SPLIT APPLICATION OF MURIATE OF POTASH AND SULPHATE OF POTASH ON GROWTH, YIELD ATTRIBUTES, UPTAKE AND AVAILABILITY OF NUTRIENTS IN LOWLAND RICE CV. PY-5

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ABSTRACT

Field experiments were conducted in Typic Chromusterts of the experimental farm of the Annamalai University, Tamil Nadu, India to study the split application vis-a-vis customary full dose/basal application of different Potassic fertilizers viz: muriate of potash (MOP) and sulphate of potash (SOP) on rice. The soil was low in available N, medium in available P, high in available K and low in available S. Results showed that split application of potassium was found to be better than entire basal application. Application of 50 per cent K_2O each at tillering and panicle initiation stages increased the growth and yield attributes of rice and N, P, K and S uptake. Similarly it has a positive impact on available potassium and sulphur. However, available nitrogen and phosphorus was higher in treatment where the entire application of K was done as basal. Among the sources tried, MOP was superior to SOP.

Key words: *Basal, Split application, MOP, SOP*

INTRODUCTION

Potassium is the third essential plant nutrient after N and P, which has assured importance as a fertilizer in most of the countries of the world, but its consumption is still lower than N or P. This is because the response ratio of K is lower than that of N and P (Steineck, 1974). Potassium is linked with all phenomena of plant physiology either directly or indirectly viz., photosynthesis, respiration, metabolism of fats, carbohydrates and nitrogenous compound, enzyme activation, cell elongation and water use efficiency (Ghosh *et al.*,1995). Crops like rice (*Oryza sativa L.*) require potassium throughout its growth period but with varying intensity. Acute shortage of potassium during critical period of growth affects the yield of the crop. It is now believed that this may be due to wrong timing of potash application. To obviate the possibility, this acute shortage of K, timely application of potassium is essential. It has therefore become important to know the amount and time of application of potassium. Hence, the present investigation was carried out to find the suitable time and proportion of application of potassium for the rice crop.

MATERIALS AND METHODS

The field experiments were conducted in the field Q-6 of the wetland block of the experimental farm,Annamala University, Annamalainagar (11^0 24' N 79^0 41' E) of Tamil Nadu in *kharif* 1999 (June to September) and *rabi* 2000 (December to March). The soil *(Typic Chromusterts)* of the experimental site was clay in texture with pH 7.9, Organic carbon 0.62 per cent and cation exchange capacity 29.54 c mol (p+) kg^{-1}. The soil is low in available $KMnO_4$- N (218.5 kg ha^{-1}),

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medium in available Olsen - P (16.5 kg ha^{-1}), and high in available K (475.8 kg ha^{-1}) and low in available S (13.6 kg ha^{-1}). A uniform dose of 100:50:50 kg N, P_2O_5, and K_2O ha^{-1} was applied to all the plots. Phosphorus was applied fully as the basal dressing and nitrogen was applied in three split doses viz., 50 per cent at basal, 25 per cent at tillering stage and 25 per cent at panicle initiation stages in the form of SSP and Urea, respectively. The fertilizers were applied uniformly to each plots in both the years except absolute control (without any fertilizers). The K_2O was applied as per the treatment schedule namely, T_1 – absolute control ,T_2 –entire K_2O as basal dose , T_3- application of 50 per cent K_2O as basal and the remaining split in to two equal halves and applied at tillering (TD1)and panicle initiation stages (TD2),T_4 – Basal skipping of K_2O and application of 50 per cent K_2O each at TD1 and TD2 stages, T_5- application of 75 per cent K_2O at TD1and 25 per cent K_2O at TD2, T_6- application of 50 per cent K_2O as basal and the remaining 50 per cent applied at TD1 and T_7- application of 50 per cent K_2O as basal and 50 per cent K_2O applied at TD2 stage. The treatments were replicated thrice with two sources of potassic fertilizer *viz*., muriate of potash (MOP) and sulphate of potash (SOP) in a randomized block design with factorial arrangement. Rice seedlings of cv. PY-5 were transplanted in 5 x $4m^2$ plots with a spacing of 15cm between the rows and 10cm plant to plant. Crop biometrics and yield attributes were recorded at tillering, panicle initiation, flowering and maturity stages. The crop was adequately protected from pest, disease and weed infestation. Grain and straw yields were recorded at full maturity for each treatment separately. The collected grain and straw samples were analysed for the content of N by microkjeldahl method (Humphries,1956), P by vanadomolybdate yellow colour method (Jackson,1973) and K by flame photometer (Piper,1953) and the uptake of respective nutrients was computed. The post harvest soil samples were analysed for available N (Subbiah and Asija, 1951), P (Olsen *et al*., 1954), K (Stanford and English, 1949) and S (Chesnin and Yien, 1951). All the data were statistically analysed by following the methods suggested by Gomez and Gomez, 1984. The package used for analysis is IRRISTAT (IRRISTAT, 1999)

RESULTS AND DISCUSSION

Growth and yield attributes

Split application of potassium had a significant effect on growth and yield attributes of rice over entire basal application (Table 01). The results revealed that plant height, number of productive tillers, filled grains per panicle, panicle length, grain and straw yield of rice were higher in the plots which receive K in two splits (50 per cent at tillering and 50 per cent at panicle initiation- T_4). This treatment recorded the highest plant height (95.5 cm), number of productive tillers (14.0 per plant), filled grains per panicle (175.8) and panicle length (18.9 cm). Among the fertilizer sources tried, MOP recorded a higher growth and yield attributes than SOP. Potassium applied entirely as basal recorded the lowest growth and yield attributes other than the control. Application of 50 per cent K_2O each at tillering and panicle initiation stages supplied adequate K and optimum N to K ratio both in soil and plant and

Table 01: Effect of split application of MOP and SOP on growth and yield attributes of lowland PY-5 (Mean data of two years)

Treatment	Plant height (cm)			No of productive tillers			Panicle length (cm)			No of filled grains panicle		
	MOP	SOP	Mean	MOP	SOP	Mean	MOP	SOP	Mean	MOP	SOP	Mean
T1	84.2	83.5	83.8	8.9	8.6	8.7	15.4	15 .0	15	154 .0	132. 0	133 .0
T2	89.2	88.4	88.8	11. 0	10.8	10.9	17. 0	16.9.	17. 0	151.7	148.7	150.2
T3	93.2	93. 0	93.1	12.2	11.8	12. 0	18.6	18.2	18.4	172. 0	170.3	171.2
T4	95.8	95.2	95.5	14.1	13.8	14. 0	19.2	18.7	18.9	176.7	174.3	175.8
T5	90.2	89.8	90. 0	11.5	11.2	11.4	18. 0	17.9	18. 0	161.7	160.3	161. 0
T6	91.4	90.6	91. 0	11.8	11.6	11.7	18.3	18. 0	18.2	167. 0	162.7	164.8
T7	89.8	89.2	89.5	11.2	11. 0	11.1	17.8	17.6	17.7	157. 0	155.3	156.2
Mean	90.5	89.9	90.2	11.5	11.3	11.4	17.8	17.5	17.6	160. 0	157.3	158.8

	SE d	CD(P=0. 05))	SE d	CD((P=0. 05)	SE d	CD((P=0. 05)	SE d	CD(P=0. 05))
Source	0.13	0.25	0. 10	0.21	0.11	0.22	0.73	1.46
Treatment	0.24	0.47	0.19	0.39	0. 20	0.41	1.36	2.74

Table 02: Effect of split application of MOP and SOP on grain and straw yield of rice cv. PY-5.

Treatment	Grain yield (kg ha^{-1})						Straw yield (kg ha^{-1})					
	Kharif -1999			*Rabi-2000*			*Kharif-1999*			*Rabi*-2000		
	MOP	SOP	Mean	MOP	SOP	Mean	MOP	SOP	Mean	MOP	SOP	Mean
T1	2283	2187	2235	2342	2248	2295	5393	5513	5453	5303	5158	5230
T2	3533	3133	3423	3425	3308	3367	6607	6410	6508	6540	6332	6435
T3	4503	4203	4353	4358	4125	4242	7597	7193	7395	7320	7010	7165
T4	4790	4597	4693	4563	4320	4442	7913	7387	7650	7607	7395	7501
T5	3800	3593	3697	3713	3610	3662	7010	6860	6935	6798	6593	6696
T6	3997	3800	3898	3912	3865	3888	7187	6993	7090	7008	6920	6964
T7	3593	3500	3547	3502	3403	3452	6917	6663	6790	6583	6508	6546
Mean	3786	3599	3692	3688	3540	3614	6946	6717	6832	6737	6559	6648

	S Ed	CD(P=0.05)	S Ed	CD(P=0.05)	S Ed	CD(P=0.05)	S Ed	CD(P=0.05)
Source	10.00	20.00	22.03	44.28	13.20	26.60	22.54	45.31
Treatment	18.60	37.50	41.21	82.85	24.80	49.80	42.17	84.76

efficient translocation of nutrients with the plant, which may finally attribute the higher growth and yield attributes. Similar results were observed by Devasenapathy (1997).

Grain and straw yields of rice as influenced by split application of potassium over entire basal application are presented in Table 02. The highest grain and straw yields were recorded in T_4 which received 50 per cent K_2O each at TD1 and TD2 stages, respectively (4693 kg ha^{-1} in *kharif* , 4442 kg ha^{-1} in *rabi*; 7650 kg ha^{-1} in *kharif*, 7501 kg ha^{-1} in *rabi*). The results indicate that under transplanted conditions of rice, requirement of K at early stages are met by the indigenously available soil K and then the requirement of K at tillering and panicle initiation stage was best satisfied by the application (top dressing) of water soluble K fertilizer receiving 50 % at the respective stages. Among the sources of fertilizer tried, the highest mean grain and straw yield was observed in muriate of potash treated plots than in sulphate of potash treated plots. Application of potassium in proper time (split doses) enhanced the enzymatic activities, probably caused higher mobilization of nutrients in soil and plant and translocation of photosynthetics in plant system, which ultimately resulted in higher grain and straw yields. Devasenapathy (1997) and Pal *et al.,* (2000) have also reported similar results.

Table 03: Effect of split application of MOP and SOP on nutrient availability in post harvest soils (kg ha^{-1})

Treatment	Nitrogen			Phosphorus			Potassium			Sulphur		
	MOP	SOP	Mean	MOP	SOP	Mean	MOP	SOP	Mean	MOP	SOP	Mean
T1	196	200	198	13.2	12.8	13. 0	402	402	402	10. 0	10. 0	10. 0
T2	214	214	214	25.4	23.8	24.8	449	449	449	14.1	15.9	15. 0
T3	207	207	207	18.4	18. 0	18.2	454	453	454	14.3	17. 0	15.6
T4	206	206	206	17.6	17.2	17.4	456	455	456	14.7	17.6	16.2
T5	210	209	210	20.8	19.4	20.1	453	452	452	12.8	16.5	14.6
T6	209	208	209	19.2	18.5	18.8	448	447	448	13.4	16.6	15. 0
T7	212	211	211	23.1	22.6	22.8	451	450	450	12.6	15.6	14. 0
Mean	208	208	208	19.7	18.9	19.3	445	444	444	13.1	15.6	14.4
	SE d	CD(P=0. 05))		SE d	CD((P=0. 05)		SE d	CD((P=0. 05)		SE d	CD(P=0. 05))	
Source	1.58	2.11		0.11	0.22		0.38	0.77		0.16	0.22	
Treatment	2.96	3.95		0.21	0.42		0.72	1.47		0. 30	0. 60	

Table 04: Effect of split application of MOP and SOP on grain N,P and K uptake (kg ha^{-1})

Treatment	Kharif-1999									Rabi-2000								
	N Uptake			P Uptake			K Uptake			N Uptake			P Uptake			K Uptake		
	MOP	SOP	Mean	MOP	SOP	Mean	MOP	SOP	Mean	MOP	SOP	Mean	MOP	SOP	Mean	MOP	SOP	Mean
T1	24.3	23.3	23.8	5.2	5. 0	5.1	4.7	4.4	4.5	23.6	21.4	22.5	5.1	4.8	4.9	4.6	4. 0	4.3
T2	58.2	57.2	57.7	10.2	9.5	9.9	10.1	8.9	9.5	57.5	55.8	56.7	10. 0	9.5	9.8	9.8	8.6	9.2
T3	62.4	60.5	61.4	12.9	12.6	12.8	17.6	15.5	16.6	61.9	60.5	61.2	12.4	12.4	12.3	17. 0	14.8	15.9
T4	64,5	61.6	63. 0	13.6	13. 0	13.3	19.6	17.7	18.7	63.8	62.7	63.2	13.2	12.9	13.1	18.8	17. 0	17.9
T5	60.4	59.6	60. 0	11.8	11.1	11.4	13. 0	11.8	12.4	59.7	58.7	59.2	11.5	11. 0	11.2	12. 0	11.5	11.7
T6	61.4	60.1	60.7	12.2	11.8	12. 0	14.4	13. 0	13.7	60.8	60.1	60.5	11.9	11.7	11.8	13.8	12.5	13.1
T7	59.3	58.7	59. 0	11.3	10.8	11. 0	11.4	10.4	10.9	58.6	57.9	58.3	10.9	10.2	10.6	10.8	10. 0	10.4
Mean	55.8	54.4	55.1	11. 0	10.5	10.8	13. 0	11.7	12.3	55.1	53.9	54.5	10.7	10.3	10.5	12.4	11.2	11.8

	SEd	CD(P=0.05)	SEd	CD(P=0.05)	SEd	CD(P=0.05)	SEd	CD(P=0.05)	SEd	CD(P=0.05)	SEd	CD(P=0.05)
Source	0.23	0.48	0.13	0.26	0.24	0.47	0.25	0. 50	0.16	0.32	0.12	0.25
Treatment	0.44	0.89	0.24	0.49	0.44	0.88	0.47	0.94	0. 30	0. 60	0.23	0.46

Table 05: Effect of split application of MOP and SOP on straw N, P and K uptake (kg ha^{-1})

Treatment	Kharif-1999									Rabi-2000								
	N Uptake			P Uptake			K Uptake			N Uptake			P Uptake			K Uptake		
	MOP	SOP	Mean	MOP	SOP	Mean	MOP	SOP	Mean	MOP	SOP	Mean	MOP	SOP	Mean	MOP	SOP	Mean
T1	12.1	11.1	11.6	4. 0	3.8	3.9	33.4	31.7	32.5	12. 0	11.1	11.5	4. 0	3.7	3.9	31.9	30.4	31.1
T2	34.2	33.5	33.9	8.1	7.4	7.8	44.5	40.9	42.7	33.9	33. 0	33.4	7.8	7.3	7.5	42.6	40.3	41.4
T3	39.2	38.6	38.9	10. 0	9.4	9.7	56.2	51.9	53.6	38.4	37.6	38. 0	9.6	9.2	9.4	53.3	50.7	52. 0
T4	41.8	40.1	40.9	10.6	10. 0	10.3	60.2	53.2	56.7	40.2	38.6	39.9	10.1	9.9	10. 0	57.6	53.8	55.7
T5	36.4	35.9	36.1	9.2	8.8	9. 0	49. 0	47.2	48.1	35.9	35. 0	35.4	8.6	8.5	8.5	46.1	45.2	45.6
T6	37.1	36.5	36.8	9.4	9.1	9.3	52.5	49.8	51.2	36.8	35.9	36.4	9.2	8.9	9.1	50.4	48.3	49.3
T7	35. 0	34.7	34.9	8.7	8.4	8.6	46.8	44.3	45.5	34.1	33.9	34. 0	8.1	8. 0	8.1	44.1	43.4	43.7
Mean	33.7	32.9	33.3	8.6	8.1	8.4	48.9	45.4	47.1	33. 0	32.3	32.7	8.2	7.9	8.1	46.6	44.6	45.5

	SEd	CD(P=0.05)	SEd	CD(P=0.05)	SEd	CD(P=0.05)	SEd	CD(P=0.05)	SEd	CD(P=0.05)	SEd	CD(P=0.05)
Source	0. 30	0. 60	0.12	0.25	0.27	0.54	0. 20	0. 40	0.11	0.23	0.18	0.36
Treatment	0.55	1.11	0.23	0.46	0. 50	1. 01	0.37	0.74	0.22	0.44	0.34	0.68

Nutrient Availability

The data on post harvest nutrient status of soil are presented in Table 03. Entire basal application of K_2O (T_2) recorded higher available N and P when compared with other treatment (214 kg ha^{-1}, 24.8 kg ha^{-1}). The increase in available N may be due to the release of fixed NH_4 $^+$ ion by K^+ ion owing to the similarity in ionic radii (Natarajan, 1980). Among the split application of K_2O, basal skipping and addition of 50 % K_2O each at TD1 and TD2 stages respectively recorded lower values of available N and P. This is because of more amount of added NH_4^+ was fixed firstly due to the presence of its higher bonding energy over K^+ and also the presence of similarly fixable K which prevented the release of already fixed NH_4^+- N. Available N and P is more in MOP treated plots than the SOP treated plots. Split application of K significantly increased the soil available K and S when compared to the entire basal application. The plots in which basal skipping was adopted and application of 50 per cent K_2O each at TD_1 and TD_2 stages recorded higher soil available K and S (456 kg $ha^{-1}$and 16.2 kg ha^{-1}). The increase in available K may be probably due to reduced K fixation when NH_4-N was added simultaneously with K fertilizers. Available sulphur was more in SOP treated plots than in MOP treated plots. This may be attributed to the substantial release of SO_4^{2}- ion from K_2SO_4.

Nutrient uptake

The N, P and K uptake by grain and straw were improved significantly over control (T_1) by the split application of potassium (Tables 04 and 05). The maximum uptake of N,P and K in grain were observed in T_4 (63.0; 13.3 and18.7 kg ha^{-1} in *kharif* and 63.2; 13.1 and 17.9 kg ha^{-1} in *rabi*) which received 50 per cent K_2O at tillering and remaining 50 per cent at panicle initiation stage. Similar trends were also observed in straw uptake. Entire basal application of K was also proved to be higher in N, P and K uptake than absolute control. Yet when compared with split application it was found to be significantly low (P = 0.05) in N, P and K uptake. Among the sources tried, MOP recorded a better uptake of N, P and K nutrients in both the seasons. Potassium performs many functions in plant metabolism, promoting photosynthesis, harnessing the interaction of K with N, and hence could have increased the nutrient uptake. Similar findings are observed by and Thakur *et al.* (1999).

CONCLUSIONS

The results of the above studies showed that soils with high status of K_2O, there is no need for basal dressing. Application of K_2O in two equal splits at tillering and panicle initiation stage could favourably influence the yield and uptake of nutrients. Potassium application to rice as basal could be skipped off in soils having high available K. In order to maintain utmost economy of K fertilization and adequate supply of K during peak periods its demand by the crop, it is imperative that K can be applied in split doses for better rice production.

References

Chesnin F, Yien C.H., (1951). Turbidimetric determination of available sulfates. Proceedings of Soil Science Society of America **18,** 149-151

Devasenapathy P., (1997). Split application of potassium on rice. Madras Agricultural Journal **84(5),** 265-266.

Ghosh S.K., Pal S, A.K.Mukhopadhyay, (1995). Split application of potassium to maximize its efficiency on yield of high yielding rice. Indian Agricultural Journal **39(4),** 259-261.

Gomez KA, Gomez AA (1984) Statistical procedures for agricultural research. ((John Wiley and Sons, New York).

Humphries E.C., (1956), Mineral components and ash analysis: In 'Modern methods of plant analysis'. Soil Science **100,** 112-117.

IRRISTAT, (1999), Biometrics unit, International Rice Research Institute, M.C.P.O. Box 3127, 1271 Makati CityMetro Manila, Philippines.

Jackson M.L., (1973). Soil Chemical Analysis. (Prentice Hall of India Private Limited: New Delhi).

Natarajan S., (1980). 'Studies on Potassium in major soil series of Coimbatore District, Tamil Nadu'. M.Sc (Ag) Thesis submitted to TNAU, Coimbatore-3.

Olsen S.R., C.V. Cole, F.S. Watanabe, L. Dean, (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S.D.A Circ., 939. (U.S.Govt. Printing Office, Washington DC).

Pal S., S.K. Ghosh, A.K. Mukhopadhyay, (2000). Split application of potassium on rice in coastal zone of West Bengal. Indian Journal of Agronomy **45(3),** 575-579.

Piper C.S., (1966). Soil and Plant analysis (Hans Publishers: Bombay).

Stanford S., L. English, (1949). Use of flame photometer in rapid soil test of K and Ca. Agronomy Journal 41, 446-48.

Steineck O. (1974). The relation between N and K in the production of plant material. Proceedings of the 10th Congress by International Potash Institute, Bern, Switzerland

Subbiah B.V., G.L. Asija, (1956). A rapid procedure for estimation of available Nitrogen in soils. Current Science **25,** 259-260.

Thakur D.S., S.R. Patel, N. Lal, (1999). Effect of split application of K with FYM on rice (*Oryza sativa*) Indian Journal of Agronomy **44(2),** 301-303.