Soil & Environ. 28(2): 193-196, 2009
www.se.org.pk
ISSN: 2074-9546 (Print)
ISSN: 2075-1141 (Online)

Short Communication

Effect of potassium application on yield and protien contents of late sown wheat (*Triticum aestivum* L.) under field conditions

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Abstract

Potassium (K) is known to improve yield and quality parameter of higher plants. A field experiment was conducted for two consecutive years to study the effect of K on yield and protein contents in late sown wheat. Experiment was laid out in randomized complete block design (RCBD). Potassium levels applied were 0, 25, 50, 75, 100, 125 and 150 kg K_2O ha^{-1} along with a basal dose of 100-100 kg NP ha^{-1}. Agronomic traits and yield of wheat were significantly improved by addition of K application. The highest grain yield of 4235 kg ha^{-1} was recorded with the application of 75 kg K_2O ha^{-1} which was at par with 100 kg K_2O ha^{-1} (4209 kg ha^{-1}). Protein contents in grain improved significantly with K application over check being the highest (11.13 %) in grains receiving 150 kg K_2O ha^{-1} indicating thereby that K plays an important role in increasing protein contents. In nut shell, application of 75 kg K_2O ha^{-1} increased wheat yield and grain protein contents by 8.58 and 4.7 per cent, respectively, compared with control.

Key words: Potassium, protein contents, wheat

Potassium (K^+) is of special significance because of its active role in bio-chemical functions of the plant like activating various enzymes, improvement of protein, carbohydrates and fat concentration, developing tolerance to drought and resistance to frost, lodging, pests and disease attack (Marschner, 1995). Thus deficiency of K^+ in soils may result in decreased yield of higher plants (Tisdale *et al*., 2002; Ali *et al*., 2005; 2008).

Pakistani soils are mostly derived from loess or alluvial deposits and have large capacity to provide K^+ to crops under ordinary conditions because of specific mineralogy (Saleem and Bertilson, 1978; Bajwa, 1994). The agronomic data regarding benefits of K fertilization in Pakistan is erratic and non-consistent and experiments are mostly conducted in pots (Rahmatullah *et al*., 2002; Wakeel *et al*., 2005). However, increase in the intensity of cropping and introduction of high yielding fertilizer responsive cultivars have resulted in a considerable drain of soil K^+ reserves. This heavy exploration of soils is likely to result in severe depletion of K^+ and eventually limits efficiency of other nutrients.

Furthermore, K^+-depleted mica may fix large quantities of soluble K^+ ions so that considerable quantity of this nutrient would be needed to overcome fixation before it is made available to plants (Rahmatullah *et al*., 2002; Tisdale *et al*., 2002). In the present day intensive and high yield oriented agriculture, there is a negative K^+ balance and consequently the soils are being mined of this essential nutrient (Roy, 2000; Tan *et al*., 2005). On many soils containing large amount of total K^+, crop may respond to addition of K^+ fertilizer. Furthermore, farmers are reluctant to use K^+ fertilizers and judiciously use N fertilizers. Increased use of N without adding required K^+ in the soil has further aggravated the K^+ deficiency (NFDC, 2003).

It is thus imperative to formulate a fertilization technology facilitating the use of K^+ in appropriate combination with N and P for enhancing wheat yield and grain quality. The present study was, therefore, planned to determine the quantitative response of late sown wheat to K^+ application under field situations.

The present study was conducted on a sandy-clay loam soil at the University of Agriculture, Faisalabad for two consecutive years. The objective of the study was to determine the effect of K^+ on the agro-qualitative traits of late sown wheat genotype Pak-81. The experiment was laid out in a randomized complete block design with three replication having a net plot size of 3 m x 15 m. The experimental soil was analyzed before sowing the crop for NPK which indicated that there was 0.045 % N, 7.8 mg kg^{-1} P and 130 mg kg^{-1} K. The soil was non-saline and non-sodic with EC 2.4 dSm^{-1} and pH value of 7.9. The K levels applied were 0, 25, 50, 75, 100, 125 and 150 kg ha^{-1} along with a basal dose of 100-100 kg NP ha^{-1}. The crop was sown with a single row hand drill on a well prepared

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seedbed using a seed rate of 100 kg ha^{-1}. Urea, single super phosphate and potassium sulphate were used as source of N, P_2O_5 and K_2O, respectively. Urea was applied in two splits i.e. first at seed bed preparation and second with first irrigation while full doses of PK were incorporated in to the soil during seed bed preparation. First irrigation was given 22 days after sowing and the remaining three were applied each at jointing, booting and grain development stages. The average rainfall received during the entire growth period amounted to 83 mm. Observations on desired agro-qualitative traits were recorded using standard procedures. Harvest index (HI) was computed by using the following formula.

$$\text{H.I.} = \frac{\text{Economic yield (grain yield) ha}^{-1}}{\text{Biomass yield ha}^{-1}} \times 100$$

Nitrogen concentration in grains was determined in the laboratory by using Gunning and Hillard's method of sulphuric acid digestion and distillation was made with micro Kjeldahl's apparatus (Jackson, 1979). Crude protein was calculated by multiplying the total nitrogen with 6.25.

Data collected were statistically analysed by Fisher's analysis of variance technique and New Duncan's multiple range test was employed to compare the treatment means at 0.05 p (Steel *et al*., 1997).

Spike m^{-2}

Potassium application had significant effect on spike density m^{-2} (Table 1). Crop produced significantly the maximum spikes m^{-2} (300) with 75 kg K ha^{-1} against the minimum of 199.67 m^{-2} in check plots. This clearly indicated that wheat showed a positive response to K^+ in exploring the tillering potential. Tahir *et al*. (2003) also reported a positive response of wheat to K^+ application in improving tillering.

Plant height

There was significant effect of K^+ application on plant height (Table 1). Addition of K^+ beyond the level of 75 kg ha^{-1} did not increase the plant height to a significant extent. However, K^+ interaction with NP was found to be favorable for plant growth upto the highest level. Ashraf (1986) observed a significant increase in plant height with K^+ application in combination with NP.

Number of grains spike^{-1}

Number of grains spike^{-1} is an important yield contributing parameter and has a direct bearing on the final grain yield of wheat. There was significant increase in the number of grains spike^{-1} with each successive dose of K^+ over check (Table 1). However, among the fertilizer treatments, although K^+ application at the rate of 100 kg ha^{-1} produced significantly the highest number of grains spike^{-1} (43.25) but was at par with the treatment of 75 kg K^+ ha^{-1} which produced 42.65 grains spike^{-1}. Increase in the number of grains spike^{-1} with K^+ application has also been reported by Roy *et al*. (1990).

1000-grain weight

Application of K above 50 kg ha^{-1} along with NP increased significantly the 1000-grain weight over check (Table 2). However, K^+ application beyond 75 kg ha^{-1} did not help increasing the grain weight to a significant extent. These results are quite in line with those of Roy *et al*. (1990) who reported significant increase in grain weight with high doses of K^+.

Grain yield ha^{-1}

Wheat grain yield increased significantly with the application of K fertilizer @ 75 kg ha^{-1} over check and all other treatments except the treatment of 100 kg ha^{-1} with which it was at par (Table 2). The reason for no significant increase in yield beyond 75 kg ha^{-1} might be the reach of economic thresheshold level of the N-use efficiency with K^+ application beyond the level of 75 kg ha^{-1}. Roy *et al.* (1990) also reported increased grain production by K^+ application. Potassium is involved in translocation of photosynthates and carbohydrates within plant tissues, hence K application results in increased yield (Tisdale *et al.*, 2002)

Harvest Index (%)

Harvest index represents the ratio of reproductive produce and biological yield and is an important parameter for studying the effect of added nutrient. The results showed significant effects of K application rates on harvest index (Table 2). The highest harvest index (37.45%) was recorded for 100 kg K ha^{-1} which was statistically equal to 75 kg K ha^{-1} (37.26%) against the lowest of 32.93 % in case of check.

Grain protein concentration

Protein concentration in grain was affected significantly ($p<0.05$) with K application (Figure 1). There was progressive increase in protein content with each successive dose of K over check with the maximum of 11.3 % with the application of 150 kg ha^{-1} against the minimum of 9.32 % in check. This clearly indicates that K plays an important role in improving the grain protein concentration of wheat probably by enhancing the N-use efficiency (Tisdale *et al*., 2002).

Conclusion

Potassium application in late sown wheat under field conditions significantly increased all yield relating

Table 1. Effect of potassium application on number of spikes, plant height and number of grains per spike of late sown wheat under field conditions

Fertilizer treatments N – P – K (kg ha^{-1})	Spikes m^{-2}	Plant height (cm)	Number of grains spike^{-1}
0 – 0 - 0	199.67 e	71.22 d	30.97 f
100 -100 - 0	269.28 cd	81.47 bc	38.46 de
100 -100 - 25	260.83 d	80.74 c	38.11 e
100 -100 - 50	278.80 bc	82.54 abc	40.21 cd
100 -100 - 75	300.73 a	85.25 a	42.65 ab
100 -100 - 100	291.70 ab	85.29 a	43.25 a
100 -100 - 125	287.08 ab	83.79 ab	40.86 bc
100 -100 - 150	283.53 b	84.31 ab	40.57 bc

The data are average of two years (three replications per year). Means in a column not sharing a similar letter differ significantly at p = 0.05

Table 2. Effect of potassium application on 1000-grain weight, Grain yield and Harvest index of late sown wheat under field conditions

Fertilizer treatments N – P – K (kg ha^{-1})	1000-grain weight (g)	Grain yield (kg ha^{-1})	Harvest index (%)
0 – 0 - 0	32.32 c	2675 e	32.93 d
100 -100 - 0	35.68 d	3903 d	36.63 c
100 -100 - 25	35.85 cd	3925 d	36.59 c
100 -100 - 50	36.27 b-d	3963 cd	36.69 bc
100 -100 - 75	39.25 a	4235 a	37.76 ab
100 -100 - 100	38.51 a	4209 a	37.45 a
100 -100 - 125	36.90 b	4044 b	36.70 bc
100 -100 - 150	36.95 b	4088 b	36.86 a-c

The data are average of two years (three replications per year). Means in a column not sharing a similar letter differ significantly at p = 0.05

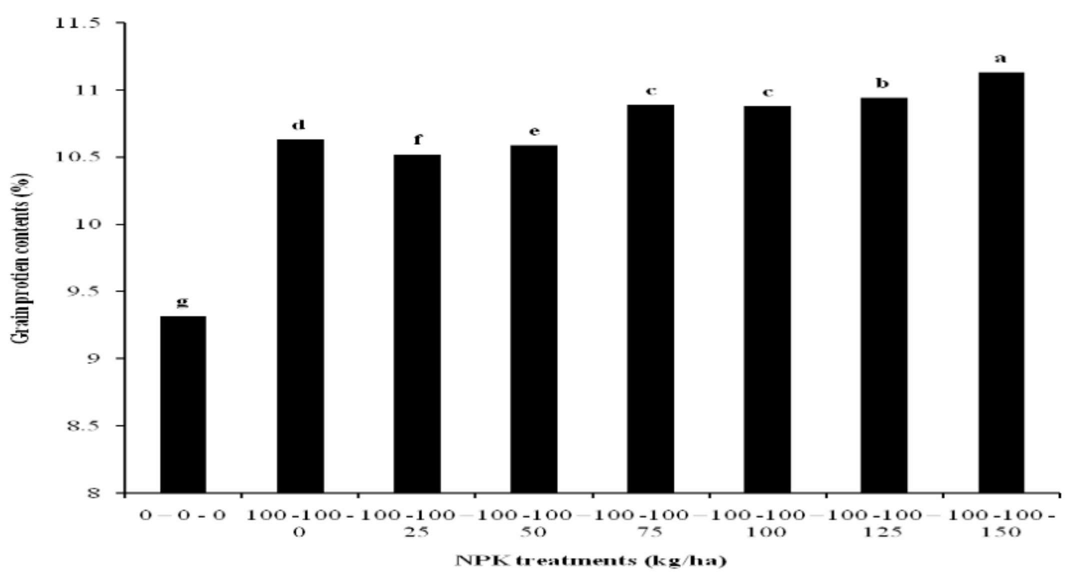

Figure 1. Effect of different K doses on grain protien contents (%) in wheat

parameters and yield. Potassium application @ 75kg ha^{-1} increased wheat yield significantly compared to control and lower doses of K.

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