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Effect of Water Deficit on the Some Qualitative Characteristic of Corn (*Zea Maize* L.)

Mustafa R. Al-Shaheen[1*], Rabah S. Shareef[2], Awang Soh Mamat[3]

[1]*College of Agriculture, University of Anbar, Iraq.*

[2]*College of Applied Sciences - Hit, University of Anbar, Iraq.*

[3]*School of Bioprocess Engineering, University Malaysia Perlis, Perlis, Malaysia*.

Corresponding Author:** ***DeressaKebebe, *Oromia Agricultural Research Institute, Holeta Bee Research Center, Oromia, Ethiopia*

Abstract: *The present study was carried out at the Agro technology Research Station, University Malaysia Perlis Padang Besar, Perlis, Malaysia from 15/2/2014 the first season, as for the second season have been planted on 15/2/2015. In each year, two experiments were conducted. The objectives of the study were to investigation the effect of water deficit on the corn.*

The results showed clearly and significantly decline in the most of the characteristics of study and yield. The results showed a high percentage of Ribonuclease Enzyme and α-amylase enzyme with increased of water deficiency. In the same direction the accumulation of proline has increased remarkably consistent with increased the water deficit.

Keywords: *Deficit, qualitative, Corn, maize, water.*

1. INTRODUCTION

The most limiting and most variable environmental factor affecting the productivity of plants is water. Whenever adequate water is not available, farmers have always tried to irrigate their crops. Irrigation water has always been in short supply, but it is becoming a scarce commodity in many regions. Even where it is available, pumping and/or transportation costs have increased dramatically in many locations. Today the profitability of irrigated agriculture is dependent on the efficient use of water [1]. The effective and efficient use of irrigation is dependent on four factors.

- The effect of irrigation on plant production.
- The best system for a given field and water supply.
- Determining how much water to apply at peak usage rate and when to apply it.
- The quality of the water.

Agricultural plants need warm temperatures, sunlight, nutrients, and water to grow. In many regions of the world the required temperature and sunlight are available, but water is not. All plants have a minimum annual water requirement to survive and an optimum annual water requirement for maximum production. Historically, the availability of water has determined where crops can be grown[2]. A high demand crop, such as rice, could not be grown in a region that has a low annual rainfall. In addition, whenever the water available to the plant is less than the optimum amount the production is reduced [3].

Grain maize originated in the tropics, where environmental factors such as high light intensities, high temperatures, and water deficit es exist. Since grain maize possesses the C4 photosynthetic pathway, it is well adapted to these environmental conditions. The lowest level of photorespiration and high water-use efficiency are responsible for the adaptation of corn to tropical environments [4]. Water deficit or drought probably limits plant production more than any other environmental parameter. Drought is a deficiency of available soil moisture which produces internal water deficits which are severe enough to reduce plant growth. Drought resistance may be attributed to either drought tolerance or avoidance. Drought avoidance includes any mechanism which allows the plant to keep its tissue water potential above that which would cause injury to the cells [5]. Roots are very important in plant growth as they absorb soil moisture and nutrients. Drought deficit affects root weight of the plant during water deficit conditions. Root length is often directly related to absorbed water from soil [6]. Root growth is an important drought tolerance mechanism in beans for drought avoidance and absorbing water from a depth of soil, but root growth decreases in drying soil [7]. Proline content accumulation is a common metabolic response of higher plants to water deficits and salinity deficit and substantially increase in both young and old leaves during a dry period.

2. MATERIALS AND METHODS

2.1. Preparation of Field for Planting

The field plowed and divided to prepare for planting. The plot units measure 2m × 2m each and space, 1m apart between the plots unit and between replicate spaced 1.5m for the purpose of controlling the water movement. Recommend quantities of NPK fertilizer added to the soil before planting [8]. Soil samples will be collected from the field before planting in different areas at a depth of 20,30, and 40 cm. The samples then are analyzed using standard methods to determine their physical and chemical properties. The corn seeds (seedling length of 5 cm) planted in containers using media culture (Peatmoss) for a week and then planting in the field. The seedlings will be planting in rows (spaced 50 cm apart) and between plants (spaced 25 cm apart). It has manual weeding continuously during the growing season to ensure the flow of water and distributed evenly on the board.

Were planted on 15/2/2014 the first season, as for the second season have been planted on 15/2/2015.

It was estimated the field capacity of the field soil and it was measured the soil moisture directly in the field.

According to the field capacity, which has been measured previously after that soil samples were taken from the experimental treatments at depths (20,30,40) by Soil Auger. Mixed the samples, weighed and put in an electric oven at a temperature of 105 C0 for 24 hours, after drying the samples were weighed and calculated the moisture loss and compared with field capacity, after that, be completed moisture in the soil to field capacity depending on the experimental factors (25%, 50%, and 75%).

Statistical analyzed the data In accordance with the design randomized complete block sectors (R.C.B.D) By Program (GenStat Discovery Edition 3) Also been used Least significant difference test L.S.D To distinguish the different statistical averages At the level of probability of 5% (Steel and Torrie, 1960).The experiment included three treatment for irrigation is given symbols W1, W2, W3. Treatments were distributed indiscriminately in an experiment with three replications.

The methods used as follows:

- Soil texture: estimated by the pipette method as set out in [9] explained in [10].
- Bulk density: estimated in a core sampler method [9] explained in [11].

The soil sample was taken by a vicious cylinder (moist soil) from three different places of experiment field. The soil was chosen randomly. The diameter and height of the cylinder, was measured the sample and then weighed the samples in a sensitive balance and values of these weights was recorded, and then the samples was placed in an oven with temperature of 105 ° c for 8 hours.

$$\text{Bulk Density (BD)} = [M \div D] \times L \tag{3.1}$$

BD = bulk density of the soil (g / cm 3).

M = dry sample weight (grams).

D = cylinder diameter (cm).

L = Length of the cylinder (cm).

- Electrical conductivity EC: measured in the extract of saturated dough by using a conductivity bridge by way of [12] explained in [13].
- Soil moisture: estimated the percentage of the soil moisture at tensile 33 kpa (field capacity) and 1500 kpa (The wilting point) by using a pressure membrane apparatuspressure plate by the method reported by [9] explain in [14].

The percentage of soil moisture is measured on a dry weight basis to calculate the percentage of soil moisture taken a sample of moist soil from 3 different places, at least on the experiment field these places are selected randomly, weighed samples in a sensitive balance and recorded the values of these weights samples be placed in an oven with temperature of 105°C for 8 hours, and use the following formula to calculate the moisture content of the soil:

$$MC = W1 - W2 \qquad (3.2)$$

MC = moisture content of the soil depending on the dry weight (%).

W1 = weight of moist sample (grams).

W2 = weight of dry sample (grams).

- Determination of soil reaction (pH): the measurement in leaky saturated soil dough by using pH-meter according to method cited by [12] , [15].
- Determine of matter: The organic matter was determined by weighing one gram of air-dried soil sample in an Erlenmeyer flask of 500 ml capacity. 10 ml of 1N potassium dichromate solution was added at the rate of 10 ml per sample and 20 ml of sulfuric acid (concentrated) was added by means of a pipette. The sample was mixed by shaking and left for 30 minutes. Distilled water at the rate of 150 ml and 0.5 N ferrous sulfate solutions at the rate of 25 ml was added to the sample and the excess was titrated using 0.1 N solution of potassium permanganate to pink end point (Moodie et al., 1959).
- Available nitrogen in the soil: ready nitrogen in the soil is estimated by using a micro-Kjeldahl device according to the method of [12].
- Phosphorus determine: estimated according to the method (Olson) as stated [12].
- Potassium: extraction by using an ammonium acetate solution (1n) was estimated by optical flame device flame photometer as stated in [9]. All results were recorded in Table 3.1.

Table1. *The chemical and physical properties of the soil before planting*.

Measurement	Value
Electrical conductivityds.m^{-1}	4.89
The degree of soil interaction	7.35
Nutrients:	
Total nitrogen (N) %	1.12
Available Phosphors (P) (mg.kg^{-1} soil)	32
Potassium (K) (mg.kg^{-1} soil)	96.1
Organic Metter (OM) %	0.18
Apparent density megagram/m^{3}	1.22
Volumetric distribution of separate soil)G. kg $^{1-}$soil(	
Sand	70.32%
Clay	10.74%
Silt	18.94%
Conception	Sandy Loam
Percentage soil moisture when pulling 33 KPa	18.4
Percentage soil moisture when you lift 1500 kPa	6.6

2.2. Determine the Soil Moisture by the Gravimetric Method (B).

Soil moisture was measured by following the gravimetric method. It was taken the soil samples at deep (20, 30, 40 and 60 cm), was mixed with samples depending on the experimental factors (75%, 50%, 25% of field capacity) then weighed moist soil and recorded values, after that all samples was entered to the electric oven at a temperature of 105 for 24 hours after the soil was dry weight again soil moisture calculated according to:

$$\text{The moisture content of the soil} = \frac{\text{Moist soil weight} - \text{Dry soil weight}}{\text{Dry soil weight}} \qquad (3.3)$$

This process was returned every three days for all Experimental treatment.

2.3. Irrigation

According to the field capacity, which has been measured previously after that soil samples were taken from the experimental treatments at depths (20, 30, 40, 60) by Soil Auger. Mixed the samples, weighed and put in an electric oven at a temperature of 105 C0 for 24 hours, after drying the samples were weighed and the moisture loss was calculated and compared with field capacity, after that, be completed moisture in the soil to field capacity depending on the experimental factors (25%, 50%, and 75%).

3. LEAF RELATIVE WATER CONTENTS (RWC).

Figure (1) explains the significant influence of water deficit on the Leaf relative water contents (RWC).

Results are shown a superiority of the plants was irrigated (25% of field capacity) in the highest average of total Leaf relative water contents (RWC), reached (67.67%), with a significant difference from the other treatment (50%) and (75%) that has given (61.32%) and (54.33%) respectively. While the lowest average of total Leaf relative water contents (RWC) in plants was irrigated by (75% of field capacity) reached (54.33%) with a significant difference from the other treatment (50% and 25% of field capacity). This due maybe to resistances to water movement in the plant and the soil is finite, the plants did not absorb water fast enough to replace that lost by transpiration, even though the water potential was relatively high. Because of lack soil moisture and the difficulty of compensated the missing moisture from the plant.

Current results revealed that total Leaf relative water contents are dramatically decreased with the increasing water deficit. These results are in agreement with [16] those of who find a similar decrease of total Leaf relative water contents in alfalfa as a result of drought deficit . The changes in plant water potential might be attributed to a change in osmotic potential.Same way [17] Who confirmed that exposure the plant to water deficit lead to a clear reduction in the water content of the leaves this decrease reflected a negative on the building of carbon and convert nutrients from the source to the sink.

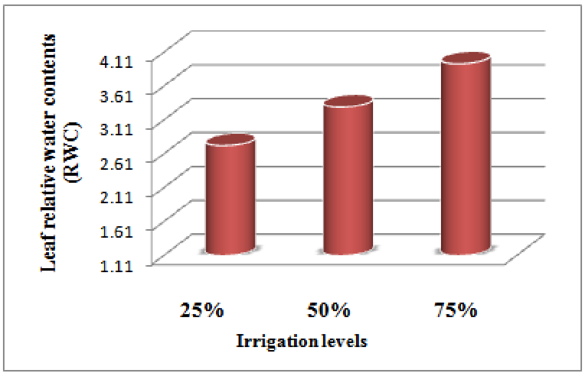

Figure1. *Effect of the irrigation levels on the relative water content% (RWC).*

4. LEVELS OF RIBONUCLEASE ENZYME (RNASES) (MMMG-1TISSUE).

Have emerged from the search results described in the Figure (2) a significant influence of water deficit on thelevels of Ribonuclease enzyme.

Results are shown in the superiority of the plants was irrigated (75% of field capacity) in the highest average of Ribonuclease enzyme levels, reached (3.76µm mg-1 tissue), with a significant difference from the other treatment (50%) and (25%) that has given (3.23µm mg-1 tissue) and (2.86µm mg-1 tissue) respectively. While the lowest average of Ribonuclease enzyme levels in plants was irrigated by (25% of field capacity) reached (2.86µm mg-1 tissue) with a significant difference from the other treatment (50% and 75% of field capacity).

Plant tissue is exposed to many changes, including enzymatic changes and changes in the content of carbohydrates and proteins when exposed to water deficit , as studies have shown that moderate water deficit or severe causes an increase in the activity of antioxidant enzymes.

These findings are consistent with [18] who got an increase in the level of Ribonuclease enzyme when exposed the wheat to water deficit.

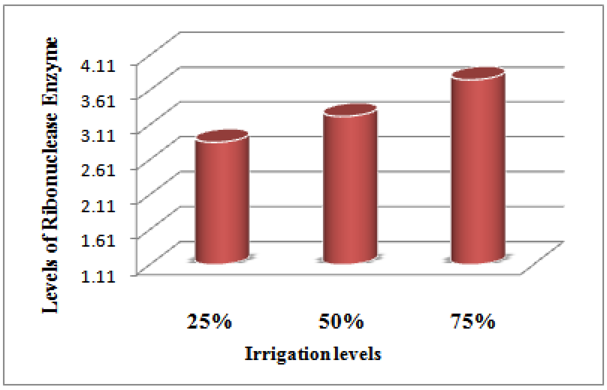

Figure2. *Effect of the irrigation levels on the levels of ribonuclease enzyme (µm mg^{-1} tissue).*

5. ESTIMATE THE LEVELS OF AMYLASE ENZYME (MM MG-1 TISSUE):

Figure (3) explains the significant influence of water deficit on the levels of amylase enzyme. Amylase shows increased activity in the experimental plants as compared with control treatments. Results are shown a superiority of the plants was irrigated (75% of field capacity) in the highest average of the levels of amylase enzyme, reached (3.94µm mg-1tissue), with a significant difference from the other treatment (50%) and (25%) that has given (3.30µm mg-1 tissue) and (2.73µm mg-1tissue) respectively. While the lowest average of the levels of amylase enzyme in plants was irrigated by (25% of field capacity) with a significant difference from the other treatment (75% and 50% of field capacity).

Acclimation of plants to drought deficit is considered to promote antioxidant activity. Antioxidant enzymes like catalase, peroxidase and amylase are related to water deficiency and are considered as the main component of antioxidant machinery for drought resistance in plants. This indicated a cumulative increase in total amylase activity in shoots of deficit ed seedlings of tolerant cultivar, resulting in the rapid hydrolysis of transitory starch of shoots, leading to more availability of glucose for shoot growth [19]. Consequently, water deficit tolerance was enhanced by faster hydrolysis of starch in shoot and root due to stimulation of amylase activity, so as to maintain the concentration of low molecular weight carbohydrates, which helped plants to retain turgidity and protect protoplasmic constituents [20]. A drought-induced decrease in starch contents was correlated with inhibition of starch synthase activity. It has been suggested that under water deficit, the products from starch hydrolysis could be used as a substrate for sucrose biosynthesis [21].

These results are consistent with other studies reporting the increased amylase activity in response to drought deficit in.

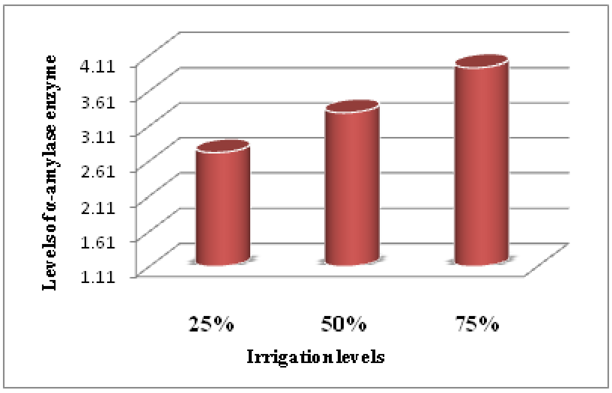

Figure3. *Effect of the irrigation levels on the levels ofthe α-amylase enzyme (µm mg^{-1} tissue).*

6. CONCLUSION

The previous results showed the importance of water at all stages of plant growth; also the results showed that the flowering stage is the most important stage of the plant. Irrigate the plant with the quantity it needs is one of the most important ways to rationalize the water use. Using the correct and modern techniques in irrigation will be able to provide irrigation water thereby increasing cultivated areas.

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