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Effect of Different Levels of Irrigation and Potassium on Qualitative and Quantitative Characteristics of the Beans in Yasooj, Iran

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Abstract

To study the effects of different levels of irrigation and potassium on Bean components practice, this study was carried out in Yasooj-Iran region in 2012-2013 cultivation year. Factorial experiment with two factors was carried out where the first factor of potassium sulfate fertilizer levels (zero, 100 and 200 kg per hectare) and the second factor of Irrigation (4 days, 8 days and 12 days) in a randomized complete block design were performed in triplicate. Developmental characteristics such as plant height, number of branches, stem diameter, number of pods per plant, seeds per pod, number of seeds per plant, seed weight, seed yield, biological yield and harvest index were measured. Results showed that treatment with potassium sulphate on stem height, number of branches, stem diameter, number of pods, number of seeds per pod, number of seeds per plant, seed weight, seed yield, biological yield and harvest index had a significant effect. The maximum amount of 1000 grains weight and harvest index was observed in the treatment of 100 kg per hectare of potassium sulfate. Irrigation factors on traits such as plant height, shoot fresh weight and seed yield showed a significant effect, the maximum amount of plant height, shoot fresh weight and seed yield was obtained from 4-day irrigation. Applying 100 KG per hectare of potassium sulfate is recommended to increasing of beans grown in.

Keywords: Beans, Irrigation, Potassium

Introduction

The bean of the scientific name "*Phaseolus vulgaris*" is one of the most important cereals. The plant is originated in Central and South America. The plant has five crop species and wild species around 50. Crop species include *Ph.vulgaris, Ph. coccineus, Ph. lunatus, Ph. Acutifolius, Ph. polyanthus*. All dry beans are grown in IRAN are of the genus and species of *Phaseolus vulgaris*. The cowpea of the scientific name "*Vigna unguiculata*" and of genus of "*Vigna*" has six sub-genera and a species with a name *Vigna nervosa*. This species has the four sub-species of crops, including Unguiculata, *Biflora*, *Sequipedali* and *Texfilis* (Oweis and Hachum, 2003). In tropical and subtropical conditions, planting beans occurs in different soil types, but they are not able to grow in clay soils with heavy texture in which there is a high-surface groundwater. By high salinity of the soil, the beans' yield can be significantly reduced (Dubtz and Mahalle, 1999). Water, soil and plant are of a three-component system, each of which affects a final product and herbal productions. Soil is a reservoir for water storage and the water is essential for plant growth. Water stress decreases the elongation of leaves, dry weight of shoots, leaf area index, the leaflet numbers and average leaf area and pressure of turgor in plant tissues (Turk, 2005). The action impacts on physiological processes such as photosynthesis, respiration, translocation of and absorption of nutrition, and ultimately affects the growth (Sivakumar and Shaw, 1998). Also, environmental factors such as rainfall, relative humidity, temperature and sunlight, and crop factors such as planting date, fertilizing,

planting method and plant density affect yield potential of the plant (Pandey et al., 1999). The delay in planting date decreased dry matter production, leaf area index, leaf area duration, crop growth rate, net photosynthetic rate and yield of the plants (Srivastava, 1996). In general, the delay in planting reduced the number of pods per area and yield potential (Arnon, 2002). Another important factor that decreases in cereals' production and the fluctuation of yield is the temperature stress, including heat and cold (Sxena et al., 2003).

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Materials and Methods

To evaluate the effect of different levels of potassium sulfate and irrigation period on yield and yield components of bean, an experiment was conducted in 2012-2013 cultivation year. The experiment was implemented in factorial and a basic fully design of randomized blocks with three replications. The experiment factors consisted of three levels of potassium sulfate (0, 100 and 200 kg per hectare) as main plots and irrigation period (4, 8 and 12 days) were the subplots. The land under experiment was plowed by tractor, having plotted the land, potassium sulfate was strewed by hand sprayer on the land and then, followed by, the shovel and rake were used to smooth the soil and mix the fertilizer (Taylor, 2003). The plot sizes under experiment were of 4 × 3 m and the distance between plots 0.5 m and between blocks 1 m. Each plot of experiment consisted of 7 planting rows to 30 cm distance and plant density was considered equal to of 33.3 herbs per square meter. Using Benomyl fungicide, before planting, seed sterilization was done the ratio which was one in a thousand. In each row, of distance of 10 c, bean planting was done manually after creating slits to a depth of approximately 7 cm by Fuca. After planting, the seeds were covered by the soil using rakes. After one month of bean seedling emergences, in order to achieve the desired density (40 herbs per square meter) it was performed thinning operations. To estimate the seed yield, biopsy at the time of maturity ended, compliance with margin, it is taken action the ratio of harvest area of 2 square meters per plot to determine grain yield, herb height, 1000-seed weight, harvest index, matter dry weight, number of pods per herb, and number of seeds per pod by the pod-throwing in dimensions of 1 × 1 m. Action of separating grain from plants harvested was made after drying the herbs within oven at 48 ° C. the experiment was conducted in split of plot and based on fully randomized block design with two factors, irrigation period and potassium sulfate in four replications on pinto beans. In sum, 36 plots were selected and after planting, husbandry and harvesting and calculating data, it was analyzed using *SAS* software and mean values were compared using Duncan's multiple range test. Graphs were plotted using *Excel* software (Tavakkoli and Oweis, 2004, Nagarajan et al., 1999).

Results and discussion

The results of analysis of variance of the traits under investigation are given in a fully randomized block design, in Table 1. Also, the mean of test data are compered in terms of the effects of different levels of irrigation period and potassium sulfate, given in Table 2.

The interactions between different levels of irrigation period and potassium sulfate are shown in Table 3, too.

The herb height

Data variance analysis results indicated that the effects of potassium sulfate, irrigation period and also, the interaction of these two factors for pinto beans, were significant on plant height at the 1% level (Table 1).

Results of comparison of mean data indicated from effect of different levels of potassium sulfate is of a significant difference on the plant height and it was maximum height in the treatment S_2 (100 kg ha potassium sulfate) at a rate of 33.88 cm (Table 2). Evaluation of different levels of

irrigation period on the plant height in pinto beans showed it had a statistically-significant effect on this trait. The highest value of plant height was observed in treatment D_1 (irrigation period of 4 days) at a rate of 33.44 cm. Also, the lowest value was observed in the treatment of D_3 (12-day irrigation period) at the rate of 30.3 cm (Table 2). The results of the comparison between the interactions showed that there were significant differences between the treatments and the highest plant height 38.42 cm in the treatment of S_2D_1 (potassium sulfate 100 kg per hectare and 4-day irrigation period) (Table 3).

Table 1. Analysis of variance yield and yield components

MEAN-SQUARE									DF	Source of change
HI	Biological Yield (gr/m^2)	Wet weight Air organs (gr/m^2)	Grain (gr/m^2)	Grain weight (gr)	Pod Height (cm)	Number of seed per pod	Number of Pods per plant	Plant height (cm)		
30/296^{ns}	135/04^{ns}	23749/6^{ns}	1612/22*	6/293^{ns}	10/03^{ns}	3/66^{ns}	4/175^{ns}	19/175*	3	Repeat
98/78**	2303/08*	465704/7**	6590/95**	72/86^{ns}	17/58*	65/58**	115/75**	62/135*	2	Potassium sulphate
142/53**	368/78^{ns}	250944/4**	6058/65**	201/26**	30/34**	20/34**	74/08**	30/043**	2	Period irrigation
35/11*	1894/79*	249056/6**	4066/45**	70/015*	20/92**	18/17**	73/58**	28/596**	4	Potassium sulphat e Period× irrigation
13/15	672/19	41285/4	144/115	23/095	4/881	1/553	63/41	5/093	24	Error
8/77	8/77	5/54	1/38	1/38		23/05	14/52	24/3	7/1	CV(%)

*& ** Respectively significant at the 5% & 1% level, and ns is insignificance.

Table 2.The main compare of yield and yield components

HI	Biological Yield (gr/m^2)	Wet weight Air organs (gr/m^2)	Grain (gr/m^2)	Grain weight (gr)	Pod Height (cm)	Number of seed per pod	Number of Pods per plant	Plant height (cm)	TEST FACTOR	
37/33a	284/03c	3039/4b	189/9c	345/88ab	8/33c	8/42b	9/67b	29/36b	0 KG	Potassium sulphate
18/17a	310/94a	3019/8a	233/6a	349/17a	10/75a	11a	15/17a	33/88a	100 KG	
32/83b	291/77b	3141/2b	226/4b	344/34ab	9/67b	6/33a	9/92b	32/04a	200 KG	
40/08a	310/86a	3364/85a	242a	351/19a	11/08a	10/08a	14/22a	33/44a	4 day	Period irrigation
34/33b	293/53a	3141/4b	208/5b	344/2b	7/92c	7/92b	11/17b	31/54b	8 day	
33/91b	291/63a	3094b	199/4b	343/99b	9/75b	7/75b	9/33b	30/3b	12 day	

The number of pods of the herb

As shown at the tables, the effects of utilization of different levels of potassium sulfate, irrigation period, and the interaction of these two factors on this trait was significant at 1% level. Also, in terms of the table comparison of the mean data for the potassium sulfate (Table 2), the lowest number of pods per plant was for control treatment by 9.67, the highest number of pods per plant was for the treatment of S_2 (100 kg potassium sulfate per hectare) with an average of 15.17 per plant. According to the table of comparison between means, the effect of irrigation period was

significant on a number of pods per plant (Table 1). The lowest number of pods per plant was for the treatment of D_3 (irrigation period of 12 days) and the mean was 33.9. The highest number of pods per plant was in treatment D_1 (4-day irrigation period) by 14.22 per plant (Table 2). Interaction effect of potassium sulfate and irrigation period of pods per plant was significant (Table 1). Comparison between mean data showed the highest number of pods per plant was for treatment S_2D_1 (100 kg potassium sulfate per hectare and irrigation period of 4 days) was obtained by 23 per plant (Table 3).

Table 3.The main compare of interaction

HI	Biological Yield (gr/m^2)	Wet weight Air organs (gr/m^2)	Grain (gr/m^2)	Grain weight (gr)	Pod Height (cm)	Number of seed per pod	Number of Pods per plant	Plant height (cm)	TEST FACTOR	
									Period irrigation (day)	Potassium Sulphat (kg)
38/25b	274/8b	3023/8b	195/27d	347/9b	8/5b	8/25bc	11/5bc	27/85d	4	0
38b	275/6b	2964b	183/2d	345/4b	7/75b	8/25bc	10bc	29/02cd	8	0
35/75b	301/7ab	3130/3b	191/25d	344/3b	8/75b	8/75bc	7.5c	31/2cd	12	0
45a	339/6a	3883/8a	289/8a	358a	15/25a	15/25a	23a	38/42a	4	100
35/75b	299/9ab	3213/5b	194d	341/9bc	10/75b	8/75bc	11bc	31/47bcd	8	100
33/75b	293/7b	3162/3b	216/9c	347/6b	9/75b	9b	11/5bc	31/75bc	12	100
37b	291/1b	3187b	241b	347/6b	9/5b	6/75cd	8/25c	34/05b	4	200
29/25c	305/9ab	3246/8b	248/2b	345/3b	8/75b	6/75cd	12/5b	30/4bcd	8	200
32/25b	278/7b	2989/7b	190d	340bc	7/25b	5/5d	9bc	31/67bc	12	200

According to this table, the minimum number of pods per plant for the treatment S_1D_3 (lack of potassium sulfate and 12-day irrigation period) was obtained by value of 5.7.

The number of seeds per pod

Results of analysis of data variance showed effects of different amounts in treatment with potassium sulfate, irrigation period and also interaction between potassium sulfate fertilizer and irrigation period for pinto beans were significant on the number of seeds per pod at 1% level (Table 1). Results of comparison between the mean data showed the effect of different amounts of potassium sulfate was significant on the number of seeds per pod and the highest number of seeds per pod was obtained in treatment S_2 by 11 (sulfate of potash 100 kg per hectare). The lowest number of seeds per pod was obtained in treatment S_3 (200 kg potassium sulfate per hectare) by 33/6 (Table 2).

Evaluation of different levels of irrigation period on the seed numbers per pod of pinto bean showed that the use of different levels of irrigation period had significant effect on the trait. The highest number of seeds per pod was in treatment D_1 (irrigation periods of 4 days) at a rate of 10.8. As well, the lowest value was in the treatment of D_3 (12-day irrigation period) by 7.75 (Table 2). The results of the comparison between the interactions showed that there were significant differences between the mean data and maximum number of seeds per pod was in treatment S_2D_1 (sulfate of potash 100 kg per hectare and irrigation periods of 4 days) and lowest in treatment S_3D_3 (potassium sulfate 200 kilograms per hectare and irrigation period of 12 days) by 5.5 (table 3).

Mean of pod length (cm)

The results of variance analysis showed that the effect of potassium sulfate use and irrigation period, as well as their interactions was significant on mean weight of pod length. Therefore, the

effect of potassium sulfate at 5% level, but the effect of irrigation period and interaction between these two factors was significant at the 5% level on the traits. Based on comparison table between means in terms of the effect of potassium sulfate, treatment S_2 (100-kg potassium sulfate per hectare) with a mean pod length of 10.75 cm, was known as the superior treatment. Based on the effect of irrigation period, treatment D_1 (irrigation period of 4 days) with a pod length of 11.8 cm showed the highest values (Table 2). Also according to the comparison table between means, the interactions between potassium sulfate and irrigation periods (Table 3), the highest pod length was obtained in the treatment S_2D_1 (100 kg potassium sulfate per hectare and irrigation period of 4 days) by 15.25 cm. The lowest pod length of 7.25 cm was obtained in treatment S_3D_3 (200-kg potassium sulfate per hectare and irrigation period of 12 days). Except of treatment S_2D_1, other ones were analyzed in the same statistical group.

Mean seed weight (g)

The results of variance analysis showed that the effect of potassium sulfate was not affected on 1000-grain mean weight. According to this table, there was a significant effect of irrigation period at 1% level, and interaction of potassium sulfate and irrigation period at 5% level on the trait (Table 1). Based on comparison table of means in terms of the efficacy of potassium sulfate, however, all treatments were at the same level, but the treatment S_2 (100-kg potassium sulfate per hectare) with 1000-seed weight of 349.17 gr was recognized as a superior treatment. Based on effect of irrigation period, also treatment D_1 (4-day irrigation period), with 1000-seed weigh of 242 gr, showed the highest amount (Table 2). Also, according to the comparison table between means and evaluation of interactions between potassium sulfate and irrigation period (Table 3), the biggest 1000-seed weigh of treatment S_2D_1 was obtained by 358 gr. The lowest 1000-seed weigh of treatment S_3D_3 (potassium sulfate 200 kg per hectare and irrigation period of 12 days) was obtained by 340 gr.

Mean of grain yield (gr per square meter)

Results of variance data analysis showed the effect of potassium sulfate, and irrigation period and interaction between potassium sulfate and irrigation period was significant on seed yield of pinto beans (Table 1). The results of comparison of means at the 1% level suggested that in the genotype studied (pinto beans), it was seen the highest mean grain yield (233.6 gr per square meter) at the level of potassium sulfate S_2 (sulfate of potash 100 kg per hectare), and the lowest yield (189.9 gr per square meter) in the treatment S_1 (control). The effect of different irrigation levels was various on the sort under investigation and there was, among treatments, significant difference at the 1% level and it was observed, at the level of D_1 (irrigation period of 4 days), the highest grain yield by 242 gr per square meter. Results of the interaction between potassium sulfate and irrigation period on average grain yield showed that the highest mean of grain yield was of treatment S_2D_1 (100 kg potassium sulfates per hectare and irrigation period of 4 days) equal to 289.8 gr per square meter and the lowest, of treatment S_1D_2 (soil without potassium sulfates and irrigation period of 8 days) by 183.2 gr per square meter.

Shoot fresh weight (gr)

Results of variance data variance showed significant differences among the various levels of potassium sulfate, irrigation period, as well as the interaction of these two factors on shoot fresh weight at 1% level (Table 1). Comparison of experimental data mean showed that potassium sulfate has a significant effect on shoot fresh weight and it increased by altering the levels of this factor. The shoot fresh weight of 3419.8 gr per square meter was obtained of treatment S2 (sulfate of potash 100 kg per hectare) and lowest one of treatments S_1 (control) of 3039.4 gr per square meter. The difference between different levels of irrigation period was significant at the 1% level and treatment D_1 (irrigation period of 4 days), with 3364.85 gr per square meter, shoot fresh weight was

identified as a superior treatment. The lowest shoot fresh weight of 3094 gr per square meter was seen at treatment D_3 (12-day irrigation period) (Table 2).

Evaluation of comparison table of interaction mean between potassium sulfate and irrigation period indicated that interaction between these factors had significant effect on the trait under investigation at 1% probability level (Table 3). The treatment S_2D_1 was the best one in terms of the shoot fresh weigh (100 kg per hectare and irrigation period of 4 days), in which the shoot fresh weigh was increased by 3383.8 gr per square meter. Other treatments are put of the same statistical category.

Average biological yield (gr per m)

Results of variance analysis showed that the effect of potassium sulfate on biological yield was significantly different at 5% level. Irrigation period had no significant effect on this trait, but the interaction between potassium sulfate and irrigation period on biological yield were statistically significant at the 5% probability level (Table 1).

Comparison of different level means of potassium sulfate showed an increase in biological yield and there were significant differences among treatments. The average biological yield was the highest value at the level of S_2 (100 kg potassium sulfate per hectare) equal to 310.94 gr per square meter, and the lowest at level S_1 (control) equal to 284.03 gr per square meter (Table 2). No significant effect of irrigation period on biological yield. So the D_1 level (irrigation period of 4 days), equal to 301.86 gr per square meter, indicated maximum biological yield that was placed in the same level of the treatments D_2 (8-day irrigation period) and D_3 (12-day irrigation period).

The results of interaction between potassium sulfate and irrigation period on biological average yield showed that the highest biological average yield was of treatment S_2D_1 (sulfate of potash 100 kg per hectare and irrigation period of 4 days) of 339.6 gr per square meter and the lowest one of treatment S_1D_1 (control and irrigation period of 4 days) of 274.8 gr per square meter.

Average harvest index (HI)

The results of analysis of data variance showed that the main effects of potassium sulfate and irrigation period at 1% probability level and the interaction of these two factors were significant at the 5% level on harvest index (Table 1).

The study and comparison of different levels of potassium sulfate (Table 2) showed that harvest index was of the highest value of 38.17 in treatment S_2 (sulfate of potash 100 kg per hectare) which was at the same statistical level as treatment S_1 (control), with harvest index value was 37.33. Treatment S_3 (200 kg potassium sulfate per hectare) had the lowest rate of 32.83. The comparison, also, of means showed at different levels of irrigation period that treatment D_1 (4-day irrigation period) had the highest value of HI by 40.08. The lowest harvest index of 33.99 of the treatment D_3 (12-day irrigation period) were obtained.

Investigating interaction of potassium sulfate and irrigation period on harvest indices of the genotypes under study indicated (Table 3) that means of data of the treatment S_2D_1 (sulfate of potash 100 kg per hectare and irrigation period of 4 days) was the highest harvest index by 45. Other treatments were at the same statistical level. The lowest harvest index was obtained of treatment S_3D_3 (200 kg potassium sulfate per hectare and irrigation period of 12 days) by 32.25.

Conclusion

1. The most suitable level of potassium sulfate, often in terms of traits under study, was treatment S_2 (100 kg potassium sulfate per hectare).

2. The most suitable irrigation period level, often in terms of traits under study, was treatments D_1 (4-day irrigation periods).

3. With respect to climate and soil conditions in Yasooj, the highest grain yield in treatments S_2D_1 (sulfate of potash 100 kg per hectare and irrigation period of 4 days) was obtained by 298.8 gr per square meter. Therefore, this treatment was judged as the superior treatment.

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