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Khanda A
Assistant Professor, Department of Agriculture, Dolphin (PG) Institute of Biomedical & Natural Sciences, Dehradun, Uttarakhand, India

Choudhary NB
Assistant Professor, Department of Agriculture, Dolphin (PG) Institute of Biomedical & Natural Sciences, Dehradun, Uttarakhand, India

Barman U
Department of Agricultural Chemistry and Soil Science, Bidhan Chandra Krrishi Viswavidyalaya, West Bengal, India

Mukherjee P
Department of Agricultural Chemistry and Soil Science, Bidhan Chandra Krrishi Viswavidyalaya, West Bengal, India

Pandey CS
Associate Professor, Department of Agriculture, Dolphin (PG) Institute of Biomedical & Natural Sciences, Dehradun, Uttarakhand, India

Mukhopadhayay PK
Retired Professor, Bidhan Chandra Krrishi Viswavidyalaya, West Bengal, India

Correspondence
Khanda A
Assistant Professor, Department of Agriculture, Dolphin (PG) Institute of Biomedical & Natural Sciences, Dehradun, Uttarakhand, India

Transformation of some major nutrients in tea garden soils of North Bengal

Khanda A, Choudhary NB, Barman U, Mukherjee P, Pandey CS and Mukhopadhayay PK

Abstract
The intensity of land uses increase without passable and unprejudiced apply of chemical fertilizers and with less or no use of organic manure have caused severe decrease in fertility status of tea garden soils. Sixteen soil samples (0-30cm) from four farmers' field (Small tea garden) located at Malabari village, in Naxalbari block under Darjeeling district of West Bengal were collected. Most of the soils were acidic in reaction and the pH ranged from 5.19 - 6.30. Oxidizable organic carbon was found to vary from 0.61%-1.24%. Lime requirement of the soils were estimated by SMP buffer method and found to be varying between 1.9 to 4.2 ton/acre. The laboratory incubation study was conducted with application of lime, vermicompost and their combination. Vermicompost application in general showed higher availability of nitrogen and phosphorus than lime application. Effect of liming was found to be superior over the vermicompost application with respect to sulphur availability in different soils. Combined effect of lime and vermicompost on availability of nitrogen, phosphorus and sulphur were much higher than their individual application. Maximum benefit of availability of nitrogen, phosphorus and sulphur were recorded on 60th day of incubation followed by 90th day and minimal availability at 30th day of incubation.

Keywords: tea garden, soil physico-chemical properties, nutrient transformation

Introduction
Tea (*Camellia sinensis* L.) is a perennial evergreen plant growing in an extensive range of soil types derived from various parent material in tropical, subtropical and temperate climate (Eden, 1976) [1]. India contributes about 27% of the world's tea demand in terms of domestic and international requirements. Cultivation of tea for quite long years in a particular garden leads to the loss of desired yield due to deterioration in soil quality (Dang, 2000) [3].

Nutrient management has greater importance particularly to sustain yield potential and improvement of soil health. In a given locality, however, soil characteristics as well as nutrient parameters play an important role for better tea production (Sarwar *et al*., 2011) [4].

Among the three major nutrients nitrogen has received considerable importance and attention in the past as compared to P and K. S are also assuming importance for plantation crops. The role of phosphorus in improving tea productivity did not receive adequate attention, though regional responses were reported (Sen, 1964) [5]. Primary reason for the variability in response of phosphorus may be attributed to the variation in the inorganic and reductant soluble phosphate, as well as organic and total phosphate in the soils (Bhattarcharya and Dey 1978) [6]. The iron and aluminum fractions in acid tea growing soils also make up the slowly available pool of soil phosphorus. The dynamics of organic matter in soil seems to play a dominant role in this regards (Sanyal 2002) [7].

Sulphur is a vital nutrient for tea. Generally sulphur availability in tea soil is low (Natesonet, *et al*.1989) [8] and is largely influenced by organic matter status. There is a positive correlation between the available S in soil and the organic matter content (Ghosh *et al*.1994, Verma 1997) [10, 9]. Therefore, there is a need to critically examine the effect to different doses of S on yield of tea and to identify the suitable sources of S for tea, together with the effect of S application in tea soil.

The present study was initiated to evaluate the effect of liming and application of organic amendment on the availability of nitrogen, phosphorus and sulphur in small tea garden soils

with acidic in soil reaction. In order to fulfill the above objectives the following measures were undertaken:

1. To estimate the amount of lime required to raise the pH of soils under consideration
2. To examine the organic matter content of the soil
3. To evaluate the change in available NO_3^- – N, NH_4^+ – N and total available N during 90 days period of laboratory incubation with lime and with organic amendments.
4. To estimate the changes in available P and available S during 90 days period of laboratory incubation with lime and organic amendments.

Materials and Methods

Study area

Soil used in the present study were collected from different farmers' field (small tea garden) in the village Malabari under Naxalbari Block district Darjeeling West Bengal, at 26.68^0 N latitude and 88.22^0 E longitude at an elevation of about 152 m (501feet) above mean sea level.

Soil sampling and analysis

The soils were collected from sixteen small tea gardens during March 2012. The ages of the tea plants were 8-10 years. Four soil samples from each tea garden were collected randomly from each plot up to the depth of 30cm. The randomly collected soil samples from each depth were mixed up thoroughly to obtain composite samples for each plot.

pH, Organic Carbon, Available Phosphorus of the samples were determined following standard protocol (Jackson 1967). The factor of 1.724 was used to convert the organic carbon percentage into soil organic matter (%). Available Nitrogen was estimated by the method of Bremner and Keeney (1966). Available sulphur was estimated by the turbidity measurement using barium chloride ($BaCl_2$) as described by Tabatabai (1974). The lime requirements of 16 soil samples under study were determined by SMP buffer method (Mehlich, 1976) [20]. The water holding capacities of the soil samples were determined gravimetrically using Keen's box.

A laboratory incubation study was conducted with 16 surface soils collected. The following treatments were applied: control (T1), 5 ton/ha vermicompost (T2), 100% lime requirement (T3) and 50% of vermicompost + 50% of lime requirement (T4). Replicated soil samples from each treatment are collected on 30, 60 and 90 day period of incubation and analyzed for available nitrogen, phosphorus and sulphur.

Results

Physical and chemical property of soils

Soil reaction (pH), lime requirement, percentage of oxidizable organic carbon and water holding capacity of sixteen surface soils (0-30cm) are presented in Table 1. Results in Table 1 indicated that the soils were acidic to moderately acidic in reaction.

pH of the soils varied within 5.19-6.30 with an average of value of 5.49 ± 0.41. Lime requirement of these soils were found to vary between 1.4 to 4.2 tons per acre and with average of 2.5 ± 0.95 tons per acre. Oxidizable organic carbon was found to vary between 0.61% to 1.24% and average being 0.95 ± 0.18%. Amount of organic carbon content of these were computed and presented in Table 1 and the results indicated that the average organic matter content of the soils under present study was high. Water holding capacity of soils varied between 16.24% to 30.14% and the average water holding capacity is 24.77 ± 4.39%.

Results presented in Fig. 1 and 2 indicate the changes in available ammonical nitrogen (NH_4^+-N), Nitrate Nitrogen (NO_3^--N), Phosphorus and Sulphur (mg/kg) content of the soils during 30, 60, and 90 day's period of incubation.

There was no appreciable change in the amount of available ammonical nitrogen on 90^{th}day period of incubation in 70% of the soil samples under control treatment (without any amendment). While in the remaining soils, there was increase in available ammonical nitrogen on 60^{th} day (average of 123.38 ± 1.68 mg/kg) followed by a decrease on 90^{th} day. But the amount of available ammonical nitrogen was higher on 90^{th} day (average of 116.08 ± 1.68 mg/kg) than that of 30^{th} day (average of 110.98 ± 1.4 mg/kg). Liming of the soils resulted appreciable increase the availability ammonical nitrogen content during 90 days period of incubation. Increase in the availability of ammonical nitrogen was found to be more in 60^{th}day (average of 151.31 ± 1.39 mg/ kg) and 90^{th} day (average of 152.08 ± 1.66 mg/kg) than that of 30^{th} day (average of 124.32 ± 1.44 mg/kg). The results suggest the increased rate of ammonification at elevated pH due to application of liming material to the acid soils under study. In case of vermicompost added soils only two out of 16 soil samples (sample no. 7 and 13) showed significantly increased mineralization of ammonical nitrogen on 90^{th} day over 30^{th} day. The majority of the soils shows vary little amount change (decrease or increase) available ammonical nitrogen in soil during the same period. The beneficial effect of liming along with vermicompost application was recorded in almost all the samples as the available ammonical nitrogen content increased during 90 day period of incubation.

Liming increased the availability of nitrate nitrogen (NO_3^--N) content of the soil under study. Liming found to increase 2% to 18.5% of available nitrate nitrogen (NO_3^--N) content over control treatment during the 30 day period of incubation. However, during 90 day period of incubation the availability of nitrate (NO_3^--N) nitrogen content of the limed soil over control increased up to 44 per-cent. Addition of vermicompost @ 5 ton per ha had considerably increased the available nitrate nitrogen (NO_3^--N) of the soils. The results in the Table also indicate the advantages of vermicompost addition over liming on available nitrate nitrogen (NO_3^- -N) content of the soils, were higher than that of limed soil on 30^{th} day period. But the differences were not prominent on 90^{th} day. The combined effect of addition of vermicompost and liming material on availability of nitrate nitrogen (NO_3^--N) in all the soils was found to be more outstanding. More than 25% increase in available nitrate nitrogen (NO_3^--N) content is recorded in most of the soil under study.

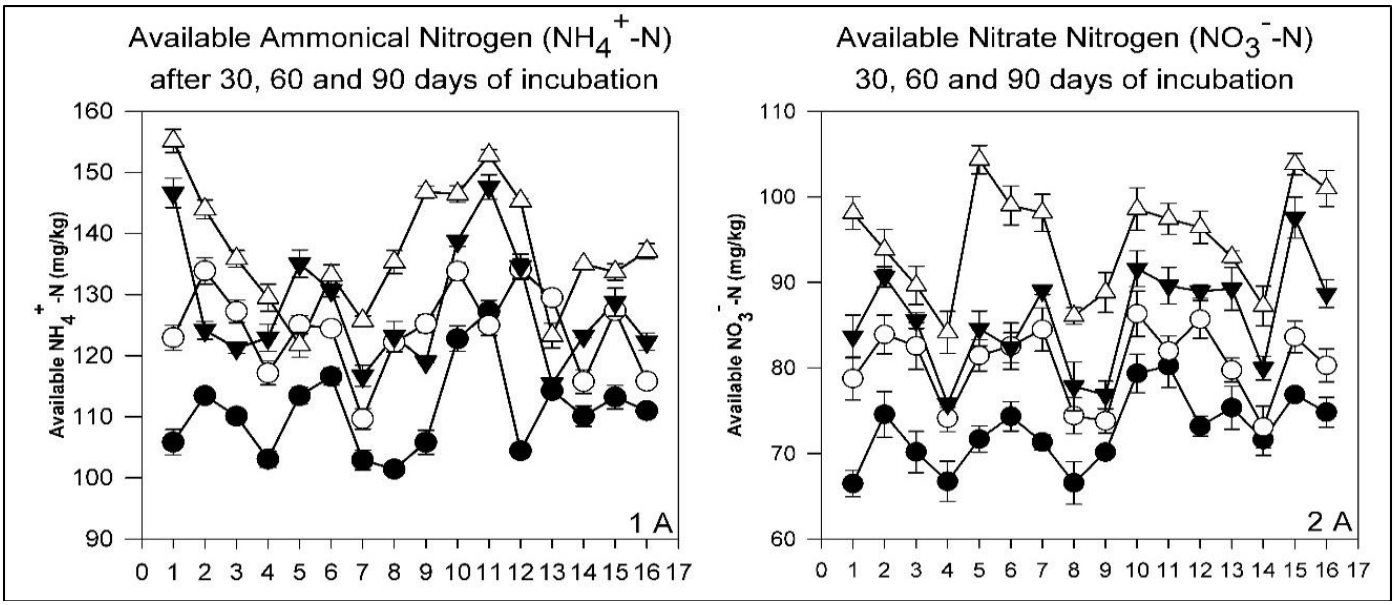
The changes in available phosphorus content of the soils under study on 30^{th}, 60^{th}, and 90^{th} day of laboratory incubation, when the soils were treated with lime, vermicompost, lime plus vermicompost and control with no addition of amendment. Available phosphorus (as extracted by Bray and Kurtz No 1 solution) increased maximum on 60^{th} day (average 26.07 mg/kg ± 1.60) of incubation over 30^{th} day (average 39.46 mg/kg ± 1.39) in case of control treatment where no amendment was added. Again decrease in available phosphorus content was recorded on 90^{th} day (average 33.88 mg/kg ± 1.60) in all the soils under study. Irrespective of the soils available phosphorus content is lowest on 30^{th} day of incubation. Liming increases available phosphorus content of all the soils, over control during 90 day period of incubation. Beneficial effect of liming on availability of phosphorus due to increase in mineralization of available phosphorus and favorable pH for the increase in solubility of P are possibly

the reason for such increment during the period of incubation. Addition of vermicompost had more positive effect over liming on availability of phosphorus in all the soils under study. Like the control treatment available phosphorus content of the soils were found to be highest on 60th day of incubation. Lowest available phosphorus was found on 30th day of incubation. However, available phosphorus content on 90th day occupies the intermediate position. Additional advantage of combined lime and vermicompost application on availability of phosphorus over single treatment of vermicompost and single treatment of lime were observed in all the soils. Maximum availability of phosphorus was found to be on 60th day of incubation. On 30th day of incubation of available phosphorus was found to be the lowest.

0.15% $CaCl_2$ extractable sulphur present in different soil during 30th, 60th and 90th day of incubation, when the soils were treated with four different treatment combinations as described in the earlier sections is given in Fig 4 (A, B and C). Like the earlier occasions (available N and available phosphorus) liming increased the availability of sulphur content over control in all treatments and all the days of analysis. Available sulphur content is found to increase two fold or more in 15 out of the 16 soils under study. Availability of Sulphur was highest on 60th day of incubation followed by 90th day and 30th day of incubation. The effect of liming on sulphur availability in different soils was found to be more outstanding than those of available N and available phosphorus. Addition of vermicompost recorded more available sulphur over their respective control, in all the soils under study. However, the benefit of vermicompost addition on availability of sulphur in less pronounced than that of liming in almost all soils during 30th, 60th and 90th day of analysis. The combination effect of liming and vermicompost application indicated higher availability of sulphur in all the soil under study irrespective of the period of incubating the soils.

Table 1: pH, lime requirement, percentage of oxidizable organic carbon and water holding capacity of tea garden soil

Sample no	Depth (cm)	pH	Tons of pure CaCO3 per acre required to bring pH to 6.8	% of oxidizable organic C	% of organic matter	Water holding capacity (%)
1	0-30	5.4	5.25	1.24	2.13	29.07
2	0-30	5.3	5.76	1.19	2.05	30.14
3	0-30	5.5	5.14	0.87	1.50	28.45
4	0-30	4.9	6.91	0.87	1.50	29.50
5	0-30	5.5	5.58	0.88	1.51	26.58
6	0-30	5.3	5.76	0.61	1.05	25.45
7	0-30	5.3	5.93	1.00	1.72	27.12
8	0-30	5.2	6.04	1.02	1.75	26.14
9	0-30	6.3	2.28	1.16	2.00	18.90
10	0-30	5.8	4.56	1.02	1.75	17.56
11	0-30	6.2	2.78	0.75	1.29	19.21
12	0-30	6.1	2.93	1.20	2.06	16.24
13	0-30	5.5	4.95	0.94	1.62	26.63
14	0-30	5.2	6.04	0.88	1.51	25.45
15	0-30	5.3	5.62	0.75	1.29	24.56
16	0-30	5.3	5.84	0.80	1.38	25.35
Mean		5.5	5.10	0.95	1.63	24.77
S.D.		0.41	1.32	0.18	0.31	4.39



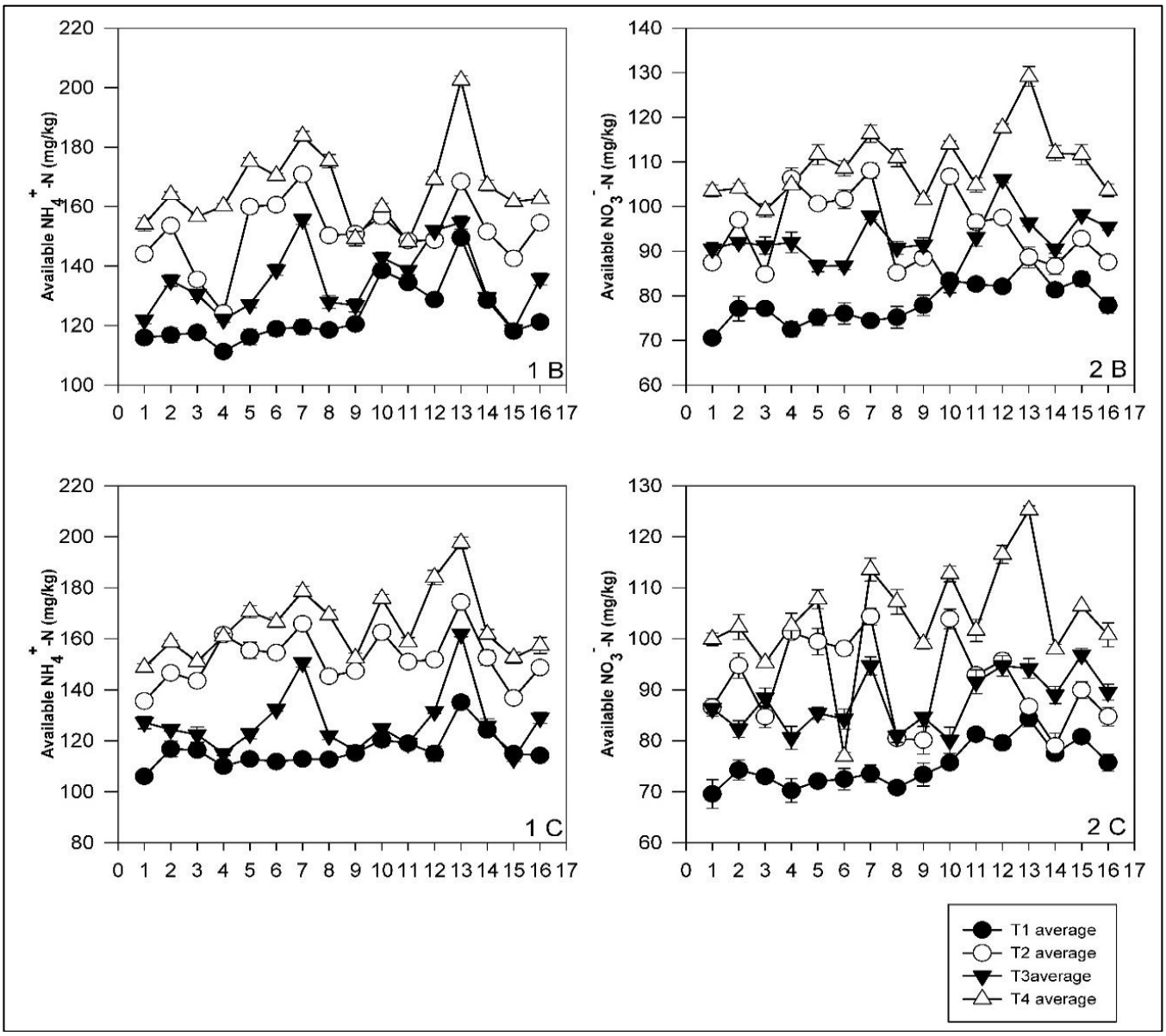
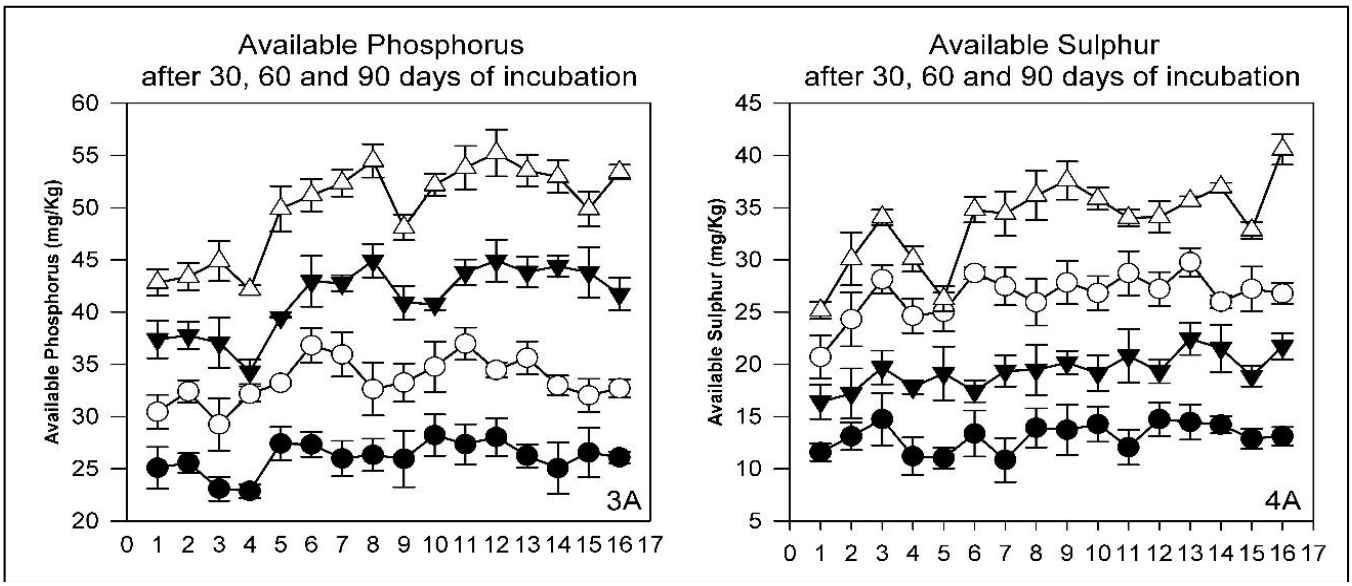


Fig 1, 2: Available Ammonical (NH_4^+-N) and Nitrate (NO_3^-N) Nitrogencontent after 30, 60 and 90 days incubation



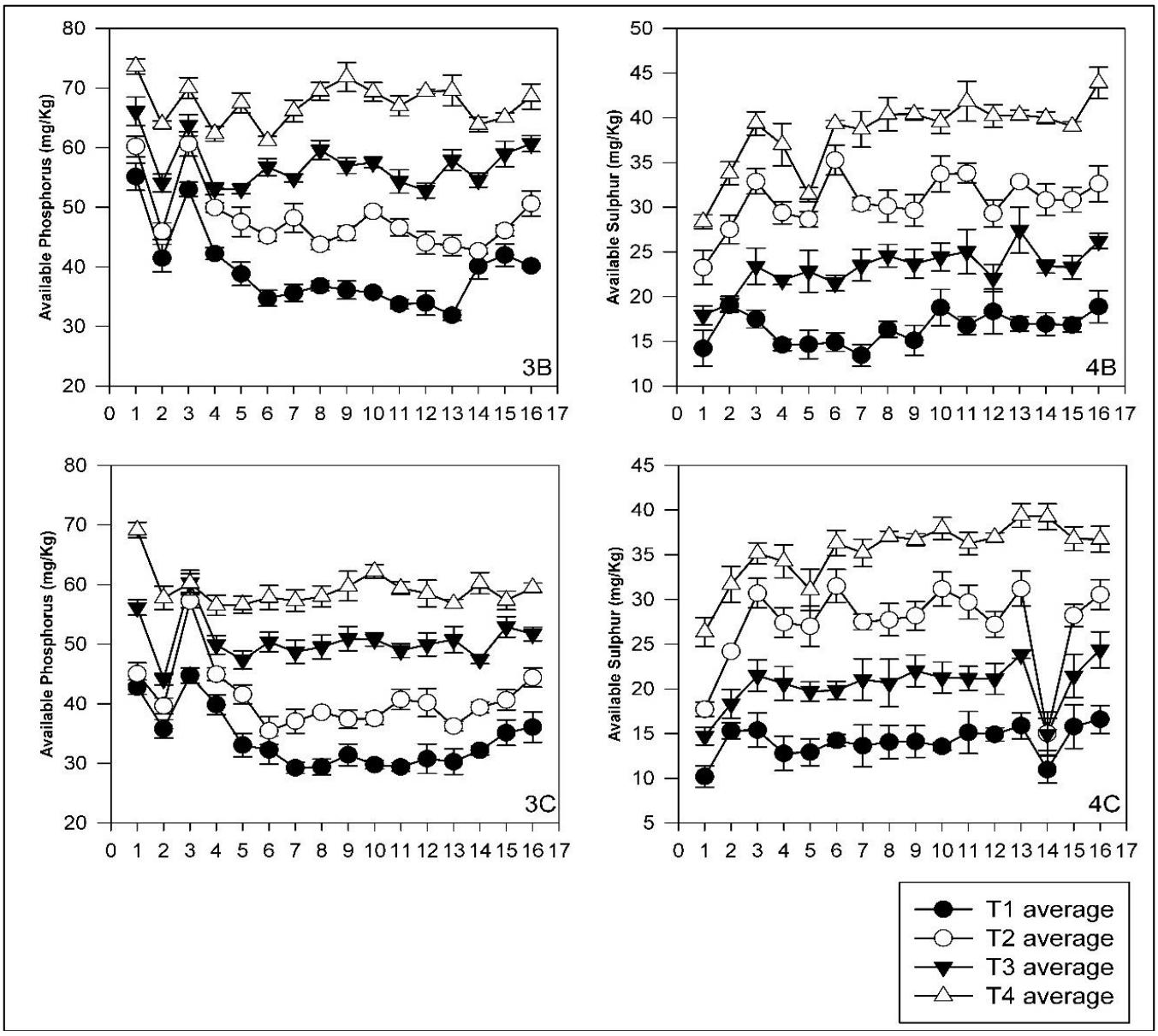


Fig 3, 4: Available Phosphorus and Sulphur content after 30, 60 and 90 days incubation

Conclusion

The presents study was conducted to understand the independent effect of addition of liming material (calcium carbonate) and organic matter in the form of vermicompost and their combined effect on availability of nitrogen, phosphorus and Sulphur in sixteen small tea gardens in the village Malabari under Naxalbari block in Darjeeling district of West Bengal.

Vermicompost application resulted in higher availability of nitrogen and phosphorus over lime application. Effect of liming was found to be superior over vermicompost application with respective to Sulphur availability in different in different soils under study. Combined application of liming and vermicompost recorded maximum benefit with respect to available nitrogen, phosphorus and Sulphur in all the soil under study. Maximum benefit of available nitrogen, phosphorus and Sulphur was recorded on 60th day of incubation followed by 90th day and minimal nutrient availability was found on 30th day of incubation.

References

1. Eden I. Tea 3rd (Eds.). Longman, London, 1976, 816.
2. Black CA. (Ed.). Methods of soil analysis. Part I and II. American society of Agronomy, Inc., Publishers, Madison, Wincosin USA, 1965.
3. Dang VM, Anderson DW. Application of soil taxonomy classification into Northern Vietnam. Vietnamese Soil Sci., Davidson DT, 2000; 13:15-23.
4. Sarwar G, Schmeisky H, Tahir MA, Iftikhar Y, Sabah. Application of Green Compost for the Improvement of Dry Matter Yield and Chemical Composition of *Lolium perenne* (Grass). J. Anim. Pl. Sci, 2011; 21(4):710.
5. Sen AR. Regional responses to P and K manuring. Two Bud. 1964; 11:98-108
6. Bhattacharyya NG, Dey SK. Phosphate in tea soils and changes on long term manuring. Two Bud. 1978; 25:32-36.
7. Sanyal SK. Colloid chemical properties of soil humic substances: A relook. In: Bulletin of the Indian Soc. Soil Sci., Indian Society of Soil Science, New Delhi. 2002; 21:537-569.
8. Nateson S, Palani N, Ranganathan V. sulphur for tea. Sulphur in Agric. 1989; 13:12-15.
9. Verma DP. Sulphur nutrition in Tea. Planters' Chrono. 1997; 92(7):297-299, 301-303.

10. Ghosh P, Rammohan CK. Studies on the fertility status of tea soils of Darjeeling. Two Bud. 1994; 41:28-31.
11. Arshad MA, Martin S. “Identifying critical limits for soil quality indicators in agro-ecosystems,” Agriculture, Ecosystems and Environment. 2002; 88(2):153-160.
12. Barooah AK, Dutta AK, Goham KK. Mineral nutrition of tea. In: Field Management in tea (Dutta A.K. *et al*. (ed)). Tea Research Association, Tocklai Experimental Station, Jorhat, 2005, 128-139.
13. Barua BK, Das B, Medhi C, Misra AK. Fertility status of soil in the tea garden belts of Golaghat district, Assam, India, 2013.
14. Dang VM. Potassium and sulphur dynamic in the soils under tea plantations. 2005; 22:21-23.
15. Ghosh JJ, George U, Borpujari N. Available sulphur status of Dooars tea soils. Intl. J. Tea Sci., 2006; 5:1-9.
16. Han WY, Shi YZ, Ma LF, Ruan JY, Xu, Y. Sulphur status and its adsorbing characteristic in soils of tea garden. J Tea Sci. 2003; 23:27-33.
17. Hao X, Cho CM, Racz GJ, Chang C. Chemical retardation of phosphate diffusion in an acid soil as affected by liming. Nutr. Cycl. Agroecosys. 2002; 64:213-224.
18. Huang QW, Yang ZH, Li XH, Xiao WJ, Liu P. Status of sulphur in tea garden soil in Hunan Province. J. Tea Sci, 2001; 21:65-68.
19. Sultana J, Siddique MNA, Kamaruzzaman M, Halim MA. Conventional to Ecological: Tea Plantation Soil Management in Panchagarh District of Bangladesh. Journal of Science, Technology & Environment Informatics. 2014; 01(01):27-35.
20. Mehlich A. Communication in Soil Science and Plant Analysis. 1976; 7:637-632.