Vol. 9, pp. 28-32 (2009)
Journal of Agricultural Physics
http://www.agrophysics.in

Effect of the Levels of Potassium and Manganese on the Uptake of N, P, and K and Yield of Wheat

ASHOK[1]*, J. SINGH[2], P. KUMAR[3], N. CHAUHAN[4] AND G.R. SINGH[1]

[1]*Department of Agricultural Chemistry and Soil Science, C.C.R. (P.G.) College, Muzaffarnagar, Uttar Pradesh*

[2]*Project Directorate of Cropping System Research, Modipuram, Meerut, Uttar Pradesh*

[3]*Sri Ram Fertilizers Ltd., Meerut, Uttar Pradesh*

[4]*SVBPUA&T, KVK, New Gopal Nagar, Numaish Camp Saharanpur*

ABSTRACT

A pot experiment conducted during *rabi* season revealed a significant increase in grain and straw yields and uptake of N, P, K and Mn by wheat with the application of K and Mn. The increase in grain yield due to such application of 25, 50 and 100 kg K ppm was 14.7, 29.1 and 30.6 per cent respectively over control and corresponding increases in, straw yield were16.6, 28.8 and 30.5 per cent respectively over control. Application of 25, 50 and 100 ppm K, N uptake by wheat grain with 10 and 20 ppm manganese over control were 3.5 and 5.9 per cent and corresponding increases in the N uptake by wheat straw were 4.4 and 9.5 per cent, respectively. The highest values of P uptake in wheat were recorded under 40 ppm Mn + 50 ppm K treatment. The maximum values of K uptake in wheat were recorded with 100 ppm K level. The maximum value of manganese uptake by wheat was recorded at 50 ppm K. The highest level of K could not increase the manganese uptake over 50 ppm K addition. However, the value of Mn uptake obtained at 100 ppm K was significantly higher as compared to control by wheat grains.

Key words: Potassium, Manganese, Grain, Straw, Uptake, Yields

Introduction

Wheat is an important cereal crop of Uttar Pradesh. The soils of U.P. are known to be getting depleted in available K and Mn due to continuous cropping with out externally supplementing these nutrients (Rattan et al. 1995). In case of wheat, manganese deficiency is exhibited by stunted growth, chlorotic spots or streaks, which range in colour from white and whitish yellow to yellowish green. The dynamics of manganese is greatly influenced by the interaction of various fertilizers applied to the soil. For optimum utilization of manganese by the crops knowledge of behavioural interaction of these fertilizers and manganese is essential. The beneficial effect of ammonium sulphate on the availability of manganese is well known and have been attributed to changes in pH, which accompany the uptake and nitrification of NH_4^+. It may be expected that the nitrogen compounds exert a direct effect on the uptake of manganese. Application of nitrogen and sulphur also increases the uptake of manganese. However, the information on the response of K and Mn application by wheat is meager, therefore, the present study was under taken.

*Corresponding author

Materials and Methods

A pot experiment was conducted to study the response of K and Mn application. The pod soil had the composition: sand 60.2 per cent, silt 18.1 per cent, clay 21.6 per cent, texture sandy loam, pH 7.7, EC 0.16 (dSm^{-1}), calcium carbonate 0.45 per cent, organic carbon 0.25 per cent, available N 267 (kg/ha), available K 245 (kg/ha),available iron 3.6 (kg/ha) and available Mn 1.7(ppm). Wheat plant samples were individually washed thoroughly with tap water and teepol, rinsed and individually swabbed with wet cotton. Distilled water was used for rinsing and swabbing and subsequent washing. After washing, the plants were dried in oven at 60-70^{0}C and manually crushed. The soil samples were air dried and kankar modules were removed. The samples were crushed with wooden hammer and sieved through cloth. Thereafter, samples were stored in the wide mouthed bottles after proper labelling. These samples were later subjected to chemical analysis. Five kg soil was placed into earthen pots. The experiment comprising of the four levels of potassium (0, 25, 50 and 100 ppm) and Mn (0, 10, 20 and 40 ppm) was laid out in randomized block design with three replications. Basal nutrients solution N as urea and P as diammonium phosphate, were applied in all pots which were watered to field capacity and wet soil was equilibrated for seven day before sowing ten germinated seeds of wheat. Plants were thinned of five per pot fifteen day after sowing and top dressed with addition of nitrogen as urea. The plant samples were digested in nitric acid and perchloric acid. Nitrogen was estimated by Kjeldahl method. Phosphorous was estimated by using the molybdo-vanadophosphate method and Potassium was determined directly on flame photometer while Mn as per BAAS method.

Results and Discussion

Effect of Potassium and Manganese

Data presented in Table 1 revealed that Grain and straw yields increased significantly with increase in K application. Increases in grain yield at 25, 50 and 100 ppm K levels were 14.7, 29.1 and 30.6 per cent over control, respectively. The corresponding increases in straw yield were 16.6, 28.8 and 30.5 per cent. The highest yields of grain and straw were recorded with 100 ppm K addition. Responses to K application in wheat have also been reported by Tiwari et al. (1974), Singh and Malik (1979). The yield of wheat also increased significantly with the application of manganese. The highest grain and straw yields were recorded with 10 ppm Mn. The differences in yield due to 10 and 20 ppm Mn application were significant over control. From these results, it may be concluded that 20 ppm Mn is optimum dose for proper growth and development of wheat. The significant response of wheat to manganese in the present study may be accounted for the low amount of DTPA-Mn in soil. The interaction effect of K and Mn on grain and straw yields was found to be significant (Table 2). Wheat yield increased significantly with K application under all the levels of Mn. Similarly, an increase in yield was also recorded with the application of manganese. However, the highest level of Mn (40 ppm) decreased the yield over

Table 1. Effect of potassium and manganese on yield of grain and straw in wheat

K levels	Mn levels (ppm)				
(ppm)	0	10	20	40	Mean
		Grain yield (g/pot)			
0	4.25	4.45	4.56	4.37	4.40
25	4.95	5.38	5.45	5.46	5.31
50	5.60	6.40	6.24	5.98	6.05
100	5.73	6.50	6.10	5.76	6.02
Mean	5.13	5.43	5.65	5.34	
		K and Mn		K x Mn	
SEm+		0.002		0.004	
LSD. (P=0.05)		0.004		0.009	
		Straw yield (g/pot)			
0	6.10	6.40	6.70	5.90	6.28
25	7.27	7.45	7.67	6.93	7.32
50	8.00	8.15	8.36	7.85	8.09
100	8.16	8.30	8.35	8.00	8.20
Mean	7.38	7.58	7.76	7.14	
		K and Mn		K x Mn	
SEm+		0.003		0.006	
LSD. (P=0.05)		0.006		0.012	

Table 2. Effect of potassium and manganese on N uptake by wheat grain and straw in wheat

K levels (ppm)	Mn levels (ppm) 0	10	20	40	Mean
N uptake by grain (mg/pot)					
0	96.8	101.2	106.4	96.9	100.0
25	111.2	115.0	118.2	108.3	113.2
50	124.2	128.6	131.4	128.2	128.1
100	125.2	131.8	129.0	123.5	126.6
Mean	114.3	118.4	121.2	114.0	
		K and Mn		K x Mn	
SEm+		0.177		0.352	
LSD. (P=0.05)		0.362		0.724	
N uptake by straw (mg/pot)					
0	25.3	27.9	29.3	26.1	27.2
25	29.8	31.3	32.3	28.2	30.4
50	31.4	33.1	34.3	32.3	32.7
100	30.4	31.0	32.8	29.8	31.0
Mean	29.3	30.7	32.3	31.3	
		K and Mn		K x Mn	
SEm+		0.251		0.501	
LSD. (P=0.05)		0.512		1.024	

Table 3. Effect of potassium and manganese on P uptake by wheat grain and straw in wheat

K levels (ppm)	Mn levels (ppm) 0	10	20	40	Mean
P uptake by grain (mg/pot)					
0	9.7	10.5	12.1	10.8	10.7
25	11.7	13.3	13.6	13.0	12.8
50	14.5	14.8	15.6	15.8	15.1
100	14.7	14.4	15.1	14.5	14.7
Mean	12.6	13.2	14.1	13.6	
		K and Mn		K x Mn	
SEm+		0.177		0.352	
LSD. (P=0.05)		0.362		0.724	
P uptake by straw (mg/pot)					
0	4.1	4.9	5.2	5.1	4.8
25	6.3	6.5	6.4	6.7	6.5
50	7.0	7.1	8.1	8.1	7.6
100	7.2	6.4	7.3	7.8	7.1
Mean	6.1	6.2	6.7	6.9	
		K and Mn		K x Mn	
SEm+		0.258		0.578	
LSD. (P=0.05)		0.528		NS	

control in the absence of K. The maximum yield was recorded under 50 ppm K + 20 ppm Mn treatment. The highest level of K (100 ppm) could not increase the yield of wheat in the presence of 40 ppm Mn over 20 ppm Mn.

Interaction Effect of K and Mn on N Uptake of Wheat

The N uptake by wheat was increased significantly up to 50 ppm K which was decreased with increase in K level. The values of N uptake obtained with 100 ppm K were significantly higher than those obtained with control treatment. Singh and Malik (1979) also reported similar results. The uptake of N by wheat increased significantly at lower levels of Mn. Since, N content of grain is an index of its protein percentage, the Mn application can be considered very much beneficial in improving the quality of wheat grain. The maximum uptake of N by wheat was recorded with 10 ppm Mn level. The increase in N uptake by wheat grain with 10 and 20 ppm manganese over control were 3.5 and 5.9 per cent, respectively. The corresponding increases in N uptake by wheat straw were 4.4 and 9.5 per cent. The interaction effect of Mn and K on N uptake by wheat was significant (Table 2). The lower levels of both Mn and K application had a beneficial effect on the N uptake by wheat. The maximum values of N uptake were recorded under 50 ppm K + 20 ppm Mn treatment. The higher levels of K and Mn (100 ppm K + 40 ppm Mn) could not improve the utilization of N by wheat over 50 ppm K + 20 ppm Mn treatment.

Effect of K and Mn Levels P Uptake

Data given in Table 3 revealed that there was a significant increase in P uptake by wheat with K application. The effect of 25 ppm K in enhancing the P uptake was also significant over control. The highest value of P uptake was recorded at 50 ppm K application. All the levels of K proved significantly superior to control for P utilization by wheat. However, a non-significant reduction in P uptake by grain and straw was noted with 100 ppm K over 50 ppm K levels. There was a significant increase in P uptake by wheat with Mn application. All the levels of Mn

Table 4. Effect of potassium and manganese on K uptake by wheat grain and straw in wheat

K levels (ppm)	Mn levels (ppm) 0	10	20	40	Mean
K uptake by grain (mg/pot)					
0	17.8	20.5	20.7	18.1	19.8
25	26.4	26.3	26.4	23.2	25.6
50	33.5	33.8	36.1	31.6	33.0
100	41.4	40.5	39.9	37.3	39.7
Mean	30.3	30.3	30.0	27.5	
		K and Mn		K x Mn	
SEm+		0.163		0.327	
LSD. (P=0.05)		0.333		0.667	
K uptake by straw (mg/pot)					
0	110.7	115.0	119.1	104.0	112.2
25	113.4	155.7	158.9	142.6	152.6
50	189.0	189.3	190.8	177.5	186.6
100	205.9	206.2	206.6	195.4	203.5
Mean	164.7	166.5	168.8	154.8	
		K and Mn		K x Mn	
SEm+		0.246		0.492	
LSD. (P=0.05)		0.502		1.000	

Table 5. Effect of potassium and manganese on Mn uptake by wheat grain and straw in wheat

K levels (ppm)	Mn levels (ppm) 0	10	20	40	Mean
Mn uptake by grain (mg/pot)					
0	0.21	0.23	0.27	0.27	0.17
25	0.21	0.24	0.27	0.27	0.17
50	0.21	0.23	0.25	0.27	0.23
100	0.17	0.21	0.23	0.24	0.21
Mean	0.20	0.22	0.27	0.26	
		K and Mn		K x Mn	
SEm+		0.002		0.004	
LSD. (P=0.05)		0.004		NS	
Mn uptake by straw (mg/pot)					
0	0.17	0.20	0.23	0.22	0.20
25	0.19	0.22	0.23	0.23	0.22
50	0.19	0.21	0.24	0.25	0.22
100	0.16	0.18	0.21	0.22	0.19
Mean	0.17	0.20	0.23	0.23	
		K and Mn		K x Mn	
SEm+		0.003		0.006	
LSD. (P=0.05)		0.006		0.011	

had significant beneficial effect on the P utilization by wheat as compared to control. The maximum P uptake in wheat grain and straw were noted under 20 and 40 ppm Mn treatment, respectively. Application of 40 ppm Mn resulted in reduced P uptake by wheat grain over 20 ppm Mn level. Singh and Raina (1981) reported an increase in P uptake by oats with Mn addition. The highest P uptake was recorded under 40 ppm Mn + 50 ppm K treatment. The lower levels of Mn and K both proved beneficial as they increased the utilization of P by wheat . But highest level of K failed to increase the P uptake over its lower level.

Effect of K and Mn Levels on K Uptake

Table 4 revealed significant increase in K uptake by wheat with its application in crop. The maximum value of K uptake was recorded with 100 ppm K level. All the levels of K proved significantly superior to control in respect of its uptake by wheat grain and straw. Similar results were also recorded by Singh and Malik (1979), and Singh et al. (1986). The uptake of K by wheat straw increased significantly with lower level of Mn. The maximum uptake of K by wheat straw was recorded with 20 ppm Mn application. However, lower level of Mn (10 ppm) could not improve the utilization of K by wheat grain over control. The higher levels (20 and 40 ppm) of Mn reduced the uptake of Mn by wheat grain significantly over control. The interaction effect of K and Mn on K uptake by wheat crop was significant (Table 4.31). Lower levels of Mn also had a beneficial effect on K uptake by wheat straw. However, Mn addition showed an antagonistic effect on the utilization of K by wheat grain.

Effect of K and Mn Levels on Mn Uptake

Table 5 revealed that the uptake of Mn by wheat increased significantly with K application. The maximum uptake of manganese by wheat crop was recorded at 50 ppm K. The highest level of K could not increase the Mn uptake over 50 ppm K addition. However, the value of Mn uptake obtained at 100 ppm K was significantly higher as compared to control in wheat grains. The 100 ppm K reduced the uptake of Mn by

wheat straw over control. The uptake of Mn by wheat increased significantly with its application. There was a gradual increase in Mn uptake with the increasing levels of Mn and maximum values of Mn uptake in wheat grains and straw were noted at 20 and 40 ppm Mn, respectively. All the levels of Mn proved significantly superior over control in respect of Mn uptake by wheat grain and straw. Mishra and Tripathi (1973) and Singh and Raina (1981) also reported an increase in Mn uptake with its addition. The interaction effect of K and Mn on the utilization of manganese was significant (Table 5) and maximum values were recorded under 50 ppm K + 40 ppm Mn treatment. The highest level of K (100 ppm) showed an antagonistic effect on the utilization of Mn by wheat grain and straw.

References

Gangwar, M.S. 1986. Studies on iron and manganese in soils of Rohilkhand Region of Uttar Pradesh. Ph.D. thesis, Agra University, Agra.

Singh, V., Prakash, C. and Singh, S.P. 1986. Effect of potassium on yield and uptake of N, Ca, Mg, K by wheat. *J. Indian Soc. Soil Sci*. **8**: 22-26.

Lindsay, W.L. and Norvell, W.A. 1978. *Soil Sci. Soc. Am. J.* **42**, 421.

Olsen and Sommers 1982. In Methods of Soil Analysis Part 2: Chemical and Microbiological Properties, (Eds. Page *et al.*), 2nd edn. Agronomy. 9, ASA & SSSA, Madison, Wisconsin, USA, p.403

Richards, L.A. 1954. Diagnosis and improvement of saline and alkali soils, USDA Hand Book No. 60, Washington, DC.

Rattan, R.K. and Balloli, S.S. 1995. Soil Sulphur Status and crop responses to sulphur in Western Uttar Pradesh. *Fertilizer News*, **40**(4): 31-40.

Mishra, B. and Tripathi, B.R. 1973. Effect of N, P and K fertilizers on the availability of native and applied manganese to wheat. *Indian J. Agric. Sci*. **81**: 369-373.

Singh, V. and Raina, B.D. 1981. Effect of graded doses of phosphorus and manganese on nutrients availability and yield of oat crop. *Agra Univ. J. Res*. (Sci.), **30** (11): 33-36.

Singh, Vinay and Malik, P.S. 1979. Effect of potassium fertilization on the chemical composition of wheat at different stages of growth. *Agra Univ. J. Res*. (Sci). **28** (3): 121-128.

Singh, Vinay, Prakash, C. and Singh, S.P. 1986. Effect of potassium on the yield and uptake of N, Ca, Mg and K by wheat. *J. Agric. Sci. Res*. **8**: 22-26.

Tiwari, K.N. Pathak, A.N. and Singh, M.P. 1974. Studies on phosphorus and potassium requirement of wheat variety Kalyan sona in relation to soil type and fertility status. *J. Indian Soc. Soil Sci*. **22**(1): 52-56.