Int.J.Curr.Microbiol.App.Sci (2018) Special Issue-7: 3442-3447

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 Special Issue-7 pp. 3442-3447
Journal homepage: http://www.ijcmas.com

Original Research Article

Effect of Liming Materials on Available Phosphorus and Organic Carbon in Acid Soil of Ranchi, Jharkhand

Neha Toppo and Shashi Bhushan Kumar*

Department of Soil Science and Agricultural Chemistry, Ranchi Agricultural College, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India
**Corresponding author*

Keywords

Wheat, lime, dolomite, basic slag, available phosphorus and organic carbon

ABSTRACT

A field experiment was laid out in Randomized Block Design with three replications in Wheat at experimental plot of the Department of Soil Science & Agricultural chemistry, Birsa Agricultural University, Ranchi, Kanke, Jharkhand during Rabi season of 2016-17 in acid soil of Ranchi with an objective to study the effect of different liming materials such as lime, dolomite and basic slag on available phosphorus and organic carbon in acid soil of Ranchi at 30 days of intervals. Treatments for wheat were T1: RDF (Control), T2: RDF+ Lime@4q/ha, T3: RDF + Lime@ LR, T4: RDF +Dolomite@4q/ha, T5: RDF + Dolomite@ LR, T6: RDF + Basic slag@4q/ha and T7: Basic slag@ LR. In the field experiment, results showed that available phosphorus was more in limed plots as compared to that of control plot at initial. The available phosphorus was more in Basic slag treated plots, during 30 to 120 days of liming as compared to other plots. In case of organic carbon, there was no significant result observed in the plots treated with liming materials. But the changes in the percentage of organic carbon in the soil were observed.

Introduction

Soil structure of Jharkhand is poor with low fertility. Almost 90% of the soils are acidic in nature and deficient in nutrients (Anonymous, 2009). The organic carbon content of soils of about 47 per cent of TGA are low to medium (<0.5% to 0.75%). Soils of about 66 per cent area are low (<10 kg/ha) in available phosphorous content while about 28 per cent area are found to be medium (10 – 25 kg/ha) in available P content (Agarwal *et al.*, 2013).

The soils of uplands and medium land are red and lateritic in nature, highly permeable, coarse textured, shallow depth, low base saturation, acidic soil reaction, low cation exchange capacity and poor water retention capacity. These soils are generally deficient in available phosphorus and poor in organic matter (Sarkar, 2013).

Cereal is the main source of food which provide up to 85% of the total calories and 50-80% of the total protein requirement in the developing countries (Sikka *et al.*, 1989). The productivity of wheat was 335.93 lakh MT (Singh, 2012) and that of food grain was 43.10 lakh MT (Anonymous, 2009). Optimum productivity of any cropping systems depends on adequate supply of plant nutrients. As Food is the basic and primary requirement of human life, it is important to give more emphasis on increasing productivity. As per the fourth Advance Estimates for 2013-14, the production of wheat is likely to be 95.9 million tones. Thus, Wheat is second most important crop after rice and is main Rabi crop in many parts. As wheat is not able to grow in acidic soils, it is important to maintain soil fertility and soil pH for such crop for their proper growth and to maintain or increase their productivity in acidic soils. Hence, liming is the best method which is currently used worldwide. Soil acidity adversely affects a number of soil chemical properties, such as accessibility of macro and micronutrients, as solubility of soil chemical compounds is related to soil pH.

In such conditions, despite the standard mineral fertilization, there is a lack of expected fertilization effects on the growth and development of agricultural crops. Soil pH below 5.5 needs major emphasis for amelioration of soil acidity, because major portion of exchangeable Al is present in soils with pH below 5.5, which adversely affects plant growth and yield. Hence, the crops grown on such problematic soils do not give remunerative return rather it lowers down the yield to a great extent. So, one of the most important and practically feasible management practices is the use of liming materials to ameliorate the soil acidity.

Pioneering work on management of acid soils was carried out at Ranchi by Mandal and his coworkers (Mandal *et al.,* 1966; Mathur *et al.*, 1985) during the past five decades (Sarkar, 2013). These workers have identified liming as the most important input for amelioration of acid soils. Liming improved the physical, chemical and biological properties of acid soils, which resulted in availability of plant nutrients. This, in turn brought about significant yield improvements in crops grown in such soils.

Materials and Methods

A field experiment was conducted at experimental site of the Department of Soil Science & Agricultural Chemistry, Birsa Agricultural University, Ranchi (Jharkhand), which is situated at 23°-19' N latitude, 83°-17'E longitude at an altitude of about 625 meter above the mean sea level. The experimental field was divided into 21 sub-plots as per treatment for the conduct of field experiment. The soil of the experimental field was having low organic carbon (0.49%) and medium available phosphorus (22.31 kg/ha).

At the time of sowing, maximum and lowest temperatures recorded were 25.4 ℃ and 10.1℃ respectively. But during harvest, maximum temperature was 37.5℃ and lowest was 21.2℃ and throughout the crop period, maximum and lowest temperatures were 39.5℃ and 1.1℃ respectively. Throughout the crop period, rainfall was recorded only during booting stage i.e. 6mm. At the time of sowing, maximum RH recorded was 89% and lowest was 70%. But during harvest, 84% was the maximum RH and 60% was the lowest. Throughout the crop period, maximum and lowest RH recorded were 92% & 16% respectively.

The weeds of the experimental field were treated with herbicide before ploughing in order to minimize weed infestation. The land was ploughed by using spade and thoroughly leveled by planks. Total area of the experimental field was 31 m X 20 m which was further divided into 3 replications, each of 6 m width and 31 m length. Further, each replication was sub-divided into 7 sub-plots. Size of each sub-plot was 6 m X 4 m leaving required channels in between for irrigation purposes. The experiment was laid out in a Randomized Block Design with three replications. Three commonly used and available liming materials viz., lime, dolomite and basic slag were tested compared to control (RDF). All three liming materials used were similar in grade and on the basis of calcium carbonate equivalent with recommended doses of NPK fertilizers. Each liming material was divided into 2 treatments, first as 0.1 LR in furrow and second as recommended dose of lime, i.e. 4 q/ha in furrow along with RDF. Altogether 7 treatments were formed. Each treatment was replicated into 3. Thus, total number of plots became 7 X 3 = 21.

The crop taken was wheat (Variety- K1006), grown with and without liming materials to see the liming effect as compared to control (RDF). Seed rate of wheat was 100 kg/ha. The date of sowing was 2/12/2016 and date of harvesting was 20/4/2017. Urea, SSP and MOP fertilizers were applied to all the plots as RDF. 50% Nitrogen, 100% phosphorus and 100% potassium were applied as basal application at the time of sowing. Remaining 50% of Nitrogen was applied in two equal splits doses. Liming materials were applied into soil with required amount (i.e. @ 4 q/ha & @ $1/10^{th}$ of LR in furrow) and mixed well for minimizing the soil acidity.

The soil samples were collected from the plots at 30 days of intervals after liming i.e. 30 DAS, 60 DAS, 90 DAS, 120 DAS and after harvest (140 DAS). Initial soil sample was also collected before application of liming material. The soil samples were randomly taken by using *Khurpi* and collected in plastic bags using proper scientific method. Organic carbon of the soils was estimated by chromic acid wet digestion method as outlined by Walkley and Black (1934). Available phosphorus was extracted with Bray P1 extractant (0.03 N NH4F in 0.025 N HCL solution) and was determined Bray and Kurtz (1945) as described by Jackson (1973) on a double beam digital spectrometer (Spectrascan UV 2600). The data obtained from laboratory and field experiment were analyzed statistically by Fisher's method of analysis of variance. The value of critical difference (CD) at 5% level of significance was computed as outlined by Panse and Sukhatme, (1985). Amount of lime requirement was estimating through SMP method. The method of Shoemaker, Mc lean and Pratt (the SMP method) was developed using a modified buffer (Shoemaker *et al.*, 1961).

Results and Discussion

The acid soils are base unsaturated and quickly immobilize soluble phosphates and therefore crops that require liberal supplies of P and Ca cannot give good yields unless they are suitably limed and fertilized. The availability of phosphorus was more in limed plots as compared to that of control plot although it is treated with SSP, this may be due to breaking of the complex of iron and aluminum phosphates on liming of acid soils and lime keep the phosphates in higher availability in the form of calcium phosphates. Similar result was also reported by Crusciol *et al.*, (2016). Liming influences all elements in soils and as such there are numerous simultaneous changes to soil processes which in turn affect the plant nutrient uptake; two examples of positive impact for crops are increased P availability and decreased uptake of toxic heavy metals, reported by Holland *et al.*, 2017. In contrast, Available phosphorus increased only with fertilizer reported by Costa, 2012. In case of available phosphorus, the significant result was showed by basic slag @ 4q/ha as well as @ LR treated plots (Table.2.). The maximum availability of phosphorus was found in basic slag@ LR.

Table.1 Treatment details of experimental plots

S. No.	Treatments	Dose	Notation
1.	Control	RDF	T1
2.	Lime	4q/ha + RDF	T2
3.	lime@ LR	4.8 q/ha + RDF	T3
4.	Dolomite	4q/ha + RDF	T4
5.	Dolomite @LR	4.42 q/ha + RDF	T5
6.	Basic slag	4q/ha + RDF	T6
7.	Basic slag @LR	5.58 q/ha + RDF	T7

Table.2 Available phosphorus (kg/ha) in soil at 30 days of intervals After application of liming materials

TREATMENTS		30DAS	60DAS	90DAS	120DAS	HARVEST
T1	RDF	29.58	27.16	24.02	21.63	20.78
T2	RDF+ lime@ 4q/ha	31.68	28.95	26.57	23.95	21.78
T3	RDF+ lime@ LR	34.12	30.93	27.54	25.47	23.11
T4	RDF+ dolomite@ 4q/ha	30.60	28.25	25.45	24.50	22.87
T5	RDF+ dolomite@ LR	32.00	29.91	27.83	26.44	26.07
T6	RDF+ basic slag@ 4q/ha	36.60*	34.23*	31.06*	28.87*	27.60*
T7	RDF+ basic slag@ LR	38.84*	36.62*	33.00*	30.86*	29.73*
	CD (0.05)	5.89	5.64	6.94	6.76	5.46
	CV (%)	9.93	10.27	13.98	14.63	12.50
	INITIAL: Avail. P=22.31kg/ha					

Statistically significant value is indicated by *

Table.3 Organic carbon in soil at 30 days of intervals after application of liming materials

TREATMENTS		30DAS	60DAS	90DAS	120DAS	HARVEST
T1	RDF	0.56	0.51	0.54	0.58	0.59
T2	RDF+ lime@ 4q/ha	0.51	0.46	0.47	0.54	0.50
T3	RDF+ lime@ LR	0.42	0.35	0.45	0.51	0.52
T4	RDF+ dolomite@ 4q/ha	0.52	0.51	0.54	0.53	0.51
T5	RDF+ dolomite@ LR	0.51	0.40	0.48	0.55	0.50
T6	RDF+ basic slag@ 4q/ha	0.55	0.46	0.51	0.54	0.53
T7	RDF+ basic slag@ LR	0.41	0.39	0.47	0.56	0.54
	CD (0.05)	0.05	0.05	0.08	0.09	0.07
	CV (%)	5.78	7.02	9.41	9.43	7.84
	Initial values: OC%=0.494					

Throughout the growth period of wheat crop, the availability of phosphorus was more in basic slag @LR as compared to basic slag @4q/ha. This may be because it is also a source of phosphorus. Similar results were also found by Mariakulandai *et al.*, (1995). In the field experiment, there was no significant result observed in plots treated with liming materials. But the changes in the percentage of organic carbon in the soil were observed, may due to the favorable condition provide to microbes in the soil. The increased in soil organic matter (includes organic carbon) with liming reported by Costa (2012) in acid soil. MassaoInagaki *et al., (*2016) reported that lime application significantly improved the stocks of several SOC pools. In contrast, Chatzistathis *et al.,* (2014) reported that on lime application organic carbon significantly reduced.

It was observed that all the limed plots at the rate of lime requirements (LR) showed less availability of organic carbon at 30 days after sowing than that of other plots treated with liming materials at the rate of 4q/ha. This may be due to increase in biological activities in the soil. At 90 days after sowing, it was observed that organic carbon percentage in the soil increased during booting stage, this may be because liming ameliorates soil conditions to plant growth, plant productivity increases and also the return of C inputs to soil, thus potentially increasing soil organic carbon concentrations. The similar result was also observed by Paradelo *et al.,* (2015).

Basic slag was found to be significantly superior over other liming materials in increasing available phosphorus in the soil. The effects of liming on soil organic carbon still poorly known because the reason for increase in soil organic carbon can be the results of several factors.

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