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Effect of Agroindustrial Wastes on Nutrients Status and Performances of Tomato

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Abstract: Agroindustrial wastes such as spent grain, cocoa husk, rice bran and sawdust, unamended and amended with cattle, poultry and goat droppings were studied as to their effect on growth, fruit yield and nutrient composition of tomato (*Lycopersicum escutentum Mill*) in two experiments. Analysis of the wastes showed varying nutrient composition with C:N values of 11.1, 12.5, 23.3 and 18.2 respectively. Cocoa husk had highest P and K, while spent grain had highest N. The wastes applied at 5 t ha^{-1} increased leaf N, P, K and Ca content of tomato. Cocoa husk, spent grain and rice bran increased growth and fruit yield significantly (P>0.05). The increases in fruit yield were 177, 149 and 60% respectively. Amendment of spent grain and cocoa husk at 2.5 t ha^{-1} with animal droppings at 2.5 t ha^{-1} increased effectiveness of the wastes in improving tomato yield. The amended forms increased plant height, dry matter and fruit yield compared with NPK fertilizer.

Key words: Agrowastes · fertilizer · growth · nutrient · tomato · yield

INTRODUCTION

High cost and scarcity of inorganic fertilizers in developing countries led to renewed interest in use of unorthodox organic materials as nutrient sources for the cultivation of nutrient demanding crops such as tomato. Application of NPK fertilizer is a normal practice in tomato production [1] and the crop is known to respond to Mg [2]. The use of easily available and cheap agroindustrial wastes by vegetable farmers in pericurban areas ensure sustainability of production more balanced crop nutrition and environmental sanitation.

While agrowaste such as poultry droppings and compost were successfully used on tomato [3], agroindustrial wastes such as spent grain, cocoa pod husk, rice bran and sawdust are yet to receive research attention in tomato production. Studies by Moyin Jesu and Ojeniyi [4], Moyin Jesu [5] and Moyin Jesuand Atoyosoye [6] found that these agroindustial wastes were effective in increasing uptake of N,P,K, Ca and Mg and growth and yield of amaranthus cocoa seddling and okra respectively.

In Nigeria about 8,000 000 tones of dry cocoa pod husks are left to waste annually and with this 6,4000-94000 tones of K, Ca and P are lost annually [7], Also a large amount of sawdust estimated at over 1 million tones accumulates everyday in over 2000 saw milling plants and the sawdust contains Ca, P, K, Mg, Cu, Zn and Fe [8]. The field experiments being reported studied effect of ordinary and animal droppings amended agroindustrial wastes on performance and nutrient composition of tomato.

MATERIALS AND METHODS

Experiment 1: Experiments were conducted at Akure (7° 30'N, 3° 52'E) in tropical rainforest Zone of South West Nigeria on a sandy day loam soil (Oxic tropuldalf). Core surface (0-15 cm) soil samples collected at sites of experiments were vbulked, air-dried and 2 mm sieved for chemical analysis [9]. The soil had a PH ($CaC1_2$) of 6.0, organicmatter 1.8%, total N0.11%, exchangeable K 0.08 cmol $kg^{-1,}$ Mg 1.1 cmol $kg^{-1,}$ Ca 0.16 cmol kg^{-1} and available P 4.7 mg kg^{-1}.

The first experiment was carried out in 2003 to test effect of four agroindustrial wastes applied at 5 t ha^{-1} on tomato. The wastes were brewery spent grain (sorghum basedground cocoa pod husk (air-dried), rice bran and sawdust and there was a control. The five treatments were replicated three times in a randomised complete block design. There were two trials respectively between April and July (early season) and mid-August to November

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(late season). The tomato seedlings were transplanted to manually cleared field at 75x50 cm after being raised for 3 weeks in the nursery. There were 66 plants in each of 25 m^2plot. The early crop was transplanted in may and the late crop in August. Manure was applied by ring method two weeks after transplanting.

Fifteen plants were selected per plot for determination of yield, plant height and leaf area. The number andweight of harvested ripe fruits were determined between 62 and 90 days after transplanting.

Agrowaste and Leaf Analysis: At 40 days after treatment application, leaf samples were collected, oven dried at 80°C and ground for chemical analysis [9]. Air-dried waste were also analysed. Total N was determined by micro-Kjeldahl method for P, K, Ca and Mg digestion of sample was done using nitric-perchlorcic-sulphuric acid mixture. The P was determined using vanadomolybdate colorimetry, K by flame photometer and Ca and Mg by EDTA litration.

Experiment 2: Based on experiment 1, ground cocoa pod husk and spent grain were selected as the more suitable agroindustrial wastes for improving performances of tomato. The reduced levels (2.5 t ha^{-1}) of these materials were amended (mixed) with 2.5 t ha^{-1} of air-dried cattle (CD), poultry (PD) and goat (GD) droppings. In addition to the six treatments, there were NPK 15-16 fertilizer at 200 $Kgha^{-1}$ and a control, given eight treatments. The treatments were applied and replicated three times on tomato plants established as described in experiment 1. Growth and yield data and leaf nutrients content were determined as in experiment 1. Dry matter was obtained by keeping fresh matter in oven at 80°C for 24 hr. The experiment was on early and late crops in 2004.

Mean datacollected on treatment basis were compared using the least significant difference (LSD) at 95% level of probability.

RESULTS AND DISCUSSION

Data of analysis of tested agroindustrial wastes are presented in Table 1. Spent grain and cocoa husk had least and similar values of C;N ratio and they also had relatively high N and P, spent grain had highest value of N, rice bran and sawdust with higher C: N had relatively high Ca and Mg. Cocoa husk had highest value of K. Adu-Dapaah *et al.* [10] had successfully used cocoa as source of K in maize production. The relatively high C:N for:

Table 1: Composition of major nutrients in tested agroindustrial wastes

	(g kg^{-1})					
Waste	N	P	K	Ca	Mg	C:N
Spent grain	52.0	17.8	0.7	14.4	5.8	11.1
Cocoa husk	18.4	23.8	41.2	11.9	4.4	12.5
Rice bran	18.7	6.3	4.1	36.5	12.0	23.3
Sawdust	1.2	7.2	7.2	23.6	5.2	189.2

Table 2: Effect of agroindustrial wastes on leaf nutrient composition of tomato

	(g kg^{-1})				
Waste	N	P	K	Ca	Mg
Spent	44.2	33.9	51.8	1.9	0.8
grain	44.1	37.6	62.3	1.6	0.6
Cocoa	25.6	28.2	52.2	3.0	0.8
husk	20.6	32.1	46.2	2.9	0.9
Rice bran	15.8	27.1	41.6	0.6	0.4
Sawdust	2.4	0.9	3.0	0.5	NS
Control	15.8	27.1	41.6	0.6	0.4
LSD (0.05)	2.4	0.9	3.0	0.5	NS

Small and rice bran, especially the former, suggests that they would have decomposed more slowly [11] thereby making less nutrientsavailable during the short span of tomato in the field.

Considering the low values of organic matter, N, P, K and Ca in the slightly acidic soil at experimental site, the agroindustrial wastes, especially the less carboniferous spent grain, cocoa husk and rice bran, are expected to improve soil fertility and availability of nutrients to tomato plant. Hence it was found in Table 2 that agrowastes enhanced nutrient status of tomato significantly (P>0.05) especially in case of N, P, K and Ca. Tomato grown with sawdust with highest C:N had least value of leaf among the wastes.

This is because it would have been most resistant to decomposition and caused microbial inmobilization of nutrients especially N leading to depressed plant growth [12]. Spent grain that had highest N content gave highest leaf N. Spent grain and cocoa husk with highest P gave highest leaf P content. Cocoa husk that had highest value of K gave highest leaf K value. The observations above suggest that the wastes influenced nutrient availability to tomato.

The increased availability of nutrients to tomato adduced to application of agroindustrialwastes led to significant (P>0.05) increases in growth and yield of tomato as indicated by values of plant height, leaf area,

Table 3: Effect of agro -industrial wastes on tomato

Waste	Plant height cm	Leaf area per nt (cm^2)	No. of fruits per plant	Fruit yields (t ha^{-1})
Spent grain	52.8	114.1	50.0	10.7
Cocoa husk	65.9	92.4	53.0	11.9
Rice bran	70.6	92.8	41.0	6.9
Sawdust	61.1	81.6	25.0	5.6
Control	61.1	79.8	30.0	4.3
LSD (0.05)	2.6	5.9	8.5	1.7

Table 4: Effect of animal manure amended agroindustrial wastes on growth of early (E) and late (L) tomato crops.

	Plant height (cm)		No of branches		Leaf Area (cm^2)		Dry matter (g)	
Treatment	E	L	E	L	E	L	E	L
SG+ CD	71.5	76.8	5.2	6.7	102.2	110.2	208.2	210
SG+ PD	89.9	84.5	8.5	7.7	112.4	114.1	211.3	221.2
SG+ GD	78.7	81.3	5.6	8.9	100.6	100.2	201.2	191.9
CH+ CD	72.9	76.3	7.1	6.9	111.3	131.3	114.3	117.2
CH+PD	79.3	82.2	6.5	8.1	115.3	131.3	114.3	171.2
CH+GD	79.3	79.9	6.6	7.7	95.2	100.9	193.2	190.2
NPKF	68.1	80.1	7.2	0.5	100.2	103.6	172.1	180.1
Control	66	72.3	4.5	5.7	78.4	88.4	99.2	100.2
LSD (0.05)	5.8	NS	2.3	4.2	10.1	9.2	9.3	7.7

SG = Spent grain; CH = Cocoa husk; CD = Cattle droppings: PD = Poultry droppings; GD = Goat droppings; NPKF = NPK fertilizer.
• Data on single plant basis

number and weight of fruits in Table 3. This is especially so in case of spent grain, cocoa husk and rice bran. Sawdust did not increase plant height and number of fruits, although it increased leaf area and fruit weight insignificantly. Therefore sawdust is not recommended for direct application. Olayinka and Adebayo [11] had found that incorporation of highly signified sawdust reduced growth and yieldof maize and uptake of N and P. Relative to control, spent grain, cocoa husk and rice bran increased fruit weight by 149, 177 and 60% respectively and increase in number of fruits were 67, 77 and 37%. The increases given by spent grain and cocoa husk were statistically similar. This is consistent with similar values of leaf N, P, K, Ca and Mg recorded for the wastes. Rice bran and sawdust with lower values of tomato yield had lower values of leaf N and P.Cocoa husk that gave highest fruit yield also gave highest leaf P and K. These observations highlighted the importance of availability of N, P and K in determining tomato performance [13] and importance of spent grain and cocoa husk as source of N, P and K.

Table 5: Effect of animal manure amended agroindustrial wastes on yield of early (E) and late (L) tomato.

	No of fruits		Fruit yield (t ha^{-1})	
Treatment	E	L	E	L
SG+ CD	14.6	14.1	29.1	31.4
SG+ PD	16.1	15.6	32.4	42.6
SG+ GD	15	14.5	30.2	38.4
CH+ CD	14.8	14.3	36.2	40.5
CH+ PD	17.3	17.7	38.2	43.7
CH+ GD	14.3	14.9	34.3	37.1
NPKF	14.7	13.7	25.3	31
Control	12.1	10	7.1	8.2
LSD (0.05)	0.9	4.3	6.8	10

SG = Spent grain; CH = Cocoa husk; CD = Cattle droppings; PD = Poultry droppings; GD = Goat droppings: NPKF = NPK fertilizer

Reduced rates of agroindustrial wastes amended with types of animal droppings significantly increased plant height, branching, leaf area, dry matter yield (Table 4) and number and weight of tomato fruits (Table 5) significantly (P> 0.05) although NPK fertilizer (NPKF) increased branching more than amended wastes, tended to increase plant height, leaf area, dry matter and fruit yield than fertilizer. The mean fruit yield for six amended agroindustrial wastes (Table 5) was 36.2 tha^{-1} compared with 28.2 and 7.7 tha^{-1} respectively for NPKF and control. Amendment with poultry droppings increased fruit yield than amendment with cattle and goat droppings which gave similar yields. This is consistent with the finding of Macrere *et al.* [14] that poultry droppings had higher total N, total P, lower C:P and C:Ncompared to goat and cattle droppings. Mean yield recorded for cocoa husk irrespective of amendment material (40.4 tha^{-1}) was higher than mean yield for spent grain (37.5 tha^{-1}) similarly it is indicated above that cocoa husk gave higher fruit yield than spent grain and rice bran.

Animal manure amended wastes gave significantly higher leaf N and K content of tomato compared with control (Table 6). Amended cocoa husk gave higher leaf K than NPKF and amended spent grain gave higher leaf N than NPKF. The leaf P values were not significantly (P>0.005) affected by amendment.

The finding that unamended cocoa husk, spent grain and rice bran significantly increased growth, yield and nutrient content of tomato is consistent with initially low soil fertility. The wastes contain macro and micro nutrients such as Fe, Mn, Cu and Zn which are not supplied by NPK fertilizer [5]. Earlier Moyin Jesu and Atoyosoye [6] showed that rice bran and cocoa pod husk

enhanced soil and cocoa leaf N, P, K, Ca and Mg, soil pH, organic matter and growth of cocoa seddlings. Moyin Jesu[5] also found that cocoa husk, rice bran and spent grain increased availability of nutrients to amaranthus and increased leaf yield.

Enhancement of tomato performance and nutrient status by amendment of agroindustrial wastes with animal mancures is attributable to the fact that the manures have lower C: N values compared with crop wastes [5]. For example, Moyin Jesu [5] recorded C:N values of 6.9 and 7.9 for poultry and goat droppings respectively, whereas the values for spent grain, rice bran and sawdust were 12.8, 23.3 and 75.0 respectively. Animal manures were richder in N and P. The higher nutrient status and lower C: N of animal manures should have increases decomposition and nutrient release from the crop wastes. Hence the higher tomato yield recorded for amended wastes (Table 5) compared with unamended wastes (Table 3). Olayinka [12] had reported that amendment of sawdust with poultry manure increases maize height, dry matter yield and uptake of N, P, K, Ca and Mg. Olayinka and Adebayo [11] also found that amendment of sawdust with dairy manure enhanced its decomposition and soil N, P and K content.

CONCLUSIONS

Agroindustrial wastes such as spent grain, ground cocoa husk and rice bran contained major nutrients which were released for uptake of tomato. When applied to soil, the wastes were effective in increasing growth, fruit yield and N, P, K, Ca and Mg content of tomato. Amendment of reduced levels of spent grain and cocoa husk with animal droppings increased growth and yield of tomato more than NPK fertilizer.

REFERENCES

1. Adams, P., J.M. Davies and W. Windsor, 1978. Effects of nitrogen potassium and magnesium on the qualiity and chemical composition of tomatoes grown in peat. J. Hort Sci., 53: 115-122.
2. Agbede, O.O. and E.A. Aduayi, 1975. Role of phosphorus and magnesium on some growth components and yield of Ife plum tomato plants in two soil series of South Western Nigeria. East Africa for Agric. J., 43: 246-251.
3. Adediran, J.A., L.B. Taiwo and R.A. Sobulo, 2003. Effect of organic wastes and method of composting on compost, nutrientmaturity composotion of compost and yields of two vegetable crops. Journal of Sustainable Agric., 22: 95-109.
4. Moyin Jesu, E.I. and S.O. Ojeniyi, 2000. Response of leaf nutrientcontents growth and yield of okra to application of sole and amended plant residues, Proceedings 26th Annual Conference of Soil Science Society of Nigeria, Ibadan. pp: 126-129.
5. Moyin Jesu, E.I., 2003. Incorporation of agricultural biomas and their effects on growth and nutrient content of four successive crops of amaranthus. Partanika J. Trop. Agric. Science, 26: 49-58.
6. Moyin Jesu, E.I. and B. Atoyosoye, 2002.Utilization of agricultural wastes for the growth of leaf and soil chemical composition of cocoa seedlings in the nursery. Partamka J. Trop. Agric. Science, 25: 53-62.
7. Egunjobi, O.A. 1975. On the possible utilization of discarded cocoa pod husks as fertilizer and nematicicle. Proceedings 5th International Cocoa researchConference, CRIN Ibadan, pp: 541-547.
8. Owolabi, O., S.O. Ojeniyi, A.O. Amodu and K. Hazzan, 2003. Response of cowpea okra and tomato to sawdust ash manure.Moor J. Agric. Res., 4: 178-182.
9. Tel, D.A., 1984. Soil and plant analysis. Department of Land Resources Science, University of Gnelph, Outario Canada. pp: 277.
10. Adu-Dapaah, H.K., J. Cobbina and E.O. Asare, 1994. Effect of cocoa pod ash on the growth of maize. J. Agric. Sci., 122: 31-33.
11. Olayinka, A. and A. Adebayo, 1985. The effect of methods of application of sawdust on plant growth plant nutrient uptake and soil chemical properties. Plant soil, 86: 47-56.
12. Olayinka, A., 1990. Effects of poultry manure, corn straw and sawdust on plant growth and Soil chemical properties Ife J. Agric., 12: 36-44.
13. Saxena, G.K. S.J. Locascio and J.B. Lucas, 1975. Effect of N.P and K rates on response of cabbage and tomato grown on a coastal clay soil of Guyana. Trop. Agric., 52: 149-156.
14. Macrere, A.P., G.G. Kumbi and D.L.M. Nonga, 2001. Comparative effectiveness of animal manures on soil chemical properties yield and root growth of amaranthus (*Amaranthus cruentus* L.) AJST., 1: 14-21.