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EFFECTS OF COW DUNG MANURE AND SINGLE SUPERPHOSPHATE ON SOIL PHOSPHORUS AVAILABILITY, GROWTH AND YIELD OF MAIZE IN A GLEYSOL OF KABBA, NIGERIA

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ABSTRACT

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Field experiments were conducted to determine the effect of cow dung amended with single superphosphate on phosphorus availability, growth and yield of maize in a Gleysol. The treatments consisted of sole application of cow dung 10 t ha⁻¹ and reduced levels of cow dung (2, 4 and 6 t ha⁻¹) combined with varying levels of single superphosphate (30, 20 and 10 kg ha⁻¹) fertilizer. Significant treatment effects were observed in plant height and leaf area whereas stem girth was not significantly affected. Leaf phosphorus (P) concentrations were significantly affected by the amendments and the percentage changes ranged from 0.17 - 0.48 and 0.23 - 0.43 in 2011 and 2012 respectively. The P content of maize leaf significantly improved under combined application of cow dung and SSP compared with sole cow dung application and control. The complementary use of cow dung at 4 t per ha + 20 kg per ha SSP produced the highest seed yields of maize (3.21 and 2.56 t per ha) in 2011 and 2012 respectively. It is therefore recommended that the use of cow dung (4 t per ha) combined with 20kg SSP per ha be adopted for maize cultivation in the study area.

Keywords: Nutrient, Maize, cow dung, Amended, SSP, Analysis and Fertilizer

INTRODUCTION

Maize (*Zea mays* L) is an important cereal crop in the tropics and sub tropics. It is particularly important in West Africa. Maize is produced on about 60 million hectares with an average yield of 1.2 t ha⁻¹. Maize provides invaluable roughages for dairy and beef cattle and constitutes a high proportion of the concentrate mixture in livestock feeds (Ogundare, 2011). Soils of Southern Guinea Savanna Zones are low in nutrient, especially nitrogen, phosphorus and organic matter, consequently, yield of crops grown on these soils are low (Nottidge *et al.*, 2005). The low nutrient status of most tropical soils necessitates the use of fertilizers (Adetunji, 1994). Phosphorus is often described as the second limiting nutrient in crop production after nitrogen (Thompson and Throch, 1975). Phosphorus is known to be deficient in savanna soils. The deficiency is not due to low level of P but rather to its fixation as a result of soil acidity and low level of solubilization (Banger *et al.*, 1985). Akande *et al.* (2003) evaluated the effect of poultry manure on solubilization of rock phosphate and on the growth and yield of okra. Okra growth and yield were significantly enhanced by the addition of poultry manure. The objective of this study was to evaluate the effect of cow dung manure amended with single superphosphate on phosphorus availability, growth and yield of maize in a Gleysol of the southern guinea zone of Nigeria.

MATERIALS AND METHODS

Description of the study site

Field experiments were conducted at the experimental field plot of Kabba College of Agriculture, Horticulture Section in 2011 and 2012 seasons. Kabba is located in the Southern Guinea Savanna Ecological Zone of Nigeria of latitude 07° 53' N and longitude 6° 8' E. The rainy season spans from April to November with the maximum rainfall in August while dry season extends from December to March. The mean annual rainfall is 1570mm, while annual temperature ranges from 18 to 32 °C and mean relative humidity is 59%. The major soil order within the experimental site is Gleysol (Higgins, 1957; Babalola, 2010).

Sample analysis

The site was ploughed and harrowed. Soil samples for chemical analysis were randomly collected from the top 15 cm depth prior to cropping in 2011 and at 60 days after planting (DAP). Laboratory soil analysis revealed that the pH was 5.8 and exchangeable sodium (Na), potassium (K), calcium (Ca) and magnesium (Mg) were 0.26, 33, 2.31, 0.46 cmol kg⁻¹ for respectively. The total N and available P were 0.3% and 2.3 mg kg⁻¹ respectively. The cow dung chemical analysis results were 43.4%, 2.8%, 1.1%, 0.8%, 1.2% and 0.2% for organic carbon, total N, phosphorus, potassium, calcium and magnesium respectively. The C/N ratio was 15.9.

Experimental design

The experimental design adopted was randomized complete block with four replications. The blocks consist of five plots of 5 by 4 m with a space of 0.5 m between plots. Treatments consisted of the control (unmanured) and

2, 4 and 6 t ha⁻¹ cow dung combined with 10 kg ha⁻¹ single superphosphate. There was a basal application of urea and muriate of potash at 120 kg ha⁻¹ and 60 kg ha⁻¹.

Crop establishment

Maize cultivar DMR-SR-Y open pollinated variety was planted at rate of three seeds per hole and at spacing of 75 by 50cm. The seedlings were later thin down to two. Weeds were controlled manually with the use of hoe. Cow dung was applied a week before planting by broadcasting and then, covered with soil using hoe. Stem borer was controlled with the use of chlorophryphos at the rate of 150 ml per 20 liters of water.

Agronomic data collection

Agronomic data such as plant height, stem girth and leaf area were measured at 60 DAP. Maize ear was allowed to dry on the stalk before harvesting. Yield was determined at 14% moisture content. At 8 weeks after planting (WAP), maize ear leaf samples were taken for chemical analysis.

Data analysis

All the data collected from each experiment were subjected to analysis of variance (ANOVA) and treatment means were compared using Duncan's Multiple Range Text at 5% probability level (Steel and Torrie, 1987).

RESULTS AND DISCUSSION

The results of the laboratory analysis of the soil physical and chemical properties prior to cropping are presented in Table 1. The soil classified as Gleysol (Babalola, 2010) and used for the field study was slightly acidic and characterized by low levels of organic matter, nitrogen and phosphorus. The fertility of the soils was low as indicated by the generally low values of exchangeable bases and other nutrients including phosphorus. The chemical characteristics of cow dung showed that it was relatively high in all the essential nutrients including phosphorus. However, the relatively high C/N ratio indicated its slow rate of decomposition when applied to the soil. Ogundare (2011) reported that cow dung is high in essential nutrients necessary for the growth and development of maize but its slow decomposition may be due to it high C/N ratio.

Maize plant height and leaf area were significantly influenced by sole application of cow dung and when combined with single super phosphate fertilizer in both cropping seasons. Complementary use of cow dung and single super phosphate at 4 t ha⁻¹ + 20 kg ha⁻¹ produced the tallest plant in 2011 while cow dung 6 t ha⁻¹ + 10 kg ha⁻¹ SSP gave the tallest plant in 2012. However, integrated application of cow dung and SSP irrespective of levels of combination significantly improved plant growth over sole application of cow dung and the untreated (control). The percentage increases in maize height under complementary use of cow dung and SSP over sole cow dung application are 17.6% and 19.9% in 2011 and 2012 respectively. This agreed with the findings of Akande *et al.* (2003). They obtained increase in maize height under complementary use of Ogun rock phosphate and cow dung over sole cow dung. Stem girth were not significantly affected by either sole cow dung application or combine use of cow dung and single superphosphates in 2011 and 2012. Control plants were remarkably shorter and thinner than those grown in amended soil.

Leaf area of maize was positively affected by treatment application in both years. Combined use of cow dung and SSP produced significant higher leaf areas than sole cow dung application and the control. There was no significant difference between integrated application of both cow dung and SSP irrespective of the rate of combinations. The significant response of maize to combined application of cow dung and SSP in terms of growth parameters (plant height and leaf area) is an indication that P is an important nutrient element influencing the performance of maize on the field (Tenebe *et al.*, 1995; Ogundare, 2011). The percentage P content in maize leaves sampled after treatment application was presented in Table 4. Significant increase in leaf P concentration was observed in all treatments compare with control. The percentage leaf P concentration ranged between 0.17 and 0.43 in 2011 and 0.23 and 0.48 in 2012. There was a slight increase in P content as the rate of cow dung increase from 2 t ha⁻¹ to 4 t ha⁻¹. The highest leaf P was observed in plots with cow dung treated with 4 t ha⁻¹ in 2011 and 2012. Significantly improved leaf P content observed due to the treatment applied was in line with the findings of Ogundare (2011) that organic manure has positive effect on the concentration of P in plant tissue. This observation confirmed the claims that an organic material improves P availability to crop.

The soil available P increased with increase in the rate of cow dung combined with decrease in the rate of single superphosphate. Soil available P in plots with 30 kg SSP ha⁻¹ plus 2 t ha⁻¹ cow dung, 20 kg SSP ha⁻¹ plus 4 t ha⁻¹ cowdung and 10 kg SSP ha⁻¹ plus 6 t ha⁻¹ were similar and significantly higher than plots with sole application of cow dung and control. Akande *et al.* (2003) reported the efficiency of cow dung in facilitating the release of P from rock phosphate resulting in significantly higher available P than using rock phosphate alone. The increase in P availability observed was explained by Khanna *et al.* (1983) to be as a result conversion of water insoluble P to soluble form. Cowdung significantly improved grain yield in maize resulting in as much as 90.6% and 57.7% yield increase in 2011 and 2012 respectively. Cowdung applied in combinations with SSP further significantly resulted in yield increase. The highest increase was obtained when cow dung (4 kg ha⁻¹) was amended with SSP (20 kg ha⁻¹) in both 2011 and 2012 seasons. This was significantly higher than results obtained at 30 kg ha⁻¹ + 2 t

ha⁻¹ cow dung, SSP at 10 kg ha⁻¹ + 6 t ha⁻¹ cow dung. Control plots recorded the lowest yield in 2011 and 2012 respectively.

The result of the present study showed that maize performance could be enhanced with cow dung amended with single superphosphate. Cow dung (4 t ha⁻¹) combined with 20 kg SSP ha⁻¹ gave the highest maize grain yield in this experiment. It is therefore recommended that the use of cow dung (4 t ha⁻¹) combined with 20 kg SSP ha⁻¹ be adopted for maize cultivation in the study area.

Table 1: Pre -planting physical and chemical properties of soil of site of experiment

Pre planting soil analysis	
Particle size (g kg ⁻¹)	
Sand	562
Clay	260
Silt	178
Soil texture	Sand clay loam
pH	5.8
Bulk density	1.3
Organic matter (g kg ⁻¹)	0.16
Total nitrogen (g kg ⁻¹)	0.03
Available P (mg kg ⁻¹)	2.3
Exchangeable cat ions (cmol kg ⁻¹)	
Potassium	0.33
Calcium	2.31
Magnesium	0.46
Sodium	0.26

Table 2: Chemical composition of cow dung used

Composition	(%)
Organic carbon (C)	43.4
Total nitrogen (N)	2.8
Available phosphorus	1.1
Potassium	0.8
Calcium	1.2
Magnesium	0.2
C/N	15.5

Table 3: Effect of cow dung manure amended with single superphosphate on growth parameters of maize

Treatments	Plant height (cm)	Stem girth (cm)	Leaf area (cm ²)	Plant height (cm)	Stem girth (cm)	Leaf area (cm ²)
	2011			2012		
Control	146c	4.6a	342d	138c	3.5	303c
CwD1	172b	5.3a	366c	159b	3.9	401b
CwD2	206ab	5.3a	436b	183b	4.1	463b
CwD3	212a	5.8a	551a	188b	4.3	503ab
CwD4	189ab	5.6a	517ab	201a	4.6	524a

CwD1 (10 t per ha); CwD 2 (2 t per ha + 30 Kg SSP); CwD3 (4 t per ha + 20 Kg SSP); CwD4 (6 t per ha + 10 Kg SSP)

Table 4: Effect of cow dung manure amended with single superphosphate on phosphorus concentrations (%) in leaves of maize

Treatments	2011	2012
Control	0.17d	0.23c
10 t ha ⁻¹ cow dung	0.32c	0.35b
2 t ha ⁻¹ Cwd +30 kg ha ⁻¹ SSP	0.40b	0.41ab
4 t ha ⁻¹ Cwd +20 kg ha ⁻¹ SSP	0.45ab	0.48a
6 t ha ⁻¹ Cwd +10 kg ha ⁻¹ SSP	0.43a	0.43a

Table 5: Effect of cow dung manure amended with single superphosphate on soil available Phosphorus (mg kg⁻¹)

Treatment	2011	2012
Unmanured control	3.36c	2.42c
10 t ha ⁻¹ cow dung	11.21a	14.68a
2 t ha ⁻¹ Cwd +30 kg ha ⁻¹ SSP	9.41b	11.26b
4 t ha ⁻¹ Cwd +20 kg ha ⁻¹ SSP	9.89b	11.32b
6 t ha ⁻¹ Cwd +10 kg ha ⁻¹ SSP	10.63c	11.68b

Table 6: Effect of cow dung manure amended with single superphosphate on grain yield of maize

Treatments	2011	2012
control	0.96d	0.78d
10 t ha ⁻¹ cow dung	1.83c	1.23c
2 t ha ⁻¹ Cwd +30 kg ha ⁻¹ SSP	2.68b	2.44ab
4 t ha ⁻¹ Cwd +20 kg ha ⁻¹ SSP	3.21a	2.56a
6 t ha ⁻¹ Cwd +10 kg ha ⁻¹ SSP	2.66b	2.24b

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