Journal of Research in Agricultural Science
Vol. 6 (2010), pages: 55- 59

Evaluation of Verticillium Wilt Tolerance in Different Cotton Cultivars

ABBAS KHEIRI[1*], MOHSEN FATAHI[2]
1- Plant Protection Department, Abooreyhan Campus, University of Tehran,Iran
2- Cotton Research Institute,Gorgan,Iran

Received:12 July 2009 Accepted:25 February 2010

[*]Corresponding author: Email:Abbas_kheiri2005@yahoo.com

ABSTRACT
Field experiments were conducted to evaluate yield and *Verticillium* resistance in cotton, 6 cultivars were studied as randomized complete block design with 4 replications in Estahban Research Station, during 2005 to 2006. Disease percent, the index and severity were determinated based on foliar symptoms.Results showed that Bakhtegan, 818 and B-557 had the least percent (20-29.38%),Severity (1.42-1.62) and index (32.13-45.69) of disease.On the other hand, Varamin had the most percent (85.63%) from Severity (3.23) and index (278) of disease. Bakhtegan, 818 and B-557 were significantly differed of others in yield.

Keywords: Cotton, Cultivar, Tolerance, *Verticillium*

INTRODUCTION

Verticillium wilt caused by *Verticillium dahlia* kleb is the most serious disease in cotton production, which is the major factor influencing high yield of cotton in worldwide and Iran (Moshirabadi, 1981).

Control of Verticillium wilt is difficult under intensive cropping systems, such as those adopted in the area infested with the disease in Iran. Currently, no fungicides were registered for control of this disease on cotton. In addition, the ability of sclerotia of the fungus to survive in the soil for seven or more years (Wilhelm, 1955) and the wide host range of the fungus, make cultural control difficult, emphasizing the need for resistant cultivars (Heale, 1988).

High tannin content was reported to be associated with Verticillium wilt resistance (Singh, 1998). The original selection for *Verticillium* resistance was made before 1917 (Hillocks, 1992). Cultivars that have moderate to high levels of resistance to Fusarium wilt and low to moderate levels of resistance to Verticillium wilt include Deltapine 50, Deltapine 20, Stoneville506, Stoneville 112, GC-510 and DESL99.

465 varieties and lines including *Gossypium hirsutum* L. and *Gossypium barbadense* L. were evaluated for resistance to Verticillium wilt in field conditions and 23 varieties and lines showed resistance to disease (Chen *et al.,* 1980).

Resistance of 32 cotton cultivars to Verticillium wilt (*V.dahliae*) was tested in the field and four cultivars showed high resistance to the disease (Jian *et al.,* 2003). 28 of the most commonly grown cotton cultivars (*Gossypium hirsutum* L.) of Turkey were evaluated for the presence of field resistance to wilt. Most of the evaluated cultivars were susceptible. Carmen cultivar was susceptible to the defoliating but resistant to the

nondefoliating pathotype. ST-373 cultivar was moderately susceptible to both pathotypes of *V. dahliae* (Gore *et al.,* 2009).

Four isolates of *Verticillium dahliae* were used in screening four cotton cultivars. Pimas-7 and Acalaprema gave the highest resistance reactions and Acala44 was the most susceptible (Bolek *et al.,* 2005).

135 forms of *Gossypium arboreum* and *G.herbaceum* were studied for Verticillium wilt resistance in field. Both species proved resistance to race 2 of *V.dahliae* which effects *G.hirsutum* Tashkent1 (Alyamov and Kas yanenko, 1980).

The spread of Verticillium wilt and it's crop loss in cotton fields of Fars, Mazandaran and Golstan provinces make it necessary to determine the susceptibility of cotton cultivars to *V.dahliae*. In view of present studies were designed to determine resistance cultivars with high yield and climate (year) effects on Verticillium wilt.

MATERIALS AND METHODS

Experiment was carried out in Estahban Research Station (south of Iran) in 2005 and 2006. Station soil was naturally infested with Verticillium wilt. Six cultivars of cotton (*Gossypium hirsutum* L.) were evaluated for resistance to Verticillium wilt. The experimental traits were randomized complete block With 4 replications. Cultivars included: Varamin, Crema, Deformeh leaf, 818, Bakhtegan and B-557.

Disease percent, index and severity were determined four months after cultivation. Disease Severity (DS) and index (DI) calculated with formula.

$$DS = \frac{(A\times O)+(B\times 1)+(C\times 2)+(D\times 3)+(E\times 4)}{M}$$

Where A, B, C, D, E and M refer, respectively

A=plant No. with degree 0
B=plant No. with degree 1
C=plant No. with degree 2
D=plant No. with degree 3
E=plant No. With degree 4
M=total plant No .

Verticillium wilt degrees of every plant were assessed from 0 to 4 using the following degree (Booth, 1970).

0=No symptoms
1= Chlorosis of few leaves at the bottom of plant, without leaf defoliation.
2=Chlorosis of many leaves up to the top of the plant, associated with defoliation lesser than 50% of leaves and buds.
3=Chlorosis and marginal necrosis of leaves and defoliation more than 50% of leaves and buds.
4=Necrosis of the whole lamina, whole defoliation, dead plant.
DI= Disease percent×Disease severity

Data were analyzed by using of the statistical method adapted by Gomez and Gomes (Gomez and Gomez, 1984). Mean comparion were achived by Duncan's Multiple range test using. MSTATC soft ware.

RESULTS AND DISCUSSION

Analysis of variance showed that disease severity was significantly different in 2005 and 2006 (Table1). Results were demonstrate climate changed *Verticillium* severity and virulance of the pathogen was increased by favourable weather conditions. Disease percent and index were not significant in 2 years of experiment. Climate did not change Verticillium wilt percent (Table1). Year × cultivars interaction was significant for percent, severity and index of Verticillium wilt at p=0.01.All cultivars were showed reaction to year (climate) and tolerant cultivars were infected in favourite year. Cultivars were infested with *Verticillium* but percent and severity of wilt disease of susceptible cultivars were increased (Table1).

The percentage and the severity of infestation depend on the environmental factors as well as cultivar and stage of plant growth. As temperature between 22 and 27°C and excessive soil moisture favour disease, there are great differences between years as well as within the same cultivar and growing period (Basset 1974; Friebertshauser and DeVay 1982, Gutierrez *et al.,*1983).

Results showed that Varamin had the most disease percent (85.63%) and this cultivar had the greatest infected plant. Otherwise, Bakhtegan, 818 and B-557 had the least disease percent (29.38, 23.75 and 20% respectively) and they had the least infected plants (Table2).

Varamin had the highest disease severity. The most of plants were infected to degree 3 and 4.Vascular penetration of *Verticillium* was increased in Varamin cultivar. Probably, *Verticillium* fungus decreased seed cotton production (yield) (Table 2). Cultivars with moderate to high levels of resistance to Verticillium wilt have also been developed in several countries: Sahel in Iran (Moshirabadi, 1998) Albar G501 in Zimbawe (Hillocks, 1991) and Zhong Mein12, 8004, 8010 and Laoyang 5 in China (Shen, 1985).

Bakhtegan, 818 and B-557 had the lowest disease severity (1.45, 1.625 and 1.425respectively).Penetration *Verticillium* fungus to vascular was least and the most of plants had disease degree 1 and 2. Seedling of *Verticillium* tolerant cotton cultivar Acala 4852 were subjected to chilling at 10°C. Radicle exudates were taken after 2-5 days. Disease severity increased significantly with increase of amino acids and sugars exudation, while top dry weight decreased also significantly (Shao and Christiansen, 1982).

Varamin had the most disease index (278) and was the most susceptible to wilt disease. Bakhtegan, 818 and B-557 had the least disease index (45.69, 39.88 and 32.13 respectively).

Table 1. Analysis of variance on Verticillium wilt percent, severity, index and yield in 2005 and 2006

		Meansquare			
Source	df	***Verticillium* percent**	***Verticillium* serverity**	***Verticillium* index**	**Yield**
Year	1	133.333	0.682*	928.4	440641.688
Error	3	115.278	0.063	836.851	139611.743
Cultivars	5	4773.333**	3.707**	69649.57**	2189000.438**
Year×cultivars	5	463.333**	0.227**	2026.318**	194856.438
Error	30	79.167	0.038	630.112	116263.271
Cv(%)		21.35	10.22	26.63	10.49

*p<0.05 and **p<0.01

Table 2. Data means of Verticillium wilt and yield separated by Duncan's multiple range test

Cultivars	*Verticillium* percent	*Verticillium* severity	*Verticillium* index	Yield (kg/ha)
Varamin	85.63a	3.237a	278a	2780cd
Crema	51.88b	1.904b	99.68b	3285bc
Deformeh leaf	39.38c	1.744b	70.28bc	2404d
818	23.75d	1.625bc	39.88cd	3583ab
Bakhtegan	29.38cd	1.45c	45.69cd	3789a
B-557	20d	1.425c	32.13d	3575ab

Within columns, numbers followed by the same letters are non significantly different

These cultivars were resistance to *Verticillium* disease (Table2). Modern cultivars such as the Acola's released recently from California and New Mexico, as well as the pima's *G.barbadense* are highly resistant to *V.dahdiae*. Other upland cultivars such as paymaster HS-26, Deltapine5690 and Stoneville495 have moderate resistance to Verticillium wilt (Zhang and Percy, 2007).

In the combination of R×S, R×R cross progeny of upland cotton, each combination showed 3R: 1S to *Verticillium dahliae*. After F1 back crossing with the resistant parent, progenies from many combinations were 1R:1S, and the progenies from combination of R×R were resistant. Therefore the cotton varietal resistance to *Verticillium* was thought tobe controlled by multiple dominant gene (Kuai and Pan, 1987). major dominant gene, but it is also possible of the different gens reciprocity (Pan *et al.,*1994) and it is a quantitative inheritances in which the additive effect is most important and the dominat effect is second (Wang *et al.,* 1989).

Bakhtegan, 818 and B-557 (3789, 3583 and 3575 kg/ha, respectively) were recorded the highest yield. Resistant cultivars had higher yield comparing with other cultivars. Marani and Yacobi (1976) planted the same cotton genotypes in infested and not infested fields with *V.dahliae* and difference of yield for each genotype at the two locations indicated yield loss by Verticillum wilt also resistant and susceptible cultivars indicated 31 to 45% varation in yield.

REFERENCES

Alyamov A. and A.G. Kas yanenko. 1980. Selection for wilt resistance and other useful characters in forms of Afroasian cotton species. Ahboroti Akademijai fanhoi Rss Togikiston su bui fanhi Biological, 3: 104-108 (in Russian).

Basset D.M. 1974. Resistance of cotton cultivars to Verticillium wilt and its relation to yield. Crop Science, 14:864-867.

Bolek Y., A.A. Bell, K.M. El-Zik, P.M. Thaxton and C.W. Magill. 2005. Reaction of cotton cultivars and an F2 population to stem inoculation with isolates of *Verticillium dahliae.* Journal of Phytopathology, 153: 1-5.

Booth J.A. 1970.*Verticillium albo-atrum*. In:Chiarappa, L. (Ed.), Crop loss assessment methods: FAO manual on the evaluation and prevention of losses by pests, diseases and weeds.Commonwealth Agriculture Bureaux., Farnham Royal, UK, pp.50-51.

Chen Z.S., J.H. Lu, S.F. Wang, M.R. Li and Y.M. Wang. 1980. Evaluation of cotton germplasm resources resistant to Verticillium wilt in the field. Cotton, 3:25-28(in Chinese, with English abstract).

Friebertshauser G.E. and J.E. DeVay. 1982. Differential effects of the defoliating and nondefoliating pathotypes of *Verticillium dahliae* upon the growth and development of *Gossypium hirsutum*. Phytopathology, 72: 872-877.

Gomez K.A., A.A. Gomez. 1984. Statistical Procedures for Agricultural Research.2. A Wiley-Interscience Publication, John Wiley and Sons,New York.

Gore M.E., K.O. Caner, N. Altin, M.H. Aydin, O. Erdogan, F. Filizer and A. Buyukdogerlioglu. 2009. Evaluation of cotton cultivars for resistance to pathotypes of *Verticillium dahliae*. Crop protection,28: 215-219.

Gutierrez A.P., J.E. DeVay, G.S. Pulman and G.E. Friebertshauser. 1983. A model of Verticillium wilt in relation to cotton growth and development. Phytopathology, 7:89-95.

Heale J.B. 1988. *Verticillium* spp. the cause of vascular wilts in many species. Advances in Plant Pathology, 6:291-312.

Hillocks R.J. 1991. Screening for resistance to Verticillium wilt in Zimbabwe. Tropical Agriculture, 68: 144-148.

Hillocks R.J. 1992. Cotton Diseases. CAB International Wallingford. UK.

Jian GL., C. Ma, CL. Zheng and YF. Zou. 2003. Advances in cotton breeding for resistance to Fusarium and Verticillium wilt in the last fifty years in China. Agricultural sciences in China, 2:280-288.

Kuai B.K. and J.J. Pan. 1987. The primary studies on the inheritance of resistance to *Verticillium dahliae* in Cotton.In:Wang,Z., Chang, X.(Eds.), Basic Research on cotton Breeding. Proceedings of symposium,21-24 September 1987, Beijing, China. Beijing Academic Periodical Press, 59-64(in Chinese, with English abstract).

Marani A. and Y.Z. Yacobi. 1976. Evaluation of Verticillium wilt tolerance in Upland cotton relative to lint yield reduction. Crop Science,16:392-395.

Moshirabadi H. 1981. Veticillium dahliae Kleb. In Iran. Proceedings of the third International *Verticillium* Symposium, 25-28 August 1981, Bari, Italy, pp. 46.

Moshirabadi H. 1998. Development of genotypes that are tolerant to Verticillium wilt in Iran. Proceedings of the second World Cotton Research Conference, 6-12 September 1998, Athens, Greece,pp.950-951.

Pan J.J., T.Z. Zhang, B.K. kuai, X.P. Guo and M. Wang. 1994. Studies on the inheritance of resistance to *Verticillium dahliae* in cotton. Journal of Nanjing Agricultural University, 3:8-18(in Chinese, with English abstract).

Shao F.M. and M.N. Christiansen. 1982. Cotton seedling radicle exudates in relation to susceptibility to Verticillium wilt and Rhizoctonia root rot. Journal of Phytopathology,105: 351-359 .

Shen C.Y. 1985. Integrated management of Fusarium and Verticillium wilts of cotton in China. Crop Protection, 4:337-345.

Singh P. 1998. Cotton Breeding. Kalyani Publishers , India.

Wang Z.S., Z.Y. Ma and J.M. Qu. 1989. Analysis of gene effect of resistance to Fusarium and Verticillium wilts in Upland cotton. Journal of Hebei Agricultural University, 12: 21-25(in Chinese, with English abstract).

Wilhelm S.1955. Longevity of Verticillium wilt fungus in the laboratory and in the field. Phytopathology, 45: 180-181.

Zhang J. and R.G. Percy. 2007. Improving Upland cotton, *Gossypium hirsutum* by introducing desirable genes from G. barbadense. Proceedings of the fourth World Cotton Research Conference, 10-14September 2007, Lubbock, Texas, USA, pp.19.