

Original Research Article

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Efficacy of Fungicides in Control of *Fusarium oxysporum* f. sp. *dianthi*, the Cause of Wilt in Carnation

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ABSTRACT

Keywords

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The fungus that causes wilt of carnations is *Fusarium oxysporum* f. sp. *dianthi*, specific only to carnations and closely related plants. In our study, six fungicides were selected and tested their efficacy in reducing the Fusarial population and wilt incidence. The fungicides were applied to the soil by drenching method. Fusarium population was recorded at before the application of fungicides and every 15 days interval upto 45th day after application. Among all the tested fungicides, propiconazole @0.1 per cent (1.66×10^3 cfu per gram of soil and 9.33% wilt incidence) followed by carbendazim @0.2 per cent (2.66×10^3 cfu per gram of soil and 11.19% wilt incidence) were significantly found effective in reduction of soil population of *Fusarium* and wilt incidence in polyhouse condition.

Introduction

Carnation (*Dianthus caryophyllus* L.) is one of the most important commercially grown flowers of the world. It is native to Mediterranean region. It belongs to family caryophyllaceae. It is popular as cut flower on account of its exquisite shape, wide range of colours, good vase life and light in weight which makes it ideal for distant markets. In Karnataka, Carnation is grown under 19 units with a production of 338 lakh tons cut flowers per annum, valuing 1029 lakh rupees, as per 2002-03 estimates (Anon., 2004).

The average yield level per hectare in Karnataka is very low; many factors may be

attributed for the low yields, of which one of the important factors may be poor management of pests and diseases.

A number of biotic stresses such as, the fungal diseases are fusarium wilt (*Fusarium oxysporum* f.sp. *dianthi*), bud rot (*Rhizoctonia solani*), rust (*Uromyces dianthi*), Grey mould (*Botrytis cinerea*), Stem and root rot (*Phytophthora* spp.), fairy ring spot (*Heterosporium edinulatum*), bacterial wilt (*Pseudomonas caryophylli*), southern blight (*Sclerotium rolfsii*). The Root knot nematode (*Meloidogyne incognita*) disease associated with carnation are predominant in India

(Nagesh *et al.*, 2001). Among all the pathogen, *Fusarium* wilt (*Fusarium oxysporum* f. sp. *dianthi*) is one of the major constraints worldwide in carnation (*Dianthus caryophyllus* Linn.) cultivation in greenhouse and field plantations.

The fungus is soil inhabitant and has the potential ability to cause significant yield reduction and loss in flower quality (Jacob and Krebs, 1985). The planting is done through cuttings and therefore the plant becomes more susceptible to this disease. Wilting occurs on the affected side of the plant, followed by vascular discolouration and stem necrosis.

Materials and Methods

***In vivo* evaluation of fungicides**

Field experiment was conducted in a farmer field at Yelachagere, Nelamangala Taluk, and Bengaluru district. The carnations wilt pathogen, *Fusarium oxysporum* f.sp. *dianthi*, the fungicide propiconazole (0.1%) difenconazole (0.1%), carbendazim (0.2%), captan (0.2%) benomyl (0.2%) and chlorothalonil (0.1%) were drenched to the *Fusarium* infected plants. The soil drenching of fungicides was done in different application. Each chemical drenched in following ways.

Details of the treatments imposed

Soil drenching of fungicides (One application)

T1 - Propiconazole @ 0.1% one application, T2 - Difenconazole @ 0.1% one application, T3 - Carbendazim @ 0.2% one application, T4 - Captan @ 0.2% one application, T5 - Benomyl @ 0.2% one application, T6 - Chlorothalonil @ 0.1% one application, T7 - Control without any fungicide.

Soil drenching of fungicides (Two applications)

T1 - Propiconazole @ 0.1% two application, T2 - Difenconazole @ 0.1% two application, T3 - Carbendazim @ 0.2 % two application, T4 - Captan @ 0.2 % two application, T5 - Benomyl @ 0.2% two application, T6 - Chlorothalonil @ 0.1% two application, T7 - Control without any fungicide.

Soil drenching of fungicides (Three applications)

T1 - Propiconazole @ 0.1% three application, T2 - Difenconazole @ 0.1% three application, T3 - Carbendazim @ 0.2% three application, T4 - Captan @ 0.2% three application, T5 - Benomyl @ 0.2% three application, T6 - Chlorothalonil @ 0.1% three application, T7 - Control without any fungicide.

The untreated beds were kept for comparison by without fungicide applications. Each treatment was replicated three times. The carnation variety was used in this experiments was Indios and soil type was red sandy loam. The design used for experiment was RCBD. Before soil application of fungicides, the *Fusarium* population was worked out by using PCNB agar medium. The soil samples were collected with an interval of 15 days and population of *Fusarium* was worked out by using PCNB agar medium and the wilt incidence also recorded in one square meter area and data converted in to per cent wilt incidence.

The fusarial population count, 10 grams of soil sample collected in each fungicides treated plots and poured to 90 ml water blank and shaken for 30minutes. After 1ml of supernatant collected and poured to 90ml water blank. Similarly serial dilution was made up to 10^6 . The one ml of dilution of 10^3 was poured on to sterilized petriplates. And

then 15ml of specific peptone PCNB agar medium was poured in to the petriplates. The petriplates were shaken clockwise and anticlockwise direction and the plates were incubated at room temperature for one week and further development of fusarial colonies on specific media were recorded.

Results and Discussion

Field evaluation of fungicides

The Fusarial population was reduced from 24 to 4×10^3 cfu per gram of soil, in the propiconazole applied soil. The same fungicide drenched twice and thrice on 15 and 30 days interval were recorded 3 and 1.66×10^3 cfu per gram of soil respectively (Tables 1, 2 and 3).

The fungicide difenconazole showed the soil population 5.0, 8.3 and 7.33×10^3 cfu per gram of soil in the fungicide applied once, twice and thrice respectively. Similar results were obtained by Nel *et al.*, (2007) reported that the DMI fungicides, prochloraz, propiconazole significantly reduced the incidence of *Fusarium oxysporum* f.sp. *cubense* with the root dip and soil drench treatments one week after planting up to 80.6 per cent. The fungicide benomyl recorded the least soil population of *Fusarium* viz., 2.33, 3.66 and 7.0×10^3 cfu/g, when the fungicide applied once, twice and thrice respectively.

The three time application of carbendazim reduced the soil population from 23.00 to 2.66×10^3 cfu per gram of soil. The results are comparable with Pratibha Sharma (2000) who found that carbendazim at 0.2 per cent was the best treatment amongst the fungicides tested against carnation wilt. Sunita and Katoch (2001) also reported that under field conditions carbendazim and benomyl reduced the carnation wilt incidence up to 80 per cent.

Effect of soil drenching on wilt incidence

The fungicide carbendazim reduced wilt incidence from 23.20 to 11.19 per cent in single application. The fungicides applied twice and thrice the wilt incidence significantly reduced to 5.00 and 0.00 per cent respectively. The carbendazim also inhibited the fungal growth of carnation wilt pathogen *Fusarium oxysporum* f.sp. *dianthi* *in vitro* condition and also the same fungicide drenched for three application reduced fusarial population in soil with wilt incidence. Similar observations have been made by Javed *et al.*, (1997), who achieved best control of *Fusarium solani* infection in onion by carbendazim *in vitro* and *in vivo*. Suppression of root colonisation of mung bean by *Fusarium* spp. (Shahzad, 1994).

Bavistin showed maximum inhibition of mycelium of *Fusarium solani* under *in vitro* conditions while under field conditions gave the lowest root rot incidence of *Acacia catechu* (Tomar, 2004). The results are comparable with Pratibha Sharma (2000) who found that carbendazim at 0.2 per cent was the best treatment amongst the fungicides tested against carnation wilt. Kapoor and Kumar (1991), Rathnamma (1994), Gopinatha *et al.*, (2006), Narendrappa and Jayarame Gowda (1995), Ghosh and Sinha (1981).

The wilt incidence reduced from 21 to 9.33 per cent in single application of propiconazole. In second and third application the wilt incidence was recorded 5.28 and 4.88 per cent respectively. Earlier reports suggested that the efficacy of propiconazole for disease control in several crop plants against various diseases. Propiconazole spray significantly reduced anthracnose of strawberry (Smith and Black, 1991), grey leaf spot of maize (Munkvold *et al.*, 2001) and fungal leaf spots of rye grass (Koelsch *et al.*, 1995).

Table.1 Management of carnation wilt by soil drenching with fungicides (One application)

Sl. No.	Treatments	Fusarial population (cfu/g of soil×10 ³)				Per cent wilt incidence	
		Zero day (Before application)	15 th day after application	30 th day after application	45 th day after application	Before application	45 th day after application
1.	Propiconazole @ 0.1%	24.00	14.00	13.00	4.00	21.00 (27.20)*	9.30(17.70)
2.	Difenconazole @ 0.1%	22.00	17.00	11.30	5.00	24.60 (29.70)	11.00(19.30)
3.	Carbendazim @ 0.2%	42.30	15.00	7.60	4.30	23.20 (28.70)	11.10(19.50)
4.	Captan @ 0.2%	41.00	32.00	16.60	10.60	19.90 (26.50)	12.30(20.50)
5.	Benomyl @ 0.2%	23.00	14.60	16.30	2.30	25.40 (30.20)	15.50(23.10)
6.	Chlorothalonil @ 0.1%	22.00	19.00	7.30	5.30	26.10 (30.70)	22.30(28.10)
7.	Untreated check	24.00	25.30	27.30	26.30	27.10 (31.40)	28.00(31.90)
S.Em±			0.78	0.66	0.49	0.77	0.75
CD @ 5 % level			2.41	2.04	1.52	2.38	2.32
CV %			6.94	8.08	10.31	5.60	8.34

*Figures in the parenthesis are arc sine transformed values

Table.2 Management of carnation wilt by soil drenching with fungicides (Two applications)

Sl. No.	Treatments	Fusarial population (cfu/g of soil×10 ³)				Per cent wilt incidence	
		Zero day (Before application)	15 th day after application	30 th day after application	45 th day after application	Before application	45 th day after application
1.	Propiconazole @ 0.1%	25.60	14.00	14.30	3.00	21.50(27.60)*	11.20 (19.60)
2.	Difenconazole @ 0.1%	23.60	17.00	11.00	8.30	15.50(23.10)	11.60 (19.90)
3.	Carbendazim @ 0.2%	12.60	15.00	7.30	4.60	15.50(23.10)	11.60 (19.90)
4.	Captan @ 0.2%	39.00	32.00	11.30	5.30	29.90(33.10)	20.50 (26.90)
5.	Benomyl @ 0.2%	21.60	14.60	11.60	3.60	23.50(28.90)	13.00 (21.10)
6.	Chlorothalonil @ 0.1%	23.30	19.00	11.60	3.60	28.10(32.00)	21.30 (27.50)
7.	Untreated check	25.60	25.30	27.30	26.30	27.10(31.40)	28.00(31.90)
S.Em±			0.84	0.78	0.61	0.44	0.63
CD @ 5 % level			2.59	2.41	1.89	1.37	1.94
CV %			6.06	6.94	7.87	9.81	4.88

*Figures in the parenthesis are arc sine transformed values

Table.3 Management of carnation wilt by soil drenching with fungicides (Three applications)

Sl. No.	Treatments	Fusarial population (cfu/g of soil×10 ³)				Per cent wilt incidence	
		Zero day (Before application)	15 th day after application	30 th day after application	45 th day after application	Before application	45 th day after application
1.	Propiconazole @ 0.1%	29.80	9.30	14.30	1.60	29.80(33.10)*	15.80 (23.40)
2.	Difenconazole @ 0.1%	15.60	17.60	11.00	7.30	15.60(23.20)	9.20 (17.70)
3.	Carbendazim @ 0.2%	22.80	43.30	7.30	2.60	22.80(28.50)	12.70 (20.90)
4.	Captan @ 0.2%	25.30	21.60	11.30	3.60	25.30(30.20)	18.60 (25.50)
5.	Benomyl @ 0.2%	23.10	14.60	11.60	7.00	23.10(28.70)	15.00 (22.80)
6.	Chlorothalonil @ 0.1%	29.60	20.30	11.60	6.30	29.60(32.90)	19.00 (25.80)
7.	Untreated check	27.10	25.30	27.30	26.30	27.10(31.40)	28.00 (31.90)
S.Em±			0.64	0.82	0.78	0.66	0.64
CD @ 5 % level			1.97	2.53	2.41	2.03	1.97
CV %			4.47	6.53	6.94	14.56	4.47

*Figures in the parenthesis are arc sine transformed values

The fungicide propiconazole was the most important groups of fungicides (Baldwin and Rathmell, 1988). This fungicide showed that the greatest effectiveness in inhibiting *Fusarium oxysporum* f.sp. *cubense* growth *in vitro* as well as suppression of the disease in the green house and they act by inhibiting the demethylation step in the biosynthesis of sterol, which is need in fungal cell walls, they most likely bind to cytochrome P-450 involved in sterol demethylation (Uesugi, 1998). Nel *et al.*, (2007) reported that the fungicides, propiconazole significantly reduced the incidence of *Fusarium oxysporum* f.sp. *cubense* with the soil drench treatments 1 week after planting up to 80.6 per cent. Several workers also reported the effectiveness of propiconazole against *Fusarium* pathogen (Gopinatha *et al.*, 2006; Soad Ahmed and Amar Hemada, 2005).

The wilt incidence in benomyl treated plot reduced to 25.44 to 10.00 per cent in single application of fungicide. The wilt incidence reduced in second and third application of fungicide that is 8 and 4 per cent respectively. Benomyl being a systematic fungicide, acts as a multiplication inhibitor during fungal mitosis (Uesugi, 1998). In the current study, benomyl inhibited the mycelia growth of both *Fusarium oxysporum* f.sp. *dianthi* isolates effectively at a high concentration. In the greenhouse trials benomyl was most effective especially as a soil drench for three application. Ram *et al.*, (2004) reported that benomyl was the most effective treatment for the control of corn rot caused by *Fusarium oxysporum* f.sp. *gladioli*, followed by carbendazim.

Sunita and Katoch (2001) also reported that, under field conditions carbendazim and benomyl reduced the carnation wilt incidence up to 80 per cent. These results are in line with Fletcher and Martin, (1972) found that soil drenching of benomyl at the rate of 1.5 g

per liter suppressed the symptom expression of fusarium wilt of carnations.

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