per hectare but the value did not differ significantly from that obtained when cow dung was applied at 8 t ha^{-1}. The application of 8 t of poultry droppings per hectare also resulted in the best yield in LD88-1 which was significantly higher than those of other treatments. In 2011, application of 8 t ha^{-1} of poultry droppings resulted in the significantly higher seed yield in NHAe47-4 compared to all other fertilizer treatments. Among the LD88-1 plots however, all the rates of poultry droppings produced similar yield values which were significantly greater than those of the cow dung, control and NPK fertilizer.

Table 9 : Main effects and interaction of variety and fertilizer on seed yield per ha (kg)

Factor level/ interaction	Cropping season (years)		
	2009	2010	2011
Variety (V)			
NHAe47-4	200.83b	361.6a	334.14b
LD88-1	249.38a	389.89a	389.44a
± SE	6.0	29.0	11.6
Fertilizer (F)			
Control	115.11e	392.3a	201.46f
2 t ha^{-1} PD	207.87cd	396.9a	240.76f
4 t ha^{-1} PD	204.13cd	415.4a	410.42cd
6 t ha^{-1} PD	329.71b	444.07a	463.43b
8 t ha^{-1} PD	428.65a	473.5a	542.41a
2 t ha^{-1} CD	159.05d	382.9a	446.99bc
4 t ha^{-1} CD	174.13d	388.1a	263.18ef
6t ha^{-1} CD	216cd	400.6a	337.15de
8t ha^{-1} CD	250.19c	403.4a	361.14cde
NPK	166.22d	396.7a	348.95cde
± SE	13.5	36.8	26.0
Interaction			
V × F	**	NS	**

PD= P oultry droppings; CD= Cow dung; means followed by the same letter(s) for same factor in a column are not significantly different (p> 0.05) by Student -Newman-Keuls (SNK) test; NS= Not significant

Table 10: Interaction effects of variety × fertilizer on seed yield per ha (kg)

Variety	Fertilizer	2009	2011
NHAe47 -4	Control	123.9e	191.0d
	2 t ha $^{-1}$ PD	163.8de	321.9bc
	4 t ha $^{-1}$ PD	161..8de	353.5bc
	6 t ha $^{-1}$ PD	269.7c	376.9bc
	8 t ha $^{-1}$ PD	358.8bc	495.6a
	2 t ha $^{-1}$ CD	149.8e	256.8cd
	4 t ha $^{-1}$ CD	148.9e	251.4cd
	6 t ha $^{-1}$ CD	211.6d	380.8bc
	8 t ha $^{-1}$ CD	240.4cd	402.8b
	NPK	179.7de	310.6bc
LD88 -1	Control	106.3e	215.9cd
	2 t ha $^{-1}$ PD	251.9cd	467.3ab
	4 t ha $^{-1}$ PD	246.5cd	550.0a
	6 t ha $^{-1}$ PD	389.7b	589.2a
	8 t ha $^{-1}$ PD	498.5a	637.2a
	2 t ha $^{-1}$ CD	168.3de	159.6d
	4 t ha $^{-1}$ CD	199.4de	274.9cd
	6 t ha $^{-1}$ CD	220.4cd	293.5c
	8 t ha $^{-1}$ CD	260.0cd	319.5bc
	NPK	152.8e	387.3bc

PD= P oultry droppin gs; CD= Cow dung; means followed by the same letter(s) for same factor in a column are not signif icantly different (p> 0.05) by Student -Newman -Keuls (SNK) test; NS= Not significant

4.16 One-hundred seed weight

Both variety and fertilizer significantly affected 100-seed weight throughout in the three seasons (Table 4.26). Seeds of NHAe47-4 were significantly heavier than those of LD88-1. In 2009, application of organic fertilizers (poultry droppings and cow dung) produced seed weights that were not significantly different from each other. However, seeds from plants to which 6 and 8 t ha^{-1} of poultry droppings were applied were significantly heavier than those from NPK plots. Plots that received zero fertilizer application had the highest seeds. In 2010, seed weights of plants treated with 2-8 t ha^{-1} of poultry droppings and 4-8 t ha^{-1} of cow dung were statistically similar but were significantly higher than those of the control, 2 t ha^{-1} of cow dung and NPK treatments. In 2011, significantly heavier seeds were obtained from application of poultry droppings at 6 and 8 t ha^{-1} compared to all other treatments except that obtained from plots to which poultry droppings was applied at 4 t ha^{-1}. Generally there were no significant differences amongst the 100-seed weights of all the cow dung rates and NPK fertilizer treatments. Control plots produced seeds which weighed significantly lower than all other fertilizer sources.

Table 4.26: Main effects and interaction of variety and fertilizer on 100-seed weight (g)

Factor level/ interaction	Cropping season (years)		
	2009	2010	2011
Variety (V)			
NHAe47-4	5.06a	5.12a	4.44a
LD88-1	4.12b	4.41b	3.79b
± SE	0.1	0.0	0.0
Fertilizer (F)			
Control	3.13c	4.49b	3.42e
2 t ha^{-1}PD	4.80ab	5.88a	4.28bc
4 t ha^{-1}PD	4.84ab	5.16a	4.52ab
6 t ha^{-1} PD	4.98a	5.21a	4.61a
8 t ha^{-1} PD	5.05a	5.03a	4.700a
2 t ha^{-1} CD	4.60ab	4.89a	4.03cd
4 t ha^{-1}CD	4.67ab	4.87a	3.92d
6t ha^{-1} CD	4.73ab	4.89a	3.87d
8t ha^{-1}CD	4.73ab	4.14c	3.98cd
NPK	4.37b	3.88c	3.84d
± SE	0.1	0.1	0.1
Interaction			
V × F	NS	NS	NS

PD= P oultry droppings; CD= Cow dung; means followed by the same letter(s) for same factor in a column are not significantly differe nt (p> 0.05) by Student -Newman-Keuls (SNK) test; NS= Not significant

Discussion

The similarity in the height of NPK fertilized plants with those fertilized with organic fertilizers (poultry droppings and cow dung) at 50% flowering in 2009 and 2011 and the subsequent significantly taller plants produced with the application of 8 t of poultry droppings per hectare generally at maturity in this study may be linked to mobility of nitrogen from inorganic sources of fertilizers. Major nutrients like N, P and K from inorganic fertilizers are readily available to plants at early stages of plant growth. However, nitrogen from such sources is readily depleted through crop removal, leaching and/or denitrification. This can retard the growth of plants with age. Organic manures release nutrients slowly through all the stages of plant growth. This might have guaranteed the consistence in plant growth over time which might have conferred the superiority in height at maturity in this study. These results are in agreement with the reports of Kale and Banu (2004) in brinjal. Nitrogen from poultry manure has been reported to be superior over inorganic fertilizers because of the greater ability of the former to conserve N (Olaniyiet al., 2010). Organic manures serve a major role of boosting cation exchange capacity (CEC) of the soil andimprove soil water availability through retention and aeration which promote better crop utilization of nutrients.

The significantly better performance in leaf number at maturity and dry fruit yield scored for plants to which poultry droppings at 6 and 8 t ha^{-1} were applied compared to all other fertilizer treatments in this study indicates that poultry droppings at those rates contain more of the nutrients needed for optimum plant growth than cow dung and NPK fertilizer. This view has also been adjudged by Omisoreet al. (2009) to be the most valuable of all manures produced by livestock or synthetically because of their capability to balance soil nutrients and check the possibility of soil pH fluctuations, thereby enhancing efficient plant nutrient absorption and utilization for optimum performance. Significant differences between LD88-1 and NHAe47-4 in respect of plant height in this study may be due to differences in genetic makeup as has been reported in other studies (Keericet al., 2003).

Results of this study revealed further that significantly higher seed yield was obtained with application of poultry droppings at 8 t ha^{-1} in 2009 and 2011 and that significantly greater seed weights were recorded on all plots from which organic fertilizers was applied during 2009 and 2011 compared to the values obtained with NPK fertilization. Increase in seed yield may be attributed to increase in 100-seed weight and seed weight per fruit as a result of improvement in seed number due to adequate mother plant nutrition. It can also be ascribed to influence of other yield attributes such as number of fruits per plant and fruit weight per plant. Mishra and Ganesh (2005) stated that organic manure from different sources boosted okra seed yield because they contain most of the nutrients essential for plant growth and development. The greater seed yield per hectare in LD88-1 compared to NHAe47-4 in this study may be due to greater plant height which is responsible for higher fruit yield in the former.

The poor performances of unfertilized plants (control) in all the traits tested in this study is a known phenomenon due to poor plant nutrition. Mbah and Mbagwu (2009) reported that although okra can thrive on a wide range of soil type, its optimum performance in terms of growth and fruit yield is known to be greatly limited by soil fertility and cultural management. Olaniyiet al. (2010) stressed that the performance of okra is largely determined by the application of fertilizers.

Conclusion and Recommendations

It is concluded from this study that application of poultry droppings at 6 or 8 t ha^{-1} to okra (Abelmoschusesculentus L. Moench) mother-plants enhanced plant height and seed yield compared to other fertilizer treatments. Results further revealed that greater plant height (84cm) and seed yield (about 400 kg ha^{-1}) were recorded in LD88-1 compared to the other variety.

Based on the results of this study, it is recommended that poultry droppings at 6 to 8 t ha^{-1} should be applied to mother-plants of okra for optimum plant growth and seed yield. On the basis of agronomic traits for high productivity proven by LD88-1. The variety is recommended for seed production.

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