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Impact of *Fusarium* wilt on horticultural attributes of Chilli crop

Muhammad Atiq*[1], Fatima Nasir[1], Muhammad Rizwan Bashir[2], Nazir Javed[1], Muhammad Bashir[3], Syed Aftab Ali Bukhari[1], Muhammad Shafiq[4], Iqra Mubeen[1], Khansa Khafoor[1], Waseem Abbas[5]

[1]*Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan*

[2]*Oilseeds Research Institute, Ayub Agricultural Research Institute, Faisalabad, Pakistan*

[3]*Department of Plant Pathology, Bahauddin Zakariya University, Multan, Pakistan*

[4]*Directorate of General Agriculture (Water Management), Lahore, Pakistan*

[5]*Vegetable Research Institute, Ayub Agricultural Research Institute, Faisalabad, Pakistan*

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Abstract

The present research was conducted to find out the impact of *Fusarium* wilt on horticultural attributes of chilli pepper under filed conditions. Chilli (*Capsicum annum*) belongs to Solanaceae family which is infected by number of diseases but *Fusarium* wilt disease is a destructive one which is produced by *Fusarium oxysporum* f. sp. *capsici*. Twelve chilli genotypes were screened out against this disease to find out the resistant variety with good horticultural attributes. Experiment was conducted under RCBD design in the research area of department of Plant Pathology. Out of twelve varieties, five varieties showed moderately resistant response. Moderately resistant variety i.e. P6 showed maximum fresh and dry weight of shoots (85.90 and 84.04g), shoot length (84.13cm), plant height (99.03cm) and highest number of fruits (518.03g) while ADV 513 showed maximum NOL (101.80) and plant weight (177.07g). Two moderately susceptible varieties 49 and capino exhibited maximum root length (17.93g) and fresh and dry weight of roots (12.83 and 10.96g) respectively. It is concluded that P6 is a moderately resistant variety with good horticultural attributes which should be incorporated in breeding program.

* **Corresponding Author:** Muhammad Atiq ✉ dratiq@yahoo.com

Introduction

Chilli (*Capsicum annum* L.) is an important vegetable crop which belongs to the nightshade family Solanaceae. In several parts of United States, the word Chile is referred as *Capsicum* peppers (Smith *et al.*, 1987). It produces capsaicinoids which are alkaloids that play a significant role in pharmaceutical industry (Hayman and Kam, 2008). Fresh chillies are rich source of carotenoids, provitamin A, vitamin B and vitamin C which contains ascorbic acid (Navarro *et al.*, 2006; Chatterjee *et al.*, 2007; Conforti *et al.*, 2007; Deepa *et al.*, 2007; Serrano-Martinez *et al.*, 2008). Chillies are grown all over the world but China is the largest producing country of chillies and green pepper (Diane, 2011). Many diseases limit the yield of this crop but *Fusarium* wilt is a potential threat for the successful production of chillies which is caused by soil borne pathogen *Fusarium oxysporum* f. sp. *capsici*. After 30 days of soil infestation, *Fusarium oxysporum* kills 56% chilli seedlings (Mona *et al.*, 2012). Wilting of leaves, vein clearing, stunting, epinasty and yellowing of older leaves are the characteristic symptoms of this disease (Agrios, 2005). High temperature and high moisture plays a significant role in disease development (Sanogo, 2003). In tropical and subtropical regions fungal pathogens cause huge crop losses. Improper agronomic practices and inappropriate use of fertilizers lead to the low yield of chilli (Jack *et al.*, 2006). *Fusarium* wilt increases the spore formation of fungus which causes decrease in growth parameters of plant like plant length, total yield per plant, fresh and dry weight of the plant (Monaim and Ismail, 2010).

Fungal diseases can be managed by the application of different fungicides but these fungicides have hazardous effects on crop and environment that's why it is the need of the hour to find out the alternatives of fungicides which must be eco-friendly and cost effective. Horticultural attributes play an important role in the selection of resistant varieties against the disease. On the basis of data regarding the growth parameters like plant weight, fresh weight of shoot and root, dry weight of shoot and root, plant height, shoot and root length and total yield we can choose the resistant varieties. Resistant varieties with good horticultural attributes should be incorporated in breeding programme but development of resistant varieties through breeding is a long term process. The alternative of this method is the screening of available germplasm to identify the source of resistance. So, the present study was designed to find out the resistant variety with good horticultural attributes by screening of chilli germplasm against *Fusarium* wilt disease and its impact on horticultural attributes.

Materials and methods

Establishment of sick field

Transplantation of two susceptible chilli varieties Desi and Maxi was done in the field. Prior to that, this area was sprayed two to three times with *F. oxysporum* f. sp. *capsici* culture with the interval of ten days. Fungal spore suspension with concentration of 1×10^6 spores/ml of water was used for the inoculation of these varieties. 3-4ml of water was required for the preparation of this suspension and it was taken on petri plate which contained *Fusarium oxysporum* pure culture (7-10 days old). It was shaken well and then it was poured in the beaker having 250ml of H_2O. 1ml of this suspension was kept on haemocytometer (Horsham, PA 19044). Number of spores was calculated under stereomicroscope for three times. Sterilized water was added in the beaker for the adjustment of number of spores. Root zone of the plants was inoculated with this suspension which results in the maximum production of inoculum in the field. When the symptoms of the disease were established, samples were brought in the laboratory for the morphological study of *F. oxysporum* f. sp. *capsici*. After the confirmation of presence of this pathogen the diseased plants were mixed in the soil in order to increase the decomposition of plant debris and growth of fungus by providing appropriate conditions (Naik *et al.,* 2008).

Establishment of disease screening nursery

Seed of chilli varieties i.e. Green Pridf, CBS-1292, Skyline, Capino, 1310, 49, 52-2012, 60, Fenjiao, P6, Highline and ADV-513 were collected from the

Vegetable Research Institute of Ayub Agricultural Research Institute (AARI), Faisalabad and sown in the pots (5x7″). When the seedlings were emerged these were transplanted on ridges under Randomized Complete Block Design (RCBD) in sick field with P×P distance 20 cm and R×R distance 60 cm with three replications. All the cultural practices were performed to keep the crop in healthy condition. Data related to *Fusarium* wilt disease was recorded with the following disease rating scale i.e. 0= Immune, 1-20%= Resistant, 21-40 % = moderately resistant, 41-50%= moderately susceptible, 51-70%= Susceptible and 71-100%= highly susceptible **(**Monaim and Ismail, 2010).

Observation record

Data regarding horticultural parameters like plant height and weight, fresh weight of shoot and root, dry weight of shoot and root, shoot and root length and total yield were recorded during the whole period of experiment. Three plants were selected randomly and their height, shoot and root length were measured with the help of meter rod (Seco HI 2-Meter GNSS Pocket Rod) and then average was calculated. Leaves were counted manually from the three plants which were selected randomly from each replication and then average was calculated. Plant weight, fresh weight of shoots and roots were calculated on weighing balance (Sartorius Company TH-600). Three plants were selected randomly and placed in the sunlight for 24 hours after that these plants were placed in oven for oven drying at 72^{0} C for 28 hours. Then dry weight of shoots and roots were calculated on weighing balance. Chillies which were completely ripened plucked from each plant and these were counted manually then weighed.

Statistical analysis

Data obtained from field trial parameters was subjected to randomize complete block design (RCBD) as described by Steel *et al.*, 1997. To determine the significant differences, least significant difference (LSD) design was applied. All the statistical tests were performed by using SAS/STAT statistical software (SAS Institute, 1990).

Results and discussion

Out of twelve varieties, five chilli varieties/lines showed moderately resistant response (rating 2) while four varieties/lines expressed moderately susceptible response with disease rating of 3. Similarly one variety i.e. CBS 1292 showed susceptible response and disease incidence 56.00 % with disease rating of 4. Two varieties expressed highly susceptible response i.e. Skyline (63.76) and Highline (87.10) % disease incidence with rating 5. Capino exhibited the highest dry weight of root i.e. 10.96g whereas in case of dry weight of shoot P6 showed the maximum result i.e. 84.06g. ADV 513 (11.10) and 1310 (11.00) g has the least dry weight of shoot. Maximum fresh weight of root presented by Capino i.e. 12.83g whereas P6 has the highest fresh weight of shoots i.e. 85.90g. ADV 513 (13.73) and 1310 (14.00) g has minimum fresh weight of shoot. Highest plant height expressed by P6 i.e. 99.03cm. ADV 513 has the highest no. of leaves i.e. 101.80 as compared to all other varieties grown in the field. 49 showed the maximum root length i.e. 17.93cm whereas P6 has the highest shoot length i.e. 84.13cm. Similarly, ADV 513 plants expressed the highest weight i.e. 177.07g and P6 gave the maximum yield of 518.03g. Highline and ADV 513 gave same yield while Fenjiao, Green Pridf, 52-2012, 1310, 49, 60, and Skyline gave 319.10, 310.00, 305.10, 300.10, 269.97, 262.80 and 165.87g respectively.

P6 expressed as moderately resistant variety which showed the highest shoot length (84.13) cm and expressed maximum dry and fresh weight of shoot that is (86.04) and (85.90) g respectively. Production of reactive oxygen species and accumulation of phytoalexins which are antimicrobial secondary metabolites include in defense mechanism of plants and promotes the growth of the plant (Heath, 2000; De Gara *et al.,* 2003; Agrios, 2005). P6 gave maximum yield while skyline had expressed minimum yield because fungal pathogen reduces the photosynthesis by producing toxins like Tabtoxin and Tentoxin which inhibits the enzymes that are involved in photosynthesis. Infected plants keep stomata closed which lead to the reduction in chlorophyll

content and ultimately photosynthesis stops which results in smaller growth of the plants and low yield (Agrios, 2005). Improper agronomic and cultural practices, inappropriate use of fertilizers and use of contaminated tools lead to the low yield of chilli (Jack *et al.*, 2006).

Premature fall of flowers and small size of fruit due to the hormonal changes in plants caused by pathogen also results in poor yield (Goicoechea *et al.*, 2001; Garmendia *et al.*, 2004).

Table 1. Impact of Fusarium wilt disease on horticultural attributes of chilli crop under field conditions.

Varieties/ Lines	DI %	DWR (g)	DWS (g)	FWR (g)	FWS (g)	PH (m)	NOL	RL (cm)	SL (cm)	PW (g)	Chillies/ plant(g)	Response
52-2012	27.83k	5.03d	13.06i	7.56c	16.80i	59.06j	77.00f	12.06e	49.06h	107.03i	305.10g	MR
ADV 513	33.06j	4.83d	11.10j	5.53d	13.73j	64.10h	101.80a	14.13c	54.13g	177.07a	330.10d	MR
Green Pridf	36.10i	3.03f	41.13d	4.65ef	42.96d	75.93c	75.07g	13.06d	62.96b	160.03c	310.00f	MR
P6	36.90h	3.00f	84.06a	4.10fg	85.90a	99.03a	62.93h	14.13c	84.13a	130.03f	518.03a	MR
1310	37.73g	2.76f	11.00j	3.85g	14.00j	72.80d	79.13e	15.80b	56.80e	100.07i	300.10h	MR
Fenjiao	45.86f	2.80f	19.16h	3.00h	22.70h	79.10b	57.03i	17.86a	60.90c	172.93b	319.10e	MS
60	46.00f	7.10b	29.93g	9.76b	31.70g	65.83g	86.17c	9.30h	55.00f	126.93g	262.80j	MS
49	49.00e	5.86c	50.10b	7.73c	51.83b	72.90d	84.07d	17.93a	56.86e	149.93d	269.97i	MS
Capino	50.76d	10.96a	35.86e	12.83a	38.63e	55.10k	36.07l	9.96g	45.06j	120.13h	414.93b	MS
CBS 1292	56.00c	3.10f	43.86c	4.76e	48.03c	60.03i	39.10k	10.13g	47.16i	93.17k	330.80c	S
Skyline	63.76b	3.70e	40.83d	4.83e	43.03d	66.96f	42.07j	11.10f	54.73f	132.87e	165.87k	HS
Highline	87.10a	3.00f	35.03f	4.00g	35.43f	70.10e	99.03b	10.10g	60.10d	160.03c	330.10d	HS

*Mean values in this column having similar letters do not differ significantly as determined by the LSD test ($P \leq 0.05$). Comparison of different growth parameters such as DWR=Dry weight of roots, DWS=Dry weight of shoots, FWR=Fresh weight of roots, FWS= Fresh weight of shoots, RL=Root length and SL= Shoot length with DI= disease incidence.

Moderately susceptible chilli varieties/lines Capino and 49 had showed maximum dry (10.96) and fresh weight of root (12.83) g and maximum root length (17.93) m respectively. Many strains of *Fusarium oxysporum* colonize the roots of the plant as endophytes which give benefits against pathogens (Swarupa *et al.*, 2014). Numbers of microorganisms are present in the rhizosphere which surrounded the roots of plant and this interaction between roots and microbes is beneficial for the survival of plant and its growth (Whipps, 2001).

Conclusion

Fusarium wilt caused by *Fusarium oxysporum* f. sp. *capsici* causes deleterious effects on chilli crop. P6 showed highest shoot length, maximum dry and fresh weight of shoot and yield while ADV 513 expressed maximum weight and number of leaves. These moderately resistant varieties with good horticultural parameters can be incorporated in breeding program.

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References

Agrios GN. 2005. Plant Pathology. 5th edition. Elsevier Academic Press. London.

Altinok HH. 2005. First report of *Fusarium* wilt of eggplant caused by *Fusarium oxysporum* f. sp. melongenae in Turkey. Plant Pathology **54,** 577. http://dx.doi.org/10.1111/j.1365-3059.2005.01235.x

Chatterjee S, Niaz Z, Gautham S, Adhikari S, Pasad SV, Sharma A. 2007. Bioactive compounds in chilli peppers (*Capsicum annuum* L.) at various ripening (green, yellow and red) stages. Food Chemistry, **102,** 515-523. http://dx.doi.org/10.3390/antiox4020427

Conforti F, Stati GA, Menichini F. 2007. Bioactive compounds in chilli peppers (*Capsicum annuum* L.) at various ripening (Green, yellow and red) stages. Food Chemistry, **102,** 1094-1104.

Deepa N, Kaur C, George B, Singh B, Kapoor HC. 2007. Bioactive compounds in chilli peppers (*Capsicum annuum* L.) at various ripening (green, yellow and red) stages. LWT-Food Science and Technology, **40**: 212-219.

De Gara L, de Pinto M, Tommasi F. 2003. The antioxidant systems via-a-via reactive oxygen species during plant-pathogen interaction. Plant Physiology and Biochemistery, **41,** 863-870.
http://dx.doi.org/10.1016/S0981-9428(03)00135-9

Diane H. 2011. A national information resource for value added agriculture. Agricultural marketing resource center, Iowa State University.

Fravel D, Olivain C, Alabouvette C. 2003. *Fusarium oxysporum* and its biocontrol. New Phytologist. **157,** 493-502.
http://dx.doi.org/10.1046/j.1469-8137.2003.00700.x

Faustino JMF, Barroca MJ, Guine RPF. 2007. Study of the drying kinetics of green bell pepper and chemical characterization. Food Bio product and Process. **85,** 163–170.
http://dx.doi.org/10.1205/fbp07009

Garmendia I, Goicoechea N, Aguirreolea J. 2004a. Plant phenology influences the effect of mycorrhiza fungi on the development of *Verticillium*-induced wilt in pepper. European Journal of Plant Pathology **110,** 227-238.
http://dx.doi.org/10.1007/s00572-004-0336-z

Goicoechea N, Aguirreolea J, Cenoz S, Garcia-Mina JM. 2001. Gas exchange and flowering in *Verticillium*-wilted plants. Journal of Phytopathology, **149,** 281-286.
http://dx.doi.org/10.1046/j.1439-0434.2001.00622.x

Heath M. 2000. Hypersensitive response related death. Plant Molecular Biology, **44,** 321-334.
https://www.ncbi.nlm.nih.gov/pubmed/11199391

Hayman M, Kam PCA. 2008. Bioactive compounds in chilli peppers (*Capsicum annuum* L.) at various ripening (green, yellow and red) stages. Current Anaesthesia & Critical Care, **19,** 338-343.

Jack HE, Syndi B, Krystle C, Axiom C. 2006. How to grow a tomato plant under different fertility regimes. Wiki How, 1-10.

Monaim MFA, Ismail ME. 2010. the use of antioxidants to control root-rot and wilt diseases of pepper. Notualae Scienticia Biologia, **2(2),** 46-55.

Mona MM, Ashour AMA, Abdel-Kader MM, El-Mohamady R, Abdel-Aziz A. 2012. *In Vitro* Evaluation of Some Fungicides Alternatives against *Fusarium Oxysporum* the Causal of Wilt Disease of Pepper (*Capsicum annum* L.). International Journal of Agriculture and Forestry, **2(2),** 70-77.
http://dx.doi.org/10.5923/j.ijaf.20120202.11

Navarro JM, Flores P, Garrido C, Martinez V. 2006. Bioactive compounds in chilli peppers (*Capsicum annuum* L.) at various ripening (green, yellow and red) stages. Food Chemistry, **96,** 66-73.
http://dx.doi.org/10.3390/antiox4020427

Naik MK, Devika GS, Madhukar HM. 2008. Identification of resistant sources against wilt of chilli (*Capsicum annum* L.) caused by *Fusarium solani* (Mart.) Sacc. Journal of Mycopathology and Research, **46(1),** 93-96.

Smith PG, Villalon B, Villa PL. 1987. Horticultural classification of peppers grown in the United States. Hortorticultural Science, **22,** 11-13.

SAS Institute. 1990. SAS/STAT Users Guide Version 6. SAS Institute, Cary, NC, USA.

Steel RGD, Torrie JH, Dickey DA. 1997. Principles and procedures of statistics. A biometrical approach. 3rd Edit. McGraw Hill Pub. Co., New York.

Sanogo S. 2003. Chile pepper and the threat of wilt diseases. Plant Health Progress.

Serrano-Martinez A, Fortea FM, Del Amor FM, Nufiez-Delicado E. 2008. Bioactive compounds in chilli peppers (*Capsicum annuum* L.) at various ripening (green, yellow and red) stages. Food Chemistry. **107,** 193-199.

Swarupa V, Ravishankar KV, Rekha A. 2014. Plant defence response against *Fusarium oxysporum* and strategies to develop tolerant genotypes in banana. Planta **239,** 735-751. http://dx.doi.org/10.1007/s00425-013-2024-8

Whipps JM. 2001. Microbial interactions and biocontrol in the rhizosphere. Journal of Experimental Botany, **52,** 487–511. https://doi.org/10.1093/jexbot/52.suppl_1.487