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RESPONSE OF POD NUTRIENT CONTENT AND YIELD OF OKRA TO APPLICATION OF SOLE AND AMENDED PLANT RESIDUES

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Abstract

A study was conducted to determine the effect of wood ash, sawdust, ground cocoa pod husk, spent grain and rice bran, used ordinarily or amended with goat, pig and poultry manure on pod nutrient content and yield of okra (Abelmochus esculentus (L.) Moench). The twenty organic fertilizer treatments were compared with the control and 400 kg/ha NPK fertilizer in four field experiments. Application of sole and amended 6t/ha plant residue to soil increased pod N, P, K, Ca and Mg content and pod count. Wood ash was most effective in improving pod nutrient content and pod count, whereas rice bran and sawdust were least effective. Amendment of plant residues with animal manure tended to improve the effectiveness of the plant residues on pod N and P status and count. Compared to NPK fertilizer, plant residues increased pod Ca and Mg content and pod count. Relative to the control, NPK fertilizer, wood ash, cocoa husk, rice bran, spent grain and sawdust increased pod count by 79, 385, 168, 115, 230 and 185%, respectively.

INTRODUCTION

Continuous cropping in the humid tropics leads to loss of soil fertility and nutrient availability to the crops which necessitate the use of chemical fertilizers. High cost and scarcity of chemical fertilizer, nutrient imbalance due to nutrients not supplied, soil acidity due to continuous use of N fertilizer, and degradation of soil physical quality due to loss of organic matter are some of the problems that arise with continuous use of chemical fertilizers. Hence there is need to investigate the use of locally available and relatively cheap organic sources of plant nutrients. The use of plant residues such as wood ash, sawdust, cocoa husk, spent grain and rice bran as source of plant nutrient, especially in vegetable crop production, has not received research attention, even though it is known that decomposing plant residues release important and appreciable amounts of nutrients into the soil (Ayanlaja and Sanwo, 1991).

Okra (*Abelmoschus esculentus* (L.) Moench) is a popular vegetable grown for its pods. It has been found that continuous use of nitrogen containing fertilizer increases soil acidity and reduces nutrient uptake and yield of okra (Aduayi, 1980, 1981). This study was carried out on four croppings of okra to investigate the effect of sole and amended plant residues on pod nutrient content and yield of okra.

MATERIALS AND METHODS

Experiments were carried out at Akure in Ondo State, Nigeria, on a sandy loam soil with pH (water) of 5.1; organic matter, 053%; nitrogen, 0.02%; extractable P, 4.6 mg/kg; exchangeable K, 0.08% mmol/kg; exchangeable Ca, 0.11 mmol/kg and exchangeable Mg, 1.12 mmo/kg. The experimental site had been continuously cropped for 10 years. The determinations made were carried out on the early and late season okra crops of 1997 and 1998. Therefore, there were four field experiments.

Twenty plant residue treatments (made up of five sole and fifteen amended treatments), were applied to each crop, in addition to the reference NPK fertilizer treatment (400 kg/ha 15-15-15 NPK fertilizer) and the control (no treatment). The plant residues were wood ash, ground cocoa pod husk, rice bran, spent grain (sorghum based brewery waste) and sawdust. The materials were applied sole at 6t/ha, or amended with each of goat manure, pig manure and poultry manure at the rate of 3t/ha. The 22 treatments were replicated three times in each of the consecutive croppings at the same site, using a randomized complete block design. The size of each plot was $4m^2$. The manure and fertilizer were incorporated into soil two weeks before planting.

Four seeds of an early maturing okra variety (NH A 47-4) were planted per stand at 60 x 30cm in April and in August 1997 and 1998, respectively. Thinning to one plant per stand was done two weeks after planting, and the plots were manually weeded three times during the experiment starting from the second, third and seventh weeks after planting. Out of the 28 plants per plot, six were selected for observation. Harvest of pods started 50 days after planting and the harvest continued at 4-day interval till senescence of the plant. Pod count was recorded per plot. Ten pods harvested last in each plot were oven-dried for two days at 70°C and then milled into powdered form before ashing at 500°C for 6 hours. The nutrients in the ash were extracted with water. Total N was determined using micro-kjeldahl method, and P by the vanadomolybate colorimetry on B and L spectrophotometer. The K and Ca contents were read on the flame photometer and Mg content by atomic absorption.

The mean pod nutrient and yield data for the manurial treatments were compared using the Duncan Multiple Range Test at 5% level of probability.

RESULTS AND DISCUSSION

The sole and amended plant residues significantly increased pod N, P, K, Ca and Mg contents (Table 1) and pod count (Table 2) as compared with the control. Wood ash, cocoa husk, rice bran, spent grain and sawdust increased pod count by 385, 168,115, 230 and 185%, respectively. Among the plant residues, wood ash followed by cocoa husk gave the highest values of pod N, P, K, Ca and Mg, while sawdust and rice bran had the lowest value for pod N, P, K, Ca and Mg. Sawdust also gave the least pod P value. Wood ash, followed by spent grain, gave the highest pod count, while rice bran gave the lowest pod count. Thus wood ash was most effective in improving pod nutrient content and yield. Rice bran and sawdust least improved pod nutrient contents.

The compound fertilizer (NPK) gave better pod N, P and K values compared with the sole and amended plant residues. However, NPK fertilizer gave the lowest pod count. When compared with NPK fertilizer, wood ash, cocoa husk, rice bran, spent grain and sawdust increased pod count by 170, 49, 20, 84 and 59% respectively. Also, the plant residue gave better pod Ca and Mg status than the NPK fertilizer.

The amendment of the plant residues with goat, pig and poultry manure increased pod N and P status (Table 1) and count (Table 2). Except in the case of wood ash amended with goat manure, amendment also improved pod K and Ca status of okra. Amendment of cocoa husk, rice bran, spent grain and sawdust with pig and poultry manure increased pod Mg status. Therefore, amendment of the plant residue with animal manure tended to increase pod nutrient content (Table 1) and yield (Table 2).

Even though the okra pod N, P, K, Ca and Mg contents tended to increase with addition of sole and amended plant residue, pod count fell after the third addition of residue. Therefore, continuous application of manure would appear to have enhanced nutrient availability and growth of okra at the expense of pod yield (Table 2).

The increases in pod nutrient content and pod count due to application of ordinary and amended plant residues is consistent with the initially low fertility and low pH status of the soil. Nutrient availability, growth and yield of okra are adversely affected by low soil fertility and low pH (Aduayi, 1980). The application of plant residues increased soil pH and fertility of the soil. The mean values of soil organic matter for the control, NPK fertilizer, wood ash, cocoa husk, rice brain, spent grain and sawdust treatments were 0.35, 0.52, 2.03, 1.92, 1.68, 1.91 and 1.64%, respectively. The corresponding values for soil pH were 5.1, 5.6, 5.9, 6.8, 5.9, 6.2, and 5.9, and the values for soil bulk density were 1.67, 1.61, 1.45, 1.48, 1.52, 1.41 and 1.52g/cm^3 respectively (Folorunso, 1999). Olayinka and Adebayo (1985) had found that surface application of sawdust in Southwest Nigeria increased soil N. P. K, pH, uptake of P, K and Ca and grain yield of maize.

The better pod Ca and Mg contents recorded for residue and residue plus manure treatments agree with the fact that the organic materials are sources of plant nutrients, including Ca and Mg not supplied by the NPK fertilizer. The lower pod yield recorded for NPK fertilizer

Table 1: Effect of Plant residue plus manure (M) on mean pod nutrient content (%) of Okra

TREATMENT	N	P	K	Ca	Mg
No fertilizer	0.03	0.05	0.03[a]	0.03[a]	0.02[a]
NPK fertilizers	2.80[0]	0.62[no]	1.50[t]	0.06[b]	0.02[a]
Wood ash	1.57[h]	0.42[h]	1.40[s]	1.03[me]	0.24[o]
Wood ash + Goat M	2.90[is]	0.52[j]	0.91[e]	0.77[gh]	0.13[0]
Wood ash + Pig M.	2.84[pq]	0.65[q]	1.02[fi]	1.08[c]	0.24[n]
Wood ash + Poultry M	2.86[q]	0.71[s]	1.55[tu]	1.29[q]	0.26[p]
Cocoa husk	1.49[fg]	0.60[n]	1.05[i]	0.98[i]	0.15[gh]
Cocoa husk + Goat M	2.88[r]	0.65[r]	0.96[f]	1.16[q]	0.28[q]
Cocoa husk + Pig M	2.82[p]	0.57[kl]	1.23[no]	1.11[op]	0.16[i]
Cocoa husk +Poultry M	2.89[f]	0.63[pq]	1.17[l]	0.92[l]	0.19[l]
Rice bran	0.51[b]	0.35[q]	0.43[b]	0.48[c]	0.12[c]
Rice bran + Goat M	1.43[f]	0.37[f]	0.82[d]	0.59[d]	0.13[c]
Rice bran + Pig M	1.45[f]	0.56[k]	1.30[r]	0.72[f]	0.14[e]
Rice bran + Poultry M	1.72[k]	0.61[n]	1.11[lk]	0.99[k]	0.21[l]
Spent grain	1.33[e]	0.27[c]	0.60[c]	0.59[d]	0.15[f]
Spent grain + Goat	2.63[l]	0.25[e]	1.29[d]	0.78[gh]	0.07[b]
Spent grain + Pig M	2.79[n]	0.62[no]	1.20[m]	1.03[m]	0.15[fg]
Spent grain + Poultry M	2.97[m]	0.58[m]	1.02[q]	1.02[m]	0.19lk
Sawdust	0.79[c]	0.22[c]	0.44[b]	0.29[c]	0.12[c]
Sawdust + Goat M	1.59[j]	0.23[d]	1.21[n]	0.63[e]	0.08[b]
Sawdust + Pig M	1.24[d]	0.45[l]	1.09[j]	1.29[r]	0.14[d]
Sawdust + Poultry M	1.57[hi]	0.66[r]	1.24[p]	1.33[s]	0.22[m]

Treatment means followed by the same letters are not significantly different, using DMRT at 5% level of probability.

Table 2: Effect Of Ordinary And Mature (M) Amended Plant Residue On Pod Count Per Six Plants Of Okra

TREATMENT	CROP 1	CROP 2	CROP 3	CROP 4	CROP 5
No fertilizer	5.3	5.3	5.3	5.3	5.3[a]
NPK fertilizers	6.3	7.7	12.1	12.0	9.5[b]
Wood ash	9.3	15.3	40.5	35.7	25.7[l]
Wood ash + Goat M	10.5	16.7	51.8	39.1	29.5[o]
Wood ash + Pig M.	9.5	14.1	40.0	33.0	24.2[k]
Wood ash + Poultry M	9.0	15.4	46.7	39.3	27.6[m]
Cocoa husk	7.5	9.7	23.0	16.7	14.2[ef]
Cocoa husk + Goat M	8.3	12.0	33.1	25.1	19.6
Cocoa husk + Pig M	7.6	11.3	22.6	21.8	15.8[h]
Cocoa husk +Poultry M	8.7	12.8	24.3	24.0	17.5[i]
Rice bran	6.7	8.4	18.5	12.2	11.4[c]
Rice bran + Goat M	6.9	9.0	20.8	13.9	12.7[d]
Rice bran + Pig M	7.3	9.3	22.5	15.1	13.5[e]
Rice bran+ Poultry M	7.7	9.6	23.3	16.6	14.3[ef]
Spent grain	8.2	11.1	29.3	21.5	17.5[j]
Spent grain + Goat	13.6	24.0	79.5	64.0	45.3[q]
Spent grain + Pig M	14.4	25.3	88.0	69.8	49.4[r]
Spent grain + Poultry M	17.8	33.1	117.4	92.1	65.1[t]
Sawdust	7.3	9.2	25.2	18.6	15.1[g]
Sawdust + Goat M	12.2	22.2	70.3	56.1	40.2[p]
Sawdust + Pig M	12.0	25.7	91.5	70.1	49.8[rs]
Sawdust + Poultry M	10.7	16.6	51.5	34.1	28.2[n]

Treatment means followed by the same letters are not significantly different, using DMRT at 5% level of probability.

when compared with sole and amended plant residue treatments might have resulted from higher soil acidity, lower soil organic matter status and higher bulk density recorded for the soil under fertilizer treatment. The dense soil could have reduced root growth and adequate uptake of nutrients found not supplied. The soil under sole and amended residue treatments had higher pH, higher organic matter level and lower bulk density as compared with the chemically fertilized soil.

The fact that the amendment of plant residue with animal manure increased pod nutrient content and pod count is consistent with increased availability of nutrients as a result of organic amendment of the soil. The types of animal manure used in this study had lower C: N and higher P status as compared to the plant residues (Folorunso, 1999) and could have aided the decomposition of the residue and release of nutrients for crop use. Olayinka (1990) found that amendment of sawdust with poultry manure increased maize plant height, dry matter yield, soil organic C, pH and uptake of N, P, K. Ca and Mg. Olayinka and Adebayo (1984) had found that amendment of sawdust with dairy manure enhanced the decomposition of the sawdust. The finding that wood ash gave the highest pod count supports the observation that the residue gave the highest pod N, K, Ca and Mg and one of the highest pod P values. The relatively low pod count recorded for rice bran and sawdust is consistent with the lowest pod N, K, Ca and Mg values recorded for those plant residues.

CONCLUSION

Application of wood ash, ground cocoa husk, rice bran, spent grain and sawdust to relatively low fertility soil increased the availability of nutrients to okra, thereby increasing its fruit/pod yield. Wood ash and spent grain were the most effective. The plant residues investigated were more effective than NPK fertilizer in increasing okra pod count. The amendment of the residue with goat, pig and poultry manure increased their effectiveness as sources of major plant nutrients.

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