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Effect of single super phosphate and rock phosphate on nutrient uptake of paddy

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Abstract
A pot experiment was conducted in department of Soil Science and Agricultural Chemistry of College of Agriculture, Central Agricultural University, Imphal (Manipur) during kharif season of 2016, to study the effect of Single Super Phosphate (SSP) and Rock Phosphate (RP) on nutrient uptake of paddy (CAU-R1). Results revealed that phosphorus uptake increase up to 75 days with slight decline on 100 days and an increase at harvest. Comparatively higher P-uptake in T_6 (25% RD of P_2O_5 from SSP + 75% RD of P_2O_5 from RP, RD- Recommended Dose) which is at par with T_5 (50% RD of P_2O_5 from SSP + 50% RD of P_2O_5 from RP) and T_3 (100% RD of P_2O_5 from RP). T_4 (75% RD of from SSP + 25% RD of P_2O_5 from RP) shows comparatively higher accumulation of P-concentration in plant at different stages starting from 50th day up to harvest which is at par with T_6. Critical study of the data revealed more dry matter accumulation in paddy grown in T_6 added soil on 100th day and T_5 at harvest which are at par with T_5 and T_6, respectively.

Keywords: Nutrient uptake, single super phosphate, rock phosphate, paddy

Introduction
Rice (*Oryzasativa* L.) is the most widely consumed staple food for a large part of the world's human population, covering an area of 150 million ha with a production of 575 million tonnes. India is the largest rice growing country in terms of area and second in production but the average productivity is still low compare to many other countries. The low productivity is mainly due to use of low yielding varieties and improper fertilizer management. Phosphorus (P) is second most limiting plant nutrient after nitrogen in most of the soil for rice production. Application of phosphorus fertilizer is often necessary for rice production to meet our food security in future (Zhang *et al.* 2006) [15]. Considering the low recovery (less than 20%) of applied and native P and the high cost of chemical phosphatic fertilizers in addition to an increasing concern about environmental degradation, it is important to find viable source of P to increase fertilizer use efficiency. Increasing the P-uptake from applied P fertilizers and replacing the expensive chemical P fertilizers with novel, cheaper, more ecologically friendly but nevertheless efficient P source like rock phosphates can play vital role in this aspect. Soluble phosphate fertilizersuch as single or triple super phosphate has high cost which generated considerable interest in the utilization of rock phosphate (Nnadi and Haque, 1988; Chien and Hammond, 1989; Akande *et al.* 1998) [1, 3, 9]. The combined application of soluble P fertilizer with local rock phosphate significantly enhanced P uptake (Kundu and Basak, 1999; Ravi and Siddaramappa, 2000 and Xiong *et al.*, 2002) [7, 11, 14]. Increase in rock phosphate level can significantly increase the dry matter yield and P uptake by paddy (Poleshi *et al.* 2008) [10].

Materials and Methods
Soil Sampling and pot experiment
A pot experiment was carried-out during kharif season 2016 in the Rice Research Farm of the College of Agriculture, Central Agricultural University, Iroisemba, Imphal to study the effect of single super phosphate and rock phosphate on nutrient uptake of paddy. The location of the field experimented is situated at $24^0 45''$ N latitude and $93^0 56''$ E longitude with an elevation of 790m above the mean sea level. Soil type was clay loam in texture and acidic reaction having pH value of 5.5 (Length of day 12 h, day average temperature 29^0C, night average temperature 16^0C and humidity 77% in experiment duration). Recommended dose of fertilizers i.e. 60: 30: 30 N, P_2O_5, K_2O ha^{-1} were added before transplanting (15 days old seedling)

to all the pots(4 kg soil pot^{-1}) equally. Each pot was kept in submerged condition throughout the period of experiment maintaining water level at 5-10 cm above the soil surface. Treatments included in the pot experiment were T_1= Control, T_2= 100% Recommended Dose (RD) of P_2O_5 from SSP, T_3= 100% RD of P_2O_5 from RP, T_4= 75% RD of P_2O_5 from SSP + 25% RD of P_2O_5 from RP, T_5= 50% RD of P_2O_5 from SSP + 50% RD of P_2O_5 from RP, T_6= 25% RD of P_2O_5 from SSP + 75% RD of P_2O_5 from RP.

Methods adopted

Plant samples were digested in di-acid mixture of nitric acid and perchloric acid in 4:1 ratio and phosphorus content was analysed in the digested plant materials by vanadomolybdo phosphoric yellow colour method as described by Jackson (1973) [6]. The uptake of phosphorus was computed from the data on P concentration and dry matter yield using the formula

P uptake (mg $hill^{-1}$) = P conc.in plant (µg g^{-1}) x dry matter yield (g $hill^{-1}$) x$\frac{1}{1000}$

= P conc.in plant (mg g^{-1}) x dry matter yield (g $hill^{-1}$)

Statistical Analysis

The experiment was carried out under randomized block design (RBD). Altogether there were six treatment combinations replicated thrice. All the data pertaining to the investigation were statistically analysed through analysis of variance technique for comparing the treatments effects as described by Gomez and Gomez (1984). The significance of various effects was tested at 5% level of probability.

Results and Discussion

P concentration in plant

Results revealed that irrespective of different treatments, there was an increase of P concentration on 25th day with decline up to 100th day and slight increase at harvest (Table 1). Exhibition of P decline with crop age was also reported earlier by Liu and Zhu (1996) [8]. All phosphorus applied treatments shows significantly higher total-P accumulation over control. Similar reports on higher P concentration in rice plants receiving P sources was also presented by White *et al*. (1999) [13] and Banerjee and Pramanik (2009) and Vandamme *et al*. (2016) [12]. Soil fertilized with 75% SSP+25% RP shows comparatively higher accumulation of total P at different stages starting from 50th day up to harvest which is at par with 25% SSP+75% RP.

Dry matter yield

Results showed that irrespective of different treatments, there was an increasing trend of dry matter of paddy up to harvest (Table 1) as reported by Liu and Zhu (1996) [8]. All phosphorus treated soil gave significantly higher dry matter yield of paddy over untreated control at different stages of crop growth. This is at par with the findings of Poleshi *et al*. (2008) [10] and Banerjee and Pramanik (2009). Among the different treatments, significantly (p=0.05) higher dry matter of paddy was recorded in soil applied with 50% SSP+50% RP on 50th day followed by 25% SSP+75% RP. Critical study of the data revealed more dry matter accumulation in paddy grown in 25% SSP+75% RP added soil on 100th day and 50% SSP+50% RP at harvest which are at par with 50% SSP+50% RP and 25% SSP+75% RP, respectively.

P-uptake

Results revealed that irrespective of treatments there was an increasing trend of phosphorus uptake by paddy up to harvest (Table 1). Rice absorbed P nutrient during its whole growth duration. No matter the different uptake amount due to the P supply, rice plant generally had the greatest P nutrient uptake from tillering stage to elongation stage, and along with the rise of the rice dry matter, amount of P uptake was gradually increased (Liu and Zhu, 1996) [8]. Critical study pointed out that significantly (p=0.05) greater phosphorus uptake was observed in paddy grown in SSP and RP fertilized soil over the untreated control as reported by Goswami and Baroova (1998); Ravi and Siddaramappa (2000) [11]; Xiong *et al*. (2002) [14]; Poleshi *et al*. (2008) [10] and Banerjee and Pramanik (2009). Data further showed comparatively higher phosphorus uptake by paddy grownin soil added with 50% SSP + 50% RP which is at par with 100% RP on 50th day. However, on 75th and 100th days, comparative higher phosphorus uptake was observed in 25% SSP+75% RP added soil showing parity with 100% RP and 50% SSP+50% RP, respectively. At harvest, significantly (p=0.05) higher phosphorus uptake was found in 50% SSP+50% RP fertilized soil which is at par with 100% RP. Reports on higher P uptake by paddy due to combined application of SSP and RP were also given by Bhardwaj *et al*. (1996) [2].

Table 1: Changes in P concentration (mg g-1), Dry matter yield (g hill-1) and Phosphorus uptake (mg hill-1) by paddy grown in soil fertilized with single super phosphate and rock phosphate

Treatments	P concentration (mg g^{-1})					Dry matter yield (g $hill^{-1}$)					Phosphorus uptake (mg $hill^{-1}$)				
	25 DAT	50 DAT	75 DAT	100 DAT	Harvest	25 DAT	50 DAT	75 DAT	100 DAT	Harvest	25 DAT	50 DAT	75 DAT	100 DAT	Harvest
T_1	2.82	3.60	2.79	2.23	3.22	6.17	10.47	16.13	23.27	26.83	17.40	37.65	45.03	51.84	86.43
T_2	3.18	3.76	3.44	2.88	3.46	7.17	12.20	19.57	26.40	29.87	22.80	45.92	67.23	76.16	103.39
T_3	3.14	3.77	3.54	2.91	3.66	7.60	13.63	20.37	28.17	32.40	23.86	51.37	72.06	82.06	118.51
T_4	3.09	3.89	3.62	3.01	3.69	8.03	12.80	19.67	27.10	30.53	24.80	49.85	71.10	81.61	112.68
T_5	3.10	3.76	3.56	2.97	3.59	8.17	13.73	19.87	28.23	33.67	25.34	51.64	70.69	83.87	120.94
T_6	3.21	3.88	3.57	2.99	3.63	7.73	12.83	20.40	28.33	32.57	24.79	49.83	72.92	84.75	118.19
S.E.d(±)	0.06	0.07	0.06	0.05	0.07	0.14	0.23	0.36	0.50	0.57	0.44	0.89	1.25	1.43	2.03
CD(p=0.05)	0.13	0.16	0.14	0.12	0.15	0.32	0.52	0.80	1.11	1.27	0.97	1.98	2.78	3.19	4.51

T_1= Control, T_2= 100% Recommended Dose (RD) of P_2O_5 from SSP, T_3= 100% RD of P_2O_5 from RP, T_4= 75% RD of P_2O_5 from SSP + 25% RD of P_2O_5 from RP, T_5= 50% RD of P_2O_5 from SSP + 50% RD of P_2O_5 from RP, T_6= 25% RD of P_2O_5 from SSP + 75% RD of P_2O_5 from RP, DAT= Days after transplanting.

Conclusion

Comparing with the untreated control all phosphorus treated soil gave significantly higher P concentration, dry matter yield, P uptake at different stages of crop growth. Irrespective of different treatments, there was an increase in P concentration in paddy on 25th day with decline up to 100th day and slight increase at harvest. Rice absorbed P nutrient during its whole growth duration. No matter the different uptake amount due to P supply, amount of P uptake was gradually increased along with the increase of the paddy dry matter yield. Comparatively higher P uptake in T_5 which is at par with T_3 was also observed. Finally it should be noted that RP is poorer source of P but its effectiveness increases when combined with SSP and further studies are needed to be taken up under various management practices on number of soils.

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