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Amelioration of Light Textured Soil through Addition of Ash and Press Mud for Increasing Sugarcane Production

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ABSTRACT

The experiment was conducted at Regional Sugarcane Research Station (RSRS), Thakurgaon during the cropping season 2012-13. Ash and pressmud, produced from fifteen sugarmills of Bangladesh can be used in the sugarcane field for increasing production of sugarcane by improving soil health like physical properties of soil. Using of ash and pressmud may make the mill environment clean and pollution free. Ash, pressmud and their mixture were applied to improve water holding capacity and fertility of light textured soil. The experiment consists of ten treatments-T_0: Control (No application of Ash or pressmud); T_1-T_3: Application of ash @ 5, 10 and 15 t/ha, respectively; T_4-T_6: application of pressmud @ 5, 10 and 15 t/ha, respectively and T_7-T_9: application of ash and pressmud mixture (1:1) @ 5, 10 and 15 t/ha, respectively. Improvement of physical properties of soil in terms of water holding capacity of light textured soil such as loamy sand through addition of solid wastes of sugar mills like ash, press mud and their mixture were determined. Ash and pressmud made the soil loose since bulk density decreased from 0.90 to 1.28 g cm^{-3}. It also increased porosity from 54.5% to 62.6% and moisture content at field capacity also increased from 45.6% to 57%. Sugarane yield and yield contributing parameters increased significantly due to application of ash and pressmud. Yield varied from 42.92 t/ha to 63.19 t/ha due to different treatment. Lowest yield was found 43.00 t/ha from treatment T_0 where no ash/press mud was applied. The highest yield 63.33 t/ha was found at treatment T_9 when 15 t/ha ash and pressmud mixture (1:1) was applied. There was no significant difference in brix.

Key words: Ash, pressmud, amelioration, soil health

INTRODUCTION

Bangladesh is a rivarian country, contains near about 230 numbers of rivers and having huge amount of char land. But the productivity of these lands is very low due to its poor water holding capacity consequently low irrigation efficiency. Both vertical and horizontal increase of food production needs to feed the growing population of the country. By improving its water holding capacity it is possible to increase the irrigation efficiency as well as productivity of char land. It can be done by mixing ash and pressmud with sandy soil of char land and that ash and pressmud will be available from rice mill and sugar mill. The sugar industry releases a number of by-products during the process of sugar production including bagasse, molasses, boiler ash, mill effluent, and trash. Mill

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mud or filter mud is the solid material left after filtering cane juice while ash is the residue produced when bagasse is burned in boilers. Sugar mills generate between 0.02 to 0.06 tonnes of mud for each tonne of cane crushed (Chapman, 1996). Anecdotal evidence suggests that 0.05 tonnes of mill mud and 0.01 tonnes of ash are produced per tonne of cane crushed on average for Queensland (Barry *et al.*, 1998). The re-use of these by-products has been of mutual benefit to the farming and milling sectors as well as supporting the industry's endeavours to be viewed as clean, green, and responsible (Barry *et al.*, 2000). Kingston (1999) argued that mill by-products contribute towards better yield, productivity, and profitability by affecting the physical condition of the soil, such as reducing bulk density in the surface soil and by raising pH of the surface soil. BSES (1994) reported on the application of mill mud and ash increased plant cane yield and the heavy addition of mill mud and ash altered the texture of the soil, turning it from hard setting to soil which was loose and friable. The moisture holding capacity also increased substantially resulting in more available moisture for the cane plant. By increasing the availability of water for the crop, the mill mud and ash mixtures reduced the effects of salinity on crop growth. The reasons for the yield improvements were described as complex and linked to the dramatic changes in soil physical characteristics due to the mill mud and ash applications (BSES, 1994). Mill by-products have also been applied to normal soils as a cheap source of nutrients. Kingston (1999) found that these mill by-products reduced bulk density of the surface soil but did not influence pre-harvest soil moisture content. Filter mud/ash treatments raised pH of the surface soil for the first ratoon, and in the second ratoon for additional treatments. Cane growth improved with lower bulk density. Indeed the estimated size of the nutrient resource in mill mud alone produced by Queensland sugar mills is 7,300 tonnes of nitrogen and 4,500 tonnes of phosphorus each year. For phosphorus, this represents 60% of the estimated 7,700 tonnes of phosphorus applied as fertilizer to Queensland cane lands in 1994, while a significant amount of nitrogen is also available (Barry *et al.*, 2000). The re-use of these by-products have been of mutual benefit to the farming and milling sectors as well as supporting the industry's endeavours to be viewed as clean, green, and responsible (Barry *et al.*, 2000). In this aspect an experiment was designed for increasing water holding capacity of light textured soil; fertility and productivity of the soil.

MATERIALS AND METHODS

Site characteristics

The experiment was conducted during the cropping season 2012-13 at RSRS Thakurgaon under Old Himalayan Piedmont Plain Soils of Bangladesh (AEZ 1). The site is situated at 26.02^0 N latitude and 88.47^0 E longitude. The climate of the location was sub-tropical. The fractions of sand, silt and clay in the soils were determined by Hydrometer Method. By plotting the percentage values of these fractions on the Marshall's triangular co-ordinate, the textural class of the soil was determined. The soil was loamy sand which contains 87% sand, 12.68% silt and 0.25% clay.

Treatments and experimental design

The experiment consisted of single factor, application of solid waste of sugar mill (Ash and Pressmud). Then solid wastes as ash, press mud and their mixture were added to the soil following the treatments. The experiment was conducted at randomized complete block (RCB) designed with three replications having ten treatments. The

treatments were, T_0: Control (No application of Ash or pressmud); T_1-T_3: Application of ash @ 5, 10 and 15 t/ha, respectively; T_4-T_6: application of pressmud @ 5, 10 and 15 t/ha, respectively and T_7-T_9: application of ash and pressmud mixture (1:1) @ 5, 10 and 15 t/ha, respectively. The plot size was 8m × 6m. Soil samples were collected from each treatment plot which were dried in air and sieved through 2 mm square mesh sieve and stored in polyethylene bags for analysis in the laboratory. Three replicated samples for each treatment were prepared in core samplers of 5 cm diameter and 5 cm height. The volume of water that drained from a saturated soil core by gravity in 48h was measured. The gravitational water was calculated from the ratio of the volume of water drained to the volume of soil and expressed as a percentage. The volume of the soil was calculated from the diameter and height of the core sampler. The water retained by the soil was determined by the difference in weight of the sample after the gravitational water was drained out and that of the oven dry sample. The field capacity was then calculated from the ratio of the volume of water retained to the volume of the soil and expressed as a percentage. After measuring the gravitational water and field capacity, the porosity was calculated by adding the gravitational water and field capacity with the assumption of full saturation of the soil samples. The bulk density was calculated by the ratio of the mass of soil to the total volume of the soil. Chemical analysis of ash and pressmud were done. Sugarcane variety Isd 37 was planted in conventional method. Three budded set were planted on 12.12.2012 and harvested on 02.02.14. The numbers of irrigation were four. Fertilizer application and intercultural operation were done properly. Tiller count, millable cane during harvest, yield and brix % were recorded and analyzed statistically by statistix10 software.

RESULTS AND DISCUSSION

Physical and hydraulic properties

The average bulk density of soil sample collected from control plot was 1.28 gm/cc. Due to application of ash, pressmud or ash-pressmud mixture @ 5 to 15 t/ha bulk density was found between the ranged from 0.90 to 1.15 gm/cc, 1 to 1.10 gm/cc and 1.05 to 1.00 gm/cc respectively. So it can mention that bulk density decreased due to the application of ash, pressmud or ash-pressmud mixture. On the other hand porosity or saturated moisture content was increased due to the application of ash and pressmud. Porosity or saturated moisture content of soil sample collected from control plot was 54.5%. Due to application of ash, pressmud or ash-pressmud mixture @ 5 to 15 t/ha porosity or saturated moisture content was found between 55.5 to 60.0%, 57 to 62.6% and 55.7 to 59.7% respectively. Moisture content at field capacity was also increased in different treatments. That was 45.6% for the soil sample collected from control plot. Moisture content at field capacity ranged 49.8 to 53.0%, 51.3 to 57.0% and 50.1 to 52.4% due to application of ash, pressmud or ash-pressmud mixture @ 5 to 15 t/ha respectively. The gravitational water which indicates the macro pore of the soil decreased due to the application of ash and pressmud. Gravitational water of soil sample collected from control plot was 8.9%. Due to application of ash, pressmud or ash-pressmud mixture @ 5 to 15 t/ha gravitational water ranged from 5.3% to 7%, 5.1% to 5.7% and 5.6% to 7.3% respectively. Ash and pressmud increased the organic matter of soil and made the soil loose since bulk density decreased besides it increased porosity and moisture content at field capacity. Chapman, 1996 also found that applying ash improved the structure, water holding capacity, and aeration of soil Table 1.

Table 1. Impact of ash and pressmud on physical properties of sandy soil of RSRS farm, Thakurgaon

Treatment	bulk density (gm/cc)	Porosity or MC at saturated condition%	MC at field capacity %	Gravitational Water %
T_0	1.28	54.5	45.6	8.9
T_1	1.15	55.5	49.8	5.7
T_2	0.90	60.0	53.0	7.0
T_3	0.91	58.3	53.0	5.3
T_4	1.10	57.1	52.0	5.1
T_5	1.10	57.0	51.3	5.7
T_6	1.00	62.6	57.0	5.6
T_7	1.00	59.7	52.4	7.3
T_8	1.04	56.8	51.2	5.6
T_9	1.05	55.7	50.1	5.6

Chemical Properties of the waste materials

Ash was alkaline and pressmud was acidic. As shown in Table 2, the pH of ash was higher than pressmud. Lerner and Utzinger, 1986; Vance, 1996 also mentioned that the most beneficial aspect of ash additions to soils is their high pH and therefore their liming capacity. Ash contained substantial amounts of P, K, Ca, Mg and Si. The pressmud had a relatively high N content and also contained significant quantities of P, Ca and Si. The pressmud contains substantial amounts of CaCO3, and with the filtered impurities, it constitutes a valuable fertilizer/liming material as well as an organic amendment (Alexander, 1971; Roth, 1971; Moberly and Meyer, 1978).

Table 2. Some chemical properties of the waste materials

Waste	pH	Total element content (%)						
		N	P	K	Ca	Mg	Si	OC*
Bagasse Ash	7.5	0.11	0.47	0.48	4.6	0.52	8.5	1.0
Pressmud	6.0	2.34	0.62	0.56	1.0	0.40	3.1	20

*OC=Organic carbon

Sugarcane yield and yield contributing parameter

Sugarcane yield and yield contributing parameters were varied significantly under different treatment combination Table 3. Yield ranged from 43.00 t/ha to 63.33 t/ha due to different treatment. Lowest yield was found 43.00 t/ha from treatment T_0 where no ash/press mud was applied. The number of tiller and millable cane was highest at treatment T_6 (T_6=15 t/ha press mud) but the final yield was highest at treatment T_9 (T_9=15 t/ha Ash+PM(1:1)). There is evidence that cane yield increased following application of mill mud (Chapman, 1996; Kingston, 1999). Kingston (1999) compared sugar mill ash applications and a filter mud/ash mixture with various green cane trash management strategies to ameliorate hard setting of the fine sandy loam surface of a gleyed podsolic soil in the Isis District, Queensland. There was no significant different in brix. Hossain

et al. 2009 also found that ash and pressmud increase cane yield significantly but there is no significant different in brix.

Table 3. Yield and yield contributing parameters under different treatments in RSRS farm, Thakurgaon during 2012-2013

Treatment	Tiller ($x10^3 ha^{-1}$)	Millable cane ($x10^3$ ha^{-1})	Brix %	Cane Yield (tha^{-1})
T_0	80.8	72.7	21.27	43.00
T_1	122.8	82.3	20.93	53.33
T_2	115.4	77.8	21.40	53.00
T_3	118.8	84.4	20.88	55.00
T_4	105.3	82.4	21.13	54.00
T_5	123.1	81.4	21.02	59.33
T_6	129.2	90.3	20.35	55.33
T_7	110.1	82.0	20.71	53.00
T_8	112.92	81.1	20.53	57.67
T_9	115.1	85.6	20.60	63.33
LSD 5%	14.7	9.00	NS	6.415

Sugar mills' solid waste, ash and pressmud make the soil friable and improve soil health. Thus sugarcane yield and yield contributing parameters increased significantly by applying ash or pressmud or mixture of them. Application of 10-15 tha^{-1} ash and pressmud mixture to light texture soil is beneficial for optimum yield of sugarcane. But there is no significant effect on brix percent of cane. With proper management of ash and pressmud it is possible to make the industrial area clean and green.

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