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Full Length Research Paper

Yield of sweet corn in response to fertilizer sources

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Alternative source of plant nutrition is now becoming imperative in vegetable production in Nigeria, because of health problems associated with excessive usage of inorganic fertilizer. Research was conducted in vegetable research plot of National Horticultural Research Institute (NIHORT), Ibadan, Nigeria, to evaluate the effect of N fertilizer sources and rate on the growth and development of sweet corn. Fertilizer sources significantly increased yield and its components at both years of study. Sweet corn yields with applied inorganic were greater than those receiving organic sources of fertilizer. Sweet corn yielded 3063 kg ha^{-1} and 3333 kg ha^{-1} in 2003 and 2004 at 120 kg ha^{-1} inorganic fertilizer rate compared to 1803 kg ha^{-1} and 996 kg ha^{-1} in 2003 and 2004 respectively, with organomineral fertilization. These results suggest that sweet corn yield could be enhanced by the application of inorganic fertilizer, because of the slow release nature of organic sources of fertilizer in relation to growth duration.

Keywords: Fertilizer sources, yield components, dry matter accumulation and proximate analysis.

INTRODUCTION

Sweet corn is gradually becoming an important vegetable crop in Nigeria, since it forms a useful ingredient in the preparation of salad and other food ingredient both at home and in hotels. Sweet corn is a heavy feeder requiring high amount of nutrients such as nitrogen, phosphorus and potassium. Most of the required nutrients are usually applied in the form of inorganic fertilizers. Even though many studies have shown that organic manure has a potential to increase soil concentration of nutrients and organic matter (Chang et al., 1991; Eghball, 2002). The residual effects of increased nutrients and organic matter in soil following manure or compost application on crop yield and soil properties can last for several seasons (Eghball et al., 2004).

Most Nigerian soil is typically low in organic matter and the supply of all through chemical fertilizer is becoming increasingly important. All fertilization practice that maintain or increase production level and simultaneously decrease water pollution potential should be encouraged, since excessive application of fertilizers can result in high soil nitrate level after crop harvest (Stone et al, 1995; Dormar and Chang, 1995).

The use of organic fertilizers as a source of nutrients for plant can greatly reduce the environmental problems associated with the use of inorganic fertilizers. Most organic wastes release nutrients slowly compared to synthetic fertilizers while reducing the rates of nutrient loss (Chen et al., 1996; Mazzarino et al, 1997). Other benefit of organic fertilizers include enhancement of nitrogen availability, improvement of soil structure and water retention and increased soil organic matter. (Li et al., 1990; Ancheng and Sun, 1994). Alternatively, inorganic fertilizer provides readily available nutrients to crops and this are often associated with excessive absorption of nitrate and sulphate that may cause health problems in humans (Noble and Conventry, 2005).

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One source of organic fertilizer that could be used in agricultural production is municipal waste and organomineral (decomposed organic materials fortified with inorganic fertilizer). Composting is the biological degradation of organic waste into humus like substance by microbial populations, which results in the transformation of less stable forms of nutrients such as nitrogen into stable polynerizerised holmic substances (Munich and Hunt, 1979). The wastes are gathered unto a heap in order to conserve heat, thereby raising the temperature and accelerating the degradation process (Gray and Biddlestone, 1981). The use of municipal waste in agriculture would present a better disposal alternative, it would lower the disposal cost and reduce environmental hazard associated with the use of commercial fertilizer in agriculture, as well as present an environmental friendly way of disposing municipal waste.

The use of organic wastes in agriculture holds promise, since they offer a locally available fertility source and their removal reduces the risks of pollution and cost of disposal (Mazzarino et al., 1997). If the cost associated with transporting and applying organic wastes, such as municipal wastes to agricultural land can be kept low, farmers can benefit by reducing the amount of inorganic fertilizers applied while improving soil fertility and crop yield (Entry et al; 1997). The aim of this research was to evaluate the potential of organic fertilizer to supply and enhance availability and uptake by sweet corn.

MATERIALS AND METHODS

Field experiments were conducted during 2003 and 2004 growing seasons on the experimental field of National Horticultural Research Institute (NIHORT), Ibadan (3^{o} 52'E and 7^{o} 25'N). The soil of the experimental site was sandy loam and classified as Alfisol (Harpstead, 1973). The experimental field was cleared, harrowed and ridged. The experimental field was divided into plots and each plot measured 2 m X 3 m (6 m^2) with spacing of 1 m between each plot. Before planting a representative soil sample was taken at different parts of the field, and was thoroughly mixed together to form a composite sample, which was air-dried and made to pass through a 2, and 0.5 mm sieve for soil texture and chemical analyses. The soil in 2003 had 83.1% sand, 8.9% silt and 8.0% clay, a pH of 6.3, 0.79 g kg^{-1} organic carbon, 0.142 g kg^{-1} total N and 7.63 $mgkg^{-1}$ available P (at 0-15 cm soil depth), while in 2004, the soil had 81.6% sand, 8.0% silt and 10.4% clay, a pH of 5.4, 0.49 g kg^{-1} organic carbon, 0.027 g kg^{-1} total N and 14.5 mg kg^{-1} available P (at 0-15 cm soil depth).

The experimental design was a split plot factorial fitted to randomized complete block. The treatment consisted of three different sources of fertilizer applied at four different levels. The fertilizer sources are organomineral, inorganic, cured poultry manure and the control (no application). The organomineral used contained 2.54% N, 1.1% P, 1.92% K, 1.11% Na and Zn, Pb, Mn, Fe and Cu at 0.51, 0.04, 0.91, 32.12 and 0.19 mg kg^{-1}, while poultry manure contained 1.94% N, 5.82% P, 2.89% K and 1.65% Na and Zn, Pb, Mn, Fe, and Cu at 1.20, 0.03, 2.12, 46.12 and 0.35 $mgkg^{-1}$. Fertilizer application was done based on soil test values. The fertilizer N sources were the main plot while the sub plot consisted of different fertilizer rates (0, 40, 80, and 120 kg ha^{-1}). Open pollinated shrunken variety was used for the experiment. The chemical fertilizer was applied in two split doses. The treatment dose was applied basally at planting and the other was top dressed at 4 weeks after planting. However, due to the slow release nature of organic fertilizer, poultry manure was applied a week before planting while organomineral was applied at planting. The trials were conducted between June and September at both years of study using separate plots. The spacing used for the experiment was 75 cm between rows and 25 cm within rows. Two seeds were planted per hole and later thinned to one plant per stand. Weeds were controlled with a combination of pre-emergence and contact herbicides applied at planting, followed by hand weeding at 3 weeks and 7weeks after planting.

Grain yield at maturity was determined by harvesting the two central rows of each plot. Random samples consisting of 10 ears per plot were taken for the determinations of yield component parameters at harvest. Yield components measured included ear diameter, ear length, kernel number, and weight of 100 kennels. In addition total dry matter of plant maturity was measured. Also four ears were taken for proximate analysis. A mixed-model analysis of variance (AOU) was used to evaluate effects of fertilizer source, rates and their interactions on grain yield, its components and proximate analysis of the fruits.

RESULTS

Sweet corn yield increased with increase in N fertilizer sources used for the study (Table 1). There were significant differences among the rates, with sweet corn yield increasing from 0 to the highest application rate irrespective of the source and year except with organomineral fertilizer in 2004, where there was a slight decrease after 80 kg ha^{-1} and poultry manure in both years with a slight drop after 80 kg N ha^{-1} (Table 1). For a given fertilizer rate, sweet corn yields with inorganic fertilizer were normally greater than those receiving organic sources of fertilizer. Sweet corn yielded 3063 kg ha^{-1} and 3333 kg ha^{-1} in 2003 and 2004 at 120 N kg ha^{-1} inorganic fertilizer rate compared to 1803 kg ha^{-1} and 996 kg ha^{-1} in 2003 and 2004 respectively, with organomineral fertilization. However, there was only a small rise from the 80 kg N ha^{-1} level to 120 kg N ha^{-1}, especially with inorganic fertilization (Table 1).

Table 1. Effect of fertilizer sources and rate on yield of sweet corn grown in derived savanna of Nigeria.

		Yield (kg ha^{-1})	
Sources	Rate	2003	2004
NPK	0	1116.7	1260.0
	40	2389.9	3816.6
	80	3009.6	4766.7
	120	3063.7	4443.3
Organomineral	0	889.9	1483.3
	40	1276.9	1520.0
	80	1559.1	1470.0
	120	1803.1	1633.3
Poultry manure	0	806.6	950.0
	40	1210.3	466.7
	80	2280.0	2000.0
	120	2031.3	3083.3
SE (source)		47.4	67.3
SE (rate)		58.5	77.8

Table 2. Effect of N sources and rate on yield components of sweet corn grown in derived savanna of Nigeria.

Sources	Rates	2003				2004			
		Ear diameter (mm)	Ear length (cm)	Kernel number	100 kernel weight (g)	Ear diameter (mm)	Ear length (cm)	Kernel number	100 kernel weight (g)
NPK	0	7.43	10.1	123.6	5.25	4.89	5.33	177.6	5.25
	40	8.47	17.67	234.8	7.32	12.30	8.37	303.1	5.10
	80	8.67	17.50	367.2	7.26	11.13	10.63	448.6	7.50
	120	8.13	18.57	398,1	7.50	12.17	12.63	464.0	7.96
Organomineral	0	7.70	11.73	103.4	4.30	4.50	4.67	179.7	5.06
	40	7.33	13.03	167.9	4.89	7.33	4.93	323.7	5.90
	80	8.10	13.77	204.7	5.90	7.73	9.53	408.7	6.50
	120	8.30	14.33	234.1	6.50	9.46	9.73	391.7	7.03
Poultry manure									
	0	7.23	9.60	115.3	5.12	3.90	4.27	166.3	4.57
	40	7.55	10.17	123.4	5.29	5.20	5.27	241.8	4.67
	80	7.40	10.97	215.5	4.94	8.03	7.93	339.8	5.30
	120	8.16	12.23	256.2	5.88	8.86	9.10	408.9	7.77
SE (Source)		0.26	0.19	64.5	0.26	0.14	0.18	45.9	0.26
SE (Rate)		0.30	0.22	70.5	0.30	0.16	0.23	62.1	0.30

Yield components (100 kernel weight, ear diameter, ear length and kernel number) and dry matter production at harvest increased with increasing rates of fertilizer (Tables 2). It was also observed that rates, which had higher values in 100-kernel weight and kernel number, had higher sweet corn yield. Dry matter partitioning also followed the same trend, with increased values from no application to the highest fertilizer rate (Table 3). Higher dry matter yield were obtained from the inorganic fertilizer treated plots, when compared with organomineral and poultry manure in both years of study (Table 3).

For most of the yield components considered, the NPK fertilizer treatment produced higher yield components (ear diameter, ear length, 100 kernel weight and kernel number)

Table 3. Effect of fertilizer source and rate on dry matter accumulation of sweet corn grown in derived savanna of Nigeria.

Source	Rate	2003				2004			
		Leaf (g/plant)	Stem g/plant	Root(g/ Plant)	Total (g/plant)	Leaf (g/plant)	Stem (g/plant)	Root (g/plant)	Total (g/plant)
NPK	0	25.63	49.9	8.47	84.00	25.63	49.90	10.83	86.40
	40	29.80	60.53	18.57	108.90	39.8	78.91	19.97	138.73
	80	47.40	91.53	33.50	172.43	49.13	87.27	32.60	169.00
	120	45.73	95.50	33.06	173.80	50.9	108.73	41.10	204.97
Organomineral	0	24.47	38.50	8.00	58.40	17.8	31.33	9.27	79.00
	40	36.17	51.30	21.47	113.70	32.83	69.10	21.77	103.70
	80	35.87	61.86	21.03	152.67	45.87	87.53	19.27	117.00
	120	38.27	65.73	28.60	168.47	51.60	101.70	16.17	131.93
Poultry manure	0	32.5	38.00	9.93	72.4	21.37	34.60	9.80	65.77
	40	30.9	59.10	31.77	127.03	31.60	82.97	28.33	142.90
	80	34.10	50.85	20.50	107.23	42.43	91.87	31.03	165.33
	120	37.10	45.03	15.17	98.47	50.93	99.07	38.60	188.60
SE (Source)		3.26	3.21	0.98	5.94	1.33	2.21	1.17	2.24
SE (Rate)		3.76	3.71	1.14	6.86	1.53	2.55	1.38	3.27

Table 4. Effect of fertilizer sources and rates on proximate analysis of sweet corn grown in derived savanna of Nigeria in 2003.

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Source	Rate	2003						
		Ash%	Fats%	Protein	Moisture	Starch	Fibre	Sugar
NPK	0	0.969	0.996	2.859	72.70	11.11	1.08	9.46
	40	0.989	1.031	2.993	72.66	11.33	1.12	9.86
	80	0.998	1.039	3.048	72.74	11.68	1.13	9.90
	120	1.027	0.999	3.059	72.77	11.79	1.15	9.88
Organomineral	0	0.964	0.999	2.793	72.33	11.07	1.06	9.47
	40	0.975	1.010	2.905	72.48	11.42	1.11	9.70
	80	0.981	1.039	2.973	72.48	11.48	1.12	9.77
	120	0.986	1.024	2.73	72.57	11.52	1.13	9.75
Poultry manure	0	0.966	1.003	2.774	72.50	11.13	1.08	9.49
	40	0.987	1.025	2.929	72.59	11.31	1.11	9.63
	80	0.987	1.030	2.980	72.69	11.43	1.12	9.71
	120	0.992	1.035	3.002	72.74	11.51	1.11	9.76
SE (Source)		0.003	0.004	0.010	0.024	0.031	0.005	0.017

Table4. Continue

SE (Rate)		0.003	0.005	0.011	0.028	0.036	0.006	0.020
			2004					
NPK	0	0.969	0.996	2.859	72.70	11.11	1.08	9.46
	40	0.989	1.031	2.993	72.66	11.33	1.12	9.86
	80	0.998	1.039	3.048	72.74	11.68	1.13	9.90
	120	1.027	0.999	3.059	72.77	11.79	1.15	9.88
Organomineral	0	0.964	0.999	2.793	72.33	11.07	1.06	9.47
	40	0.975	1.010	2.905	72.48	11.42	1.11	9.70
	80	0.981	1.039	2.973	72.48	11.48	1.12	9.77
	120	0.986	1.024	2.73	72.57	11.52	1.13	9.75
Poultry manure	0	0.966	1.003	2.774	72.50	11.13	1.08	9.49
	40	0.987	1.025	2.929	72.59	11.31	1.11	9.63
	80	0.987	1.030	2.980	72.69	11.43	1.12	9.71
	120	0.992	1.035	3.002	72.74	11.51	1.11	9.76
SE (Source)		0.003	0.004	0.010	0.024	0.031	0.005	0.017
SE (Rate)		0.003	0.005	0.011	0.028	0.036	0.006	0.020

than the organic fertilizer sources in both years of the study (Table 2).

In 2003 fresh sweet corn cobs were subjected to proximate analysis and results showed that fertilizer application significantly increased the values of ash, fat, protein, moisture, sugar, fibre, and starch as fertilizer rate increases with higher values obtained from plants treated with inorganic fertilizer (Table 4).

DISCUSSION

Among the major nutrient required by crops, N is perhaps the most important of the nutrients because of its biological roles and because it is required in large quantities by the plants. However, the application of large quantities of commercial fertilizers provides a great potential for N contamination of surface and ground water (Dormaar and Changi, 1995). Continuous fertilization has resulted in increased soil N that has led to environmental concerns. The use of organic fertilizers as a source of N and other nutrients for plants can greatly reduce the environmental problems associated with the use of inorganic fertilizers (Tilston et al., 2005).

In this study, differences were observed for sweet corn yield and yield components and dry matter production at harvest, in terms of the different N rates and sources that were evaluated. The application of NPK fertilizer treatment yielded significantly higher than the organic fertilizer sources used. These results are in agreement with those of Paul and Beauchamp (1993) who observed that corn yields were higher in plots amended with urea compared to those amended with organic fertilizer source. Warman and Havard (1996) also reported that in two out of three years, sweet corn grown with convectional fertilizer out-yielded organically grown sweet corn.

Brinton (1985) observed that corn plants fertilized with compost had significantly lower tissue N compared to those fertilized with inorganic fertilizer which subsequently resulted in significantly lower yields in the compost plots. This is presumably what happened in this experiment at both years of study and supports the suggestion by other researchers that the low availability of compost N might reduce plant yield.

From this study, it can be concluded that the application of NPK fertilizer source produced higher yields than organic fertilizer sources, because of the slow release nature of organic fertilizers. This suggests that organically grown sweet corn requires supplemental dozes of convectional fertilizers in order to achieve optimum production.

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