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DETERMINATION OF VEGETATIVE AND GENERATIVE CHARACTERISTICS OF DIFFERENT COTTON VARIETIES UNDER DROUGHT STRESS

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Abstract

The research was carried out to determine the effect of different irrigation water requirements of different irrigation levels (mm), on the evapotranspiration seed yield (kg da^{-1}) with vegetative and generative properties of two cotton types (drought tolerant, BA 525) and (drought susceptible, Lydia), in the Eastern Mediterranean region (Turkey). Drought or water deficit stress elicits many different phenological responses in plants. The study of vegetative features included the fresh and dry weight of plant (g), leaf area (cm^2), number of leaves (number plant^{-1}), number of fruit branches (number plant^{-1}), number of bud formation (number plant^{-1}) and number of node (number plant^{-1}).This result indicates that water stress in plants limit the phenological development significantly and the average of all measurements made after flowering has been observed to decrease.

Keyword: *Cotton, Irrigation Level, Drought, Drought tolerance, Growth Periods*

INTRODUCTION

Drought (water stress) is of the major abiotic stress factors that affect all living organisms including human in terms of health and food. Plant responses to drought are complex, and different mechanisms are adopted by plants when they encounter drought (Jones, 2004). These mechanisms can include: (1) drought escape by rapid development, which allows plants to finish their cycle before severe water stress; (2) drought avoidance by, for instance, increasing water uptake and reducing transpiration rate by the reduction of stomatal conductance and leaf area; (3) drought tolerance by maintaining tissue turgor during water stress via osmotic adjustment, which allows plants to maintain growth under water stress; and (4) resisting severe stress through survival mechanisms (Izanloo et al., 2008).The plants crops are imperative to improve the drought tolerance of crops under the changing circumstances.

Water stress has been identified as a factor that negatively affects the ratio of reproductive to vegetative growth, seed yield and its components (Mattinello, 1998). When water stress is reduced from – 1.0 to – 2.0 MPa, cells become smaller and leaves develop less, resulting in a reduced area for photosynthesis. At these water potentials, ion transport is slowed and may also lead to a decrease in yield (Medrano et al., 2002). Achten et al. (2010) observed that drought treatment significantly influenced growth, biomass allocation, allometry and leaf area.

The objective of this study is to investigate the effect of water stress on growth, vegetative and generative characteristics of two cotton cultivars grown in the Antakya of Turkey. A number of growth parameters were determined under water deficit stress, including plant height, leaf area, dry matter, number of leaves, number of fruit branches, number of node and total plant dry weight.

MATERIAL AND METHOD

In this study space improved varieties of ProGen Seed Firm of Turkey, namely as BA525 (drought tolerant), and LYDIA (drought sensitive) were evaluated in a split plot design; 4 different irrigation levels, 3 replications and each replication consisted of 15 meters. Each irrigation level is planned 4 ordinary, and intra-row spacing is 0,70 m, row spacing is 15 cm. The first irrigation is made when consumed 50% of the suitable capacity the subsequent irrigations are also completion of the missing moisture (about 6 days intervals). Irrigation subjects are waterless (waterless, I_0), full irrigation subject (I_{100}) the missing moisture is brought to field capacity), 66% and 33% of full irrigation. 120 cm layer is discussed for determination of moisture content. In the irrigation, the area of land to be soaked 35% of the total experimental area since drip irrigation was used. Long annual average rainfall in the region is more than 720 mm (Yıldırım, 2008).

Plant samples were taken to determine the effects of drought on cotton vegetative features in three growing periods (first flowering, mid flowering and boll formation). Plant samples were taken in each iteration from 50cm. Properties studied in plants are **Plant Height (cm):**Plants is measured as the growth cone cm distance from the top of the cotyledon leaves. After then the average of these values is taken. **The Number of Fruit Branch (number/plant**): Primary fruit branches were counted formed on the main stem of the plant and average of these values is taken. **Leaf Area (cm^2/plant):** All the leaves of plants were taken from the stem and plant area were measured with a LICOR Laser Area Meter, thereafter the average of these values was taken. **Seed Cotton Yield (kg da^{-1}):**Plant from vegetative features were number of leaves, number of bud, and number of node was counted on the example of plants and averaged. **The Number of Bud Formation (number/plant):** Primary bud formations were counted on the main stem of the plant and the average of these values were taken.**The Number of Leaves (number/plant**): All the leaves of plants were taken from the stem and average of these values was taken. **The Wet and Dry Weight of Plant (g):** Samples taken from the field for biomass plants were weighed immediately by precision scales after that the average of these values is taken. After standing leaf area measured plants for 48 hours in 70^0C, dry weight was measured the average of these values were taken.

RESULT AND DISCUSSION

Irrigation Water and Evaporation: Both cotton varieties in the test were irrigated 8 times. Same amount of water was given to the each cottons variety during the irrigation period, respectively compared to I_{33}, I_{66}, I_{100} subjects; 433 mm, 852 mm, 1287 mm irrigation water was given to plants. Evapotranspiration was determined respectively compared to I_{33}, I_{66}, I_{100} subjects in Lydia were 195.5, 532.4, 942 mm; in BA525 were 206.9, 532.4, 945.0 mm. Evapotranspiration occurred at very low levels (53mm) in I_0 subject because of that it was not rain.

Yield: Drought resistant (BA525) and drought-sensitive (Lydia) the difference between the yields of the cultivars were significant at *p <0.001* level (Table 1). When the type of average value calculated BA525 type 490 767 kg da^{-1} Lydia type 377 150 kg da^{-1} was produced. 23.5% is calculated as the difference in yield between varieties. When type of efficiencies realized in different irrigation levels were assessed, at I_0 average 187.80 kg da^{-1} at I_{33} 391.08 kg da^{-1} at I_{66} 541 567 kg da^{-1} at I_{100} 615 383 kg da^{-1}yield was obtained. Average yields took place in a different group at each level of irrigation.

The response of both cotton varieties to irrigation levels have varied considerably. For the BA525 it was measured as 239.9 kg da^{-1}or I_0 ried, 415.17 kg da^{-1} or I_{33}, 596.9 kg da^{-1}or I_{66}. and 711.0 kg da^{-1}or I_{100}; In Lydia varieties,135.7 kg da^{-1} or I_0, 367.0 kg da^{-1}or I_{33}, 486.2 kg da^{-1}or at I_{66}. 519.7 kg da^{-1}or I_{100} were measured. On the difference between watering levels of type has been calculated as 43% at $I_{0,}$ 11.6%, at I_{33} 18.5% at I_{66}, 27% at I_{100}. As seen, the biggest difference in yield occurred waterless subjects. This suggests that an extremely powerful mechanism of drought resistance varieties of BA525. Author (2009), yield decrease in soil water deficit degree stated that stress sensitivity of plants and effective atmospheric conditions.

Table 1. Analysis of variance results for the yields

Variance Source	Sd	Sum of Squares	F
Variety	1	77452.482	45.359***
Irrigation Level (Sd)	3	641560.648	125.239***
Variety * Sd	3	15638.628	3.053od
Error	23	761972.738	

Vegetative and Generative Results: Variance analysis of the number of leaves, average of leaf area, plant height, the number of fruit branches, number of the bud formation, number of node and wet and dry weight of plant forming the material value of the range results and the groups are formed according to DUNCAN test are given in Table 2,3,4,5.

The number of leaves, average of leaf area, plant height, the number of fruit branches, number of the bud formation, number of node in the resistant varieties (BA525) were found to be higher than in the susceptible variety (LYDIA) at all irrigation levels (Figure 1). In this research, average leaves area of plants was measured as I_0=564.056, I_{33}=865.056, I_{66}=1701.44, I_{100}=10576.278 cm^2. Average leaf areas were showed diversity between varieties ($p<0.05$). The average leaf area was found to be insignificant for variety and variety*irrigation levels interaction. Increased levels of irrigation increased the leaf area. Birda et al. (1998) reported that number of leaves per plant, increases the leaf area index.

The plant height was varied depending on the variaties ($p\geq0.05$), irrigation levels ($p<0.01$), and variaties*irrigation levels of interactions ($p\geq0.05$).Plant height, number of leaves and leaf area occurred at I_0 treatment. Increased irrigation level increased the plant height, leaf number and leaf area (Figure 1). Asraf and Iram (2005) reported that, limiting the development of plant water stress one of the most important factors. Sankar et al. (2008) in a study conducted in five different varieties of okra found that drought stress causes leaf area and net assimilation rate decreased compared to control plants.

When the average number of fruit branches examined in terms of the cultivars, the number of the average fruit branches of BA525 is number of 6,472 and at the LYDIA is also 5,639. The number of fruit branches have varied according to the level of irrigation ($p<0.01$), varieties ($p\geq0.05$) and variety*irrigation level of interactions was found insignificant (Table 4).The maximum number of fruit branches were observed in BA525 (7,889). In both kinds of fruits branches also increased by increased irrigation levels. When studied impact of irrigation on different cotton genotypes study in Hatay conditions, Mert (2005) showed that different response of genotypes in the different growth period.The number of fruits branches, plant height, number of cocoons in all varieties of decrease at the application of irrigation were not done.

Plant fresh weight (stem+leaves) varied depending on the varieties ($p \geq 0.05$), irrigation levels ($p<0.01$), and varieties*irrigation levels of interactions was found insignificant.Plant fresh weight was realized with the lowest dry matter (I_0) and average of the fresh weight of the I_0 was 444,167 g. Increased irrigation levels increased plant wet weight.plant fresh weight of the two varieties of waterless condition occurred at about the same level (BA525 444,111g and LYDIA 444,222g).Irrigation levels has created two different groups in terms of fresh weight of plants. I_{33}, I_{66}, I_{100} were included in the same group. Drought stress occurred as a result of cell dehydration,plasma membrane resulting sag and released hydrolytic enzymes causes cytoplasm autolysis,eventuall the slowdown in growth and turgor reduction occurs (Kalefetoğlu and Ekmekçi 2005).

In our research, the dry weight (stem+leaves) of the plants was different between varieties but it was found insignificantat irrigation levels ($p>0.05$). n Duncan group, irrigation levels were divided into two groups. I_{100} and I_{66}, I_{33} and I_0 were in the same group. Average dry weight of the BA525 was measured as 128,417g in LYDIA, 123,639galso. maximum average of dry weight is calculated in BA525 variety.Tsuji et al. (2003) in study of sorghum and Alexieva et al. (2001) in study of wheat emphasized that drought stress results fresh and dry weights of losses of plants.

Table 2. Variance results related to number of bud formation

Variations Supply	Sd	Sum of Square	F
Variety	1	1,125	0,893od
Irrigation level (Sd)	3	641,375	169,620**
Variety * Sd	3	0,123	0,040od
Error	64	80,667	

d.f.: Degree of freedom

Water stress has a major impact on the production of mainstem nodes and thus the number of fruiting branches and fruiting sites (Best 2011). In this research the number of node and bud formation were increased by increased irrigation level (Figure 1). The number of nodes and bud formation showed differences between varieties but it was not important level (*p*≥*0.05*) (Table 2,3).The average number of nodes in both varieties were found about the same (BA525=10.278 and LYDIA=10.028). The average number of bud formation disparity between varieties were calculated as I_0=3.0-2.4 (18,66%), I_{33}=3.78-3.44 (8,9%), I_{66}=5.0-4.22 (15,6%) and I_{100}=5.11-5.0 (2,15%). The average number of node and bud formation were affected at $p<0.01$ level by the irrigation levels.

Table 3, Variance results related to number of node

Variations Supply	Sd	Sum of Square	F
Variety	1	3,556	1,575od
Irrigation level (Sd)	3	58,889	8,697**
Variety * Sd	3	1,111	0,164od
Error	64	144,444	

d.f.: Degree of freedom

Table 4. Variance results related to number of fruit branch

Variations Supply	Sd	Sum of Square	F
Variety	1	12,500	7,392*
Irrigation level (Sd)	3	81,000	15,967**
Variety * Sd	3	6,056	1,194od
Error	64	108,222	

d.f.: Degree of freedom

Table 5. Variance results related to leaf area

Variations Supply	Sd	Sum of Square	F
Variety	1	1347808,347	5,894*
Irrigation level (Sd)	3	1239295042,931	1806,44**
Variety * Sd	3	922454,486	1,345od
Error	64	14635577,111	

d.f.: Degree of freedom

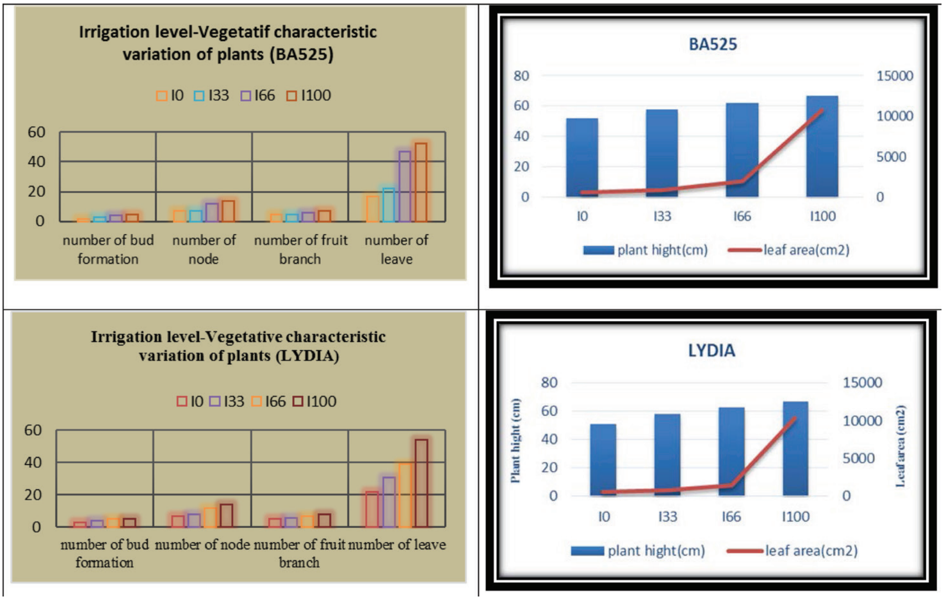

Figure 1. Change of the vegetative measurement depending on the level of irrigation and varieties

CONCLUSIONS

Water availability is potentially one of the most limiting factors to profitable cotton (*Gossipium hirsutum* L.) production.This study aimed to identify which parameter is more reliable in terms of vegetative and generative for determining the response to water stress of two distinct cotton varieties.

According to the analyzed plant characteristics, it was showed that in both varieties were significantly affected by the water stress. Average number of bud formation, node, leaves, plant height, plant fresh weight and dry weight properties were unaffective significantly from variaties but they are affected significantly from irrigation levels. Average number of fruit branch and leaf area were affected significantly from irrigation levels and varieties. To estimate the efficiency of determining the plant characteristics in the different growth periods (bud formation and flowering) is more effective in the estimation of cotton yield. Because of that, the average value of the weakening due to stress and aging undermines the significant effect of vegetative features on yield.

REFERENCES

Achten, W.M.J.; Maes, W.H.; Reubens, B.; Mathijs, E.; Singh, V.P.; Verchot, L.; Muys, B. (2010) iomass production and allocation in Jatropha curcas L. seedlings under different levels of drought stress. Biomass and Bioenergy, Vol.34, No.5, (May 2010) pp.667 – 676, ISSN 0961-9534.

Alexieva V, Sergiev I, Mapelli S, Karanov E (2001). The effect of drought ultraviolet radiation on growth and stress markers in pea and wheat. Plant, Cell and Environment 24 (12): 1337-1344.

Asraf M, Iram A (2005). Drought stress induced changes in some organic substances in nodules and other plant parts of two potential legumes differing in salt tolerance. Flora 200: 535–546.

Best, Eric C. (2011). Source sink relations in cotton: Genetic and environmental affectors. Crop and Soil Env. Sci.

Izanloo, A.; Condon, A.G.; Langridge, P.; Tester, M.; Schnurbusch, T. (2008). Different mechanisms of adaptation to cyclic water stress in two South Australian bread wheat cultivars. Journal of Experimental Botany, Vol. 59, No. 12, (August 2008), pp. 3327–3346, ISSN 1460-2431.

Iannucci, A.; Mattinello, P. (1998). Analysis of seed yield and yield components in four Mediterranean annual clovers. Field Crops Research, Vol.55, No.3, (February 1998), pp.235-243, ISSN 0378-4290.

Jones, H. (2004). What is water use efficiency?, In: Water use efficiency in plant biology, Bacon, M.A. (Ed.), pp. 27-41, Wiley-Blackwell, ISBN 978-1-4051-1434-9, Oxford.

Kalefetoğlu T, Ekmekçi Y (2005). The effect of drought on plants and tolerance mechanisms. G. U. Journal of Science, 18 (4): 723 – 740.

Medrano, H.; Escalona, J.M.; Bota, J.; Gulías, J.; Flexas, J. (2002). Regulation of photosynthesis of C3 plants in response to progressive drought: stomatal conductance as a reference parameter. Annals of Botany, Vol.89, No.7, (June 2002), pp.895-905, ISSN 0305-7364.

Mert, M. (2005). Irrigation of cotton cultivars improves seed cotton yield, yield components and fibre properties in the Hatay region, Turkey. Acta Agricultural Scand., B 55: 44–50.

Sankar, B., Abdul Jaleel, C., Manivannan, P., Kishorekumar, A., Somasundaram, R., Panneerselvan, R., (2008). Relative Efficacy of Water Use in Five Varieties of Abelmoschus esculentus (L.) Moench. under Water Limited Conditions. Biointerfaces, 62: 125-129.

Tsuji W, Ali MEK, Inanaga S, Sugimoto Y (2003). Growth and gas exchange of three sorghum cultivars under drought stress. Biomedical and Life Sciences 46 (4): 583-587.

Yıldırım. O. (2008). Design of Irrigation System. Ankara University Fac. Agr. Pub. Num: 1565. Ankara.

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