Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2700

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (2):** 1042-1048 (2017)

Research Article

OPEN ACCESS

Evaluation of Susceptibility of Carnation Genotypes to *Fusarium* Wilt (*Fusarium oxysporum* f. sp. *dianthi*)

Purnachandra Gowda G.[1*], M. V. Dhananjaya[2], and Halesh[3]

[1]Ph.D Scholar, College of Horticulture, Bangalore

[2]Principle Scientist, Division of Ornamental Crops, IIHR, Bangalore

[3]Assistant Professor, College of Horticulture, Bangalore

*Corresponding Author E-mail: purnachandra.gowda@gmail.com

Received: 18.03.2017 | Revised: 30.03.2017 | Accepted: 1.04.2017

ABSTRACT

Evaluation of twenty carnation genotypes for their susceptibility to two isolates of Fusarium oxysporum f. sp. dianthi revealed that, the genotypes Loris and Malaga recorded the least number of days taken for first symptom appearance for Pune (38.5 days) and Solan (41 days) isolates respectively, whereas the highest number of days taken for first symptom appearance was recorded in the genotype Praga (57 and 58.5 days) in both Pune and Solan isolates respectively. In the presence of Pune isolate, the highest per cent disease incidence was recorded in the genotype Hunza (100 per cent), whereas, the lowest per cent disease incidence was recorded in Praga (16.66 per cent). On the other hand, for Solan isolate, Big Mama and Dark Dona recorded the highest per cent disease incidence (100 per cent) and Praga recorded the lowest per cent disease incidence (24.99 per cent). Disease severity was recorded to be highest in the genotype Loris (65.95 %) and Malaga (68.96 %) in case of Pune and Solan isolates respectively, the genotype Praga recorded the lowest disease severity for both isolates viz., Pune (8.98 %) and Solan (7.77 %).

Key words: *Carnation, Fusarium oxysporum f. sp. dianthi, isolates, evaluation, disease severity.*

INTRODUCTION

Carnation (*Dianthus caryophyllus* L.) is one among the most popular commercial cut flowers of the world, ranking second in commercial importance next to rose. The genus name 'Dianthus' is derived from the Greek words 'dios' meaning 'God' or 'divine' and 'anthos' meaning 'flower' and hence known as 'Divine Flower'. The species name 'caryophyllus' is derived from the Greek word 'caryan' meaning 'nut' and 'phyllon' meaning 'leaf'. The name 'caryophyllus' has been chosen by Linnaeus after the genus name of clove, due to the clove-like fragrance of carnation. The common name 'carnation' probably must have come from the Greek word 'coronation' because these flowers were used in decorating the crown of Greek athletes. Carnation is the national flower of Spain.

Cite this article: Gowda P.G., Dhananjaya, M. V. and Halesh, Evaluation of Susceptibility of Carnation Genotypes to *Fusarium* Wilt (*Fusarium oxysporum* f. sp. *dianthi*), *Int. J. Pure App. Biosci.* **5(2):** 1042-1048 (2017). doi: http://dx.doi.org/10.18782/2320-7051.2700

In India, carnation is grown in Nasik, Pune, Kodaikanal, Nilgiris, Kalimpong, Darjeeling, Bangalore, Solan, Palampur, Shimla, Srinagar, Nainital and Chaubattia. The most suitable climate for commercial carnation flower production in India prevails in the Nilgiris and Kodaikanal of Tamil Nadu and parts of Himachal Pradesh. Carnation has earned its preference in the international as well as domestic flower markets due to its excellent keeping quality, wide range of forms, colours and ability to withstand long distance transportation. Cut carnations, roses and chrysanthemums contribute close to 50% of the world cut flower trade[9].

The most important phytopathological problem affecting carnation in most areas of the world is *Fusarium* wilt, caused by *Fusarium oxysporum* f. sp. *dianthi*. *Fusarium* wilt is prevalent in 79 % of the national production areas of carnation and affects 45 % of its total production[12]. Symptoms include vascular discoloration, root rot, leaf and stem wilt, acropetally developing necrosis in individual stems or the whole plant, and, in the most severe cases, leading to plant death[7,14]. Consequently, crop yield declines slowly, due to the lower vigor of plants and the reduced crop stand. *Fusarium* pathogens survive in the upper soil layers (0-20 cm)[3] as chlamydospores or as mycelium that colonizes the root debris that remain in soil from previous crops[11]. Both fungal structures may infect carnation plants at any stage of the crop cycle. At the world level, *Fusarium* pathogens have increased in importance, putting flower-growers and growers in general on alert, because these pathogens have expanded their range of hosts and developed resistance to chemical treatment[1].

Although many strategies have been laid out to manage the disease, it has been proved to increase the cost of cultivation, thereby necessitating the need to come out with new strategies such as identifying resistant genotypes/varieties[8]. The most successfully form to address the problem is the cultivation of resistant varieties, obtained by traditional breeding methods[2]. So, the crop of resistant varieties in our country will produce an important reduction of production costs and avoid losses by the disease. Taking into consideration the severity of the problem prevailing in the cultivation of carnation, the present experiment has been laid out, with the objective of identifying genotypes that are resistant against different isolates of *Fusarium oxysporum* f. sp. *dianthi*.

MATERIAL AND METHODS

The present experiment was conducted at the Division of Ornamental crops, Indian Institute of Horticultural Sciences, Hesaraghatta, Bangalore during November 2015 to March 2016. A total of twenty carnation genotypes were screened in this experiment (Table 1). The experiment was laid out in Factorial Completely Randomized Design, with two replications. Each of the replication consisted of 8 pots with two plants in each pot. Prior to planting of the rooted cuttings in the pots, the media *i.e.*, soil, sand and FYM (1:1:1) was sterilized.

The two isolates *viz.*, Pune and Solan isolates were obtained from the Division of Plant Pathology, Indian Institute of Horticultural Sciences, Hesaraghatta, Bangalore. These isolates were multiplied using PDA. Using a Haemocytometer, the spore count in each of these isolates was determined. These isolates were mixed with autoclaved sand and then applied to the media in which the plants were planted. The plants were observed for the number of days taken for first symptom appearance, per cent disease incidence (PDI) and disease severity. The number of days taken for first symptom appearance was considered from the day of inoculation of isolates to the media, whereas, per cent disease incidence (PDI) was calculated using the formula below;

$$\mathbf{PDI} = \frac{\text{No. of plants infected} \times 100}{\text{Total No. of plants observed}}$$

Similarly, disease severity was calculated using the scale: 1 = no symptoms; 2 = chlorosis of plant base; 3 = chlorosis or wilt of the third to half basal part of the plant; 4 = wilt reaching at least one branch of the upper part of the plant; and 5 = dead plant[13].

Table 1: List of the genotypes used in the experiment

Genotypes		Genotypes	
T_1	Bizet	T_{11}	Big Mama
T_2	Vincidor	T_{12}	Golem
T_3	Pintado	T_{13}	Red King
T_4	Dona	T_{14}	Praga
T_5	White Magic	T_{15}	Queen Mary
T_6	White Dona	T_{16}	Seychelles
T_7	Soto	T_{17}	Gioele
T_8	Darjeeling	T_{18}	Loris
T_9	Hunza	T_{19}	Malaga
T_{10}	Happy Golem	T_{20}	Dark Dona

RESULTS AND DISCUSSION

The response of the genotypes to two different isolates of *Fusarium oxysporum* f.sp. *dianthi* varied significantly w. r. t. number of days taken for first symptom appearance (Table 2). Among the twenty genotypes screened for susceptibity across two isolates of *Fusarium oxysporum* f.sp. *dianthi viz*., Isolate-1 (Pune) and Isolate-2 (Solan), the least number of days taken for first symptom appearance for Pune isolate was observed in the genotype Loris (38.5 days) and for Solan isolate, was observed in the genotype Malaga (41 days). On the other hand, the highest number of days taken for first symptom appearance for Pune isolate was observed in the genotype Praga (57 days) followed by Gioele (56.5 days), whereas, for Solan isolate, the highest number of days taken for first symptom appearance was also in the genotype Praga (58.5 days).

Among the twenty genotypes evaluated for their susceptibility against two isolates of *Fod.*, it was observed that, for percent disease incidence there was significant difference among the genotypes (Table-3). For the isolate-Pune, the highest per cent disease incidence was recorded in the genotype Hunza (100 per cent), followed by the genotypes Dona, White Dona, Big Mama, Seychelles, Loris and Dark Dona (91.66 per cent). Whereas, for the isolate-Solan, the highest per cent disease incidence were recorded in the genotypes Big Mama and Dark Dona (100 per cent).

On the other hand, for the isolate-Pune, the lowest per cent disease incidence was observed in the genotype Praga (16.66 per cent) followed by the genotype Gioele (58.33 per cent). Similarly, for the isolate-Solan, the lowest per cent disease incidence was recorded in the genotype Praga (24.99 per cent) followed by White Dona (33.33 per cent).

Table 2: Number of days taken for first symptom appearance by carnation genotypes for two different isolates of *Fusarium* wilt (*Fusarium oxysporum* f.sp. *dianthi*)

Treatments	Isolate-1 (PUNE)	Isolate-2 (SOLAN)
T_1	43.5	44
T_2	42.5	42.5
T_3	43	43
T_4	46	44
T_5	46.5	43
T_6	43	56
T_7	46	46.5
T_8	44	44
T_9	46.5	42
T_{10}	44	45.5
T_{11}	44.5	42.5
T_{12}	43.5	45.5
T_{13}	44	47
T_{14}	57	58.5
T_{15}	44	46
T_{16}	45.5	47
T_{17}	56.5	47.5
T_{18}	38.5	42
T_{19}	42.5	41
T_{20}	46.5	47
	SEm ±	**CD @ 1 %**
Treatments	0.409	1.540
Isolates	0.034	0.128
Treatments X Isolates	0.819	3.081

The genotypes evaluated for their susceptibility against two different isolates *viz.*, Pune and Solan, exhibited significant difference for disease severity at the 90th day after inoculation. It was observed that, among the genotypes exposed to the isolate-Pune, the highest disease severity was expressed by the genotype Loris (65.95 %) and it was on par with the genotype Seychelles (64.24 %). Similarly, among the genotypes exposed to the isolate Solan, the highest disease severity was expressed by the genotype Malaga (68.96 %) followed by the genotype Seychelles (67.33 %). On the other hand, the genotype Praga recorded the lowest disease severity for both isolates *viz.*, Pune (8.98 %) and Solan (7.77 %). In addition to the genotype Praga, another genotype, White Dona recorded the least disease severity (9.01 %) for the isolate Solan.

Table 3: Percent Disease Incidence (PDI) expressed by carnation genotypes for two different isolates of *Fusarium* wilt (*Fusarium oxysporum* f.sp. *dianthi*)

Treatments	Isolate-1 (PUNE)	Isolate-2 (SOLAN)
T_1	83.33	91.66
T_2	75	83.33
T_3	66.66	66.66
T_4	91.66	83.33
T_5	74.99	75
T_6	91.66	33.33
T_7	75	74.99
T_8	74.99	83.33
T_9	100	91.66
T_{10}	83.33	83.33
T_{11}	91.66	100
T_{12}	83.33	74.99
T_{13}	66.66	58.33
T_{14}	16.66	24.99
T_{15}	50	66.66
T_{16}	91.66	91.66
T_{17}	58.33	74.99
T_{18}	91.66	83.33
T_{19}	75	91.66
T_{20}	91.66	100
	SEm ±	**CD @ 1 %**
Treatments	3.70	13.94
Isolates	0.30	1.16
Treatments X Isolates	7.41	27.89

The responses of the genotypes to different isolates of *Fod*. varied significantly, owing its differential response to the Gene- for- Gene hypothesis stated by Harold Henry Flor. The presence or absence of the resistance gene in the plant and the presence or absence of avirulence gene in the pathogen is the main factors responsible for the manifestation or absence of the appearance of infection in the plants. Plants producing a specific resistance gene product are resistant towards a pathogen that produces the corresponding avirulence gene product. In this experiment, the responses of the genotypes to the isolates of *Fusarium oxysporum* f. sp. *dianthi* confirmed the hypothesis given by Harold Henry Flor. The differential response of the genotypes, expressed by means of days taken for first symptom appearance, per cent disease incidence and disease severity pointed out to the presence of a factor that decides the ability of the plants suppress the outbreak of a disease. In addition to many other factors such as the presence of passive defense mechanisms *viz*., physical barriers (cell wall, wax layer, cuticle, etc) and chemical barriers (pH, phytoanticipins and plant defensins), active defense mechanisms too play a vital role is suppressing pathogen dominance on host.

Table 4: Disease severity (%) expressed by carnation genotypes for two different isolates of *Fusarium* wilt (*Fusarium oxysporum* f.sp. *dianthi*)

Treatments	Isolate-1 (PUNE)	Isolate-2 (SOLAN)
T_1	41.66	46.60
T_2	53.61	56.80
T_3	34.05	37.3
T_4	38.87	39.04
T_5	55.94	56.16
T_6	37.54	9.01
T_7	61.60	62.64
T_8	38.85	46.22
T_9	59.43	62.55
T_{10}	45.78	42.83
T_{11}	41.37	45
T_{12}	35.55	34.40
T_{13}	32.65	36.26
T_{14}	8.98	7.77
T_{15}	47.09	56.16
T_{16}	64.24	67.33
T_{17}	36.77	29.15
T_{18}	65.95	63.33
T_{19}	56.25	68.96
T_{20}	40.28	40.76
	SEm ±	**CD @ 1 %**
Treatments	0.65	2.46
Isolates	0.05	0.20
Treatments X Isolates	1.31	4.93

Programmed cell death or the production of reactive oxygen species (ROS), phytoalexin accumulation, presence or timely production of secondary metabolites *viz*., phenols, Flavonoids are some of the ways the by which the active defense mechanism works in the plant/host system in response to pathogen infection[4,5,6,10]. Many of these or some of these may be the reason for the presence or absence of the ability of the genotypes to resist the pathogen outbreak, thereby the plants showing different responses *viz*., resistant or susceptible.

REFERENCES

1. Abeywickrawa, A. and Beal, S., The *Fusarium* relation races. *Physiol. Mol. Plant Pathol*., **32:** 89-92 (1992).
2. Arbeláez, G., Fungal and bacterial disease on carnation in Colombia. *Acta Hort*., **216:** 151-157 (1987).
3. Ben-Yephet, Y., Reuven, M., Szmulewich, Y. and Mor, Y., Effect of methyl bromide on the control of *Fusarium oxysporum* f. sp. *dianthi* propagules in carnation greenhouse soil and on inoculum increase after one growth cycle of carnation. *Crop Prot*., **13:** 357-361 (1994).
4. Curir, P., Dolci, M., Dolci, P., Lanzotti, V., Cooman, L.D., Fungitoxic phenols from carnation (*Dianthus caryophyllus* L.) effective against *Fusarium oxysporum* f. sp. *dianthi*. *Phytochem. Analysis*., **14:** 8–12 (2003).
5. Curir, P., Dolci, M. and Galeotti, F., A phytoalexin-like flavonol involved in the carnation (Dianthus caryophyllus)-*Fusarium oxysporum* f. sp. *dianthi* pathosystem. *Plant Pathol*., **153:** 65–67 (2005).
6. Curir, P., Dolci, M., Lanzotti, V. and Taglialatela, O., Kaempferide triglycoside:

a possible factor of resistance of carnation (*Dianthus caryophyllus* L.) to *Fusarium oxysporum* f. sp. *dianthi*. *Phytochemistry*, **56:** 717–721 (2001).

7. Fattahi, B., Rahanandeh, H., Chavoshi, S., Zamanisadeh, H.R., Bayat, H. and Moshayedi, M., Report primary of *Fusarium proliferatum* and *F. solani* agents of *Dianthus caryophyllus* wilting in Markazi province in Iran. *Int. J. Biosci*., **4:** 143-148 (2014).
8. Garibaldi, A. and Gullino, M.L., *Fusarium* wilt of carnation. In: Gullino, M.L., Katan, J., Garibaldi, A. (Eds.), *Fusarium* wilts of Greenhouse Vegetable and Ornamental Crops. APS, St. Paul. 191-198 (2012).
9. Jawaharlal, M., Ganga, M., Padmadevi, R., Jegadeeswar, V. and Karthikeyan, S., A technical guide on carnation. Tamil Nadu Agricultural University, Coimbatore (2009).
10. Kuc, J., Phytoalexins, stress metabolism, and disease resistance in plants. *Annual review of Phytopathology.* **33:** 275-297 (1995).
11. Leslie, J.F. and Summerell, B.A., The *Fusarium* Laboratory Manual. Blackwell Publishing Professional, Ames, IA USA (2006).
12. Mahalakshmi, P. and Raja Yesu, I., Biocontrol potential of *Trichoderma* species against wilt disease of carnation (*Dianthus caryophyllus* L.) caused by *Fusarium oxysporum* f.sp. *dianthi*. *Journal of Biopesticides*, **6(1):** 32-36 (2013).
13. Prados-Ligero, A.M., Basallote-Ureba, M.J., Lopez-Herrera, C.J. and Melero-Vara, J.M., Evaluation of susceptibility of carnation cultivars to *Fusarium* wilt and determination of *Fusarium oxysporum* f. sp. *dianthi* races in southwest Spain. *Hort. Sci*., **42:** 596-599 (2007).
14. Zhang, J., Xingxing, W., Yunqing, B., Yixin, W., Guanhui, I., Yueqiu, H. and Zichao, M., First report of *Fusarium proliferatum* infecting carnation (*Dianthus caryophyllus* L.) in China. *J. Phytopathol*., **16:** 850-854 (2011).