Pak. J. Agri. Sci., Vol. 31, *No.* 3, 1994

EFFECT OF TEMPERATURE AND ORGANIC MATTER ON FIXATION OF APPLIED POTASSIUM IN THREE ALLUVIAL SOIL SERIES

S.M. Mehdi & A.M. Ranjha*
Soil Salinity Research Institute, Pindi Bhattian
**Department of Soil Science,*
University of Agriculture, Faisalabad

Combined effect of temperature (30, 45 and 60° C) and organic matter (5, 7.5 and 10 g kg-I) was studied in laboratory on fixation of applied potassium (0, 50 and 100 mg kg-I soil) to Lyallpur, Sultan pur and Shahdra series. With the increase of applied potassium, its fixation was increased but with the increase of organic matter, it decreased while temperature showed inconsistent effect on potassium fixation. Maximum K fixation was noted with 100 mg K kg-I soil application rate, initial level of organic matter and at all temperature levels except in the Shahdra series where it was maximum at 30 °C and decreased at higher temperatures. The minimum K fixation was noted at 0 level of K application rate, along with 10 g organic matter kg-· at all temperature levels except in the Shahdra series where it was minimum only at 60 °C.

INTRODUCTION

Potassium fixation may be beneficial as it tends to retain the applied potassium temporarily in an unleachable state thus reducing the luxuriant consumption by crops. The extent of K fixation and its release depends on the size of the mineral particles, lirning, soil structure, plant roots, wetting and drying and freezing and thawing etc. (Goulding, 1987). It is generally believed that K is fixed when water molecules get expelled from the interlayer spaces and it is desirable that the K should fit into the ditrigonal holes of the Si-AI-O sheet. The prerequisite for K fixation is expanded state of the mineral when K supplied and it should collapse as K enters the interlayer spaces (Kittrick, 19(6). K fixation is increased/accelerated at higher temperatures and its concentration in the solution (Chouhand, 1980). The higher doses of K usually increase the K fixation but the proportion of applied K is decreased (Shakir, 1984; Ranjha *et al.,* 1992). Contrary to that the organic matter is said to have a depressive effect on K fixation (Joffe and Levine, 1947; Jou and Grime, 1980) likely could be due to increased CEC of the soil and resultantly increase of adsorption sites and reduction in selective adsorption sites (van Diest, 1978). The combined effect of K rate doses, organic matter and temperature on K fixation in alluvial soils has not been reported. Hence, a laboratory experiment was planned to see the interactive response of three alluvial soil series of Pakistan to temperature, organic matter and applied K and its fixation.

MATERIALS AND METHODS

The effect of temperature, organic matter and applied K was studied in three alluvial calcareous soil series of Pakistan namely the Lyallpur (fine silty, mixed, hyperthermic, ustollic haplargids), the Sultanpur (coarse silly, mixed, calcareous, hyperthermic, fluventic camborthids) and the Shahdra (coarse silly, calcareous, hyper-thermic, typic, torrifluvcnts). The surface soil samples (0-15 cm) were collected from the field and brought to the laboratory where they were air dried, ground and added to 400 mlcapacity plastic beakers @ 200 g beaker". Organic matter was applied @ original,S, 7.5 and 10 g kg-I, temperature was maintained 10 an oven at 30, 45 and 60 °C and K application was used @ 0, 50 and 100 mg K kg-I soil. These factors were studied in all possible combinations. Distilled water was added to bring each soil to almost field capacity and three. alternate wetting and drying cycles were completed. All the treatments were triplicated. After each drying, the soil was crushed, passed through 2 mm sieve and transferred back to the respective beakers before moving on to the next wetting, d;ying cycle. 1 N NH.OAc extractable K was determined ana K fixation calculated by the formula:

Fixed K = Original K ~ Added K _
Extracted K after
Welting-Drying cycle

(Shaviv *et al., 1985).*

All the analyses were done according to the methods given in Handboo,~ No. 60 *(V.S.* Salinity Laboratory Staff, 1954) except textural class by Moodic *et al.* (JQ39). All the data were analysed statistically by using factorial in Completely Randomised Design (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

The soil series used were non-saline, alkaline in reaction and calcareous having EC. 0.74 to 0.86 dS m-I, pHs 7.8 to 7.9 and $CaCO_3$ 7.1 to 12%. Extractable K ranged between 113 to 150 mg kg-I soil.

Table [illegible]. Effect of temperature, organic matter and applied potassium on potassium fixation in the Lyallpur soil series

Treatment (mg K kg^{-1} soil)		[illegible]				[illegible]				[illegible]			
		Organic matter (g kg^{-1})											
		0	5	7.5	10	0	5	7.5	10	0	5	7.5	10
0	mg kg^{-1} soil	9.87 l	8.32 mn	7.54 mno	7.05 o	8.23 mno	7.55 mno	7.30 no	7.15 o	8.67 m	8.05 mno	7.34 no	7.10 o
	Per cent of applied	-	-	-	-	-	-	-	-	-	-	-	-
50	mg kg^{-1} soil	24.47 g	23.60 gh	21.80 ij	19.07 k	23.47 fg	22.78 gh	22.09 hi	[illegible]	24.50 f	23.02 gh	21.25 j	19.13 k
	Per cent of applied	48.94	47.20	43.60	38.14	46.94	45.56	44.18	[illegible]	49.00	46.04	42.50	38.26
100	[illegible]	43.00 a	37.38 b	36.93 bc	35.29 de	[illegible]	36.71 bc	36.35 bcd	34.47 e	42.70 a	37.40 b	36.07 cd	34.93 e
	[illegible]	43.00	37.38	36.93	35.29	[illegible]	36.71	36.35	34.47	42.70	37.40	36.07	34.93

Effect of applied potassium, organic matter and temperature on potassium fixation: The results (Tables 1,2,3) depict that K fixation increased by three series as the rate increased from 0 to 100 mg kg-! soil but the percentage fixed of applied component (K) decreased. The Lyallpur series fixed comparatively more K than the Sultanpur and the Shahdra at both rates and it might be due to age although the Sultanpur has more clay contents but less weathered. The increase in K fixation by increasing its rates of application had also been reported by shakir (1984) and Hussain *et al.* (1986). The decrease in per cent fixed of applied K was also noted by Ranjha *et al. (1992).*

Potassium fixation decreased by increasing the organic matter contents in all the three soil series. The interaction between organic matter contents and applied potassium showed a decreasing trend on K fixation i.e. maximum fixation was observed in a combination of 0 (original) organic matter application with 100 mg K kg-^{t} soil rate followed by 5, 7.5 and 10 g kg-I organic matter at the same potassium level. The minimum fixation was noted in 0 and 10 g kg-! combination of organic matter. The higher rate of organic matter application decreased K fixation most probably due to the fact that organic matter increased the cation exchange capacity (CEC) of the soil by virtue of which more K was adsorbed on exchange complex and very little was left for fixation in the interlauicc spaces (van Diest, 1978).

The temperature had a significant but inconsistent effect on K fixation in all the series except the Sultan pur where it showed non-significant effect. Maximum K fixation was noted in the 30 °C and 100 mg K kg^{-1} soil combination in all the series with the exception that it was non-significant at other temperature levels i.e. 45 and 60 °C at the same K application ratc in the Sultanpur series. The minimum K fixation was noted at 0 K application at all temperature levels. the inconsistent effect of temperature might be due to the reason that low levels of temperature were used which could not cause to remove sufficient water from interlattice spaces. Similar observations w,cre made by Burns and Barber (1961) but other workers who studied K fixation at higher temperature i.e. 80 °C and beyond 300°C (Inoue, 1983), 80°C (Kaila, 1965) and 103°C (Karim and Malik, 1957) found significant effect of temperature on K fixation.

At all the temperature levels, potassium fixation was maximum when combined with original level of organic matter and 100 mg K kg-I application rate except the Shahdra series where it was maximum only at 60 °C temperature. This fixation was reduced by decreasing K rate and increasing organic matter levels but independent of temperature. Minimum fixation was noted in the treatment 10 g kg-! organic matter with 0 potassium at all temperature levels. These results lead us to conclude that although temperature had non-significant effect but yet it increased the decomposition of organic matter which in turn increased the CEC and available potassium content of soils due to which potassium fixation was decreased. Similarly, Patel *et al.* (1989) found that per cent K fixation generally decreased with increasing level of K application to the soils with increased incubation period. The trend for K fixation was distinctly variable in different soil series under alternate wetting and drying cycles. Wetting enhanced K fixation while drying reduced it whereas organic matter increment decreased K fixation.

REFERENCES

Burns, AF. and S.A. Barber. 1961. The effect of temperature and moisture on exchangeable K. Soil Sci. Soc. Am. Proc. 25: 349-352.

Chouhan, S.D. 1980. Potassium equilibria in calcareous soils of Pakistan. M.Sc. Thesis, Dept.. Soil Sci., Univ. Agri., faisalabad.

Goulding, K.W.T. 1987. Potassium fixation and release. pp: 137-154. In: Proc. 20th IPI Congo Methodol. . in Soil K Res., June, 1987. baden bei Wien, Austria.

Hussain, T., S.D. Chouhan and MJ. Makhdoom. 1986. Influence of texture on potassium equilibrium in calcareous soil. Pak. J. Soil Sci. 1: 7-12.

Inoue, A 1983. Potassium fixation by clay minerals during hydrothermal treatment.. Clay and Clay Minerals, 31 (2): 81-91.

Joffe, J.S. and AK.. Levine. 1947. Fixation of potassium in relation to exchange capacity of soil. 11, Ill.. Soil Sci. 63: 241-247.

Jou, AS.R. and H. Grime. 1980. K status in major soils of tropical Africa with special reference to K availability. Potassium Workshop, Ibadan, Nigeria. pp: 7-22.

Kaila, A. 1%5. Fixation of potassium in finish soils. Maataloust. . Aikak. 37: 116-126. (Commonwealth Bureau of Soils, Bib. Series No. 1409/36, 116.32.110, 1970).

Karim, AQ.M.B. and M.A.. Malik. 1957. Potassium fixation in East Pakistan soils under different conditions. Soil Sci. 83:.229-238.

Kittrick, JA. 1966. Forces involved in ion' fixation by vermiculites clays. Clay Mineral.. 21: 479-4R8.

Moodic, CD., H.W. Smith and R.A Mc-Creery. 1959. Laboratory Manual for Soil Fertility. Dept.. Agron., State College of Washington, Pullman. pp: 31-39.

Patel, M.S., G.J. Had~ani and B.S. Yadav. 1989. Fixation of potassium in important soil groups of Western Gujrat.. J. Potassium Res. 5: 134-142.

Ranjha, AM., S.M. Mehdi and R.H.. Qureshi. 1992. 'potassium behaviour in some alluvial soil series of Pakistan. J. Agri.. Res. 30 (1): 101-110.

Shakir, M.A 1984. Potassium dynamics in soils. M.Sc. Thesis, Dept.. Soil Sci., Univ, Agri., Faisalabad.

Shaviv, AM., M. Mohsin, P.F. Pratt ansJ., S.Y. Mattigod, 1985. Potassium fixation characteristics of five Southern California soils. Soil Sci. Soc. Am. J. 49: 1105-1109.

Steel, R.G.D. and LH, Torrie. 1980. Principles and Procedures of Statistics. Znd Ed., McGraw Hill Book eo. Inc., New York, USA

U.S. Salinity Lab. Staff. 1954. Diagnosis a~-d Improvement of Saline and Alkali soils. USDA Handbook No. 60, Washington, D~160~

van Diest, A. 1978: Factors affecting the availability of potassium "in soils. In: Potassium Res. Rev. Trends. 25th'Anniv. Sci. Board, Int. Potash Inst.. pp: 75-98.