International Journal of Microbiology Research
ISSN: 0975-5276 & E-ISSN: 0975-9174, Volume 9, Issue 3, 2017, pp.-878-880.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000234

Research Article

SCREENING CARNATION GENOTYPES FOR RESISTANCE AGAINST *FUSARIUM* WILT (*Fusarium oxysporum* f. sp. *dianthi*) ISOLATES *viz.* IIHR AND PUNE

PURNACHANDRA GOWDA G.[1*], DHANANJAYA M.V.[2] AND HALESH G.K.[3]

[1,3]College of Horticulture, B University of Horticultural Sciences, GKVK Post, Bengaluru, 560 065, Karnataka
[2]Division of Ornamental Crops, ICAR - Indian Institute of Horticultural Research, Hessaraghatta lake post, Bengaluru, 560 089, Karnataka
*Corresponding Author: Email-purnachandra.gowda@gmail.com

Received: March 10, 2017; Revised: March 18, 2017; Accepted: March 19, 2017; Published: March 28, 2017

Abstract- Screening twenty genotypes of carnation for resistance against two isolates *viz.,* IIHR and Pune of *Fusarium oxysporum* f. sp. *dianthi*, revealed that the genotypes varied in their response to the presence of the pathogen. It was observed that the genotype Loris, took the least number of days for first symptom appearance in both IIHR (39.5 days) and Pune isolates (38.5 days), whereas, the genotype Gioele took the highest number of days for the isolate IIHR (60 days) and the genotype Praga for the isolate Pune (57 days). In addition, the genotype Praga recorded the least per cent disease incidence for both IIHR (24.99 %) and Pune (16.66 %) isolates and also the least disease severity for both IIHR (8.56 %) and Pune (8.98 %) isolates.

Keywords- Carnation, *Fusarium oxysporum,* Isolates, Disease Severity, Percent disease incidence.

Citation: Purnachandra Gowda G., et al., (2017) Screening Carnation Genotypes for Resistance against *Fusarium* Wilt (*Fusarium oxysporum* f. sp. *dianthi*) Isolates *viz.* IIHR and Pune. International Journal of Microbiology Research, ISSN: 0975-5276 & E-ISSN: 0975-9174, Volume 9, Issue 3, pp.-878-880.

Academic Editor / Reviewer: Gholamian Asadollah

Introduction

Carnation is an important cut flower crop with high commercial value owing to its excellent keeping quality and diverse array of colors coupled with forms [1]. It is believed that the perpetual carnation was developed from cross between *D. caryophyllus* and *D. chinensis* and the resultant varied forms have been grouped as standards and spray types. Carnation (*Dianthus caryophyllus* L.), belongs to the family Caryophyllacae, is one of the important cut flowers in the world, owing its origin to the Mediterranean region. The stems are green with clear nodes, with leaves in pairs aligned opposite to each other. Flowers are borne at the terminal end of the stems, color varying from white to red, and also bicolored. Carnation ranks 2nd in commercial importance next to rose in the world. It has a wide range of colors and excellent keeping quality. They are also used for bedding, pots, borders, edging, indoors and rock gardens. Miniature carnations are now gaining popularity for their potential use in floral arrangement.

In India, carnation is grown in and around Nasik, Pune, Kodaikanal, Nilgiris, Kalimpong, Darjeeling, Bangalore, Solan, Palampur, Shimla, Srinagar, Nainital and Chaubattia. In India, places like Nilgiris and Kodaikanal of Tamil Nadu and some specific regions of Himachal Pradesh have the suitable climate for carnation cultivation. *Fusarium* wilt is one of the major diseases that restrict carnation (*Dianthus caryophyllus* L.) crops to be grown profitably around the world. *Fusarium oxysporum* Schltdl. f. sp. *dianthi* (Prill. &Delacr.) W. C. Snyder & H. N. Hansen (*Fod*) is the causal agent of *Fusarium* wilt in carnation (FWC), but two other species have been recently reported to infect carnation, causing symptoms analogous to those caused by

Fod except for the vascular colonization, i.e. *Fusarium proliferatum* (Matsush.) Niremberg Gerlach & Niremberg in China and Iran, and *Fusarium solani* (Mart.) Sacc. in China, [13,8]. 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 [12,8]. Ultimately, the yield of the crop declines, due to the decrease in the plant vigor and reduced crop stand. *Fusarium* pathogens are found to survive in the upper layers of soil, usually at 0-20 cm [4] as chlamydospores or as mycelium that colonizes the root debris that remain in soil from previous crops [10]. Both of these fungal structures infect carnation plants.

In addition to the pathogen *F. oxysporum* f. sp. *dianthi*, its sister species, *F. redolens* f. sp. *dianthi*, continue to cause severe losses wherever carnations are grown, despite of sanitation practices like routine soil disinfestation prior to each crop and the use of cuttings obtained from *Fusarium*-free meristem tissue cultures [3]. Severe epidemics of *Fusarium* wilt in the 1980s and 1990s caused a strong reduction in the acreage devoted to the carnation industry in some areas of Southern Europe, such as Italy, France, and Spain. Fusarium wilt along with cheaper production cost in Colombia, Morocco, Kenya, and Tanzania shifted the industry out of Europe and the United States. Despite the availability of cultivars that are resistant to the most common races of *F. oxysporum* f. sp. *dianthi*, *Fusarium* wilt remains a critical disease for this crop whenever it is grown [9]. The same momentum led to the introduction of commercial carnation production in India.

Carnation for decades has been threatened by the most limiting disease, vascular wilt, caused by *Fusarium oxysporum* f. sp. *dianthi* (Prill and Delacr) W.C. Snyder and H.N. Hansen. The loss caused by this disease may exceed 10% of total production or sometimes exceeding the limits. Chemical management is expensive and inefficient. The most successfully form to address the problem is the cultivation of resistant varieties, obtained by traditional breeding methods [2,6]. So, the crop of resistant varieties in our country will produce an important reduction of production costs and avoid losses by the disease [7].

The menace created by *Fusarium* pathogens have increased, putting flower-growers and growers in general on alert, the main reason being, these pathogens have expanded their range of hosts and developed resistance to chemical

applications. Another problem added to the existing is, the diversity within the species; causing diseases in a wide range of plant species and their varied forms appearing across different localities *i.e.,* isolates. The present investigation is carried out with the objective of screening available carnation genotypes against two different isolates of *Fusarium oxysporum* f.sp. *dianthi* (Isolates- IIHR and Pune) to identify resistant genotypes.

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.,* IIHR isolate and Pune 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;

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

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 [12].

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 experiment clearly revealed that there was significant difference among the carnation genotypes against two different isolates of *Fusarium oxysporum* f.sp. *dianthi* (*Fod*) for the number of days taken for first symptom appearance [Table-2]. Among the twenty genotypes screened for their response against *Fod* isolates *viz.,* IIHR and Pune, the least number of days taken for the first symptom appearance was recorded in the genotype Loris (39.5 and 38.5 days respectively), followed by the genotype White Magic (42.5 days) for the isolate- IIHR and the genotypes Vincidor and Malaga for the isolate Pune.

On the other hand the highest number of days taken for first symptom appearance in case of isolate- IIHR was recorded in the genotype Gioele (60 days) followed by Praga (58 days) and in case of the isolate Pune, it was Praga followed by Gioele.

Of the twenty genotypes screened for the resistance 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-IIHR, the highest per cent disease incidence was recorded in the genotype Loris (100 per cent), followed by the genotypes Vincidor, Hunza and Malaga (91.66 per cent). Whereas, 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).

On the other hand, for the isolate-IIHR, the lowest per cent disease incidence was observed in the genotype Praga (24.99 per cent), followed by the genotype Gioele (41.66 per cent). Similarly, for the isolate Pune, Praga (16.66 per cent) followed by the genotype Gioele (58.33 per cent) recorded the least per cent disease incidence

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

Treatments	Isolate-1 (IIHR)	Isolate-2 (PUNE)
T_1	44.5	43.5
T_2	46.5	42.5
T_3	43	43
T_4	44.5	46
T_5	42.5	46.5
T_6	45.5	43
T_7	47	46
T_8	43.5	44
T_9	47.5	46.5
T_{10}	46	44
T_{11}	48	44.5
T_{12}	47	43.5
T_{13}	46.5	44
T_{14}	58	57
T_{15}	43.5	44
T_{16}	46	45.5
T_{17}	60	56.5
T_{18}	39.5	38.5
T_{19}	46	42.5
T_{20}	44.5	46.5
	SEm ±	**CD @ 1 %**
Treatments	0.552	2.078
Isolates	0.046	0.173
Treatments X Isolates	1.104	4.156

Table-3 *Percent Disease Incidence (PDI) expressed by carnation genotypes for different isolates of Fusarium wilt (Fusarium oxysporumf.sp. dianthi).*

Treatments	Isolate-1 (IIHR)	Isolate-2 (PUNE)
T_1	74.99	83.33
T_2	91.66	75
T_3	83.33	66.66
T_4	66.66	91.66
T_5	79.16	74.99
T_6	75	91.66
T_7	66.66	75
T_8	83.33	74.99
T_9	91.66	100
T_{10}	66.66	83.33
T_{11}	83.33	91.66
T_{12}	74.99	83.33
T_{13}	75	66.66
T_{14}	24.99	16.66
T_{15}	75	50
T_{16}	70.83	91.66
T_{17}	41.66	58.33
T_{18}	100	91.66
T_{19}	91.66	75
T_{20}	83.33	91.66
	SEm ±	**CD @ 1 %**
Treatments	3.851	14.488
Isolates	0.320	1.207
Treatments X Isolates	7.702	28.977

All the genotypes screened for resistance against two different isolates *viz.,* IIHR and Pune, exhibited significant difference for disease severity at the 90th day after inoculation. It was observed that, among the genotypes exposed to the isolate-IIHR, the highest disease severity was expressed by the genotype Loris (63.82 %)

and it was on par with the genotype Seychelles (63.34 %). Similarly, among the genotypes exposed to the isolate Pune, the highest disease severity was expressed by the genotype Loris (65.95 %) followed by the genotype Seychelles (64.24 %). On the other hand, the genotype Praga recorded the lowest disease severity for both isolates *viz.,* IIHR (8.56 %) and Pune (8.98 %). In addition to the genotype Praga, another genotype Gioele recorded the least disease severity (11.68 %) for the isolate IIHR.

Table-4 *Disease severity (%) expressed by carnation genotypes for different isolates of Fusarium wilt (Fusarium oxysporumf.sp. dianthi).*

Treatments	Isolate-1 (IIHR)	Isolate-2 (PUNE)
T_1	33.34	41.66
T_2	53.67	53.61
T_3	33.87	34.05
T_4	47.44	38.87
T_5	34.89	55.94
T_6	40.44	37.54
T_7	51.37	61.60
T_8	37.96	38.85
T_9	60	59.43
T_{10}	47.57	45.78
T_{11}	42.02	41.37
T_{12}	44.05	35.55
T_{13}	39.88	32.65
T_{14}	8.56	8.98
T_{15}	46.21	47.09
T_{16}	63.34	64.24
T_{17}	11.68	36.77
T_{18}	63.82	65.95
T_{19}	56.82	56.25
T_{20}	27.24	40.28
	SEm ±	**CD @ 1 %**
Treatments	0.605	2.278
Isolates	0.050	0.189
Treatments X Isolates	1.211	4.557

Considering the reactions exhibited by the genotypes in terms of disease severity to the isolates of *Fusarium oxysporum*f. sp. *dianthi*, it can be concluded that, the genotypes Praga and Gioele are resistant. In addition it has to be taken into consideration that some genotypes like Dark Dona was found to be medium resistant to the isolate IIHR. Except for a very few genotypes, most of the genotypes showed a varying range of reaction against the pathogen *Fusarium oxysporum*f. sp. *dianthi*. Similar instances were reported by Ligero *et. al.,*2007. Pathogenicity tests conducted under a controlled environment in growth chambers or greenhouses are useful to evaluate the resistance or susceptibility of carnation cultivars to particular isolates of the pathogen but do not predict the degree of resistance under conditions in commercial greenhouses where different races frequently occur together [5]. Under such conditions, resistance to Fod might be shown as a delay in the onset of an epidemic or a reduction in the rate of disease progress compared with susceptible cultivars [11]. Therefore, artificial inoculation of carnation cuttings grown in pots usually provides evidence of the potential of virulence that would not necessarily coincide with the reactions under natural conditions [5].

Conclusion

Screening twenty carnation genotypes for resistance against two isolates of *Fusarium oxysporum* f. sp. *dianthi* revealed that the genotype Praga was resistant to both isolates of *Fusarium oxysporum* f. sp. *dianthi viz*., IIHR and Pune, in addition the genotype Gioele was found to be resistant for the isolate IIHR. The experiment helped identify resistant genotypes for commercial cultivation in region infected with the above used isolates *viz*., IIHR and Pune. Thereby, the losses occurring due to *Fusarium* pathogens can be avoided using the resistant genotypes identified above.

Acknowledgement / Funding:
The Department of Plant Pathology, Indian Institute of Horticultural Sciences, Hessarghatta, Bangalore has helped by providing the required isolates for the experiment.

Author Contributions:
Dr. M. V. Dhananjaya, Principle Scientist, Indian Institute of Horticultural Sciences, Hessarghatta, Bangalore has helped out by guiding me and by providing the required facilities and expertise, whereas, Dr. G. K. Halesh has helped in statistical analysis.

Abbreviations:
Fod: *Fusarium oxysporum* f. sp. *dianthi*
IIHR: Indian Institute of Horticultural Research
PDA: Potato Dextrose Agar
PDI: Per cent Disease Incidence

References

[1] Ana Maria Prados-Ligero, Maria Jose Basallote-Ureba, Carlos Jose Lopez-Herrera and Jose Maria Melero-Vara (2007) *Hort. Sci.,* 42(3), 596–599.
[2] Arbelaez G. (1987) *Acta Hort.,* 216, 151-157.
[3] Baker R.R., Nelson P.E. and Lawson R.H. (1985) *Diseases of Floral Crops,* 1, 507-563.
[4] Ben-Yephet Y., Reuven M., Szmulewich Y. and Mor Y. (1994) *Crop Prot.,* 13, 357-361.
[5] Ben-Yephet Y. and Shtienberg D. (1997) *Phytoparasitica.,* 25, 207–216.
[6] Filgueira J. (2009) *Revista de la Asociación Colombiana de Exportadores de Flores (Asocolflores),* 72, 53-54.
[7] Filgueira J. (2011) Experienceias en mejoramiento del clavel (*Diantuscaryophyllus*). Universidad Militar Nueva Granada, Bogota. 183-185.
[8] Fattahi B., Rahanandeh H., Chavoshi S., Zamanisadeh H.R., Bayat H., Moshayedi M. (2014) *Int. J. Biosci.,* 4, 143-148.
[9] Garibaldi A. and Gullino M.L. (2012) *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.
[10] Leslie J.F. and Summerell B.A. (2006) The *Fusarium* Laboratory Manual. Blackwell Publishing Professional, Ames, IA USA.
[11] Melero-Vara J.M., Prados A.M., Basallote M.J. and Lopez-Herrera C.J. (2005) *Acta Hort.,* 698,175–179.
[12] Prados-Ligero A. M., Basallote-Ureba M. J., Lopez-Herrera C. J., Melero-Vara J. M. (2007) *Hort. Sci.,* 42, 596-599.
[13] Zhang J., Xingxing W., Yunqing B., Yixin W., Guanhui I., Yueqiu H. and Zichao M. (2011) *J. Phytopathol.,* 16, 850-854.