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Impact of method of application and concentration of potassium on yield of wheat

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Abstract

A field experiment was conducted to study the effect of different levels and methods of potassium application on yield, K uptake and forms of potassium in wheat crop at experimental field of Division of Soil Science, Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir. The treatment consisted of 5 levels of potassium (0, 20, 40, 60 and 80 kg K_2O ha^{-1}) and two methods of application viz Single basal and split (1/2 basal+1/2 at tiller initiation stage). Out of various treatments, split application of potassium @ 80 kg K_2O ha^{-1} was found superior to single basal application in terms of grain yield (43.20 q ha^{-1}) and K uptake (22.89 kg ha^{-1}) by grains at harvest. However, it was at par with split application of 60 kg K_2O ha^{-1}. All forms of potassium viz water-soluble, exchangeable, available, boiling HNO_3 extractable and lattice increased with increasing levels of potassium and were found maximum (3.20, 62.80, 66.00 ppm 0.723 and 1.440 % respectively) when potassium was applied @ 80 kg K_2O ha^{-1} in two equal splits except for lattice K which was maximum (1.440 %) when potassium was applied @ 60 kg K_2O ha^{-1}

Key words

K-uptake, Potassium, Wheat, Yield

Introduction

Wheat crop by virtue of its potentiality is emerging as a potential field crop under the Kashmir valley conditions. In Jammu and Kashmir, it is grown on an area of about 274 thousand ha with an annual production of 4.84 lakh metric tones (Anonymous, 2010-2011). However, its productivity in Kashmir valley is very low due to the lower application of nutrient fertilizers especially potassium, which plays an important role in sustaining higher productivity of the crop (Saifullah *et al.,* 2002). In addition to its major role in metabolic processes and grain/seed formation, potassium improves the quality of agricultural produce, prevents lodging in cereal crops, imparts resistance to pests and diseases and tolerance to cold and frost (Marschner, 1995). Today potassium is recognized as an important factor in crop production. With the introduction of high yielding varieties under intensive cropping system, soils have starting depleting from high to medium to low K status as evidenced by soil testing and experiments conducted under AICRP programme of ICAR (Sharma and Swarup, 2001). Also in absence of adequate potassium fertilization, significant depletion of soil-K reserves takes place, which results in yield loss and higher economic risk to farmers (Srinivasarao *et al*., 2011). Potassium supplying capacity of soil depends on their total potassium content and releasing characteristic from different forms which are influenced by physico-chemical properties of soil. In general, crops remove more potassium from soil than the amount present in soil as water soluble and exchangeable forms (Wani *et al*., 2009).

Potassium is not supplied from decomposing humus. Immediate crop obtains all K from soluble and exchangeable forms. It has been observed that a significant proportion of K requirement by plants are met from non exchangeable fraction of soil K. The additional amount of potassium is taken up by the plant from the applied inorganic fertilizer (Yadav *et al.,* 1993). Proper level and method of potassium application favourably influences the yield and yield attributing characteristics of wheat than single basal application. (Yang, *et al.,* 1997 and Chaudhary and Roy 1992) Since the information regarding this aspect is meagre, therefore the study on impact of methods of application and concentration of potassium on wheat yield was undertaken in temperate conditions of Kashmir valley.

Materials and Methods

The experiment was undertaken on the experimental farm of Division of Soil Science, Sher-e-Kashmir University of Agricultural Sciences and Technology Kashmir, Shalimar during 2008-09 with wheat Variety HS-240 as test crop. Before sowing, a representative composite soil sample was taken and analysed for different physico-chemical characteristics following standard methods as outlined by Jackson (1973). The experiment was laid out in randomized block design with three replication and nine treatments. The details of treatment are :.T_1-control (0 kg K_2O ha^{-1}) ; T_2-20 kg K_2O ha^{-1} basal; T_3- 40 kg K_2O ha^{-1} basal; T_4-60 kg K_2O ha^{-1} basal; T_5-80 kg K_2O ha^{-1} basal, T_6-20 kg K_2O ha^{-1} (half basal +half at tillering stage) T_7-40 kg K_2O ha^{-1} (half basal +half at tillering stage); T_8-60 kg K_2O ha^{-1}(half basal+ half at tillering stage) T_9-80 Kg K_2O ha^{-1} (half basal +half at tillering stage). Potassium was applied in the form of Muriate of potash (MOP) at the time of sowing and tiller initiation stage (150 DAS) as per treatments. Nitrogen and phosphorus was applied in the form of urea and DAP respectively as per package of practices. The seeds were sown in lines with a spacing of 25 cm X 10 cm. Plant samples were collected at tillering (150 DAS) and flowering stage (170 DAS) for their dry matter and K content. At harvest (210 DAS) the grain and straw yield was recorded. The grain and straw samples at harvest were collected treatment wise and digested in diacid mixture (HNO_3:HCl:: 10:1) as per procedure outlined by Jackson (1973). Digested samples were preserved for estimation of potassium. The soil samples at harvest were collected treatment wise and analysed for various forms of K as per procedure outlined by Black (1965). The data collected was subjected to statistical analysis following standard statistical procedures of Gomez and Gomez (1984).

Results and Discussion

Data presented in Table 1 revealed that the dry matter yield of wheat increased significantly with increasing levels of potassium upto 60 kg K_2O ha^{-1} at all stages of growth i.e tillering, flowering and harvest, when potassium was applied as basal dose. The yield recorded at tillering, flowering and harvest (grain and straw) was 15.17, 38.00, 40.00 and 58.00 q ha^{-1} respectively when potassium was applied at 60 kg K_2O ha^{-1}(T4) as a basal dose only (Table 1). Further, increase in the level of potassium upto 80 kg ha^{-1} as basal dose had non significant effect on dry matter yield of wheat (Table 1). In split application, the dry matter yield also increased significantly upto 60 kg K_2O ha^{-1}. The yield recorded at tillering, flowering and harvest (grain and straw) was 14.83, 42.00, 43.00 and 62.78 q ha^{-1} respectively, when potassium was applied at 60 kg K_2O ha^{-1}(T8) in two splits (Table 1). Further increase in the level of potassium had a non significant effect on the dry matter yield. From the results it was observed that the split application of potassium proved better in terms of yield productivity at all stages of growth as compared to single basal application irrespective of potassium level. Higher response of potassium in split application may be attributed to the higher buffering capacity of soil coupled with lower fixation of applied potassium. Similar findings were reported by Tariq and Shah (2002).

Data presented in Table 2 show that there was a significant increase in K-uptake by crop with increasing levels of potassium upto 60 kg ha^{-1} after which a non significant effect on the K uptake was observed at all growth stages. Perusal of data revealed that uptake of potassium was significantly more at tillering stage (30.34 kg K ha^{-1}) when applied as a basal dose at the rate of 80 kg K_2O ha^{-1} in comparison to its split application where uptake of potassium was 29.35 kg K ha^{-1}. This may be attributed to the increased availability of potassium in soil solution added as basal dose resulting in the better utilization of potassium by plants at early stage. At flowering stage, more uptake of K 55.52 kg ha^{-1} by crop was observed in the treatment where 60 kg K_2O ha^{-1} was applied in two split doses compared to single basal application. At harvest, maximum uptake of K 22.89 kg ha^{-1} by

Table 1 : Effect of levels and methods of potassium application on dry matter yield (q ha^{-1}) of wheat at different stages of growth

Treatment	K_2O applied (kg ha^{-1})	Tillering (150 DAS)	Flowering (170 DAS)	Harvesting	
				Grain	Straw
T_1	0	8.50	28.17	25.00	40.00
T_2	20	12.67	36.10	30.00	45.50
T_3	40	13.83	37.00	35.50	56.55
T_4	60	15.17	38.00	40.00	58.00
T_5	80	15.25	38.20	40.25	58.28
T_6	20	12.57	36.10	32.00	47.68
T_7	40	13.07	39.67	37.00	53.28
T_8	60	14.83	42.00	43.00	62.78
T_9	80	14.90	42.20	43.20	62.98
LSD at 5%		0.1642	0.2385	1.20	0.90

T2-T5 = Single application as basal; T6-T9= Split application (1/2 basal + ½ at tillering stage) grain was observed in the treatment where 80 kg K_2O ha^{-1} was applied in split doses compared to single basal dose (Table 2). This may be attributed to higher availability of potassium and lower transformation of potassium into non-exchangeable pool which may result in the better utilization of potassium by crop. This is in agreement with the findings of Arabinda *et al.* (2009).

With increasing levels of potassium application there was increase in the content of water soluble potassium in soil (Table 3). It was found slightly more in the treatments where K was applied in two splits as compared to single basal application. The maximum content of potassium 3.25 ppm was observed (higher than control 2.85 ppm) when potassium was applied at 80 kg K_2O ha^{-1} in two splits. This signifies that the application of potassium in splits improves the retention of this element. The similar trend was also reported by Mishra *et al* (1993). The data presented in Table 3 revealed that the available potassium increased with increase in the K-levels. The maximum content of available K 66 ppm was observed in T_9, where potassium was given in two splits and it was higher than control. It may be attributed to the retention of potassium due to higher CEC and illitic nature of soil. Bangroo *et al.* (2012) also reported similar trend while studying some Kashmir soils Results have shown that exchangeable potassium increased with increase in K levels (Table 3). The maximum content of potassium 62.80 ppm was observed in T_9, where potassium was applied in split doses. The increase in retention of exchangeable-K may be attributed to the cation exchange reaction of soil. Similar findings were observed by Wani *et al.*, (2009). The data presented in Table 3 revealed that extractable potassium also increased with increasing levels of potassium application and was found maximum in T_9 (0.723 %) ,where potassium was given in two splits. This may be attributed due to shifting of equilibrium solution phase to non-exchangeable as well as illitic nature of the clay mineral. Wani (2009) has also reported a higher content of NEK in Kashmir soils.

Lattice potassium increased with increasing levels of potassium upto 60 kg ha^{-1} after which no increases was observed (Table 3). The maximum content of lattice potassium (1.44 per cent) was observed when potassium was applied @ 60 kg ha^{-1} both as basal and in two splits. This signifies that the mode of application had no significant effect on the content of lattice potassium. Higher content of lattice potassium may be attributed to the higher fixing capacity of soil due to presence of illitic type of clay minerals. These findings are in confirmation with the previous reports of Bangroo *et al.* (2012). Significant positive relationships of water soluble, exchangeable, available and lattice potassium with organic carbon (0.671**, 0.661**, 0.662** and 0.636**

Table 2 : Effect of levels and methods of potassium application on K uptake (Kg ha^{-1}) by wheat at different stages of growth

Treatment	K_2O applied (kg ha^{-1})	Tillering (150 DAS)	Flowering (170 DAS)	Harvesting	
				Grain	Straw
T_1	0	13.60	21.40	8.250	56.00
T_2	20	23.05	33.21	12.00	76.20
T_3	40	26.00	35.52	15.05	95.00
T_4	60	29.88	38.38	18.80	100.92
T_5	80	30.34	39.35	19.32	102.00
T_6	20	20.47	33.93	13.76	78.67
T_7	40	22.61	40.46	17.40	93.24
T_8	60	27.43	55.52	22.36	112.37
T_9	80	29.35	45.20	22.89	113.36
LSD at 5%		1.22	1.50	0.50	1.20

T2-T5 = Single application as basal; T6-T9= Split application (1/2 basal + ½ at tillering stage)

Table 3 : Effect of potassium application on different forms of potassium at harvest in soil (210 DAS)

Treatment	K_2O applied (Kg ha^{-1})	WS-K(ppm)	Exch-K(ppm)	Avail-K(ppm)	I NHNO$_3$-K(%)	Lattice-K(%)	Total-K(%)
T_1	0	2.85	47.15	50.00	0.716	1.438	2.154
T_2	20	2.94	52.06	55.00	0.718	1.439	2.156
T_3	40	3.05	56.45	59.50	0.719	1.439	2.159
T_4	60	3.15	60.35	63.50	0.721	1.440	2.161
T_5	80	3.22	62.28	65.50	0.723	1.440	2.162
T_6	20	3.00	53.00	56.00	0.719	1.438	2.157
T_7	40	3.07	56.93	60.00	0.720	1.439	2.159
T_8	60	3.15	61.35	64.50	0.722	1.440	2.162
T_9	80	3.25	62.80	66.00	0.723	1.440	2.163

Table 4 : Correlation coefficient between physico-chemical characteristics and forms of potassium

	pH	EC	OC	Ca^{2+}	Mg^{2+}
Ws-K	-0.200	-0.268	0.671**	0.901	0.944**
Exch-K	-0.127	-0.215	0.661**	0.934	0.942**
Avail-K	-0.128	-0.216	0.662**	0.933	0.943**
1N HNO_3-K	-0.230	0.017	0.210	0.007	0.016
Lattice –K	-0.141	-0.253	0.636**	0.860**	0.906**
Total-K	-0.096	-0.223	0.633	0.949**	0.946**

* Significant at 5 %; ** Significant at 1 %

respectively), exchangeable Ca (0.901, 0.934, 0.933 and 0.860, respectively) and Mg (0.944**, 0.942**, 0.943** and 0.906**, respectively) were also observed. A non significant correlation of I N boiling HNO_3 extractable potassium with all physico-chemical properties of soil was observed. pH and EC had a negative and non signification relationship with all forms of potassium (Table 4). It may be concluded that the split application of potassium @ 80 kg K_2O ha^{-1} is superior to single basal application in terms of grain yield and K uptake by the grain at harvest, although at par with split application of 60 kg K_2O ha^{-1} and all forms of potassium *viz.,* water-soluble, exchangeable, available, boiling HNO_3 extractable and lattice increased with increasing levels of potassium. Hence, split application of potassium bearing fertilizer may be preferred in place of whole basal dose for wheat crop.

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