Effect of drought stress on corn root growth

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Abstract: Research in Islamic Azad University research farm in southwest and 3 kilometers away the city of Ahwaz with an average rainfall of 256 mm was performed. A split plot design experiment in randomized complete block design (treatments main plot: different amounts of irrigation (I) and sub-plots: plant growth phases(S)) was performed with four replications. Drought conditions, important parameters such as root length, number, weight and root volume, decreased if mild water stress to some extent in root length was increased, but severe water stress conditions root length was significantly reduced, but treatment mild water stress during root 16.7 cm g soil to control increased weight, root length and number of roots unlike the mild stress can be increased to some extent, by applying the smallest levels of water stress, decreased in severe water stress treatments 17.7 grams per plant almost half the root weight without stress treatment was water, full size dependence root growth components such as the number and weight of roots decreased in the past two components of stress, volume Root also decreasing trend has provided four tests mean Duncan will provide that treatment (control) and treated with 151cc highest volume I_3 with severe water stress 81cc scaled lowest water cylinder size showed. The ratio of root to shoot in different levels of water stress decreased shoot and root weight decreased, but both decreasing trend in shoot weight of so much more stress the process of root weight was reduced. Comparing two-phase vegetative and reproductive growth period (respectively S_1 and S_2) of root weight reduction process at different levels of water stress, it was clear that root weight decreasing trend in the treatment of stress treatment, S_2 very more S_1 was in treatment S_2, percentage of root weight significantly decreased 47% in treatment S_1, but this value was 24%, respectively. [Report and Opinion 2010; 2(2):47-53]. (ISSN: 1553-9873).

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1.Introduction

Status of soil and water is one of the most important factors that affected on root growth and the genetic analysis of maize roots (Frank Holdyngr Hatch, 2008), announced the following results:

1 - Gene Rtcs, the formation of seed roots and they are expanding, expanding process may be vertical or horizontal expansion that this process completely dependent temperature and soil moisture is, the growth of corn root temperature C º 18 to about 30 degree horizon and the temperature C º 36 with angle is 61 degrees.

2 - Gene Lrt1, the growth of corn roots is horizontal and a high dependence of soil moisture, the moisture deficiency, the effect of this gene is limited, the horizontal expansion of corn roots, reduced root growth of vertical continues.

3 - Slr1 and Slr2 genes, that if water deficiency, the effect of higher gene Lrt1 and all growth is vertical roots (Figure 1).

Many studies have Any soil that is dry root value will be less if the soil is wet for a long time, longitudinal growth and slower root dry reverse the long, longitudinal growth of roots down is faster (Doerr etal, 2004). Between root depth and soil moisture and soil used are related in that That planting corn, soybeans, barley gross soil water storage capacity less Micro weave soil have deeper roots in (Bltrans, 2003). Some researchers used to estimate soil moisture regime quickly have used the root system (5). Generally observed that root growth potential of blue artifacts -50 MPa and started to decrease to about -1500 MPa would continue to slow, this year oats plants, gramineous species of corn, peas, grapefruit juice, tomatoes and soybeans has been achieved.

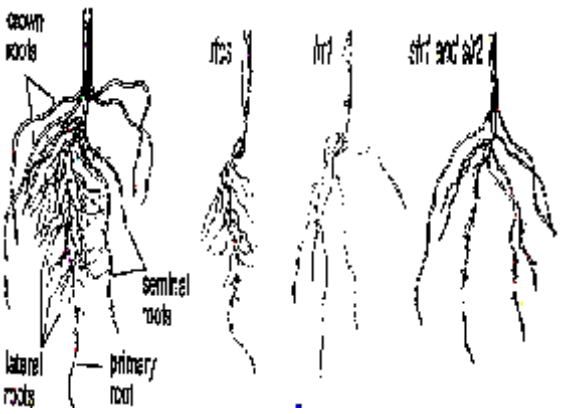


Figure 1.Effect genes on root growth (18)

If part of the roots of corn and tomatoes should be in the proper humidity, other parts of the roots can be less than potential moisture - 4 MPa must grow as well (Tamhyda, 2001) that root growth in soil moisture can be enough ventilation is limited (6).

The relationship between soil water potential and plant water potential is also found. That the moisture of the root of corn low metric - 1.09 MPa did not decrease. More root part of plants that soil moisture will have been gathering if the soil is dry roots in soil depth profiles draw more development. In general, the soil with little water storage capacity, depth of roots, stem and soil storage capacity above the roots are shallow. Soil moisture on significantly affect the root morphology. The results of the growth of corn in a silty soil (Mac When and Barber 2004) can be reported for example is mentioned. Increase soil moisture of 22 (MPa=1730) to 32 percent (MPa =7.8) significantly increased total root length, length of hairy roots, hairy root density and root surface from the hairy roots level are, respectively. Dryness and excessive soil moisture development of hairy roots prevent the house (7, 12).

2.Materials and Methods

In this experiment a split plot design in randomized complete block design with four replications was tested in the field of Islamic Azad University research and distance 3 km southwest of Ahvaz city with an average rainfall of 256 mm was performed. Location experiment and semi-arid climate is dry and the 40-year Meteorological Data Ahvaz 213 mm average annual rainfall, mean annual temperature of 25, 32 annual average maximum temperature, mean minimum degree temperature annual 18.4°C is. Minimum temperature in agronomic 2007 years 6.5° C in January and maximum temperature in September 53 ° C has been reported.

Before running experiments, to study farm soil, the depth of samples of 0-15, 0-30 and 30-60 cm was performed (Table 1). The three parameters fixed: FC= 21.22, PWP=13.7 and Pa= 1.19 g cm cubic method and cylinder pressure plates gauge size was measured.

Table 1: Results of soil analysis

soil	Deep (cm)	EC	Organic matter (%)	PH	Nitrogen (ppm)
Silty	0-15	6.5	0.6	7.7	635
Silty	15-30	6.6	0.3	7.6	648
Clay loam	30-60	5.7	-	7.3	211

Table 2: Review of different treatments tested

Main plot: **Drought stress Levels**	**Sub-plots:** **Different growth phases**
I_0 : Full irrigation point of FC, control, without water stress	**S_0**: growing phase, the establishment of the plant stem to the emergence
I_1 : 75% of the amount of irrigation treatments I_0, mild stress	**S_1**: natal phase: to stem the rise of coffee being resilient and end silk pollination
I_2 : 50% of the amount of irrigation treatments I_0, severe stress	**S_2**: grain filling phase: the end of pollen grain maturity and the emergence of black layer
I_3 : 25% of the amount of irrigation treatment I_0, very severe stress and point of PWP	-

2.1. Morphological characteristics calculated root

2.1.1. Root dry weight: washing with distilled water and drying the roots by placing 20th in Avon for 10 hours (depending on thickness and succulent roots) in the temperature of the root dry weight of 75 grams per plant was calculated.

2.1.2. The root length: root for the measurement using the drill sampling (15 core cylinder height and diameter of 7 cm) soil samples with roots were obtained after separating the roots, soil samples were immediately weight, then using the formula

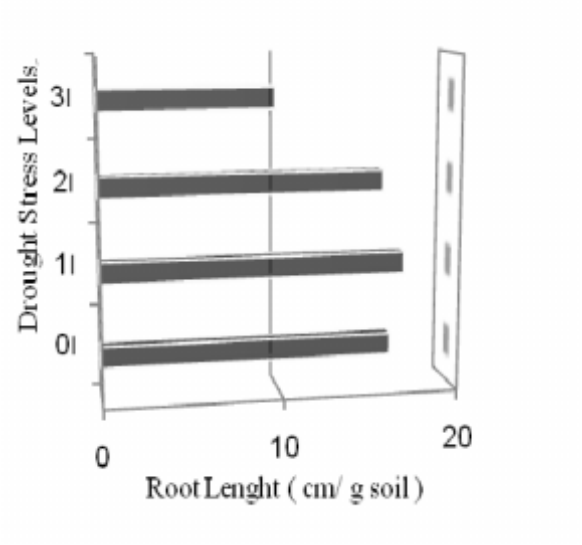


Fig3. Effect drought stress on root length

Newman and application of millimeter graph paper address the networking, the root length of root per unit cm g soil, respectively.

2.1.3. Number and size of root: root volume measure water movement and graduated cylinder for counting the number of notes taken root and were used.

3. Results

Analysis of variance showed that the effects of water stress treatments, periods of growth and interaction of these two length, number, weight and root volume, were significant. Drought conditions, important parameters such as root length, number, weight and root volume, decreased although mild water stress to some extent I_1 root length was increased, but severe water stress reduced root length I3 can clear all but the mild treatment Water stress root length 20.11 cm of soil to warm control unit with increased 19.11 Duncan test showed that mean 21.14 treated with the highest root length I_1 and I_3 treatment with the lowest root of 10.87 were present (Figure 3).

During phases of growth, treatments S_2 and S_3 that have done their full growth in terms of statistical difference, although not with each other on the study of root length data, which had root treatment S_3 (grain filling period) than treatment 2 S_2 probably because of the elimination of aging is part of the plant root, growth period S_1 (before the advent of double ring) lack of complete root development offers very little but what to plant to plant by the rapid growth stage, treatment S_2 goes, with increasing age of plant increased root length. Maximum root growth during the S_2 and S_3 was that although the terms of the two treatments did not show statistically different, but treatment 2 S will provide more of the root, the lowest growth in root length with treatments S_1 mean 0.17, respectively (Table 3) Growth phases of treatment, the highest number of roots in treatment S_3 (grain filling period) and treatment S_2 (reproductive growth period and after the formation of double ring) was obtained due to the completion of that plant and root growth occurred.

Table 3: Comparison of mean length, number, weight and volume of root Duncan test method

Treatment	root volume **cc**	root weight **g/plant**	root number **in plant**	root length **cm/g soil**
I_o	152a	29.12a	2275b	19.11a
I_1	131b	26.14b	2282a	20.01a
I_2	122c	22.08c	1823c	17.23a
I_3	81d	15.17d	1117d	10.7c
S_1	5b	0.85b	9b	0.17b
S_2	132a	25.8a	2044a	12.8a
S_3	132a	25.81a	2047a	12.1a

Number of roots similar trend root offers various water stress and mild water stress increased the number of roots Duncan test, different treatment irrigation (I) to four groups can mean separation, treatment group I1 with the highest numerical average 2276 higher plant roots rest Water stress treatments were applied to the other with mild stress root number significantly with control (without water stress) was all the controls were. imposing severe water stress treatment, the number of significant reduction in plant roots can be found, but each What will increase the severity of stress, number of roots showed significant reduction in severe water stress (treatments 3I)

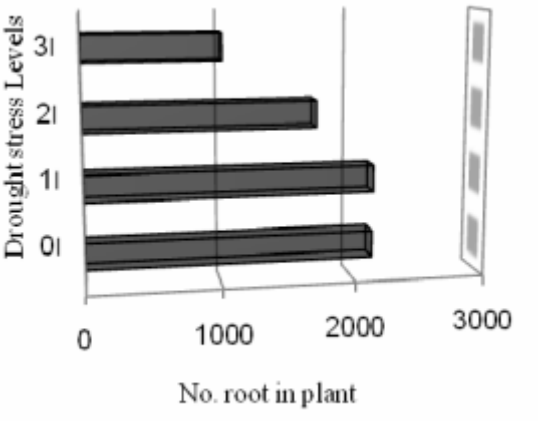


Figure 4.Effect drought on number root

Total root number per plant 2157 (without water stress) to 1016 numbers per plant decreased, following comments can specify the causes of this phenomenon must. Thus reducing the pressure was necessary growth mechanical resistance of soil dryness, the number and root length reduction become. Different phases of increased root growth in S_2 above the other two were treated in S_1 in terms of number of roots in the lowest group mean Showed the number of roots in other words, much less period of growth and full reproductive growth period the grain (Table 3).

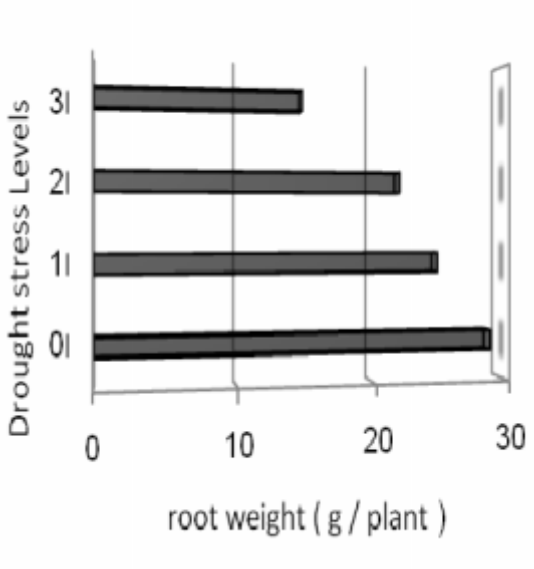


Figure 5.Effect drought on root weight

Unlike root weight and length, number of roots that mild stress can be increased to some extent, by applying the smallest levels of water stress, decreased so that the severe water stress treatments 14.7 grams per plant, almost half the root weight control was 5% level Duncan's test showed different levels of water stress were divided into four groups the highest mean average control group without stress and water lowest average treatment group 3I (severe treatments water) were other words with increasing Water stress significantly reduced root weight demonstrated. Holdyngr (2001) except that the relationship between root weight and root length is a negative relationship with increasing unfavorable environmental conditions the regression trend more negative self-will, as seen in this experiment, the different levels of water stress intensity of water stress (mild stress such as treatment) increased root length, but root weight decreased growth phases Duncan's test, two groups mean that they provide treatment group 2 S and 3S in the second group of treatments 1 S root weight limit were very low, showed the (Table 3)

Size dependence of root growth complete with components such as root number and root weight are two factors that reduce the effects of recent drought stress, root size reduction process has provided the Duncan test four groups to provide mean that treatment (control) with the highest volume and 151cc treated with I_3, 81 cc lowest graduated cylinder of water showed root size. And growth phases of the test can identify two groups mean that in group S_2 and S_3 treatments that had the highest root size and the second group treated with S_1 root size were lowest growth restriction and development of corn root stress drought by different models such as models Avrtly (1996), Boyer (2001) and Richard (1992) is presented as the all these models has been limited development of lung water roots in soil is limited, especially "in the high tensions develop vocal been very deadly and the number of vocal intensity decline to find that this reduces root size and the absorption radius is rooted in the soil is limited (Table 3).

Investigated physiological parameters shoot to root ratio was observed both component weight and shoots decreased with water shortage but decreasing trend in shoot weight of drought much more than root weight was decreasing trend Boyer (1991) announced the change of root stress and environmental conditions such as less than body Air is the result of these factors, shoot to root ratio decreased, the amount of moisture near the root intake and water source, i.e. soil and roots of sweating, lack of light and temperature environment, and ultimately root less than in terms of environmental changes is to shoot and so much slower than changes in root depth is caused shoot. Comparing two growth periods 1 S and S_2 of root weight reduction process at different levels of water stress, it was clear that the trend of decreasing root weight water stress treatments S_2 very more treatments S_1 was in treatment S_2, percent weight loss treatments to control root 47%, but treatment S_1 this value was 24%, respectively.

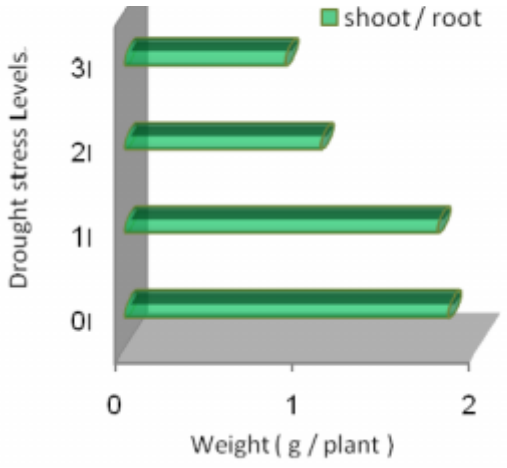
4. Discussion

Drought conditions, important parameters such as root length, number, weight and root volume, decreased if mild water stress to some extent in root length was increased, but severe water stress conditions root length was significantly reduced, but treatment mild water stress during root 16.7 cm /g soil to control increase to some extent, by applying the smallest levels of water stress, decreased in severe water stress treatments 17.7 grams per plant, i.e. almost half the root weight without stress treatment was water, shoot to root ratio at different levels of water stress decreased shoot and root weight of both the decreasing trend of decreased body weight Air stress caused much greater reduction of root weight in the process of

root size dependence with complete root growth components such as the number and weight of roots decreased in the past two components of stress, the process of root volume decreased.

Restriction of root growth and development of corn under drought stress conditions such as different models Avrtly (1996), Boyer (2001) and Richard (1992) is presented. Drought conditions, important parameters such as root length, number, weight and root volume, decreased if the mild water stress (treatment) to some extent, but root length was increased under conditions of severe water stress (treatment) significantly reduced root length But treatments can be found in mild water stress (treatment) to the root control treatment increased Boyer (2001) except that this increase as a kind of defensive mechanism

Figure 7.Effect drought on shoot / root ratio



to deal with drought conditions which is root weight, root length increased . Holdyngr (2002) knows that this phenomenon of genetic gene (responsible for longitudinal growth of roots and vertical) than genes (responsible for the horizontal growth weight) under drought stress conditions shown to result in root development and also the process of vertical root will increase within the soil during different periods of growth and growth treatments that have done their full growth in terms of statistical difference, although not with each other on the study data can be seen that root treatment (grain filling period) less than treatment probably because of the elimination of aging is part of the plant root, growth period (before the advent of double ring) complete lack of root development showed that only the amount of root length, but offers very little what to plant by the rapid growth stage age treatment plants will increase root length increased. Total root trend similar offers various water stress and mild water stress increased the number of roots, Avrtly (1996) increased the number of roots plant defensive mechanisms to maintain and expand the rhizosphere soil of root radius knows that the mild conditions Drought is created and one of the reasons for increase in drought resistance of plants to water, the same term as the problem that also concentrates in the structure and chemical materials increased solution, increased root length and resistance to mild drought stress increased shows, although the intensity will increase stress, number of roots showed a significant reduction in severe water stress (treatment) Total root number per plant in control treatment 2157 (without water stress) to 1016 numbers per plant decreased Richard (1992) proclaims the lack of root growth pressure necessary to prevent actual number of root are also due to drought stress considerably increased soil mechanical resistance against the root growth provides, thus reducing the pressure necessary growth, number and become root length reduction. In different growth highest number of roots in treatment (period filling plant) and treatment (reproductive growth period and after the formation of double ring) was obtained due to the completion of that plant and root growth occurred.

Unlike root weight and length, number of roots that mild stress can be increased to some extent, by applying the smallest levels of water stress, decreased so that treatment (severe water stress treatment) to 14.7 grams per plant, almost half root weight control was Holdyngr (2001) except that the relationship between root weight and root length is a negative relationship with increasing unfavorable environmental conditions this negative trend more self-will, as seen in this experiment, the different levels of stress water intensity of water stress (mild stress such as treatment) increased root length, but root weight decreased, compared physiological parameters studied at different levels of water stress showed that both shoot and root weight components decreased the decreasing trend in shoot weight Effect of drought stress much more than root weight was decreasing trend Boyer (1991) announced the change of root stress and environmental conditions such as shoot is less than the result of these factors than decreased, the amount of moisture intake, and near root source of water and soil, sweating root light and temperature environment, and finally a change of less root to shoot ratio is environmental and therefore much slower than changes in root depth is caused shoot. Highest ratio of treatment (no water stress and growth period) with 2.21 and the lowest treatment (severe water stress and growth period with 0.91

was obtained which indicated severe water stress effects on the rapid growth period (treatment) is go the reduced weight is shoot. Complete dependence on the root volume components such as number of root growth and root weight are two factors that reduce the effects of recent drought stress, root size is also decreasing trend.

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