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Morphological and Physiological Responses of Eggplant Cultivars (*Solanum melongena* L.) to Drought

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ABSTRACT. Four eggplant cultivars namely Black Beauty (BB), Long Purple (LP), Florida Market (FM), Egyptian White (EW) were used to test the effect of drought on morphological and physiological traits under field conditions during summer and spring seasons in 1991-92. Drought stress reduced plant height, leaf area, number of leaves, number of branches, stem diameter, leaf dry weight and root dry weight during both seasons. Significant differences were observed among different eggplant cultivars in their response to seasonal variation causing substantial effect on plant growth. High temperature associated with drought stress during summer caused more plant injuries than spring season. Florida Market (FM) cultivar showed more tolerance to stress than other eggplant cultivars in most morphological and physiological traits. It appears from the results that an improvement in eggplant cultivars could be made through breeding program.

KEY WORDS: Eggplant, drought stress, plant height, dry weight, root, shoot, stem, morphology, physiology, tolerance.

Introduction

Drought is a major factor limiting vegetable crop production in many arid and semi-arid regions of the world. Frequent irrigation is required in order to maintain healthy growth and high yield during the growing season. Growers in recent years have attempted to develop water management practices that would minimize stress on their crops to improve plant growth and yield (Mitchell *et al.*, 1991). Controlled periods of soil water deficit were imposed by increasing the intervals between irrigations for tomato production (Al-Jibury and May 1970). High soil moisture increased tomato plant growth, yields and root weight of plants (Maynard *et al.*, 1980; Sanders *et al.*,

1989). However, root weight of tomato plant near the soil surface increased with increase in the rate of irrigation (Bar-Yosif *et al.*, 1980). The growth of eggplant seedlings was greater with intermediate soil moisture level, whereas, the stem-root ration was lower with low moisture level (Lou and Kato 1988). Water stress also caused reduction in leaf surface area, plant height, number of branches, and dry weight of shoots and root (Bonanno and Mack 1983; Abou-Hadid *et al.*, 1986; Daunay *et al.*, 1986; Tan 1988; Zhong *et al.*, 1989; Bray 1990). Several investigators reported a great variability for the responses of species cultivars to water deficit (Goncharova *et al.*, 1982, 1983; Daunay 1986; Sun *et al.*, 1990). The climatic changes induced a seasonal variation in most plant characteristics of aubergine (Gupta and Rao 1984; Sun *et al.*, 1990).

This study was conducted to evaluate the growth rate of different eggplant cultivars under water stress and to ascertain the morphological and physiological factors associated with eggplant cultivars in response to drought.

Materials and Methods

The pot experiment was carried out in a nursery field at the Faculty of Meteorology, Environment and Arid Land Agriculture, King Abdulaziz University, Jeddah during 1991-92 crop seasons.

Four eggplant cultivars namely Black Beauty (BB), Long Purple (LP), Florida Market (FM) and Egyptian White (EW) were grown as test plants.

Seeds were planted in beat cubes in plastic flats on April 30, 1991 in a Growth Chamber, Faculty of Meteorology, Environment and Arid Land Agriculture, at room temperature between 22 to 25°C with a relative humidity ranging from 50 to 60% during summer season. Seedlings were transplanted into plastic pots (28 × 28 cm) containing a mixture of sand, peatmoss, and vermiculite in 1:1:1 ratio after five weeks from date of planting.

Plants were fertilized with one tablespoon/gallon of "rapid grow" 20, 20, 20 fertilizer every 21 days, after plant emergence, during the experimental period. Pesticides dimethoate and malathion were sprayed on plants every 2-3 weeks. Soil pH was 7.3, light intensity was 560 $UE/M^2/sec^{-1}$ with a photoperiod of 13 to 14 hr, temperature as day (32 to 37°C) and relative humidity (40 to 60%). There were four levels of irrigation based on daily, day after day, every three days and every four days intervals. These irrigation intervals were also treated as stress periods on plants.

A split plot design was used. Main plots were assigned to irrigation treatments and the subplots to cultivars with three replications. Plants morphological and physiological traits measured were plant height, leaf length, leaf width, leaf area, number of leaves, stem diameter, and stem, root and leaf dry weight.

The same experiment was repeated in spring season of 1991. Seeds were planted on October 3, 1991. Irrigation was applied on daily, every 4 days, every 8 days and every 12 days interval for stress application on plants

Plants were randomly distributed at the university nursery field in Jeddah. Dry weight of leaves, stem and roots were determined at the end of experiment.

Results

The results indicate that drought reduced plant height significantly in both seasons viz. summer and spring (Tables 1 and 2). High temperature during summer associated with drought caused more injuries to plants. Significant differences were found in plant height among eggplant cultivars in response to drought during summer (Table 3) as well as in spring (Table 4). The plant height was maximum for Florida Market (FM) and Long Purple (LP) cultivars during summer, whereas the plant was maximum for LP followed by FM during spring. The performance of Black Beauty (BB) and Egyptian White (EW) was poor during both seasons with respect to plant height. Drought caused significant reduction in leaf area, number of leaves, and number of branches in both seasons (Tables 1 and 2). Eggplant cultivars showed different responses to water stress in leaf area, number of leaves, and number of branches. Florida Market showed the largest leaf area during summer and spring planting. Whereas LP was the second in summer and the leaf area was minimum dur-

TABLE 1. Means for the effect of water interval on different morphological and physiological traits of eggplant cultivars grown in the King Abdulaziz University Nursery (First Experiment).

Water treatment	Plant height (cm)	Leaf area (cm^2)	No. of leaves	No. of branches	Stem thickness (cm)	Leaf dry weight (g)	Stem dry weight (g)	Root dry weight (g)
1 Day	1 59.54 A	1 50.41 A	1 9.38 A	1 2.68 A	1 0.81 A	1 21.50 A	1 27.21 A	1 26.98 A
2 Days	3 53.92 A	3 50.34 A	2 8.38 A	3 2.43 A	2 0.75 AB	4 21.25 A	2 26.79 A	3 25.33 A
3 Days	2 53.13 A	2 47.02 A	3 8.08 A	2 1.92 A	3 0.74 B	3 21.15 A	3 24.47 A	2 25.08 A
4 Days	4 41.58 A	4 42.93 A	4 5.58 A	4 1.23 A	4 0.65 B	2 20.98 A	4 22.79 A	4 22.94 A
LSD	20.07	27.03	5.47	1.750	0.1579	3.77	8.44	5.488

TABLE 2. Means for the effect of water interval on different morphological and physiological traits of eggplant cultivars grown in the King Abdulaziz University Nursery (Second Experiment).

Water treatment	Plant height (cm)	Leaf area (cm^2)	No. of leaves	No. of branches	Stem thickness (cm)	Leaf dry weight (g)	Stem dry weight (g)	Root dry weight (g)
1 Day	1 45.35 A	4 80.68 A	1 40.49 A	1 8.12 A	1 1.12 A	1 25.55 A	1 21.68 A	1 15.88 A
4 Days	2 40.53 AB	3 75.77 AB	2 35.34 B	2 7.38 A	2 1.03 B	2 21.22 AB	2 16.38 B	2 12.36 AB
8 Days	4 34.87 BC	2 75.48 AB	3 32.36 B	4 6.47 B	3 0.91 C	3 18.63 C	3 12.29 C	3 38.90 B
12 Days	3 34.75 BC	1 71.64 A	4 31.94 B	3 6.43 B	4 0.91 C	4 16.57 C	4 11.38 C	4 48.26 B
LSD	4.364	8.7369	3.609	0.9989	0.063129	4.018	1.9087	4.3920

ing spring. However, BB had intermediate leaf area and EW was the lowest in leaf area. The number of leaves in BB were highest during summer and in EW during spring. Florida Market showed good performance in summer and lowest number of leaves during spring. Long Purple produced highest number of branches during summer and was the second in spring, while EW recorded the highest number of branches during spring and was third in summer planting. Black Beauty ranked second in number of branches during summer and third in spring. However, the number of branches in FM were the lowest during during both seasons (Tables 3 and 4).

TABLE 3. Means for the effect of drought on different morphological and physiological traits of eggplant cultivars grown in the King Abdulaziz University Nursery (First Experiment).

Variety	Plant height (cm)	Leaf area (cm^2)	No. of leaves	No. of branches	Stem thickness (cm)	Leaf dry weight (g)	Stem dry weight (g)	Root dry weight (g)
1 BB	3 62.83 A	3 64.98 A	1 9.71 A	2 3.83 A	3 0.84 A	3 22.90 A	3 29.23 A	3 28.09 A
2 LP	2 57.63 A	2 47.83 B	3 8.92 AB	1 1.77 B	2 0.80 B	1 21.84 A	2 26.15 A	2 24.86 B
3 FM	1 45.04 B	1 45.07 BC	2 7.13 B	4 1.44 B	1 0.68 C	4 20.30 AB	1 23.43 AB	1 24.83 B
4 EW	4 42.67 B	4 32.83 C	4 5.67 C	3 1.23 B	4 0.63 C	2 19.83 B	4 22.45 B	4 22.56 B
LSD	10.74	13.48	2.39	1.08	0.106	1.905	3.157	2.364

BB = Black Beauty; LP = Long Purple; FM = Florida Market; EW = Egyptian White.

TABLE 4. Means for the effect of drought on different morphological and physiological traits of eggplant cultivars grown in the King Abdulaziz University Nursery (Second Experiment).

Variety	Plant height (cm)	Leaf area (cm^2)	No. of leaves	No. of branches	Stem thickness (cm)	Leaf dry weight (g)	Stem dry weight (g)	Root dry weight (g)
1 BB	2 42.86 A	3 89.82 A	4 37.14 A	4 8.24 A	4 1.12 A	4 23.77 A	3 16.93 A	3 14.55 A
2 LP	3 39.43 B	1 79.98 B	1 36.69 A	2 7.95 A	1 0.98 A	3 23.27 A	4 15.19 A	4 11.31 B
3 FM	4 39.25 B	4 77.75 B	2 35.98 A	1 7.03 B	3 0.96 B	1 22.37 A	2 14.92 A	1 10.97 B
4 EW	1 33.96 C	2 56.01 C	3 30.32 B	3 5.18 C	2 0.92 B	2 12.56 B	1 14.69 A	2 8.06 C
LSD	2.445	8.007	2.442	0.825	0.0532	2.778	2.1835	2.0339

Drought reduced stem diameter of all eggplant cultivars and the response of eggplant cultivars to drought was variable (Table 3 and 4). Drought also reduced the dry weight of leaves, stem and roots during both seasons. The treatment differences were significant during spring and non-significant during summer. Eggplant cultivars were variable in their tolerance to water stress during both seasons, for leaf dry weight, stem dry weight and root dry weight. Florida Market showed the best performance during both seasons for dry weight of leaf, stem and root. However, FM was the second in leaf dry weight during spring. Egyptian White was the best in leaf dry

weight during spring and third during summer. However, EW showed good performance during spring and poor performance in summer. Black Beauty was intermediate in performance in summer. Black Beauty was intermediate in performance among all other cultivars during both seasons with respect to leaf, stem and root dry weight (Tables 3 and 4).

Discussion

Drought reduced plant height, leaf area, number of leaves, and number of branches of all eggplant cultivars during both seasons viz., summer and spring. The results obtained were in agreement with the findings of Bonanno and Mack (1983); Abou-Hadid *et al.* (1986); Tan (1988); Zhong *et al.* (1989), and Bray (1990). Daunay *et al.* (1986) stated that drought caused reduction in leaf area, plant height, number of branches and dry weight of shoots and roots. However, the response of eggplant cultivars to water stress was variable. These results were similar to those found by Goncharova *et al.* (1982, 1983); Daunay *et al.* (1986) and Sun *et al.* (1990). They reported differential responses of species cultivars to water stress. These differences were possibly due to the difference in genotypes.

Heat associated with water stress during summer caused more injuries to plants. Drought stress caused reduction in stem thickness of eggplant cultivars and produced weaker plants. The results also indicated that drought reduced the leaf, stem, and root dry weight. The results were comparable with the findings of Bar-Yosef *et al.* (1980); Maynard *et al.* (1980); Lou and Kato (1988) and Sanders *et al.* (1989). They reported increases in plant growth parameters with increase in soil moisture.

The analysis of data of this study indicates that water stress, when associated with stress, caused severe injuries to plants and the eggplant cultivars varied in their tolerance to drought stress. An improvement can be made through a good breeding program and further study of other plant characteristics under extreme conditions in an arid environment.

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استجابة بعض أصناف الباذنجان « *Solanum melongena* L. » من الناحية المورفولوجية والفسيولوجية للجفاف

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المستخلص . أستخدمت أربعة أصناف من الباذنجان وهي بلاك بيوتي Black Beauty ولونج بربل Long Purple وفلوريدا ماركيت Florida Market والمصري الأبيض Egyptian White لدراسة تأثير الجفاف على الصفات الفسيولوجية والمورفولوجية في ظروف الحقل في موسم الصيف و الربيع لعام ١٩٩١ – ١٩٩٢م .

لوحظ أن شدة الجفاف أنقصت من طول النبات و مساحة الأوراق وعدد الفروع في النبات وسمك الساق ووزن الأوراق الجاف ووزن الساق والجذور الجاف خلال الفصلين الربيع و الصيف .

وقد لوحظ أن هناك فروقات معنوية لأصناف الباذنجان لفصول السنة والنمو و درجة الحرارة العالية مع شدة الجفاف أثناء موسم الصيف أثرت على النباتات . و اتضح من الدراسة أن صنف فلوريدا ماركيت Florida Market كان أكثر الأصناف تحملا للجفاف لمعظم الصفات الفسيولوجية و المورفولوجية . واتضح أيضا إمكانية تحسين أصناف الباذنجان في برنامج تربية جيد .