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ASSESSMENT OF TWO POTASSIUM SOURCES IN A RICE-WHEAT CROPPING SYSTEM

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Field experiments were conducted to assess the relative effectiveness of muriate of potash (MOP) and sulphate of potash (SOP) in rice and wheat for two consecutive years (1994-95 and 1995-96) on a sandy-clay loam soil. Whole of P and K along with one-third N were applied at sowing, while rest of the nitrogen was added in two equal splits at 35 days after sowing and at panicle/ear initiation stage. Response of each treatment was determined by recording observations on growth and yield parameters and chemical composition of plant and soil. The plant growth parameters like plant height, number of tillers per hill of rice and m^{-2} of wheat, grain and straw yield and 1000-grain weight of both the crops were not affected significantly by potassium fertilization. Both the K sources failed to improve the above mentioned parameters over control and no ill effect of chloride on the rice and wheat plant was observed. Both the K sources were similar in their effects on N, P and K concentration in grain and straw of both the crops. However, Cl concentration in grain and straw of the two crops increased significantly with the application of MOP. Though chloride concentration in wheat plant increased initially with MOP application but decreased with advancement of plant growth. Subsoil chloride contents increased with the application of MOP.

Key words: potassium sources, rice-wheat cropping system

INTRODUCTION

In Pakistan, the entire requirement of K fertilizer is met as sulphate of potash (SOP). Muriate of potash (MOP) is another source which is much cheaper and is widely used as K fertilizer in many countries of the world. Although MOP costs half that of SOP but its use is not considered appropriate for all crops and soils (Davide *et al.,* 1986). There is a prevailing fear that the use of MOP will increase the chloride ion concentration of Pakistani soils as they are inherently rich in chloride ions and further use of chloride containing fertilizer may increase the concentration of this ion to the toxic level, By contrast, use of MOP is preferred because of the reduction of S04 to toxic S02 (sulphide) under wet anaerobic conditions (Glander and Peter, 1962), whereas chloride being an inert anion is well tolerated by the crops over a wide range of concentration (Clarkson and Hanson, 1980). Considerable recent evidence also suggests that chloride addition is beneficial under wide range of soil conditions (Fixen, 1987). Initially chloride was classed as a micro nutrient with only relatively low concentration of abm{t 100 ppm required for its bio-chemical function. Higher levels are apparently needed for its biophysical or osmoregulatory action and for its prophylactic rol-ein disease suppression (Beaton *et al., 1988).*

Although a lot of research work on the use of potassium as MOP and SOP has been done in the past yet the results are highly inconsistent. For example yield of rice (Amin *et al.,* 1990), and wheat (Malik *et al.,* 1988a) was found to be statistically similar with the use of both the K sources. On the contrary, Rehman (1992) reported higher yield of rice and wheat with SOP compared to MOP. Hussain and Jilani (1991) compared MOP and SOP for five years under rice-wheat rotation and did not find any significant yield difference in both the crops inspite of the increase in chloride content from 2.75 mel-t to 4.75 mel-! during the period of experimentation. Consequently this study was planned to assess the relative efficiency of MOP and SOP as potassium sources in a rice-wheat cropping system under the agro-ecological conditions obtaining at Faisalabad.

MATERIALS AND METHODS

The effect of two sources of potassium on soil chloride contents and agro-chemical traits of rice and wheat was investigated under field conditions on a sandy-clay soil having on average 0.063% N, 7.85 ppm P205, 126 &0 with chloride concentration of 5.09 me1! at the University of Agriculture, Faisalabad during 1994-95 and 1995-96. The experimental soil was duly sampled from different places at the depth of 0-15, 15-30, 30-60 and 60-90 cm before the start of the experiment to determine the chloride contents and physico-chemical charactersitics. Before transplanting rice nursery,

the soil was puddled by giving two ploughings each followed by planking. The rice cultivar used was Basmati-385. The row to row and plant to plant distance was maintained as 25 cm. The experiment was laid out according to a randomized complete block design with four replications using a plot size measuring 2x5m. The treatments tested were 150-100-0, 150-100-100 (MOP) and 150-100-100 (SOP) kg NPK ha-l. Nitrogen and phosphorus were applied in the form of urea and single super phosphate, respectively. Whole of P and K along with one-third of nitrogen were applied at the time of transplanting rice nursery. The rest of nitrogen was topdressed 35 days after transplanting and at paniele initiation stages of the crop in two equal splits. Recommended cultural practices were adopted for all the treatments up to crop maturity. The crop was harvested at full maturity and data were recorded on plant height, tillers per hill, 1000-grain weight and paddy and straw yield ha-'. Oven-dried grain straw samples of rice collected from each treatment were ground and analysed for N, P, K and Cl concentration. After the crop harvest, four soil samples were again taken at the depth of 0-15, 15-30, 30-60 and 60-90 cm from each treatment to determine the chloride contents of soil. The field was then prepared by giving two ploughings each followed by planking for the sowing of wheat. The cultivar used was Inqalab-91. The fertilizer treatments and layout plan for the wheat were the same as for the rice crop. The wheat crop was harvested at full maturity- and the data on plant height, number of tillers m^{-2}, 1000-grain weight, grain and straw yield ha^{-1} were recorded. Grain and straw samples of wheat taken from each treatment were ground and analysed for N, P, K and Cl concentration. After the harvest of wheat crop soil samples at 0-15, 15-30, 30-60 and 60-90 cm depths were also taken from each of the treatments for Cl content determination. Analytical procedures followed were based on the methods described by Chapman and Pratt (1982). Soil texture was determined by using the international textural triangle. Potassium was determined by Jenway PFP-7 Flame-photometer, while chloride was estimated by titration of the extract with standard silver nitrate using potassium chromate as indicator. The data collected for various parameters were analysed by using the analysis of variance technique and the treatment means were compared by LSD test at 0.05 P (Steel and Torrie. 1980).

RESULTS AND DISCUSSION

Plant Height: The data on plant height of rice and wheat as affected by K application as MOP and SOP (Table 1) revealed that both the sources failed to increase the plant height of both the crops significantly over check (150-100-0 kg NPK ha-t). This might be ascribed to a large capacity of Pakistani soils to provide potassium to crops under ordinary conditions because of illitic clay matereial (Ranjha *et al.,1990)*. Potassium fertilization in beth forms (MOP and SOP) had non-significant effect on tillering potential of both the crops under study. This might be attributed to already adequate K availability in the experimental soil (126 ppm).

lOOO-Grain Weight: Although lOOO-grainweight of both rice and wheat increased a little bit with K application in both forms (MOP and SOP) yet the difference was non-significant. However, MOP had an edge over SOP probably because of the active role of chloride as an essential nutrient. Similar conclusions were drawn by Rasool *et al.* (1987) who reported that both the potassium sources had the same effect on lOOO-grainweight of maize.

Table 1. Effect of MOP and SOP on agronomic traits of rice and wheat

Fertilizer treatments (kgha·ı)	Plant height (cm)	No. of tillerslhill m^{-2}	lOOO-grain wt (g)	Grain yield (t ha-t)
N-P-K		Rice		
150-100-0 (check)	100.10 NS	18.70 NS	21,02 NS	4.25 NS
150-100-100 (MOP)	102.30	19.10	21,89	4.31
150-100-100 (SOP)	104.50	19.72	21,64	4.36
		Wheat		
150-100-0 (check)	106.70NS	275.50 NS	44.96NS	3.26NS
150-100-100 (MOP)	106.90	280.82	47,44	3.33
150-100-100(SOP)	109.70	281,80	47,42	3,41

Each value is average of two years data; NS= Non-significant.

Table 2. Effect of MOP and SOP on N, P, K and Cl concentration (%) in straw and grain of rice and wheat

Fertilizer treatments (kg ha-t)	Nitrogen		Phosphorus		Potassium		Chloride	
N-P-K	~traw	Grain	Straw	Grain	Straw	Grain	Straw	Grain
				Rice				
150-100-0 (check)	0,44	1,39	0.081	0.28	2.10	0.50	0.312 b	0.155 b
150-100-100 (MOP)	0,43	1,41	0.084	0.29	2.19	0.53	0,444 a	0.164 a
150-100-100 (SOP)	0,44	1,44	0.088	0.30	2.18	0.52	0.303 b	0.156 b
				Wheat				
150-100-0 (check)	0.52	1,44	0.098	0.31	1,63	0,44	0.321 b	0.168 b
150-100-100 (MOP)	0.56	1,46	0.099	0.32	1,68	0,46	0.506 a	0.184 a
150-100-100 (SOP)	0.58	1,48	0.101	0.34	1,69	0,46	0.311 b	0.164 b

Values followed by a similar letter are significantly different ($P<0.05$).

Grain Yield: The data on grain and straw yield ha-! (Table 1) indicated that although potassium application as SOP increased rice paddy and wheat grain yield ha-lover MOP as well as control yet the differences among these were statistically non-significant. It might be ascribed to adequate initial K status in the soil. Probably no adverse effect of chloride on rice and wheat grain yields was observed since a fairly long period is required to establish chloride toxicity level for growth with the use of MOP in a soil with restricted drainage. These results are in line with those of Khattak *et al (1983)* and Shafiq and Ranjha (1998) who reported non-significant difference in grain yield of wheat and rice due to K application using MOP and SOP. The same trend was noted for straw yield ha-t of both the crops with the application of K as MOP and SOP. These results led to the conclusion that there is no toxic effect of chloride on plant growth and grain yield of rice and wheat with MOP fertilization under the given conditions.

Data pertaining to N concentration in straw and grain of rice and wheat (Table 2) indicted that there were no significant differences among the three treatments. These results agree with the findings of Sajjad (1993) who reported that application of MOP and SOP had similar effect on N concentration in wheat grain and straw. Following the same trend, neither of the potassium sources had a significant effect on the phosphorus concentration in straw and grain of rice and wheat (Table 2). Ashraf (1982) also reported similar results. Application of either source of K although caused an increase in K concentration in straw and grain of both the crops over check but this increase was again statistically non-significant (Table 2). These results are in consonance with those of Khan (1985) who reported that both SOP and MOP were equally effective in maintaining the level ofK in grain and straw of wheat and rice.

Data on chloride concentration (Table 2) revealed that MOP fertilization increased the chloride contents in rice and wheat straw significantly (0,444 and 0.506%) over SOP (0.303 and 0.311%) and control (0.311 and 0.321%) which in turn were at par with each other. This clearly indicates greater absorption of chloride by rice and wheat plants from the soil treated with MOP. Rashid *et al.* (1992) also reported that chloride contents in wheat and maize were significantly higher with -MOP than with SOP fertilization. Regarding rice and wheat grain, significantly higher chloride level in rice and wheat grain was recorded in plants fertilized with MOP @ 100 kg &0 ha-t than that fertilized with SOP. Soil chloride contents were significantly higher under MOP than SOP after the harvest of both the crops (Table 3). There was an increasing trend of chloride accumulation with an increase in soil depth from 0-15 to 30-60 cm which was attributed to highly mobile nature of chloride under adequate supply of soil moisture. These results agree with those of Khattak *et al.* (1983) and Fixen *et al.* (1987) but are contradictory to those of Waheed *et al.* (1994) and Shafiq and Ranjha (1998) who reported that soil chloride contents up to the depth of 40 cm were almost the same under MOP after rice harvest. This was probably due to high water requirement of rice crop which caused heavy leaching of chloride due to its high mobility.

Table 3. Effect of MOP and SOP on chloride contents (me l^{-1}) of saturated extract of soil after the harvest of rice and wheat crops

Fertilizer treatments (kg ha^{-1})	0·15 cm depth	15·30 cm depth	30-60 cm depth	60·90 cm depth	Mean
			Rice		
N-P·K					
150-100-0 (check)	3.70	3.79	3.80	3.74	3.76 b
150-100-100 (MOP)	3.90	4.31	4.50	3.83	4.14 a
150-100-100 (SOP)	3.74	3.80	3.83	3.77	3.78 b
Mean	3.78 b	3.97 a	4.05 a	3.78 b	
			Wheat		
150-100-0 (check)	3.81	3.89	3.93	3.67	3.83 b
150-100-100 (MOP)	3.89	4.13	4.62	3.93	4.14 a
150-100-100 (SOP)	3.76	4.19	3.93	3.74	3.90b
Mean	3.82 b	4.07 a	4.16 a	3.78 b	

Values followed by a similar letter are not significantly different ($P<0.05$).

REFERENCES

Amin, R., M.S. Zia, M. Aslam and A Ali. 1990. Potassium requirements for rice. Pak. J. Agri. Res. 11(4): 223-228.

Ashraf, M. 1982. Effect of two sources of potassium on yield and chemical composition of wheat. M.Sc. Thesis, Univ. Agri., Faisalabad.

Beaton. J.D., K.M. Pretly and J.L. Sanders. 1988. The chloride components of fertilizers can be beneficial. Thrid Chemical Congress of North America, Toronto, Canada.

Chapman, D.H. and P.F. Pratt. 1982. Methods of analysis for soils, plants and water. Div. of Agri. Science's, Univ. of California, USA

Clarkson, D.T. and J.B. Hanson. 1980. The mineral nutrition of higher plants. Ann. Rev. Plant Physiol. 31:239-298.

Davide, J.G., H. Nabhan, M.T. Aleem and N. Ahmad. 1986. Potash fertilizer in Pakistan: Sulphate and Muriate of Potash. pp.52. NDFC Planning and Development Division, Govt. of Pakistan, Islamabad.

Fixen, P.E. 1987. Chloride fertilization: Recent research gives new answers. Crop and Soils, 39(6): 14-16.

Gharbi, A 1989. The effects of potassium fertilizer application on N, P and uptake and yield of durum wheat *(triticum durum)*. Agri. Mediterranean, 119(3): 272-275 (Soil and Fert. 5319: 11362, 1990).

Glander, H. and AV. Peter. 1962. Discoveries and experience of manuring rice. Potash Res., pp.29. Topic No. 9 Int. Potash Inst., Bern, Switzerland.

Hussain, T. and G. Jilani.. 1991. Evaluation of nutrient response and fertilizer sources for sustainable rice production. Ten Years' Report, Dept. of Soil., Univ. Agri., Faisalabad.

Khan, M. 1985. Differential response of potassium chloride and potassium sulphate on wheat and rice under varying levels of salinity. M.Sc. Thesis, Univ. Agri., Faisalabad.

Khattak, J.K., AU. Bhatti and A Bakhus. 1983. Comparative effect of potassium chloride and potassium sulphate on the performance of wheat. Potash Rev., Int. Potash Inst., Bern. Switzerland. Subj. 4:27th suite No. 3, 1985.

Malik, M.N.A, S.U. Din and M.I. Makhdum. 1988a. Effect of muriate and sulphate of potash on the growth and yield components of late sown wheat. Sarhad J. Agri. 4(5): 565~569.

Ranjha, AM., AJabbar and R.H. Qureshi. 1990. Effect of amount and type of clay minerals on potassium fixation in some alluvial soils of Pakistan. Pak. J. Agri. Sci. 27:187-192.

Rashid, M., Z. Saleem and Obaid-ur-Rehman. 1992. Use of MOP vs SOP on a wheat-maize cropping system. Pak. J. Soil Sci. 7(3-4): 20-24.

Rasool, G., J.K.. Khattak and A Bhatti. 1987. Comparative effect of K2So4 and KCI on the yield and chemical composition of maize under D.I.Khan conditions. Pak.. J. Agri. Res. 8:29-33.

Rehman, H. 1992. Fertilizer use efficiency in NIOFP. Paper presented at 4th National Congress of Soil Science, May 24-26, Islamabad, Pakistan.

Sajjad, N. 1993. Evaluation of MOP and SOP as potassium fertilizers. M.Sc. Thesis, Univ. Agri., Faisalabad.

Shafiq, M. and AM. Ranjha. 1998. Use of MOP vs SOP for rice growth. J. Agri. Res. 36(1): 51-56.

Steel, R.G.D. and J.H.Torrie. 1980. Principles and Procedures of Statistics. Mcgraw **Hill** Book Co., New York.

Waheed, T., AM. Ranjha and S.M. Mehdi. 1994. Relative efficiency of muriate of potash (MOP) for rice. Pak.J. Sci. 46(1-2):1-7.