GROWTH AND YIELD OF OKRA (*Abelmoschus esculentus* L.) AS AFFECTED BY ORGANIC AND INORGANIC FERTILIZERS

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ABSTRACT

A study on the effect of poultry and cattle manures on the growth and yield of okra (*Abelmoschus esculentus* L.) was carried out in the transitional zone of Ghana in 2008 and 2009 in a randomized complete block design experiment with three replicates. The treatments were; 350 kg NPK ha^{-1}, 8t Poultry Manure ha^{-1}, 12t Cow dung Manure ha^{-1}, 175 kg NPK + 4t Poultry Manure ha^{-1}, 175 kg NPK + 6t Cow dung Manure ha^{-1} and No treatment of manure (control). The combined treatments of 175 kg NPK + 4t Poultry Manure ha^{-1} and 175 kg NPK + 6t Cow dung Manure ha^{-1} produced higher levels of the growth and yield parameters than the rest of the treatments in both seasons. The 175 kg NPK + 4t Poultry Manure ha^{-1} recorded the highest figures of the parameters which were not significantly (P=0.05) different from the figures of the 175 kg NPK + 6t Cow dung Manure ha^{-1} treatment. The combined treatments were found to be economically profitable. The treatment combination of 175 kg NPK + 4t Poultry Manure ha^{-1} was more superior in the areas assessed.

Keywords: *Abelmoschus esculentus*, organic fertilizer, inorganic fertilizers.

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is traditionally grown in countries such as Cote d'Ivoire, Ghana, Nigeria, Egypt, Sudan, Togo, Benin, Burkina Faso, Cameroon, Tanzania, Zambia and Zimbabwe. The most important production countries are Ghana, Burkina Faso and Nigeria (Raemaekers, 2001).

Okra is widely grown primarily for its soft immature fruits or pods. The pods contain a glutinous, sticky substance that is used to thicken soups and stews. They are boiled or fried and eaten as vegetable. They can also be cut into pieces, dried and/or powdered and stored for use in soups during the dry season when fresh Okra fruits are scarce. The young leaves are also boiled and used in soups (Norman, 1992). The leaves are further used for medicinal purposes. Martin and Ruberte (1978) in their studies on "Vegetables of the humid tropics" confirmed the usefulness of okra leaves as a curative medicine against ulcers and haemorrhages. Again, okra leaves promote digestion since it has considerable amount of roughages. The seeds can be used as a source of edible oil as well as in the soap industry (Oyolu, 1983).

Okra is an important vegetable as its contribution to Ghana's agricultural Gross Domestic Production (G.D.P.) in 2010 was 32, 309, 445, 183, US Dollars (FAO, 2011).

Donahue *et al*. (1990) reported that NPK fertilizer increases soil fertility and yield of okra. However, NPK fertilizer is very expensive and therefore increases cost of production. It is also not environmentally friendly (Ullysses, 1982). Alternative sources of fertilizer are therefore sought to increase yield of okra and in that wise different combinations of fertilizers have been used. Combinations of inorganic and organic fertilizers in soil amendments have been used to increase okra production (Olaniyi *et al*., 2010; Akande *et al*., 2010). Okwuagwu *et al*. (2003) combined NPK and cattle manure at 125 kgha^{-1} and 1.5tha^{-1} respectively in soil amendment for the growth of okra and reported of increases in the growth and yield parameters of the crop. Akande *et al*. (2010) found the application of 60 kg N + 2.5 Mt ha^{-1} poultry manure (PM) and 60 kg N + 2.5 Mt ha^{-1} Organic-based Fertilizer (OBF) to give higher increases in the growth parameters and yield of okra, respectively.

The current study was carried out to continue determine the effects of different levels of poultry and cattle manures on the growth and yield of okra.

MATERIALS AND METHODS

The study was carried out from October 2008 to February 2009 and July to October 2009 at the Multipurpose Nursery research site of the University of Education, Winneba, Mampong-Ashanti. Mampong-Ashanti (70, 45' N, 10, 24' W) lies in the transitional zone between the forest and Guinea Savanna zones of Ghana and it is 402m above sea level. The area has a bimodal rainfall pattern with the major rains occurring from March to July and the minor rains occurring in late August to November (Asiamah, 1988).

Poultry and cattle manures were obtained from the animal farm of the College of Agriculture Education, University of Education Winneba, Mampong Campus. Both manures were air dried and allowed to decompose for four weeks. Six (6) treatments made up of sole inorganic and organic fertilizers and their combinations were prepared from the manures as: 350 kg NPK ha-1; 8t Poultry Manure ha-1; 12t Cow dung Manure ha-1; 175 kg NPK + 4t Poultry Manure ha-1; 175 kg NPK + 6t Cow dung Manure ha-1; Control(Neither organic manure nor inorganic manure).

The manures (poultry and cattle) were worked into the soil at a depth of 15cm two (2) weeks before sowing of okra seeds. The treatments were laid out in a Randomized Complete Block Design (RCBD) with plots measuring 4m x 3m (12m2). The planting distances of okra were 60cm between rows and 50cm within rows, with 35 plants per plot and a total plant population of 810.

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There were four (4) replicates. Tables 1 and 2 show some of the chemical properties of the soil in the experimental site and some nutrient composition of the poultry and cow dung manures used in the study respectively.

Table-1. Some chemical properties of the soil at the research site.

Chemical property	Amount in soil
Org matter	1.60
Nitrogen (%)	0.09
Exchangeable cations (me/100g soil)	
Ca	0.54
Mg	0.36
K	0.21
Na	0.05
ECEC (me/100g soil)	1.71
Base saturation (%)	68.3
Available P (mg/kg)	1.85
pH(H_2O)	4.6

Table-2. Nutrient composition of the poultry and cow dung manure.

Manure	Nutrient concentration (%)					Moist content (%)
	N	P	K	Ca	Mg	
Poultry	4.27	1.77	0.90	2.14	0.65	15.40
Cow dung	1.68	1.04	1.35	1.99	0.70	14.89

Data were collected on growth parameters - plant height, plant diameter (girth), number of leaves and number of branches. Yield parameters included, number of fruits per plant, fruit length, fruit girth (diameter) and fresh fruit yield. Results were analyzed using the Analysis of Variance (ANOVA) by means of Statistical Analysis System (SAS) (SAS, 1999). The Least Significant Difference (LSD) at 5% was used to separate the means of treatments.

RESULTS AND DISCUSSIONS

In both 2008 and 2009 seasons, all the amended treatments produced significantly (P=0.05) higher number of leaves, plant height, plant girth and number of branches than the unamended treatment. There were no significant differences among the amended treatments (Figures 1 to 4) for the measured parameters, however, the ½NPK + ½PM in most cases gave a shade higher values.

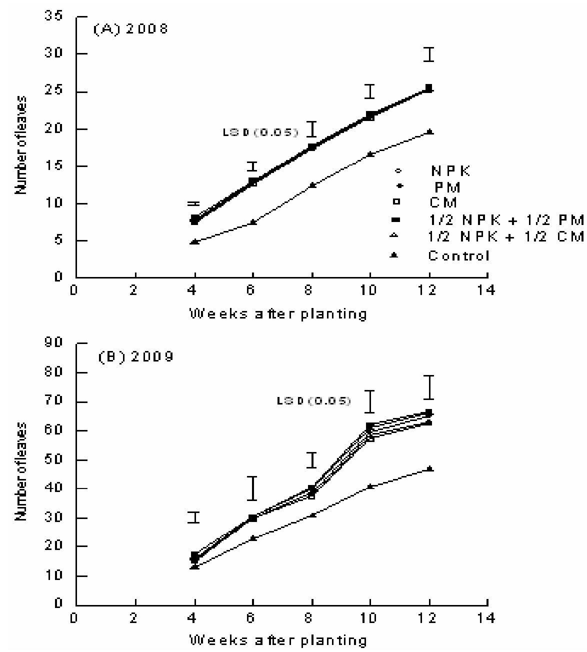

Figure-1. Treatments effect on number of leaves with age of growth (weeks) of okra.

350 kg NPK ha^{-1} = NPK; 8t Poultry Manure ha^{-1} = PM; 12t Cow dung Manure ha^{-1} = CM; 175 kg NPK + 4t Poultry Manure ha^{-1} = ½ NPK + ½ PM; 175 kg NPK + 6t Cow dung Manure ha^{-1} = ½ NPK + ½ CM; No treatment of manure = Control.

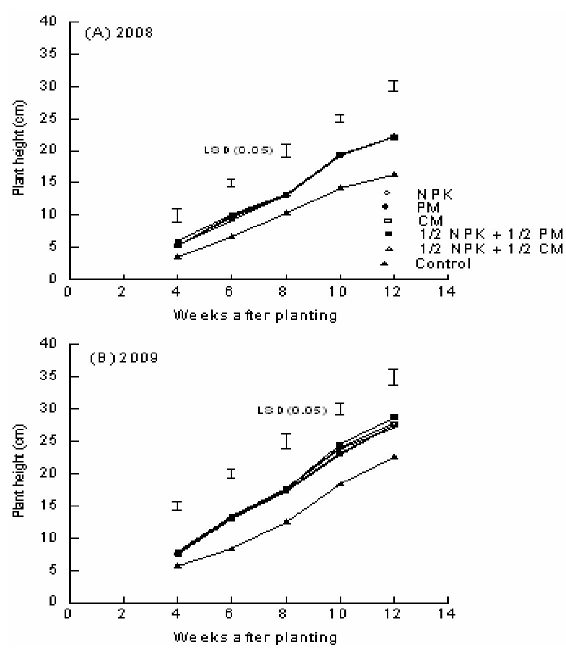

Figure-2. Treatments effect on plant height with age of growth (weeks) of okra.

350 kg NPK ha^{-1} = NPK; 8t Poultry Manure ha^{-1} = PM; 12t Cow dung Manure ha^{-1} = CM; 175 kg NPK + 4t Poultry Manure ha^{-1} = ½ NPK + ½ PM; 175 kg NPK + 6t Cow dung Manure ha^{-1} = ½ NPK + ½ CM; No treatment of manure = Control.

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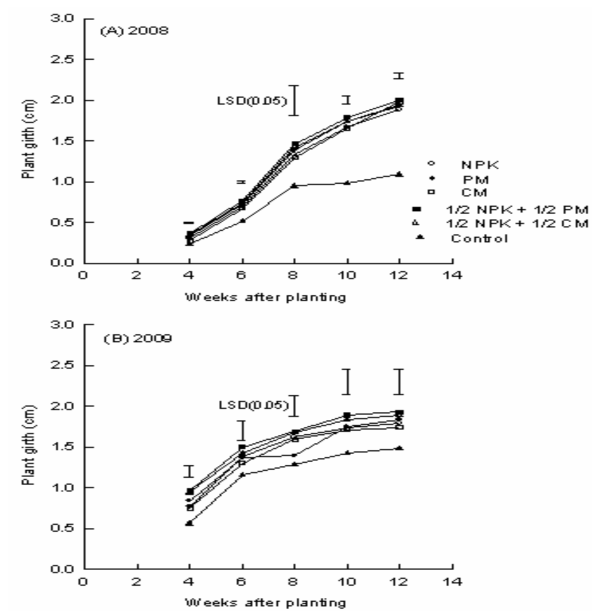

Figure-3. Treatments effect on plant girth with age of growth (weeks) of okra.

350 kg NPK ha^{-1} = NPK; 8t Poultry Manure ha^{-1} = PM; 12t Cow dung Manure ha^{-1} = CM; 175 kg NPK + 4t Poultry Manure ha^{-1} = ½ NPK + ½ PM; 175 kg NPK + 6t Cow dung Manure ha^{-1} = ½ NPK + ½ CM; No treatment of manure = Control.

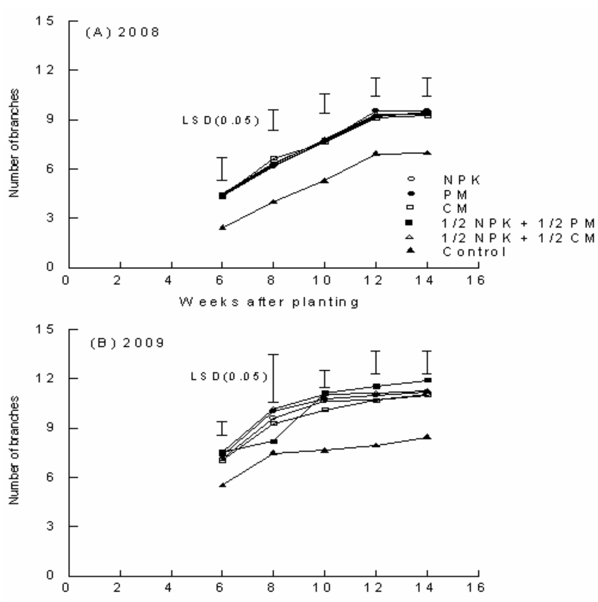

Figure-4. Treatments effect on number of branches with age of growth (Weeks) of okra.

350 kg NPK ha^{-1} = NPK; 8t Poultry Manure ha^{-1} = PM; 12t Cow dung Manure ha^{-1} = CM; 175 kg NPK + 4t Poultry Manure ha^{-1} = ½ NPK + ½ PM; 175 kg NPK + 6t Cow dung Manure ha^{-1} = ½ NPK + ½ CM; No treatment of manure = Control.

In a similar study, Blay *et al*. (2001) using different levels of organic and inorganic manures observed that combined poultry manure and NPK fertilizers, increased plant height, number of leaves per plant and number of fruits / plantlet and longer and wider girth of okra fruits.

Other studies have also observed combined treatments of organic and inorganic manures to produce the highest levels of growth parameters of some crops as compared to the sole applications of either input (Busari *et al*., 2008; Efthimiadou *et al*., 2010). Such observations might be attributed to the complementary effect of the combined inorganic and organic fertilizers.

On the yield parameters of the okra, a similar trend as observed by Blay *et al*. (2001) was recognized, the combined ½NPK + ½PM treatment recorded the highest figures for the yield parameters (number of fruits, fruit length, fruit diameter and fresh fruit yield) of okra which were significantly (P=0.05) higher than the control (Table-3). With the exception of the fruit length and fruit yield in 2008, the combined treatment of ½NPK + ½CM registered the second highest Figures of the yield parameters which were significantly (P=0.05) found to be the same as the values from the ½NPK + ½PM treatment. Similar to the current study, combined sources of fertilizers have been found to bring higher yield in okra. Moyin-Jesu and Ojeniyi (2000) studied the effect of animal manure and crop wastes on yield of okra (*Abelmoschus esculentus*) and found that the amendment of wood ash, ground cocoa husk, rice bran, spent grain and saw dust with goat, pig and poultry manures enhanced okra yield. Dennis *et al*. (1994) indicated that the combination of organic and mineral fertilizers does not only improve the physical status of the soil, but also improves crop yield. The combined application rates of 75kg NPK and 3 t.ha^{-1} organo mineral fertilizers gave the best okra performance compared to other treatments (Olaniyi *et al*., 2010).

Climatic differences, especially the amount of rainfall received might have brought the differences in the growth and yield parameters between the two seasons. The period for the 2008 season was "between" October 2008 to February 2009 which was a dry period and therefore the crop received less rains than the 2009 season which was between July to October 2009 where rainfall was higher and therefore recorded higher levels of the parameters.

Table-3. Treatments effect on some yield parameters of okra.

Treatment ha^{-1}	No. of fruits per plant		Fruit length (cm)		Fruit diameter (cm)		Fresh fruit yield (kg ha^{-1})	
	2008	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**
NPK	35	84	5.4	7.4	2.3	2.6	2430	4057
PM	35	85	5.3	7.2	2.4	2.5	2439	4002
CM	31	79	4.9	7.1	2.2	2.5	2130	3763
½ NPK + ½ PM	40	89	5.7	7.6	2.5	2.6	2650	4527
½ NPK + ½ CM	36	88	5.1	7.6	2.4	2.6	2288	4277
Control	22	62	4.1	6.7	2.0	2.4	1723	2680
LSD (0.05)	4.1	16.9	0.3	0.5	0.1	0.1	463.4	882.0
CV (%)	8.3	13.8	8.3	4.1	1.8	3.0	13.5	15.1

350 kg NPK ha^{-1} = NPK; 8t Poultry Manure ha^{-1} = PM; 12t Cow dung Manure ha^{-1} = CM; 175 kg NPK + 4t Poultry Manure ha^{-1} = ½ NPK + ½ PM; 175 kg NPK + 6t Cow dung Manure ha^{-1} = ½ NPK + ½ CM; No treatment of manure = Control.

Table-4. Economic benefits of organic and inorganic manures on the yield of okra.

Treatment ha^{-1}	Fresh fruit yield (kg ha^{-1})		Value of yield (GH¢ ha^{-1})		Production cost (GH¢ ha^{-1})		Net benefit (GH¢ ha^{-1})	
	2008	2009	2008	2009	2008	2009	2008	2009
NPK	2288	4057	4576	4057	1200	1200	3351	2857
PM	2439	4002	4878	4002	1250	1250	3628	2752
CM	2130	3763	4260	3763	1250	1250	3010	2513
½ NPK + ½ PM	2650	4527	5300	4527	1225	1225	4075	3302
½ NPK + ½ CM	2430	4277	4860	4277	1225	1225	3660	3052
Control	1723	2680	3446	2680	900	900	2546	1780

350 kg NPK ha^{-1} = NPK; 8t Poultry Manure ha^{-1}= PM; 12t Cow dung Manure ha^{-1} = CM; 175 kg NPK + 4t Poultry Manure ha^{-1} = ½ NPK + ½ PM; 175 kg NPK + 6t Cow dung Manure ha^{-1} = ½ NPK + ½ CM; No treatment of manure = Control.

The benefit of the treatments economically in the production of okra is presented in Table-4. The amended soil treatments had higher cost of production than the control; the sole organic manures had the highest cost due to the high amount of manure used. The combined treatments recorded higher economic benefit of production than the rest of the treatments. The ½ NPK + ½ PM treatment, however, registered the highest (4075 and 3302 GH¢ ha^{-1} for 2008 season and 2009 season respectively) net benefit. Though the yield levels in the 2008 season were lower than the 2009 season, the price of okra was one and half times higher in 2008 (dry season) than the 2009 season, and hence the net benefit was higher in the 2008 season than in the 2009 season.

Combining organic and inorganic manures in soil amendments would be more economically beneficial in the production of okra than the application of the sole organic and inorganic manures.

CONCLUSIONS

The study showed that the combined application of poultry and cow dung manures and NPK fertilizer increased the growth and yield components of okra better than the sole application of the individual materials. The combined treatments were also more economically beneficial. The treatment combination of 175 kg NPK + 4t Poultry Manure ha^{-1} was more superior in the areas assessed.

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