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THE IMPACT OF BRICK KILN OPERATION TO THE DEGRADATION OF TOPSOIL QUALITY OF AGRICULTURAL LAND

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ABSTRACT

Brick kiln is a big environmental issue for the agriculture of Bangladesh as it was observed that the agricultural production in the soil close to the brick kiln was lesser than the same soil far from brick kiln. The study was conducted to assess the impact of brick kiln operation to the degradation of topsoil quality at Singair of Kalihati upazila in Tangail, Bangladesh, during the period of July to December 2013. The Soil was collected from areas close to the brick fields and far from the brick fields at a depth of 0-15 cm. The Electrical Con-ductance (EC) was found almost double in the soil samples close to the brick field than the soil samples far from brick field. The organic mattter content in the soil sample close to the brickfield was significantly lower than that of the far soil sample. The mean values of total N, available P and S were also significantly lower in the soil samples close to the brick kiln, 0.05%, 12.4, and 8.36 ppm respectively in the close soils, while 0.06%, 24.6, and 11.7 ppm respectively in the far soil. There were no significant changes observed in the other elements.

Keywords: burnt soil; degradation; topsoil quality; unburnt soil

INTRODUCTION

Topsoil, the upper surface of the earth's crust, is a naturally deposited material that mixes rich humus with minerals and composted material. It is one of the earth's most vital resources, because it contains all the essential chemical, physical and biological components for growing plants (Tucker *et al.*, 1995; Rai *et al.*, 2009). It represents a delicate nutritional balance that provides food for many of the animals on earth, either directly in the form of plant material or indirectly in the form of products from animals that eat plants (Rai *et al.*, 2009). But topsoil degra-dation and environmental pollution are the most serious problems in the world today as a result of natural or anthropogenic factors, because of their adverse effects on agriculture and the life on earth (Eswaran *et al.,* 1999; Khan *et al.,* 2007). Brick burning is one of the principal agents of topsoil degradation (Rahman and Khan, 2001). The brick kiln operation over the years covers not only the neighboring area of vegetation with layers of brick dust, but also consistently dissipates heat all around. It alters the physicochemical properties and habitats of nearby soil by destroying the topsoil nutrient elements (macronutrients such as C, H, O, N, P, K, Ca, Mg and S, and micronutrients such as B, Cu, Fe, Mn, Mo and Zn) and soil biota (Gupta and Narayan, 2010; Imtiaz *et al.*, 2010). Moreover, emission of gaseous pollutants and ash signif-icantly affect the human health and vegetation (Gupta and Narayan, 2010). Brick kilns also have adverse effects on biodiversity and biogeo-chemical cycling (Khan *et al.,* 2007).

Brick kilns are destroying large area of land every year especially in Bangladesh where bricks are made by collecting topsoil from agricultural land. It increased into 5000 ha during the 1998 to 1999 period in different pockets of brick fields (Rahman and Khan, 2001). These affected areas are expanding rapidly due to the increase in brick production (IUSS, 2002). There are about 6,000 brick manufacturers in Bangladesh which pro-

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duce about 18 billion pieces of brick a year. Many of them do not have proper license and the local government authorities do not have necessary resources to keep track of the fields (Rahman, 2012). Unfortunately, brick kilns are mostly situated on fertile agricultural land, as brick manufacturers need silty clay loam to silty clay soils with good drainage conditions. The urbanization and the demand of brick manufacturing have resulted in change of the land used pattern from the good agricultural land turned into agriculturally unproductive lands around several growing cities of the developing world (Kathuria, 2007).

Indigenous soil knowledge, concerns about environmental quality, wisdom and economic uses of soils are, therefore, very essential for long-term protection of soil resources (Warkentin*,* 2002; Ekosse *et al.,* 2006). The objective of the study was to assess the impact of brick kiln operation to the topsoil quality, especially on topsoil nutrient status of agricultural land around the brick field area.

MATERIALS AND METHODS

Study Area

Shingair village at Balla union of Kalihati upazila in Tangail district, Bangladesh, was selected to carry out the study. The Kalihati upazila is located between 24º17´and 24º26´ N latitudes and between 89º45´and 90º11´ E longitudes. The upazila has an area of 301.22 km^2. About 47% of people living in the study area are directly involved in agriculture. Main crops produced in the area are paddy, wheat, corn, mustard seed, potato, ginger, garlic, onion and varieties of pulse and vegetable (Nath, 2012).

Sample Collection

A total of ten samples were randomly collected from ten different points of the study area. Five samples were from area which was close to the brick kiln (named as burnt soil in the manuscript) $B_{1,}$ B_2, $B_{3,}$ B_4, and B_5. Another five samples were collected from far area of the brick kiln where, apparently no change in crop production was observed as said by the local farmers (named as unburnt soil in our all discussions) U_1, U_2, U_3, U_4, and $U_{5.}$ The samples were collected from the depth of 0-15 cm by auger from each point and mixed thoroughly to make composite sample. Samples were placed in sealed polythene bags and then transported to the laboratory for preparation and analysis.

Sample Preparation and Analysis

The composite samples were air dried and sieved through a 2 mm sieve and then 500 gm each sample were stored for chemical analysis. There were three replication for each sample. The soil pH was determined by glass electrode pH meter at a soil: water ratio of 1:2.5 as described by Jackson (1985). The EC was measured by digital EC meter, HM digital meter (Model 831E) in 1:5 of soil water suspension (Biswas and Mukherjee, 1987). The organic carbon (OC) of the soil samples was determined by Walkley and Black's wet oxidation method as outlined by Jackson (1985). The (OM) content was calculated by multiplying the content of organic carbon by Van Bemmelen's factor 1.73 (Piper, 1950). Total N in the soil was determined by semi-micro Kjeldahl method by digesting soil sample with concentrated H_2SO_4 and catalyst mixture (K_2SO_4: $CuSO_4.5H_2O$: Se = 10:1:0.1). The N in the digest was estimated by distillation with 40% NaOH followed by titration of the distillate trapped in boric acid with 0.01N H_2SO_4 (Page *et al.*, 1982). Available P was extracted by Olsen's method $SnCl_2$ as reducing agent. The extract was estimated colorimetrically following the blue color method and was analyzed by a spectrophotometer at 660 nm wavelength (Black *et al.*, 1965). Available S was determined by Tur-bidimetric method with the help of a spectrophotometer. $CaCl_2$ solution (0.15%) was used for the extraction of soil (Page *et al.*, 1982). The amount of S in the extractant was estimated turbid metrically by spectrophotometer at 420 nm wavelength (Jackson, 1973). The Zn and Cu were determined with the help of Atomic Absorption Spectrophotometer (AAS) followed the pro-cedure of McLaren *et al.* (1984).

Statistical Analysis

After laboratory analysis of the samples, data were analyzed using Statistical Package for Social Sciences (SPSS 14.0) and Microsoft office excel 2010.

RESULTS AND DISCUSSION

The observed values of chemical properties and nutrient status of burnt and unburnt soils are shown in the Table 1. The pH values of the samples ranged from 6.52 to 7.23 in the burnt soils and from 5.62 to 6.15 in the unburnt soils (Table 1). All kinds of crops are grown well in the range of 5.6-7.3, because all types of essential nutrients are available in this range (SRDI, 2009). The study found that the range of both the burnt and unburnt soil pH is suitable for crop cultivation. Though the brick kiln operation decreases the pH of surrounding soil (Khan *et al*., 2007), the study found the comparatively greater burnt soil pH than the unburnt soil in the study area.

The study revealed that the EC of the burnt soil increased twice of the unburnt soil as a result of the brick kiln operation. The EC of the burnt soil samples ranged from 32.4 to 70.9 µS cm^{-1}, while the EC of the unburnt soil samples ranged from 17.2 to 24.8 µS cm^{-1} (Table 1). Khan *et al*. (2007) carried out a study on the degradation of agricultural soils arising from brick burning in Western part of Bangladesh. They found that the significant increment in the EC value of the burnt soil was due to burning of salts/nutrients in the soils, which supports the results of the present study. High value of EC can toxic to plants and may prevent them from obtaining water from the soil (Rai *et al*., 2009).

The OM content of the samples recorded from 1.07 to 2.05% in the burnt soil and from 2.41 to 2.52% in the unburnt soil (Table 1). Soil OM is a reservoir for plant nutrients, enhances water holding capacity, protects soil structure against compaction and erosion, and thus determines soil productivity (Martius *et al.,* 2001). The SRDI (2009) reported that the OM values of Balla agricultural soils ranged from 2.20 to 2.70%, respectively. The study found that the OM content of the agricultural land in Balla union around the brick field area was decreasing day by day due to the burning of topsoil. Similar result was also observed by Khan *et al*. (2007).

The total N content ranged from 0.046 to 0.051% and 0.057 to 0.072% in the burnt and unburnt soil, respectively. The average total N content was found 0.05% in the burnt and 0.06% in the unburnt soils (Table 1). According to BARC (1997), the standard level of total N in soil is 0.32%. Regarding the report of SRDI (2009), the N values of Balla union agricultural soil ranged from 0.13 to 0.15%. The study observed lower level of total N in both the burnt and unburnt soil samples, where burnt soil contains much less quantity than the unburnt soil. Lower value of N is due to loss of organic carbon which contains nitrogen and nitrogen fixing micro-organisms in soil (Rai *et al.*, 2009). The available S content ranged from 4.3 to 10.6 ppm in the burnt and from 9.47 to 13 ppm in the unburnt soil. The mean values of available S content was found 8.36 ppm and 11.684 ppm in the burnt and unburnt soil, respectively (Table 1). The SRDI (2009) reported that the available S values of Balla union agricultural soil ranged from 5.35 to 11.80 ppm.

Table 1. Observed values of chemical properties and nutrient status of burnt and urburnt soil in the study area

	Sampling Points	Soil Quality Parameters					
		pH	**EC (µS cm^{-1})**	**OM (%)**	**N (%)**	**P (ppm)**	**S (ppm)**
Burnt Soil	B_1	6.80	40.5	2.05	0.047	11.21	8.7
	B_2	6.95	32.7	1.82	0.049	12.31	4.3
	B_3	6.52	32.4	1.07	0.046	10.54	10.6
	B_4	7.05	33.6	1.74	0.051	13.12	9.7
	B_5	7.23	70.9	1.54	0.047	14.57	8.5
	Mean ± SD	6.91 ± 0.27	42.02 ± 16.48	1.64 ± 0.002	0.048 ± 1.59	12.35 ± 1.59	8.36 ± 2.42
Unburnt Soil	U_1	5.62	17.2	2.46	0.061	32.72	12.50
	U_2	5.72	24.5	2.41	0.072	28.08	9.47
	U_3	6.11	22.4	2.42	0.057	25.90	13.00
	U_4	6.00	18.7	2.45	0.072	18.93	11.85
	U_5	6.15	24.8	2.52	0.058	17.54	11.60
	Mean ± SD	5.92 ± 0.28	21.52 ± 3.43	2.45 ± 0.04	0.06 ± 0.007	24.63 ± 6.37	11.7 ± 1.35

The available P content of the samples were within the range of 10.54 to 14.57 ppm in the burnt soil and of 17.54 to 32.72 ppm in the unburnt soil (Table 1). The lower amount of P was found in burnt soil than the unburnt soil, suggested the negative impact of brick burning on the topsoil P content. The BARC (1997) reported on the standard level of P for crop cultivation that is 21 ppm. The SRDI (2009) reported that the available P values of Balla union agricultural soil ranged from 0.90 to 1.67 ppm. Thus, the study revealed that the P content in the study area was relatively higher than the finding of SRDI.

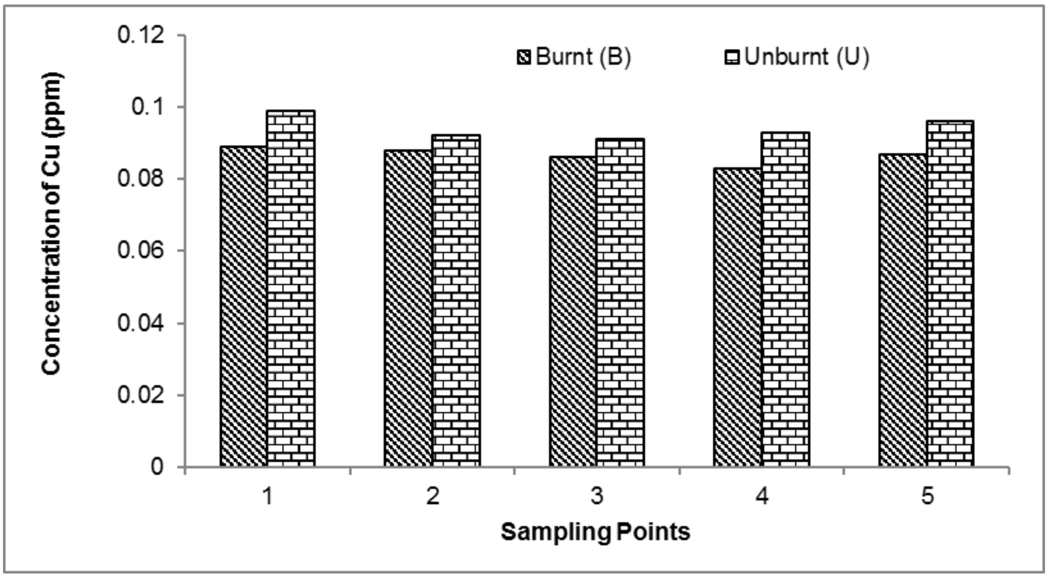

Figure 1. Copper (Cu) content found at different sampling points in burnt and unburnt soils.

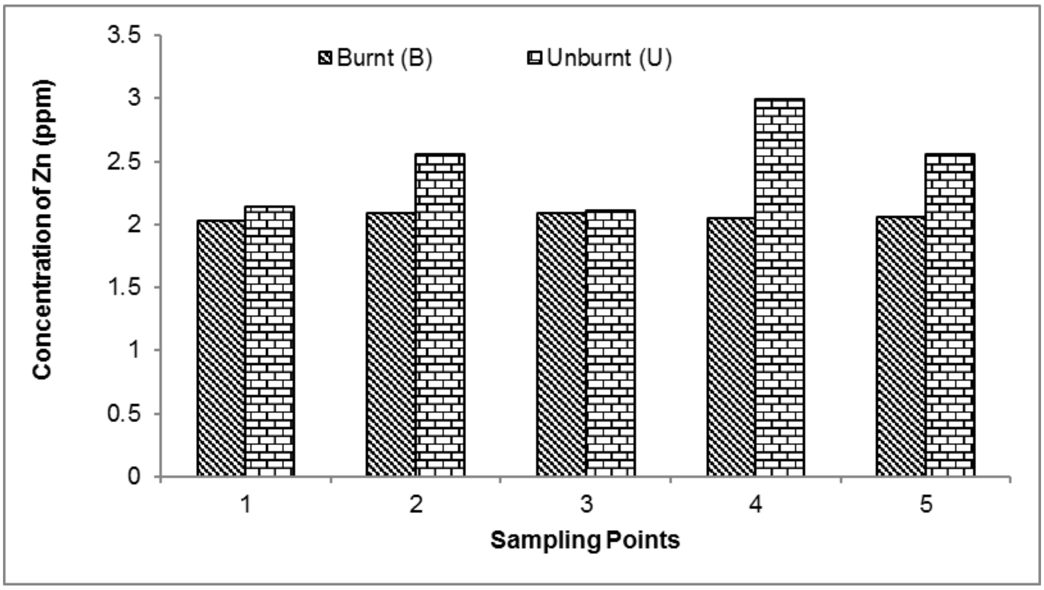

Figure 2. Zinc (Zn) content observed at different sampling points in burnt and unburnt soils.

Micronutrients nutrition of crops has immense economic importance since an adequate supply of micronutrients can help to ensure that optimum yields are obtained with the given inputs of other crop requirements (Imtiaz *et al.*, 2010). The total Cu content was recorded ranging from 0.083 to 0.089 ppm in the burnt and from 0.091 to 0.099 ppm in the unburnt soils (Figure 1). The mean value of total Cu contents was found 0.087 and 0.094 ppm in the burnt and unburnt soils, respectively. The total Zn content ranged from 2.030 to 2.089 ppm in the burnt and from 2.112 to 2.991 ppm in the unburnt soil in the study area (Figure 2). The mean value of total Zn content was found 2.062 and 2.47 ppm in the burnt and unburnt soils, respectively. The loss of burnt soil nutrients (both macronutrients and micro-nutrients) was caused by the brick kiln activity in long term (Khan *et al.*, 2007; Gupta and Narayan, 2010). Though all agriculture to some extent depends on the content of soil nutrients, this huge loss of nutrients associated with the burning of topsoil has not only reduced the crop production but also led to pollution of the environment and atmosphere (Khan *et al.*, 2007).

CONCLUSION

Brick kilns are not only destroying large areas of lands, but also the organic material and nutrients in the soil. In the study area, the values of OM and nutrients (both macro and micro) were found very low in the burnt soil compared to the unburnt soil, while the soil pH and EC were relatively higher. The study clearly depicted that the brick kiln operation decreases the OM and essential nutrients by degrading the topsoil qual-ity. The present investigation insight us in in-creaseing awareness about the status of soil degradation and environmental pollution induced by the brick kilns operation. To minimize soil nutrients loss and soil quality degradation, the study recommends: (i) brick fields should be built away from the productive agricultural land; (ii) restoring organic material and nutrient status so as to offset the negative impact of brick burning operation; and (iii) rules and regulations for the brick field management must be developed by the government and related authorities.

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