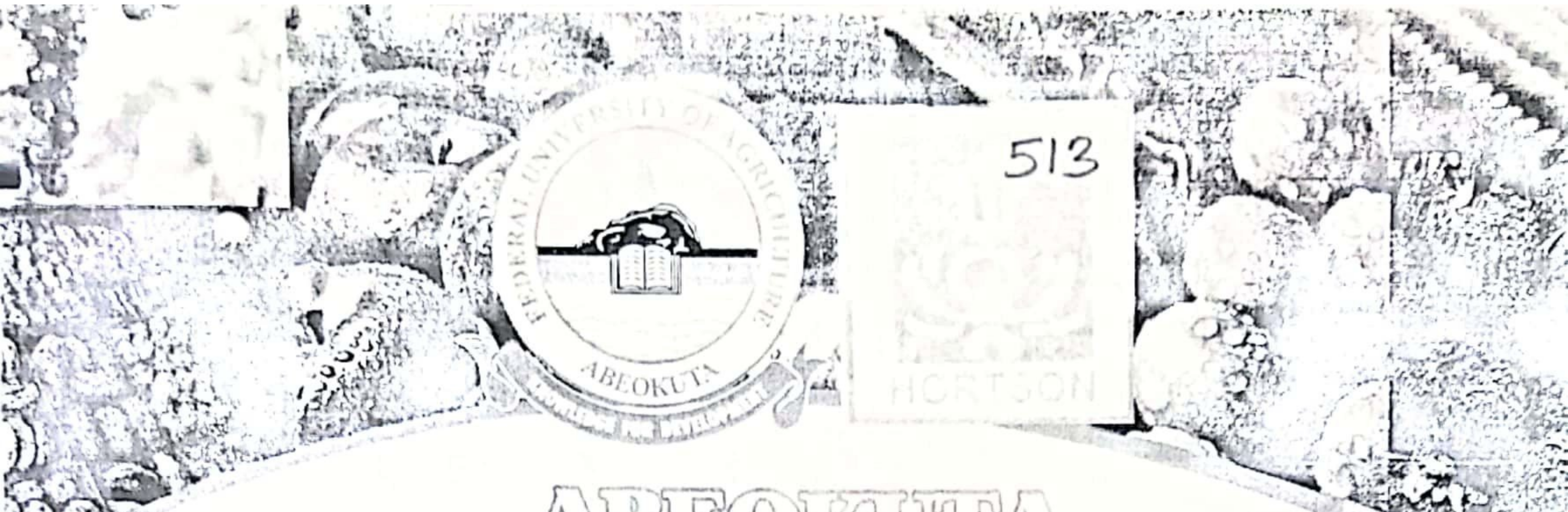

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THEME:

Horticulture for a Healthy and Wealthy Nation

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FLOWERING RESPONSE AND FRUIT YIELD OF OKRA (*ABELMOSCHUS ESCULENTUS* L. MOENCH) FERTILIZED WITH DIFFERENT NUTRIENT SOURCES

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ABSTRACT

The effects of different levels of poultry droppings and cow dung and recommended dosage of inorganic fertilizer on the flower response and fruit yield of okra (**Abelmoschus esculentus L. Moench**) were evaluated at the Federal University of Technology, Minna, Nigeria from 2009-2011. The objective was to determine the nutrient source and rate for optimum okra performance for use among the urban and peri-urban okra producers in Minna metropolis. Two varieties of okra (NHAe47-4 and LD88-1) and 10 fertilizer treatments of poultry droppings and cow dung each at 2, 4, 6 and 8 t ha^{-1}; combination of NPK 15-15-15 + urea fertilizers supplying 100 kg N ha^{-1}, 50 kg P_2O_5 ha^{-1}, 50 kg K_2O h^{-1} and 0 fertilizer) were factorially combined using a Randomized Complete Block Design (RCBD) with three replicates. Results revealed that plants from plots to which 6 or 8 t of poultry droppings per hectare was applied performed significantly better than those to which other fertilizer treatments were applied ($p<0.05$). Nonetheless, delayed flowering significantly in the two varieties used. It however reduced the incidence of flower abortion which eventually resulted in higher fruit yield (9.2 t ha^{-1}). Higher fruit yield (about 12 t ha^{-1}) was recorded in LD88-1compared to the 5 t 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 enhanced flowering and fruit yield compared to other fertilizer treatments. It is therefore concluded that poultry droppings at 6-8 t ha^{-1} should be applied for successful flowering and optimum fruit yield of okra.

Key words: Nutrient sources, fruit, poultry droppings, cow dung, yield

INTRODUCTION

Successful flowering and improved crop yield require that all essential nutrients especially Nitrogen, Phosphorus and Poassium are available to plants in the right proportion. On an exhausted soil, such nutrient availabilities become a limiting factor and okra yield is adversely affected by flower abortion. Successful flowering and subsequent fruit set in okra depends on the supply of balanced source of about 20 soil nutrient elements including nitrogen, phosphorus, potassium, calcium, manganese, boron and zinc (Achieng *et al*., 2010). Organic fertilizers supply most of these essential nutrients needed for all the growth stages of plants which are released gradually (Achieng *et al*., 2010). The gradual release of nutrients ensures their availability throughout the stages of growth thereby meeting the vegetative and reproductive demands for such nutrients. This is unlike those contained in inorganic NPK fertilizers where in nutrients may have been exhausted before flower stimulation due to nitrogen mobility or even deficiency of some necessary nutrients for flowering process (Rachel and Demand, 2014). Kumar and Singh (2006) reported much fewer flower and fruit drops in pepper plots treated with poultry droppings compared with synthetic fertilizer and absolute control fields. Agbede *et al*. (2008) reported that flower abortion was very mild in egg plants grown on soils amended with organic manures compared with plots treated with inorganic fertilizers. Adequate supply of organic nutrients has been reported by Olaniyi *et al*. (2010) to result in optimum fresh fruit yield in okra. Adediran *et al*. (2003) found that poultry droppings at 8 t ha^{-1} gave the highest tomato fruit yield in the rainforest region of South Western Nigeria. According to Mishra and Ganesh (2005), organic manures promote higher fruit yields in most vegetables compared to inorganic fertilizers because they contain most of the essential nutrients for plant growth and production. A similar effect was also recorded for egg plant (Smill, 2000) and pepper (Moniruzzaman *et al*., 2007). Deficiency of plant nutrients such as nitrogen, potassium, calcium, iron, zinc and manganese during flowering has been identified to impede the production of hormone called auxin which is responsible for flower stimulation and fruit set (Pandey and Sinha, 2006).

The current production of okra in Nigeria is much lower than the potential productivity because of indiscriminate use of inorganic fertilizers with resultant deterioration of soil quality (Mbah and Mbagwu, 2009). Farmers need to be encouraged to take to vegetable production due to their richness in vitamins and mineral contents and increasing demand by consumers for this group of crops. For this to happen, production technology that would ensure high yield but will also be eco-friendly must be developed. Organic manures are known to be eco-friendly. In the context of the above, an attempt was made to evaluate the effect of organic manures using poultry droppings and cow dung at graded levels and inorganic fertilizer using NPK fertilizer at recommended rate on flowering success and fruit yield of okra.

MATERIALS AND METHODS

This study 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. The two varieties of okra and ten fertility management options were evaluated in a factorial experiment fitted to RCBD with three replicates. The ten fertility management options were poultry droppings at 2, 4, 6 and 8 t ha^{-1}; cow dung at 2, 4, 6 and 8 t ha^{-1}; NPK 15-15-15 + urea fertilizers supplying 100 kg N, 50 kg P_2O_5 and 50 kg K_2O ha^{-1} plus an untreated control. Each plot had dimensions of 6m × 2m and was made up of eight ridges that were 2 m long and were constructed 75 cm apart giving a dimension of 12 m^2. Two weeks prior to sowing, properly cured organic manures (poultry droppings and cow dung) were incorporated into the ridges manually using the detailed rates. Three seeds each were sown into holes at 50 cm apart. Following emergence, seedlings were thinned to one per stand at two weeks after sowing. Manual weeding was done at four, seven, and nine weeks after sowing. Inorganic fertilizer application was done by applying NPK 15-15-15 at 2 weeks after sowing to supply 50-50-50 kg ha^{-1} N, P_2O_5 and K_2O. Urea was applied 3 weeks later to supply additional 50 kg ha^{-1} N. The fertilizers were applied by side placement in two small holes, 5 cm away from the base of each stand and covered up. Soil samples were collected, air dried, gently crushed and sieved using a 2 mm screen. The samples were subjected to routine physical and chemical analysis following the procedures of Okalebo *et al.* (1989).

The poultry droppings and cow dung used were analyzed for P, Ca, Mg, K and Na using the procedures for organic materials described by Okalebo *et al.* (1989).

Data were collected on days to first flower bud sighting, days to first flower opening, days to 50% flowering, fruit abortion incidence and fruit yield per ha.

Picking of fruits was done at four days interval from plants in the four middle rows of each plot. Fresh fruit weight (yield) was determined using a Salter Balance. 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

The soil texture is sandy clay loam and the pH was slightly acidic (Table 1). Going by the standard prescribed by Esu (1991), the soil of the experimental site was high in organic carbon and total nitrogen content, moderate in available phosphorus and potassium while calcium and magnesium contents are low. The chemical compositions of poultry manure and cow dung used in the study shows a N content range of 0.51 to 0.63g/kg. Varieties significantly ($p<0.05$) differed in the number of days to appearance of first flower bud with earlier appearance in NHAe47-4 (40 days) than in LD88-1 (43 days) in 2009 (Table 3). The trait was however, not significantly ($p>0.05$) affected in 2010 and 2011 cropping seasons. Furthermore,

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

	Value		
Soil properties	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 1:2 (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 applied to the study site

	Poultry droppings			Cow dung		
Soil properties	2009	2010	2011	2009	2010	2011
Carbon (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
Moisture (%)	13.1	13.2	13.2	53.0	53.1	52.8

Table 3: Main effects and interaction of variety and fertilizer on days to first flower bud sighting

	Cropping season (years)		
Factor levels/ Interaction	2009	2010	2011
Variety (V)			
NHAe47-4	40b	41a	41.53a
LD88-1	43a	42a	41.7a
± SE	0.6	8.9	0.2
Fertilizer (F)			
Control	43ab	40a	40d
2 t ha^{-1} PD	39b	42a	42c
4 t ha^{-1} PD	47a	42a	43b
6 t ha^{-1} PD	48a	44a	45a
8 t ha^{-1} PD	47a	44a	45a
2 t ha^{-1} CD	35c	40a	40d
4 t ha^{-1} CD	33c	40a	40d
6t ha^{-1} CD	41b	41a	40d
8t ha^{-1} CD	42b	40a	40d
NPK	41b	40a	40d
± SE	1.3	20.0	0.4
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

fertilizer effect on this trait was only significant in 2009 and 2011 cropping seasons. In 2009, first flower bud appearance was significantly earlier (33-35 days) with the application of 2 and 4 t ha^{-1} of cow dung manure compared to other fertilizer sources and rates. The application of 2 t ha^{-1} of poultry droppings resulted in significantly earlier formation of flower buds than other poultry droppings rates. Flower bud initiation was delayed significantly with increasing levels of fertilizer application irrespective of source. Days to first flower bud sighting of cow dung treated plants in 2011 season was not significantly different (40 days) from those of control or NPK + urea treatments values, but were significantly earlier than those treated with poultry droppings (42-45 days). Application of 6 and 8 t ha^{-1} of poultry droppings delayed flower bud formation significantly in 2009 and 2011.

The interaction effect of variety×fertilizer on number of days to first flower bud sight was highly significant ($p \leq 0.01$) in 2009 and 2011 (Table 4). Application of 2 and 4 t ha^{-1} of cow dung to NHAe47-4 resulted in

Table 4: Interaction effects of variety × fertilizer on days to first flower bud sighting

Fertilizer	Variety	2009	2011
Control	NHAe47-4	42b	39c
2 t ha^{-1} PD	NHAe47-4	38b	40c
4 t ha^{-1} PD	NHAe47-4	47ab	42b
6 t ha^{-1} PD	NHAe47-4	47ab	46a
8 t ha^{-1} PD	NHAe47-4	47ab	46a
2 t ha^{-1} CD	NHAe47-4	28c	40c
4 t ha^{-1} CD	NHAe47-4	27c	39c
6 t ha^{-1} CD	NHAe47-4	38b	39c
8 t ha^{-1} CD	NHAe47-4	41b	40c
NPK	NHAe47-4	42b	44b
Control	LD88-1	43b	40c
2 t ha^{-1} PD	LD88-1	40b	44b
4 t ha^{-1} PD	LD88-1	46ab	44b
6 t ha^{-1} PD	LD88-1	48a	43b
8 t ha^{-1} PD	LD88-1	47ab	44b
2 t ha^{-1} CD	LD88-1	42b	40c
4 t ha^{-1} CD	LD88-1	38b	40c
6 t ha^{-1} CD	LD88-1	43b	40c
8 t ha^{-1} CD	LD88-1	43b	40c
NPK	LD88-1	39b	42b

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

significant earliness (27-28 days) to first flower appearance in 2009. In LD88-1, except when poultry droppings at 6 t ha^{-1} was used when flower buds were slightly at about 48 days after planting, there were no significant differences in the time to sighting of first flower bud amongst all the other fertilizer treatments. In 2011 however, unfertilized plants and those fertilized with 2 t ha^{-1} of poultry droppings and all the cow dung manure levels budded significantly earlier (39-40 days) in NHAe47-4 compared to about 46 days recorded when poultry droppings were applied at 6 and 8 t ha^{-1}. The shortest duration to flower bud appearance in LD88-1 was recorded when plants were grown without fertilizer and among those that were treated with any of the cow dung rates was applied. Application of any of the poultry dropping levels resulted in similar delay in flower bud appearance.

Days to first flower opening was significantly affected by variety and fertilizer in 2009 and 2011 cropping seasons but not in 2010 (Table 5). NHAe47-4 flowered significantly earlier than LD88-1 in both years. Comparable earliness to flowering time was observed for cow dung at 2 and 4 t ha^{-1} (48 and 50 days respectively) and for poultry droppings at 2 t ha^{-1} (50 days) in 2009 cropping season. Conversely, when 6 and 8 t ha^{-1} of poultry droppings were applied, flower opening was significantly delayed till 59 and 60 days respectively compared to a period of 48-55 days in other fertilizer sources and rates, flower opening was significantly faster (50 days) when no fertilizer was applied compared to 56-60 days at all the other fertilizer sources and rates. There were no significant differences amongst all the poultry droppings, cow dung and NPK treatments. Variety × fertilizer interaction effect on this parameter was not significant throughout the study.

Varietal effect on the number of days to 50% flowering was significant in 2009 and 2011 cropping seasons, but not in 2010, with NHAe47-4 flowering earlier than LD88-1 in both seasons (Table 6). Fertilizer effect on days to 50% flowering was not significant in 2009 but was however significant in the cropping seasons of 2010 and 2011. Application of poultry droppings at 6 and 8 t ha^{-1} delayed the attainment of 50% flowering significantly than other fertilizer sources and rates in both years. In 2010, there were no significant differences amongst unfertilized plants and those to which NPK + urea, poultry droppings at 2 and 4 t ha^{-1} as well as cow dung at any of the rates were applied, with values of 76 and 77 days compared to 80 days when poultry droppings were applied at 6 or 8 t ha^{-1}.

Table 7 shows that varietal effect on fruit abortion

Table 5: Main effects and interaction of variety and fertilizer on days to first flower opening in Okra

Factor levels/ interaction	Cropping season (years) 2009	2010	2011
Variety (V)			
NHAe47-4	51b	55a	56b
LD88-1	55a	57a	58a
± SE	0.4	12.3	0.4
Fertilizer (F)			
Control	55b	55a	50b
2 t ha^{-1} PD	50de	56a	58a
4 t ha^{-1} PD	56b	56a	58a
6 t ha^{-1} PD	59a	59a	60a
8 t ha^{-1} PD	60a	59a	60a
2 t ha^{-1} CD	48e	55a	58a
4 t ha^{-1} CD	50de	55a	56a
6t ha^{-1} CD	54bc	55a	57a
8t ha^{-1} CD	52cd	56a	57a
NPK	54bc	55a	59a
± SE	0.9	27.5	1.0
Interaction			
V × F	NS	NS	NS

PD= Poultry droppings; CD= Cow dung; mean s followed by the same letter(s) in a column are not significantly different (p=0.05) by Student - Newman-Keuls (SNK) test.

Table 6: Main effects and interaction of variety and fertilizer on days to 50% flowering

Factor levels/ interaction	Cropping season (years) 2009	2010	2011
Variety (V)			
NHAe47-4	74b	77a	65b
LD88-1	75a	77a	66a
± SE	0.7	0.2	0.3
Fertilizer (F)			
Control	75a	76b	59e
2 t ha^{-1} PD	73a	76b	65c
4 t ha^{-1} PD	74a	77b	69b
6 t ha^{-1} PD	78a	80a	74a
8 t ha^{-1} PD	77a	80a	74a
2 t ha^{-1} CD	72a	76b	61de
4 t ha^{-1} CD	73a	76b	62de
6t ha^{-1} CD	74a	76b	62de
8t ha^{-1} CD	76a	77b	63d
NPK	74a	76b	67bc
± SE	6.6	0.4	0.8
Interaction			
V × F	NS	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 grown on control plots and those to which NPK fertilizer was applied recorded significantly greater flower abortion. Zero fertilizer application as well as the application of NPK resulted in the greatest incidences of fruit abortion in the three seasons.

Variety LD88-1 plants produced significantly greater fruit yield (7-11 t ha^{-1}) per hectare than NHAe47-4 (about 4-7 t ha^{-1}) across the three seasons (Table 8). The effect of fertilizer was significant in 2009 and 2011. In 2009, application of poultry droppings at 8 t ha^{-1} resulted in the highest green (fresh) fruit yield (9.25 t ha^{-1}) which was significantly greater than those of other treatments. Growing of plants without fertilizer of any sort resulted in the poorest fruit yield per hectare. In 2011, application of 8 t ha^{-1} of poultry droppings and NPK fertilizer gave the best fresh fruit yield (6.17 and 5.83 t ha^{-1} respectively) per hectare compared to other fertilizer sources and rates which had a maximum yield of about 4 t ha^{-1}.

The interaction effect of variety and fertilizer on this trait was also significant in 2009 and 2011 (Table 9). The table shows that in 2011, NHAe47-4 plants to which 8 t ha^{-1} of poultry droppings was applied out-yielded plants from plots to which other fertilizer treatments were applied. LD88-1 on the other hand, yielded best with the application of 6 and 8 t ha^{-1}. Though application of 6 and 8 t ha^{-1} of poultry droppings also gave the best yield in LD88-1 in 2009, the value obtained was similar to those of poultry droppings at 4 t ha^{-1} and cow dung at 2-6 t ha^{-1}. In 2011, yields of about 19 t ha^{-1} were recorded for LD88-1 plants at 6 and 8 t ha^{-1} of poultry droppings which was significantly higher than the yields obtained from other treatments.

DISCUSSION

The delay in flower bud sighting, subsequent opening and days to 50% flowering recorded during growth of okra plants of the two varieties that were treated with poultry droppings especially at 6 and 8 t ha^{-1} in this study is an indication that nitrogen content of poultry droppings at those rates was surplus. Olaniyi *et al.* (2005) and Olaniyi *et al.* (2010) cautioned against the use of excess nitrogen on vigorous plants as the practice may result in plants producing heavy foliage which will

Table 7: Main effects and interaction of variety and fertilizer on flower abortion incidence (no) per plant

Factor level/ interaction	Cropping season (years) 2009	2010	2011
Variety (V)			
NHAe47-4	5a	4b	3b
LD88-1	5a	5a	4a
± SE	0.1	0.2	0.1
Fertilizer (F)			
Control	6a	6a	6a
2 t ha^{-1} PD	6a	4bc	3c
4 t ha^{-1} PD	2b	5ab	3c
6 t ha^{-1} PD	2b	3d	3c
8 t ha^{-1} PD	2b	3d	3c
2 t ha^{-1} CD	6a	5ab	5b
4 t ha^{-1} CD	6a	5ab	3c
6t ha^{-1} CD	5a	3d	3c
8t ha^{-1} CD	5a	3d	3c
NPK	6a	6a	6a
± SE	0.4	0.4	0.3
Interaction			
V × F	NS	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 8 : Main effects and interaction of variety × fertilizer on fresh fruit yield per ha (tons)

Factor level/ interaction	Cropping season (years) 2009	2010	2011
Variety (V)			
NHAe47-4	4.36b	4.28b	6.92b
LD88-1	6.78a	9.43a	10.79a
± SE	0.1	0.4	0.1
Fertilizer (F)			
Control	3.22e	5.34a	2.67c
2 t ha^{-1} PD	4.85d	6.14a	3.00c
4 t ha^{-1} PD	6.1c	8.09a	3.00c
6 t ha^{-1} PD	7.93b	5.14a	4.50b
8 t ha^{-1} PD	9.25a	6.93a	6.17a
2 t ha^{-1} CD	4.1d	7.42a	2.50c
4 t ha^{-1} CD	4.77d	8.47a	3.50c
6t ha^{-1} CD	4.92d	8.45a	3.50c
8t ha^{-1} CD	5.9c	6.42a	2.83c
NPK	4.57d	6.16a	5.83a
± SE	0.2	1.0	0.3
Interaction			
V × F	**	NS	**

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

Table 9 : Interaction effects of variety × fertilizer on fresh fruit weight per ha (tons)

Fertilizer	Variety	2009	2011
Control	NHAe47-4	4.3c	4.3e
2 t ha^{-1} PD	NHAe47-4	4.1c	5.7e
4 t ha^{-1} PD	NHAe47-4	4.1c	6.2e
6 t ha^{-1} PD	NHAe47-4	4.0c	11.2c
8 t ha^{-1} PD	NHAe47-4	3.7c	12.1c
2 t ha^{-1} CD	NHAe47-4	4.6bc	4.8e
4 t ha^{-1} CD	NHAe47-4	4.8bc	5.2e
6 t ha^{-1} CD	NHAe47-4	4.4c	5.9e
8 t ha^{-1} CD	NHAe47-4	4.5c	7.3de
NPK	NHAe47-4	4.0c	6.5e
Control	LD88-1	6.3b	5.8e
2 t ha^{-1} PD	LD88-1	8.2b	12.7c
4 t ha^{-1} PD	LD88-1	12.0a	14.1b
6 t ha^{-1} PD	LD88-1	10.2ab	19.1a
8 t ha^{-1} PD	LD88-1	10.2ab	18.7a
2 t ha^{-1} CD	LD88-1	10.2ab	5.2e
4 t ha^{-1} CD	LD88-1	12.1a	7.5de
6 t ha^{-1} CD	LD88-1	12.5a	8.4de
8 t ha^{-1} CD	LD88-1	8.3b	8.7de
NPK	LD88-1	8.3b	7.7de

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 delay flowering and will eventually translate to poor fruit yield. Recently, Daram and Kumar (2013) reported that higher rates of poultry droppings (6 t ha^{-1}) resulted in significant delay in flowering and fruiting of egg plant compared to plants of the control, 4 tons of poultry droppings per hectare and mineral fertilizers.

Plant uptake and efficient utilization of nutrients, environmental interaction with plants and or genetic makeup of plants are known to affect the number of days to first flower opening and days to 50% flowering (Olaniyi *et al.*, 2005). For instance, the delay in first flower opening and attainment of 50% flowering in NHAe47-4 compared to LD88-1 plants may be due to the plants inability to regulate their uptake of nutrients which might have resulted in excess uptake.

Growing okra plants with 4-8 t ha^{-1} of poultry droppings in 2009 resulted in lower abortion incidences compared to other fertilizer treatments in this study. The greater abortion incidences in plants to which NPK and zero fertilizer were applied in this study suggest the insufficiency or deficiency of some nutrients in NPK fertilizer that were needed for the flowering process. Poultry droppings have been reported to contain several crop nutrients and have the ability to check the possible cases of nutrient imbalance and pH fluctuations which may curtail plant uptake of nutrients (Mishra and Ganesh, 2005). The enhanced performance recorded with the use of poultry droppings especially at rates ranging between 4 and 8 tons per hectare suggests that all the nutrient requirements for flower formation other than the N P and K provided by synthetic fertilizers are met by poultry droppings. According to Steve (2009), organic soil amendment, such as farmyard manure, plant compost and natural sources of nutrients, can be used to remedy mineral imbalance, ensuring healthy growth, successful flowering and fruiting in plants. Rachel and Demand (2014) also stated that for plants to grow and develop successful flowers and fruit, they need a balanced source of 20 mineral elements, or nutrients, including N, P, K, Ca, Mn, B and Zn. Organic fertilizers supply most of the essential nutrients needed for all the growth stages of plants which are released gradually (Achieng *et al.*, 2010). This ensures nutrient availability to plants throughout the crop cycle thereby meeting the vegetative and reproductive demand for these nutrients compared to those contained in NPK that may have been exhausted before flower stimulation due to nitrogen mobility or even deficiency of some necessary nutrients for flowering process (Rachel and Demand, 2014). Pest incidences and flower abortion were greatly reduced with organic manure application in melon compared to conventional fertilizers (Esawy *et al.*, 2008).

Significantly greater number of flower drops has also been reported in okra plots treated with only inorganic fertilizer by (Agele, 2001). Kumar and Singh (2006) recorded much fewer flower and fruit drops in pepper plots amended with poultry droppings compared with a severe case on the inorganic fertilizer and absolute control fields. Agbede *et al.* (2008) also reported a mild incidence of flower abortion and leaf droppings in plots treated with organic manure in contrast to a severe incidence in plots treated with inorganic fertilizers. Deficiency of plant nutrients such as nitrogen, potassium, calcium, iron, zinc and manganese during flowering is known to impede the production of auxin which is responsible for flower stimulation and fruit set (Pandey and Sinha, 2006). Another probable cause of flower abortion in this study may be the high relative humidity experienced during the growth periods of the plants, suggesting that plants treated with fertilizer sources other than those rates of poultry droppings could not tolerate the high humidity recorded during the cropping seasons which was not adequate for optimum okra production. Okra requires humidity range of 21–30% for optimum performance (Ezeakunne, 2004). High relative humidity is capable of causing pollen clumping condition which makes pollination less effective (Pandey and Sinha, 2006). Adequate plant nutrients obtained from application of about 6 t ha^{-1} of poultry droppings might have produced vigorous plant growth to counter the negative effect of high humidity. Significantly higher flower abortion was recorded in plants of the NHAe47-4 than the LD88-1. The former's poor performance could be due to poor plant uptake of available nutrients or efficient utilization of absorbed nutrients during growth which can cause nutrient stress. Nutrient stress has been reported to result in reduced flowering and total plant yield in cowpea (Amador and Dieguez, 2007) and in mungbean (Ahmad, 2009).

The significantly better fruit yield in plants to which poultry droppings were applied at 6 and 8 t ha^{-1} compared to all other fertilizer treatments in this study indicated that poultry droppings at those rates contained more of the nutrients needed for optimum plant growth than cow dung and NPK fertilizer. Omisore *et al.* (2009) and Olaniyi *et al.* (2010) adjudged poultry droppings 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. Mishra and Ganesh (2005) also reported a significant boost in tomato growth and subsequent fruit yield when organic manure was used compared to mineral fertilizers. They concluded that the performance of organic manure was due to the fact that it contained most of the nutrients essential for plant growth and development than are found in mineral fertilizers. Their report also indicated that plant uptake of nutrients was poor in inorganic fertilizer plots which resulted in poor plant performance. Adediran *et al.* (2003) also reported that the application of poultry manure at 10 t ha^{-1} produced the highest tomato fruit yield in the rain forest region of South Western Nigeria. Similarly, application of 10 t ha^{-1} of farmyard manure was found to increase okra plant growth and fruit yield over the untreated control and inorganic fertilizers (Moniruzzaman *et al.*, 2007). The use of poultry manure has also been reported to result in yield improvement in egg plant over the use of synthetic fertilizers and the control (Kumar and Singh, 2006). Significant differences between LD88-1 and NHAe47-4 in respect of fruit yield in this study may be due to differences in genetic makeup as has been reported in other studies (Keeric *et al.*, 2003).

It is concluded from this study that application of poultry droppings at 6 or 8 t ha^{-1} to okra (*Abelmoschus esculentus* L. Moench) mother-plants delayed flowering, though, flower abortion was significantly reduced. Furthermore, application of the same nutrient source and rate enhanced higher green fruit yield compared to other fertilizer treatments.

It is recommended that soils should be amended with poultry droppings at 6 to 8 t ha.$^{-1}$ for enhanced and successful flowering in okra production. For optimum fruit yield, the same manure and rate should be applied to mother-plants of okra. LD88-1 is recommended for green (fresh) fruit production on the basis of its agronomic traits for high productivity proven in preference to NHAe47-4.

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