International Journal of Science, Environment and Technology, Vol. 5, No 5, 2016, 3309 – 3319

ISSN 2278-3687 (O)
2277-663X (P)

EFFECT OF DOSE AND TIME OF APPLICATION OF PHOSPHOROUS ON YIELD AND ECONOMICS OF RICE GROWN ON P ACCUMULATED SOIL

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Abstract: A field experiment was conducted in sandy clay loam soil during *kharif* 2015 to study the effect of different levels of phosphorus and its time of application on yield and economics of rice. As part of this investigation, a survey was carried out during May, 2015 from 50 rice growing farmers to identify the farmer's practice of dose and time of P application. Based on the survey data, the average of 50 farmers P fertilizer dose (85 kg P_2O_5 ha^{-1}) was fixed as 100 % farmer's dose and majority of the farmers practice *i.e.* two equal splits at basal and at top dressing at early tillering stage (14 to 20 DAT) was decided as farmer practice of splits for conducting field experiment on rice in P accumulated soil. The crop has given good response to application of 100 % farmers dose of P (85 kg P_2O_5 ha^{-1}) but at the same time which was found to be on par with the application of 100 % RDP (60 kg P_2O_5 ha^{-1}), 75 % farmers dose (64 kg P_2O_5 ha^{-1}) and 75 % RDP (45 kg P_2O_5 ha^{-1}). This can be inferred as saving of P fertilizer to rice from current recommended dose and farmer's dose in soils having higher initial available P. The benefit cost ratio obtained with application of P in two equal splits was more or less equal when compared to complete P as basal at puddling before transplanting of rice grown in P accumulated soil.

Keywords: Phosphorous, Time, Dose, Rice, Yield, Economics

INTRODUCTION

Crop utilization of applied fertilizer phosphorus is generally low due to sorption and precipitation reactions in soils. Consequently, a large accumulation of phosphorus takes place over the years, particularly in the soils that receive regular and liberal rates of P applied to each crop in a cropping system. The long-term fertilization experiments conducted across the country have clearly demonstrated the accumulation of phosphorus in the soils of different types, in spite of using recommended fertilizer doses (Nambia, 1994). This is mainly because the applied P is usually fixed very quickly and is being retained in the top layers of the soil leading to slow and steady saturation of P-fixation sites on the soil. Under these

*Received Sep 13, 201 * Published Oct 2, 2016 * www.ijset.net*

circumstances, it is necessary to ascertain the requirement of P on such soil to crops not only to reduce the cost of chemical P fertilizer input from the current level of general recommendation but also to avoid any nutritional imbalances that might arise due to excess P availability (*e.g.* zinc).

The availability of P to rice grown on submerged soils depends on dose of fertilizers and time of fertilizer application. The rice growing farmers in many regions applying P fertilizer in split doses through complex fertilizers because they perceive that plants require P throughout the crop growth period like nitrogen. However, according to many researches, application of P at the time of transplanting is the recommended practice for paddy. Moreover, farmers do not pay much attention on time of phosphorus fertilizers application resulting in low phosphorus use efficiency. But more often, due to various reasons, it is not always possible to apply the entire P at the time of transplanting as required. Under such circumstances, it is appropriate to know whether split applications of P or delayed application is permissible without any loss in yield, P use efficiency and its economy in these P accumulated soils. Keeping in view, the significance of optimum level and time of application for improving the soil phosphorus availability and yield of rice, present experiment was planned to study the phosphorous requirement and its time of application to rice grown on P accumulated soil.

MATERIALS AND METHODS

As part of this investigation, a survey was conducted on May, 2015 from 50 rice growing farmers from different villages of Nizamabad district, to identify the way of farmers applying fertilizers including farmer's practice of dose and time of P application. Based on the survey data, treatments were decided for conducting field experiment on rice in P accumulated soil. Soil samples were collected from rice growing soils of Nizamabad district. A total of 50 soil samples were collected at the same geo-reference sites for characterizing soil nutrient status.

A field experiment was conducted during *kharif* 2015 with rice (*Var.*, BPT 5204) at Regional Sugarcane and Rice Research Station, Rudrur, Nizamabad District, Telangana. As per title of experiment we have selected phosphorus accumulated soil for conducting field experiment on rice. The experimental site was sandy clay loam in texture. The soil was slightly alkaline in reaction and non-saline in nature. It was low in organic carbon and available nitrogen and high in available phosphorus and potassium. The experiment was laid out in Randomized Block Design with factorial concept consisting of twelve treatment combinations with six levels of phosphorus viz., P_1 (100% Farmers dose of P), P_2 (75% of Farmers dose of P), P_3 (50% of Farmers dose of P), P_4 (100% RDP), P_5 (75% RDP) and P_6

(50% RDP) and its time of application viz., T_1 (No. of splits as per farmers practice) and T_2 (Basal Application). A common dose of N and K_2O was applied to all the treatments. The details of the treatment combinations and amount of P fertilizers applied under different treatments are presented in Table 1.

Table 1: Phosphorus nutrient use under different treatments

Treatments	Total P_2O_5 applied (kg ha^{-1})		
	Basal	Topdressing	Total
P_1 T_1	42.50	42.50	85.00
P_1 T_2	85.00	-	85.00
P_2 T_1	32.00	32.00	64.00
P_2 T_2	64.00	-	64.00
P_3 T_1	21.25	21.25	42.50
P_3 T_2	42.50	-	42.50
P_4 T_1	30.00	30.00	60.00
P_4 T_2	60.00	-	60.00
P_5 T_1	22.50	22.50	45.00
P_5 T_2	45.00	-	45.00
P_6 T_1	15.00	15.00	30.00
P_6 T_2	30.00	-	30.00

RESULTS AND DISCUSSION

Current Status of Fertilizer Use by Rice Growing Farmers

The fertilizer use trends in the surveyed region indicated that, the total (N, P_2O_5 and K_2O) fertilizer use by farmers was highest in all the villages, with an average of 132, 85 and 76 kg N, P_2O_5 and K_2O kg ha^{-1} (Table 2). The recommended NPK fertilizer application rate for rice is 120-60-40 kg N, P_2O_5 and K_2O ha^{-1}, respectively. Thus, application of NPK fertilizers is higher than crop demand. These results also indicated that application of phosphorus fertilizer by farmers was almost two times higher than the crop requirement. The difference in phosphorus application between farmers practice and recommended dose of phosphorus is about 25 kg P_2O_5 ha^{-1}, which is equal to 42 %. These results are in conformity with the findings of Swamy and Rao (1995) who have reported that more than half of the farmers

surveyed indicated that they were using increased rates of fertilizers inspite of higher costs of these materials.

This survey also revealed that, farmers applying are P fertilizer in split doses through complex fertilizers because they perceive that P is required throughout the crop growth period like nitrogen. However, according to many researches, application of P at the time of transplanting is the recommended practice for paddy. The survey indicated, majority of the rice growing farmers (44 %) in this area applying p fertilizers at basal and top dressing at early tillering stage. Whereas 26, 10, 10, 6, and 4 % of the farmers applying P fertilizers at basal, basal + mid tillerig, basal+mid tillering + panicle initiation, basal + early tillering + panicle initiation and basal + panicle initiation stages, respectively.

The average of 50 farmer's phosphorus fertilizer application dose *i.e.* 85 kg P_2O_5 ha^{-1} was described as 100 % farmer's dose of P fertilizer application for conducting field experiment on rice in P accumulated soil. With respect to time of P fertilizer application, majority of the farmer's practice two equal splits at basal and at top dressing at early tillering stage (14 to 20 DAT) was decided as per the objective laid out in the experiment.

Table 2. Current status of fertilizer use by rice growing farmers of different villages of Nizamabad District

S.No.	Name of the Farmer	Name of the Village	Farmer Practice of NPK			Details of splits
			N	P_2O_5	K_2O	
1	A. Pedda Ganga Reddy	Chepoor	116	80	78	Basal+ ET
2	V. Chinnaiah	Mamidipally	103	115	75	Basal
3	V. Gangadhar	Chepur	88	80	78	Basal+ ET
4	S. Ashok	Pipri	133	75	75	Basal
5	R. Raju	Manthani	132	115	75	Basal + ET
6	N. Ganga Reddy	Degam	113	105	40	Basal+ MT
7	P. Srinivas	Machharla	142	60	38	Basal+ PI
8	G. Bajanna	Mamidipally	130	120	150	Basal+ ET
9	G. Gangaram	Padkal	128	75	78	Basal+ ET
10	G. Srinivas	Armoor	130	50	115	Basal+ET+PI
11	M. Shivanna	Perkit	142	80	40	Basal+ET
12	A. Linganna	Padkal	138	92	78	Basal+ET

13	Y Raja Reddy	Argul	135	75	78	Basal+MT+PI
14	A. Srinivas	Aloor	142	105	38	Basal
15	Ch. Chinnaiah	Anksapur	145	115	113	Basal+ ET
16	P. Ghanesh	Padkal	124	46	40	Basal+ MT
17	J D Jagadeesh	Chepur	112	105	40	Basal
18	G Satyam Reddy	Argul	142	115	78	Basal+ ET
19	S Raja Reddy	Argul	126	112	38	Basal+ ET
20	T Gangadhar Rao	Rudrur	118	68	40	Basal
21	N Srenivasa Rao	Varni	98	80	78	Basal+ ET
22	V. Rajendra Prasad	Sevalaltanda	108	88	113	Basal+ ET
23	D Lingam	Boppapur	135	72	115	Basal+MT+PI
24	SK Latif	Nasurullabad	132	75	78	Basal+MT+PI
25	Kasiram	Bommandev pally	128	80	115	Basal
26	S Srikanth	Thimmapur	158	60	38	Basal+ ET
27	P Potha Reddy	Nemli	145	62	78	Basal
28	Hanma goud	Hunsa	126	80	112	Basal+ ET
29	Venkateswara Rao	Pantakurthi	118	58	72	Basal+ ET
30	Santhosh	Koyyagutta	145	68	78	Basal+ MT
31	Hanmandlu	Borlam	136	115	78	Basal
32	Ravindra Babu	Venkatapur	142	75	40	Basal+ET+PI
33	D Bhrahmam	Deshaipet	142	80	38	Basal
34	N Balraj	Beerkur	136	128	40	Basal+ ET
35	N Sailu	Kistapur	116	115	78	Basal+ ET
36	Arjun Rao	Ranampally	88	64	113	Basal+ MT
37	A Balaji	Suddulam	146	115	78	Basal
38	S Srinivas Yadav	Kotagiri	105	60	40	Basal+ET+PI
39	Sudhakar Patel	Potangal	142	80	38	Basal+ PI
40	N. Gangadhar	Hangargav	138	80	78	Basal+MT+PI
41	Ranga Babu	Karegam	152	75	78	Basal+ ET

42	Ch. Nagaiah	Jankampet	164	54	115	Basal
43	P. Maruthi	Pocharam	162	115	115	Basal+ ET
44	Veeraju	Bapunagar	156	64	78	Basal
45	D Srinivas	Jamalam	126	105	38	Basal+ ET
46	Moulana	Oddepally	120	80	150	Basal+ PI
47	Murali	Brahmanapally	152	48	78	Basal
48	Sudhakar Rao	Pitlam	146	115	113	Basal+ ET
49	Balaraju	Darmaram	132	75	38	Basal+MT+PI
50	M Raghupati Reddy	Burnapoor	135	80	115	Basal+ ET
		Average	**132**	**85**	**76**	

ET: Early Tillering MT: Maximum Tillering PI: Panicle Initiation

Grain and Straw Yield (t ha^{-1})

The results revealed that there was significant increase in rice grain and straw yield with application of different levels of phosphorus. However, time of application of phosphorus and their interaction effects were found to be non-significant. The mean grain yield of the crop was highest (6.41 t ha^{-1}) when 100 % farmers dose of P was supplied to the crop but at the same time it was found to be on par with the application of 100 % RDP (6.38 t ha^{-1}), 75 % farmers dose (6.37 t ha^{-1}) and 75 % RDP (6.34 t ha^{-1}). Lower grain yield was recorded in 50 % RDP (5.83 t ha^{-1}) which was significantly lower than the rest of the treatments (Table 3&4).

The data also indicate that, the yield level that could be achievable with 100 % farmers dose of P (85 kg P_2O_5 ha^{-1}) to P accumulated soil can be obtained with a lower dose of 75 % RDP (45 kg P_2O_5 ha^{-1}) supplied to the same crop and thus saving 40 kg of cost of P input in P accumulated soil. These observations point out that, there is a possibility of reducing the farmer's dose and recommended dose of P by 40 kg (48 % of farmer's dose) and 15 kg (25 % of RDP) P_2O_5 ha^{-1}, respectively without sacrificing the yield of rice crop grown on P accumulated soils. The results of this finding also corroborate earlier finding of Babu *et al.* (2004), Kumar *et al*. (2015) and Meena *et al.* (2014). Higher yields associated with higher levels of P are obviously due to better root growth and increased uptake of nutrients favoring better of the crop.

With respect to time of P application, farmers practice of P *i.e.,* two equal splits at basal and top dressing at early tillering stage (14 to 20 DAT) along with first top dressing of N after the first weeding recorded highest grain and straw yield (6.27 and 7.55, t ha^{-1}, respectively) which was on par with complete P as basal application (6.21 and 7.51 t ha^{-1}, respectively). Based on the results, it can be inferred that, P is more absorbed in first 20 DAT for root growth and penetration. The P absorbed during the early tillering stage of long duration rice var. BPT 5204 was more efficiently utilized for grain production. The results revealed that, soil having high P supplying capacity top dressing may be done without decrease in yield. This positive relationship of two splits of P was reported by Rao *et al.* (1973) at basal and 21 DAT, Ramaiah (1979) at basal and top dressing at 30 DAT and Budhar (1992) at basal and tillering stage. Similar positive results in three splits of P were reported by Singh *et al.* (1988) and Yadav *et al.* (2004) and four splits of P were reported by Thakur (1993). Non significant differences in grain yield due to split application were also reported by Balasubramanian *et al.* (1982), Sahu and Sahoo (1969) and Reddy *et al.,* (1984). The interaction of levels of P with its time of application found to be non significant.

Table 3. Effect of levels of phosphorous and its time of application on grain yield (t ha^{-1}) of rice.

Fertilizer Phosphorus Levels (t ha^{-1})	**Time of P Application**		**Mean**
	T_1: Farmer No. of splits	T_2: Basal Application	
P_1: 100 %Farmer dose (85 kg P_2O_5 ha^{-1})	6.43	6.39	6.41
P_2: 75 % of Farmers dose (63 kg P_2O_5 ha^{-1})	6.42	6.32	6.37
P_3: 50% of Farmers dose (42 kg P_2O_5 ha^{-1})	6.11	6.06	6.08
P_4: 100% RDP (60 kg P_2O_5 ha^{-1})	6.41	6.35	6.38
P_5: 75% RDP (45 kg P_2O_5 ha^{-1})	6.37	6.31	6.34
P_6: 50% RDP (30 kg P_2O_5 ha^{-1})	5.85	5.81	5.83
Mean	6.27	6.21	

	S.Ed±	**CD (0.05)**
P	0.08	0.17
T	0.05	N.S.
PXT	0.11	N.S.

Note: Farmer No. of Splits**:** 50 % Basal + 50 % at Early Tillering Stage

Table 4. Effect of levels of phosphorous and its time of application on straw yield (t ha^{-1}) of rice

Fertilizer Phosphorus Levels (t ha^{-1})	Time of P Application		Mean
	T_1: Farmer No. of splits	T_2: Basal Application	
P_1: 100 %Farmer dose (85 kg P_2O_5 ha^{-1})	7.70	7.65	7.67
P_2: 75 % of Farmers dose (63 kg P_2O_5 ha^{-1})	7.69	7.59	7.64
P_3: 50% of Farmers dose (42 kg P_2O_5 ha^{-1})	7.33	7.33	7.33
P_4: 100% RDP (60 kg P_2O_5 ha^{-1})	7.68	7.62	7.65
P_5: 75% RDP (45 kg P_2O_5 ha^{-1})	7.61	7.59	7.60
P_6: 50% RDP (30 kg P_2O_5 ha^{-1})	7.30	7.27	7.28
Mean	7.55	7.51	
	S.Ed±		**CD (0.05)**
P	0.06		0.13
T	0.03		N.S.
PXT	0.08		N.S.

Economics of Rice

The data pertaining to benefit cost ratio are presented in table 5&6. Among the phosphorus levels, the highest benefit cost ratio was noticed in P_5 (2.08) followed by P_4 (2.04), P_2 (2.02), P_3 (1.96), P_1 (1.95) and lowest was recorded under P_6 (1.90). With respect to time of P application, split application of P recorded highest benefit cost ratio (2.00) over basal application (1.98). Among the interaction effects, the highest gross and net returns and benefit cost ratio (98,367 Rs. ha^{-1}, 66,515 Rs. ha^{-1} and 2.09, respectively) were obtained with 75 % RDP in two equal splits at basal and at early tillering stage (P_5T_1) followed by 75 % RDP at basal application (P_5T_1). The lowest gross returns (90,064 Rs. ha^{-1}), net returns (58,873 Rs. ha^{-1}) and benefit cost ratio (1.89) were recorded with basal application of 50 % RDP (P_6T_2). The gross and net returns and benefit cost ratio obtained with application of P in two equal splits viz., basal and top dressing at early tillering stage was more or less equal when compared to complete P as basal at puddling before transplanting of rice grown in P accumulated soil.

The cost of P fertilizers applied (Rs./ha) in P_1 (100 % Farmers Dose) and P_5 (75 % RDP) were Rs.3740 and 1980/- respectively. This indicates that there is a significant difference in the cost of P fertilizers applied in P_1 and P_5 to the extent of Rs.1760/- per hectare. It could be noticed from the data that, application of 75 % RDP (45 kg P_2O_5 ha^{-1}) recorded at par grain yields in rice as that of 100 % farmers practice (85 kg P_2O_5 ha^{-1}) and there was a net savings in the cost of P fertilizers applied per hectare to the extent of Rs.1760/-. Similar results were obtained by Reddy and Ahmed (2000) who stated the possibility of saving of P fertilizers to the extent of 25 to 75 per cent on soils having high status of available P. The gross and net returns and benefit cost ratio were obtained with application of P in two equal splits viz., basal and top dressing at early tillering stage was more less equal when compared to complete P as basal at puddling before transplanting of rice grown in P accumulated soil. Similar results reported by Reddy *et al.* (1984) and Srujana *et al.* (2013).

This is clear from the fore going discussion that, though the rice yields were higher in treatments receiving 100 % farmer's dose of P, the benefit cost ratio was reduced due to high cost of P fertilizer applied to rice grown in P accumulated soil.

Table 5. Effect of levels of phosphorous and its time of application on benefit cost ratio of rice

Fertilizer Phosphorus Levels (t ha^{-1})	**Time of P Application**		**Mean**
	T_1: Farmer No. of splits	T_2: Basal Application	
P_1: 100 %Farmer dose (85 kg)	1.95	1.94	**1.95**
P_2: 75 % of Farmers dose (63 kg)	2.04	1.99	**2.02**
P_3: 50% of Farmers dose (42 kg)	1.97	1.95	**1.96**
P_4: 100% RDP (60 kg)	2.05	2.02	**2.04**
P_5: 75% RDP (45 kg)	2.09	2.06	**2.08**
P_6: 50% RDP (30 kg)	1.91	1.89	**1.90**
Mean	**2.00**	**1.98**	

Table 6. Economics of rice as influenced by different of levels of phosphorous and its time of application

Treatments	**Cost of Cultivation (Rs/-)**	**Gross Returns (Rs/-)**	**Net Returns (Rs/-)**	**BC Ratio**
P_1T_1	33611	99217	65606	1.95

P_1T_2	33611	98687	65075	1.94
P_2T_1	32643	99159	66515	2.04
P_2T_2	32643	97592	64949	1.99
P_3T_1	31719	94289	62570	1.97
P_3T_2	31719	93640	61921	1.95
P_4T_1	32511	99007	66495	2.05
P_4T_2	32511	98095	65583	2.02
P_5T_1	31851	98367	66515	2.09
P_5T_2	31851	97452	65601	2.06
P_6T_1	31191	90617	59426	1.91
P_6T_2	31191	90064	58873	1.89

Cost of grain per kg =Rs.14.00
Cost of straw per kg = Rs. 1.2

Cost of nitrogen per kg = Rs.12.26
Cost of phosphorus per kg = Rs.44.0
Cost of potassium per kg = Rs.30.0

CONCLUSIONS

The results on grain yield and economics of rice concluded that, there is a possibility of saving of P fertilizers from current recommended dose and farmer's dose without sacrificing the yield of rice crop grown on P accumulated soils. Hence the application of 75 % RDP may be recommended for rice grown in P accumulated soil under Nizamabad condition. With respect to time of P application, the split application also be followed successfully in rice crop without any adverse effect on grain yield of rice grown in P accumulated soil.

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