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INFLUENCE OF SEWAGE SLUDGE ON YIELD AND MINERAL CONTENTS OF RICE GRAIN

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Abstract

Sewage sludge at the rate of 0, 40, 80, 120 and 240 t/ha showed that the number of filled grains per panicle, dry weight of grains and weight of 1000 grains of rice (*Oryza sativa* L.) were the significantly highest where 240 tons of sewage sludge per hectare was added. The contents of N, P, K, Ca, Mg, Fe, Cu, Zn and Pb in rice grains increased significantly with increasing rate of sewage sludge application, while that of Mn decreased significantly. Chromium, cadmium and nickel contents in the rice grain were below detection limit.

Key words: Sewage sludge, rice grain yield, mineral contents

Introduction

Sewage sludge is an organic residue containing large amounts of mineral elements (N, P, K, Ca and Mg) and microelements (Zn, Cu, Mn and B), that influence plant growth and yield (Parat *et al.* 2005, Mohammad and Athamneh 2004 and Henze *et al*. 2002). It has been widely used in cropped land especially in Europe, America and some parts of Asia. Its application to soils not only improves organic matter and essential nutrient contents, but also improves soil physical and microbial conditions (Parat *et al*. 2005, Mohammad and Athamneh 2004 and Webber *et al.* 1996). However, it may cause a potential hazard, especially heavy metal pollution (Cd, Ni, Cu, Zn and other metals) to soil (Bozkurt and Yarilgac 2003, Mohammad and Athamneh 2004).

Approximately 54,750 tons of sewage sludge containing about 1,000 to 1,400 tons of nitrogen and 350 to 500 tons of phosphorus are produced per year in Dhaka city (BARC 1997). However, information regarding the potential use of sewage sludge on agricultural land and its consequences on soils as well as crops is scarce. Therefore, the objective of this study is to find out the effect of sewage sludge on yield and mineral contents of rice grain.

Materials and Methods

The experimental soil (0 - 15 cm depth) was collected from low lying area of Zirani, Savar, Dhaka. Dried sewage sludge (SS) was collected from Dhaka WASA sewage treatment plant, Pagla, Narayanganj. The collected soil and sewage sludge samples were air-dried, ground and sieved through a 2 mm sieve for physical analysis. Total N, P, Na, K, Ca, Mg, Fe, Cu, Zn, Mn, Pb, and Cr contents of sewage sludge were 1.705, 0.98, 0.022, 0.092, 0.069, 0.043, 1.17, 0.025, 0.21, 0.028%, 186 and 29 µg/g, respectively. The total contents of Cd and Ni in sewage sludge were below detection limit.

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A pot experiment was laid out in a completely randomized design with five treatments of sewage sludge (0, 40, 80, 120 and 240 t/ha) with BRRI dhan 29 grown in boro season with three replications. Sewage sludge was added to each pot containing 8 kg soil, 14 days before transplantion. Basal doses of N (25 kg/ha), P (80 kg P_2O_5/ha) and K (80 kg K_2O/ha) were applied. One hundred kg N/ha was applied to SS_0 treatment to achieve the normal growth of rice. Fifty per cent of N was applied at the time of pot preparation and the rest 50% N was top dressed in two equal splits after 55 and 100 days of transplantation. Eight uniform rice seedlings of seven weeks old were transplanted (2 seedlings/hill) in each pot but after 15 days, only the best four were allowed to grow. Pots were irrigated properly with normal tap water and intercultural operations were done whenever necessary. At maturity dry weight of rice grain, weight of 1000 grains and the number of filled and non-filled grains were determined.

Total N content of rice grain was determined by Micro-Kjeldhal’s method (Jackson 1973). The total contents of Ca, Mg, Fe, Zn, Cu, Mn, Pb, Cr, Cd and Ni were determined after wet digestion of rice grain by HNO_3-$HClO_4$ acid mixture (5 : 1) using atomic absorption spectrometer (Perkin Elmer 3110). The total P and K contents were determined colorimetrically and flame photomertically, repectively. The results were statistically analyzed (Gomez and Gomez 1976).

Results and Discussion

Results showed that the number of filled grains per panicle, dry weight of grains and weight of 1000 grains were found highest in the treatment $SS_{240,}$ while decreased significantly with decreasing sewage sludge applications, but no significant difference was found in most of the treatments (Table 1). Significantly the lowest number of non-filled grains per panicle was observed in the treatment SS_0 and the highest in the treatment SS_{40}. The yield contributing

Table 1. Effects of different levels of sewage sludge on the selected parameters of rice grain.

Treatments (kg/ha)	Number of grains/panicle		Dry weight of grains (g/pot)	Weight of 1000 grains (g)
	Filled	Non-filled		
SS_0	72.91 ^{a}	35.29 ^{d}	42.11 ^{a}	29.14 ^{a}
SS_{40}	57.52 ^{c}	40.26 ^{a}	35.18 ^{c}	22.83 ^{d}
SS_{80}	63.35 ^{b}	38.92 ^{b}	36.39 ^{bc}	24.35 ^{c}
SS_{120}	67.17 ^{b}	36.78 ^{c}	37.40 ^{b}	26.13 ^{b}
SS_{240}	73.14 ^{a}	36.50 ^{cd}	43.30 ^{a}	30.00 ^{a}

Means followed by the same letter(s) in a column do not differ significantly from each other at 5% level of DMRT.

characteristics were the highest in the treatment SS_{240}. This might be due to the fulfilment of nutrient requirements provided by the treatment SS_{240}. Increased yields of maize (Costica *et al*. 2007), sunflower (Lavado 2006) and rice grain (Kabir *et al*. 2011) were reported from sewage sludge application.

The contents of N, P, K, Ca and Mg in the rice grain increased gradually with increasing sewage sludge application and were significantly highest in SS_{240} treatment (Table 2). However, in the case of N, P, K, Ca and Mg no significant difference was observed in most of the treatments as in the case of growth parameters. The elevated N and P contents in rice grain might be due to the better supply of N and P through mineralization of added sewage sludge (Costica *et al*. 2007). The higher contents of nitrogen in silage maize and oat (*Avena sativa* L.) from soil amended with sewage sludge were observed by Cerny *et al*. (2012) and Peterson *et al*. (2003), respectively. Rice grains accumulated more K, Ca and Mg probably due to its availability from applied sewage sludge (Hinesly *et al*. 1979).

Table 2. Effects of different levels of sewage sludge on the mineral contents of rice grain.

Treatments (kg/ha)	Mineral content				
	%	(μg/g)			
	N	P	K	Ca	Mg
SS_0	0.83 ^{d}	164 ^{c}	460 ^{c}	420 ^{c}	230 ^{d}
SS_{40}	1.05 ^{c}	172 ^{c}	520 ^{c}	510 ^{b}	380 ^{c}
SS_{80}	1.17 ^{b}	190 ^{bc}	770 ^{b}	550 ^{b}	420 ^{bc}
SS_{120}	1.21 ^{b}	211 ^{b}	870 ^{b}	560 ^{b}	470 ^{ab}
SS_{240}	1.91 ^{a}	254 ^{a}	1020 ^{a}	660 ^{a}	490 ^{a}

Means followed by the same letter(s) in a column do not differ significantly from each other at 5% level of DMRT.

Significantly the lowest and highest amounts of heavy metals such as Fe, Cu, Zn and Pb were observed in SS_0 and SS_{120} treatments, respectively (Table 3). The contents of Fe, Cu, Zn and Pb in the rice grain increased significantly with the increasing rate of sewage sludge application. Fe, Cu and Zn concentrations in maize grain were reported high in Zimbabwe due to heavy fertilization with sewage sludge (Muchuweti *et al*. 2006). In wheat grain, the content of Fe, Cu, Zn and P increased with the increase in sewage sludge application (Hinesly *et al*. 1979). Manganese content in the rice grain decreased significantly with increasing rate of sewage sludge application. This

Table 3. Effects of different levels of sewage sludge on the heavy metal content (μg/g) of rice grain.

Treatment (kg/ha)	Heavy metal content (μg/g)				
	Fe	Cu	Zn	Mn	Pb
SS_0	482.33 ^{e}	27.75 ^{e}	74.68 ^{e}	76.61 ^{a}	10.02 ^{e}
SS_{40}	508.67 ^{d}	32.84 ^{d}	88.35 ^{d}	66.25 ^{b}	21.01 ^{d}
SS_{80}	522.34 ^{c}	49.56 ^{c}	96.19 ^{c}	49.73 ^{c}	27.26 ^{c}
SS_{120}	643.00 ^{b}	52.02 ^{b}	98.97 ^{b}	43.47 ^{d}	33.69 ^{b}
SS_{240}	719.00 ^{a}	55.32 ^{a}	102.23 ^{a}	33.34 ^{e}	47.32 ^{a}

Means followed by the same letter(s) in a column do not differ significantly from each other at 5% level of DMRT.

could be due to the less availability of Mn by the added sewage sludge (Hinesly *et al*. 1979, Hiroki and Fujii 1984). No detectable contents of Cr, Cd and Ni were found in the rice grain.

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