FULL LENGTH RESEARCH ARTICLE

EFFECTS OF ORGANIC MANURE AND COWPEA (*Vigna unguiculata* (L.) WALP) VARIETIES ON THE CHEMICAL PROPERTIES OF THE SOIL AND ROOT NODULATION

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ABSTRACT

An experiment was conducted in the Teaching and Research Farm of the Faculty of Agriculture and Veterinary Medicine, Imo State University, Owerri southeastern Nigeria to investigate effects of organic manure (poultry and cow dung) on 5 cowpea varieties (IT93K-452-1, IT89KD-288, Vital 7, IT848-2246-4 and Ife brown) on the soil chemical properties and nodulation of roots of the cowpeas. The experiment was arranged in a randomized complete block design of a split plot fashion in three replications with the varieties of cowpea on the main plots while the organic manures and a control (no-treatment) plot constituted the subplots. The organic manure was incorporated into the soil by pulverizing the manure with the tilled soil and cowpea seed sown two weeks post incorporation at a planting distance of 50 cm x 50 cm. Four plants were randomly selected at flowering stage and the number of nodules on the plant counted and recorded; the dry weights of the nodules were determined and yield was also estimated. Results revealed that organic manure significantly influenced the nodulation of the cowpea varieties as poultry manure gave the highest number of nodules (15.9) which was significantly different from the values (12.2 and 10.3) observes from cow dung-treated plots and untreated plots respectively. Also the organic manures significantly influenced the chemical properties of the soil as poultry manure improved the Nitrogen (0.320), Phosphorus (6.8) and Potassium (0.04) levels of the soil. The yield of cowpea was also improved with the application of poultry manure with a mean yield of 744.7kg/ha, which was significantly different from values (571.9kg/ha and 505.0kg/ha) observed for untreated plots and cow dung treated plots respectively. There was significant difference in the number of nodules among the cowpea varieties. Vita 7 variety recorded the highest mean number of nodules (15.4), which was significantly different from the other varieties. It is recommended that Vita 7 varieties should be used for cowpea cultivation in the Southeastern Nigeria, especially when poultry manure is the main source of fertilizer.

Keywords: Effect, chemical, properties, nodulation, cowpea varieties, yield, soil, organic manure

INTRODUCTION

The problem of declining soil fertility in crop-based farming system of sub-Saharan Africa is well known (Nwajiuba & Akinsanmi 2002). The use of organic amendments in agriculture has increased over the years, due to the increasing cost of inorganic (chemical) fertilizers and high demand for quality and uncontaminated products (Sangakkara 1993). The value of organic amendments in crop production is centered on the ability of animals and plants to provide nutrients and to improve the chemical, physical and biological properties of soils (IFIA 1992). The regular addition of organic amendments to soil is very important in the developing world of the tropics, where most traditional farming systems are not sustainable (Sangakkara 1993). Organic manure improves soil tilth, infiltration rate and soil water holding capacity; contributes nutrient to the crop and it is an important source of raw or partially decomposed organic matter (Bill 2001). The particular significance of organic manure for soil fertility is that it influences so many different soil properties (IFIA 1992). Maynard (1991) reported that in many parts of the tropics most annual crops respond well to application of organic manure. Organic manure enhances soil water holding capacity and reduces bulk density (Sangakkara 1997). The beneficial effect of organic matter on crop productivity is a function of so many factors, which include greater vigor of plant, improvement of soil properties and greater uptake of nutrients (Higa 1994).

Like many other legumes, cowpeas can symbiose with nodule bacteria (*Rhizobia*) present in most, if not all tropical soils. The *Rhizobia* posses the nitrogenase complex, an enzyme capable of reducing atmospheric Nitrogen into compounds assimilable by the host plant (Mulongoy 1985). Legumes need a high phosphorous requirement for nodule development and optimal growth (Barret 1990) and nodulation in cowpea is generally reduced in acid-aluminum-rich soils where even tolerant strains fail to infect root hairs (Applebaum 1990). Factors such as manganese toxicity may also be involved in reducing cowpea nodulation at low pH (Applebaum 1990). The general paucity of literature on the effect of organic manure on the nodulation of cowpea encouraged this investigation aimed at identifying the possible effect of organic manure on soil chemical properties and nodulation of cowpea varieties in the southeastern part of Nigeria where cowpea production is still on the marginal level.

MATERIAL AND METHODS

The experiment was conducted during the late planting season (August-September) of 2006 at the Teaching and Research Farm of the Faculty of Agriculture and Veterinary Medicine, Imo State University, Owerri, Nigeria.

Soil samples were randomly collected on the farm site at the depth of 15 cm to ascertain the physico-chemical properties before incorporating the organic manure. The mean monthly rainfalls, mean monthly temperature, and mean monthly humidity were 291.7 mm, 29.6 ^{0}C and 83 % respectively (NIMET 2006). Five varieties of cowpea (IT93K-452-1, IT89KD-288, Vita 7, IT848-2246-4 and Ife-brown) collected from International Institute of Tropical Agriculture (IITA) were planted and poultry manure and cow dung collected from the university's livestock farm were used.

The soil was tilled manually and the manures incorporated by pulverizing the manure with the tilled soil. The cowpea seeds were sown in the prepared plots, which measured 4m x 3m, each. The planting distance was 50 cm x 50 cm, which gave a plant density of 48 plants per plots. The field layout was designed in a randomized complete block arranged in a split-plot fashion in three replications. No chemicals (insecticides or herbicides) were applied and hand weeding was carried out twice; first at 4 wks after planting (WAP) and second at 8 WAP. At the flowering stage, four plants were carefully uprooted at random from each plot. The roots were carefully washed with distilled water by dipping into a beaker containing distilled water and the nodules on the roots were counted and recorded. The nodules were carefully removed from the roots of each plant, weighed and recorded as the fresh weight and then oven-dried of 60^{o}C for 48 hrs and the dry weight was also determined and recorded. Yield data was estimated by harvesting matured pods from each plant in the various plots. The pods were processed and seeds weighed and recorded in kg/ha. Soil samples were collected from the experimental site after harvest and air-dried for analysis to ascertain the physico-chemical properties after the duration of the experiment.

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RESULTS

The chemical composition of the organic amendments used revealed high Nitrogen content, 0.23 % in poultry manures and 0.21 % in cow (Table 1). The manganese content was also high for both amendment (poultry 3.47 and cow manure 2.98). The organic amendments were moderately acidic for poultry manure (pH 4.01) and cow manure (pH 5.43) (Table 1). Table 2 shows the record of the relative humidity and rainfall. The relative humidity was fairly stable throughout the period with 85% in September as the highest observed humidity and 81% in October as the lowest observed humidity. The highest rainfall was also observed in September with 490.6mm and the lowest in October with 194.2 mm.

Table 3 shows the records of the pH while nodule development is given in Table 4. The highest pH (5.43) was recorded from poultry manure treated plots while the lowest pH (4.01) was observed from the untreated (control) plots. The highest number of nodules (15.9) was observed from plots that received poultry manure and the lowest number of nodules (10.3) per plant was obtained from the untreated (control) plots. Generally, the varieties produced equal weight of dry nodules at $p \leq 0.05$ (Table 4). However the yield of cowpea was highest (1126.8kg/ha) in Vita 7 variety while IT89KD-288 produced the lowest (152.8kg/ha) and also plots that received poultry manure gave the highest (744.7kg/ha) which is significantly different from the lowest yield (505.0kg/ha) observed from cow manure treated plots cowpea yield.

TABLE 1. CHEMICAL AND PHYSICAL CHARACTERISTICS OF SOIL AT THE EXPERIMENTAL SITE BEFORE PLANTING AND AFTER HARVEST.

Period of sampling	Treatments	pH (H_20)	OC (%)	N (%)	P (ppm)	Exch. Acidity (meq/100g soil)	Ca (cmol/kg)	Mg (cmol/kg)	K (cmol/kg)	Na (cmol/kg)	Mn (ppm)	Sand (%)	Silt (%)	Clay (%)
Before planting	Soil sample	4.10	0.87	0.085	6.7	0.010	0.62	0.25	0.07	0.30	4.94	70.2	4.4	25.4
After planting	Poultry manure	4.01	0.84	0.230	6.9	0.015	0.65	0.30	0.05	0.30	3.47	63.2	11.7	25.1
	Cow dung manure	5.43	0.82	0.21	6.6	0.011	0.60	0.28	0.04	0.20	2.98	68.1	6.3	24.6
	Zero treatment (control)	4.07	0.84	0.083	4.4	0.010	0.57	0.20	0.02	0.10	4.30	69.8	5.3	24.9

TABLE 2. METEOROLOGICAL DATA FOR PRODUCTION PERIOD (AUGUST – OCTOBER 2005)

Months	Rainfall (mm)	Temperature (^{o}C)	Relative Humidity (%)
August	190.5	28.5	83.0
September	490.6	28.7	85.0
October	194.2	30.0	81.0

Source: Meteorological Department, Federal Secretariat, Owerri, Nigeria

TABLE 3. EFFECT OF ORGANIC MANURE ON SELECTED SOIL CHEMICAL PROPERTIES

Treatments	Organic carbon (%)	pH (H_20)	N (%)	P (ppm)	K (cmol/kg)	Mn (ppm)
Untreated soil	0.79	4.01	0.081	4.7	0.03	4.10
Poultry manure	1.02	5.43	0.320	6.8	0.04	2.06
Cow manure	0.98	4.98	0.221	6.4	0.03	0.73

TABLE 4. EFFECT OF ORGANIC MANURE AND VARIETY ON NODULAITON, DRY MATTER AND YIELD OF COWPEA

	Number of nodules (per plant)	Nodule dry weight (g)	Root dry weight (g)	Yield (kg/ha)
A. Varieties				
ITG9K-452-1	11.5ab	0.1a	0.5a	649.4
IT89KD-288	2.6c	0.0b	0.4ab	152.8
Vita 7	15.4a	0.1a	0.5a	1126.8
IT848-2246-4	15.4a	0.1a	0.4ab	696.3
Ife-brown	13.4b	0.1a	0.2b	426.9
B. Manure				
Untreated soil	10.3b	0.1b	0.2b	571.9
Poultry manure	15.9a	0.2a	0.5a	744.7
Cow manure	12.2ab	0.1b	0.4ab	505.0
Interaction	10.2	0.2	0.3	

Means having the same letter(s) are not significantly different at P<0.05.

DISCUSSION

It was observed that the relative humidity over the period was high and in contrast, the amount of rainfall was relatively low, but however, enough to support cowpea growth under high humidity (Bationo & Mokwunye 1991).

Application of organic manure increased the pH of the soil after harvest as seen in Table 3. The increase was higher in the plots treated with poultry manure. This agreed with the findings of Mulongoy & Merckx (1993), who reported that poultry manure is superior to other organic manures. Generally, application of organic manure improved the chemical properties of the soil (Table 3). However, poultry manure was more effective in amending the soil; improving the organic carbon content as well as phosphorous and potassium levels of the soil (Table 3). The highest increase was observed from plots treated with poultry manure.

Application of manure enhances symbiosis with nodule bacteria as observed in this study. This is in conformation with the findings of Gerald (2004), who reported that addition of organic manure in the soil enhanced the symbiotic relationship between microorganisms in the soil. On the other hand, the lowest number of nodules (10.3) per plant was obtained from the untreated (control) plots (Table 4). The highest number of nodules (15.9) was observed from plots that received poultry manure treatment and this was significantly different from the number of nodules per plant recorded for the cow manure treated plots at p< 0.05. The smaller number of nodules per plant observed from plots treated with cow manure and the untreated (control) plots could be associated with toxicity of manganese, which was reported to reduce cowpea nodulation at low pH (Gerald 2004)

Varietal differences significantly affected nodulations of cowpeas. Varieties such as vita 7 and IT848-2246 had the highest (15.4 each) of nodules number per plant (Table 4) while the least, number (3.6) was observed from IT89KD-288. Production of nodules in plants could be attributed to poor development of bacterial gene (Applebaum 1990).

Observations in this study suggested a significant interaction between organic manure and varieties. This was evidenced by the record of high nodulation in the cowpea varieties that received the organic manure, against low nodulations in the varieties that were not treated with the organic manures. This is in agreement with Sangakkara (1997), who reported that varietal difference influenced nodulation, however, variations in nutrient uptake of specific varieties is another contributory factor. Nodulation of cowpea varieties is one of the determinant factors for the yield of cowpea. The highest seed yield (1,126.8kg/ha) was observed from Vita 7 variety, which also had the highest nodule number (15.4) per plant. The effect of organic manure in terms of practical value was best shown by yields (Sangakkara 1997). Thus the highest yield of cowpea (744.7kg/ha) was observed from plants treated with poultry manure (Table 4).

The study showed the practical benefits of employing organic manure for a sustainable farming. The best performance was poultry manure especially when the soil condition is less conducive for crop growth. The benefit of poultry manure could be seen in increased number of nodules and higher yields and also in the efficient amendment of degraded soil conditions. It is therefore recommended to employ the use of organic (poultry) manure in the production of cowpea and also Vita 7 variety should be the preferred choice of variety.

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