IS PROLINE ACCUMULATION UNDER WATER DEFICIT REVERSIBLE IN COTTON?

Hayri GARAN[1], Uğur ÇAKALOGULLARI [1], Deniz İŞTİPLİLER[2], Özgür TATAR[1]

e-mail: ozgur.tatar@ege.edu.tr

Abstract

Proline is an amino acid which is used in biosynthesis of proteins is widely accepted as a biochemical indicator for various stress environment and species. In order to assessed the function of proline we aimed to determine if proline accumulation in cotton leaves under water deficit condition is reversible or not. For this purpose, a pot experiment was conducted under fully controlled growth chamber. Cotton plants (*Gossypium hirsutum* L.) subjected to well water (WW), water deficit (WD) and water deficit/re-watering (WDR) treatments 8 weeks after sowing. Canopy Temperature Depression (CTD) and transpiration decreased with stress treatment and rapidly recovered with re-watering whereas SPAD value didn't clearly respond to water treatments. Leaf area and dry weight of plants significantly decreased under both stress treatment while root and stem dry weights didn't change. The highest water use efficiency was found under WDR treatment. Proline content of leaves was similar under WW and WD treatments whereas it was markedly higher in WDR treatment.

Key words: proline, cotton, water deficit, SPAD, CTD.

Water scarcity is one of the major limiting factors for crop development and yield. The anticipated demand in additional water supplies for agricultural production will lead to increase water scarcity in near future. Thus, irrigated crop production such as cotton system needs a better management to increase water use efficiency. Deficit irrigation receives remarkable attention to keep productivity while minimizing water use. But it requires better understanding of how cotton response to limited water in soil. Proline is an amino acid which is used in biosynthesis of proteins is widely accepted as a biochemical indicator for various stress environment and species. However, its role in stress conditions is still under discussion. In order to assessed the function of proline we aimed to determine if proline accumulation in cotton leaves under water deficit condition is reversible or not.

MATERIAL AND METHOD

A pot experiment was carried out in a fully controlled growth chamber in Ege University Faculty of Agriculture Department of Field Crops. Four Seeds of the Turkish cotton cultivar MAYP06 (*Gossypium hirsutum* L.) were sown to PVC pots filled with commercial garden soil and sand (3:1). The size of the pots was 10 cm height and 10 cm diameter. Three seedlings were eliminated from each pot after emerging. A total of 11.8 mg nitrogen, 11.8 mg potassium and 11.8 mg were added each pot at the beginning of the experiment. Light was supplied from 8:00 a.m. to 6:00 p.m. and light intensity at plant level was at least 300 µmol $m^{-2}s^{-1}$. Relative moisture content of the growth chamber was kept around 40-50%. The water content of soil was maintained 60 % of WHC (Water Holding Capacity) until onset of treatments 28 days after sowing (DAS).

Three soil moister contents were applied for 10 days after onset of treatments. The soil moister content was kept 60 % in well-watered treatment (WW) whereas drought treatment (DD) was applied via withholding watering. In re-watering treatment (DW), drought subjected plants were irrigated 24 hours before end of treatments. Then all plants were harvested 38 DAS.

SPAD values using with SPAD 502 Plus Chlorophyll Meter® and Canopy Temperature Depression (CTD) using with Infrared Thermometer IR-77L® were measured daily. Transpiration of single plants was determined through difference weighing every other day. Plants were separated to leaf, stem and root parts. Leaves were scanned by digital scanner and leaf

[1] Ege University, Faculty of Agriculture, Izmir, Turkey

area was determined via Photoshop CS6® software. All plant parts were own dried at 60℃ for 75 hours. Then dry weights are measured. Prolin content of leaves were determined according to Bates et.al. (1973) using with UV/VIS spectrophotometer (Carry 50®).

RESULTS AND DISCUSSIONS

Transpiration of cotton plants decreased 4 days after drought treatment started (*figure 1*). And a slight increase was observed after re-watering plants in DW treatment. Average water uses were 18.5, 6.0 and 3.7 g/day in WW, DW and DD treatments respectively. SPAD values of the plants grown all treatments steadily increased (Figure 1). However there were not significant differences between the treatments. CTD initiated to decrease 8 days after drought application in DW and DD treatments whereas not clearly changed in WW treatment (*figure 1*). A slight increase in CTD was recorded due to re-watering plants in DW treatment.

CTD values had similar trend with transpiration during treatments. However, the effect of drought observed in CTD 4 days following the transpiration. Higher CTD values in higher transpiring plants were also reported by Belko *et al* (2012). Sharma and Kumar (2014) emphasized relation between CTD, leaf water potential and transpiration rate of wheat plants under drought conditions.

Leaf dry weight of cotton plants decreased while stem and root dry weight did not change due to drought treatments (*figure 2*). Leaf area also reduced due to drought stress in DW and DD treatments (*figure 2*). However, re-watering plants subjected to drought did not significant effect on both leaf dry weight and leaf area.

Karademir *et al* (2012) reported 30% percent decrease in leaf area of drought affected cotton plants which is similar to our findings. Our results also indicated inverse relation between leaf area and SPAD value (Data is not shown). We earlier observed increasing SPAD value while leaf area was decreasing due to limited water application in cotton plants (Çakaloğulları, 2015). This invers relation can be attributed tighten leaf tissues via water loss and increased chlorophyll pigments in unit leaf area.

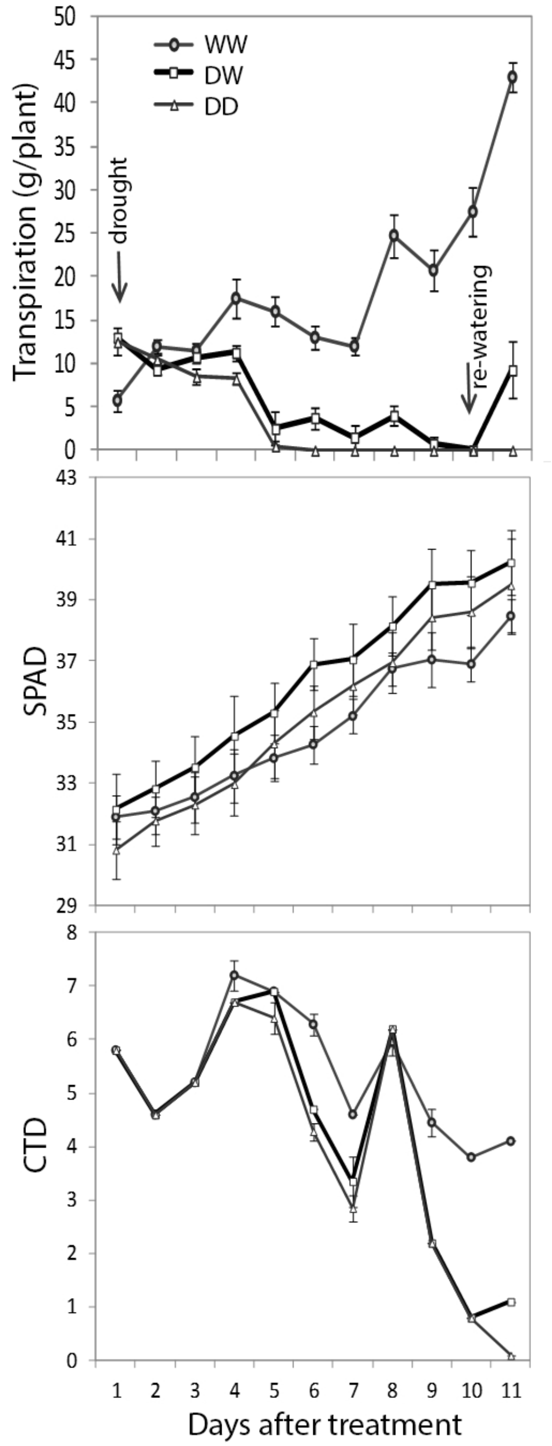

Figure 1 **Daily transpiration amount, SPAD values and Canopy Temperature Depression (CTD) values of cotton plants under well-water (WW), drought (DD) and re-watering (DW) treatments**

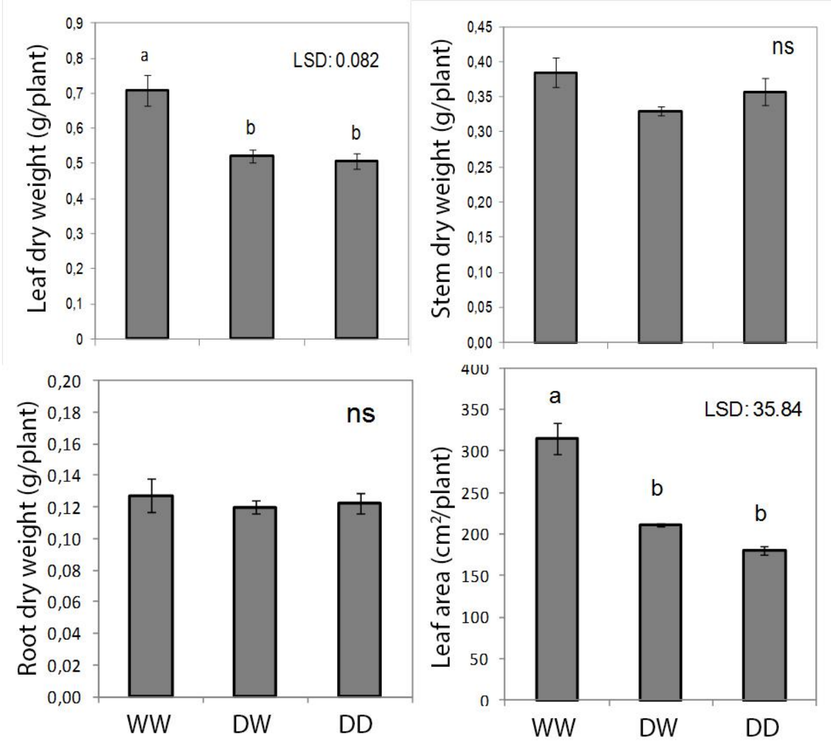

Figure 2 **Leaf, stem and root dry weights and leaf area of cotton plants under well-water (WW), drought (DD) and re-watering (DW) treatments**

Proline content of leaves drastically increased in DD treatment (*figure 3*). However similar proline accumulation was found in WW and DW treatments. Increasing proline content has been previously reported in drought subjected wheat (Tatar, Gevrek, 2008), cotton (Ferreira *et al*, 1979), maize (Ilahi, Dörffling, 1982) and faba bean (Siddiqui *et al*, 2015) plants. Lower proline accumulation in re-watered plants, in the present study, revealed this biochemical response of cotton plant was reversible. This reversible response via proline biosynthesis may play crucial role in adjustment of cellular state and acclimation of cotton plants to drought conditions.

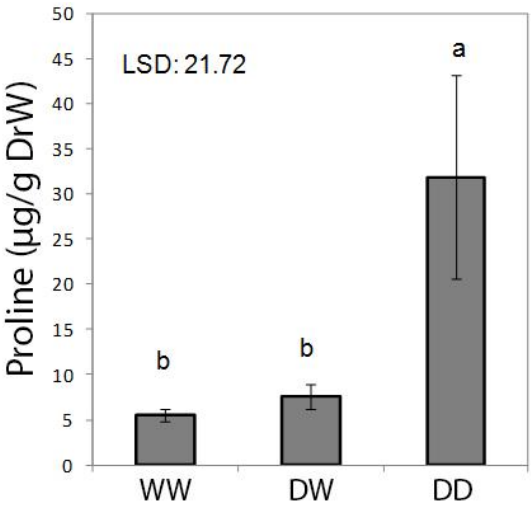

Figure 3 **Proline content of cotton plants under well-water (WW), drought (DD) and re-watering (DW) treatments**

CONCLUSIONS

In conclusion, we may suggest that both stress treatment caused decrease in CTD and transpiration than inhibited dry matter production of cotton plants. Proline accumulation drastically increased with drought stress but it immediately reversed after re-watering cotton plants.

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