Journal of Applied Horticulture, 8(2): 155-158, July-December, 2006

Effects of organic manure on okra (*Abelmoschus esculentus* (L.) Moench) production

J. Ofosu-Anim*, E.T. Blay, and M.E. Frempong

*Department of Crop Science, University of Ghana, Legon, Ghana, *Email: aweze2002@yahoo.co.uk*

Abstract

The effect of different organic manures (cow dung, poultry manure and compost) on the yield of okra, soil physical and chemical characteristics was investigated at the University of Ghana, Legon. Results obtained revealed that the application of recycled garden solid waste compost, poultry manure and cow dung improved the soil physical condition, particularly, structure and drainage, increased nutrient and organic matter levels and enhanced the yield components of okra plants. Inorganic fertilizer improved only chemical properties, but soil physical properties such as structure was not improved. There were improvements in pod yield, yield components and pod fibre content on all manured plots. The study clearly inidicated the superiority of poultry manure over cow dung and compost as a source of manure for okra production.

Key word: *Abelmoschus esculentus*, okra, organic manure, soil characteristics, yield

Introduction

To sustain crop yields, the removal of nutrients from the soil has to be balanced by added amounts. Fertilizers are therefore added to the soil to supply elements essential to the growth of plants. The use of chemical fertilizer is necessary for supplying the nutrient requirements but without recycling of crop residues, yields suffer. Organic manures are normally derived from animal or plant sources and are excellent sources of organic matter, but relatively low in nutrients. Organic manures therefore need to be applied at very high rates (20,000-40,000kg/ha) to make up for their low nutrient content and to supply enough humus to measurably improve the soil physical condition (Mathew and Karikari, 1995).

Animal manure is an important source of N, P and K and its additions to the soil increases the available P and exchangeable K, Ca and Mg content (Magdoff, 1998). In addition to providing nutrients for crop growth, manure has several beneficial effects on soil properties. Several researchers have reported that the application of organic waste leads to improved structural stability, lower bulk density of the soil by increasing both the organic fractioning of the soil and a balance between fine and coarse pores, organic manures improve moisture retention, water infiltration rate and the hydraulic conductivity of soil (Tisdale *et al.,* 1990; Young, 1997).

Most of the okra produced in Ghana and other West African countries are grown on sandy loam and loam soils which, with time, may become deficient in N, P, K, Mg and B (Nelson and Tisdale, 1978). Chemical fertilizers do not sustain soil fertility for longer and after their continual use there is deterioration of soil characteristics. This study was undertaken to investigate the effectiveness of different nutrient supply regimes namely, cow dung, poultry manure and compost and inorganic fertilizer for improvement and maintenance of soil fertility, yield and quality of okra.

Materials and methods

Field experiment was conducted at the University of Ghana, Legon. The soil in the farm belongs to the Adenta series, Ferric Acrisols (WRB, 1998). Poultry manure and cow dung used for the research were collected from the Agricultural Research Station, University of Ghana and dried thoroughly before application. Garden solid waste compost was prepared from elephant grass, lawn clippings, leuceana tree prunings (*Leuceana leucocephala*), topsoil and cow dung. Bulk samples of soil, and a mixture of soil plus manure were collected from the top 0-15 cm at the time of land preparation for physical and chemical characterization. Analyses were carried out at the Soil Science Laboratory, University of Ghana, Legon. Parameters determined included particle size, pH in 1:1 soil:water ratio and 1:2 soil:0.01 $CaCl_2$. Organic carbon was determined by Walkley and Black method and total nitrogen by the macro Kjeldahl's method involving digestion and distillation. Bray's No 1 method was used to determine available phosphorus and exchangeable cations were determined by the flame photometry.

Cow dung, poultry manure, compost, inorganic fertilizer and control (no-manure) were used as treatments in this study. NPK (15:15:15) was applied two weeks after planting (WAP) at the rate of 300 kg ha^{-1}, and ammonium sulphate as side dress at 4 and 6 weeks after planting at the rate of 125 kg ha^{-1}. Treatments were arranged in a randomised complete block design with 3 replications. Okra var: Asontem White was used. Each replicate had 36 plants and 16 record plants. Manure was incorporated into the soil two weeks before planting the test crop at the rate of 25 t ha^{-1}. Soil and a mixture of soil and manure sampling were carried out before planting and at 12 WAP and analysed. Chemical fertilizers were applied to inorganic fertilizer treatment plots. At fruit maturity, yield, yield components and pod fibre were determined.

Results

Table 1 depicts nutrient content of compost, cow dung and poultry manure used in the study. Poultry manure had the highest total nitrogen (N), total phosphorus (P) and potassium (K) levels followed by cow dung and compost.

Initial effects of manure application on some soil physical and chemical properties are shown in Table 2. Both the untreated soil (no manure) and compost-supplemented soil were within the sandy loam texture range. Poultry manure supplemented soil gave higher levels of organic matter, available P and K, exchangeable Ca, Mg than the other manured soil and control. Soil in control plots had a slightly acidic pH, however, the cow dung and poultry manure supplemented soils were near neutral. The Cation Exchange Capacity (CEC) of soil of the control plot was 14.3 Cmol kg^{-1}, incorporation of organic matter such as poultry manure, cow dung and compost increased the CEC of the soil to 17.1, 16.8 and 16.7 Cmol kg^{-1}, respectively.

Table 3 shows the effect of manure application on soil physical and chemical characteristics at 12 weeks after planting. Soil bulk

Table 1. Chemical characteristics of poultry manure, cow dung and compost used in the studies

Property	Manure		
	Compost	Cow dung	Poultry manure
Kjedhal–Nitrogen(%)	0.7	0.76	2.04
Total P (%)	0.06	0.18	1.54
Total K (%)	0.24	0.55	0.65

Table 2. Physical and chemical characteristics of soil and soil plus manure within a 0-15 cm soil depth (before planting)

Characterstics	Untreated soil (Control)	Inorganic fertilizer + soil	Compost + soil	Cow dung + soil	Poultry manure + soil
Sand (%)	57.4	56.9	56.5	49.6	47.2
Silt (%)	11.6	12.2	11.5	19.4	17.8
Clay (%)	35.0	34.5	30.0	25.0	24.6
Organic carbon (%)	0.72	0.73	0.75	0.96	1.04
Kj-nitrogen (%)	0.10	0.11	0.12	0.13	0.15
Total P (ppm)	188.1	259.8	234.2	398.7	398.9
Total K (%)	0.08	0.13	0.11	0.14	0.16
Available K (mg kg^{-1})	0.60	0.93	0.82	1.20	1.36
Available P (mg kg^{-1})	8.15	13.83	9.43	45.0	50.2
Water holding capacity (WHC)	40.0	40.2	42.0	45.0	49.0
Ca^{2+} (mg kg^{-1})	2.2	2.2	3.6	5.0	5.6
Mg^{2+} (mg kg^{-1})	4.4	4.4	5.8	7.4	8.1
Cation exchange capacity (CEC) [Cmol kg^{-1}]	14.3	13.9	16.7	16.8	17.1
pH	6.1	6.4	6.4	6.6	6.8
Bulk density	1.4	1.4	1.3	1.2	1.2

Table 3. Physical and chemical characteristics of soil and soil plus manure within a 0-15 cm soil depth (twelve weeks after planting)

Characterstics	Untreated soil (Control)	Inorganic fertilizer + soil	Compost + soil	Cow dung + soil	Poultry manure + soil
Sand (%)	57.5	57.8	56.2	52.9	55.6
Silt (%)	10.8	10.5	15.6	19.6	16.9
Clay (%)	35.0	35.1	29.5	27.5	27.4
Organic carbon (%)	0.78	0.75	0.81	1.02	1.32
Kj-nitrogen (%)	0.11	0.13	0.13	0.14	0.15
Total P (ppm)	198.7	261.7	229.1	415.8	432.6
Total K (%)	0.07	0.12	0.10	0.14	0.16
Available K (mg kg^{-1})	0.58	0.95	0.77	1.24	1.54
Available P (mg kg^{-1})	9.02	13.95	9.58	46.3	51.42
Water holding capacity (WHC)	41.5	41.4	43.1	47.0	51.4
Ca^{2+} (mg kg^{-1})	2.0	2.1	3.4	4.8	5.5
Mg^{2+} (mg kg^{-1})	4.4	4.4	5.9	7.8	8.6
Cation exchange capacity (CEC) [Cmol kg^{-1}]	15.01	14.2	16.91	17.03	17.15
pH	6.2	6.5	6.6	6.8	6.9
Bulk density	1.4	1.4	1.2	1.1	1.0

density decreased in the poultry manure, cow dung and compost treated plots while soil pH, nitrate-N, available P, available K and organic matter contents increased.

Water infiltration rate at 12 WAP was higher in the poultry manure, cow dung and compost treated plots as compared to the inorganic fertilizer and control plots. The increase is probably due to the cumulative effect of applied organic manure on soil structure. The results in Table 3 indicate that inorganic fertilizer supplemented plots showed improvement only in the soil chemical properties, but not on soil physical properties such as bulk density and water holding capacity.

Manure application resulted in significantly greater soil organic matter level and a positive organic matter balance in the soil. In a study to evaluate the effects of organic matter and nutrients in manure on soil organic matter dynamics and crop production, Eghball *et al.* (2002) reported significantly greater soil organic matter level in plots treated with organic manure. In the present study, poultry manure gave the higher organic matter content compared to other manured treatments. The addition of the organic manure might have provided supplemental exchangeable cations such as potassium, calcium, magnesium and ammonium (NH_4^+) in the topsoil (Olsen *et al.*, 1970). The application of manure influenced the soil pH and bulk density. The soil in the farm was slightly acidic but the application of organic manure decreased the acidity as indicated by the increased pH. Magdoff (1998) reported that, organic matter is a reservoir of plant nutrients and exhibits a high cation exchange capacity and buffers the soil against pH changes. Manured soils recorded a significant decrease in bulk density. The decrease in bulk density of the manured soils could be attributed to the increase in organic matter content of the soil. Young (1997) stated that addition of organic matter lowers bulk density, improves structure and increase a balance between fine and coarse pores. The result of the studies indicates that the addition of manure increases the water holding capacity of the soil which might be due to the organic matter in the soil. Organic matter improves water infiltration rate, water holding capacity and the hydraulic conductivity of soil (Cross and Fischbach, 1972; Hafez, 1974).

There was significant effect of treatments on the number, length, girth and fresh weight of pod (Table 4). The application of poultry manure resulted in a significant ($P < 0.05$) increase in the number of okra pods compared to the control. The pods produced by poultry manure treatment were double in number than in the control. Non significant ($P < 0.05$) difference in the number of pods per plant was observed between cow dung and poultry manure. Significant ($P < 0.05$) difference was observed in pod length between pods from manured plants and control. Poultry manure produced the longest pod (6.5cm). Significant ($P < 0.05$) increase in pod diameter was observed in poultry manure treated plot as compared to control (Table 4). There was a significant ($P < 0.05$) difference in pod girth between manure treated plots and the control. Pod fresh weight per plant was significantly ($P < 0.05$) increased with poultry manure application compared to the control.

The increase in okra yield and other yield components such as pod length, diameter and fresh weight apparently resulted from improved soil chemical and physical characteristics under manure application. Plants responded to the improved conditions under manure, especially poultry manure, with an increased yield (Bhangoo *et al.*, 1988; Howard and Albregts, 1981). The significant increase in total yields in manured plots might also be attributed to the increased branching. In okra, more branching accounts for increased yield as pod developed in the axil of every branch once flowering has began. Similarly, the significant difference in pod length, girth and pod fresh weight with manured plots compared to the control might be due to differences in soil structure and fertility. The increase in the water holding capacity and increased availability of nutrients of the soil in manured plots might have provided additional support to the plants (Agarwala *et al.,* 1981; Nelson and Tisdale, 1978).

Table 4. Number of pods, pod length, pod girth and pod fresh weight of okra

Treatment	Pod number plant^{-1}	Pod length (cm)	Pod girth (cm)	Pod fresh weight (g)
Control	2.13	5.30	1.97	9.47
Inorganic fertilizer	2.33	5.53	2.13	11.10
Cow dung	3.53	5.93	2.13	13.03
Compost	2.83	5.77	2.17	11.53
Poultry Manure	4.33	6.50	2.40	15.90
LSD ($P < 0.05$)	1.36	0.39	0.31	1.77

Increased organic matter in the soil from application of poultry manure, cow dung and compost improved both soil physical and chemical properties compared to inorganic fertilizer alone and the control. Poultry manure was identified as a better source of organic manure for okra production than cow dung and compost.

Acknowledgement

We thank the staff of the Agricultural Research Station,University of Ghana, Legon for proving the poultry manure and cow dung and the Soil Science Laboratory, University of Ghana, for analysing the soil.

References

Agarwala, S.C., P.N. Sharma, C. Chatterjee and C.P. Sharma, 1981. Development and enzymatic changes during pollen development in boron deficient maize plants. *J. Plant Nutr.,* 3: 329-336.

Bhangoo, M.S., K.S. Day, W. R. Sudanagunta and V. E. Petrucci, 1988. Application of poultry manure: Influences Thompson seedless grape production and soil properties. *HortSci.,* 23(6): 1010-1012.

Cross, D.E. and P.E. Fischbach, 1972. Water intake rates and a silt loam soil with various manure applications, ASAE Paper No. 72-218, Amer. Soc. of Agric. Eng., St. Joseph, Mitch.

Eghball, B., D. Ginting, C.A. Shapiro, J.S. Schepers and C.J. Bauer, 2002. Manure As Carbon Source For Soil Improvement And Crop Production: Site-Specific Application. *Proceedings Great Plains Soil Fertility Conference,* 9: 22-28.

Hafez, A.A.R. 1974. Comparative changes in soil physical properties induced by ad-mixtures of manure from various domestic animals. *Soil Sci.,* 118: 53-59

Howard, C.M. and E.E. Albregts, 1981. Effect of poultry manure on strawberry fruiting response, soil nutrient changes and leaching. *J. Amer. Soc. Hort. Sci.,* 106: 295-298.

Magdoff, F. 1998. *Building soils for better crops: Organic matter management,* Ohio Agronomy Guide, Bulletin 672.

Mathew, I.P. and S.K. Karikari, 1995. *Horticulture Principles and Practices*. Macmillan Education Ltd., London and Basingtroke, 80-84 pp.

Tisdale, S.L. and W.L. Nelson, 1978. *Soil fertility and fertilizers*,. Macmillan Publishing Co. Inc., New York, USA, 67-70 pp.

Tisdale, S.L., W.L. Nelson and J.W. Beaton, 1990. *Soil Fertility and fertilizers*. Macmillan Publishing Company, New York, 369-655 pp.

WRB, 1998. World Reference Base for World Soil Resources Report, No. 84. FAO, Rome, 91 pp.

Young, A. 1997. *Agroforestry for soil management*. CAB International Wallingford Oxan OX10 8DE, UK, 98-100pp.