

*

Effect of drought stress on yield and its components in four cotton genotypes in Darab region

(*Gossypium hirsutum* L.)

A

() B557 818-312 Siokra

(WUE) ()

% %

%

818-312

|||

*

()

(Yuan *et al.*, 1994)

F7

(McDaniel, 1997)

(LWP)

T₃ , T₂, T₁
/

(McWilliams, 2002)

()

()

(Steger *et al.*, 1994)

%

(r= /)

(r= /)

(Randa *et al.*, 1997)

× -

% % %
% %) (% %)

B557 HAR Crema
(Zangi, 1997)

(

(% %)
(Hekmat and Haghigatnia, 1999)

Archive of SID

() ()

Loam

Fine loamy carbonatic hyper termic aridic haple
ustept

()

(Hekmat *et al.*, 2003)

Table 1. Metreological data at agricultural research station of Darab in 2003 and 2004

| Month | ماه | درجه حرارت (سانتی گراد) Temperatour (°C) | | | | | | بارندگی (میلی متر) Precipitation (mm) | | تبخیر (میلی متر) Evaporation (mm) | |
|-------------|----------|---|-----------|------------------------------|-----------|-----------------------------|-----------|---|-----------|---|-----------|
| | | میانگین Mean Temp. | | میانگین ماکزیمم Mean Max. | | میانگین مینیمم Mean Min. | | 2002-2003 | 2003-2004 | 2002-2003 | 2003-2004 |
| | | 2002-2003 | 2003-2004 | 2002-2003 | 2003-2004 | 2002-2003 | 2003-2004 | | | | |
| March-April | فروردین | 19.7 | 18.8 | 27.0 | 26.0 | 12.3 | 11.6 | 68.8 | 4.5 | 5.0 | 5.7 |
| April-May | اردیبهشت | 24.4 | 24.6 | 32.6 | 33.0 | 16.1 | 16.1 | 7.70 | 0.4 | 8.5 | 8.5 |
| May-June | خرداد | 30.1 | 29.9 | 39.2 | 39.2 | 21.0 | 20.5 | 0.00 | 0.0 | 10.8 | 11.6 |
| June-July | تیر | 34.0 | 32.5 | 42.0 | 40.3 | 26.0 | 24.6 | 1.20 | TR | 12.5 | 12.2 |
| July-Aug. | مرداد | 34.2 | 33.2 | 42.6 | 41.2 | 26.1 | 25.7 | 2.40 | TR | 13.9 | 11.5 |
| Aug.-Sep. | شهریور | 30.2 | 30.2 | 38.8 | 38.2 | 21.5 | 22.1 | 0.00 | TR | 9.7 | 9.8 |
| Sep.-Oct. | مهر | 25.3 | 24.4 | 34.0 | 33.6 | 16.6 | 15.2 | 0.00 | 0.0 | 7.1 | 7.7 |
| Oct.-Nov. | آبان | 18.1 | 18.7 | 26.6 | 27.2 | 9.5 | 10.2 | 0.50 | 2.5 | 4.5 | 4.5 |
| Nov.-Dec. | آذر | 13.1 | 13.1 | 20.0 | 18.8 | 6.2 | 7.3 | 78.40 | 121.5 | 2.2 | 2.2 |
| Dec.-Jan. | دی | 12.2 | 9.6 | 17.4 | 15.3 | 7.0 | 3.8 | 200.80 | 142.2 | 1.5 | 2.1 |
| Jan.-Feb. | بهمن | 12.1 | 9.3 | 18.5 | 15.4 | 5.6 | 3.2 | 36.70 | 59.6 | 2.5 | 1.9 |
| Feb.-March. | اسفند | 17.0 | 14.9 | 25.2 | 20.4 | 8.8 | 9.4 | 15.40 | 37.5 | 4.4 | 2.8 |

(Ehyae, 1997)

× ()

()

I₂ = 100, I₁ = 70

I₄ = 160 I₃ = 130

A

G1 = Bakhtegan ()

G4 = B557 G3 = 818-312 G2 = Siokra

()

()

()

%

()

()

(Farshi *et al.*, 1997)

() = (× × ×) / /

(Akram Ghaderi *et al.*, 2004)

Ln (y) = 0.9091 + 1.5983 Ln (x)

() : y

() : X

(

(WUE)

Table 2. Physico-chemical properties of soil and water for experimental site.

| | () | Amount |
|--|-------|--------|
| <u>Soil properties (0-30cm)</u> | | |
| %Clay | | 22.00 |
| % Organic Carbon | | 0.54 |
| Electric Conductivity (ds/m) | () | 1.03 |
| pH | | 8.40 |
| T.N.V. (mg/Kg) | () | 44.00 |
| P _{ava.} (mg/Kg) | () | 9.60 |
| K _{ava.} (mg/Kg) | () | 244.00 |
| Fe _{ava.} (mg/Kg) | () | 3.60 |
| Mn _{ava.} (mg/Kg) | () | 10.00 |
| Zn _{ava.} (mg/Kg) | () | 0.40 |
| Cu _{ava.} (mg/Kg) | () | 0.80 |
| <u>Irrigation water</u> | | |
| Electric Conductivity (ds/m) | () | 0.44 |
| pH | | 7.60 |
| Hco ₃ ⁻ (meq/litr) | () | 4.00 |
| Cl ⁻ (meq/litr) | () | 5.00 |
| So ₄ ⁻ (meq/litr) | () | 0.11 |
| Ca ⁺⁺ + Mg ⁺⁺ (meq/litr) | () + | 4.00 |
| Na ⁺ (meq/litr) | () | 0.61 |

(Burke and Omahony, 2001)

Archive of SID

Table 3. Combined analysis of variance for different traits and characteristics in cotton genotypes.

| | | MS | | | | | | | | | |
|----------------|---|----|-----------|--------------|-------------|-------------------|------------------------|------------------|-------------------------|-------------------|--------------|
| S.O.V. | | df | Earliness | Yield | Boll weight | Boll number/plant | Sympodial number/plant | Sympodial length | Monopodial number/plant | Monopodial length | Plant height |
| year (Y) | | 1 | 1863.8 ** | 9492868.1 ** | 8.706 ** | 51.188 ns | 41.344 ** | 95.800 ** | 1.654 ns | 1053.3 ** | 2773.5 ** |
| Y/R | / | 4 | 6.3 ns | 889653.8 ** | 0.506 ns | 24.069 ns | 6.148 ns | 71.964 ** | 1.282 ns | 20.4 ns | 40.4 ns |
| Irrigation (I) | | 3 | 108.0 ns | 4505724.1 ** | 3.397 ** | 78.769 ns | 4.872 ns | 47.836 ** | 0.325 ns | 113.4 ns | 139.9 * |
| Y × I | × | 3 | 85.1 ns | 816977.3 * | 0.490 ns | 3.425 ns | 4.075 ns | 57.683 ** | 0.689 ns | 82.9 ns | 61.1 ns |
| Error a | a | 12 | 42.7 | 190157.5 | 0.434 | 34.553 | 2.683 | 8.288 | 0.436 | 91.4 | 37.7 |
| Genotype (G) | | 3 | 885.9 ** | 89238.0 ns | 2.571 ** | 15.633 ns | 1.966 ns | 86.803 ** | 3.810 ** | 270.5 ** | 1243.6 ** |
| Y × G | × | 3 | 7.9 ns | 92829.8 ns | 0.512 ns | 8.792 ns | 3.082 * | 43.530 ** | 2.271 ** | 45.7 ns | 62.5 * |
| I × G | × | 9 | 16.4 ns | 81265.6 ns | 0.385 ns | 11.334 ns | 0.531 ns | 5.469 ns | 0.430 ns | 46.9 ns | 38.8 ns |
| Y × I × G | × | 9 | 14.8 ns | 89560.3 ns | 0.508 ns | 18.149 ns | 0.714 ns | 18.619 ns | 0.262 ns | 45.9 ns | 36.3 ns |
| Errore b | b | 48 | 20.3 | 105880.5 | 0.530 | 13.953 | 0.876 | 9.317 | 0.291 | 33.8 | 23.476 |
| CV (%) () | | | 5.43 | 12.08 | 14.02 | 21.50 | 8.87 | 21.82 | 16.79 | 16.56 | 6.53 |

* and ** : significant at the 5% and 1% of probability levels, respectively

ns: Non- significant

:** *

: ns

Table 4. Mean of main effects of year and experimental treatments on different traits

| Year | Earliness (%) | Yield (Kg/h) | Boll weight (g) | Boll number/plant | Sympodial number/plant | Sympodial length (cm) | Monopodial number/plant | Monopodial length (cm) | Plant height (cm) |
|----------------|---------------|--------------|-----------------|-------------------|------------------------|-----------------------|-------------------------|------------------------|-------------------|
| Year | | | | | | | | | |
| 2003 | 78.58b | 2379 b | 4.88b | 16.64a | 11.21a | 12.99b | 3.08a | 31.82b | 68.77b |
| 2004 | 84.40a | 3008a | 5.49a | 18.10a | 9.89b | 14.99a | 3.34a | 38.44a | 79.52a |
| Irrigation | | | | | | | | | |
| I ₁ | 84.79a | 3026a | 5.557a | 17.65ab | 10.94a | 15.41a | 3.067a | 38.10a | 76.41a |
| I ₂ | 83.21ab | 3072a | 5.418ab | 19.55a | 10.37a | 12.80b | 3.346a | 33.01a | 72.93a |
| I ₃ | 79.96b | 2511b | 5.070bc | 17.14ab | 10.90a | 14.99a | 3.246a | 35.23a | 75.89a |
| I ₄ | 84.00ab | 2168c | 4.717c | 15.14b | 9.996a | 12.74b | 3.192a | 34.18a | 71.35b |
| Genotype | | | | | | | | | |
| G ₁ | 75.54c | 2630a | 5.565a | 17.23a | 10.88a | 14.94a | 3.046b | 33.08b | 72.58b |
| G ₂ | 80.75b | 2678a | 4.810c | 16.32a | 10.21b | 15.10a | 3.662a | 32.22b | 64.60c |
| G ₃ | 86.54a | 2777a | 5.327ab | 17.72a | 10.66ab | 14.76a | 3.392a | 39.72a | 79.65a |
| G ₄ | 89.13a | 2683a | 5.060bc | 18.21a | 10.45ab | 11.14b | 2.750b | 35.50b | 79.76a |

%

Means, in each column for each factor, followed by similar letter(s) are not significantly different at the 5% probability level - using Duncan's Multiple Range Test

G₁=Bakhtegan, G₂=Siokra, G₃=818-312, G₄=B-557

I₁ = 70, I₂ = 100, I₃ = 130, I₄ = 160 mm evaporation from class A pan

I₁

(Fathi, 1997)

()

I₄

(/)

()

I₁

I₄

/

()

/

(/)

(/)

I₁

()

(/)

(/)

I₄

(McMichael and Hesketh, 1982)

B 557

/

×

(/)

F

I₂ I₁

I₄ I₃

() I₂

×

I₄ (/)

%

(/)

" "

.()

818-312

/

818-312

:

×

.()

()

()

×

()

-

)

818-312

(

.()

%

(McMichael and

Hesketh, 1982)

(Boyer, 1985)

%

818- B-557

:

312

(McDaniel, 1997)

.()

.(Ramezani Moghadam and Taherian, 2004)

.()

(I₁)

/

(I₂)

.()

:

/

()

"..."

×

Table 5. Interaction of irrigation × Genotype on different traits

| Treatment | () Earliness (%) | () Yield (Kg/h) | () Boll weight (g) | () Boll number/plant | () Sympodial number/plant | () Sympodial length (cm) | () Monopodial number/plant | () Monopodial length (cm) | () Plant height (cm) | |
|----------------|-------------------------|------------------------|---------------------------|-----------------------------|----------------------------------|---------------------------------|-----------------------------------|-------------------------------------|-----------------------------|------------|
| I ₁ | G ₁ | 77.67 de | 3075 ab | 5.887a | 16.92 abcd | 11.53 a | 16.12 ab | 2.967 bcd | 34.32 bcd | 76.37 bcd |
| | G ₂ | 84.17 abc | 3009 ab | 5.318abc | 14.95 bcd | 10.20 bcd | 15.82 ab | 3.417 abc | 30.53 cd | 64.13 fgh |
| | G ₃ | 87.83 ab | 3062 abc | 5.592ab | 19.42 abc | 11.00 abc | 16.58 a | 3.200 bcd | 42.57 a | 82.92 a |
| | G ₄ | 89.5 a | 2957 abc | 5.432ab | 19.30 abcd | 11.02 abc | 13.12 abcde | 2.683 cd | 33.52 bcd | 80.15 ab |
| I ₂ | G ₁ | 76.5 e | 2959 abc | 5.357abc | 21.47 a | 10.47 abcd | 13.97 abcd | 3.167 bcd | 30.80 cd | 71.68 de |
| | G ₂ | 79.33 cde | 2917 abc | 4.965abcd | 18.53 abcd | 10.47 abcd | 14.68 bc | 4.017 a | 29.25 d | 61.13 h |
| | G ₃ | 88.00 ab | 3322 a | 5.877a | 18.18 abcd | 10.57 abcd | 12.03 bcde | 3.617 ab | 36.25 abcd | 76.52 abcd |
| | G ₄ | 89.00 a | 3089 ab | 5.472ab | 20.02 ab | 9.98 bcd | 10.53 de | 2.583 d | 35.75 abcd | 82.40 ab |
| I ₃ | G ₁ | 70.17 f | 2382 def | 5.598ab | 16.40 abcd | 11.17 ab | 15.60 ab | 3.150 bcd | 36.62 abcd | 73.52 cde |
| | G ₂ | 78.00 de | 2661 bcd | 4.710bcd | 17.53 abcd | 10.53 abcd | 15.90 ab | 3.233 bcd | 39.42 ab | 69.75 ef |
| | G ₃ | 83.00bcd | 2563 cde | 5.027abcd | 17.18 abcd | 11.23 ab | 17.30 a | 3.517 ab | 41.23 ab | 82.90 a |
| | G ₄ | 88.67 ab | 2337 def | 4.943abcd | 17.45 abcd | 10.65 abcd | 11.17 cde | 3.083 bcd | 35.12 abcd | 79.48 abc |
| I ₄ | G ₁ | 77.83 de | 2103 f | 5.420ab | 14.15 d | 10.35 abcd | 17.08 abcd | 2.900 bcd | 30.58 cd | 68.75 efg |
| | G ₂ | 81.5 cde | 2161 ef | 4.245d | 14.25 cd | 9.65 d | 14.02 abcd | 3.983 a | 29.70 cd | 63.37 gh |
| | G ₃ | 87.33 ab | 2160 ef | 4.812bcd | 16.10 bcd | 9.85 cd | 13.12 abcde | 3.223 bcd | 38.82 ab | 76.25 bcd |
| | G ₄ | 89.33 a | 2237 def | 4.392cd | 16.07 bcd | 10.13 bcd | 9.75 e | 2.650 d | 37.63 abc | 77.02 abcd |

%

Means, each column, followed by similar letter(s) are not significantly different at the 5% probability level - using Duncan's Multiple Range Test

G₁=Bakhtegan, G₂=Siokra, G₃=818-312, G₄=B-557

I₁=70, I₂=100, I₃=130, I₄=160 mm evaporation from class A pan.

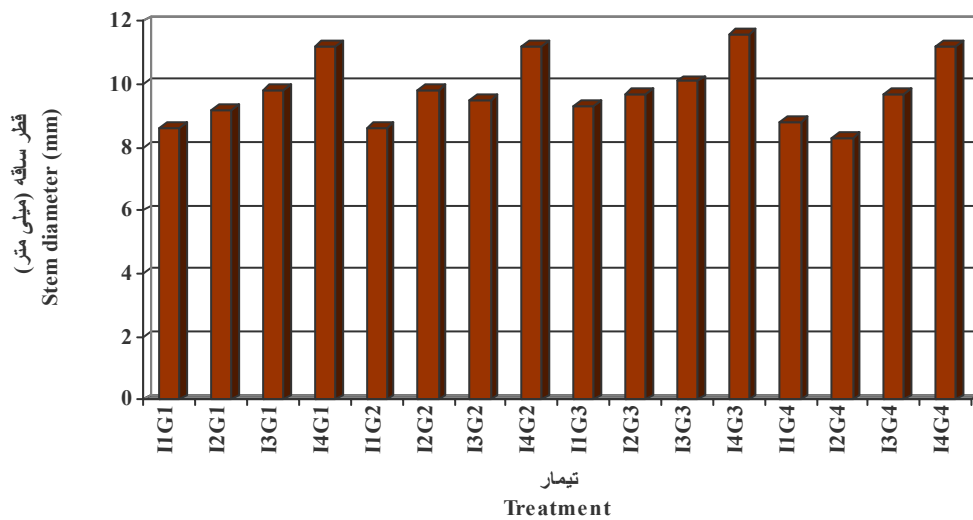


Fig. 1. Variation in stem diameter (mm) in different irrigation treatments

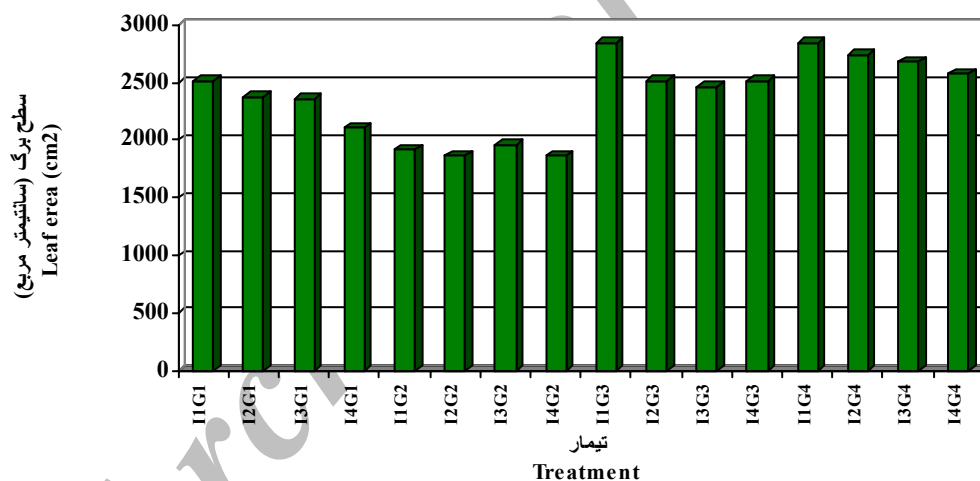


Fig. 2. Variation of leaf area (cm²) in different irrigation treatments

× × ()
 ()

(Kg/m³)

Table 6. Water use efficiency (Kg/m³) in different irrigation treatments in 2003-04

| | | I ₁ | I ₂ | I ₃ | I ₄ |
|------------------------------|----------------------|----------------|----------------|----------------|----------------|
| 2003 | | | | | |
| Number of irrigation | | 16a | 13ab | 11bc | 8c |
| Used water (m ³) | (m ³) | 9831a | 9355b | 9222c | 8622d |
| Yield (Kg/h) | (Kg/h) | 2918a | 2760a | 1955b | 1885b |
| W.U.E (Kg/m ³) | (Kg/m ³) | 0.2968a | 0.2950a | 0.2119b | 0.2151b |
| 2004 | | | | | |
| Number of irrigation | | 18a | 14ab | 11bc | 9c |
| Used water (m ³) | (m ³) | 10277a | 9937b | 9633c | 9611c |
| Yield (Kg/h) | (Kg/h) | 3133a | 3383a | 3067a | 2450b |
| W.U.E (Kg/m ³) | (Kg/m ³) | 0.3048a | 0.3404a | 0.3183a | 0.2549b |
| Mean | | | | | |
| Number of irrigation | | 17a | 13.5ab | 11bc | 8.5c |
| Used water (m ³) | (m ³) | 9829a | 9646b | 9427c | 9116d |
| Yield (Kg/h) | (Kg/h) | 3025a | 3071a | 2511b | 2167b |
| W.U.E (Kg/m ³) | (Kg/m ³) | 0.3008a | 0.3177a | 0.2651b | 0.2350b |

Means, in each column for each year, followed by similar letter(s) are not significantly different at the 5% probability level -using Duncan's Multiple Range Test.

$$\left(\frac{\text{Yield}}{\text{Used water}} \right) \times 100 \quad (I_2)$$

References

- Akram Ghaderi, F., A. Soltani. And J. Rezai. 2004.** Estimation of leaf area from plant vegetative characteristics in cotton cultivars. *Agric. Sci. Natur. Resour.* 11(1): 15-23.
- Biolorai, H., A. Mantell. and S. Moreeshet. 1983.** Water relation of cotton. PP.49-57 in: Kozwasei, T.T.(ed).Water deficits and plant growth. Vol. VII. New York Academic Press. U. S. A.
- Boyer, J. S. 1985.** Water transport. *Ann. Rev. of Plant Physiol.* 36: 473-516
- Burke, J. J. and J. Omahony. 2001.** Protective role in acquired term tolerance of developmentally regulated heat shock proteins in cotton seeds. *Journal of Cotton Science.* 2: 147-183.
- Dewey, D. and K. H. Lu. 1958.** A correlation and path – coefficient analysis of components of crested wheat grass seed production. John Wiley and Sons Pub. New York. 586 pp.
- Ehyaee, M. 1997.** Description methods of soil chemical analysis. Soil and Water Research Institute. 2: 1024
- Farshi, A., M. R. Shariati., R. Charelahi., M. R. Ghaemi., M. Shahabifar and M. M. Tavallae. 1997.** Estimation of water requirement of main crops and horticultural plants in country. Soil and Water Research Institute. *Agric. Edu. Pub.* 1: 367-401.

- " "
- Fathi Saadabadi, M. 1997.** Determination of selection indices in cotton cultivars (*Gossypium hirsutum* L.). M.Sc. Thesis Tarbiat Modarres University, Tehran, Iran. 148 pp.
- Galeshi, S., S. Farzaneh and A. Soltani. 1995.** Investigation of drought tolerance at seedling stage in forty genotypes of cotton (*Gossypium hirsutum* L.). Seed and Plant. 21: 65-75.
- Hekmat. M. H. and H. Haghightania. 1999.** Determination of water requirement two cultivars of cotton in Darab region. Fars Agriculture and Natural Resource Research Center Pub.
- Hekmat. M. H., H. Haghightania. And R. Shirvanian. 2005.** Determination of economic threshold of deficit irrigation and plant growth regulator (pix) effect on cotton. Fars Agriculture and Natural Resource Research Center Pub.
- McDaniel, R. J. 1997.** Engineering stress – tolerant cotton with high quality fiber. Proceeding Belt Wide Cotton Conferences. New Orleans, L. A. USA. 2: 413-414.
- McMichael, B.L. and J.D. Hesketh. 1982.** Field investigations of the response of cotton to water deficits. Field Crop Research. 5: 319-333.
- McWilliams, D. 2002.** Drought strategies for cotton. Crop Extension Service. New Mexico State University. Agron. J. 90: 455-461.
- Ramezani Moghadam, M. and M. Taherian. 2004.** Drought strategies for cotton. Drought and Agronomy. Ministry of Jihad -e- Agriculture. 13: 80-88.
- Randa, J. A. and A. V. D. Mescht. 1997.** 2, 3 ,5-Triphenyl tetrasolium chloride reduction as a measure of drought tolerance and heat tolerance in cotton. South African Journal of Science. 93:10, 431-33.
- Soltanzadeh, H. 1993.** Evaluation and Comparison different methods of designing row irrigation and selection utility method. M.Sc. Thesis. Isfahan University of Technology, Isfahan, Iran.
- Steger, A. J., J. C. Silvertooth, and P.W. Brown. 2002.** Upland cotton growth and yield response to timing the initial post plant irrigation. Agron. J. 93: 455-461.
- Yuan, J., Z. R. Hao, and Z. G. Sum. 1994.** Path analysis on the yield components of rain fed cotton. Acta. Agri. Boreali – Sincica. 9: 7-11.
- Zangi, M. R. 1997.** Determination of indices sensitive and resistance to drought stress in cotton. M.Sc. Thesis. Tarbiat Modarres University Tehran, Iran.

Effect of drought stress on yield and its components in four cotton genotypes in Darab region.

Fathi Saadabadi¹, M. and F. Navabi²

ABSTRACT

Fathi Saadabadi, M. and F. Navabi. 2008. Effect of drought stress on yield and its components in four cotton genotypes in Darab region. *Iranian Journal of Crop Sciences*. 10(2): 110-124.

To evaluate the effect of drought stress on yield and its components in cotton and introduce the suitable cotton genotype for Darab region, four genotypes of cotton (*Gossypium hirsutum*) were studied in a field experiment using split plot arrangement in a randomized complete blocks design (RCBD) with three replications. Main factor, included four levels of irrigation (70, 100, 130 and 160 mm cumulative evaporation from class A pan) and four genotypes consisting of Siokra, 818-312, B-557 and Bakhtegan (control) assigned as sub-plots. Studied traits were plant height, length and numbers of monopodial (L.M.B and N.M.B) and sympodial branches (S.B), boll number, boll weight, yield and earliness. Also leaf area and water use efficiency were studied. Analysis of variance showed that the effect of irrigation interval on plant height, L.M.B, L.S.B, boll weight, and earliness were highly significant. Drought stress reduced boll weight, however, Bakhtegan cultivar had the biggest and heaviest bolls. The 70 and 100 mm irrigated treatments were in one group and 130 and 160 mm treatments grouped together. Therefore, there was high significant difference between them. The genotype 818-312 had the highest yield of 3322 Kg/ha in 100 mm (I₂) irrigation treatment. Water used in this treatment was 9646 m³/ha in 13 times and irrigation intervals were approximately every 10 days.

Key Words: Cotton, Genotypes, Drought stress, Irrigation interval, Yield, Monopodial, Sympodial, Boll.

Received: December, 2006.

1- Faculty member, Deputy Agriculture and Natural Resources Research Center of Fars Province, Darab, Iran (Corresponding author).

2- Faculty member, Deputy Agriculture and Natural Resources Research Center of Fars Province, Darab, Iran.