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Research Article

EFFECT OF POTASSIUM FERTILIZER AND IRRIGATION INTERVALS LEVELS ON YIELD AND YIELD COMPONENTS OF COWPEA (*VIGNA UNGUICULATA*) IN AHVAZ CONDITION

***Sara Mansouriand Alireza Shokoohfar**
Department of Agronomy, Islamic Azad University, Ahvaz Branch, Ahvaz, Iran
**Author for Correspondence*

ABSTRACT
In order to study of potassium sulphate and irrigation intervals on some growth and yield characteristics of cowpea (*Vigna unguiculata*), an experiment was carried out in 2013 in field of Elbaji village of Ahvaz. Experimental design was split plot within randomized complete block with four replications. The factors were irrigation intervals (6, 11 and 16 days) and potassium sulphate (0, 60, 100 and 140 kg/ha^{-1}) in main and subplot, respectively. The effects of irrigation intervals and potassium sulphate were significant on all traits. The interaction effects of potassium sulphate and irrigation intervals, was statistically significant on weight of 1000 seeds and seeds in pod. Among irrigation levels, 6 days irrigation has higher grain (1764.18 kg/ha^{-1}). Irrigation levels of 6 days, have been to 26.81 and 40.93% yield increase compared to 11 and 16 days irrigation. Between potassium sulphate levels, the maximum level (140 kg/ha^{-1}) significantly higher in grain yields for 18.39% and improve growth. Based on the results of this experiment and according to water shortages in most parts of the country, potassium application is recommended for drought effect reduction.

Keywords: *Cowpea, Irrigation Intervals, Potassium Sulphate, Seed Yield*

INTRODUCTION
Vigna unguiculata (Blackeyed peas) is one of the annual legumes with fast growing that its growth period has been reported 90 to 120 days (Doorenbas and Kasam, 1979). Bean plant is so sensitive to water and soil conditions and their qualities and its performance is also hurt from the short periods of water shortage, in a way that the damage resulting from the dryness and water shortage is increased with plant age (Maoor *et al.,* 1969). Irrigation time is one of the important factors in plant water stress and it has an effect on performance. When the water shortage is occurred in flowering and pod packaging stage, the performance is reduced more from other stage (Mckey and Ivans; Maoor *et al.*, 1969; Millar and Gardener, 1972).
Proper nutrition under stress conditions can somewhat help the plant enduring various stresses (Abedi *et al.,* 2011). Potassium has a direct and indirect impact on the plant growth. Using potassium directly causes the reduced transpiration, increasing water absorption or creating internal conditions in order to endure the dryness. The indirect effects take place when using potassium has no value in the plant water relations but based on feeding grounds, it causes the growth increasing. Therefore, the amount that is needed for producing each dry material is being reduced (Salaridni, 2005). Studiest show that potassium ion gathering in plants before the stresses likes water shortage, coldness, and salinity is insurance for plant survival (Loid, 1992).
(Mahammadi *et al.,* 2014) studied the potassium sulphate fertilizer effect on potassium gathering in flowering stage and black eyed peas function under the water shortage in Ahvaz weather conditions and they reported that in total caring watering period was 70 mlm evaporation and 100 kilogram in a hectare of potassium sulphate fertilizer was the best caring step. Fooladiv *et al.,* (2014) studied the dryness effect with 120 mlm (without stress), 180 (average stress) and 240 (server stress) of evaporation washbasin and potassium fertilizer (0,90,180 kilo in hectare) on qualitative features of (*Vigna radiata*) in Dezful Agricultural Research Center and reported that dryness and potassium fertilizer had a meaningful effect on the study and using 180 kilo potassium fertilizer was yielded. They also stated that total dry weight, pod numbers and seed function had a logical difference between two numbers.

Because water shortage is an important factor in decreasing plants growth and production in Iran, it is necessary to determine different plants reaction to water shortage stress in various areas. The aim of this study is to determine the most appropriate irrigation time in order to reduce water consumption and maintain performance and determine improving role of potassium sulphate fertilizer in compensation of water shortage effect on black eyed peas function and yield.

MATERIALS AND METHODS

Site Testing and Statistical Plan

This experiment was performed in 2013 in a farm in albaji village in Ahvaz located in 15 kilometer of Ahvaz-Andimeshk road with latitude 43°, ten minutes north, longitude 32°, 11 minutes east and height of 120 meters above the sea level. This research tested a splited plot in a basic design of completely random blocks.

Treatments

Experiment treatment were various levels of irrigation interval in three levels including (6,11,16 days). They were the main factors and different potassium fertilizer levels (potassium sulphate 0.50 K_2O) basically in 4 levels including zero, 60, 100 and 140 kilogram hectare as a subfactor.

The Experiment

The field was included of 48 plot that each had four row with 4 meters length and 50 centimeters distance. Treatment was randomly assigned to each plot and sub. This figure is commonly used in the Ahwaz region was named Kamran, was planted with 75,000 plant density in unit level with 12 centimeters from each other in the late tir in 2013.

Traits and Samplings

In this study, the grain yield, biologic yield and the components yield of *Vigna unguiculata* were measured including pod length, pod number in a plant, grain number in pod and weight thousand grains.

RESULTS AND DISCUSSION

Conclusion and Discussion

Pod Number in a Plant

The variance analysis results showed the number of pods in 1% probable level for irrigation level treatments and levels of potassium sulphate fertilizer (table 1). The most pods were observed in 6 day irrigation intervals treatment. But increasing irrigation intervals, this number was reduced significantly. Pods average each plant in irrigation intervals treatment in 6,11,16 days were 31/99, 28/21 and 25/13 respectively. Therefore is seems that a suitable irrigation plays an important role in increasing pods number in *Vigna unguiculata*.

However significant effect were seen between potassium sulphate use and control (without using fertilizer), but there were not significant effects between the various levels of potassium sulphate fertilizer on pods number in a plant (table 2). Abdzadeh *et al.*, (2010) reported that in rainfed conditions, management of Nitrogen and potassium fertilizer and their interactions had a significant effect on pods number, the results of Gita and Varoges (2001) also showed that using 20 kg nitrogen and potassium fertilizer each hectare, with 8 percent increase than conditions without fertilizer, pods produced the most. Results showed that as an effect of using at least 60 kg potassium sulphate fertilizer per hectare compared to not using one, we will witness increased 7/27 percent of pods in a plant.

Number of Seeds per Pod

Seed number is one of the important and effective parts in yield. Change cause in seed number per pod is the potential number of flowers that is determined in growth phase especially by leaf expansion (Koochaki *et al.*, 1993). In this study, the effect of different levels of irrigation and potassium sulphate fertilizer and also their interaction on seed number in pod was significant in one percent statistical level (table 1). Therefore, increasing irrigation the seeds per pod were reduced significantly (table 2). The irrigation interval appropriate necessities and using enough amount of irrigation were considered in many studies and researches (Yarnia *et al.*, 2009; Heidari and Asgharpour, 2012; Frost *et al.*, 2012).

The reduced seed number per pod as an effect of drought stress can be relations to less the length of pods. Lock of soil moisture has influenced the growth of reproductive parts and causes the yield reduction.

Khadem (2008) in his study on corn reported that drought stress causes reduced maize seeds. In irrigation with longer interval, because of increasing competition to provide water needs among plants, there was less green cover percent than complete irrigation that likely resulted in seed performance reduction. Yazar *et al.*, (2002), stated that seeds number in spike was related so much to providing moisture and reducing seed in panicol was the first effect of drought seed yield. Seed abortion can be resulted from flowers growth lack of synchronization, unusual growth of embryo sac before pollination and lack of seed growth after pollination and anthesis (Nilsen, 2002).

The compared result of simple effect average of applying potassium sulphate fertilizer on seeds in pod of *Vigna unguiculata* showed this trait is also changed under the influence of using potassium fertilizer. Therefore, in case of using potassium sulphate fertilizer in compared to not using it, more seeds in the plant were produced (table 2). The comparison results showed that there wasn't a significant difference between 60 and 100 kg of potassium fertilizer per hectare but there was a significant difference between 140 kg with other levels.

Increasing seeds along with using potassium sulphate fertilizer can be because of potassium role in increasing carbohydrates production and their quick translocation to the forming pods (Marshner, 1995). Yarnia *et al.*, (2009) in their study on sunflower in drought and using potassium sulphate condition stated that gain trait in plot with using 200 kilograms potassium sulphate per hectare and a suitable irrigation conditions after 50 millimeter evaporation from pan in compared to not using that caused 93/15 percent increase in seeds number in sunflower tray. Also, this rate in other levels of irrigation including irrigation after 90, 130, and 170 millimeter evaporation from pan was 65/82, - 59/91, and 47/6 percent. Due to the potassium role in keeping the plant water and preventing wasting that, in drought condition that plant encounter to drought, enough potassium causes maintaining photosynthetic activity and assimilates and with increasing stress intensity the potassium role is preventing seed reduction in plant (Daneshian *et al.*, 2006).

The comparison results of irrigation interaction effects and potassium sulphate levels also show a significant difference among treatments. Among them the most seeds per pod were seen in 6 days irrigation and using 140 kilograms potassium sulphate fertilizer. Also, the least number was seen in not using potassium fertilizer control and 16 day irrigation interval (table 3).

Pod Length

Pod length trait was also influenced by irrigation factors and potassium sulphate fertilizer levels. Therefore, variance analysis results showed that both factors had a significant effect on pod length (table 1). Increasing irrigation intervals, the pod length was reduced significantly (table 2). Reduction rate in 11 and 16 days irrigation interval in compared to suitable irrigation conditions (6 days) showed 7/2 and 14/4 percent reduction respectively.

The comparison average results of potassium sulphate simple effects on pod length showed that there was a significant difference among various levels of potassium fertilizer. However, in lowest level (60 kilograms per hectare), There was not a significant difference with control (without using fertilizer), but in other levels (100 and 140 kilograms per hectare) a significant difference was seen (table 2). Abdzadeh Gohari *et al.*, (2010) reported that in rainfed conditions, the maximum length of the pod of *Vigna unguiculata* was using 30 kilograms nitrogen and 30 kilograms potassium per hectare.

Thousand Seed Weight

Seeds weight is one of the main components and its high rate causes increase in yield. It depends on four factors including filling, active leaves in reproductive stage, leaf surface, and stem dry weight (Kouchaki *et al.*, 1993). In this study, seed weigh is influenced by irrigation treatments and irrigation effects and potassium fertilizer and with increasing irrigation intervals, seed weight was reduced significantly (table 1 and 2). Farasat *et al.*, (2012) believe that in drought stress, the plant encounter to water stress at the beginning of its growth and as a result the plant's self-regulatory mechanism is based on limited seeds. Therefore, the plant has the ability to fill in these seeds number. On the other hand, as they said, thousand

seeds weight has been less influenced by adverse environmental conditions and the other components are influenced more. Unlike this theory, Rostami (2004) reported that weight loss in drought stress is because of the seed filling reduction. Different amount of potassium sulphate fertilizer also showed a significant effect on seed weight trait. The maximum weight (231/94 grams) was obtained in using 140 kilograms per hectare, but there was not any significant difference using 100 kilograms per hectare (230/1 grams). The minimum seed weight was also observed in control treatment (207/02 grams) (table 2). Heidari and Asgharipour stated that one hundred sorghum seed weight in drought stress and applying 150 kilograms potassium sulphate per hectare had the greatest impact on one hundred seeds weight. Yarnia *et al.,* (2009) in a study on a sunflower also stated that when they did not use potassium sulphate fertilizer in irrigation treatment after 90, 130 and 170 millimeter evaporation rather than irrigation after 50 millimeter, one hundred seed weight reduced 14/78, 18/11, and 50/05 percent. Kemler (1983) stated that lack of potassium decreases the spikes in 2-3 leaves stage and in next stage, one thousand wheat weights. Potassium play on important part in increasing the cell division and increase in photosynthesis and transferring assimilatory materials.
The average results of interactions of irrigation and potassium sulphate fertilizer on beans weight was also significant (table 3). Therefore, there were maximum weight of one thousand seed (239/32 grams) in 6 days irrigation intervals and using 100 kilograms potassium sulphate per hectare, but there was not any significant difference between this and using 140 kilograms potassium fertilizer in 6 days irrigation.intervals Also in while the that irrigation increased to 16 days intervals without using any potassium fertilizer, the result was the lowest seed (177/37 grams0. Heidari and Asgharipour (2012) reported that irrigation in 70 percent of field capacity and using 150 kilos potassium sulphate per hectare produced the maximum weight of one hundred grain sorghum.

Seed Yield

Vigna unguiculata seed yield was significantly influenced by irrigation levels and potassium sulphate fertilizer, but their interaction effect on this trait was not significant (table 1). Seed yield in of 6 days irrigation intervals with production average of 174/18 kilograms per hectare was more than from 11 and 16 days irrigation intervals that showed 26/81 and 40/93 percent increase respectively (table 2). Boonari *et al.,* (1992) stated that water limitation and drought stress because the reduction in leaf activity and then reduction in plant yield. The reasons of decrease were the decrease in length of grain filling period and early senescence of leaves (Feredrick *et al.,* 1999).

In a study on the humidity effects on different growth stages, of *Vigna unguiculata* Rezaee *et al.,* (2009) reported that irrigation cut for two weeks in germination stage was tolerable but in flowering and poding and seed filling stages caused the decrease in grain yield, seed number in pod and the weight of one thousand grain.

It seems that in drought stress, the plant partitioning the photosynthesis materials to economic organs including the filling pod instead of vegetative organs. In this case, along with producing the optimum index of leaf area, minimum shading and increase of leaf duration, the plant transfers the photosynthetic materials toward grains that results in the increase of plant ability and finally increase in grain yield.

The different amount of potassium sulphate fertilizer also had a significant effect on the plant. However, among different levels of 100 and 140 kg per hectare of potassium fertilizer, no important different was observed but there was significant different in lower amounts. Yield average in 60, 100, and 140 kg per hectare were 1307/58, 1467/83, and 1479/91 kilograms respectively and the minimum amount with yield average of 1204/75 kg per hectare was the control (without using fertilizer) (table 2). Heidari and Asgfarpor (2012) also reported that in drought stress, applying different amounts of potassium sulphate had a significant effect on sorghum yield. Positive effects of applying potassium sulphate fertilizer on increasing different crops yield in drought stress were reported by other researchers (Daneshian and Jonoubi, 2001; Yarnia *et al.,* 2009; Ghasemzadeh Gagjchi, 2010; Gohari *et al.,* 1980; Ghaderi Ghahfekri *et al.,* 2010).

Table 1: Analysis variance of irrigation and different amount of potassium sulphate fertilizer on traits

Mean square (MS) Yield	weight	Pod length	Grains in pod	Pods number	df	Sources of variation
$9189.02^{n.s}$	$5.85^{n.s}$	$0.42^{n.s}$	$0.103^{n.s}$	$2.72^{n.s}$	3	Repeat (block)
2152834.08^{**}	2296.48^{**}	16^{**}	11^{**}	188.9^{**}	2	Irrigation (I)
4229.41	25.87	0.11	0.08	0.669	6	Main error
207209.57^{**}	1550.26^{**}	7.99^{**}	3.65^{**}	15.49^{**}	3	Potassium fertilizer (K)
$2295.55^{n.s}$	382.04	$0.16^{n.s}$	0.59^{**}	$1.93^{n.s}$	6	I×K
4500.46	41.88	0.17	0.06	1.82	27	Sub error
12.72	8.89	8.23	7.74	9.75	%	Coefficient of variation (C.V)

*, **, $^{n.s}$ *showing significance in 5% , 1% , and no significant difference respectively.*

Table 2: Mean comparison of simple effects of irrigation and different amounts of potassium fertilizer on traits

Grain yield (kilogram per hectar)	1000 grains weight	Grains per pod	Pod length (centimeter)	Pod per	Treatment
Irrigation					
1764.18^{a}	233.44^{a}	7.43^{a}	13.88^{a}	31.99^{a}	6 day
1291.06^{b}	226.7^{b}	6.53^{b}	12.88^{b}	28.21^{b}	11 day
1042.06^{c}	210.16^{c}	5.78^{c}	11.88^{c}	25.13^{c}	16 day
Potassium fertilizer					
1207.75^{c}	207.02^{c}	5.92^{c}	12.27^{c}	26.75^{b}	0 kg/ha^{-1}
1307.58^{b}	224.68^{b}	6.54^{b}	12.15^{c}	28.85^{a}	60 kg/ha^{-1}
1467.83^{a}	230.1^{ab}	6.6^{b}	13.25^{b}	29.08^{a}	100 kg/ha^{-1}
1479.91^{a}	231.94^{a}	7.27^{a}	13.58^{a}	29.1^{a}	140 kg/ha^{-1}

In each column, the means having common letters do not have a significant difference with each other in 5% based on Dunken test.

Table 3: Mean comparison of interactions effects of irrigation and different amounts of potassium fertilizer on traits

Grain yield (kilogram per hectar)	1000 grains weight (gr)	Grains per pod	Pod length (centimeter)	Pod per	Treatment
1592.5^{a}	222.8^{cde}	7.12^{bc}	13.07^{a}	30.43^{a}	I_1K_0
1735.75^{a}	234.04^{ab}	6.87^{cd}	13.22^{a}	33.27^{a}	I_1K_1
1844.75^{a}	239.32^{a}	7.82^{a}	14.22^{a}	32.08^{a}	I_1K_2
1883.75^{a}	237.61^{a}	7.29^{a}	15.02^{a}	32.2^{a}	I_1K_3
1147.25^{a}	220.89^{de}	5.7^{g}	12.42^{a}	26.36^{a}	I_2K_0
1197.75^{a}	222.74^{cde}	6.65^{de}	11.95^{a}	27.87^{a}	I_2K_1
1411.25^{a}	230.89^{abcd}	6.4^{ef}	13.2^{a}	29.71^{a}	I_2K_2
1408^{a}	232.28^{abc}	7.4^{b}	13.95^{a}	28.9^{a}	I_2K_3
883.5^{a}	177.37^{f}	4.95^{h}	11.32^{a}	23.46^{a}	I_3K_0
989.25^{a}	217.27^{e}	6.1^{f}	11.27^{a}	25.43^{a}	I_3K_1
1147.5^{a}	220.08^{e}	5.57^{g}	12.35^{a}	25.45^{a}	I_3K_2
1148^{a}	225.92^{bcde}	6.5^{de}	12.6^{a}	26.2^{a}	I_3K_3

In each column, the means having common letters do not have a significant difference with each other in 5% based on Dunken test.

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