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STUDY OF THE IMPACT OF MUNICIPAL SOLID WASTE DUMPING ON SOIL QUALITY IN GUWAHATI CITY

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ABSTRACT

Due to increasing population, industrialization and urbanization a huge amount of solid waste is generated daily in cities and towns. In Guwahati city, the solid waste generated is disposed by Guwahati Municipal Corporation in the dumping site. The present investigation has been carried out to study the quality of solid waste treated soil collected from different locations and depths of the presently abandoned municipal solid waste dumping ground at Adabari in Guwahati city. The study on the impact of municipal solid waste disposal on soil properties revealed that the experimental value for the physico-chemical parameters increased for the solid waste treated soil in comparison to the control soil. This leads to assess the changes in physico-chemical characteristics and propeties of solid waste treated soils.

KEY WORDS : Solid waste, Soil quality, Solid waste dumping

INTRODUCTION

In the present period of time, the huge amount of solid waste generation has posed a serious threat to the eco-friendly atmosphere in the urban areas. In India, around three lakh tons of solid waste is generated daily from major urban centre (Jeevan Rao *et al.*, 1999). According to Guwahati Municipal Corporation (GMC) sources, more than 500 metric tonnes of solid wastes are generated daily in Guwahati city. Between the time period (1995-2002) all the Municipal Solid Waste (MSW) generated in Guwahati city was disposed at Adabari dumping site by the GMC authority. But after 2002 onwards, the MSW dumping site in Guwahati city has been shifted to Chachal and until now Chachal is the one and only dumping site in the city of Guwahati. The mode of disposal of solid waste in the dumping site by the GMC authority is the open dumping.

The MSW dumping ground at Adabari is now abandoned and unused since the year 2003. At present, the MSW dumped earlier at Adabari site has become decayed and assimilated with the soil. The solid wastes contain various proportions of different materials, which may exert impact on the soil properties. The present study has been carried out to investigate the quality of solid waste treated soil collected from the abandoned MSW dumping ground at Adabari site and to observe the probable impact of the application of solid wastes on the physico-chemical characteristics of the soil. The soil samples which were not treated with MSW were also collected as control samples, so as to compare and assess the impact of the application of solid waste on soil properties. This investigation can help to evaluate the fertility status of the solid waste treated soil.

MATERIALS AND METHODS

To observe the impact of land application of MSW on physico-chemical properties of soil, the Adabari dumping site was selected for the study. The soil samples were collected from four different depths viz., 0-15, 15-30, 30-45 and 45-60 cm. Five different locations within the dumping ground were selected for the collection of solid waste treated samples. The soil samples which were not treated with MSW were also collected from outside the dumping ground as control samples. The preparation and analysis of the soil samples were carried out by following the standard methods (Piper, 1950; AOAC, 1980; Page, 1982).

RESULTS AND DISCUSSION

The solid wastes contain various proportion of different materials. The soils get contaminated with

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different nutrients and heavy metals due to addition of MSW. The soil pH at the sampling sites increased from 6.5 (control) to 9.4 (maximum). The alkaline nature of the wastes are responsible for such increase in soil pH. The alkalinity in the MSW has been attributed to the presence of CO_3, HCO_3, Na, K and other alkaline materials in varying concentration. The pH value depends upon the experimental temperature and sample to water ratio. In order to ensure safe application of solid waste compost for growing food crops, the pH value of the compost should be in the range 5.5-8.5 (Giasquini *et al.*, 1988).

pH of soil is the measure of hydrogen ion activity and depends largely on relative amounts of adsorbed hydrogen and metallic ions. pH values increases with dilution. Different laboratories follow different dilution. Here, the pH determination was carried out with (1 : 2) soil to water ratio. pH is a good measure of acidity and alkalinity of soil-water suspension and provides a good identification of soil chemical nature. With increase in soil depth, the pH was found to be decreased in the collected samples. Different factors like leaching action of wastes, soil nature, mechanical composition etc. may be responsible for the decrease in pH. However, the pH value in all the solid waste treated samples collected from the different depths were found to be in alkaline limit (>7).

The Electrical Conductivity (EC) of soils increased from 0.048 (control) to 0.531 dSm^{-1} (maximum). The EC value also depends on the dilution of the soil suspension. Here, the conductivity measurements was determined in 1:2 soil suspension. The hazard caused due to solid wastes is most often encountered because of the high total salts and sodium content level which can be studied by the conductivity measurement. Conductivity value of less than 0.5 milli Scm^{-1} is perfectly safe and it don't have any negative effect on plant growth. High value of EC can be toxic to plants and may prevent them from obtaining water from soil.

The conductivity measurement should be carried out within few hours of the preparation of soil solution, otherwise microbial activity can vary the results significantly. The presence of large amount of ionic substance and soluble salts have resulted in increased value of EC in the MSW treated soil samples in comparison to the control samples. Conductivity is a measure of the current carrying capacity, thus gives the idea of soluble salts present in the soil.

The organic carbon content of the soil was found to be ranged from 1.6 (control) to 18.5 g Kg^{-1} (maximum). The main source of organic matter in the biodegradable solid wastes is food scraps, lawn waste, cowdung waste, fallen leaves etc. The nature and composition of the solid wastes in different Indian cities lead to widely different organic carbon content for different cities. Bio-degradable solid wastes can also be used as compost to produce plant nutrients and may be applied to the soil. Organic matter and organic carbon in the vermicompost form the main source of energy for the soil organism and can act as plant nutrients which are released in assimilable form during microbial degradation (Brady, 1998). It encourages the formation of top soil and soil aggregates in the surface soil horizon.

The application of MSW increased the availability of N, P and K contents of soils. Therefore, in many countries the treated MSW are commonly used as soil amendments under strict regulatory guidelines. It was found experimentally that available P_2O_5 content ranged from 14.7 (control) to maximum 68.5 ppm, whereas the available nitrogen increased from 58.1 (control) to maximum 237 kg ha^{-1}. The water soluble and exchangeable sodium (Na) and potassium (K) content was also found to be increased several times in comparison to the control. This is evident from the changes in EC values. The sodium and potassium content in the MSW are highly soluble and readily gets leached resulting in increased Na, K content in the waste treated soil. The insoluble Na and K salt gets solubilized during decomposition of the wastes. The main source of sodium in the solid wastes are organic matter, fine earth, ash and inorganic salt, whereas the sources contributing to the potassium content in the solid wastes are organic and inorganic materials like fine earth, ash, vegetable matter, rubber, metals and other components.

In agriculture, lime is used to increase soil fertility, correction of soil acidity and for supplying nutritional calcium to crops. A good sample of lime to be used in agriculture mainly contains $CaCO_3$. It was observed from the results that the content of calcium carbonate increased upto a maximum value of 196 g kg^{-1}, whereas for control sample the maximum value was found to be 18 g kg^{-1}. It is evident that the application of MSW had attributed to the increase of calcium carbonate content in the solid waste treated soil of the dumping ground. The content of $CaCO_3$ is influenced largely by the

Table 1. Physico-chemical properties of soil treated with MSW at Adabari dumping site in Guwahati city.

Sample Location No.	Sample No.	Soil Depth (cm)	pH (1:2)	EC (1:2) (dSm^{-1})	Organic Carbon ($g\ kg^{-1}$)	Available P_2O_5 (ppm)	Calcium Carbonate ($g\ kg^{-1}$)
	1	0-15	8.5	0.356	15.4	51.7	196
	2	15-30	8.4	0.323	13.8	39.6	86
I	3	30-45	8.2	0.314	11.9	30.1	182
	4	45-60	8.0	0.295	9.6	28.8	178
	1	0-15	8.3	0.414	14.7	48.6	154
	2	15-30	8.1	0.407	13.2	50.2	150
II	3	30-45	7.8	0.386	11.4	38.9	162
	4	45-60	7.4	0.375	9.3	39.4	159
	1	0-15	8.9	0.531	13.8	68.5	147
	2	15-30	8.7	0.474	14.2	57.1	112
III	3	30-45	8.5	0.392	14.7	45.6	172
	4	45-60	8.4	0.286	13.4	26.8	164
	1	0-15	9.4	0.374	18.5	59.4	148
	2	15-30	8.0	0.358	15.8	48.6	152
IV	3	30-45	7.9	0.319	15.2	30.5	131
	4	45-60	7.6	0.325	16.3	25.6	117
	1	0-15	9.1	0.491	17.2	53.5	151
	2	15-30	8.7	0.374	15.7	57.8	147
V	3	30-45	8.2	0.356	13.5	51.6	158
	4	45-60	7.6	0.318	12.8	54.2	165
	1	0-15	6.5	0.048	1.6	12.4	18
CONTROL	2	15-30	6.3	0.037	1.3	14.7	14
SAMPLE	3	30-45	6.1	0.042	1.1	13.1	12
	4	45-60	6.0	0.040	1.0	14.3	10

presence of fine earth and ash in the MSW.

It is apparent from the experimental results that the physico-chemical characteristics of the soil differ for MSW treated samples collected from different locations within the dumping ground depending on the nature of the waste materials.

The different nature and composition of the MSW is one of the major factors which can affect the properties of waste treated soil collected from different depths and different locations of the dumping ground.

The MSW produced due to domestic and industrial activity is highly heterogeneous with respect to its physical, chemical and biological properties. It has been reported that MSW can result in increased soil fertility and water retention in the soil and decrease soil erosion and fertilizer requirements (Glaub and Golueke, 1989). Kowald et al., (1982) studied the application of refuse compost and found that pH, phosphorus, potassium, carbon content of the soil increased with increased rate of application. Hortenstine and Rothwell (1969) reported that municipal compost applications increased P, K, Ca, Mg, soluble salts, water holding capacity and conductivity in the soil. It can be pointed out that the widely different composition of MSW have significantly different effects on soil properties. Therefore, soil characteristics need to be determined in the MSW dumping ground so as to study the impact of application of municipal solid wastes.

CONCLUSION

The present investigation gives an insight into probable impact of MSW application on soil properties in comparison to the control soil. The MSW contain significant quantities of major and secondary nutrients besides containing pollutant trace elements and soluble salts. Continuous application of such wastes may attribute to the pollution of the MSW treated soil. However, most of the potential problems can be avoided through proper selection of wastes, soils and judicious management processes. There is a need to examine the composition of wastes and properties before MSW application to land. If problems of pollution are minimized, then MSW can be considered as a

Table 2.

Sample Location No.	Sample No.	Soil Depth (cm)	Available Nitrogen (kg ha^{-1})	Sodium (ppm) Na		Potassium (ppm) K	
				Water soluble	Exchangeable	Water soluble	Exchangeable
	1	0-15	195	72	354	64	534.5
	2	15-30	168	78.5	350	61	486
I	3	30-45	156	64	372	70	518
	4	45-60	150	89	386.5	73.5	552
	1	0-15	237	64	365	57	486
	2	15-30	215	60.5	358	53.5	493.5
II	3	30-45	196	56.5	350	48	454
	4	45-60	158	58	361.5	39	435
	1	0-15	218	75	358	64	318
	2	15-30	205	82.5	351	69	297.5
III	3	30-45	227	89	347	65.5	215
	4	45-60	214	78	350.5	61	298
	1	0-15	186	74	315	65	254.5
	2	15-30	172	70	286	58.5	258
IV	3	30-45	154	64.5	274.5	54	237
	4	45-60	168	68	262	49	215
	1	0-15	180	91	294	83	254
	2	15-30	152	80.5	273	75	229.5
V	3	30-45	164	75	257	63.5	207
	4	45-60	159	83.5	216.5	74	212
	1	0-15	58.1	16	48.5	13	32
CONTROL	2	15-30	45.2	18	42	11	28.5
SAMPLE	3	30-45	48.9	13.5	34	8	30.5
	4	45-60	38.7	11	37	10	24

valuable resource for use as a source of nutrients.

Balanced nutrition can be provided within the overall limits of recommended nutrient values which should be guided by consideration of nutrient need and impact on soil properties. Optimised use of MSW can invariably improve the soil productivity without creating ecological hazards.

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