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Full Length Research Paper

Effects of Fortified Cow Dung Application on Green Maize Yield and Soil Fertility

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Organic manures are known to have the ability of supplying both the required macro and micro plant nutrients but in low quantities and usually not early enough for quick utilization. Enriching the manure combats the deficiency of late and low supply of nutrients. Experiments were conducted to assess the growth and yield of maize with Nitrogen-enriched cow dung. This was compared with performance with inorganic NPK fertilization and no fertilizer control. Maize growth was significantly (P = 0.05) affected by application of an enriched cow dung. The plants were comparable in height and leaf area with inorganic fertilizer. Fertilization of maize gave significantly (P = 0.05) higher grain yields. Fortified cow dung gave an average yield of 3.78 t ha^{-1} while inorganic fertilizer gave a yield of 3.70 t ha^{-1}. The unfertilized control plants had an average yield of 2.47 t ha^{-1}. Yield from the enriched cow dung was comparable with yield from inorganic fertilization. This shows the potential of the use of N-enriched cow dung as an alternative to inorganic fertilizers. Fortified cow dung increased soil N, P and K contents by 25, 1 and 62%, respectively. It also increased the soil Ca and Mg contents by 2 and 8%, respectively. Decomposed cow dung, fortified with Nitrogen can be applied at 2.5 t ha^{-1} to cultivate maize. It gives a comparable yield as inorganic fertilizer and increases the soil N, P, K, Ca and Mg contents.

Key words: Maize, growth, yield, cow dung, N-fortification, soil nutrients.

INTRODUCTION

Manure from livestock is an important source of nitrogen for crop production in the small holder sector. It helps farmers reduce inputs of commercial fertilizer, thereby, increasing the profit margin of the farmer. Nutrients contained in organic manures are released more slowly and are stored for a longer time in the soil, thereby ensuring a long residual effect (Sharma and Mittra, 1991) thus supporting better root development, leading to higher crop yields (Abou el- Magd et al., 2005). Improve-ments of environmental conditions as well as public health are also important reasons for advocating in-creased use of organic materials (Seifritz, 1982). Mainte-nance of soil fertility is essential for optimum and sus-tained production. Inorganic fertilizers can be used to re-plenish soil nutrients and increase crop yields, but are too costly for the peasant farmers. The use of mineral fertilizers has been associated with increased soil acidity, nutrient imbalance and soil degradation (Kang and Juo, 1980). This has necessitated research on use of organic manures. The use of organic manure alone, to sustain cropping has been reported to be inadequate due to unavailability in the required quantities and their relatively low nutrient contents (Palm et al., 1997). Integrated nutrient management approaches, in which both organic manure and inorganic fertilizers are used, have been suggested (Palm et al., 1997). Supply of nutrients from the organic manures can be complemented by enriching them with inorganic nutrients that will be released fast and utilized by crops to compensate for their late start in nutrient release.

Maize is an important cereal crop within the tropics. It is widely grown within the rainforest and savanna zones. It

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Table 1. Maize growth assessment (Pooled over two years).

	Average Plant Height at 8 WAP(cm)		Average Plant Leaf Area at 8 WAP(cm^2)		No. Of days to 50% Tasselling		Average Ear Height (cm)	
	2005	**2006**	**2005**	**2006**	**2005**	**2006**	**2005**	**2006**
No Fertilizer	99.0	95.6	324.0	376.2	56	55	80.5	70.41
Pacesetter fertilizer	123.7	127.5	415.2	435.4	53	53	68.83	75.20
NPK fertilizer	119.0	123.2	347.5	390.3	50	49	70.17	72.35
LSD(0.05)	10.12	11.41	58.69	44.07	1.84	2.04	14.18	5.30

is traditionally grown in intercrop with a variety of crops, like: cassava; melon; okra; cowpea and soybean. It is well adapted to the humid condition and the traditional method of cultivation in the tropics. Maize – based cropping systems are very popular in the tropics.

This study was conducted to compare the growth and yield of maize with fortified organic fertilizer (made from cow dung) with performance with inorganic fertilization.

MATERIALS AND METHODS

The experiment was conducted at the Institute of Agricultural Research and Training, Ibadan on latitude $7^0$22½'N and longitude $3^0$50½'E in the degraded rainforest vegetation zone of Nigeria in the growing seasons of 2005 and 2006. The town is characterized by a bimodal rainfall pattern with a long rainy season, which usually starts in late March while the short rainy season extends from September to early November after a short dry spell in August. The soil of the experimental site was an Alfisol. It is strongly leached, with low to medium humus content, deep red- clayed profile with top sandy texture. The site had been cultivated to crops such as maize, cassava and legumes with little fertilizer application. It was covered by both annual and perennial weeds.

The top 30 cm of the soil had a pH (H_20) of 6.7; 1.18% Organic Carbon; 0.12% Nitrogen; 6.09 ppm Available P (Bray P_1), 0.29 cmol kg^{-1} Exchangeable K and a CEC of 4.63 cmol kg^{-1}.

The experiment was laid out in a randomized complete block design (RCBD) with three replications. Plot size was 3 x 6 m. Treatments were: No Fertilizer – Control; Pacesetter Fertilizer – 2.5 t ha^{-1} + 100 kg Urea; NPK 20 -10 – 10 @ 400 Kg ha^{-1}. The Pace-setter fertilizer was a commercial fertilizer of Cow dung from an Abattoir, fortified with inorganic Nitrogen. 100 kg Urea per ton was added to the organic fertilizer to further fortify the N contents. Prior fortification, the fertilizer contained 6.08% Organic C, 0.61% N, 0.62% P, 2.75% K, 3.50% Ca, 0.52% Mg and 0.26% Na. The experimental site was ploughed and harrowed. The organic fertilizer was applied a week before planting. It was uniformly spread on the plots and lightly worked into the soil with West - African hoe. Inorganic fertilizer (NPK 20 -10-10) was applied 2 Weeks after planting (WAP) by ringing around maize plant. The plots were weeded manually whenever necessary throughout the experimental period. Maize was harvested fresh at 14 WAP and was sun - dried to 14% moisture content to get the dry grain weight. Growth and yield parameters measured were: Plant height (cm); average leaf area per plant (cm^2); number of days to achieve 50% Tasselling and dry grain yield (t/ha). The Analysis of Variance (ANOVA) procedure was carried out to determine the difference in para-meters. The significantly different mean values were separated using the Least Significant Difference (LSD) at 5% significant level.

RESULTS

Plant height at 8 WAP was significantly (P=0.05) increased with fertilization. It was increased by about 20 and 29% with inorganic fertilization in the first and second years, respectively but by about 25 and 33% with the Pacesetter fertilizer in the first and second years, respect-tively. Pacesetter fertilizer application had the tallest plants of 124 and 128 cm height in the first and second years, respectively when NPK – fertilized plants were 119 and 123 cm tall. They were both comparable in each year but were significantly (P = 0.05) taller than plants from the control treatment (Table 1). Average plant leaf area was all similar in the first year, with the Pacesetter fertilizer giving the widest leaves of 415 cm^2 when NPK fertilizer application had leaves 347 cm^2 wide. In the second year, leaves from the unfertilized plots were 376 cm^2 wide. They were significantly (P = 0.05) smaller than leaves from either NPK fertilizer or Pacesetter fertilizer applica-tion which had leaves 390 and 435 cm^2 wide, respectively (Table 1) . Inorganic fertilizer application gave plants that achieved 50% tasselling significantly earlier than the Pacesetter fertilizer application. The unfertilized plants achieved 50% tasselling in about 56 days while the Pace-setter fertilizer achieved 50% tasselling significantly earlier at 53 days. NPK – fertilized plants attained 50% tasselling in 50 days, which was even significantly earlier than that of the Pacesetter fertilizer. Ear heights were all similar in both years, ranging between 69 and 81 cm (Table 1) .Grain yields were similar from both fertilizer types but were both significantly (P=0.05) higher than that from the unfertilized plots. Over the two years, Pacesetter fertilizer; NPK fertilizer and no fertilizer applications gave yields of 3.79t ha^{-1}, 3.70t ha^{-1} and 2.48 t ha^{-1}, respect-tively. The relative yield of the unfertilized treatment com-pared to that of the Pacesetter fertilizer and NPK- fertili-zer treatments were 0.65 and 0.67 respectively. Ave-rage cob length, cob weight and weight of 100 seeds followed the same pattern. The observed values were similar with the fertilized plants and were both signify-cantly higher than observed from the control, unfertilized plants. The cobs were 33% longer with NPK fertilization as compared to no fertilization but were 43% longer with the Pacesetter fertilizer. Pacesetter fertilizer application gave higher but comparable values with NPK fertilizer

Table 2. Maize Yield and Yield Components (Pooled Over Two Years).

	Grain Yield (t/ha)	Cob Length (cm)	Cob Weight (g)	Av. No. of Seeds/Cob	Weight of 100 Seeds (g)
No Fertilizer	2.48	11.15	113.55	335.35	19.05
Pacesetter fertilizer	3.79	15.96	137.28	439.00	25.52
NPK fertilizer	3.70	14.83	129.29	396.9	24.37
LSD(0.05)	1.20	2.60	9.49	139.63	6.37

Table 3. Soil nutrient levels before and after cropping maize with different fertilizers.

	Organic C (%)	N (%)	P (ppm)	K ($CmolKg^{-1}$)	Ca ($CmolKg^{-1}$)	Mg ($CmolKg^{-1}$)
Nutrient levels before cropping	1.18	0.12	6.09	0.29	3.35	0.76
No Fertilizer	1.14	0.08	5.65	0.22	3.08	0.68
Pacesetter fertilizer	1.42	0.15	6.15	0.47	3.42	0.82
NPK fertilizer	1.12	0.15	6.11	0.30	2.87	0.71
LSD(0.05)	0.96	0.06	0.16	0.11	0.74	0.09

application. They were generally significantly (P = 0.05) higher than observed from the unfertilized treatment. Average number of seeds/cob was however all similar, both with the fertilized and with the unfertilized plants (Table 2).

Final soil N content was reduced without fertilization. It was reduced by 33% from 0.12 to 0.08%. Both fertilizers significantly (P = 0.05) increased the content to 0.15% (Table 3). Available P and Exchangeable K followed the same trend as soil N. Pacesetter fertilizer increased the P content slightly by 1% from an initial 6.09 to 6.15 ppm while NPK fertilizer application increased the P content to 6.11 ppm. Cropping, without fertilization reduced the available soil P content by about 3% to 5.65 ppm. The exchangeable K was increased from 0.29 cmol kg^{-1} to 0.47 and 0.30 cmol kg^{-1} with the Pacesetter and NPK fertilization, respectively. It was reduced to 0.22 cmol kg^{-1} with the unfertilized treatment (Table 3). The organic carbon was generally depleted. The depletion was even higher with NPK fertilization than the unfertilized treat-ment. Application of the Pacesetter fertilizer however, limited the depletion. The Calcium content was slightly increased by 2% from an initial 3.35 to 3.42 cmol kg^{-1} with the Pacesetter fertilizer application but was reduced to 2.87 cmol kg^{-1} with NPK fertilizer, which was even lower than the reduction to 3.08 cmol $kg^{-1}$of the unfertilized plot (Table 3). The soil Mg content was significantly increased by 8% with the Pacesetter fertilizer to 0.82 cmol kg^{-1} from an initial 0.76 cmol kg^{-1} while it was reduced to 0.71 cmol kg^{-1} with NPK fertilizer and to 0.68 cmol kg^{-1} without fertilizers (Table 3).

DISCUSSION

The growth of maize that was observed to be similar with both inorganic and fortified organic fertilizer application is an indication that the added Nitrogen, which had been applied to the field 2 weeks before planting, was available to the plants. Maize growth was observed to be more favoured by the enriched cow dung than sole inorganic fertilizer application. This shows that organic manure can be enriched with inorganic nutrients to have an initial, fast release of nutrients to plants, prior to the release of nutrients from the organic source. This will solve the characteristic shortcoming of slow initial release of nu-trients from sole organic manure application. Comparable yields, as from inorganic fertilization was therefore realized with N-enriched cow dung. Ayoola and Agboola (2002) have reported maize to perform best in terms of growth, yield and yield components with fortified organic manure than either sole organic or sole inorganic fertili-zers. Similar responses have also been reported on maize (Adeniyan and Ojeniyi, 2005; Makinde et al*.,* 2001; Chung et al., 2000) on rice (Satyanarayana et al., 2002) and on sorghum (Bayu et al., 2006). Murwira and Kirchmann (1993) have observed that the nutrient use efficiency of a crop is increased through a combined application of organic manure and mineral fertilizer.

This study has shown that although the soil N, P and K contents are reduced with maize cropping, they are increased with fertilization. The increase in soil N content with fortified cow dung as with inorganic fertilizer applica-tion indicates that organic manures can be relied upon to sustain cropping and as well increase the soil N content by fortification with inorganic nitrogen. The increases in the soil N, P and K contents after two years cropping is an indication that the NPK requirements of maize can be met by the use of Nitrogen- fortified cow dung as an alternative to inorganic fertilizers. The organic carbon was more depleted with NPK fertilization because, it sup-ported a better plant growth than the unfertilized treat-ment but it did not add any organic material to the soil that can decompose to add to the soil organic matter content. The cow dung seemed to have added some organic matter to the soil at decay and so, limited the depletion.

Conclusion

The dependence on inorganic fertilizers to sustain cropp-ing of maize can be limited by the use of cattle wastes, fortified with inorganic nitrogen. It gives maize growth and grain yield comparable with inorganic fertilization and as well increases the soil nutrient contents.

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