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Effect of Changes of Soil pH on Microbial Activity and Availability of Phosphorus and Sulfur

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Abstract

The effect of correction of soil pH on microbial activity and availability of phosphorus and sulfur were studied. The low soil pH (3.70) of the tea soil collected from Nagrakata Tea Estate, West Bengal, India, was increased with the application of increasing doses of limestone and mixing garage soil of higher pH (5.38) in different proportions. It was found that due to increase in soil pH by application of limestone and soil mixing to the strongly acidic soil of the area, the microbial activity which was assessed by measuring dehydrogenase activity (DA) and mineralizable carbon (Min-C), were increased. In soil mixing evolution of CO_2 increased up to pH 4.61, beyond that there was a decreasing trend. The available phosphorus (avail-P) content of the soils was increased, whereas the available sulfur (avail-S) content was decreased significantly with the increase in soil pH both by liming and soil mixing.
Key words : Soil pH, Liming, Microbial activity, Available phosphorus, Sulfur.

Correction of soil pH by liming normally increases the chemical and biochemical reactions and microbial processes in soils. Such treatment changes the solubility of many chemical compounds and improves the environment of plant roots and increases soil microbial biomass, including microbial dynamics and diversity. It, therefore, significantly changes the enzymatic activities in soil (1, 2). Recent interest in defining soil quality identified soil properties that effect soil health and quality (3). It has been proposed that measurement of changes in soil enzymatic activities may provide a useful index of changes in soil quality (4). Even though pH is considered to be one of the most important properties affecting soil health and quality, its role in modifying enzymatic reactions is tea soil has not been demonstrated clearly. It is important to obtain a complete assessment of soil enzymatic activity with respect to changes in soil pH that reflects the changes in soil metabolic processes by using different biochemical reactions involved in nutrient cycling processes in soil. the objectives of the experiment were to study the effect of changes of soil pH on microbial activity and on availability of P and S.

Methods

Bulk soil samples were collected from Nagrakata Tea Estate, West Bengal, India. There were two sets of treatments. In the first set of treatment the collected plot soils were treated with increasing doses of limestone viz., 0, 1, 2, 3, and 4 ton/ha and in second set of treat ment the garage soils having higher soil pH 5.38 were collected from Nagrakata Tea Estate and were mixed with plot soil in different proportions viz., 0, 20, 40, 60, 80 and 100%. The microbial activity of tea soil was measure in terms of DA and Min-C. DA determination based on the estimation of the magnitude of reduction of triphenyl tetrazolium chloride (TTC) to triphenyl formazan (TPF) by soil at 30 C for 24 hours (5). Min-C was determined by the soil incubation method described by Anderson (6). Avail-P and S content of soils were determined by Bray's extractan + (7) and monocalcium phosphate extractant (8) respectively.

Results and Discussion

Microbial Activity

The effect of changes of soil pH by liming and

Table 1. Effect of changes of soil pH on DA, min-C, avail-S and P by liming. *Mean of four replications.

Doses of limes tone (t/h)	pH*	DA* (mg TPF/g 24 hr)	Min-C* (mg/g)	Avail-S* (mg/kg)	Avail-P* (mg/kg)
0	3.72	11.13	4.15	80.0	19.5
1	4.09	15.30	4.16	70.0	22.5
2	4.24	18.43	4.22	62.5	23.2
3	4.28	19.34	4.26	57.5	24.1
4	4.45	20.44	4.35	50.0	24.5

Table 2. Effect of changes of soil pH on DA, min-C, avail-S and P by soil mixing. *Mean of four replications.

Garage per cent soil mixed	pH*	DA* (mg TPF/g 24/hr)	Min-C* (mg/g)	Avail-S* mg/kg)	Avail-P* (mg/kg)
0	3.72	11.13	4.35	80.0	19.5
20	3.94	14.76	4.50	77.5	21.5
40	4.35	15.79	4.55	70.0	22.0
60	4.61	17.90	4.60	47.5	23.5
80	5.08	19.92	4.45	42.5	26.5
100	5.38	20.92	4.40	32.5	27.1

soil mixing were represented in Tables 1 and 2 respectively. The results revealed that DA was increased from 11.13 to 20.44 mg TPF/g per 24 hours as soil pH increased from 3.72 to 4.45 by liming and from 11.13 to 20.92 mg TPF/g per 24 hours as pH of the soil increased from 3.72 to 5.38 by soil mixing. Therefore, the magnitude of increase in DA followed almost similar pattern in both the cases of treatments. The increased DA might be due to the reasons that increase in soil pH provided favorable environment for microbial growth and proliferation and hence microbial activity was increased. On an average, C mineralization increased with increasing soil pH. The change in CO_2 evolution was not so high. It was only 0.20 mg/g when soil pH rose from 3.72 to 4.45 by liming. However, in soil mixing the trend was different. Carbon dioxide evolution increased up to soil pH 4.61 and the there was sudden fall in CO_2 evolution as pH increased further with 80% or more soil mixing. The change in soil pH reflected in soil respiration indicated by CO_2 evolution. Relatively higher pH resulted greater microbial activity.

P and S Availability

Avail-S content of tea soil was fairly high (80.0 mg/kg). Avail-S content of tea soil reduced to 50.0 and 32.5 mg/kg as soil pH increased to 4.45 by liming and 5.38 by soil mixing respectively. It was also found that the soil with higher organic matter contained higher amount of avail-S, because S is an integral part of soil organic matter (9, 10). Generally, microbial oxidation of S occurs over wide range of soil pH, although, with some species the optimum pH can be 4.00 or lower. The avail-P content of the original tea soil was low which might be due to fixation of phosphorus by Fe and Al-oxides. However, the availability of P increased from 19.5 (at pH 3.72) to 24.5 mg/kg (at pH 4.45) with increasing doses of limestone and to 27.1 mg/kg (at pH 5.38) by soil mixing. The results showed a significant negative relationship between increase in soil pH and availability of S. However, reverse was the case for increase in soil pH and availability of P.

From these experiments it was concluded that increase in soil pH values stimulated the microbial activity and diversity, resulting an increase in the soil enzymatic activity and thus affecting nutrient cycling. DA and min-C were increased proportionately with increasing soil pH. Avail-P content was quite low whereas avail-S content of tea soil was fairly high. The availability of S was decreased with increase in soil pH while availability of was increased with increase in soil pH. The results provided information on important chemical and biochemical processes, which had the potential and are sensitive indicators to soil health and quality.

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