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USE OF INDIGENOUS WASTE MATERIALS FOR BETTER CROP YIELD: POSSIBILITY OF USING STEEL MILL WASTE (BASIC SLAG) AS FERTILIZER

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Abstract

A pot experiment with rice plant was conducted on three acid soils to evaluate the possibility of using basic open hearth slag as fertilizer. Upto five tons per hectare of slag applied to soil raised the pH of the soils to a favourable range (6.0—6.5).

Increases in the dry matter yield (upto 74%), tiller number (upto 62%) and plant height ($\sim$11%) were observed due to the addition of basic slag. Higher P, Ca and Mg uptake values with increasing slag dose were also recorded.

Introduction:

Wastes from steel mills, cement kilns, sugar mills, paper mills, etc. have been reported beneficial in increasing crop yield (Murashav 1957, Simakov *et al.* 1962, Heintze 1963, Carroll *et al.* 1964, Bashir *et al.* 1969 and Cooke 1974). These waste materials can affect plant growth directly or indirectly or both and can be sources of organic matter, lime and various other nutrient elements. Byproducts from steel mills (basic slag), T. S. P. factory (Calcium silicate slag from rock phosphate reduction furnace) and Gas production plant of Bangladesh Oxygen Ltd. (refuse lime from acetylene plant using calcium carbide) can be the sources of lime, calcium and magnesium. Sugar mill (pressmud) and paper mill wastes (refuse air tank slime) can serve as sources of organic matter, lime, nitrogen and other plant nutrients (Bashir *et al.* 1969).

In Europe, America and many other countries, slag produced in the steel making processes is in use as agricultural input to increase crop yield. Prior to the Second World War, slag covered about 70% of the phosphorus input as fertilizer and until recently basic and Thomas slag ranked second in quantity to superphosphate as a source of phosphatic fertilizer in Federal Republic of Germany (Aziz 1974)

The basic open hearth slag, a waste product of the Chittagong Steel Mills Ltd. is available in huge quantities and contains double salts of calcium and magnesium (chiefly $Ca_3 (Po_4)_2$, $Ca_2 SiO_4$, $Mg_3 (PO_4)_2$ and $Mg SO_4$) with a composition of 1.1%P, 32.1% Ca and 9.3% Si as against 3.5% P, 29.3% Ca and 5.1% Si of slag produced in the U. S. A. (Aziz 1974). Moreover, the basic slag does also contain elements like Mn, Cu, Mo, Zn, Co, etc. which are beneficial to crops (Cooke 1974).

These indicate the possibility of the use of the basic slag produced by the Chittagong Steel Mills Ltd. as fertilizer.

This pot culture experiment with three acid soils of Bangladesh was undertaken to ascertain the effects of the Chittagong Steel Mills Ltd.'s slag on rice plants under flooded condition.

Materials and Methods:

Three soil samples with low pH values were collected from the farms of Bangladesh Tea Research Institute (BTRI), Sreemangal, Sylhet, Bangladesh Council of Scientific and Industrial Research (BCSIR), Beyazid Bostami, Chittagong and Bangladesh Atomic Energy Commission (BAEC), Kalmeshwar, Tongi, Dacca. Some of the physical and chemical characteristics of the soils are presented in Table 1.

Table 1. Some physico-chemical characteristics of the soil.

Soil	Texture	pH	Organic matter (%)	Total N (%)	Available nutrients(ppH				
					N	P	K	Ca	Mg
BTRI farm, Sree-mangal, Sylhet.	Silty clay loam (45.7% clay)	4.8	1.58	0.07	53.9	4.4	40.0	192.0	37.2
BCSIR farm, Bayezid Bostami, Chittagong.	Silt loam (17.1% clay)	5.4	1.03	0.07	80.0	4.1	63.0	180.0	67.0
BAEC farm, Kalmeshwar, Tongi.	Clay loam (32.9% clay)	5.6	1.72	0.08	21.6	1.4	155.5	140.0	31.4

Composite soil samples were collected to represent 0-20 cm depth. After air drying, the samples were ground and passed through 5 mm sieve. 3 kg soil per pot was taken in earthen pots lined with polyethene bags. There were four treatments with three replications of each. The ground (60 mesh) slag containing 0.29% Ca, 0.14% Mg and 2.0 ppm P when extracted with 2% citric acid and 32.96% Ca, 5.40% Mg and 2.16% P when digested with con HCl was applied at the rate of 0.0, 2.5, 5.0 and 7.5 tons/ha. The rates of basic slag were determined through an incubation test with the soil of BTRI form using soil water ratio of 1: 1. The basic doses of nitrogen, phosphorus and potassium were applied at the rate of 40 kg each per hactare from urea, sodium dihydrogen phosphate and murate of potash respectively.

20 days' old rice (vairety: payjam) seedlings were transplanted on July 8, 1978. During the growth period, water was given to the pots to keep the soil under submerged condition. The plants were subjected to natural light under open sky.

Harvest was done after 90 days of growth. The plant height, tiller number and soil pH values were recorded. Plants were dried at 70°C for four hours and the dry matter yield was recorded.

Mechanical analysis was done by hydrometer method; pH by glass electrode pH meter using soil-water ratio of 1:2; organic carbon by Walkey and Black's (1934) wet oxidation method; total nitrogen by Kjeldll's method as described by Chapman & Pratt (1961). KCL extractable nitrogen, O.OO2 N H_2SO_4 extractable phosphorus, 1N NH_4OAC extractable potassium, Calsium and Magnesium were determined by following the methods as outlined by Jackson (1960).

Plant samples were digested with HNO_3—$HC10_4$—H_2SO_4 mixture (2:1: 0.05). Phosphorus was determined by vanadomolyb-date yellow colour method as outlined by Jackson (1960) and Ca and Mg were determined by EDTA titration (Diehl *et al*, 1950) method.

Results and Discussion:

The changes in pH of soil (BTRI farm) with time due to increasing rates of basic slag are shown in Table 2. It shows that the slag acts as an effective liming material. Addition of slag to soil at the rate of two to five ton/ha seems suitable for raising the soil pH to a value favourable for optimum plant growth. This corresponds to Cook's (1974) views which relate that finely divided basic slag was an effective liming material. He also mentioned that one ton of basic

Table 2. pH change of BTRI farm soil with time due to increasing rates of basic slag

Basic slag rate	Incubation time (days)					
(ton/ha)	1	3	6	9	15	30
0	5.0	5.1	5.1	5.2	5.1	5.1
1	6.5	6.4	5.5	5.4	5.5	5.5
2	6.8	6.4	6.1	6.2	6.1	6.0
5	8.6	7.3	6.8	6.8	6.8	6.7
10	8.7	8.4	8.2	8.1	7.8	7.7

slag would be roughly equivalent in liming values to two-thirds as much ground lime stone.

Agronomic data which include the dry matter yield, number of tillers per hill and plant height all at harvest have been presented in Table 3. Increases in the parameters due to the increasing rates of basic slag have also been calculated. It can be seen from the Table that in all the three soils the dry matter yield was increased due to the addition of the basic slag. The response was, however, the highest for BTRI farm soil (73.67% at 2.5 ton/ha slag rate) and the lowest (14.62 at 5 ton/ha rate) for BAEC farm soil. As regards the basic slag rate, the increase was the highest at 2.5 ton/ha rate both for BTRI farm soil (73.67%) and BCSIR farm soil (71.59%) whereas for BAEC farm soil five ton/ha rate gave the highest yield increase (27.61%). This emphasizes the need for determining the basic slag dose for every individual soil with a view to attaining higher crop yield. Increase in the dry matter yield may be attributed due not only to the liming affect of slag and better P, Ca and Mg supply but also to the micronutrient content of the slag (Cooke, 1974). Application of basic slag to soils also slightly increased tiller number and height of plant in general. The situations were better for BTRI farm and BCSIR farm soils. The increases in the three parameters for the soils due to increasing basic slag rate were, however, statistically insignificant.

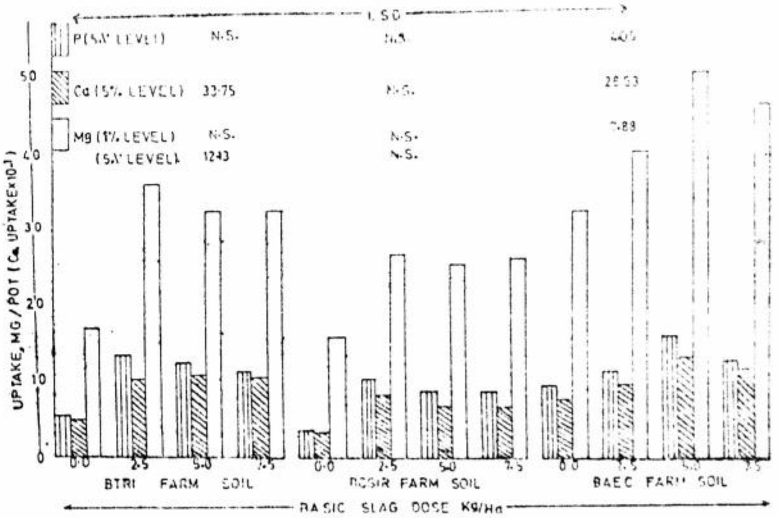

Fig. 1. Effect of different basic slag doses on P, Ca and My uptake by rice.

Figure 1 shows the P, Ca and Mg uptake by rice plant. It is evident from the figure that, in general, uptake values of P, Ca and Mg for BAEC farm soil were the highest and those for BCSIR farm soil the lowest. This is, however, an indirect effect of the dry matter yield values (Table 3) and not that of the nutrient concentration values of the dry matter (P, Ca & Mg concentration values were obtoined by dividing the uptake values by corresponding dry matter and subsequent multiplication by 100). Concentrations of P, Ca & Mg in the dry matter, however, increased due to the addition of basic slag in all the three soils.

These results indicate the promise of basic slag to be tested in high rainfall areas of the country particularly to the forest soils of tea, rubber, medical herbs, different fruit gardens and other commercially important forest plantations for better crop yield.

Table 3. Effect of different basic slag doses on the dry matter yield, tiller number and height of rice plant.

Soil	Bsic slag rate (Ton/ha)	Dry matter yield		Tillers per hill		Height of plant	
		(g/pot)	Increase over control (%)	(Number)	Increase over control (%)	(Cm)	Increase overcontrol (%)
BTRI farm.	0	12.75	—	5.56	—	114.3	—
	2.5	22.16	73.67	7.60	36.69	120.6	2.81
	5.0	20.44	60.19	8.30	49.28	110.6	5.71
	7.5	19.97	56.51	9.00	61.87	92.6	2.06
L.S.D. (at 5% level)		N.S.		N.S		N.S.	
BCSIR farm	0	9.61	—	5.30	—	102.3	—
	2.5	16.49	71.59	5.33	0.0	114.0	11.44
	5.0	14.36	49.43	5.66	4.91	110.3	7.82
	7.5	14.49	50.78	7.00	32.08	108.0	5.57
L.S.D. (at 5% level)		N.S.		N.S.	N.S.	N.S·	
BAEC farm	0	25.03	—	12.00	—	107.0	—
	2.5	28.69	14.62	11.00	8.33	107.3	0.28
	5.0	31.94	27.61	10.60	11.67	110.0	2.80
	7.5	28.73	14.78	9.30	22.50	105.6	1.31
L.S.D. (at 5% level)		15.49		N.S.		N.S.	

N. S. =Not significant.

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