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Effect of Potassium Sources on Rice Yield

A.M. RANJHA, T. WAHEED, S.M. MEHDI† AND S.S. REHMAN
Department of Soil Science,University of Agriculture, Faisalabad–38040, Pakistan
†Soil Salinity Research Institute, Pindi Bhattian–Pakistan

ABSTRACT

A pot study was undertaken to see the relative effect of SOP and MOP on rice growth in sandy clay loam soil used @ 10 kg pot^{-1}. Potassium was applied @ 0, 100, 200, 300, 400 and 500 mg kg^{-1} soil each from MOP and SOP along with basal dose of N + P @ 150 and 100 kg ha^{-1}. Plant height, number of tillers pot^{-1}, paddy yield, 1000-grain weight and straw yield remained unaffected by both the sources of potassium. Nitrogen and potassium contents of rice paddy and straw were unaffected by all the treatments. However, significant increase in P contents of rice straw was noted where SOP was applied. Sulfur contents in both grain and straw increased significantly with increasing SOP rates while Cl^- contents increased with increasing MOP rates. There was gradual decrease in Cl^- concentration at panicle emergence, straw and paddy as compared to first sampling (35 days after transplanting).

Key Words: Potassium; Rice; Yield source

INTRODUCTION

In Pakistan, the Potassium (K) needs of crops had been and are met from native K sources like weathering of mica, biotite, muscovite and illite but intensive cropping with high yielding cultivars and high levels of nitrogen (N) and phosphorus (P) fertilizers increased the demand for K due to its slow release from soil that hardly meets crop requirements and as a result K application became necessary. Commonly, there are two sources of K used as fertilizers i.e. sulphate of potash (K_2SO_4) and muriate of potash (KCl). Potassium chloride is a cheaper source of K as compared to potassium sulphate but still its use is considered inappropriate in Pakistan due to the fear of adverse Cl^- effects on plant growth. Khan (1985) compared the efficiency of MOP and SOP in pot experiment on wheat and rice using normal and saline soils, and found both the sources equal in promoting plant growth and yield. Similarly, Saurat and Boulay (1985) found that only salt sensitive crops might be benefited from the use of SOP more than MOP due to its low salt index. Krauss (1992) while discussing various aspects of both K sources i.e. MOP and SOP, suggested that MOP should be considered as K source and be used for various crops under good leaching conditions. Sultan (1985) had not observed any ill effect of Cl^- from MOP on the growth of wheat. While David *et al.* (1986) reported that SOP is a preferred K source in Pakistan because of the adverse effect of Cl^- from MOP. In terms of yield response, SOP was found superior to MOP in most cases as regards rice, wheat and maize in the Punjab and NWFP. However, Ahmad (1996) stated that plant growth parameters remained unaffected by K fertilization. Both the sources (i.e. MOP and SOP) failed to increase growth parameters over control and there was no ill effect of Cl^- on wheat plants. Keeping all this in view, this study was planned to evaluate the effect of K sources on rice growth and uptake of nutrients.

MATERIALS AND METHODS

A pot experiment was carried out using the soil with characteristics of sandy clay loam in texture, non-saline (EC_e = 1.3 d Sm^{-1}), non-sodic (pH_s = 7.6), low in organic matter, N, P but satisfactory in K (139 ppm). A composite soil sample was taken in bulk, air dried, ground, passed through 2 mm sieve and filled in glazed pots @ 10 kg pot^{-1}. Potassium was applied @ 0, 100, 200, 300, 400 and 500 mg kg^{-1} soil from each source along with a basal dose of N and P @ 150 and 100 mg kg^{-1} soil, respectively. After flooding the soil, four rice seedlings of variety Basmati-385 were transplanted in to each pot. Whole of the P and K with 1/3rd N was applied at the time of transplanting. The rest of two N splits were applied 35 and 55 days after transplanting. The leaves collected at panicle emergence stage were analyzed for Cl^- contents. The crop was harvested at maturity and all growth parameters were recorded and paddy and straw samples were analyzed for N, P, K, S and Cl^- contents. All the analyses were done according to methods given in Hand Book No. 60 (U.S. Salinity Lab. Staff, 1954) except texture by Moodie *et al.* (1959), total N by Jackson (1962), available P by Watanabe and Olsen (1965), Sulfur by Bardsley and Lancaster (1965) and chloride by Pitman (1965). All the data were analyzed statistically using standard procedures (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

Growth parameters. The growth parameters of rice plant (Table I) were no longer affected by the either source of K fertilization i.e. MOP or SOP. This was because of adequate quantity of K (139 mg kg^{-1}) already in the soil. Moreover, there were no ill effects of Cl^- even at very higher rate i.e. 500 mg kg^{-1} soil which might be due to the reason that a long period is required to develop

Cl^- toxicity in restricted drainage soil as in this case, because the pots were closed from below and there was no leaching of Cl^- from these pots. Khan (1985) also found similar results in normal soil while working on rice and wheat in normal and saline soils.

Chemical composition of plants

Nitrogen concentration. Nitrogen concentration (Table II) in paddy and straw was found non significant by the application of K at different rates from two sources i.e. MOP and SOP. It is obvious from the data that higher rates of SOP improved the N percentage to some extent as compared to low rates. At higher rate of K application, it was decreased due to dilution effect by both the sources. The small difference among MOP and SOP might be due to the reason that SO_4^{2-} is more important for protein synthesis in plants. Sulfur is the structural part of many amino acids like cystein and S-S linkage is the binding force of many organic molecules including proteins. Chloride has nothing to do with proteins or protein synthesis. These results are in agreement with those of Tergas *et al.* (1988).

Phosphorus concentration. Phosphorus concentration (Table II) was non significant in case of paddy and significant in case of rice straw. A careful observation of the data showed that in both the cases, SOP was slightly better than MOP. It may be attributed to the fact that sulphate could lower the activity of calcium ion by forming $CaSO_4$ and thus rendering phosphorus more available in case of SOP as compared to MOP. Similar results were reported by Laughlin *et al.* (1971).

Potassium concentration. Potassium concentration in paddy and straw (Table II) was non significant. It is also evident from the data that both the sources of K failed to increase K concentration in the paddy and straw over control. This was due to the fact that already adequate K was present in the soil, which was sufficient for the needs of plants (Bhatti *et al.,* 1983). As far as the response of rice to applied potassium was concerned, it was not observed due to K rich clay minerals (illite) in the soils of Pakistan and their weathering rate may be enough to replenish soil solution K (intensity) to meet the plant requirement (Ranjha *et al.,* 1990).

Sulfur concentration. Sulfur concentration in paddy and straw (Table II) was significantly increased by the application of K and was found more in SOP treatments than MOP. Moreover, with the increasing rates of SOP, Sulfur concentration was increased in both the parameters. This rise in Sulfur concentration might be due to the fact that higher concentration of applied Sulfur were present in readily available form in the soil. Although, enough Sulfur was already present in soil but lower Sulfur concentration was observed in MOP treated plants as compared to SOP treated ones and this might be due to the antagonistic effect of Cl^- on Sulfur uptake.

Table I. Effect of potassium sources on growth parameters of rice

$N-P_2O_5-K_2O$ (mg kg^{-1} soil)	Source	Plant height (cm)	No. of tillers pot^{-1}	1000-grains weight (g)	Paddy yield (g pot^{-1})	Straw yield (g pot^{-1})
150-100-0	---	110.79 N.S.	42.67 N.S.	18.39 N.S.	56.57 N.S.	110.29 N.S.
150-100-100	MOP	115.92	40.00	19.22	59.00	107.84
150-100-200	MOP	109.62	40.00	18.90	55.98	106.13
150-100-300	MOP	110.71	37.33	18.57	55.58	100.56
150-100-400	MOP	111.46	37.33	18.15	54.41	97.21
150-100-500	MOP	105.79	37.33	18.37	49.83	97.91
150-100-100	SOP	114.04	34.67	18.99	60.33	107.13
150-100-200	SOP	115.37	37.33	19.06	59.91	98.26
150-100-300	SOP	115.29	41.33	18.76	59.34	104.38
150-100-400	SOP	113.87	41.33	19.23	61.94	100.79
150-100-500	SOP	113.62	42.67	18.23	56.88	101.54

Table II. Effect of potassium sources on chemical composition of rice (%)

$N-P_2O_5-K_2O$ (mg kg^{-1} soil)	Source	Nitrogen		Phosphorus		Potassium		Sulfur	
		Paddy	Straw	Paddy	Straw	Paddy	Straw	Paddy	Straw
150-100-0	---	1.34 N.S.	0.75 N.S.	0.29 N.S.	0.154 E	0.43 N.S.	1.71 N.S.	0.133 D	0.114 E
150-100-100	MOP	1.27	0.76	0.20	0.166 DE	0.41	1.95	0.136 CD	0.122 D
150-100-200	MOP	1.24	0.80	0.31	0.166 DE	0.41	1.95	0.136 CD	0.125 CD
150-100-300	MOP	1.27	0.82	0.31	0.169CDE	0.40	1.84	0.139 CD	0.124 CD
150-100-400	MOP	1.29	0.78	0.32	0.173 BCDE	0.41	1.83	0.141 CD	0.128 BC
150-100-500	MOP	1.27	0.79	0.30	0.174 BCD	0.40	1.88	0.138 CD	0.120 DE
150-100-100	SOP	1.37	0.81	0.32	0.194 A	0.40	1.70	0.146 BC	0.132 AB
150-100-200	SOP	1.41	0.84	0.33	0.185 ABC	0.42	1.75	0.155 AB	0.132 AB
150-100-300	SOP	1.27	0.83	0.33	0.187 ABC	0.41	1.74	0.157 AB	0.136 A
150-100-400	SOP	1.27	0.84	0.33	0.196 A	0.40	1.97	0.161 A	0.138 A
150-100-500	SOP	1.24	0.84	0.34	0.190 AB	0.43	1.85	0.157 AB	0.136 A

Table III. Effect of potassium sources on Cl^- contents of rice

$N-P_2O_5-K_2O$ (mg kg^{-1} soil)	Source	35 days after transplanting	Leaves at panicle emergence	Paddy	Straw
150-100-0	---	0.607 E	0.475 D	0.126 D	0.345 DE
150-100-100	MOP	0.721 D	0.648 C	0.216 C	0.456 C
150-100-200	MOP	0.800 C	0.689 BC	0.227 BC	0.476 DC
150-100-300	MOP	0.826 BC	0.712 BC	0.262 ABC	0.501 BC
150-100-400	MOP	0.872 AB	0.752 B	0.282 AB	0.528 AB
150-100-500	MOP	0.919 A	0.840 A	0.296 A	0.578 A
150-100-100	SOP	0.571 E	0.486 D	0.130 D	0.337 DE
150-100-200	SOP	0.626 E	0.481 D	0.133 D	0.352 D
150-100-300	SOP	0.606 E	0.468 D	0.128 D	0.343 DE
150-100-400	SOP	0.630 E	0.485 D	0.126 D	0.350 D
150-100-500	SOP	0.590 E	0.467 D	0.123 D	0.269 E

Chloride concentration. Chloride concentration in leaves at 35 days after transplanting, panicle emergence, paddy and straw are given in Table III. The results indicated that chloride concentration was significantly increased in plants at all stages of growth. Maximum values were noted in MOP treated plots; whereas, control and SOP treated plots were at par with each other. Moreover, highest chloride concentration was recorded in leaves 35 days after transplanting followed by panicle emergence stage, then straw and least in the paddy. The increase in chloride concentration in MOP treatments was due to its higher concentration in soil solution because chloride source i.e. MOP was added, which resulted in more passive flux of it into the root. The maximum chloride concentration in leaves at 35 days after transplanting might be due to the reason that plants were rapidly growing, resulting in more chloride accumulation along with the uptake of water and other essential nutrients needed for its growth. With the age, its water and nutrient requirement was reduced so Cl^- concentration was decreased at panicle initiation and at maturity because there was no need of water and nutrient since plant has completed its life cycle due to which Cl^- concentration were lowered in paddy and straw. On the other hand, in SOP treatments since there was no application of Cl^- carrying material hence there was minimum Cl^- uptake and results were at par with control. These results are in agreement with those obtained by Khan (1985) who reported increased Cl^- concentration in wheat grain with increasing MOP rates in normal soil.

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