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"Screening of chilli (*Capsicum annuum* L.) genotypes for morhpological characteristics showing resistance against *Fusarium* wilt"

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Abstract
The present investigation was undertaken with an objective to screen thirteen chilli genotypes (two resistant checks; DCL 524 and CCA 4261, two susceptible checks; Punjab Surkh and Punjab Guchedar and nine advanced lines; Sel-7, Sel-11, Sel-36-1, Sel Dev, PC-6, VR-16, C-31-1, ACC-33-1 and Mehma Sarja) against *Fusarium* wilt to evaluate morphological characteristics in relation to resistance/ susceptibility to this disease at two stages of crop development i.e. 10 DAT and 105 DAT. The morphological characters viz. root length, root girth, fresh and dry weight of root and leaf were more in resistant genotypes whereas number of roots were more in susceptible genotypes at both stages. On the basis of above studies, five advanced lines viz. ACC-33-1, C-31-1, Sel-7, Sel-36-1 and VR-16 were categorized as chilli genotypes resistant to *Fusarium* wilt.

Keywords: Chilli, *Fusarium* wilt, Resistant, Susceptible, Morphological parameters.

1. Introduction
Chilli (*Capsicum annuum* L.) belongs to family Solanaceae and has domesticated in South and North America. It is an important vegetable and spice crop worldwide and plays a significant socio-economic role. The pool of chilli cultivars comes from five species of the genus Capsicum: *C. annuum*, *C. chinense*, *C. baccatum*, *C. frutescens* and *C. pubescens*. Chilli is important because of its pungency and colour. The two features commonly used in the classification are pod types (shapes, size, colour and texture) and pungency. Pungency in chilli is due to the presence of capsaicinoids in the pod. India is the major producer, exporter and consumer of chilli (Prasad and Saini 2004). The area occupied under chilli is 8.92 lakh hectares with production of 9.21 lakh tones. In Punjab, area under chilli cultivation is 9.88 thousand hectares with 15.89 thousand tones of production (Mahindra and Kolar 2011) [5].
Plants being sessile organisms are exploited as a source of food and shelter by a wide range of parasites including bacteria, fungi and viruses (Gachomo *et al.* 2003) [4]. Chilli is no exception and a fungal pathogen that invades chilli is *Fusarium* spp. and causes *Fusarium* wilt. Healthy plants can become infected by *Fusarium oxysporum* if the soil in which they are growing is contaminated with fungus. The fungus can invade the plant with its sporangial germ tube or mycelium by invading the plant roots. The roots can be infected directly with the root tips, through wounds in the roots or at the formation point of lateral roots. Once inside the plant the mycelium grows through the root cortex intercellulary. When the mycelium reaches the xylem it invades the vessels through the xylem's pits. Due to the growth of fungus within the plant's vascular tissue, the plant water supply is greatly affected. This lack of water induces the leaves stomata to close, the leaves wilt and the plant eventually dies (Agrios 1988) [1].
In compatible plant-pathogen interactions resistance mechanisms may be activated slowly to be effective or be suppressed by the invading pathogen and in induced tissue balance may be shifted in favour of the plant. Thus even in seemingly non-resistant plant, a certain level of resistance may be extend or triggered and this may be enhanced when resistance induced by primary infection. The level of basis of resistance may simply not be sufficient to halt infection and prevent extensive tissue colonization and symptom development. Often defense mechanisms are found to be activated late in infection when the plant can no longer be

benefited from these activities because the pathogen has already colonized the tissue. An earlier and quicker response of plant can be effective in limiting tissue colonization (Van Loon 1997) [6].

A detailed understanding of individual components that define the molecular and genetic basis of defense response of host to *Fusarium* wilt and intimate understanding of technology to study these mechanisms is necessary first step towards complete and durable disease resistance. So it is important to study the host-parasite interaction at morphological levels which may lead to better understanding of molecular mechanisms of disease resistance in plants. The present study was planned to screen chilli genotypes against *Fusarium* wilt which will led to better understanding of various defense mechanism with the following objective:-

- Assessment of variability in leaf morphology in chilli genotypes.
- Assessment of variability in root morphology of chilli genotypes.

2. Material and Methods

The thirteen genotypes of chilli (*Capsicum annuum* L.) i.e. two resistant checks, two susceptible checks and nine advanced lines were raised in randomized block design and studied. For morphological studies, five plants from each genotype were randomly selected and tagged. Morphological characteristics were studied at two stages of crop development i.e. at 10 and 105 DAT (i.e. days after transplanting).

2.1 Number of roots

Five plants from each replication of each genotype were selected and number of roots was counted and their average was recorded.

2.2 Root length

Five plants from each replication of each genotype were selected and root length measured and their average was recorded (cm).

2.3 Root girth

Five plants from each replication of each genotype were selected and root girth was measured and their average was recorded (cm).

2.4 Fresh and Dry weight

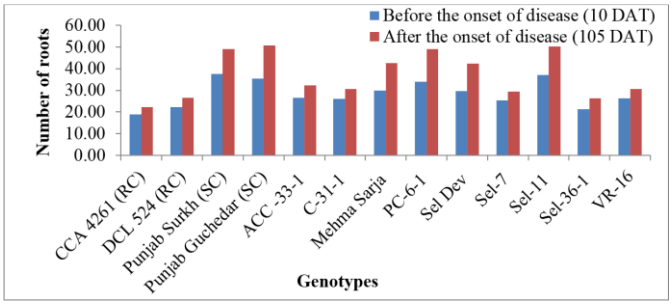
Five plants from each replication of each genotype were selected and fresh and dry weight of leaf and root was taken and their average was recorded (gm).

3. Results and Discussion

These genotypes were screened on the basis of morphological parameters showing resistance against fungal disease at two stages of crop development i.e. (i) at seedling stage (10 DAT i.e. days after transplanting) and (ii) at the onset of diseased stage (105 DAT). The studies were carried out for root and leaf at both the stages. The results obtained in present study have been discussed in this chapter under the following headings.

3.1 Number of roots

The data for number of roots is presented in Figure 1. The root number was significantly higher in susceptible genotypes as compared to the resistant ones at 10 DAT. After the onset of disease i.e at 105 DAT, the percent increase in number of roots were more in susceptible genotypes and ranged between 23.13-30.26% whereas in resistant genotypes this increase was less and ranged between 14.93-16.25%. In all other advanced lines, increase in root number was less in ACC-33-1, Sel-7, C-31-1, Sel-36-1 and VR-16 which was quite comparable to resistant genotypes. The increase in root number was higher in Mehma Sarja, Sel Dev, PC-6 and Sel-11 which were comparable to susceptible genotypes.



RC-resistant checks, SC-susceptible checks

Fig 1: Variation in number of roots of chilli genotypes in relations to *Fusarium* wilt at two stages of crop development.

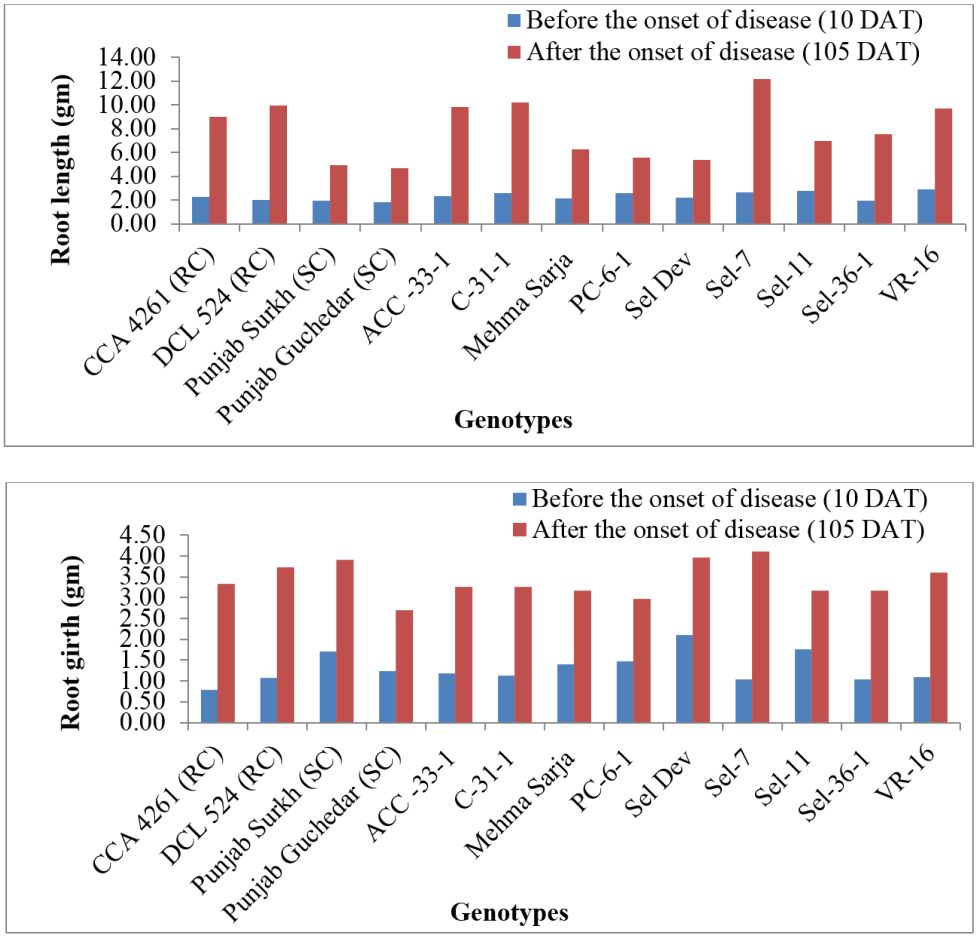
3.2 Root length (cm)

Root length at 10 and 105 DAT (Figure 2) was more in resistant genotypes as compared to susceptible genotypes (Punjab Surkh and Punjab Guchedar). The percentage increase in root length was more in resistant as compared to susceptible genotypes at both the stages. In the other advanced lines, the percentage increase in root length was more in ACC-33-1, Sel-7, C-31-1, Sel-36 and VR-16 and was more comparable to resistant genotypes. In Mehma Sarja, Sel Dev, PC-6 and Sel-11 recorded less percentage increase in root length and were comparable to susceptible genotypes.

3.3 Root Girth (cm)

The data for root girth is presented in Figure 3. The root girth was recorded more in susceptible genotypes as compared to the resistant ones at 10 DAT but after the onset of disease i.e. at 105 DAT, the percent increase in root girth was more in resistant genotypes and ranged between 71.43-76.40% whereas in susceptible genotypes this increase was less and ranged between 54.57-56.41%. resistant as compared to susceptible genotypes at both the stages.

In all other advanced lines, increase in root girth was higher in ACC-33-1, Sel-7, C-31-1, Sel-36-1 and VR-16 which was quite comparable to resistant genotypes whereas increase in root girth was lower in Mehma Sarja, Sel Dev, PC-6 and Sel-11 which was comparable to susceptible genotypes.



RC-resistant checks, SC-susceptible checks

Fig 2: Variation in root length and root girth (cm) of chilli genotypes in relations to *Fusarium* wilt at two stages of crop development.

The reduction in growth characteristics was significant and differed among four melon (*Cucumis melo* L.) cultivars. These findings were consistent with those reported by Bletsos *et al.* (1999b) [3] for the same cultivars grown on peat moss and inoculated with *Verticillium dahliae* and *Fom.* The greater reduction in plant height, main stem diameter and above-ground fresh and dry weight of winter melon compared with summer melon could be due to greater damage to the root system, as indicated by the lower root fresh weight of seedlings infected with *Verticillium* and *Fusarium*, as compared with the controls.

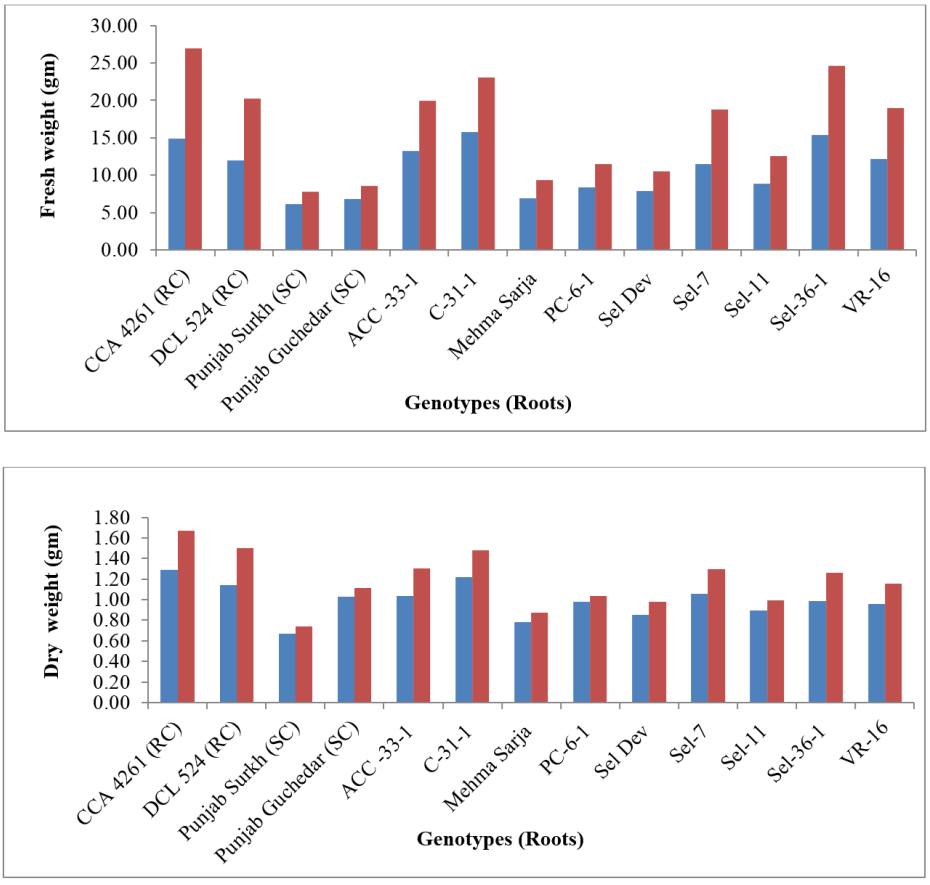
Plant height, fresh weight, main root length and lateral roots of watermelon seedling exposed to fusaric acid (FA) (400 mg·L-1) for 12 h and then grown in ordinary condition for nine days were decreased by 23.0%, 23.1%, 23.6% and 33.6% compared with control respectively. Cotyledons were wilted to death completely and necrosis occurred on the first true leaf and the upper leaves had become crinkled and chlorosis, which was a typical symptom of wilting disease of watermelon caused by *Fusarium oxysporum* f. sp. *niveum* and thus physiological functions were inhibited and damaged strongly. Net photosynthesis rate, stomatal conductance, intercellular CO_2 concentration, and chlorophyll (SPAD reading) of the seedlings decreased with the increasing of concentrations of FA and duration of exposure to FA. Chlorophyll content in the leaves of the seedlings was decreased by 42.7-72.3% (Wu *et al.* 2008) [7].

In the present study the number of roots and root girth was more in susceptible genotypes at 10 DAT but the percentage increase in both these parameters after the onset of disease was much high in resistant genotypes. The roots of susceptible genotypes after the infection of *Fusarium* wilt could not undergo the normal growth.

3.4 Fresh and dry weight of roots (gm)

Fresh and dry weight of root is presented in Figure 4. At 10 DAT, fresh and dry weight of roots was higher in resistant as compared to susceptible genotypes. All the genotypes observed increase in fresh and dry weight at 105 DAT i.e. after the onset of disease. In resistant genotypes, the percentage increase ranged between 40.71-44.78% and 22.45-23.95% respectively whereas percentage increase in fresh and dry weight in the roots of susceptible genotypes was significantly lower and ranged between 20.48-21.50% and 7.78-9.05% at the two stages of crop development respectively.

As per the other advanced lines, the percentage increase in fresh and dry weight was more in ACC-33-1, Sel-7, C-31-1, Sel-36-1 and VR-16 which were more comparable to resistant genotypes whereas in Mehma Sarja, Sel Dev, PC-6 and Sel-11 the percentage increase in fresh and dry weight was more comparable to susceptible genotypes.



RC-resistant checks, SC-susceptible checks

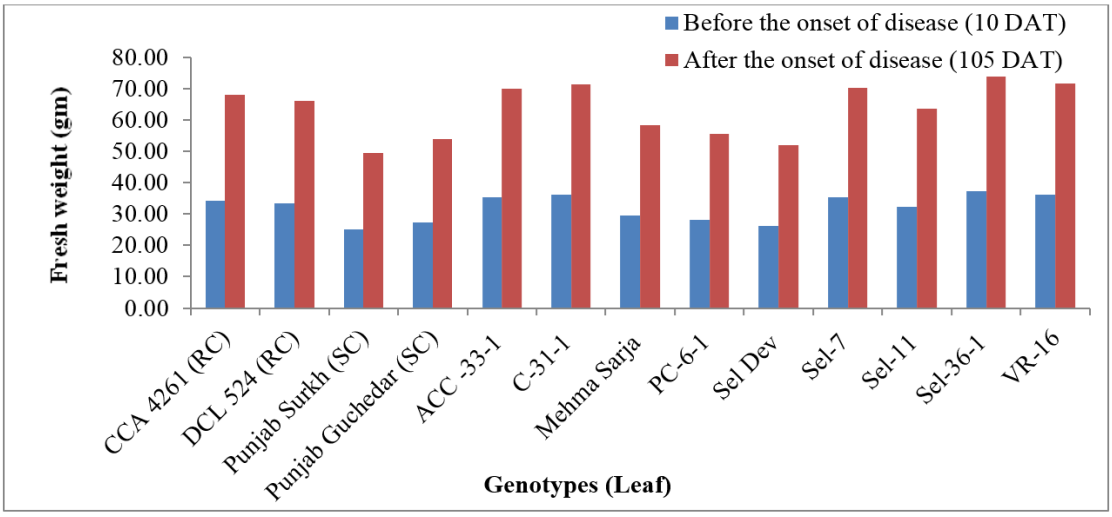
Fig 2: Variation in fresh and dry weight (gm) in roots of chilli genotypes in relations to *Fusarium* wilt at two stages of crop development

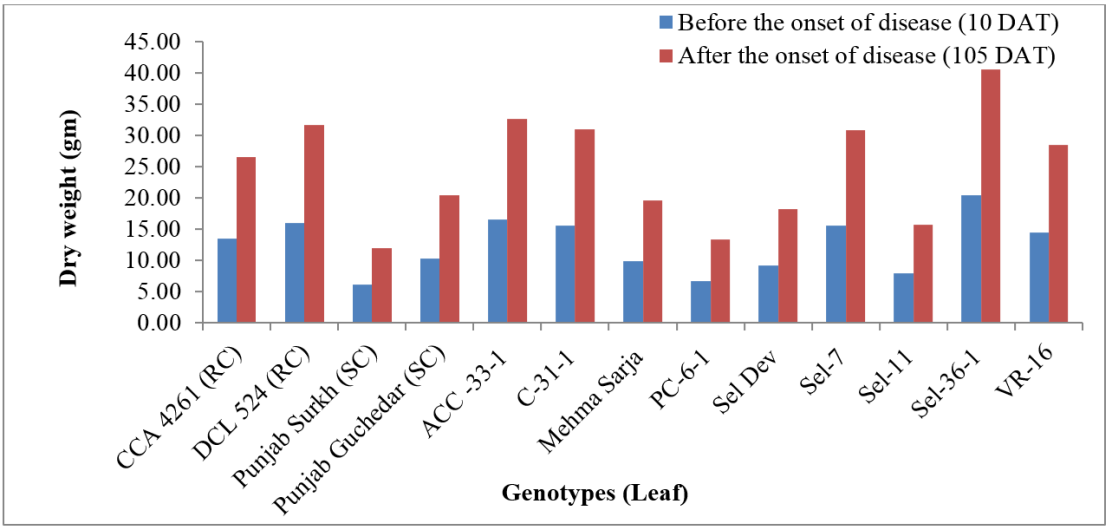
3.5 Fresh and dry weight of leaf (gm)

The data for fresh and dry weight of leaf is presented in Figure 5. The fresh weight of leaves at 10 DAT was more in resistant genotypes (DCL 524 and CCA 4261) and lesser in susceptible genotypes (Punjab Surkh and Punjab Guchedar) whereas at 105 DAT i.e. after the onset of disease, the fresh weight of susceptible genotypes was significantly lower as compared to resistant genotypes. There was an increase in fresh weight of leaf of all the genotypes at 105 DAT but the percentage increase in fresh weight of leaf was 2.5 times higher in resistant genotypes as compared to susceptible genotypes. The percentage increase in dry weight of leaf observed similar trend i.e. the percentage increase in resistant genotypes was almost 2.5 times higher as compared to susceptible genotypes.

As per the other advanced lines, the percentage increase in fresh and dry weight was more in ACC-33-1, Sel-7, C-31-1, Sel-36-1 and VR-16 and was more comparable to resistant genotypes whereas in Mehma Sarja, Sel Dev, PC-6 and Sel-11 the percentage increase in fresh and dry weight of leaf was more comparable to susceptible genotypes.

After plants of watermelon were exposed to Fusaric acid for 12 h and then grown in ordinary condition for nine days, all plant biomasses like plant height, fresh weight, length of main root, lateral roots numbers were significantly reduced because of wilt disease caused by *Fusarium oxysporum* f. sp. niveum (Wu *et al.* 2008) [7].





RC-resistant checks, SC-susceptible checks

Fig 2: Variation in fresh and dry weight (gm) in leaf of chilli genotypes in relations to *Fusarium* wilt at two stages of crop development

The reduction in fresh weight of roots amounted to 93.6% in the control treatment of sorghum against *Fusarium* root-rot inoculated with *F. oxysporum* alone whereas 71.1% reduction in fresh root weight was recorded for the treatments inoculated with both the pathogen and *B. subtilis* and 66.8% reduction in fresh root weight was recorded for the treatments inoculated with both the pathogens and *T. harzianum*. Root dry weight of the control treatment inoculated with only *F. oxysporum* decreased by 94.5% in relation to the non-inoculated control (Awatif and Jedabi 2009) [2]. Their results are comparable to our results and indicate that the roots growth is affected more in susceptible genotypes.

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