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Effect of soil use and spraying of potassium sulfate and different irrigation intervals on grain related trains in maize 704 in Khoda Afarin

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Key words: Maize, irrigation interval, potassium sulfate spraying.

Abstract

This study was conducted in khoda Afarin in 2012 Ordibehesht aiming at evaluating of using this element as a soil and spraying it in two stages of development and Tassel formation various water condition in maize single 704. The experiment was performed in spit-plot in complete random block design with three replications in this study, irrigation water per a_1: 7 days, a_2: 14 days and a_3:21 days once and potassium sulfate use as a minor factor was performed with 8 levels. Characters of the number of kernel rows per maize, the number of per row. The number of maize per plant, plant height, total dry weight number of speeds per plant, weight of 300 seeds and seed weight per plant were measured. The result showed that there was a significant difference between studied irrigation levels in traits of weight of 300 seeds, seed weight per plant, plant height, dry-weight of the whole plant and the number of seed rows and the lower part of maize in probable levels of 1 and 5 percent. There was a significant difference between potassium sulfate levels on probable level of 5 percent in the weight of 300 seeds, dry-weight of the whole plant, and seed weight per plant. A delay in maize 704 irrigation from 7 days to 14 and 21 days led to a significant reduction in characters of number of seed rows in the lower part of maize, plant height, and dry- weight of the whole plant, weight of 300 seeds and seed weight in plant. The highest values of this parameter were obtained every 7 days after irrigation. There was no significant effect on these traits in delay irrigation from 14 days to 21 days. Using potassium sulfate led to an increase in traits including the weight of 300 seeds, dry-weight of the total plant and seed weight per plant compared to not using the element. Using potassium sulfate as a soil with spraying in Tassal formation led to the highest levels of seed corn production (166.55 gr per plant). And its soil application with spraying of potassium sulfate in deployment had the highest dry-weight of total plant with the operation of 405 and gr respectively. So if the using corn is of forage, potassium sulfate spraying will be done in early plant growth and if the goal is seed production. Spraying is done during Tassel.

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Introduction

Thomas (1997) stated that there are few factors affecting stress such as low available soil moisture, high evaporation, aggravated breathing due to high temperatures, intense radiation of sun, increasing the strength of soil mechanic due to drying. Potassium has many functions in plant cells; its high concentration in simplest offers it as a mineral smolit in plant cells. Loss of potassium ions can lead to the loss of anions and cations balance, and this will ultimately lead to a decrease in cell PH (Aziz *et al*, 1999). Potassium deficiency in plants firstly doesn't lead to visible and apparent signs and symptoms, but rather there is a reduction in growth and yield rate which is celled hidden hunger, and as long as there is no severe shortage, apparent symptoms do not occur until the and of growing season. Yield reduction will definitely resulted in such condition. (Salar Dini, 2004).

Water stress will lead to a reduction in the level of growth-stimulating hormone such as cytokininis, and an increase in abscisic acid and ethylene in crops, and finally reduced crop growth but potassium is able to maintain the balance of hormones within the plant in dry conditions (FAO, 2010). Corn is one of the important and strategic products for potassium and yet most exigent. Ashidry *et al* (2011) found that lack of adequate rainfall and its uniform distribution during growing in arid and semi-arid made most crops possible to be cultivated only by irrigation and on the other hand due to limited water resources in such regions proper use of water is really important and determining accurately schedule irrigation is of special priority so that in one hand the plant isn't involved in moisture stress and in the other hand indiscriminate use of water won't cause the loss of this vital element or many other issues such as nutrient leaching and a reduce in water and fertilizer use efficiency. Corn with relatively short growing season shares so to 25% in supplying human food, 60 to 75% in livestock and poultry feed and 5% as a row material for industrial products (Barzabadi and Farahani, 2010). Rabbani and Imam (2012) reported that after rice and wheat corn is the third important crop in the world and water deficiency in its growing levels will cause different effects on grain yield and its yield parts. Khavari Khorasani (2009) stated that irrigation of this plant shouldn't be delayed because lack of soil moisture causes leaves to wilt and to roll, and stress symptoms shouldn't be allowed to appear because maize has been physiologically damaged before of emerging deficiency signs, and due to lack of root and shoot growth it won't grow enough.

Sajedi *et al* (2008) reported that studies of many researches indicate that using popular fertilizers can increase the resistance of plants against environmental stresses such as drought and salinity, also Khavari Khorasani (2009) stated that potash deficiency increases susceptibility to water deficit in maize Ibrahim Tabatabai (2010) found that with the use of appropriate amounts of potassium sulfate in water deficit conditions can partially prevent the deeline in yield and corn yield. The resulted of Abedi Babaei Arab *et al* (2010) also Barz Abadi and Farahani (2012) show that we can compensate the negative effects of water deficit at stage of vegetative and safflower seed filling and Zinc in pea in flowering stage by spraying the elements such as Zinc and potassium.

Mobser *et al* (2006) reported that effect of used Treatment elements on seed yield wheat varieties in water deficiency was significant in the level of 1 percent so that potassium sulfate treatment had the highest seed yield and this is probably due to resistance making properly to the lack of water of wheat by potassium results from Ilikaei *et al* (2010) show that selenium treatment sprays in stress percents a significant reduction of seed yield in different varieties kidney beans. So appropriate management practices are highly important for plant protective the stress of water deficiency and percent yield reduction.

Given the importance of corn in the diet of human and animals and arid and semi-arid climate for

cultivation this plant in Iran there is a need for supplement irrigation, and due to the role of potassium in the reduction of sensitivity of plants to water deficit, this study was conducted in Khoda Afarin area in different water terms aiming at evaluating use effects of this element as a soil and spray within two stages of development and Tassel formation.

Materials and methods

Space experiment

In this study single cross corn 704 cultivation was performed in 2012 in Ordibehesht on a farm of 800 m^2 areas in Khoda Afarin. The study was done in split-plot random block designs with three replications. In this study the experimented treatment are as following:

1- Irrigation interval as the major factor with 3 levels of irrigation watera_1: 7 days,a_2: 14 days anda_3: 21 days.

2- Potassium sulfate use as the minor factor with 8 levels includes:

B1: No consumption b2: soil use of potassium sulfate 250 kg per hectare, B3: potassium sulfate spray with 5% concentration in development stage (40cm of maize height), b4. Potassium sulfate spray with 5% concentration in Tassel formation, b5: potassium sulfate spray with 5% concentration in both stages of development and Tassel formation, b6: soil use of potassium sulfate for 250 kg per hectare and potassium sulfate spray with 5 % concentration in Tassel formation, b8: soil use of potassium sulfate for 250 kg per hectare and 5% concentration of potassium sulfate spray in both stage of deployment and tassel formation. The treatment of potassium use, using this element as potassium sulfate was applied based on recommended soil analysis for 250 kg per hectare in two forms of soil use as simultaneously strips with cultivation and in spray with 5% concentration in both stage of plant deployment and tassel formation in tested treatments. Using other chemical fertilizers used as strips and besed on recommendation of soil analysis in forms of urea (300 kg) per hectare, zinc and manganese sulfate 40 kg per hectare and superphosphate-triple 100 kg per hectare was done before cultivation. Furrow irrigation was simultaneously performed to plant deployment stage that is about 40 cm height, and then irrigation levels applied and continued to the end of the growing period. In late Shahrivar, the plant was harvested.

Studied traits

In this study, traits of number of seed rows in maize, seed number per row, maize number per plant, seed number per plant, weight of 300 seeds and seed weight per plant were measured. Variance analysis for measured traits was performed in split-plot experiment in random block design with three replications.

Statistical Analysis

Before analysis the variance, the assumption of normal distribution of deviations and homogeneity of variances were examined. Comparing of average characters was done by using Duncan's multi-range test in 5%. Probable level. In other to do statistical software such as MSTAT-C, SPSS-15 and excel.

Result and discussion

Results of variance analysis for studied traits are given in Table1. The results showed that there was a significant difference between studied irrigation levels in the weight of 300 seeds, seed weight per plant and number of seed rows per maize in probable of 1 and 5 percent. There was a significant difference in the weight of 300 seeds and seed weight per plant in the probable level of 5% (Table 2). The interaction of irrigation levels X potassium sulfate levels, there was no significant difference in any of studied trains.

Plant height

Delayed irrigation leads to a significant reduction in plant height. The highest rate of plant height was gained per 7 days 20632 m in irrigation conditions and the lowest amount 2.49 m per days irrigation

conditions and the lowest amount was 2.49 m per 14 days with significant difference in irrigation treatment. There was no significant difference for this amount in per 21 days irrigation. Delayed irrigation from 7 days to 14 and 21 days, plant height reduced to 5.05 and 4.22 respectively. There was a significant difference for plant height in irrigation level per 7 days and it was placed in class a and irrigation levels had the lowest plant height per 14 and 21 days were placed in class b (figure 3). Figure 3 showed that 0.55 unit of plant height reduces when each unit of water stress increases ($R^2 = 0.606$). A change in plant height is usually the most notable change from growing conditions in most plants, and plant height is affected by environmental moisture (Kuchaki *et al*, 1999). Uda *et al* (2006) reported that draught stress during growing season causes a reduction in leaf area and height of maize plant. Shoot length decreased with increasing severity of dehydration. The reason is a reduction in growth due to reduced cell division and cell growth.

Table 1. Variance analysis of studied traits in split-plot based on random block design.

S.O.V	DF	Mean of Squares				
		Plant height	seed row number in the lower part of ear	weight of 300 grain	seed weight per plant	dry weight of total plant
Rep	2	0.255**	0.477	415.986	185.414	121411.33
Factor a	2	0.122**	0.071	16.22*	590810.1*	66065.88**
Error a	4	0.02	2.286	0.014	0.035	3265.48
Factor b	7	0.019	1.445	1674.34*	8110.84*	11521.38*
b × a	14	0.014	0.094	13180.7	1159.611	4585.468
Error b	42	0.015	0.266	860.495	12283.627	4481.357
C.V%		4.74	8.26	11.97	19.73	18.18

* and ** Significantly at p < 0.05 and < 0.01, respectively.

Table 2. Comparison of mean level of irrigation water.

Irrigation Levels	traits					
	seed row number in the lower part of ear		weight of 300 grain		seed weight per plant	
7 days	10.83 ± 0.163	a	89.50±1.96	a	171.25±5.9	a
14 days	9.77 ± 0.163	b	75.33±1.96	b	137.28±5.9	b
21 days	9.83 ± 0.163	b	74.75±1.96	b	142.09±5.9	b

Differences between averages of each column which have common characters are not significant at probability level of 5%.

Number of kernel rows per lower part of ear

Number of kernel rows per lower part of ear Delayed irrigation leads to a significant reduction in the number of kernel rows in maize. The highest number of kernel row in maize which is 10.83 in irrigation conditions were gained per 7 days and the lowest number were gained with a significant difference in irrigation treatment per 14 days. There are no significant difference between this number and irrigation per 21 days. Delayed irrigation from 7 days to 14 and 21 days once, the number of seed row in maize reduce 9.78% and 9.22% relatively. There was a significant difference in lower part of maize in irrigation level per 7 day and was placed in class a and irrigation levels had the lowest seed row number in the lower part of maize every 14 and 21 days and was placed in class b. (table 2 and figure 1). Figure 1 shows that 5 units of seed row number reduce in the lower

part of maize when every unit of water stress increases (R2= 0.705) few researches have reported a reduction in seed number per row due to water deficiency. Edmeades *et al* (1993) and Ahmadi *et al* (2001) have reported that water deficiency stress reduces seed number per row and finally seed yield. Ahmadi (2005) reported that the stress has mostly affected the seed yield which is affected by a reduction in seed number per row, maize length and weight of 50 seeds in commercial late hybrids.

Table 3. Comparison of mean levels of potassium sulfate.

Sulfate Potassium levels	Traits					
	weight of 300 grain		seed weight per plant		dry weight of total plant	
No consumption	74.67±1.96	bc	126.51±5.9	c	331.47±14.27	bc
Soil use of potassium sulfate 250kg per hectare	82.44±1.96	ab	159.84±5.9	b	405.12±14.27	a
Potassium sulfate spraying with 5% concentration in deployment stage	82.89±1.96	ab	161.02±5.9	ab	395.69±14.27	ab
Potassium sulfate spraying with 5% concentration in Tassel formation	72.44±1.96	c	126.62±5.9	c	318.31±14.27	c
Potassium sulfate spraying with 5% concentration in both stage of development and Tassel formation	81.56±1.96	ab	157.69±5.9	b	369.11±14.27	bc
Soil use of potassium sulfate 250 kg per hectare and potassium sulfate spraying with 5% concentration in development stage.	82.44±1.96	ab	165.76±5.9	a	402.87±14.27	a
Soil use of potassium sulfate 250 kg per hectare and potassium sulfate spraying with 5% concentration in Tassel formation	83.87±1.96	a	166.55±5.9	a	390.97±14.27	ab
Soil use of potassium sulfate 250 kg per hectare and potassium sulfate spraying with 5% concentration in both stage of development and tassel formation	78.67±1.96	b	137.64±5.9	bc	332.39±14.27	bc

Differences between averages of each column which have common characters are not significant at probability level of 5%.

Weight of 300 seeds

Delayed irrigation lead to a significant reduction in the weight of 300 seeds. The highest amount of 300 seeds which is 89.5 was gained 7 days during irrigation conditions and the lowest was gained every 21 days which is 74.75 gr and there was a significant difference in irrigation treatment. There was no significant difference between this amount and every 14 days irrigation. Delayed irrigation from 7 days to every 14 and 21 days irrigation reduced the weight of 300 seeds in 15.83 and 16.48 percent respectively. There was a significant difference between every 7 days irrigation in the weight of 300 seeds and others. And was place in class a and every 14 and 21 days irrigation has the lowest weight of 300 seed and was placed in class b (table 2 and figure 1). Figure 1 shows that 7.375 units of the weight of 300 seeds reduce when every unit of water stress increases (R2= 0.779). Nosmith and Ritchie (1992) studied water stress in the phase of seed filling and in two planting dates and reported that stress applying 9-12 days after appearing 50% sericeous fibers with 18 days

deficiency duration, caused a more reduction in seed numbers per plant and weight of 1000 seeds in second planting then in first one. The major reason of yield reduction was due to a significant reduction in the weight of 1000 seeds in both planting times. Their experiment led to a yield reduction of 21-23 percent and 35-40% for first and second planting time, respectively. 300 seed weight range between levels of measured potassium sulfate varied from 72.44 gr (spraying in Tassel formation) to 81.78 gr (soil use and spraying in Tassel formation). Weight of 300 seeds in the levels of soil use and spraying in Tassel formation was significantly different from the others. And was placed in class a. in other hand, the weight of 300 seeds in the mentioned level 8.29% increased compared to control group (No consumption). And levels of soil use, spraying in deployment stage, spraying in both stage of deployment and Tassel formation and soil use and spraying in deployment stage was significantly different from other treatments. Also spraying level in Tassel formation had the lowest weight of 300 seeds and was placed in class C (figure 3). Those with potassium deficiency despite the fact that plant produces large numbers of tillers, the number of clusters are limited and these tillers are less grained and lean. Barley which is the most critical plant to potassium deficiency, especially in sever deficiency, the leaves become pale and white spots can be seen on the leaves but this spot and the other spots destroy after the leaves are more yellow. Tip-burning and lip-burning of occur as well (Salar Dini, 2004). Lack of K fertilizers, especially as a sarak, on wheat and maize can cause wheat and corn beans to be impotence.(Malakooti and Homayi, 2001).

Seed weight per plant

Delayed irrigation led to a significant reduction in seed weight per plant. The greatest amount of seeds per plant was gained 171.25 gr every 7 days in irrigation time and the lowest amount with a significant difference in irrigation treatment was 137.2 gr every 14 days. There was no significant difference between this and every 21 days, reduced the amount of seed weight by 19.83% and 17.02% respectively. There was a significant difference between seed weight per plant in every 6 days irrigation with other levels. And was placed in class a and every irrigation every 14 and 21 days had the lowest seed weight per plant, and was placed in class b (table 2 and figure 2). Figure 2 showed that 14.58% of weight per plant reduces when water stress increased (R2=629) Barzabadi and Farahani (2010) showed that water deficit at different growth stage of maize had different effects on seed yield and yield components.

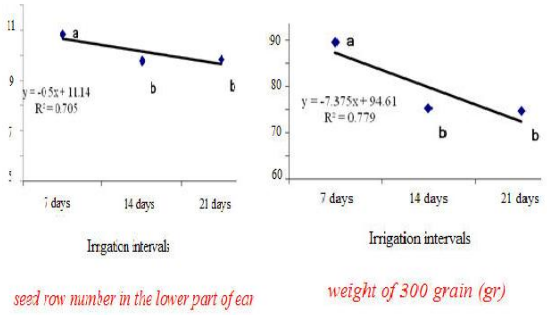

Fig. 1. Irrigation interval for seed row number in the lower part of ear and the weight of 300 seeds (gr).

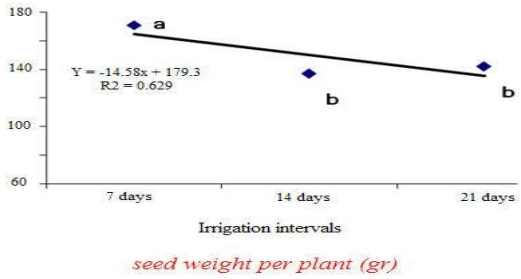

Fig. 2. Irrigation interval for seed weight per plant.

Seed weight range per plant between measured levels of potassium sulfate varied from 126.51 gr (without consumption) to 166.56 gr (soil use and spraying in both stage of development and Tassel formation). Seed weight per plant in the levels of soil and spraying in both stage of development and Tassel formation and soil use and spraying in Tassel formation were placed in class a and there was a significant difference with the level spraying in the stage of development and other levels namely seed weight per plant in the levels (soil use and spraying in both levels of development and Tassel formation and

soil use and spraying in Tassel formation) increased 16.52% and 16.49% respectively compared to control group.

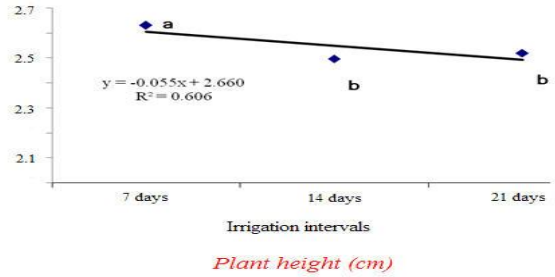

Fig. 3. Irrigation interval for plant height.

Also the levels of soil use and spraying in the level of Tassel formation and the lowest seed weight per plant and were placed in class C (table 3). Given the role of potassium in plants, water protection and preventing water loss, adequate potassium within stress conditions of water deficit protects photosynthesis activity of plant and generating photosynthetic materials and increasing stress salinity, function of potassium in preventing seed reduction per row is justifiable. And due to the function of potassium in transferring smolites and diets, increasing seeds per row with potassium use is justifiable (Daneshian *et al*, 2007). Ibrahim Tabatabai (2010) by measuring the effect of potassium values and draught stress on seed yield and seed filling of maize reported that using efficient amount of potassium sulfate can prevent yield decline and yield components of maize in the stress of water deficit. Mobser *et al* (2006) in a research studying the effect of potassium applying, zinc and copper on wheat seed yield and its enrichment in the stress of water deficit reported that potassium sulfate use treatment with 4.57 mean ton per hectare had the highest seed yield in wheat and this is probably due to the properties of wheat resistance again draught by potassium. Barzabadi and Farahani (2010) in a study called "effect of irrigation and spraying zinc sulfate on yield and yield components of pea in Arak" showed that positive of spraying zinc in flowering time on seed yield of pea is really important.

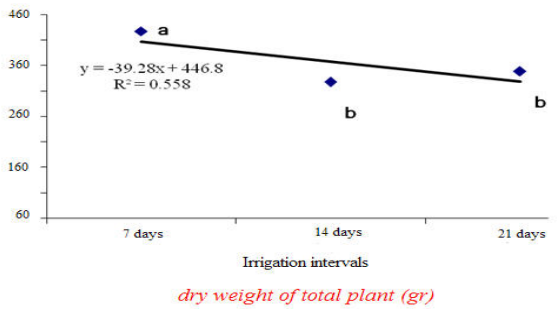

Fig. 4. Irrigation interval for dry weight of total plant.

Dry weight of total plant

Delayed irrigation led to a significant reduction in the weight of total plant. The highest amount of dry weight of total plant was 427.57 in every day's irrigation and the lowest amount with significant difference in the irrigation treatment every 14 days was 327.96 gr per plant. There was no significant difference between this value and every 21 days irrigation. Delayed irrigation from 7 days to 14 and 21 days, the dry weight of total plant reduced to 22.29% and 18.88% respectively. There was a significant difference between dry weight of total plant in every 7 days irrigation and other level and it was placed in class a and every 14 and 21 days irrigation had the lowest dry weight of total plant and was placed in class b (table 2 and figure 4). Figure 4 shows that 39.28% of dry weight of total plant reduced by increasing each unit of water stress (R^2 =0.558). Adalatifar (2007) reported that weight of shoots was significantly reduced affected by severe draught stress. Stress causes a reduction in cell development through a deficiency in cell swelling and photosynthetic reduction and due to photosynthesis reduction growth reduces and finally stops (Sarmadnia and Kouchaki, 1998). Khavari Khorasani (2009) stated that irrigation of this plant shouldn't be developed because lack of soil moisture makes the leaves to wilt and roll. Also the stress symptoms shouldn't allow appearing because Maize is damaged grow due to non-growing of root and shoot cells dry weight range of total plant between measured potassium sulfate varied from 318.31 gr (spraying in Tassel formation) to 405.12 gr (soil use). Dry weight

of total plant in levels of soil use and spraying of deployment stage were placed in class a. In the other hands, dry weight of total in the mentioned levels compared to control group (without consumption) increased 40.43% and 40.20% respectively. Also level of spraying in Tassel formation had the lowest dry weight of total plant and placed in class C (table 3). Sajedi *et al* (2010) in a research named "effect of draught stress and use of food elements on yield, yield components and water-use efficiency in maize" found that using Selenium in maize on water deficiency stress, has increased yield and yield components compared to a treatment without consumption and this is the problem of efficient function of selenium in modifying the effects of water deficiency in growing and gametophyte period. Ibrahim Tabatabai (2010) by measuring the effect of potassium values and draught stress on yield and seed filling of maize reported that by using rescannable consumption of potassium sulfate can prevent yield deficiency and yield components of maize in water deficiency.

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