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# EFFECT OF POTASSIUM AND ZINC IN DIFFERENT IRRIGATION CONDITIONS ON MORPHOLOGICAL AND PHYSIOLOGICAL CHARACTERISTICS OF MAIZE

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**ABSTRACT**
This study was designed to investigate the effect of potassium application on different conditions on morphological characteristics and physiological irrigation of summer corn, the weather conditions Mehran, was conducted in 2013. In this test, a split plot factorial, and in a randomized complete block in four replications. Stress as a major factor in three levels, including irrigation control, irrigation before flowering in 20 days, and 20 days after pollination irrigation in main plots and fertilizer amounts of potassium sulfate and zinc sulfate Level 3 subplots involving potassium sulfate at a rate of 0, 75 and 150 kg per ha and foliar zinc sulfate 0, two thousand and four hundred sub-plots were a factorial. Results showed that irrigation had a significant effect on all traits. Potassium fertilizer had a significant effect on all traits. The highest yield with 150 kg potassium per ha the amount of 6987 kg per hectare. Effect of zinc also means have all the traits except plant height and number of kernel rows. The maximum value of mode 4 in the thousands on the value of 7327 kg per hectare. Interaction of irrigation and zinc on grain yield and irrigation and potassium on biological yield was significant. In general, potassium sulfate and zinc sulfate, in the present study to reduce the adverse effects of drought stress.

**KEY WORDS:** corn, drought, plant height, yield.

## INTRODUCTION

Seasonal drought, the most important factor limiting the development and production of corn in the world are grown. Drought, on average, 17 percent of the annual yield of corn will reduce the world and even in some years more than 70 percent yield reduction due to drought have been reported. Approximately 70% of the arid and arid areas that make up the average annual rainfall less than 150 mm. In addition, the evaporation rate is lower than average precipitation and the rainfall is erratic and unpredictable. Therefore, one of the major limitations in most parts of Iran, there is a water shortage problem (Khalil *et al*, 2010). The next position is (Nourmohammadi, 2001). Corn acreage in the world is increasing day by day. In Iran and parts of the country due to the adaptation of Khuzestan and Ilam growing promising results. Basically corn plant that grows in tropical areas with adequate moisture and climate require compliance with environmental conditions is of Ilam.

Today, focusing on one of the most important nutritional deficiency in the world, the growth in calcareous soils of arid and arid world is limited, and probably the most extensive in the world are among the micronutrients (Tadon et al, 1993). Zinc deficiency in plants worldwide and has been observed in nearly all soils. Zinc deficiency alkaline soil reaction (due to its lack of solubility and availability) leaching in sandy soils and soils with acid soils (due to low levels of zinc in the soil) is more prevalent (Welch, 2004). K, as a critical factor for controlling the water shortage has been identified in plant. This element plays an important role in agricultural production and is an important element in the physiology of plant water relations (Valad Abdi et al, 2009). There is evidence that stress affected plants show a greater need for potassium. Stress due to the production of reactive oxygen species cause damage to cells, especially during photosynthesis is. Potassium balance water pressure and the opening and closing of stomata Inflammation the accumulation and transfer of carbon hydrates and helps maintain water balance of the plant. Potassium, in addition to increase production and improve product quality, increases the resistance of plants to drought and increased water and fertilizer efficiency. In 1995, Egypt's agricultural experts in drought conditions and limited water in the greenhouse, could add 15 mg per kg of potassium fertilizer, increasing production 49 percent gain (Dastbandannzhad *et al*, 2010).
Results Majidian *et al* (2008) found that drought stress significantly decreased yield in maize. The main cause of yield loss in drought treatment reduced the number of grains per ear and seed weight. These findings are consistent with the findings of other researchers who have shown stress, number of kernels per ear, seed weight per ear and grain yield decreases. Reducing the number of grains per ear, which may delay the emergence of tassels or miscarriage is due to a

  

deficiency of carbon hydrates. The most important factor is the decrease in grain yield under drought stress, grain filling period is short. Water stress decreases the assimilate supply and grain yield, grain weight per ear and grain weight also decreases.

Nerval and Singh (1994), an experiment was carried out to investigate the effect of zinc on maize and concluded that, compared with control treatments, yield is increased. Mousavi (2006) also reported that, in 60 kg and 600 kg ha zinc sulphate of potash, the highest yield was obtained. Jacob born (1997) the effect of potassium sulfate fertilizer to maize grain yield was positive and meaningful assessment. Buckthorn (1995) also reported that application of zinc fertilizer significantly increased the seed yield, seed yield in research scholars using sulfate fertilizer on 35.7 to 41 percent increase. They also concluded that soil application on yield was more effective than spraying. The objectives of this study were as follows: Effect of potassium and zinc fertilizers on maize drought tolerance. Effects of drought stress on yield and determine the most sensitive developmental stage of maize in drought conditions. Effect of potassium and zinc fertilizers on the yield and yield components of maize. Potassium role in modulating the effects of drought stress on growth and yield of maize. Investigate the interactions between potassium and zinc and drought stress on yield and yield components of maize.

## MATERIALS AND METHODS

This study, in August 2013 in the city of Mehran farming town southwest of Ilam done. To determine the physical and chemical properties of soil from different areas of the site implementation and testing of 30-0 cm depths were sampled randomly at some point the soil analysis results are shown in Table 1. In this test, a split plot factorial randomized complete block design with 4 replications. Stress as a major factor in three levels including irrigation control, irrigation before flowering in 20 days, and 20 days after pollination irrigation in main plots and fertilizer amounts of potassium sulfate and zinc sulfate 3 levels including potassium sulfate at a rate of 0, 75 and 150 kg per ha and foliar zinc sulfate 0, two thousand and four thousands of factorial, were the sub-plots. Corn used in this experiment, the hybrid sc704. Each plot consisted of nine lines -row plant spacing of 75 cm to 5 m in length, which was considered to be on the second row in each stack. Seeds 5-3 cm depth on the stack by setting ridge created. In each treatment, the operations of the seed culture Irrigation iterations concurrently performed immediately. Accordingly, the second irrigation after the first watering was done within five days of germination and seedling stage and thus was well spent. Gradually due to plant growth, ground cover and reduce evaporation from the surface between watering rose and took every eight days on soil moisture conditions. In the final stages of the growing season due to lower temperatures, irrigation was done once every twelve days.

At the final harvest, after ascertaining the maturity and cessation of irrigation water, the ear length of 3 meters from each treatment were harvested 5 midfield. The seeds were separated from the cob and grain weight and grain moisture content by hygrometer device determines, based on a 14% moisture content was calculated. The yield components, number of rows per ear, number of kernels per row, number of grains per ear, grain weight, biological yield and harvest index were measured. Data analysis was performed using SAS statistical software. Means were compared using Duncan's method at 5% level, and drawing diagrams using graphics software was excel.

**Table 1. Results of soil analysis**

| Zinc (mg/kg) | Organic carbon (%) | EC (ʼum/cm) | PH | Nitrogen (p.p.m) | Phosphorus (p.p.m) | Potassium (p.p.m) | Depth of sampling (cm) |
|---|---|---|---|---|---|---|---|
| 0.20 | 0.3 | 0.9 | 7.0 | 23.2 | 8.1 | 332 | **0-30** |

## RESULTS AND DISCUSSION

### Number of kernel rows per ear

Results showed that the effect of stress on the number of kernel rows per ear of corn was significant (Table 2). Most of the irrigation mode to the normal 14.2 pcs respectively, compared to irrigation 20 days after pollination was increased to 10% (Table 3). The effect of potassium on yield was significant at the 95% level (Table 2). The maximum amount of potassium at 150 kg per hectare to a 14.6 the number had increased to 13% compared with control treatment (Table 3).

**Number of kernels per row**

Results showed that the effect of stress on grain number per row corn was significant (Table 2). Most of the normal irrigation mode to 23.0 numbers is obtained, compared to 15 days after pollination; irrigation was increased to 25% (Table 3).

The effect of potassium on yield was significant at the 5% level (Table 2). The maximum amount of potassium at 150 kg per hectare to the 23.9 saw a 44 percent increase in the number obtained when treatment was compared (Table 3). The effect on this trait was significant (Table 2).

**1000 Seeds weight**

Results showed that the effect of stress on maize seed weight was significant (Table 2). The maximum amount of normal irrigation mode 255.1 g, compared to irrigation 20 days after pollination was increased by 25% (Table 3). Results showed that the effect of potassium on grain weight of maize was significant (Table 3). The maximum amount of 150 kg of potassium in the amount of 239.1 g, respectively, which showed a 9 percent increase compared to the control treatment (Table 3). Results showed that the effect of zinc on 1000 seeds weight were significant (Table 2). The maximum value of mode 4 in the thousands on the value of 237.5 g, which was increased by 20% compared to the control treatment (Table 3).

**Seed Yield**

Results showed that the effect of stress on grain yield was significant (Table 2). The maximum value of 7820 kg per hectare in the case of normal irrigation was found that irrigation than 20 days after pollination was increased to 43% (Table 3). Results showed that the effect of potassium on grain yield was significant (Table 2). The maximum amount of potassium in the amount of 150 kg 6987 kg per hectare, respectively, which was increased by 24% compared to non-consumers (Table 3). Results showed that the effect on grain yield was significant (Table 2). The maximum value of mode 4 in the thousands of zinc on the value of 7545 kg per hectare, respectively, compared with 39 percent of treatment failure (Table 3). The results showed that the interaction of irrigation and zinc on grain yield was significant (Table 2). The maximum amount of water in normal and mode 4 in the thousands 8955 kg per hectare. In the case of not using the least amount of zinc and irrigation 20 days after pollination, the amount of 4112 kg per hectare. At all levels of the stress maximum grain yield was obtained with 4 in the thousands of zinc (Figure 1).

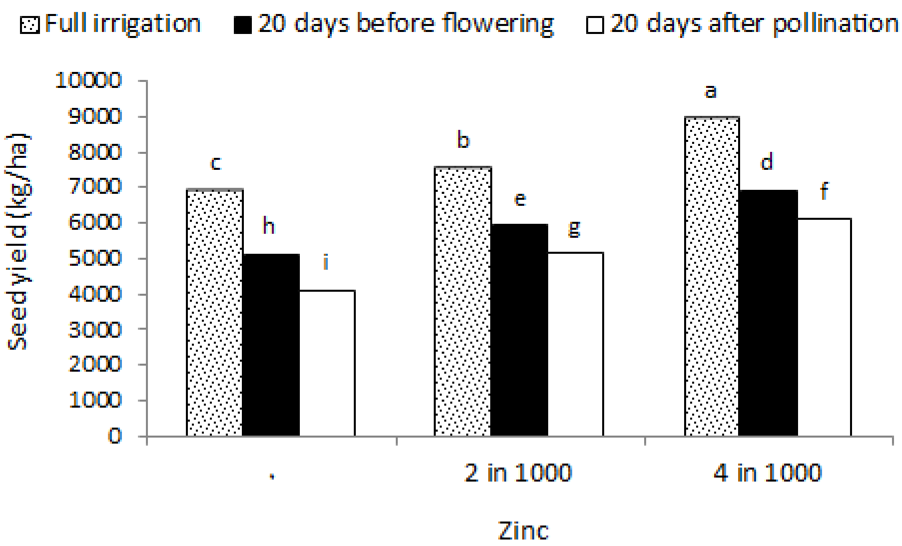


**Figure 1. Interaction effect of irrigation and zinc on seed yield**

**Biological yield**

Results showed that the effect of stress on biological yield of maize was significant (Table 2). The largest amount, at a rate of 19.522 kg per hectare was achieved normal irrigation than 20 days after pollination was increased by 20%

  

(Table 3). Results showed that the effect of potassium on grain yield was significant (table 2). The maximum amount of potassium in the amount of 150 kg 18551 kg per hectare, respectively, which was increased by 20% compared to non-consumers (table 3). Results showed that the effect of zinc on biological yield of maize was significant (Table 2). The maximum value of mode 4 in the thousands on the value of 18.533 kg per hectare, respectively, which was increased by 16% compared to the control treatment (table 3). The results showed that the interaction of irrigation and potassium on biological yield of maize was significant (table 2). The maximum value, in the case of normal irrigation and consumption of 150 kg potassium over 20926 kg per hectare. The lowest in the state and in the absence of potassium and irrigation 20 days after pollination, the amount of 14,063 kg per hectare (Fig. 2).

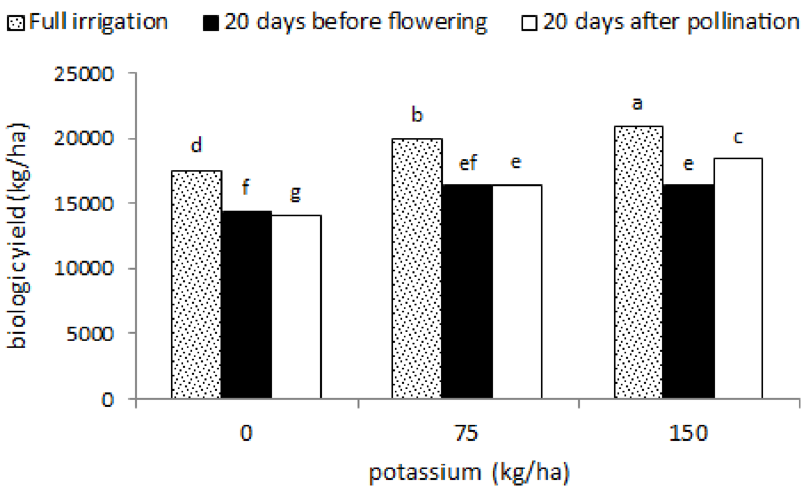


**Figure 2. Interaction effect of potassium and irrigation on biological yield**

**DISCUSSION**

According to Doberman (2004), in drought conditions, the use of potassium nitrate reeducates activity and increased rapidly improving Nitrogen fixation plant, leaf chlorophyll content was increased and consequently the process of photosynthesis, the increase in leaf area and dry matter production most continue. Potassium helps to balance the charge on the uptake and transport of anions is effective. Is known that potassium has a vital role in photosynthesis, such as direct increases in growth and leaf area index, and therefore $Co_2$ capture and assimilate translocation out of leaves is increased. Potassium has a crucial role in photosynthesis and leaf area index was increased by increasing of potassium fertilizer. Reduce the number of kernel rows, one of the main causes of the decline of corn that has a direct role in this field. The results of this study showed that by reducing the number of kernel rows, yield declined. Reproductive growth stage of the plant, the process is sensitive to drought stress at this stage will reduce yield components in the present experiments were implemented on the plant reproductive stage drought. Doberman (2004), in an experiment to investigate the effect of water stress on yield and yield components of maize did stated that stress at vegetative and flowering stages, the traits under study In particular, a greater effect on yield, yield components of said. Momeni (2011), stating that drought stress caused a significant reduction in the number of grains per ear. Maximum number of kernel control treatment and the lowest irrigation treatment in the reproductive stage. The most important factor is the decrease in grain yield under drought stress, grain filling period is short. Thus, the supply of assimilates Water stress decreased grain yield, grain weight per ear and grain weight also decreases seed increases (Movahedi, 2012). Ladlo *et al* (1990) stated that the stiffness reduction factors for photosynthesis and thus the yield. This decrease was due to reduced seed weight .has caused a decrease in yield. Movahedi (2012) reported an increase in grain yield with potassium sulfate. Seems to corn crop drought stress decreased the growth of various organs and consequently reducing the biologic function is. The most important impact of water shortages, which in most cases limit the amount of leaf development, dry matter accumulation and crop yield limits. Reduce the amount of dry matter in terms of scarcity, limiting the amount of leaf area that is associated with dry matter accumulation and crop yield. Movahedi (2012) reported an increase in biological yield of maize with zinc sulfate. Bagheri kholenjani (2011) also stated that zinc sulfate had a significant effect on increasing crop dry matter. In general, potassium sulfate and zinc sulfate in the present study to reduce the adverse effects of drought stress on yield components and vegetative growth of maize and consequently grain yield.

**Table 2. Analysis of variance test treatments traits**

| | | M.S | | | | |
|---|---|---|---|---|---|---|
| S.O.V | D.F | Number of kernel rows per ear | Number of kernels per row | 1000 Seeds weight | Seed yield | **Biologic yield** |
| Rep | 3 | 0.54 ns | 321.5 * | 89.67 ns | 176543.3 * | **198675 *** |
| irrigation | 2 | 22.03 * | 346.39 ** | 145.3 ** | 6754543.4** | **78756443*** |
| Residual a | 6 | 3.21 | 211.44 | 43.5 | 5643.65 | **10345** |
| potassium | 2 | 1.56 * | 4533.5 ** | 176.4 ** | 4321234.4** | **67456453 ns** |
| zinc | 2 | 1.1 ns | 9876.2* | 198.2 ** | 4533534.33** | **7895643 *** |
| potassium* zinc | 4 | 1.76 ns | 786.6 ns | 234.5 ns | 343543.22* | **3456889 ns** |
| Main factor*Sub factor | 16 | 3.54 | 245.5 | 57.6 | 6535.32 | **13452** |
| zinc*irrigation | 4 | 4.54 ns | 2948.93 ns | 231.4 ns | 653543.6 ns | **896564 *** |
| Potassium* irrigation | 4 | 1.43 ns | 2617.80 ns | 231.7 ns | 653457.6 ns | **644545 ns** |
| zinc* *Irrigation* irrigation | 8 | 2.45 ns | 9096.65 ns | 267.6 ns | 7643453.5 ns | **675679768 ns** |
| Residual bc | 72 | 2.432 | 343.4 | 110.43 | 7645.3 | **19865.g** |
| CV (%) | - | 11.45 | 8.65 | 8.87 | 7.76 | **9.56** |

**ns, *, **:Respectively, indicating a significant difference at 5 and 1% probability level, and the lack of significant differences**

**Table 2. Comparison of mean traits measured**

| | | Number of kernel rows per ear | Number of kernels per row | 1000 Seeds weight | Seed yield (kg/ha) | Biologic yield (kg/ha) |
|---|---|---|---|---|---|---|
| irrigation | Full irrigation | 14.2 a | 23.0 a | 255.1 a | 7820 a | 19522 a |
| | 20 days before flowering | 13.7 b | 20.0 b | 233.7 b | 6002 b | 16293 b |
| | 20 days after pollination | 13.0 c | 17.4 c | 201.7 c | 5125 c | 15676 c |
| potassium (kg/ha) | 0 | 12.8 c | 16.5 c | 219.8 c | 5596 c | 15336 c |
| | 75 | 13.5 b | 19.9 b | 231.6 b | 6362 b | 17603 b |
| | 150 | 14.6 a | 23.9 a | 239.1 a | 6987 a | 18550 a |
| zinc | 0 | 13.4 | 19.5 | 223.9 c | 5397 c | 15855 c |
| | 2 in 1000 | 13.6 | 20.0 | 229.1 b | 6223 b | 17102 b |
| | 4 in 1000 | 13.9 | 21.0 | 237.5 a | 7327 a | 18533 a |

**In each column and in each treatment that has common letters are not significantly different from each other.**

  

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