PHOSPHORUS AVAILABILITY IN LOW PHOSPHOROUS ACIDIC SOILS AS AFFECTED BY LIMING AND PHOSPHOROUS ADDITION

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ABSTRACT

An incubation study was conducted to determine the effect of lime (L) as $CaCO_3$, and phosphorus (P) as triple super phosphate (TSP) on soil pH, available P, organic matter decomposition, inorganic nitrogen content, and calcium (Ca) content of soil. Three rates of lime equivalent to 0, 1 000, 2 000 kg $(CaCO_3)$ ha^{-1} and three rates of TSP equivalent to 0, 50 and 100 mg (P) kg^{-1} were applied in combination as treatments with three replicates. With the increasing rate of lime, soil pH was significantly ($p < 0.001$) increased. Both lime and TSP had significant effects ($p < 0.001$) on P availability at three different soil test P extraction methods. Two thousand kg $(CaCO_3)$ ha^{-1} with 100 mg (P) kg^{-1}gave the highest available P irrespective of extractant used. Bray and Kurtz-1 method extracted the largest amount of P (5.63- 66.69 mg kg^{-1}) while Borax method extracted the smallest amount (3.42 – 42.42 mg kg^{-1}). Despite the varied ammonium nitrogen (NH_4^+-N) and nitrate nitrogen (NO_3^--N) contents, the NH_4^+-N content decreased and NO_3^- - N content increased in the all treatments when incubation progressed. With the increasing rate of liming, the decomposition of organic matter and the Ca content also increased.

Key Words: Acidic soil, Extraction methods, Incubation, Lime, Phosphorus

INTRODUCTION

Phosphorus is an essential nutrient both as a part of several key plant structure compounds and as a catalysis in the conversion of numerous key biochemical reactions in plants. And also it is a vital component of ATP. Phosphorus stimulates root development, increases stalk and stem strength, improves flower formation and seed production and supports development throughout entire life cycle of a plant. Phosphorus is generally available to crops at soil pH of 6 and 7. When the soil pH is less than 6, P deficiency increases in most crops (Ch'ng *et al.,* 2014). Phosphorous is deficient in most acidic soils because soluble P is fixed by aluminum (Al) and iron (Fe) oxides (Adnan *et al.,* 2003).

Throughout the world, nearly 30% of the total land area consists of acidic soils and 50% of the potential arable land are acidic and represent one of the major constraints to agricultural production due to plant growth inhibition and yield reduction (Valentinuzzi *et al.,* 2015). Acidic soils, in general, are deficient in nutrients, particularly P (Basak and Biswas, 2015). Therefore, soil acidity is one of the major constraints that should be overcome to increase the crop production to fulfill the food requirements of the rapidly growing population.

Traditionally liming is the most common practice used to overcome the impact of soil acidification. Liming is the addition of alkaline material to the soil, providing a conjugate base such as a carbonate hydroxide (HCO_3^-) silicate (SiO_3^{2-}) to react with the H^+ ions (Singer and Munns, 1996). Large amounts of lime and inorganic P fertilizers such as phosphate rocks (TSP) are used to saturate Al and Fe ions. However, most of the instances, this approach has been not successful due to the

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lack of understanding about the suitable liming and phosphorous rates for a particular soil. For an example, over liming precipitates phosphates ions with Ca as calcium phosphate. The continued long term application of fertilizers can lead to P accumulation in surface horizons greater than that required for optimum plant growth, thus increasing the potential for P loss to surface waters and eutrophication (McDowell *et al.,* 2001). And also it is important to investigate how liming influence the availability of other nutrients such as N, Ca as well as decomposition of organic matter as all of these nutrients influence the crop growth.

Even though several research studies have been carried out to find out how the phosphorus availability responds to the lime addition, information on appropriate combinations of lime and phosphorus fertilizer to enhance the phosphorus availability is lack and inconsistent. So introduction of an appropriate combination of lime and P is an important strategy for improving crop growth in acidic soils in Sri Lanka. The main objective of this study was to assess the effect of liming and P addition on phosphorus availability in an acidic soil.

MATERIALS AND METHODS
Climate and soil
The experiment was conducted at the Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka. According to the agro-ecological classification (Panabokke 1980), the region of investigation comes under agro-ecological region WL2 (Low country Wet zone). The climate of the area is tropical monsoonal, with a warm wet period (April to June) and a relatively dry period (January to March). The area receives an annual rainfall of around 2,500 mm. The distribution of rain is bi-model. Annual mean air temperature of the study area is 22 -30 ^{0}C and the relative humidity is about 80%. The soil used in this study belongs to Red Yellow Podzolic great soil group and is classified as Hapludults according to the USDA soil taxonomy (Mapa *et al.* 1998).

Sample preparation
Acidic soil samples were drawn randomly from the research farm of the Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya. Random samples were taken from 0 - 15 cm depth using a soil auger and then mixed well to make a composite sample, to be used for the incubation study. Physio-chemical characteristics of the soil were deter-mined using standard methods (Table 1).

Table 1: Initial physico-chemical characteristics of the experimental soils

Soil properties	Values
pH	4.75 ± 0.25
Electrical Conductivity	0.04 ± 0.009 mS/cm
Sand	14 ± 1.35 %
Clay	76 ± 2.34 %
Silt	10 ± 1.12 %
Borax extractable P	3.60 ± 0.54 mg kg^{-1}
Olsen extractable P	9.65 ± 0.85 mg kg^{-1}
Bray extractable P	9.76 ± 0.94 mg kg^{-1}
NO_3^- N	11.12 ± 1.12 mg kg^{-1}
NH_4^+ N	8.57 ± 0.92 mg kg^{-1}
Exchangeable potassium	71.63 ± 2.58 mg kg^{-1}
Exchangeable calcium	117.37 ± 4.67 mg kg^{-1}
Exchangeable sodium	109.64 ± 2.52 mg kg^{-1}
Organic carbon	$1.06 \pm 0,26$ %

Treatments
Three rates of lime equivalent to 0, 1 000, 2 000 kg $(CaCO_3)$ ha^{-1} and three rates of TSP equivalent to 0, 50 and 100mg (P) kg^{-1} were applied in combination as treatments with three replicates. Hundred and thirty five glass bottles (135) were cleaned and 15 of them were filled with 100 g of previously air-dried soil and kept as controls (three bottles for each week). Then 60 bottles were filled with 95 g of air-dried soil and the other 60 bottles were filled with 90 g of air-dried soil. All the above bottles (120) were equally divided into 5 sets, each contained 3 controls, 12 bottles filled with 95 g of soil and

12 bottle with 90 g of soil and those 24 bottles were used for different lime and triple super phosphate treatments. Three rates of lime equivalent to 0, 1 000, 2 000 kg (CaCO$_3$) ha^{-1} and three rates of TSP equivalent to 0, 50 and 100 mg (P) kg^{-1} were applied in combination as treatments. Then, two soil samples of 250 g were taken separately to prepare the relevant lime and TSP rates. Using above prepared soil samples, 5 g of soil form relevant liming rate and 5 g of soil from relevant TSP rate were transferred into previously prepared glass bottles and mixed thoroughly.

Incubation

Samples were then incubated in the dark at room temperature (25 ±1°C). Constant moisture content of the soil was maintained throughout the incubation period. After the incubation period of 1, 3, 5, 7 and 10 weeks, 27 glass bottles; 3 glass bottles from each treatment and three controls were removed, the soil samples were air-dried and analyzed respectively.

Analysis of soil

The soil samples were analyzed for pH and electrical conductivity (EC) using pH meter and EC meter respectively. P was measured by using Borax extractable method, Olsen method and Bray and Kurtz-1 method. Total organic matter was measured using Walkley-Black method (Tiessen and Moir, 1993). The NH$_4^+$ - N content was determined utilizing the Berthelot reaction (Searle, 1984) and the NO$_3^-$ - N by sodium salicylate yellow colour method (Bremner, 1960). Total Ca content was determined using ammonium acetate method.

Statistical Analysis

Data generated were subjected to analysis of variance procedure (ANOVA) for a Completely Randomized Design (CRD) with three replicates using SAS 9.1 software. Duncan's Multiple Range Test and Least Significant Difference at P≤ 0.05 were used to separate the means.

RESULTS AND DISCUSSION

Initial physico-chemical properties of soil

Some important physio-chemical properties of the experimental soils are given in the Table 1. Initial soil characterization of the study site indicated strong acidity (pH 4.75) and low amounts of soil available P (less than 10 mg kg^{-1}) considered as critical for the soils suggest the need for supplemental P addition. This may be due to P fixation by Fe and Al oxides in acidic soils. According to the soil particle size analysis, the soil was classified as clay loam soil.

Effect of lime and phosphorous treatments on soil pH

Changes in soil pH after application of lime and P are depicted in Table 2. Results showed that soil pH significantly increased with increase in lime application levels. The pH of the initial soil was 4.75 which increased up to 5.4 and 6.4 respectively, at the end of the incubation period for the 1 000 kg (CaCO$_3$) ha^{-1} and 2 000 kg (CaCO$_3$) ha^{-1} lime treated soil.

Decrease in soil pH was achieved with TSP alone which was slightly below the control. These results are in agreement with the findings of Tisdale *et al.,* (1990) who reported that phosphoric acid released from dissolving phosphatic fertilizers can temporarily acidify the localized zones of application. They also found that TSP could lower the pH to as low as 1.5 while mono ammonium phosphate (MAP) could decrease pH to approximately 3.5. This acidification is temporary condition and it rapidly neutralized, but the acidic reaction products may remain to influence the soil properties indicating the need for liming especially for such acid soils as an agronomic practice.

However, a significant reduction in soil pH was observed, when the incubation progressed. A similar reduction of the soil pH with the increase of incubation period was earlier reported by Anetor and Akinrinde (2007). The highest pH (6.53) was observed

Table 2: Effect of lime and phosphorous treatments on soil pH

Treatment	Weeks of incubation				
	1st	3rd	5th	7th	10th
L_0P_0	4.73±0.01	4.68±0.02	4.62±0.02	4.56±0.01	4.55±0.02
L_0P_1	4.65±0.03	4.61±0.01	4.59±0.04	4.56±0.02	4.54±0.03
L_0P_2	4.63±0.02	4.60±0.02	4.58±0.03	4.55±0.006	4.52±0.02
L_1P_0	5.54±0.02	5.49±0.01	5.47±0.01	5.46±0.02	5.45±0.02
L_1P_1	5.53±0.02	5.48±0.017	5.46±0.02	5.44±0.02	5.43±0.03
L_1P_2	5.52±0.02	5.48±0.02	5.44±0.02	5.42±0.02	5.41±0.02
L_2P_0	6.53±0.02	6.51±0.02	6.50±0.02	6.48±0.02	6.48±0.01
L_2P_1	6.52±0.02	6.51±0.02	6.50±0.01	6.48±0.01	6.47±0.02
L_2P_2	6.51±0.01	6.50±0.01	6.48±0.02	6.47±0.01	6.47±0.03
LSD Value	0.023	0.021	0.030	0.018	0.031

in the soil amended with the rate of 2 000 kg ($CaCO_3$) ha^{-1} after first week of incubation. Liming at 1 000 kg ($CaCO_3$) ha^{-1} represented inadequacy of lime application that did not completely ameliorate soil acidity, as pH values of 5.41-5.53 were still indicative of acid conditions.

Effect of lime and phosphorous treatments on extractable P

Effect of different treatments on Olsen, Bray and Kurtz-1 and Borax extractable P are shown in Table 3, 4, and 5, respectively. Both lime and TSP had significant effects (P< 0.001) on P availability at three soil test P extraction methods. The amount of available P extracted with Borax, Olsen and Bray and Kurtz-1 methods ranged from 3.42 to 42.42 mgkg^{-1}, 8.06 to 50.33 mg kg^{-1} and 5.63 to 66.69 mgkg^{-1}, respectively. The highest available P in the soil was noticed with the application of lime at 2 000 kg ($CaCO_3$) ha^{-1} at all the extraction methods. Bray and Kurtz-1 method extracted the largest amount of P (5.63 to 66.69 mg kg^{-1}) while Borax extracted the smallest amount (3.42 to 42.42 mg kg^{-1}). The mean extractable P in soils was found to be in the order of Borax<Olsen<Bray and Kurtz-1.

In all soil samples where TSP was added, there was an increase in Borax, Olsen and Bray and Kurtz -1 extractable P levels and that was in agreement with other works, in-

cluding that of Waigwa et al. (2003) and Deraoui et al. (2015). In the limed soils with no P addition, too resulted in a small increase in P concentration. This result reveals that lime alone may too increase P level. According to Opala et al. (2010) and Essington (2004), liming is related to reduce exchangeable Al and this alone may benefit plant growth as much as added P.

In Tables 3, 4 and 5, soil available P levels decreased with the incubation time. This result is comparable with the results that reported by Anetor and Akinrinde (2007) and Deraoui et al. (2015). Higher P levels were observed in the treatments where only TSP was added than in the treatments where only lime was added. It is clear that available P was sharply reduced by application of lime at the rate of 2 000 kg ($CaCO_3$) ha^{-1}, without adding TSP. This may due to the precipitation of P ions in the soil with Ca as calcium phosphate. Precipitation of insoluble calcium phosphate can be decrease phosphate availability (Oluwatoyinbo et al.,2005). This finding further suggests that adding liming at high rates without adding P fertilizers will not be suitable for low phosphorous acidic soils.

Effect of lime and phosphorous treatments on organic matter content

Effect of organic matter content of the experimental soils is shown in the Table 6. In all

treatments, organic matter content is decreasing with the incubation period. But different treatments have different levels of organic matter contents in the same week of incubation. Least organic matter content could be observed at the 10th week of incubation, in the soils were treated with lime at the rate of 2000 kg $(CaCO_3)$ ha^{-1}. The soils which were untreated had the highest level of organic matter content. It reveals that, in the soils for which lime was not added, low rates of organic matter decomposition has been occurred. According to Bolan *et al.* (2003) in highly acid conditions, organic matter accumulates giving rise to vast storehouse of nutrients that can be exploited by liming. As described by Alex-

Table 3: Effect of lime and phosphorous treatments on available phosphorous content (mg Kg^{-1}) extracted with Olsen P

Treatment	Weeks of incubation				
	1st	3rd	5th	7th	10th
L_0P_0	9.62±0.72	9.63±0.31	9.73±0.76	8.06±0.65	8.35±0.47
L_0P_1	16.75±0.27	20.03±0.76	13.37±1.43	11.50±0.98	10.72±0.77
L_0P_2	18.18±0.72	19.33±0.91	20.94±0.88	17.10±3.23	16.48±0.93
L_1P_0	10.26±0.95	17.51±1.82	14.48±0.30	10.43±1.63	10.10±0.47
L_1P_1	16.74±0.55	19.72±1.67	14.98±0.63	11.07±3.18	10.41±0.47
L_1P_2	22.45±0.99	24.17±1.09	17.40±0.46	16.24±2.61	15.55±0.61
L_2P_0	11.21±0.95	10.74±0.92	9.53±0.35	8.28±1.49	8.25±0.47
L_2P_1	26.10±1.19	34.47±0.61	18.31±1.55	13.22±3.35	11.54±0.93
L_2P_2	39.24±0.95	50.33±0.76	42.86±0.76	20.97±1.29	13.80±1.43
LSD Value	1.208	1.536	1.270	3.220	1.119

Table 4: Effect of lime and phosphorous treatments on available phosphorous content (mg Kg^{-1}) extracted with Bray and Kurtz-1

Treatment	Weeks of incubation				
	1st	3rd	5th	7th	10th
L_0P_0	9.77±0.18	9.85±0.45	10.58±0.85	11.76±0.34	6.54±0.26
L_0P_1	17.09±0.49	18.30±1.14	15.01±0.17	13.93±0.60	7.44±0.69
L_0P_2	18.27±0.65	20.41±0.26	17.18±0.30	16.78±0.61	14.98±0.27
L_1P_0	10.52±0.85	12.27±0.69	9.70±0.68	9.01±0.45	5.63±0.69
L_1P_1	19.03±0.81	20.56±0.94	19.83±1.07	18.46±0.45	17.84±0.94
L_1P_2	39.91±2.26	41.21±1.14	21.80±1.23	19.83±0.51	19.65±0.52
L_2P_0	11.60±0.67	8.35±0.94	7.53±0.45	7.14±1.19	5.63±0.69
L_2P_1	38.83±0.49	43.17±0.94	18.85±1.19	10.68±0.30	8.80±1.39
L_2P_2	55.08±1.29	66.69±1.83	50.64±2.83	30.95±0.68	21.31±1.14
LSD Value	1.458	1.443	1.583	0.880	1.150

ander (1977) acidity, virtue of governing the type, number and activity of microorganisms, regulates the rate of organic matter minerali-zation.

Effect of lime and phosphorous treatments on NO_3^- - N content

Effect of liming on availability of nitrate ni-trogen is shown in the Table 7. It reveals that with the increase of the incubation period, nitrate nitrogen level is also increasing in all soils. And significantly, the highest nitrate nitrogen level could be seen at the liming rate of 2000 kg $(CaCO_3)$ ha[-1] in the 7th week of incubation. Soils which have untreated also show a little increase in the nitrate nitrogen level with the time of incubation. But when comparing with the soils with two liming rates, nitrate nitrogen is significantly low with each week of incubation.

According to Windsor (1958) and Nyborg and Hoyt (1978), increasing the pH of acid soils by liming resulted in increased N mineraliza-tion. As described by Alexander (1977) nitri-fication can be inhibited at low pH, however, there is no clear relationship between nitrifi-cation rate and soil pH.

Effect of lime and phosphorous treatments on NH_4^+ - N content

Effect of liming on availability of ammonium nitrogen is described in the Table 8. Highest ammonium nitrogen levels can be seen in the soils which were untreated. In most of the weeks of incubation, soils which were treated with lime show significantly lower ammoni-um nitrogen levels than untreated soils. The soils which were treated at the lime rate of 1000 kg (CaCO3) ha^{-1} show significantly higher ammonium nitrogen levels when com-paring with the soils which were treated with lime at the rate of 2000 kg (CaCO3) ha^{-1}.
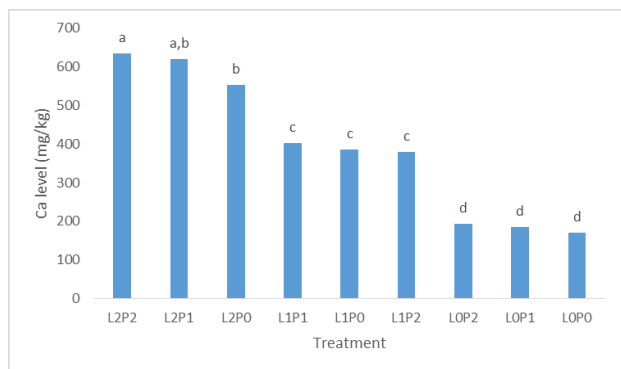

Figure 1. Effect of lime and phosphorous treatments on calcium content of soil

Table 5: Effect of lime and phosphorous treatments on available phosphorous content (mg Kg^{-1}) extracted with Borax P

Treatment	Weeks of incubation				
	1st	3rd	5th	7th	10th
L_0P_0	3.61±0.41	5.76±0.34	7.19±0.50	9.03±0.53	6.69±0.36
L_0P_1	14.53±0.42	13.65±0.70	16.12±0.49	8.79±0.60	6.92±0.20
L_0P_2	15.25±1.10	23.98±0.39	16.01±0.65	12.88±1.07	10.20±0.61
L_1P_0	4.33±0.55	7.20±0.84	9.77±0.49	7.27±1.07	7.16±0.20
L_1P_1	13.69±0.21	22.09±1.00	13.27±0.50	8.91±0.53	8.56±1.76
L_1P_2	20.77±1.08	23.53±0.69	22.58±0.19	12.53±0.73	11.13±0.40
L_2P_0	3.73±0.55	6.65±0.83	4.82±0.19	3.65±0.53	3.42±0.53
L_2P_1	29.78±0.72	32.31±1.07	17.41±0.67	14.99±0.53	11.71±0.88
L_2P_2	36.02±1.46	42.42±0.67	35.17±0.99	19.31±0.71	13.70±0.93
LSD Value	1.159	1.078	0.802	1.040	1.134

In general, ammonium nitrogen is nitrified more rapidly on addition of lime due to the increase in the activity of microorganisms involved in nitrification (Lyngstad, 1992; Puttanna *et al.,* 1999). The efficiency of nitrification inhibitors decreases with the addition of lime. This is probably due to an increase in nitrifier activity and also due to an increase in general microbial activity (Slangen and Kerkhoff, 1984).

Effect of lime and phosphorous treatments on calcium content

Effect of liming on availability of Calcium in the experimental soil is described in the Figure 1. Levels of Calcium in the soil significantly different only with the rate of liming. Time of incubation did not significantly affect the levels of Calcium in the experimental soil. The highest level of the Calcium was observed at the lime rate of 2 000 kg ($CaCO_3$) ha^{-1}. Untreated soil had the least level of Calcium.

Table 6: Effect of lime and phosphorous treatments on organic matter content (%) of soil

Treatment	Weeks of incubation				
	1st	3rd	5th	7th	10th
L_0P_0	1.81±0.05	1.62±0.03	1.56±0.01	1.48±0.03	1.17±0.06
L_0P_1	1.86±0.06	1.66±0.05	1.56±0.02	1.46±0.05	1.13±0.03
L_0P_2	1.81±0.05	1.64±0.08	1.53±0.06	1.49±0.08	1.17±0.06
L_1P_0	1.59±0.05	1.46±0.03	1.25±0.09	1.17±0.08	0.99±0.11
L_1P_1	1.65±0.05	1.43±0.08	1.23±0.02	1.14±0.08	0.93±0.01
L_1P_2	1.57±0.08	1.41±0.08	1.38±0.08	1.17±0.03	0.95±0.05
L_2P_0	1.42±0.03	1.28±0.08	1.11±0.03	0.88±0.03	0.54±0.08
L_2P_1	1.42±0.07	1.19±0.05	1.11±0.12	0.83±0.03	0.54±0.03
L_2P_2	1.41±0.07	1.17±0.06	1.16±0.08	0.87±0.06	0.54±0.08
LSD Value	0.081	0.088	0.093	0.080	0.097

Table 7: Effect of lime and phosphorous treatments on NO_3^- - N content (mg Kg^{-1}) of soil

Treatment	Weeks of incubation				
	1st	3rd	5th	7th	10th
L_0P_0	11.13±1.38	20.81±0.76	26.08±1.33	28.37±1.56	31.37±0.63
L_0P_1	11.93±0.35	20.77±1.42	25.59±1.11	28.49±0.17	30.15±1.04
L_0P_2	11.19±0.56	22.46±1.82	26.58±1.22	29.23±0.24	30.40±1.24
L_1P_0	19.98±2.20	59.28±0.58	62.36±2.04	64.41±0.75	66.19±7.68
L_1P_1	19.36±5.10	57.52±0.13	62.00±1.05	64.07±0.35	65.56±1.08
L_1P_2	20.06±6.53	57.78±0.70	61.69±2.22	64.65±0.36	65.04±2.25
L_2P_0	24.46±1.16	69.06±0.50	72.78±1.26	73.54±1.24	74.82±2.94
L_2P_1	24.57±1.35	67.81±0.73	73.11±1.09	74.46±1.43	73.77±2.57
L_2P_2	24.42±3.44	68.12±0.59	72.98±1.58	74.48±0.43	73.53±1.02
LSD Value	4.498	1.323	2.109	1.258	4.333

According to Bolan *et al.* (2003) liming materials supply Ca and Mg to soil and one of the primary purposes of liming is to overcome the deficiency of basic cations. And also he further described an increase in pH through liming increases the net negative charge, thereby increasing the adsorption of cations; and an increase in Ca in soil solution through liming is likely to decrease the adsorption of other cations.

CONCLUSION

The highest pH value was given at the liming rate of 2 000 kg($CaCO_3$) ha^{-1} in the 1st week of incubation. Combination of 2 000 kg($CaCO_3$) ha^{-1} of lime and the TSP rate at 100 mg (P) kg^{-1} gave the highest phosphorous level in the 3rd week of the incubation irrespective of extractant used. This indicates that liming at 2 000 kg($CaCO_3$) ha^{-1} is required to completely ameliorate the acid condition of the experimental soil and optimum phosphorous level can be obtained at the liming rate of 2 000 kg ($CaCO_3$) ha^{-1} and at the TSP level of 100 mg (P) kg^{-1}. Bray and Kurtz-1 method is suitable for the extraction of P for this experimental soil as this method gave the highest levels of available P throughout the incubation period. Liming also helps to increase the decomposi-

tion of organic matter content of the soil and also it increases the availability NH_4^+- N and NO_3^--N in the soil.

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Table 8: Effect of lime and phosphorous treatments on NH_4^+ - N content (mg Kg^{-1}) of soil

Treatment	Incubation Weeks				
	1st	3rd	5th	7th	10th
L_0P_0	8.56±0.49	7.38±0.44	6.21±0.54	5.93±0.06	3.74±0.59
L_0P_1	8.63±0.82	7.58±0.33	6.55±0.89	5.75±0.01	3.73±1.10
L_0P_2	8.64±0.17	7.64±0.20	6.39±0.46	5.78±0.07	3.68±0.14
L_1P_0	8.16±0.56	6.22±0.78	5.59±0.37	4.68±0.04	2.32±0.62
L_1P_1	8.19±0.20	6.44±0.31	5.74±0.24	4.73±0.06	2.14±0.43
L_1P_2	8.19±0.46	6.77±0.49	6.12±0.27	5.00±0.03	2.01±0.65
L_2P_0	7.40±1.20	5.63±1.44	4.38±0.28	3.61±0.57	1.42±0.05
L_2P_1	7.94±0.58	5.99±1.81	4.87±0.34	4.10±0.21	1.98±0.29
L_2P_2	7.74±0.22	5.87±0.41	4.96±0.16	4.08±0.13	1.94±0.51
LSD Value	0.859	1.230	0.626	0.298	0.807

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