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Effect of different levels of potassium sulphate on yield, yield components and protein content of wheat cultivars

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ABSTRACT: The aim of this study was to evaluate the effect of different levels of potassium sulphate on yield and yield components of wheat cultivars. An experiment was conducted using split plot based on randomized complete block design with three replications at Agricultural and Natural Resources Research Center of Yazd in 2011-12 growing season. Four levels of potassium sulphate (Control, 80 kg/ha, 130 kg/ha and 160 kg/ha) as main plot and four cultivar as sub-plot (Parsi, Sivand, Arg and Bam) was applied. Results showed that effect of potassium sulphate was significant on number of spike per m^2, number of grain per spike, number of spikelet per spike, protein content, biological yield, grain yield and straw yield. Cultivars had significant different in plant height, spike length, sterile tiller, number of grain per spike, 1000 grain weight, protein content and grain yield. Highest of grain yield (6523 kg/ha) was obtained from 160 kg/ha potassium sulphate application and Bam cultivar had highest grain yield (5555 kg/ha).
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INTRODUCTION

Among the nutrients, potassium (K) is a macroelement known to be very dynamic and a major contributor to the organic structure and metabolic functions of the plant. Adequate K supply is also desirable for the efficient use of Fe, while higher K applications result into competition with Fe (Celik et al., 2010). K has substantial effect on enzyme activation, protein synthesis, photosynthesis, stomatal movement and water relation (turgor regulation and osmotic adjustment) in plants (Marschner, 1995). Increased application of K has been shown to enhance photosynthetic rate, plant growth, yield and drought resistance in different crops under water stress condition (Egilla et al., 2001). Lindhauer (1985) showed that K fertilization besides increasing dry matter production and leaf area development greatly improved the retention of water in the plant tissues even under conditions of severe water stress.

Wheat (*Triticum aestivum* L.) is an important food crop grown during the winter season (Lak et al., 2013). This plant is most important cereal crop that is cultivated throughout the major agro-climatic zones of the world. Generally, crop yield depending the effect of their genetic structure, environment and their intractions. Among the environmental factors, supplemental of nutrients like potassium due to effective roles in plant is very important. Kemmler (1983) reported that wheat for production of high yield needs to enough potassium. Although in some cases the requirement of potassium was more than nitrogen and phosphorus. Abrosh et al (2009) illustrated that application of K increased grain and yield components of wheat significantly. This findings are according to Lotf Alahi et al (2005) and Ramazanpour et al (2008) in wheat. Peykarestan et al (2012) showed that use of K fertilizer increased grain yield and yield components of popcorn.

The objective of this research was to investigate the potassium sulphate levels effect on yield, yield components and protein content of wheat cultivars in yazd region.

MATERIALS AND METHODS

The field experiment was conducted with use of split plot arrangement based on randomized complete block design with three replications at Agricultural and Natural Resources Research Center of Yazd, Iran ($29^0 52^/$ N and $52^0 55^/$ E at an altitude of 1234 m above sea level) in 2011-12growing season. The treatments included: four levels of potassium sulphate (Control, 80 kg/ha, 130 kg/ha and 160 kg/ha) as main plots that before planting was mixed into the soil and four cuitivars (Parsi, Sivand, Arg and Bam) as sub-plots. The physical and chemical of soil used is present in Table 1. Each plot consisted of 6 rows and row spacing was 20 cm. The distance between each of the plots was 1 m and between

sub-plots was 0.5 m. The distance between each of the replications was 2 m. Seeds were sown at depths of 3 cm on 16 November 2011 and then irrigation was done. Plant height, spike length, fertile tiller, sterile tiller, number of spike per m^2, number of grainper spike, number of spikelet per spike were measured from 10 randomly selected plants at harvest time. For determination of 1000 seed weight, 1000 seeds were counted and then weights were measured by a balance. To measure yield and biological yield, 2 rows in the middle of each plot equal to 1 m^2, after deleting the border have been harvest on 15 June 2012.Harvest index was calculated by this formula:

$$HI = \frac{\text{Grain yield}}{\text{Biological yield}}$$

For determination of chlorophyll rate, the amount of flag leaf chlorophyll from 5 randomly selected plants at milk development was measured by Chlorophyll meter (CCM-200). Protein content was measured by the Kjeldahl method. Analysis of variance was carried out using MSTAT-C and the comparison of means was investigated using Duncan's Multiple Range Test at 0.05% probability.

RESULTS AND DISCUSSION

Results showed that effect of potassium sulphate application was significant on number of spike per m^2, number of grain per spike, number of spikelet per spike, biological yield, grain yield and straw yield (Table 2). The mean values of some characters measured in different treatments are summarized in Table 2. Generally the highest of characters was obtained with application of 160 kg/ha.

Means in each columns followed by similar letter(s) are not significantly different at 5% probability level using

Dancan's multiple-range test

Potassium sulphate. Results of this research is according to Lotf Alahi et al (2005) and Ramazanpour et al (2008) in wheat, Peykarestan et al (2012) in popcorn and Ghasemi et al (2013) in rice that reported application of K fertilizer increased yield and yield components significantly. Peykarestan et al (2012) indicated that K is the main plant nutrient witch limits plant productivity. Therefore, the use of efficient rate of Potassium is an increasingly important feature of crop production system. Generally, application of potassium increases of nitrogen metabolism, carbohydrates metabolism, enzymes activity, tissues growth, protein synthesis, crop quality and resistance of crop against disease and pests (Ramazanpour et al 2008) as a result, the grain yield increased.

Results of mean comparison showed that cultivars had significant different in plant height, spike length, sterile tiller, number of grain per spike, 1000 grain weight, grain yield and protein content (Table 5). Bam cultivar had highest grain yield (5555 kg/ha) (Table 5). Bam cultivar was introduced for salt and moderate condition as a result, high yield of this cultivar can be due to yazd region is in salt, drought and moderate region. Furthermore Bam cultivar had highest plant height (107.6 cm), spike length (10.64 cm), number of grain per spike (43.08) and lowest sterile.

Means in each columns followed by similar letter(s) are not significantly different at 5% probability level using Dancan's multiple-range test tiller (2.35) (Table 5).

Results of analysis of variance showed that interaction of potassium application and cultivar was not significant on all traits (Table 2). It seems that reaction of cultivars at different levels of potassium sulphate was similar. This findings are in agreement with Ghasemzade Ganje (2010).

Parsi cultivar had highest protein content (9.47%) that this cultivar introduce as the best cultivar of quality traits (Table 5).

Table 1. The results of soil analysis of experimental site

Soil texture	EC (ds/m)	pH	MN (mg/kg)	N (%)	Fe (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	K (mg/kg)	P (mg/kg)	Depth (Cm)
Silty Loam	5.12	7.44	3.68	0.02	2.67	0.65	0.4	100	10.74	0-30

Table 2. Analysis of variance for yield and yield components of wheat

S.O.V	df	Mean of squares											
		Plant Height	Spike length	Sterile tiller	Fertile tiller	N.Spike per m^2	N.Grain per spike	N.Spikelet per spike	1000 grain weight	Biological yield	Grain yield	Straw yield	Harvest index
Replication	2	69.04	0.28	0.33	0.01	35689.58	1.63	6.23	48.08	32905495.5	8094076	8816130	0.08
Potassium (a)	3	12.08^{ns}	0.38^{ns}	2.16^{ns}	0.27^{ns}	160670.83^{**}	311.95^{**}	14.1^{**}	10.67^{ns}	96896476^{**}	18210341^{**}	51648650^{**}	0.01^{ns}
Error (a)	6	356.43	0.65	0.50	0.38	29439.58	3.55	0.41	9.01	2542808.91	308223.35	233858.52	356.43
Cultivar (b)	3	238.43^{**}	2.24^{**}	3.82^{**}	0.12^{ns}	12113.88^{ns}	72.82^{**}	0.71^{ns}	57.83^{**}	3156833^{ns}	1762974^{*}	790962^{ns}	0.04^{ns}
a×b	9	22.46^{ns}	0.14^{ns}	0.64^{ns}	0.17^{ns}	3285.64^{ns}	6.14^{ns}	0.18^{ns}	10.41^{ns}	1426219^{ns}	280265^{ns}	755829^{ns}	0.01^{ns}
Error (b)	24	25.25	0.29	0.68	0.11	5687.5	14.83	0.51	6.57	2768026	563757	1088980	0.02
CV (%)		4.94	5.33	18.83	14.36	11.84	9.36	4.8	5.21	13.06	14.96	13.62	10.64

ns, *,** : not significant, significant at 5% and 1%, respectively

Table 3. Analysis of variance for qualitative traits of wheat

S.O.V	df	Mean of squares	
		Protein content	Chlorophyll
Replication	2	1.70	20.85
Potassium (a)	3	24.92**	23.8 ns
Error (a)	6	0.49	68.88
Cultivar (b)	3	5.93**	119.44ns
a×b	9	0.09ns	124.86ns
Error (b)	24	1.10	101.24
CV (%)		12.05	19.97

ns, *,** :not significant, significant at 5% and 1%, respectively

Table 4. Mean comparison of some traits of wheat as affected by potassium sulphate

Treatments	N.Spike per m^2	N.Grain per spike	N.Spikelet per spike	Biological yield (kg/ha)	Grain yield (kg/ha)	Straw yield(kg/ha)	Protein content(%)
Control	490 d	33.58 d	13.65 d	9618 d	3672 d	5945 d	7.16 d
80 kg/ha	609.6 c	38.83 c	14.73 c	11520 c	4460 c	7064 c	8.18 c
130kg/ha	688.8 b	42.33 b	15.36 b	13750 b	5420 b	8147 b	9.01 b
160kg/ha	760 a	45.58 1	16.23 a	16250 a	6523 a	9727 a	10.57 a

Table 5. Mean comparison of some traits of wheat as affected by different cultivars

Treatments	Plant height (Cm)	Spike length (Cm)	Sterile tiller	N.Grain per spike	1000 grain weight(gr)	Grain yield(kg/ha)	Protein content(%)
Parsi	99.7 b	9.85 b	3.11 a	38.42 bc	48.25 b	5018 ab	9.74 a
Sivand	99.8 b	9.89 b	3.54 a	37.67 c	46.33 b	4823 b	8.68 b
Bam	107.6 a	10.64 a	2.35 b	43.08 a	50.53 a	5555 a	8.26 b
Arg	104.2 a	10.61 a	2.44 b	41.17 ab	51.48 a	4679 b	8.25 b

CONCLUSION

Application of potassium sulphate increased yield, yield components and protein content of wheat cultivar. Generally, the results of this research indicated that the suitable amount of potassium sulphate was 160 kg/ha and the best cultivar was Bam. Parsi cultivar was the best cultivar for protein content.

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