REPUBLIC OF TURKEY
MINISTRY OF FOOD, AGRICULTURAL AND LIVESTOCK
GENERAL DIRECTORATE OF AGRICULTURAL RESEARCH AND POLICY

SCREENING OF COTTON GENOTYPES AGAINST VERTICILLIUM WILT DISEASE

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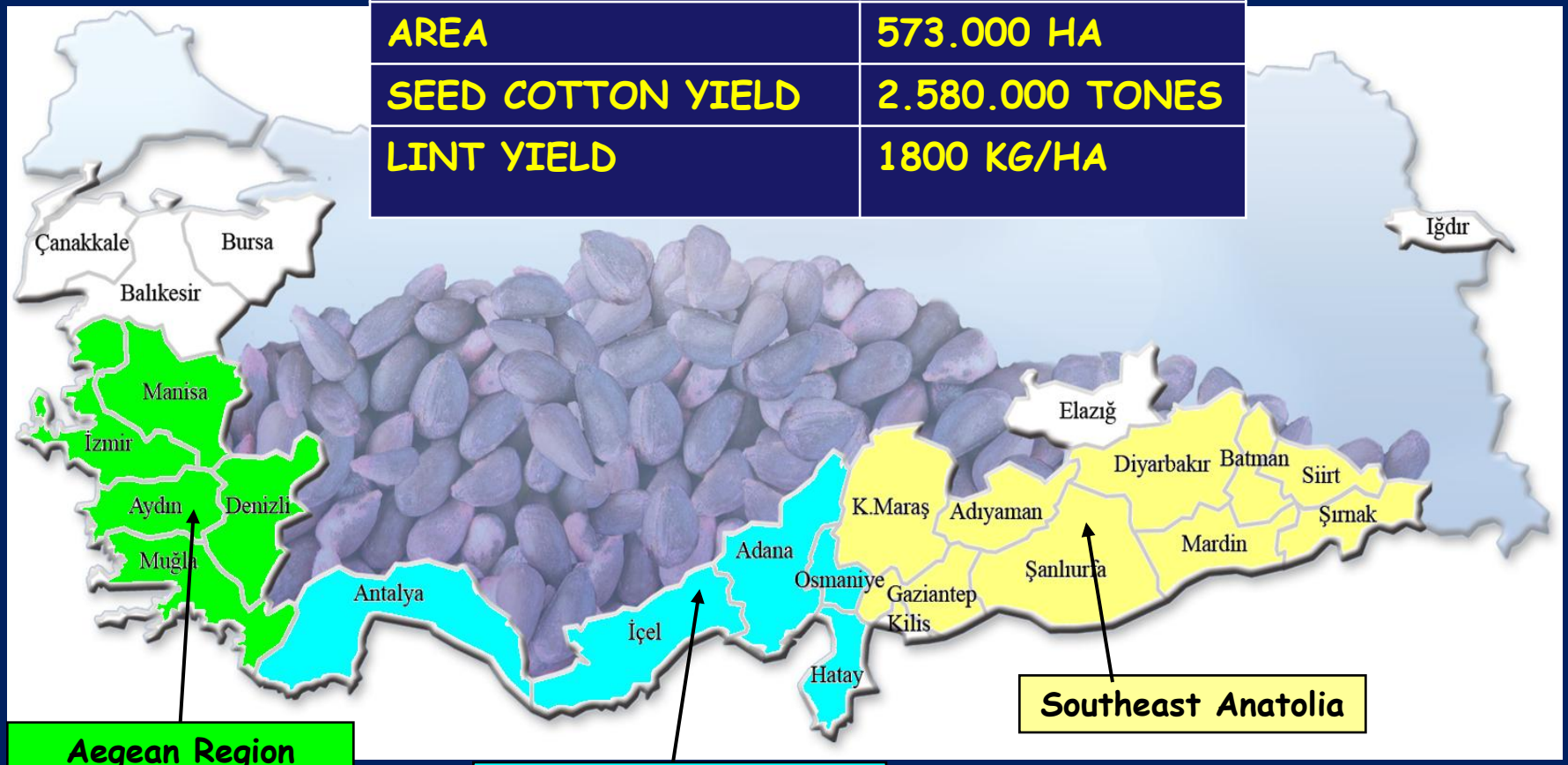
CONTENTS

- INTRODUCTION
- VERTICILLIUM WILT DISEASE
- SCREENING of COTTON GENOTYPES AGAINST VERTICILLIUM WILT
  - Greenhouse Trials
  - Field Trials

- Cotton (*Gossypium hirsutum* L.) is used for yarn, cloth, and the ready-made clothing industry etc.
- In 2009-2010, Turkey represented 3.5% of total cotton production, 6% of total cotton consumption, and 8% of total cotton imports in the world.
- Turkey is the seventh largest producer in the world, the fourth largest consumer, and the second largest in imports (Anonymous, 2010a).
- In Turkey, Upland cotton has annually been grown nearly in 495.000 ha and 450.000 mt and is grown under irrigation in three main regions including Southeastern Anatolia, Aegean and Mediterranean (Fig 1).

COTTON PRODUCTION AREAS IN TURKEY

TOTALLY	
AREA	573.000 HA
SEED COTTON YIELD	2.580.000 TONES
LINT YIELD	1800 KG/HA



➢**Cotton has long bearing period and the habit of growing infinitely.**

➢**In the lengthy bearing period of cotton, it is often damaged by various plant diseases and insect pests.**

At Present yielding condition,

❖**The economic loss of cotton will be 5 %-15 % due to plant diseases and insect pests.**

❖**If no prevention and control measure is taken, the loss can be 30 %-50 %.**

❖**A few plant diseases and insect pests can cause the loss of above 80 %.**

✓Verticillium wilt incited by the soil inhabiting fungus Verticillium dahliae Kleb., is found in many regions of the world where cotton is produced, and it can cause substantial yield losses.

✓**Verticillium wilt was first reported in 1914 in Virginia (Carpenter, 1914), and first recognized as an economically important disease of cotton in 1927 in Tennessee (Sherbakoff, 1928).**

✓**It has been recognized as one of the major diseases of cotton in many cotton producing countries: Australia, Brazil, Bulgaria, China, Greece, Peru, Turkey, Uganda, USA and Uzbekistan (Adair, 1996).**

✓**Yield losses in the USA have ranged from 0.75 to 2.78% during the past 20 years (National Cotton Council, 1980–1999), and losses in other parts of the world have been as high as 30% (Bell, 1992).**

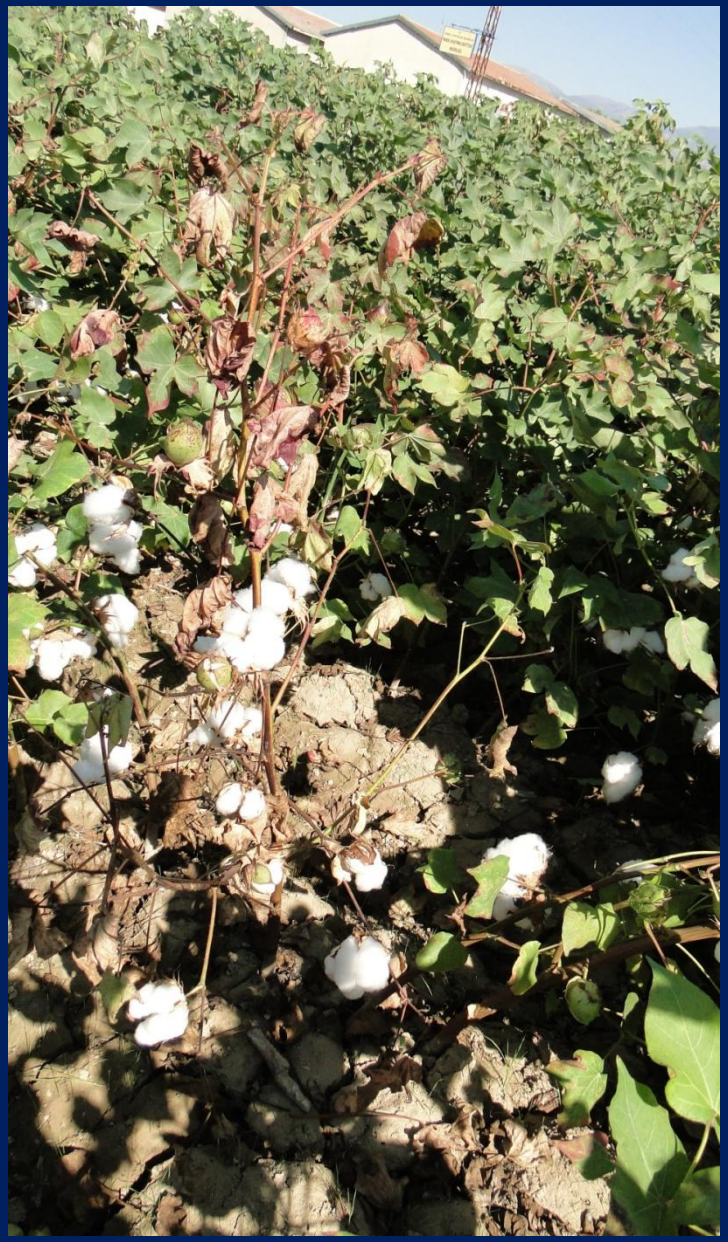
✓**The report of the Cotton Disease Loss Committee for the 2003 crop indicated that losses across the cotton belt averaged 0.42% with an estimate yield loss of 71.687 bales (Blasingame and Patel, 2004).**

✓**The severity of Verticillium wilt depends upon the inoculum density, virulence of the pathogen, the cultivar (genetic constitution, age and physiological condition), temperature, soil conditions (pH, moisture and nutrient availability) and biological antagonists (Bell, 1993).**

✓**An integrated management system is necessary to minimize losses from the disease (El-Zik, 1985). Genetic resistance can be selected within adapted desirable cultivars with a suitable breeding programme.**

✓**Modern Upland cultivars, such as Acala Maxxa, Acala Prema, Acala Royale, as well as *Gossypium barbadense* and Pima cultivars, are highly tolerant to wilt, while Deltapine 20, Deltapine 51, Deltapine 5690, Stoneville 495, Hyperformer HS-23 and Paymester HS-26 (*G. hirsutum*) have moderate tolerance and effectively control disease in areas where inoculum density is moderate (Bell, 1999).**

Verticillium Wilt (*Verticillium dahliae* Kleb.)

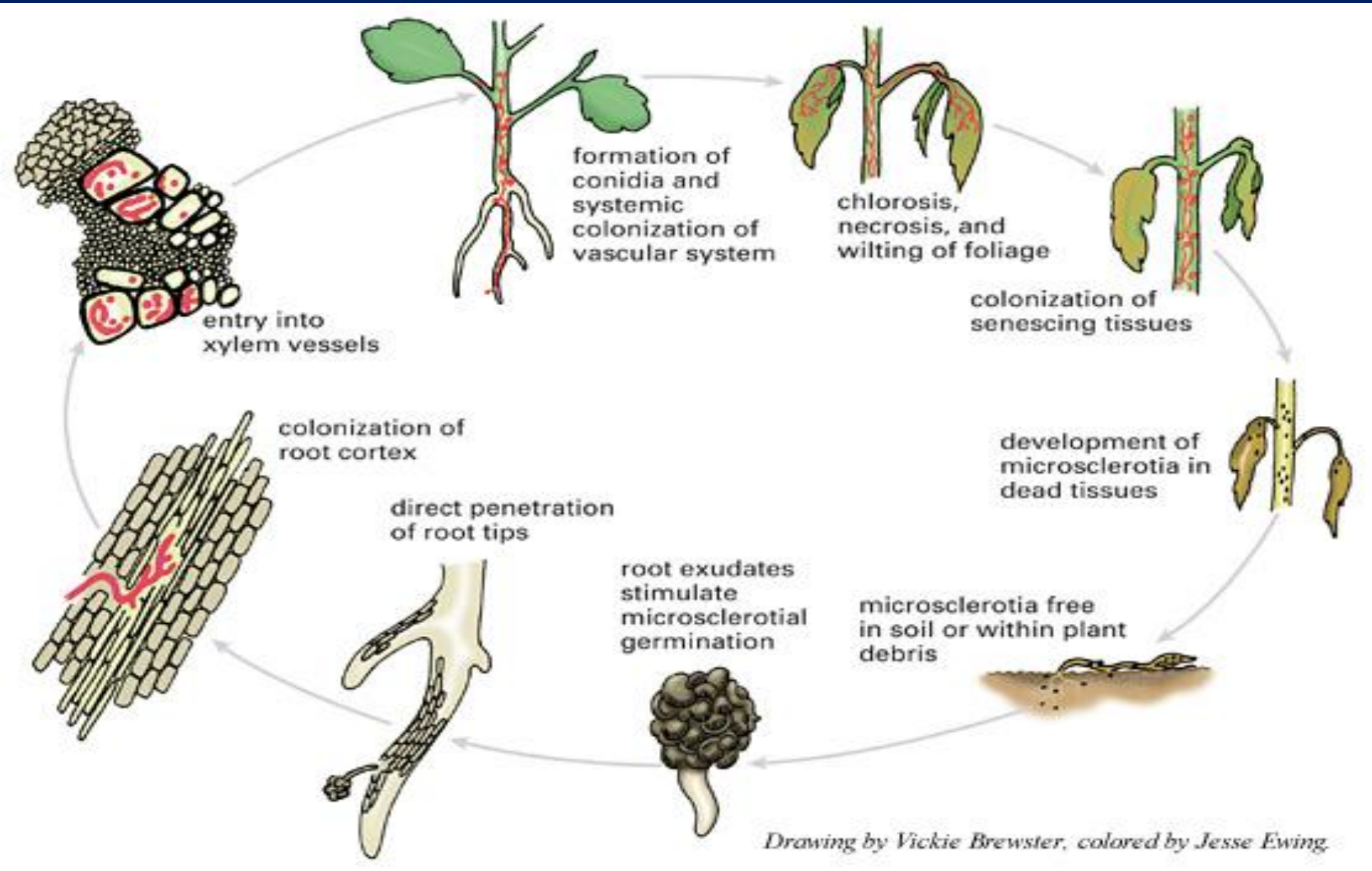


❖ **Verticillium wilt, caused by the soil-inhabiting fungus *Verticillium dahliae* Kleb. is one of the most important diseases of cotton and causes great economic losses.**

❖ **The disease is most severe during cool to warm weather, but not as prevalent in hot weather.**

❖ **The life cycle of *V. dahliae* can be divided into dormant, parasitic, and saprophytic stages (Schnathorst, 1981; Anonymous, 2000).**

❖ **The fungus has a wide host range can survive in the roots of many weed species (Wei et al., 1998; Bhat and Subbaro, 1999; Du Toit et al., 2005; Naraghi et al., 2007)**



Life Cycle of *Verticillium dahliae* Kleb. on Cotton

✓Symptoms of infection appear as necrotic areas on leaves, wilting and usually discoloration of the vascular tissue. Severely affected plants shed all their leaves and most of their young bolls. (Presley, 1953).

✓The leaves appear darker green compared to those of a normal plant and become somewhat crinkled between the veins. Cholorotic and necrotic mottling are especially apparent on the older leaves and less severe on younger ones.

✓ The fungus produces toxins that cause tyloses or gums to form in the vascular tissues, resulting in a greatly decreased flow of water from the roots to the foliage.

Cholorotic and necrotic mottling between the main veins and on margins of a cotton leaf

(left) Healthy cotton stem, (right) dark brown vascular discoloration in cotton stem

Classic Verticillium Wilt symtomps

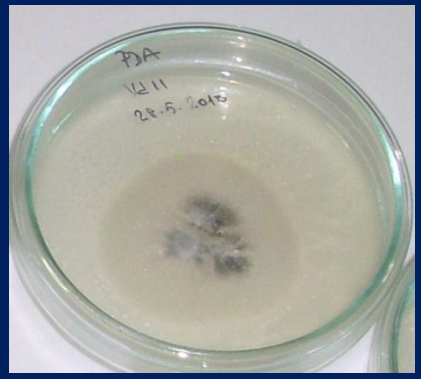
Control Measures

- ✓ **Growing adapted resistant cultivars**
- ✓ **Crop Rotation (corn, wheat, soybeans, clover etc.)**
- ✓ **Balanced fertilization and irrigation**
- ✓ **Control of weeds**
- ✓ **Sanitation**
- ✓ **Deep plowing**
- ✓ **Biological control (*Bacillus* spp., Fluorescent Pseudomonads, *Trichoderma* spp.**

Screening of Cotton genotypes against Verticillium Wilt

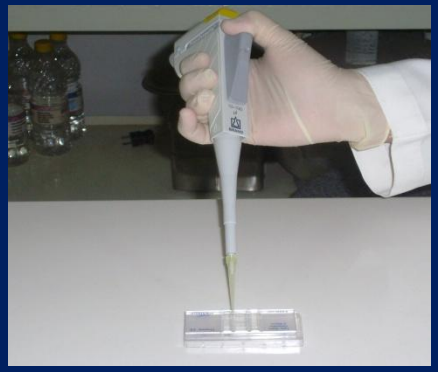
Greenhouse Trials

- **Cotton Genotypes were determined susceptibility to Verticillium wilt disease with conidia suspension method.**
- **Each cultivars was replicated six times in a randomized complete design.**



Conidia of 14-day-old PDA plates

Tween 80 (little drop)



Thoma Lam

4x10^{6} conidia/ml

Prepared conidial suspension

5 ml drop of the conidial suspension

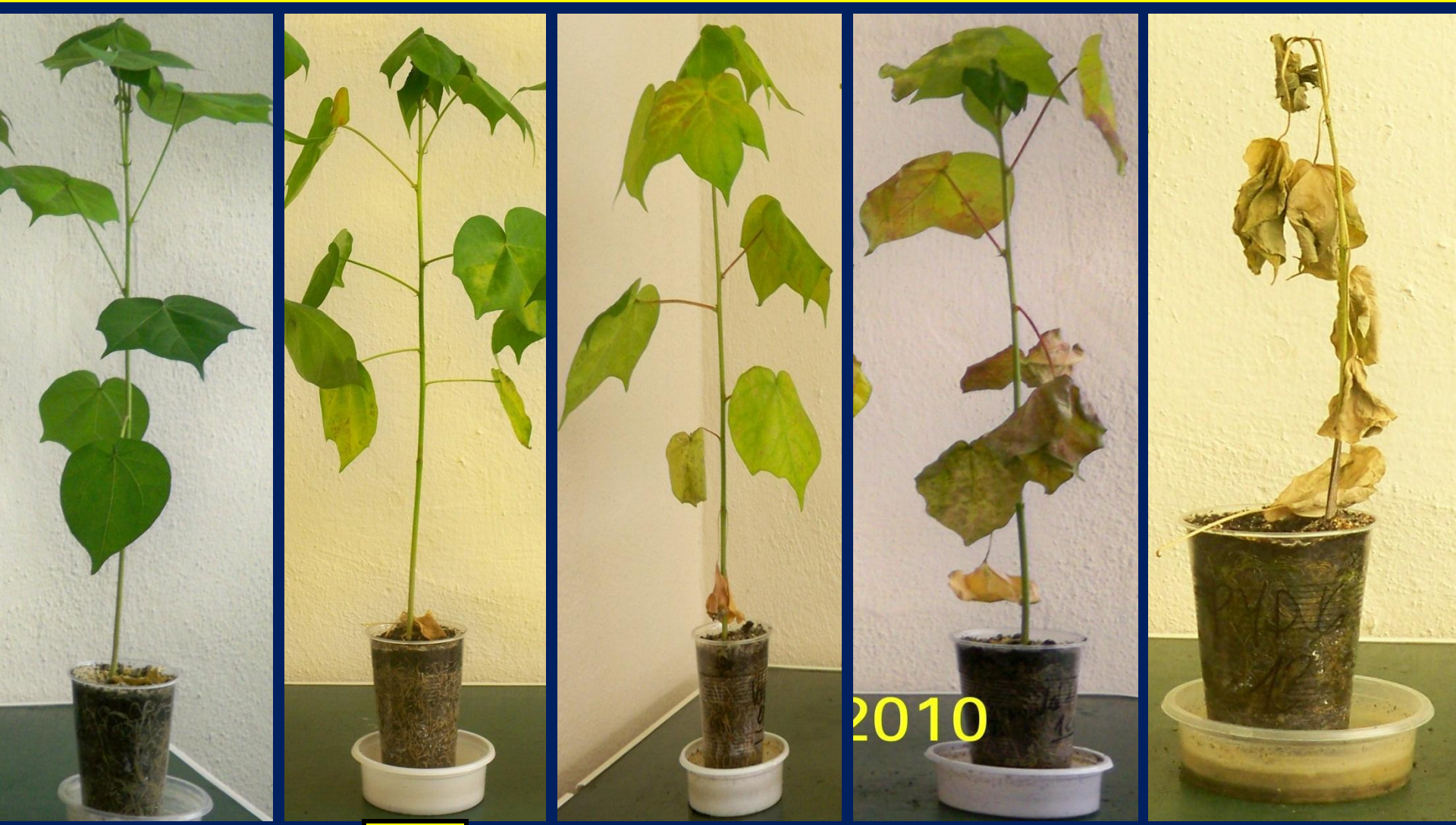
Plastic pots (250 ml)

Plants at the four-true-leaf stage

Inoculated by roots through a 5 ml drop of the conidial suspension in the plastic pots.

➢**Plants were incubated at 25 ± 2ºC with a 14-h photoperiod and fertilized once a week with liquid fertilizer.**

Three weeks after inoculation, disease severity was assessed for each plant on a 0-to-4 rating scale according to the percentage of foliage affected by acropetal chlorosis, necrosis, wilt, and/or defoliation (0 = healthy plant; 1 = 1–33%; 2 = 34–66%; 3 = 67–97%; 4 = dead plant) (Bejarano-Alcazar et al., 1995).(Bejarano-Alcazar ve ark., 1995).



0 1 2 3 4

Field Trials

- Verticillium wilt in each sampled plot was assessed two times each year during the period beginning early September and ending mid-October, in the 5–10% and 50–60% of the bolls open stage.
- At each recording date, each individual plant was examined for the foliar symptoms of wilt and the disease severity was estimated for each plant using the same scale as previously described.
- The experiments will be arranged as a randomized block design with four replications. Each plot will be consisted of four rows of 12 m length, row spaces between and within are 70 cm and 20 cm respectively.

- **Disease severity was assessed for each plant on a 0-to-4 rating scale according to the percentage of foliage affected by acropetal chlorosis, necrosis, wilt, and/or defoliation (0 = healthy plant; 1 = 1–33%; 2 = 34–66%; 3 = 67–97%; 4 = dead plant) (Bejarano-Alcazar et al., 1995).**

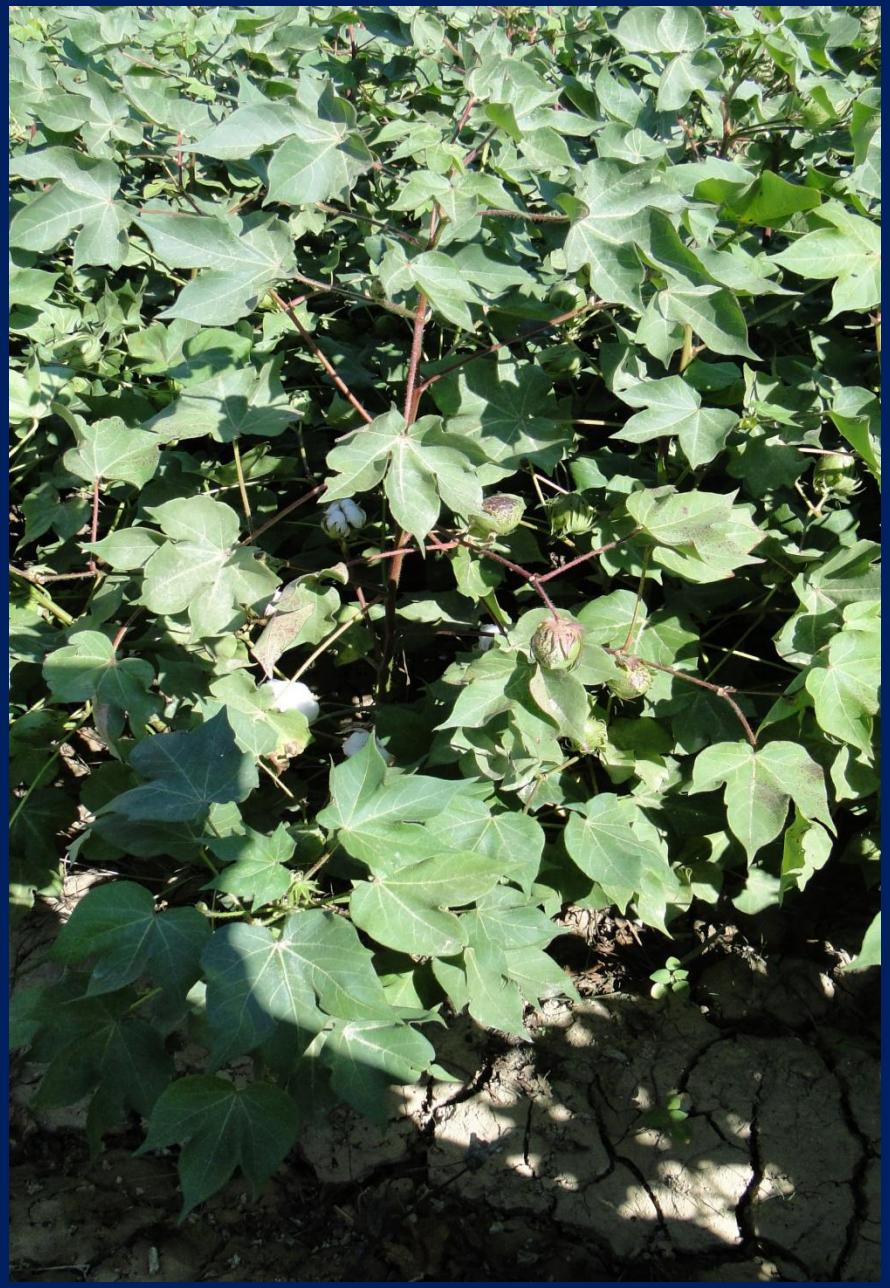
- **Disease index calculated with Formula (Karman, 1971).**

✓**Index Formula= (Ax0)+(Bx1)+(Cx2)+(Dx3)+(Ex4)/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

0-4 Verticillium Wilt Scale in Cotton Leaf



0: healthy plant

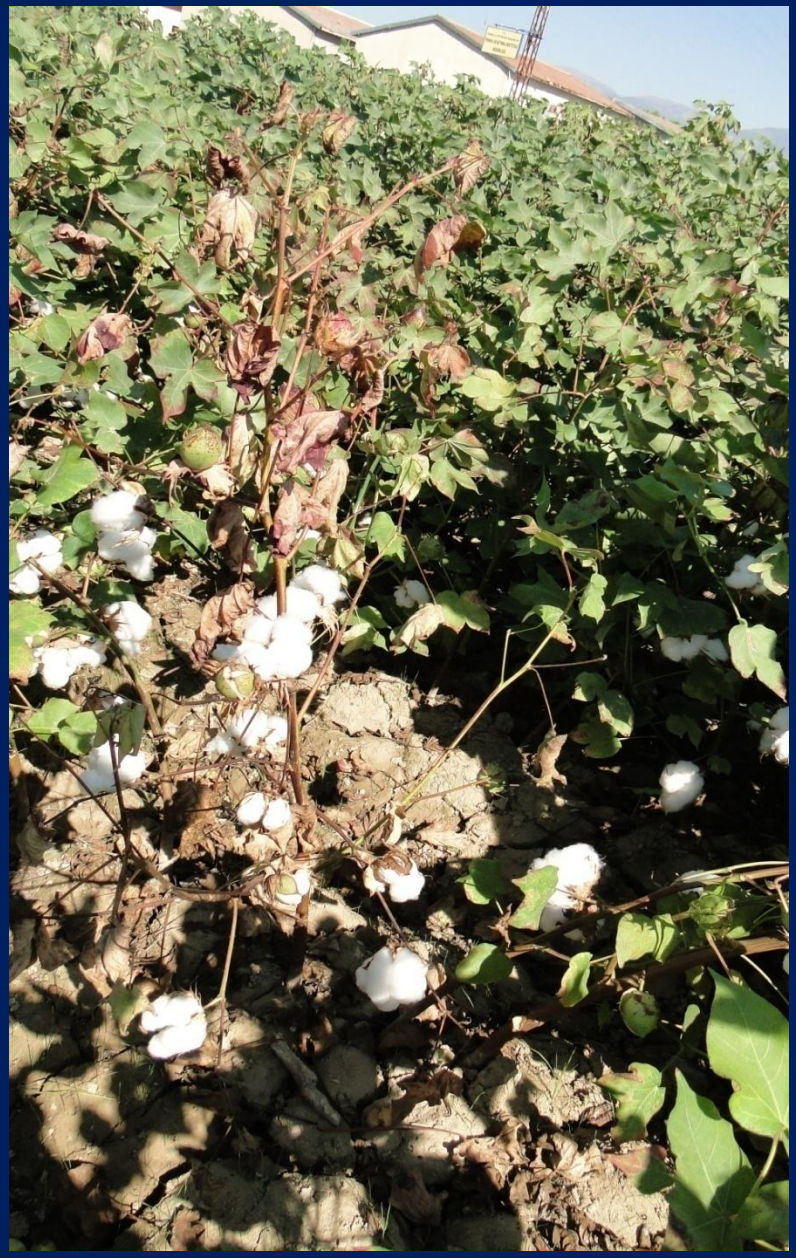
0-4 Verticillium Wilt Scale in Cotton Leaf

1: % 1-33 disease symptom of cotton plant

0-4 Verticillium Wilt Scale in Cotton Leaf

2: % 34-66 disease symptom of cotton plant

0-4 Verticillium Wilt Scale in Cotton Leaf

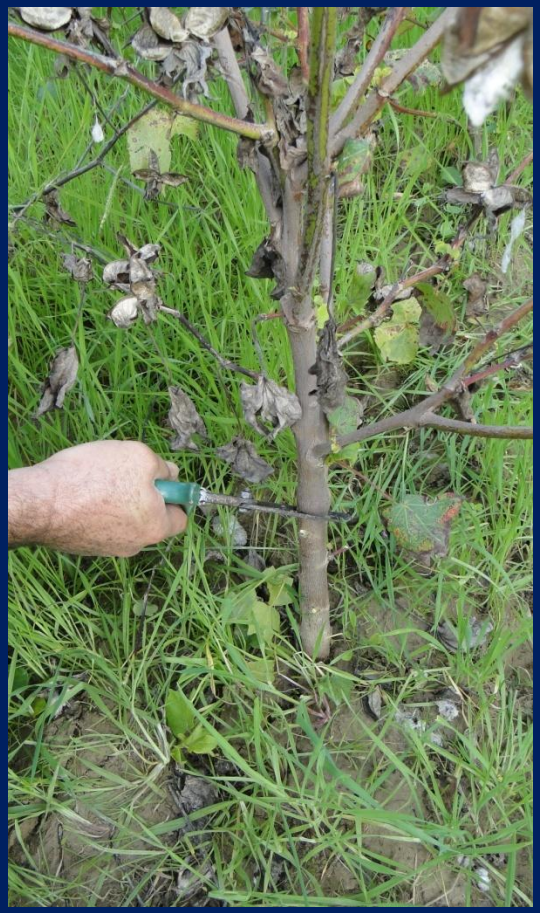


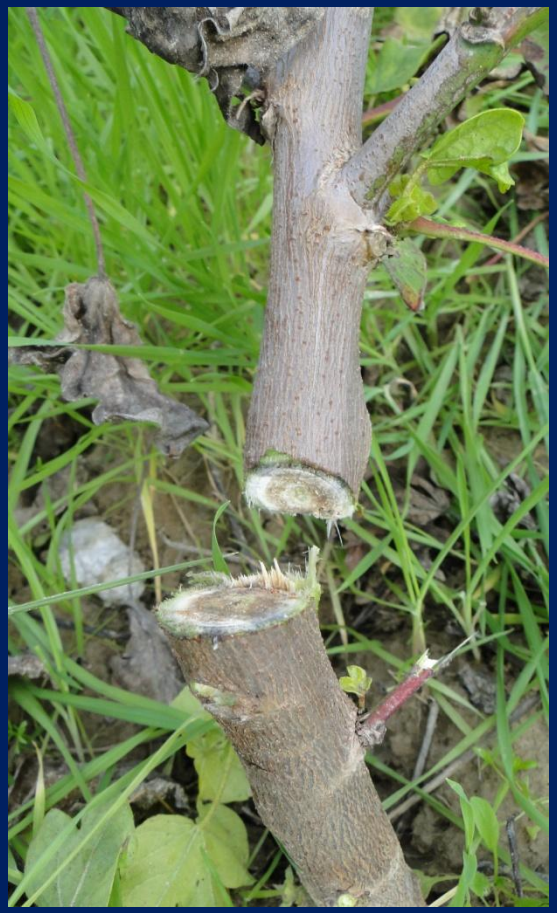
3: % 67-97 disease symptom of cotton plant

0-4 Verticillium Wilt Scale in Cotton Leaf

4: dead plant

➢At harvest, the main stem of each plant was cut near the ground at a height of about 10 cm.





Plants were rated on a scale of 0–3 for severity and pattern of vascular discolouration (0= no discoloration of a cross section of xylem tissue; 1= 1-33 % of xylem discolored; 2= 34-67 % discolored; and 3= 68-100 % discolored) (Buchenauer ve Erwin, 1976).

➢ **Disease index calculated with Formula (Karman, 1971).**

✓ **Index Formula= (Ax0)+(Bx1)+(Cx2)+(Dx3)/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,

M= Total plant no

➢ **Data were subjected to analysis of variance with the general linear models procedure of JMP statistical software (Mac version 7.0.2, SAS Institute, Cary, NC, for Macintosh computer).**

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