Evaluation of Grain Growth of Corn and Sorghum under K$_2$O Application and Irrigation According

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Abstract: In this experiment, interactive effects of different potassium application and water restrict on grain growth in Iran. The experimental unit had designed by achieved treatment in factorial on the basis completely randomized block design with three replicates. Certain factors including potassium and non-potassium applications (0 and 200 kg/ha), certain field crops (corn and sorghum) and water supply were studied. In this study crops water supply was determined by indicated irrigation conditions by keeping leaf Relative Water Content (RWC) > 95% (non-drought stress condition or irrigation conditions) and drought condition by RWC = 60-70%. We noticed, however K fertilizer significantly increased the grain growth rate of plants and although the non-drought stress treatment significantly increased grain growth rate. Whereas K application persist less damaging of drought stress result and it enabled plant to significantly grow its grain under the drought conditions. Our finding may give applicable advice to commercial farmers and agricultural researches for management and concern on fertilizer strategy and carefully estimate soil potassium supply within dry or semi-dry areas as most challengeable issues of environmental safety.

Key words: Potassium, drought stress, grain growth rate, corn, sorghum

INTRODUCTION

Drought stress is one of the most important environmental stresses affecting agricultural productivity around the world and may result in considerable yield reductions (Boyer, 1982; Ludlow and Muchow, 1990). Drought resistance refers to a plant’s ability to grow and reproduce satisfactorily under drought conditions, and drought acclimation refers to a plant’s ability to slowly modify its structure and function so that it can better tolerate drought (Turner, 1986). Apart from the effect of drying soil on the transport of nutrients to plant roots, the morphological and physiological mechanisms involved in cellular and whole plant responses to water stress are of considerable interest and are frequently examined (Hsiao, 1973; Levitt, 1980; Blum, 1988; Davies and Zhang, 1991; Smith and Griffiths, 1993; Close and Bray, 1993; Kramer and Boyer, 1995; Neumann, 1995). Downey (1971) showed that the no-stress treatments produced large amounts of dry matter. Drought stress during male meiosis stunted growth, stunted tassel development, reduced chlorophyll content and light absorption (during the period of stress) but, overall, was not very detrimental to grain yield. Drought stress during grain filling reduced grain yield by 50%; grain weight was reduced and a very high proportion of photosynthate went into sterile tillers. Moisture-stressed corn plants had relative turgidity values 18 percent lower in the leaves near the ear shoot than in the leaves near the tassel. This difference in relative turgidity could account for the lack of silk emergence while the tassels continued to shed pollen (Barnes and Woolley, 1969). Water-stressed sorghum showed larger root/shoot ratio and root length than without water stress conditions (Xu and Bland, 1993). Drought stress reduced dry matters of balm by reduction in the area of the leaf, height of plant and lateral stem number (Aliabadi Farahani et al., 2009). Also, drought stress decreased biological yield, seed yield and root length of barley (Khalvati et al., 2005). Management practices have a direct effect on P, K, S, and Ca availability and utilization by crops. Manure, as opposed to inorganic fertilizers, supplies nutrients over time throughmineralization. Also, the addition of organic matter with manure or with the use of an efficient crop rotation will affect soil properties such as cation exchange capacity and pH, and therefore root and nutrient interactions (Hickman, 2002). Furthermore, the mineral composition of the soil itself has an effect on plant uptake of selected nutrients. Interactions between elements may enhance or suppress nutrient uptake (Marschner, 1995). In addition, the presence or absence of certain elements can affect the general soil quality. For example, K is a soil aggregating agent which is known to have a positive effect on soil physical properties and subsequently crop yields (Hamza and Anderson, 2003). Potassium stratification associated with NT is of concern because adequate K nutrition for corn is not only dependent on the available K concentrations in the bulk soil, but also on the availability of K in soil volumes where roots are actively growing during periods of rapid uptake. Most K uptake occurs before pollination, and uptake corresponds closely to corn vegetative growth.

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Any deficiencies in K availability in soil volumes that are actively exploited by corn roots during the rapid dry matter accumulation phase of corn growth before pollination can result in inadequate K nutritional status and may result in reduced yields (Heckman and Kamprath, 1992). Plant cells are composed mainly of water; whilst ripe seeds of some plants (beet, sunflower, and flax) may contain only 5-15% of water, some fruit, leaves and roots consist of up to 95% of water. The function of water in the plant, indicators of its presence, definition of drought and its effect on plants, and the mechanisms of plant resistance to drought and the role played by potassium, are discussed. Potassium was found to be a crucial factor in the plants’ ability to manage water shortage (Parsons et al., 2007). Drought conditions seemed to intensify the influence of K on dry matter and grain weight of millet (Schneider and Clark, 1970). Potassium is important in the growth of crops and an important ion in the physiology of plant water relations. Therefore, this study was undertaken to examine the interactive effects of various levels of potassium and water in the soil on grain growth rate of corn and sorghum.

**MATERIALS AND METHODS**

This experiment was carried out using a factorial on the of basis completely randomized block design with three replicates. The studied factors included potassium (K) and non-application (K0) (0 and 200 kg/ha), certain field crops: corn (C1), and sorghum (C2) and irrigation levels with estimate leaf relative water content (RWC) by > 95% (non-drought stress condition (S1)) and irrigation under RWC = 60-70% (drought stress condition (S2)). The soil consisted of 22% clay, 29% silt and 49% sand (Table 1). For this approach experimental field was prepared in the dimension of 15 m² per plot (5 m × 3 m), totally 24 plots. Corn (Zea mays L. var. Single-cross 704) and sorghum (Sorghum bicolor L. var. Speed Feed) were used in this experiment. Initially, plant nutrient requirement of nitrogen supply was added by apply 300 kg/ha urea twice at the cultivation time and further at beginning of steaming stage as well as 200 kg/ha ammonium phosphate (phosphorus) and potassium (K2O) through cultivation time once. At the plants growth periods and between both irrigation levels, we collected 20 young leafs from each plot for determined RWC by under formula (Aliabadi Farahani et al., 2008).

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\text{RWC} = \frac{\text{Leaf fresh weight} - \text{Leaf dry weight}}{\text{Leaf turgid weight} - \text{Leaf dry weight}} \times 100
\]

In order to determine the grain growth rate, each 5 days between stages of first of pollination and harvest (61 and 67 days after sowing in corn and sorghum respectively), we collected plants leaf and placed under 75% in electrical oven for 48 hours and then weighted for evaluation of grain growth rate in each stage (Stocker, 1986). Finally obtained data were subjected to analysis of variance (ANOVA) using Statistical Analysis System terms were considered significant at P<0.05 (SAS institute Cary, USA, 1988).

**RESULTS AND DISCUSSION**

Final results of plants characters showed that drought stress significantly decreased the grain growth rate (P > 0.01) as compared to non-drought conditions which was higher in control plants, while grain growth rate was reduced under drought stress sorely (Table 2, Fig. 1). As it was shown in our results, drought stress had a negative effect on most of the emphasized growth compounds. In contrary, reducing water supply in soil achieved a situation for plant to pursue root growth though soil depth. This shows that in order to resist drought stress, the plant employed different strategies throughout individual survival struggle by drought conditions. In terms of reduce in evaporation plants showed an extreme reduce of leaf length and width (reduction in evaporation area). Although significantly reduction in plant height and tiller number might be due to decreasing of the evaporation area of leaves and it eventually caused of low dry matter at the end of growth period under drought conditions. Those might be correspond to the fact that under drought stomatal become blocked or half-blocked and this leads to a decrease in absorbing CO2, and on the other hand, the plants consume a lot of energy to absorb water, these cause a reduction in producing photosynthetic matters. Our observation indicated with rising increase of drought stress, its biological yield and grain yield decreased with rising of drying in soil. Further reducing of shoot dry weight might be due to the reduction of photosynthesis.

<table>
<thead>
<tr>
<th>S.O.V</th>
<th>d.f</th>
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<th>Grain growth rate</th>
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<tr>
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<tr>
<td>Drought stress</td>
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<td><strong>31.63</strong></td>
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<tr>
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<tr>
<td>K fertilizer</td>
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<td><strong>23.91</strong></td>
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<tr>
<td>Drought stress × Crops plants</td>
<td>2</td>
<td><strong>31.51</strong></td>
<td></td>
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<tr>
<td>Crops plants × K fertilizer</td>
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<td>Error</td>
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<td>15.01</td>
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**CV (%)** **8.6**

**Table 2: Mean square of grain growth rate**

* and **: Significant at 1% and 5% levels respectively
area in leaf, drop in producing chlorophyll, the rise of the energy consumed by the plant in order to take in water and to increase the density of the protoplasm and to change respiratory paths and the activation of the path of phosphate pentose, or the reduction of the root deploy, etc. Those findings are in agreement with the observations of Katerji et al. (2004); Krejsa et al. (1987); Ajayi and Olufayo (2004) and Garrity et al. (1983). In addition, K application had a significant effect on grain growth rate (P > 0.05). Therefore, our findings indicated a significant improved of plant grain growth rate under K application. Also, grain growth rate was increased under K application (Table 2, Fig. 2). Potassium is important for a plant's ability to withstand extreme drought stress. Some field crops showed ability of water relations adjustment which refers to water use efficiency. Soil nutrients like as Potassium ions affect water transport in whole plant, maintain cell pressure and regulate the opening and closing of stomates (small openings found on the leaf responsible for cooling and taking in carbon dioxide for photosynthesis). Those results were similar with the findings of Martens and Arny (1967) and Yin and Vyn (2002). Regarding to this fact, our data indicated that crops plants had a significant effect on grain growth rate (P>0.01) and preformed highest grain growth rate in corn (Table 2, Fig. 3). Data of drought subject and interactive effect between K application and crops plants has been demonstrated in Fig. 4. Significant different between crops plants treated with K application under water restriction was highlighted with compare to non-application K under drought conditions. Treatment was

Fig 1: Grain growth rate of corn (A) and sorghum (B) under drought stress

Fig 2: Grain growth rate of corn (A) and sorghum (B) under K fertilizer
Fig 3: Grain growth rate of corn and sorghum

indicated in grain growth rate (P>0.01) in the matter of crop plants, drought and K interactions (Table 2). However, highest grain growth rate was indicated in the corn with K application at none stress conditions (Figure 4). Our results of treatments interaction were similar to the results of Royo and Blanco (1999) and Ashraf et al., (2003).

CONCLUSION

Our study showed that under drought condition grain growth rate of crop plants were reduced, while the K application was contributed to protect root against damaging effects of drought stress. Currently the control of drought stress has been paying attentions due to the most important environmental factor in arid and semi-arid regions. It may useful to consider on screen certain local crops and fertilizer strategies to gain higher predictability under scope of limited available water recourse in these regions. Practically, findings may suggest farmers and agricultural researches to consider carefully on limiting or control the huge among of soil potassium application in suffered soils by water restriction as current challenge of scientist in global changes.

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REFERENCES


Fig 4: Grain growth rate of corn (A) and sorghum (B) under interaction of K fertilizer and drought stress


