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Effects of different organic wastes on growth and nutrient content of maize

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Abstract

A pot experiment was conducted to study the effect of some organic wastes *viz.* Kitchen waste (KW), Sewage Sludge (SS) and Drainage waste (DW) on growth, total dry matter yield and nutrient contents of maize. The organic compost at the rate of 05, 7.5 and 10 t ha^{-1} were employed along with recommended doses of chemical fertilizer treatments. The pots were arranged in completely randomized design (CRD) with 10 treatments and 3 replications. Among the treatments used, KW and SS @ 10 t ha^{-1} contributed higher growth and dry matter yield over drainage waste though it also responded positively over control. The maximum plant height, leaves $plant^{-1}$, fresh and dry weight of shoot and root, root length and total dry matter yield were recorded in KW @ 10 t ha^{-1}. In the plant, highest concentration of N was obtained from SS @ 7.5 t ha^{-1} treatments while the maximum P, S and Ca contents observed in treatment receiving SS @ 10 t ha^{-1} and the maximum K content in KW @ 10 t ha^{-1}.

Keywords: Organic wastes, Maize, Dry matter yield and Nutrient content

Introduction

Most of the cities in the developing countries are unable to cope with the vast amount of waste produced by their people and faces serious environmental problems and health hazard due to indiscriminate uncontrolled dumping of domestic, municipal and other wastes on streets, public places, and in closed urban drainage system (Alam *et al.,* 2002 and Quadir, 2004). On the other hand, the overall living standard can be seriously affected due to improper waste management (WM) system which is today considered to be one of the most immediate and serious environmental problems confronting in developing countries. Waste management receives concern both nationally and internationally due to the mounting urgency of identified urban environmental problems. Proper WM can save citizens from different diseases, improve environmental conditions, promote urban economic development and generate employment (Huda, 2002). To overcome this situation, maintenance and improvement of soil organic matter through regular organic recycling is deemed necessary (Ahmed *et al.,* 1998). Organic wastes can be used as compost through recycling for maintaining soil fertility which is a prerequisite for long term sustainable agriculture.

High intensity of cropping is an important way to meet food and feed requirements of the increasing population of human and livestock. This exerts an extra pressure on agricultural lands for additional yield. In Bangladesh, organic matter status of the soil is in so critical position that if the present rate of its degradation is continued, in near future the soil would become barren. At this tilting situation, composting of solid waste may play an important role on waste management of the country as well as impart Bangladesh soils new juvenility (Bari and Koenign, 2002). However, sufficient research have not yet been carried out in the country regarding the available macronutrient release from sewage sludge, kitchen and drainage waste and their effects on maize yield. Keeping the above facts in view, the present study was undertaken to study the effect of some composts on the growth, total dry matter (TDM) yield and nutrient contents of maize.

Material and Methods

A pot experiment was conducted in the green house of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during the rabi season of 2004-2005. Soil samples used in this experiment were collected from Bangladesh Agricultural University (BAU) farm belong to sonatola series of AEZ-9 (Old Brahmaputtra Flood Plains). Three types of organic wastes such as kitchen waste (KW), sewage sludge (SS) and drainage waste (DW) were collected from different areas of BAU campus, BINA and Kewatkhali village, Mymensingh. After collection, different types of inorganic materials, polyethylene bags, plastics, glass pieces, grabbles etc. were screened out from individual waste and then the samples of individual wastes were mixed thoroughly and to prepared compost following the "Bangalore method" of composting for DW and "Poudrette method" of composting for SS and KW (Murthy, 1978) and the duration of the composting was 3 and 2 months, respectively. Six kg of processed soil was taken in each of the plastic pots after appropriate processing. The test crop of the experiment was maize *cv.* Barnali. The 10 treatments consisted of one control and each of kitchen waste, sewage sludge and drainage waste @ 5,7.5 and 10 t ha^{-1} and laid out in completely randomized design with 3 replications. All the fertilizers except urea were applied as basal dose during the preparation of pot. Urea was applied in three splits, during final pot preparation first split was added. The rest two-thirds urea were top dressed in two equal splits, after 30 and 45 days after sowing (DAS), respectively.

The seeds were sown at the rate of 4 seeds per pot on 7-12-04 by hand keeping uniform distance and then the seeds were covered by soils. After germination, finally two plants were kept in each pot. The experimental crop was harvested at 63 days after sowing (DAS) on 8th February, 2005 with sickle at above ground level. The harvested plants were tagged separately, weighed, sun dried for 6-7 days until moisture content reaches to 12%. The dried straw of each treatment was weighed and stored for chemical analyses. Plant samples were dried at 100±5°C, weighed and digested in diacid mixture of HNO_3 and $HClO_4$ (2:1). The digested samples were analysed for P, K, S and Ca content following standard methods and N estimated by the micro Kjeldahl method.

Results and Discussion

Growth parameters

The treatments have significant effect on total number of leaves $plant^{-1}$ (Table 1). The highest total number of leaves $plant^{-1}$ (12.33) was observed in KW @ 10 t ha^{-1}, which was statistically identical with SS @ 10 t ha^{-1} (12.03) and the lowest was in control. The data reflects that the total number of leaves $plant^{-1}$ increased gradually with increasing doses of organic wastes. Higher number of leaves in plants particularly in the treatments of KW and SS at higher rate might be due to the fact that the nutrients notably N and S were rapidly mineralized and became available for the growth of maize. Yuging and Li (1999) observed that application of S increased the number of leaves.

Plant height increased significantly due to the application of those treatments. The plant height obtained at final harvest at 63 DAS followed the same trend as did in the number of leaves plant^{-1}. At harvest, the tallest plant (135.66 cm) was recorded from KW treated pot @ 10 t ha^{-1}, which was statistically identical irrespective of rates SS @ 10 t ha^{-1} (132.34 cm) and DW @ 10 t ha^{-1} (128.92 cm). In this study, all the wastes irrespective of rate increased the plant height over control. This might be due more release of N, S and other nutrients from those wastes. Such type of results are expected in producing plant height. The findings is at par with Howlader (2003) who observed that sludge and kitchen waste increased total available N and S contents in soil. Howlader (2003) and Hartz *et al.* (1998) reported sufficient quantity of essential nutrients were available in sewage sludge. This is in agreement with the findings of Thorne *et al.* (1975). Increasing levels of different treatments significantly increased fresh and dry weight of shoot and root after application of KW @ 10 t ha^{-1}. The highest fresh weight of shoot and root (248.83 and 157.85 g plant^{-1}, respectively) and the highest dry weight of shoot and root (34.36 and 20.62 g plant^{-1}, respectively) were observed in KW@ 10 t ha^{-1} and that was the lowest (172.44 and 87.5 g plant^{-1}, respectively) in the control (Table 1). In case of fresh and dry weight of shoot and root, plant fresh weight as well as total dry weight increased due to maximum number of leaves plant^{-1} and plant height.

Plant root length increased significantly due to application of kitchen and drainage wastes and sewage sludge. At 60 DAS the maximum root length (26.20 cm) was recorded from KW @ 10 t ha^{-1}, followed by KW @ 5.0 and 7.5 t ha^{-1} and the minimum was in control (Table 1). Root length increased due to absence of plough pan in the pot. On the other hand N enhances the growth and development of the roots which lead to higher nutrient uptake under irrigated conditions.

Total dry matter (TDM) yield of the plant did not vary significantly with different organic wastes applied. It varied from 35.66 to 54.98 g plant^{-1}. The maximum TDM yield (54.98 g plant^{-1}) was obtained from KW @ 10 t ha^{-1} and minimum (35.66 g plant^{-1}) from the control (Table 1). TDM yield increased due to increase in all growth parameters. Statin and Enzmann (1930) observed that N application increased plant dry matter production. Total dry matter production and distribution in economically useful parts determine the crop yield (Watson *et al.*, 1958). The maximum TDM accumulation was recorded at 90 DAS (Shivay *et al.* 2002). Hood (2001) stated that plant dry mater decreased significantly with increase in soil temperature and increased with increasing moisture.

Nutrient content

The treatments showed highly significant effect on K,S and Ca contents and while it was not significant on N and P of maize plant. The maximum N (1.95%) was found in SS@ 7.5 t ha^{-1} which was statistically identical with KW @ 10 t ha^{-1} (1.94%) and it was minimum (1.53%) in control (Table 2) treatments. This might be due to the highest concentration of N in sewage sludge. Hood (2001), Lasani *et al.* (2005), Zamil (2004) and Quadir (2004) found that steady minaralization of N from soil amendments increased N as well as protein content in different crops. The K concentration of maize plant was significantly influenced by organic wastes. The

highest K concentration (2.05%) of plant was recorded in KW @ 10 t ha^{-1} and the lowest (2.00%) was obtained from control which was statistically identical with all the treatments of organic wastes. In a pot experiment with rice Alam and Azmi (1989) found that K content increased significantly with increasing level of P.

The treatments had no significant effect on P content of maize plant, though the highest P content (0.24%) was observed in SS@ 10 t ha^{-1} and it was the lowest (0.17%) in control. Haque *et al.* (1999) reported that Phosphorus content increased both in straw and grain due to application of manures and fertilizers. The high concentration of major nutrients in sewage sludge and kitchen waste might be responsible for higher nutrient content in maize plant. Results in Table 2 showed that S concentration in maize plant was significantly influenced by the treatments. The content of S varied from 0.06 to 0.13%. The maximum S content was observed in SS treated pot @ 10 t ha^{-1} which was statistically similar to KW and DW @ 10 t ha^{-1} and SS @ 7.5 t ha^{-1}. The minimum S content (0.06%) in plant was found in the control. Islam *et al.* (1990) stated that application of S increased the concentration of S in straw. Similar results were found by Hossain *et al.* (1989). The levels of S in rice straw was improved in combined use of organic manures with N,P,K and S (Hossain, 1996).

The treatments had significant effect on Ca concentration. The Ca content in plant ranged from 0.20 to 0.42 %. The highest concentration of Ca in plant (0.42%) was obtained from SS @ 10 t ha^{-1}. The second highest content of Ca in plant (0.40%) was obtained from SS @ 7.5 t ha^{-1} (Table 2). The lowest concentration of Ca (0.20%) in plant was recorded in the control. McPhillips (1998) reported that P application increased Ca content in the crop. This might be due to more availability of soil nitrogen due to N minaralization, increased availability of native phosphate due to effect of S in solubilizing native phosphorus resulted more concentration of N, P, K, S and Ca in plant.

Table 1. Effect of kitchen wastes, sewage sludge and drainage waste on some growth attributes of maize cv. Bornali at 63 DAS

Treatments	Leaves $plant^{-1}$ (No.)	Plant height (cm)	Shoot fresh weight (g $plant^{-1}$)	Shoot dry weight (g $plant^{-1}$)	Root length (cm)	Root fresh weight (g $plant^{-1}$)	Root dry weight (g $plant^{-1}$)	Total dry mater (TDM) (g $plant^{-1}$)
Control	9.83	108.19	172.44	24.14	20.3	87.50	11.52	35.66
KW @ 5 ton ha^{-1}	11.09	121.13	217.33	30.01	24.83	149.06	19.28	49.29
KW @ 7.5 ton ha^{-1}	11.16	122.50	230.30	32.27	25.66	154.47	20.37	52.64
KW @ 10 ton ha^{-1}	12.33	135.66	248.83	34.36	26.20	157.85	20.62	54.98
SS @ 5 ton ha^{-1}	10.95	117.50	215.05	30.12	21.52	129.55	16.24	46.36
SS @ 7.5 ton ha^{-1}	11.07	118.91	217.65	30.52	22.20	133.64	17.13	47.65
SS @ 10 ton ha^{-1}	12.03	132.34	242.18	33.90	22.86	137.62	17.67	51.57
DW @ 5 ton ha^{-1}	10.78	117.25	214.89	30.22	22.93	138.04	17.72	47.94
DW @ 7.5 ton ha^{-1}	10.98	117.67	215.36	30.31	23.99	144.42	18.23	48.54
DW @ 10 ton ha^{-1}	11.20	128.92	235.18	32.92	24.07	144.90	18.54	51.46
LSD (0.05)	1.12	8.71	34.27	2.98	2.37	5.81	4.10	13.16
CV (%)	5.84	4.16	8.91	5.60	5.88	2.46	13.49	16.08

Note : KW = Kitchen Wastes, SS = Sewage Sludge, DW = Drainage Wastes and DAS =Days After Sowing

Table 2. Effect of kitchen waste, sewage sludge and drainage waste on nutrient content (%) of maize *cv.* Barnali at 60 DAS

Treatments	N (%)	P (%)	K (%)	S (%)	Ca (%)
Control	1.53	0.17	2.00	0.06	0.20
KW @ 5 t ha^{-1}	1.83	0.20	2.02	0.09	0.25
KW @ 7.5 t ha^{-1}	1.86	0.22	2.04	0.11	0.30
KW @ 10 t ha^{-1}	1.94	0.23	2.05	0.12	0.25
SS @ 5 t ha^{-1}	1.81	0.21	2.02	0.10	0.27
SS @ 7.5 t ha^{-1}	1.95	0.23	2.03	0.12	0.40
SS @ 10 t ha^{-1}	1.92	0.24	2.04	0.13	0.42
DW @ 5 t ha^{-1}	1.78	0.19	2.01	0.09	0.25
DW @ 7.5 t ha^{-1}	1.83	0.20	2.02	0.11	0.28
DW @ 10 t ha^{-1}	1.89	0.21	2.03	0.12	0.31
LSD (0.05)	0.29	0.54	0.32	-	0.08
CV (%)	9.19	14.26	8.74	16.53	15.81

Note: KW = Kitchen Waste, SS = Sewage Sludge, DW = Drainage Waste
DAS = Days After Sowing.

The results obtained from the study it seems that sewage sludge, kitchen waste and drainage waste can be used even without chemical fertilizer for increasing crop growth.

Correlation and regression studies

The degree of relationships among some growth parameters such as total dry matter (TDM) yield vs leaves $plant^{-1}$, plant height, root length and root dry weight vs shoot dry weight were studied. The values of correlation co-efficient (r), regression line (Y) and regression equation (y) have been shown in Fig. 1. Such results showed that higher nurient absorption by plant roots resulted in higher crop yield. It further indicated that application of organic materials such as sewage sludge, municipal wastes and crop residues might have enhanced the content of N, P, K and S due to reduction in fixation and leaching loss and consequently their increased availability in soils (Quadir 2004). The values of the correlation co-efficient were r = 0.879**, 0.863**, 0.846** and 0.848**, respectively (Fig. 1). The positive relationship indicates that higher N content would result an increase in higher K, P, S and Ca contents respectively (Fig. 2). It is clear that N source and K were major factors of N-K interaction in the plant. (Tandon, 1992). Experimental results indicates that there are few crops like vegetables, potatoes, melons, cucumber, sugarcane, maize, rice, garlic, onion, fruits etc. which responded better than any other crops since compost derived from plant and animal refuse therefore, it supplies all the plant nutrients in easily available form to the soil and finally to the plants (Tandon, 1992). Besides nutrients, it also supplies hormons and other alike substances for better plant growth (Singh, 2003). In most of the studies, a synergistic interaction between N and P was reported with maize (Tandon, 1992).

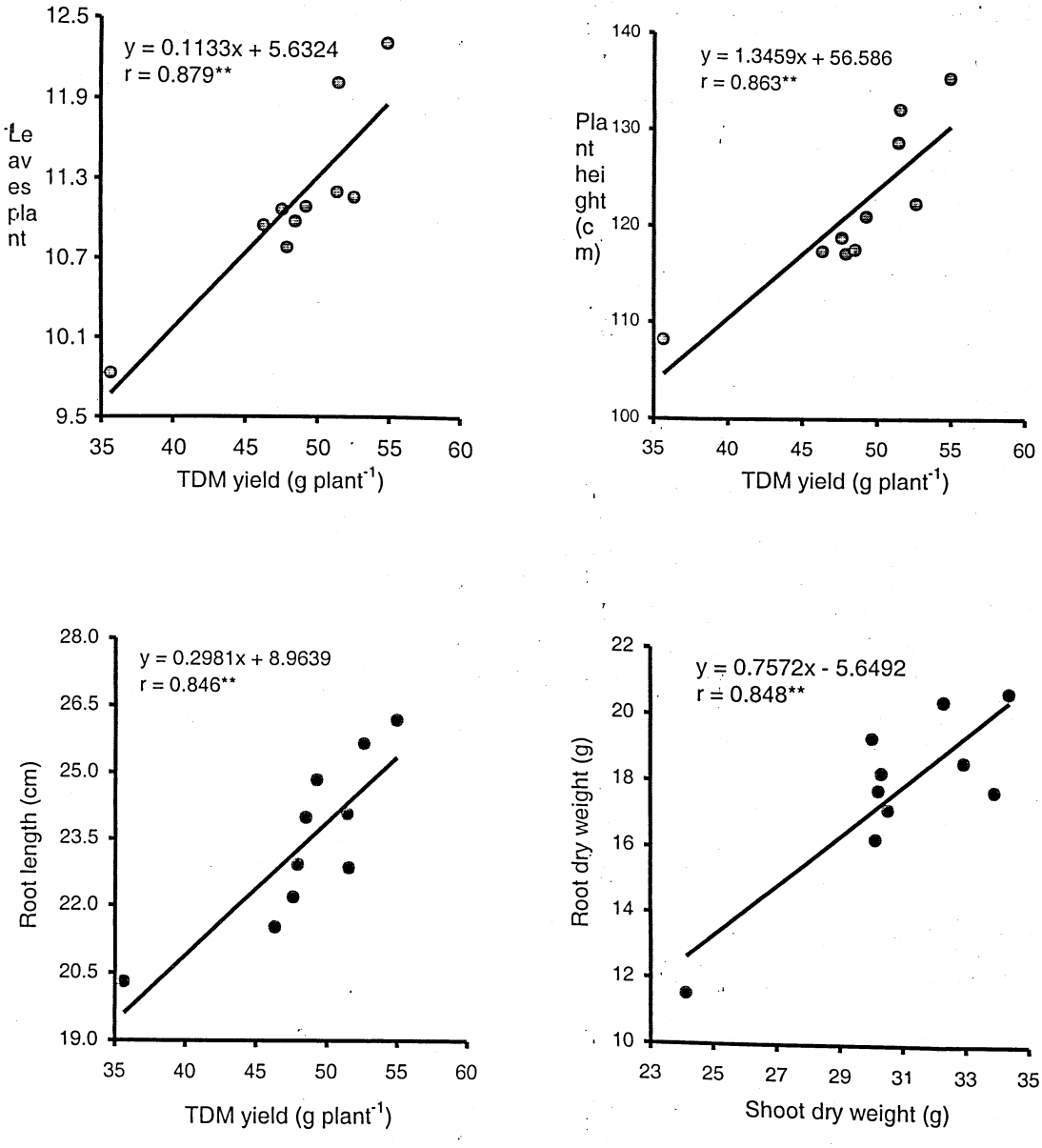

Fig. 1. Relationship between growth and TDM yield of maize *cv.* Barnali as influenced by different wastes

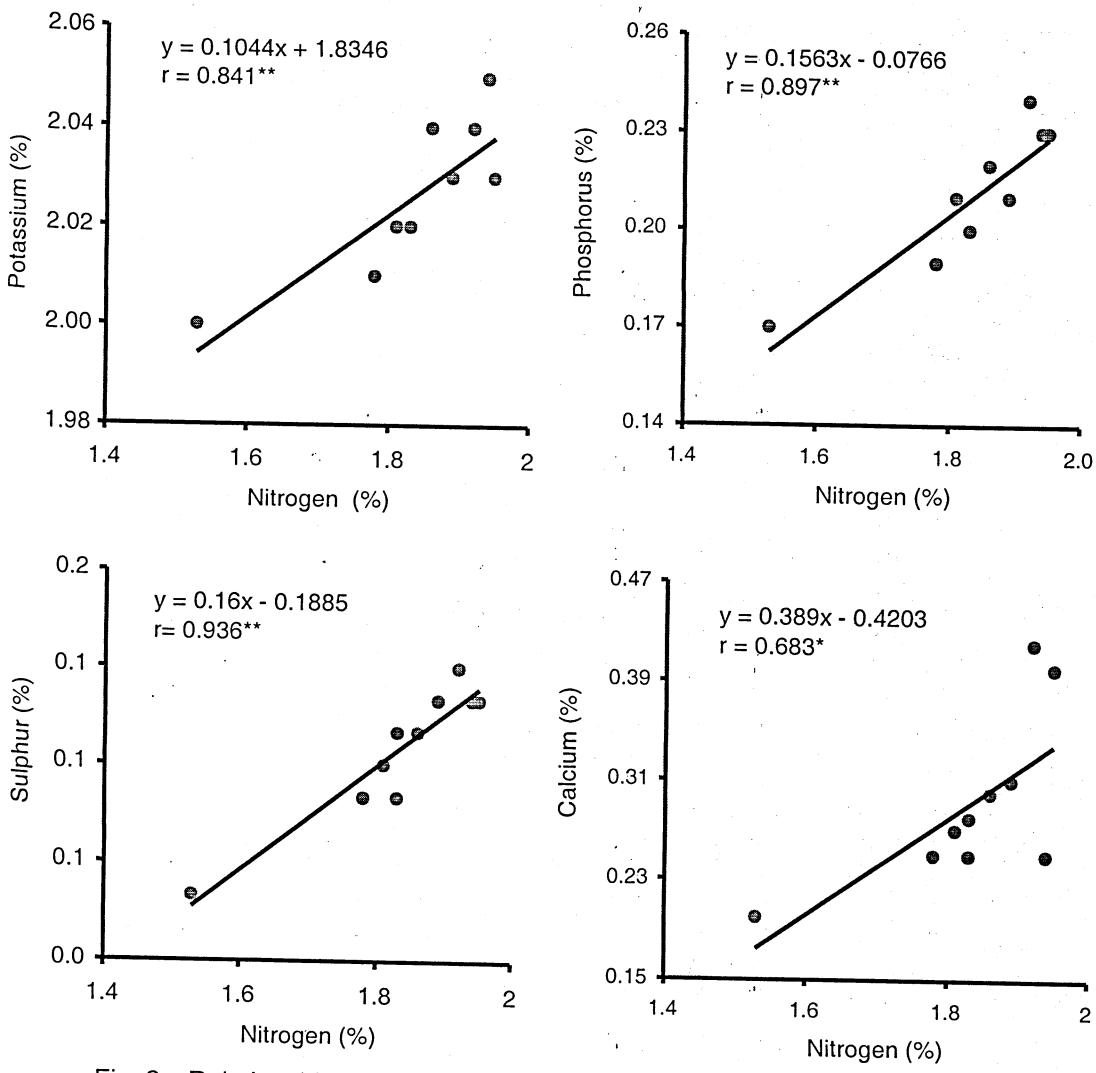

Fig. 2. Relationship between major nutrient contents of maize *cv.* Barnali as influenced by different organic wastes

Conclusion

Thus the study suggests that organic wastes can be need directly or converted to compost for better growth and yield of field crops and to increase the organic matter content of the soil.

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