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COMPARATIVE BOTANICAL STUDIES ON THE EFFECT OF IRRIGATION ON BARLEY (*Hordeum vulgare* L.)

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ABSTRACT

This study aimed to evaluate the difference between two cultivars of barley (*Hordeum vulgare* L.); namely, barley cv. Giza 123 as sensitive to drought and barley cv. 126 as a tolerant one, also the influence of treatment of the drought on the first cultivar and the irrigation treatment on the second one. At the age of 14 weeks, results revealed that, plant height, number of leaves / plant, leaf area, number of internodes/plant and number of tillers/plant achieved significant decreases using both treatments for both cultivars. At the age of 18 weeks plants of barley cv. Giza 123 which was treated as tolerant to drought compared with irrigated plants exhibited significant decreases in number of tillers/plant, number of grain rows/plant and number of grains/spike, but were insignificant in number of plants spike, number of grains/plant and weight of straw/plant. At the same age, plants of barley cv. Giza 126 which were treated as sensitive to drought compared with the tolerant one, showed significant decreases in all yield components. Root diameter was thicker in plants of barley cv. Giza 123 treated as tolerant to drought than the irrigated ones by 18.7% due to the thicker cortex and pith. The same findings were recorded in barley cv. Giza 126 plants treated as sensitive to drought by 18.3% than the tolerant one due to the thicker cortex and vascular cylinder. Concerning stem structure, both treated cultivars had thick ground tissue, by 3.7% for barley cv. Giza 123 and 12.5% for barley cv. Giza 126. Measurements of leaf lamina revealed that, barley cv. Giza 126 plants treated as sensitive to drought showed the higher measurements compared with the tolerant ones. On the contrary, plants of barley cv. Giza 123 treated as tolerant to drought exhibited lower measurements in most characters against to the irrigated ones.

INTRODUCTION

Barley (*Hordeum vulgare* L.) is one of the main grass crops grown in Egypt. The total cultivated area devoted to barley in 2004 reached 147217 fed. which yielded 167024 tons (Anon, 2004). Moreover, it is considered the most successful plant for cultivation in the sandy and new reclaimed soils (Mohamed *et al.*, 1984). Barley ranks the second after wheat among the most important cereal crops. It is being consumed as a staple food for animals as well as for human consumption (Ghulam and Ali, 1998).

Production of barley (grain and fodder) is affected by soil, water and climate, where the crop could widely vary depending upon agroclimatic conditions, soil types, quality and quantity of irrigation supplies and irrigation management (Ghulam and Ali, 1998). Scarcity of irrigation water is one of the limiting factors in crop production in dry regions. Farmers with limited water supply usually allocate the water fairly evently among different crops. Therefore, crops tend to be subjected to a water less than that required. However if the same amount of water is used more judiciously, the total benefit from a farm may increase because a larger area can be cultivated.

This could be brought about by irrigation of crops only at their most sensitive growth stages (Ghahraman and Sepaskhah, 1997).

The yield decrease is related to the crop sensitivity to water stress at various stages of growth (Doorenbos and Kassam, 1979 and Yuan *et al.*, 1991). The irrigation application efficiency was taken as 50% for flood system of irrigation according to Al-Ajaji, (1985). He conducted a study on basin irrigation evaluation in alfalfa field grown on sandy to loamy sand soils. He observed that actual deep percolation losses ranged between 40 to 60% of the actual irrigation water applied. Partial irrigation is likely to reduce yield per unit area for each crop (Ghahraman and Sepaskhah, 1997). Decreases in grain yield of barley after clipping have been attributed to reduction of spikes/m^2 at harvest (Scott *et al.*, 1988) and also to reduced grain number (Bonachela *et al.*, 1995); grain size or grain weight (Dunphy *et al.*, 1982 and Royo *et al.*, 1993). Barley grain and straw yields were significantly decreased under the use of drainge water attributed mainly to reduction in number of spikes/plant and grain weight (Osman *et al.*, 1997). Waterlogging is estimated to reduce average yield by 20-25%, but the loss may exceed 50% depending upon the stage of plant development (Setter *et al.*, 1999).

This investigation was carried out to compare between two cultivars of barley *(Hordeum vulgare* L.); namely, barley cv. Giza 123 as sensitive to drought and barley cv. Giza 126 as a tolerant one. Tolerance of the first cultivar to drought was investigated. In the mean time effect of irrigation on barley cv. Giza 126 was tested.

MATERIALS AND METHODS

The current investigation was performed on two cultivars belonging to *Hordeum vulgare* L., the sensitive to drought barley cv. Giza 123 and the tolerant one barley cv. Giza 126, during the two successive seasons of 2003-2004 and 2004-2005. The grains were obtained from the Field Crop Research Institute, Agricultural Research Center, Giza, Egypt. The field experiment was conducted at the Agricultural Experiments and Researches Station of the Faculty of Agriculture, Cairo University, Giza. Planting dates were 15th November 2003 and 17th November 2004. Cultivation was achieved according to a randomized complete design with 4 replicates for each cultivar. In concern of irrigation, each two of the four replicates of investigated cultivars received a similar number of irrigation. The first two replicates were irrigated periodically every three weeks throughout the whole growing season. However, the other two replicates were irrigated during the whole growing season at every five weeks. The plot area was 4x3 m with row to row spacing of 30 cm. The recommended fertilizer requirements of barley crop in the vicinity were applied.

For recording data, 5 plants from each treatment of each cultivar were taken at random after one and two weeks from sowing date and thereafter every two weeks until the age of 14 weeks.

The following morphological characters were studied:

1- Plant height (cm): measured from the soil surface to the shoot apex.

2- Number of leaves / plant.
3- Leaf area (cm^2) / plant: measured by using leaf area meter (L1-3000 Mod.).
4- Number of internodes / main stem.
5- Number of tillers / plant.

At maturity, 18 weeks age, 10 plants from each treatment for each cultivar were randomly selected and used for recording the following characters:

1- Number of tillers / plant.
2- Number of spikes / plant.
3- Number of grain rows / spike.
4- Number of grains / spike.
5- Number of grains / plant.
6- Weight of 100 grains (g).
7- Weight of straw / plant (g).

Morphological data and yield components were subjected to the methods of statistical analysis according to computer software designed for statistical analysis (Anon, 1986).

Specimens for anatomical study were taken at random from each treatment of each cultivar, as follows:

a) Adventitious root: Specimens 1 cm long, were taken from the root at the middle zone of 10 plants (45 days old).
b) Stem: Specimens 1 cm long, were cut from the middle part of the third internode below the shoot apex of 10 plants (75 days old).
c) Leaf lamina: Specimens were taken from the linear foliage leaves at the third node below the shoot apex of the main stem of 10 random plants (75 days old) for each treatment of each cultivar. Samples 1 cm^2 were cut from the middle of the lamina.

All specimens were killed and fixed in F. A. A. (10 ml formalin – 5 ml. glacial acetic acid – 85 ml ethyl- alcohol 70%), washed in 50% alcohol, dehydrated in normal butyl alcohol series, and embedded in paraffin wax (58°C m.p.), (Sass, 1958). Cross sections, 20 μ thick, were cut and stained by crystal violet erythrosin combination, and mounted in Canada balsam, (Nassar and El-Sahhar, 1998). Slides were microscopically examined, and counts and measurements of different tissues were taken using a micrometer eye pice. Averages of 10 readings taken from 5 slides were calculated. Section were microscopically analysed and photo- micrographed.

RESULTS AND DISCUSSION

I- Morphological studies

1- Plant height:

It is evident from Table (1) that both cultivars recorded significant increases for irrigation treatment in both seasons, except at the age of 1-2 weeks, as well as at the age of 6-8 weeks in the first season for barley cv. Giza 123. As for the treatment of drought, barley cv. Giza 123 recorded significant increases in both seasons, except at the ages of 6-8 weeks in the

first and second seasons. Concerning the plants of barley cv. Giza 123 which treated as resistant to drought, there were significant decreases in plant height compared with the irrigated plants at the ages 4, 10 and 14 weeks in the first season, while in the second season, significant decreases were recorded at all ages. On the other hand, plants treated as sensitive to drought from barley cv. Giza 126 recorded significant decreases at all ages, for both seasons. At the age of 14 weeks, plant height of barley cv. Giza 123 plants treated as tolerant to drought decreased by 5.4 and 5.9% compared to irrigated plants, in the first and the second seasons; respectively. Concerning the barley cv. Giza 126 plants treated as sensitive, plant height decreased compared to the tolerant ones by 3.4 and 4.6% in the first and the second seasons; respectively.

Table (1): Plant height (cm) of barley cv. Giza123 as sensitive to drought and barley cv. Giza 126 as tolerant to drought, measured fortnightly during two successive seasons 2003-2004 and 2004-2005 (Averages of 5 plants).

Character	Plant height (cm)							
Seasons	1st season				2nd season			
Cultivars	Giza 123		Giza 126		Giza 123		Giza 126	
Treatments / Age in weeks	Irrigation	drought	Irrigation	drought	Irrigation	drought	Irrigation	drought
1	19.8	-	-	15.2	20.8	-	-	15.8
2	20.6	-	-	15.4	21.2	-	-	16.2
4	36.8	34.4	36.8	38.2	37.8	33.8	37.0	40.2
6	43.4	42.8	47.4	49.2	45.4	44.0	46.4	49.6
8	46.4	45.4	63.6	65.0	49.8	46 4	64.0	68.4
10	72.4	69.0	82.8	86.6	74.0	67.2	83.8	89.0
12	101.0	100.4	102.4	105.6	102.0	98.6	104.6	108.8
14	124.6	118.2	137.0	141.6	124.6	117.6	137.8	144.2
L.S.D. 5% Ages	3.7				3.8			
L.S.D. 5% Treatments	1.3				1.4			

2- Number of leaves / plant :

Results in Table (2) indicate that, plants of barley cv. Giza 123 recorded significant increases in both seasons, except at the ages ranging between 1-2, 6-8 and 10-12 weeks, where insignificant increases were noticed. On the other hand, plants of barley cv. Giza 123 treated as tolerant recorded significant increases in both seasons, except at the age ranging between 10-12 weeks at the first season. These plants, in both seasons, recorded significant decreases as compared with the irrigated ones. Concerning plants of barley cv. Giza 126, there were significant increases among all ages of growth for irrigated plants in both seasons, except at the ages between 8-10 weeks at the first season. On the other hand, tolerant plants recorded significant increases, only in the first season between the ages of 2 to 6 and 12-14 weeks, while in the second season, there were significant increases through all ages, except at the ages ranging between

10-12 weeks. Relative to the irrigated plants of barley cv. Giza 126, there were significant decreases with the tolerant ones in all ages, in both seasons, except at the ages of 4 and 12 weeks in the first season where insignificant decreases were recorded. At the age of 14 weeks, plants of barley cv. Giza 123 treated as tolerant to drought recorded decreases in number of leaves/plant by 95.5 and 96.5% in the first and second seasons; respectively compared with irrigated plants. On the other hand, the number of leaves/plant of the irrigated plants of barley cv. Giza 126 decreased by 39.9 and 38.2% in the first and the second seasons, respectively compared with tolerant ones.

Table (2): Number of leaves / plant of barley cv. Giza 123 as sensitive to drought and barley cv. Giza 126 as tolerant to drought, measured fortnightly during two successive seasons 2003-2004 and 2004-2005 (Averages of 5 plants).

Character	Number of leaves / plant							
Seasons	1st season				2nd season			
Cultivars	Giza 123		Giza 126		Giza 123		Giza 126	
Treatments / Age in weeks	Irrigation	drought	Irrigation	drought	Irrigation	drought	Irrigation	drought
1	2.0	-	-	2.0	2.0	-	-	2.0
2	3.0	-	-	2.0	3.0	-	-	2.0
4	6.4	5.0	6.8	7.2	6.8	5.0	7.2	7.8
6	11.2	7.2	10.6	14.8	11.6	8.0	10.8	15.0
8	12.4	11.6	12.8	16.2	12.7	12.2	13.2	17.8
10	17.8	15.4	13.6	17.2	19.0	16.0	14.8	19.6
12	17.9	16.4	17.8	18.2	19.8	18.6	18.2	20.2
14	43.0	22.0	33.6	47.0	44.4	22.6	34.6	47.8
L.S.D. 5% Ages	1.9				1.4			
L.S.D. 5% Treatments	0.7				0.5			

3- Leaf area / plant:

It is clear from Table (3) that plants of barley cv. Giza 123 either irrigated or treated as tolerant to drought recorded significant increases in leaf area / plant during both seasons. It is worthy to notice that, plants of barley cv. Giza 123 treated as tolerant, in both seasons recorded significant decreases in leaf area / plant compared with irrigated ones, except at the age of 6 weeks, where significant deceases were found. On the other hand, plants of barley cv. Giza 126 recorded significant increases in leaf area / plant in both seasons, except at the ages between 12-14 weeks, in the first season. On the other hand, in plants of barley cv. Giza 126 treated as sensitive to drought, there were significant decreases in leaf area / plant with all ages, in both seasons, except at the ages between 12-14 weeks, in the first season. Plants of barley cv. Giza 126 which treated as sensitive recorded significant decreases compared with tolerant ones in both seasons, except at the age of 4 weeks. At the age of 14 weeks, plants of barley cv. Giza 123 treated as tolerant decreased by 14.9 and 19.1% in the first and second seasons;

respectively compared with irrigated plants, while plants of barley cv. Giza 126 treated as sensitive decreased by 7.1 and 6.7% in the first and second seasons; respectively compared with tolerant plants.

Table (3): Leaf area (cm^2) of barley cv. Giza123 as sensitive to drought and cv. Giza 126 as tolerant to drought, measured fortnightly during two successive seasons 2003-2004 and 2004-2005 (Averages of 5 plants).

Character	Leaf area (cm^2) / plant							
Seasons	1st season				2nd season			
Cultivars	Giza 123		Giza 126		Giza 123		Giza 126	
Treatments / Age in weeks	Irrigation	drought	Irrigation	drought	Irrigation	drought	Irrigation	drought
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
4	86.9	71.5	81.5	86.9	89.3	75.5	83.2	89.9
6	114.4	111.1	135.9	311.3	120.2	120.1	135.0	317.9
8	289.9	263.3	373.8	487.8	298.3	226.8	440.4	492.9
10	425.3	397.5	483.4	596.3	435.3	383.6	479.5	608.7
12	541.9	461.2	607.2	646.6	548.2	483.7	610.3	644.5
14	598.6	521.2	623.9	668.3	650.7	546.4	638.7	681.4
L.S.D. 5% Ages	27.9				21.5			
L.S.D. 5% Treatments	9.8				7.6			

4- Number of internodes / main stem:

Data recorded in Table (4) revealed that, there were significant increases in number of internodes / main stem along with the age, throughout the period from 6 to 12 weeks, in plants of barley cv. Giza 123 either irrigated or treated as tolerant. It was noticed that plants which were treated as tolerant recorded significant decreases in number of internodes / main stem in the ages 10, 12 and 14 weeks. Concerning plants of barley cv. Giza 126, there were significant increases in number of internodes/main stem along with the age in both seasons, except between 4 and 6 weeks. The same findings were recorded by plants treated as sensitive. These plants significantly decreased throughout the ages from 8 to 14 weeks compared with tolerant plants. At the end of growth period (14 weeks) plants of barley cv. Giza 123 treated as tolerant decreased in number of internodes / main stem by 6.1 and 2.9% compared with irrigated plants, in the first and the second seasons; respectively. Concerning plants of barley cv. Giza 126 treated as sensitive, number of internodes / main stem decreased by 5.7 and 5.6% compared with tolerant ones.

Table (4): Number of internodes of the main stem of barley cv. Giza123 as sensitive to drought and cv. Giza 126 as tolerant to drought, scored fortnightly during two successive seasons 2003-2004 and 2004-2005 (Averages of 5 plants).

Character	Number of internodes of the main stem							
Seasons	1st season				2nd season			
Cultivars	Giza 123		Giza 126		Giza 123		Giza 126	
Treatments / Age in weeks	Irrigation	drought	Irrigation	drought	Irrigation	drought	Irrigation	drought
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
4	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
6	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
8	3.2	3.2	3.0	3.4	3.4	3.4	3.2	3.6
10	4.8	4.6	4.6	4.8	5.3	5.0	4.4	5.4
12	6.8	6.4	5.3	5.6	7.0	6.6	5.6	6.0
14	7.0	6.6	7.0	7.4	7.2	7.0	7.2	7.6
L.S.D. 5% Ages	0.5				0.6			
L.S.D. 5% Treatments	0.2				0.2			

5- Number of tillers / plant:

It is evident from Table (5) that plants of barley cv. Giza 123 recorded significant increases in number of tillers / plant only between the ages of 4-6 and 10-12 weeks, in the first and the second seasons; respectively. On the other hand, plants treated as tolerant to drought recorded significant increases only between the ages of 4-6 and 8-10 weeks, in the first and the second seasons; respectively. Plants of barley cv. Giza 123 treated as tolerant to drought recorded significant decreases in all ages of growth. Concerning the plants of barley cv. Giza 126, there were significant increases in number of tillers / plant in the first season between the ages of 4 to 6 weeks, while in the second season significant increases were recoded among the ages of 4-6 , 8-10 and 12-14 weeks. On the other hand, plants of barley cv. Giza 126 treated as sensitive to drought recorded significant increases in number of tillers / plant between the ages of 4-6 and 6-8 weeks in the second one. These plants which were treated as sensitive recorded significant decreases in both seasons at all ages, except at the age of 6 weeks in the first season and in 8th week in the second season. At the age of 14 weeks, number of tillers/plant of barley cv. Giza 123 treated as tolerant to drought significantly decreased by 41.7 and 38.5% compared with the irrigated ones, in the first and second seasons, respectively. On the other hand, plants of barley cv. Giza 126 treated as sensitive decreased by 25.0and 35.8% compared with tolerant plants, in the first and second seasons; respectively.

Table (5): Number of tillers / plant of barley cv. Giza123 as sensitive to drought and barley cv. Giza 126 as tolerant to drought, scord fortnightly during two successive seasons 2003-2004 and 2004-2005 (Averages of 5 plants).

Character	No. of tillers / plant							
Seasons	1st season				2nd season			
Cultivars	Giza 123		Giza 126		Giza 123		Giza 126	
Treatments Age in weeks	Irrigation	drought	Irrigation	drought	Irrigation	drought	Irrigation	drought
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
4	1.0	-	1.2	1.4	0.8	0.4	1.2	1.6
6	2.2	0.8	2.4	2.4	2.6	1.2	2.2	2.6
8	2.4	1.0	2.6	2.8	2.8	1.6	2.8	2.8
10	2.4	1.8	2.6	3.2	2.8	2.2	2.8	3.6
12	3.2	2.2	2.8	3.4	3.6	2.4	2.9	3.6
14	3.4	2.4	2.8	3.5	3.6	2.6	3.4	4.6
L.S.D. 5% Ages	0.6				0.6			
L.S.D. 5% Treatments	0.2				0.2			

II- Yield components:

Mean values of yield components at maturity (18 weeks old) are represented in Table (6). It is clear that number of tillers/plant of barley cv. Giza 123 plants treated as tolerant to drought recorded significant decreases in both seasons by 44% in the first season and by 45.8% in the second one compared with irrigated plants. As for barley cv. Giza 126, number of tillers / plant of plants treated as sensitive to drought significantly decreased by 25.0 and 33.3% compared with tolerant plants, in the first and the second seasons; respectively. Concerning of number of spikes / plant, barley cv. Giza 123 plants which treated as tolerant to drought there were insignificant decrease in both seasons by 12.5 and 11.8% compared with irrigated plants. As for plants of barley cv. Giza 126 which were treated as sensitive to drought, decreased significantly by 50 and 38.5% compared with tolerant plants, in both seasons. On the other hand number of grain rows / spike, of barley cv. Giza 123 plant treated as tolerant to drought exhibited significant decreases in both seasons by 35.7 and 33.3% compared with irrigated plants, in the first and second seasons; respectively. Plants of barley cv. Giza 126 treated as sensitive to drought recorded insignificant decreases in number of grain rows/spike, in the first season by 3.5%, while in the second one, significant decreases were recorded by 11.9%. As regard to number of grains / spike, barley cv. Giza 123 plants treated as tolerant to drought recorded significant decreases compared with irrigated plants, in both season by 8.1 and 12.5%. On the other hand, barley cv. Giza 126 plants which were treated as sensitive to drought exhibited significant decreases in number of grains / spike, in both seasons by 6.2 and 7.5% against tolerant plants. As to the number of grains/plant, barley cv. Giza 123 plants treated as tolerant to

drought recorded insignificant decreases, in both seasons by 6.9 and 7.4% compared with irrigated plants. On the other hand, plants of barley cv. Giza 126 which were treated as sensitive to drought recorded significant decreases in the same trend, by 65.7 and 19.1% against tolerant plants. Concerning weight of 100 grains, plants of barley cv. Giza 123 treated as tolerant recorded significant decreases by 3.7 and 3.6% for the first and the second seasons; respectively, compared with irrigated plants, whereas plants of barley cv. Giza 126 treated as sensitive to drought gave the same results with decrease of 9.4 and 5.2% compared with tolerant plants, in the same order stated before. Finally, plants of barley cv. Giza 123 treated as tolerant to drought exhibited insignificant decreases in weight of straw/plant, in both seasons by 3.8 and 5.9% compared with irrigated plants, while barley cv. Giza 126 plants which treated as sensitive to drought recorded significant decreases in both seasons by 14.6 and 14.8% compared with tolerant plants, in the first and the second seasons; respectively.

Table (6): Yield components at maturity (18 weeks old) of barley cv. Giza123 as sensitive to drought and barley cv. Giza 126 as tolerant to drought, recorded fortnightly during two successive seasons 2003-2004 and 2004-2005 (Averages of 10 plants).

Seasons	1st season				2nd season			
Cultivars	Giza 123		Giza 126		Giza 123		Giza 126	
Treatments / Characters	Irrigation	drought	Irrigation	drought	Irrigation	drought	Irrigation	drought
No. of tillers / plant	3.6	2.5	2.8	3.5	3.5	2.4	3.3	4.4
L. S. D. 5%	0.52				0.63			
No. of spikes/ plant	3.6	3.2	2.0	3.0	3.8	3.4	2.6	3.6
L. S. D. 5%	0.58				0.63			
No. of grain rows/spike	5.7	4.2	5.7	5.9	5.6	4.2	5.9	6.6
L. S. D. 5%	0.31				0.27			
No. of grains/spike	48.5	43.5	54.7	58.1	49.5	44.0	54.5	59.6
L. S. D. 5%	2.13				4.89			
No. of grains/plant	170.0	159.0	106.8	177.0	175.0	163.0	152.0	181.0
L. S. D. 5%	26.3				26.9			
Weight of 100 grains (g)	61.6	59.4	53.3	58.3	63.7	61.5	61.2	64.4
L. S. D. 5%	0.57				0.25			
Weight of straw / plant (g)	9.3	8.96	8.2	9.4	9.45	8.92	8.1	9.3
L. S. D. 5%	1.17				1.16			

III- Anatomical studies:

1- Structure of the adventitious root:

The adventitious root was round in shape in the studied cultivars with uniseriate epidermis followed by a cortex of slightly hexagonal parenchyma cells with small intercellular spaces between the angles of the cells. The innermost layer of the cortex formed the endodermis with Casperian strips where end and inner tangential walls becoming thick. The number of cortex layers were 9-10, 11-12, 8-9 and 11-12 layers in irrigated plants of barley cv. Giza 123, plants treated as tolerant to drought of barley cv. Giza 123, plants treated as sensitive to drought of barley cv. Giza 126 and tolerant plants of barley cv. Giza 126; respectively. The cortex thicknesses were 171.9, 224.9, 190.4 and 159.0 μ, in the same sequence. The pericycle of one layer below the endodermis was observed, with cells of almost uniform size and dimensions, except outside the protoxylem points, where cells were small. The stele structure was polyarch protostele type in the two cultivars and treatments. The numbers of protoxylem strands were 14-15, 17-18, 14-15 and 15-16 in barley cv. Giza 123 (irrigated plants and those treated as tolerant to drought) and in barley cv. Giza 126 (plant treated as sensitive to drought and tolerant ones). Phloem strands were alternated with protoxylem arms in small groups of phloem cells. The thickness of vascular cylinder was 81.7, 80.3, 77.2 and 45.4 μ, in the same order stated before. The centre of the root was occupied by the pith of small lignified parenchyma. Pith diameter recorded 73.1, 107.1, 77.2 and 87.1μ at the same order; respectively. The whole diameter of the root recorded 638.7, 758.3, 661.2 and 558.7 μ in the same previous sequence, Table (7) and Fig. 1 (a, b, c and d). The present observations on the adventitious roots were in harmony with those mentioned by Hayward, (1938) and Metcalfe (1960).

Table (7): Means of measurements (μ) and counts of different tissues in transverse sections of the adventitious roots in plants 45 days old of *Hordeum vulgare* L. cv. Giza 123 (sensitive to drought) and H. vulgare L. cv. Giza 126 (tolerant to drought) (Averages of 10 readings from 5 slides).

Cultivars	Giza 123		Giza 126	
Treatments / Characters	Irrigation	drought	Irrigation	drought
Epiderms thickness (μ)	21.7	14.3	21.7	25.8
Cortex thickness (μ)	171.9	224.9	190.4	159.0
No. of cortex layers	9-10	11-12	8-9	11-12
Vascular cylinder thickness (μ)	81.7	80.3	77.2	45.4
Pith diameter (μ)	73.1	107.1	77.2	87.1
No. of vascular bundles	14-15	17-18	14-15	15-16
Root diameter (μ)	638.7	758.3	661.2	558.7

2- Structure of the stem:

The stem of the studied cultivars was hollow in the internodal regions and solid at the constricted nodes. Structure of the internode exhibited four principle zones; epidermis, mechanical tissue, fundamental parenchyma and vascular bundles.

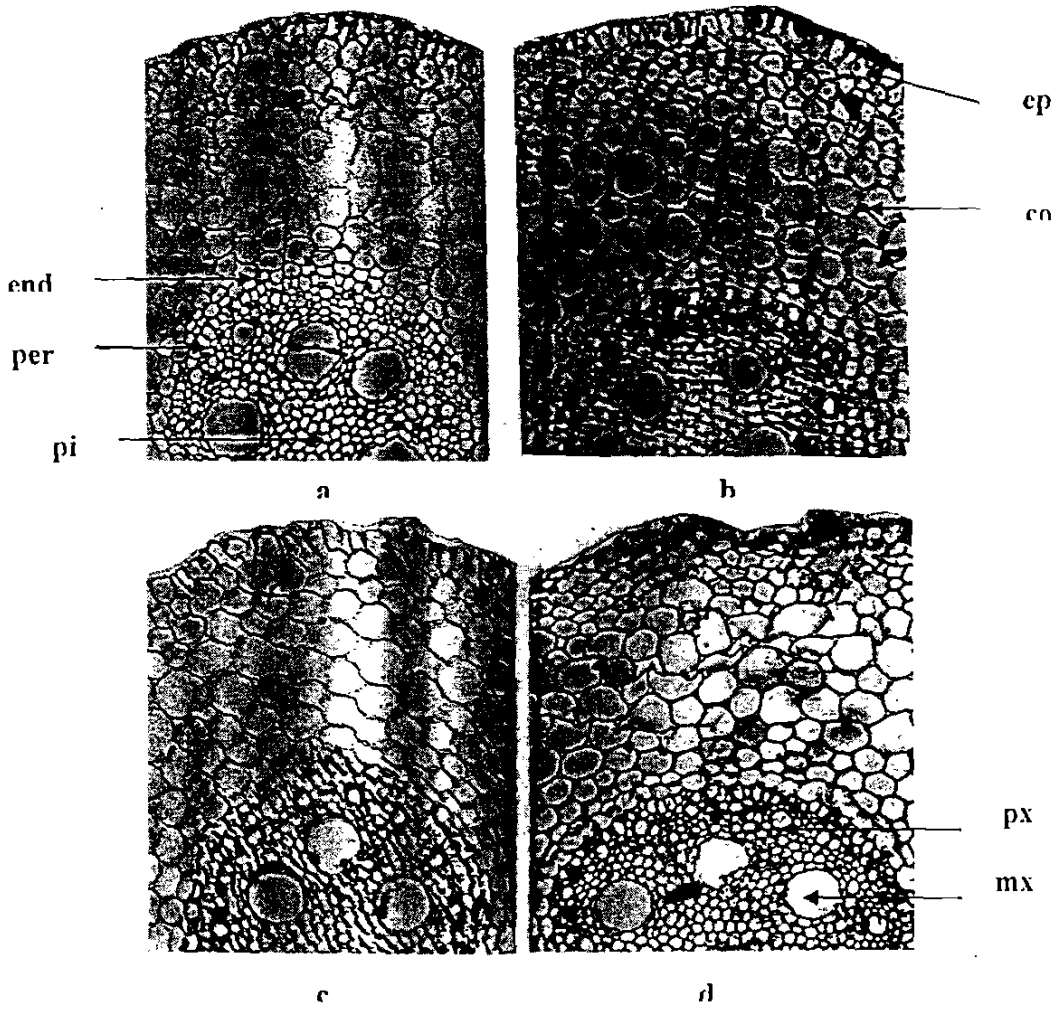

Fig.(1): Transverse sections of the adventitious roots of barley plants 45 days old X 35

(a) Barley cv. Giza 123 (Normally irrigated at 3 weeks intervals)
(b) Barley cv. Giza 123 (Irrigated at 5 weeks intervals)
(c) Barley cv. Giza 126 (Normally irrigated at 5 weeks intervals)
(d) Barley cv. Giza 126 (Irrigated at 3 weeks intervals)

Details: co: cortex; end: endodermis; ep: epidermis; mx: metaxylem; per pericycle; pi: pith; px: protoxylem.

Note: Barley cv. Giza 123 sensitive to drought
Barley cv. Giza 126 tolerant to drought

On the other hand, mesophyll thickness in the furrow regions recorded 173.1, 162.3, 142.8 and 139.5 μ, in the same sequence. Motor cells of the furrow regions of the upper epidermis measurements were 55.2, 61.7, 62.3 and 41.5, in the previous cultivars and treatments; respectively. Measurements of lamina thickness in the ridge regions were 311.5, 259.7, 321.7 and 279.9 μ in the same mentioned order. As for lamina thickness of the furrow regions was 267.1, 248.9, 244.4 and 311.4 μ; respectively. Concerning vascular bundles, there was large medium bundle in the keel region and secondary small bundles in the mesophyll tissue. Large median bundles were accompanied by lower strands of fibres, sometimes united with extensions from the bundle sheaths to form griders. On the other hand, most of the small vascular bundles were not accompanied by sclerenchyma, other small ones with minute lower strands. Small vascular bundles with xylem and phloem were not easily distinguished from one another. Large vascular bundles with double sheaths, inner complete sheath and outer one interrupted from the adaxial side. Lengths of keel region were 814.5, 799.6, 771.0 and 629.5 μ, in irrigated barley cv. Giza 123 plants, barley cv. Giza 123 plants treated as tolerant to drought, barley cv. Giza 126 plants treated as sensitive to drought and tolerant barley cv. Giza 126 plants; respectively. Dimensions of keel bundles were 107.1, 125.5, 137.6 and 126.6 μ, in length and were 152.5, 149.3, 176.5 and 146.0 μ, in width in the same order stated earlier, Table (9) and Fig. 3 (a, b, c and d). The previously mentioned anatomical structure of the lamina was in accordance with that given by Metcalfe, 1960.

Table (9): Means of measurements (μ) and counts of different tissues of the lamina in plants 75 days old of *Hordeum vulgare* L. cv. Giza 123 (sensitive to drought) and *H. vulgare* L. cv. Giza 126 (tolerant to drought) (Averages of 10 readings from 5 slides).

Cultivars	Giza 123		Giza 126	
Treatments / Characters	Irrigation	drought	Irrigation	drought
Upper epidermis thickness (μ)	26.4	17.8	30.2	17.4
Lower epidermis thickness (μ)	31.8	27.9	29.5	23.6
Mesophyll thickness (μ) in the:				
- ridge regions	249.9	210.9	259.6	236.2
- furrow regions	173.1	162.3	142.8	139.5
Motor cells thickness (μ)	55.2	61.7	62.3	41.5
Lamina thickness (μ) in the:				
- ridge regions	311.5	259.7	321.7	279.9
- furrow regions	267.1	248.9	244.4	211.4
Length of the keel region (μ)	814.5	799.6	771.0	629.5
Dimensions of keel bundle (μ)				
- Length	107.1	125.5	137.6	126.6
- Width	152.5	149.3	176.5	146.0

In essence, the present investigation indicates that, decrease of irrigation of barley cv. Giza 123 which is sensitive to drough proved harmful to most growth characters.

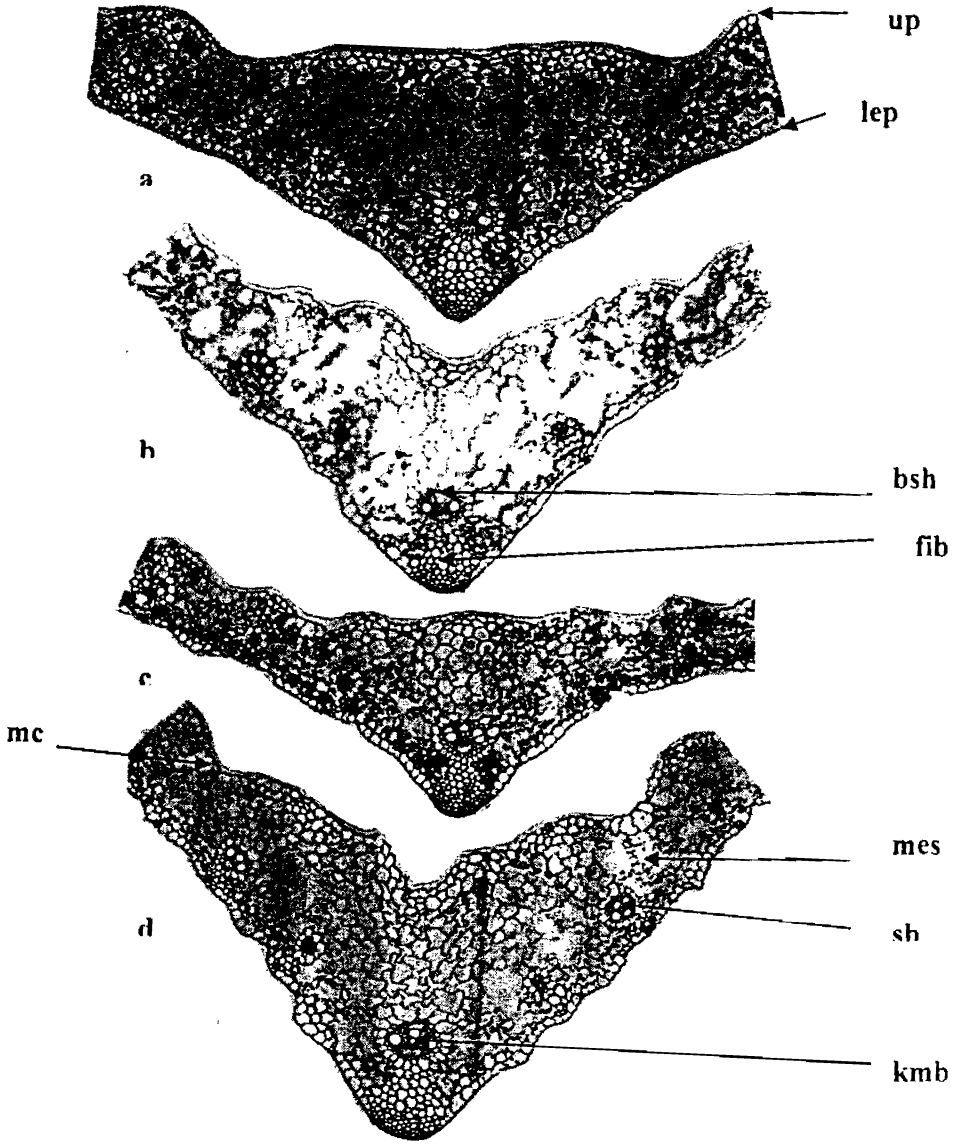

Fig.(3): Transverse sections of the leaf lamina of barley plants 75 days old X 30

(a) Barley cv. Giza 123 (Normally irrigated at 3 weeks intervals)
(b) Barley cv. Giza 123 (Irrigated at 5 weeks intervals)
(c) Barley cv. Giza 126 (Normally irrigated at 5 weeks intervals)
(d) Barley cv. Giza 126 (Irrigated at 3 weeks intervals)

Details: bsh: bundle sheath; fib : fibers; kmb: keel main bundle; lep: lower epidermis; mc: motor cells; mes: mesophyll; sb: small bundle; up: upper epidermis.

Note: Barley cv. Giza 123 sensitive to drought
Barley cv. Giza 126 tolerant to drought

In the meantime irrigation of barley cv. Giza 126 which is tolerant to drought was not in favour of its growth. Hence, when cultivating tested barley cultivars, it is recommended to subject each cultivar to the conditions suitable for its growth.

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دراسات نباتية مقارنة على تأثير الرى على نبات الشعير

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يهدف البحث إلى توضيح الاختلافات بين صنفين من الشعير هما : جيزة ١٢٣ الحساس للجفاف، وجيزة ١٢٦ المقاوم للجفاف وأيضا لمعرفة تأثير معاملة العطش على الصنف الاول ومعاملة الرى على الصنف الثانى.

أظهرت النتائج عند عمر ١٤ أسبوعا نقصا معنويا فى إرتفاع النبات، وعدد الاوراق، ومساحتها، وعدد السلاميات، وعدد الاشطاء فى معاملتى الصنفين. أظهرت نباتات الصنف جيزة ١٢٣ المعاملة كنباتات مقاومة للجفاف عند عمر ١٨ أسبوعا نقصا معنويا مقارنة بالنباتات المروية فى عدد الاشطاء للنبات، وعدد صفوف الحبوب فى السنبلة، وعدد الحبوب بها، وكان النقص غير معنوى بالنسبة لعدد السنابل، وعدد الحبوب للنبات، وكذلك وزن القش للنبات. أظهرت نباتات الصنف جيزة ١٢٦ المعاملة كحساسة للجفاف نقصا معنويا عند مقارنتها بالنباتات المقاومة فى جميع صفات المحصول.

كان قطر الجذر الاكبر فى نباتات الصنف جيزة ١٢٣ المعاملة كمقاومة للجفاف مقارنة بالنباتات المروية بزيادة ١٨,٧% نتيجة لزيادة سمك القشرة، والنخاع، وتحققت نفس النتيجة مع نباتات الصنف جيزة ١٢٦ المعاملة كنباتات حساسة للجفاف بزيادة ١٨,٣% نتيجة لزيادة سمك القشرة، والاسطوانة الوعائية. أظهر التركيب التشريحى للساق فى المعاملتين بكلا الصنفين زيادة فى سمك النسيج الأساسى بنسبة ٣,٧% فى النباتات المعاملة للصنف جيزة ١٢٣ وبنسبة ١٢,٥% فى النباتات المعاملة للصنف جيزة ١٢٦. سجلت قياسات نصل الورقة القياسات الاعلى فى نباتات الصنف جيزة ١٢٦ المعاملة كنباتات حساسة للجفاف مقارنة بالنباتات المقاومة ووجد العكس فى نباتات الصنف جيزة ١٢٣ المعاملة كنباتات مقاومة للجفاف حيث سجلت القياسات الاقل فى معظم الصفات مقارنة بالنباتات المروية.