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Evaluation of Various Management Techniques against Chilli Anthracnose, *Colletotrichum capsici* (Sydow) in Western Himalayan Zone of Uttarakhand

Vivekanand[1], S. Ravi[2*], R. C. Mishra[3] and P. Bahuguna[4]

[1&2]Department of Plant Pathology, [3]Department of Entomology, [4]Department of Basic Sciences and Humanities, College of Horticulture, VCSG UUHF Bharsar, Pauri Garhwal, Uttarakhand-246 123

*Corresponding Author E-mail: sraviachieve@gmail.com

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ABSTRACT

Evaluated the efficacy of different management methods under in vivo condition i.e. two chemicals, Captan and Mancozeb (2.5g/kg), two bioagents Trichoderma harzianum and Pseudomonas fluorescens (5g/kg) and hot water treatment (55 ^{0}C for 30 min) as seed treatment. Mancozeb among chemicals was found effective to reduce per cent disease index (PDI) at 75 and 105 days after transplanting (DAT) whereas, Captan was found to reduced maximum PDI at 90 DAT. In case of bio agents T. harzianum was found effective for reduced maximum PDI at 75, 90 and 105 DAT while hot water treatment was found least effective. Among the combination treatments (i.e. Captan + Neem extract, Mancozeb + Garlic extract, T. harzianum + Captan and P. fluorescens + Carbendazim) in comparison to T. harzanium + Captan was found most effective with least per cent infected fruits (9.29%), disease incidence (6.67%), disease severity (5.36%) and disease index (4.70, 7.03 and 9.62%) at 75, 90 and 105 DAT respectively.

Key words: *Chilli, Anthracnose, Colletotrichum capsici, Fungicides, Botanicals, Bioagents, PDI.*

INTRODUCTION

Chilli (*Capsicum annuum* L.), is an important vegetable crop grown worldwide. India accounts for 25% of the world's total production of chilli[1]. The sustainability of chilli-based agriculture is threatened by a number of factors. Anthracnose disease caused by *Colletotrichum capsici* (Sydow) is a major problem in India and one of the most significant economic constraints to chilli production worldwide[15]. Symptoms of anthracnose appears in three phases *viz*., i) Seedling blight or damping off, prevalent in the nursery, ii) leaf spotting and die-back which is initiated at different stages of growth. Die-back infection starts from the growing point of secondary branches gradually advances downwards and involves the entire branch and iii) fruit spotting and rotting[13]. It may cause yield losses of up to 50%[10]. The control of chilli anthracnose has, for many years, relied on chemicals and resulted in many undesirable problems.

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There are numerous reports of negative effects of using chemicals on farmers' income and toxic contamination to the developing environment[16]. Thus, there is a need to incorporate alternative control components that are effective in field. The use of botanical oils and biocontrol agents along with effective and safe fungicides is the best alternative for management of chilli anthracnose. Hence, the present investigation was undertaken to find the eco-friendly management of anthracnose of chilli caused by *Colletotrichum capsici*.

MATERIAL AND METHODS

The field experiment was conducted at Vegetable Research and Demonstration Block, College of Horticulture, VCSG UUHF Bharsar, about 58 km away from Pauri city, situated at an altitude of 1900 meters above mean sea level. Geographical position of experimental site lies between latitude 29^0 North and of 78^0 East longitudes under western himalayan zone of Uttarakhand.

Evaluation of different treatments: Two contact fungicides (Captan 50%WP, Mancozeb 75%WP @ 2.5g/kg seed), two bioagents (*Trichoderma harzianum* and *Pseudomonas fluorescens* @ 5.0g/kg seed) and hot water treatment (55^0C for 30 min) were evaluated as seed treatment. Seed treatment was done before 24 hrs of seed sowing and the treated seeds were shade dried before sowing. Four combination treatments viz., Captan + Neem extract, Mancozeb + Garlic extract @ 1.25g/kg seed+1ml/lit (seed treatment + foliar spray), *T. harzianum* + Captan @ 2.5g/kg seed+1g/lit (seed treatment + foliar spray) and *P. fluorescens* + Carbendazim @ 2.5g/kg seed+0.5g/lit (seed treatment + foliar spray) were also evaluated *in vivo* condition. The experiment was conducted during *kharif* season 2016. The seedlings of chilli 'Byadagi Kaddi' variety were planted in plot size of 1.8 m × 1.35 m with spacing 60 cm × 45 cm. There were ten different treatments with three replications laid out in a randomized complete block design. Three sprays were taken up starting at 20, 35 and 50 days after transplanting (DAT). Die-back and fruit rot incidence and its severity was recorded. The fruit rot severity was assessed following the score chart given by Wheeler[17]. Similarly, die-back severity was also recorded by referring the following 0-9 scale as given below.

Category	Grade/numerical value	Fruit surface covered
I	0	No infection
II	1	Slight-10% infection
III	3	11-25% infection
IV	5	26-50% infection
V	7	51-75% infection
VI	9	<75% infection

Disease Index (PDI) was calculated by using the following formula proposed by Wheeler[17]**:-**

$$PDI = \frac{\text{(Sum of all numerical ratings)}}{\text{(Total no. of sample observed)}\times\text{(maximum disease grade)}} \times 100$$

Per cent infected fruits per plant: Total number of infected fruits selected from plants at every picking was recorded. Percentage of infected fruits was recorded by adopting the grading formula of Siddaramaiah *et al*[12].

$$\text{Per cent infected fruit} = \frac{\text{No. of infected fruits}}{\text{Total no. of fruits}} \times 100$$

Disease (die back) incidence: Disease incidence/die-back incidence was estimated by using following formula.

$$\text{Disease (die back) incidence} = \frac{\text{No. of infected plants}}{\text{Total no. of plants observed}} \times 100$$

Disease severity: Disease severity was calculated with the help of following formula and the scoring table given by Wheeler[17].

$$\text{Disease severity} = \frac{\text{Sum of all disease rating}}{\text{Total no. of rating} \times \text{maximum disease grade}} \times 100$$

Statistical analysis of the data simple randomized complete block design (RCBD) was performed with the help of OPSTAT and Graph Pad (3.05).

RESULTS AND DISCUSSION

Present investigation was carried out to evaluate ten different management methods have used. Per cent disease index (PDI) at 75 days: The observations recorded for this trait showed significant differences between check and all of the treatments accept hot water treatment. The mean performance of the treatments ranged from 4.70-20.00% in (Table 1). Significantly lower per cent of disease index (PDI) were observed after 75 days in the treatment *Trichoderma harzianum*+ Captan (4.70%) which was found statistically at par with *Pseudomonas fluorescens*+ Carbendazim (6.29%) and Mancozeb + Garlic extract (7.40%). Whereas, maximum was observed in check (20.00%), followed by Hot water treatment (17.03%), *P. fluorescens* (13.33%) and *T. harzianum* (12.59%). Per cent disease index at 75 days after observations found much in check comparison to all treatments in (Fig.1).

Per cent disease index (PDI) at 90 days: The data presented in (Table 1) revealed that significant variations for disease index between check and all of the treatments accept hot water treatment and *Pseudomonas fluorescens*. It ranged from 7.03-27.77%. Significantly lower per cent of disease index was observed in the treatment *Trichoderma harzianum*+ Captan (7.03%) which disease found statistically at par with *P. fluorescens*+ Carbendazim (8.14%) and Mancozeb + Garlic extract (10.74%), whereas, maximum was observed in check (27.77%), followed by Hot water treatment (23.70%), *P. fluorescens* (21.48%) and *T. harzianum* (19.26%). All the treatments showed less per cent disease index at 90 days after transplanting and in check found maximum disease index in (Fig.1).

Per cent disease index (PDI) at 105 days: The observations recorded for this trait showed significant differences between check and all of the treatments. The mean performance of the treatments ranged from 9.62-43.33% in (Table 1). Significantly lower per cent of disease index were observed after 105 days in the treatment *Trichoderma harzianum*+ Captan (9.62%) followed by, *Pseudomonas fluorescens* + Carbendazim (13.70%), Mancozeb + Garlic extract (17.77%) and Captan + Neem extract (18.51%) whereas, maximum was observed in check (43.33%), followed by Hot water treatment (35.92%), *P. fluorescens* (28.51%) and *T. harzianum* (25.18%). Most of the treatments found minimum per cent disease index than check at 105 days in (Fig.1). Pandey and Gupta[11] (2015) found minimum per cent disease index (PDI) of anthracnose (13.33%) when foliar sprayed with Mancozeb @0.3%. Begum *et al*[2]., 2015 related work have done like Integrated management of anthracnose of chilli caused by *Colletotrichum capsici.* Jayalakshmi *et al*[5]., used Trichoderma spp. for the management of chilli die-back and fruit rot.

Table 1: Effect of different treatments on per cent disease index (PDI) after at 75, 90 and 105 DAT

Treatments	***PDI (die back)**		
	75 days	**90 days**	**105 days**
Captan	10.74 (19.08)	15.55 (23.18)	21.10 (27.32)
Mancozeb	10.37 (18.75)	16.29 (23.73)	20.74 (27.07)
Trichoderma harzianum	12.59 (20.76)	19.26 (25.96)	25.18 (30.07)
Pseudomonas fluorescence	13.33 (21.36)	21.48 (27.52)	28.51 (32.22)
Hot water	17.03 (24.33)	23.70 (29.12)	35.92 (36.79)
Captan + Neem extract	9.48 (17.88)	13.33 (21.36)	18.51 (25.47)
Mancozeb + Garlic extract	7.40 (15.52)	10.74 (19.08)	17.77 (24.90)
Trichoderma harzanium + Captan	4.70 (12.51)	7.03 (15.30)	9.62 (18.04)
Pseudomonas fluorescens+ Carbendazim	6.29 (14.51)	8.14 (16.54)	13.70 (21.67)
Control	20.00 (26.53)	27.77 (31.72)	43.33 (41.14)
C.D. (0.05)	**3.40**	**4.71**	**4.84**

*PDI = Per cent disease index

( ) = Values in parentheses are angular transformed.

Per cent infected fruits/plant: The observations were recorded for per cent infected fruits per plant showed significant differences between check and all of the treatments. The mean performance of the treatments ranged from 9.29-39.77% in (Table 2). Significantly lower percentage of infected fruits per plant were observed in the treatment *Trichoderma harzianum*+ Captan (9.29%) which was found statistically at par with *Pseudomonas fluorescens*+ Carbendazim (10.94%) and Mancozeb + Garlic extract (12.50%) and Captan + Neem extract (15.17%). While maximum per cent of infected fruits per plant were recorded in the Check (39.77%), followed by hot water treatment (33.25%) and *P. fluorescens* (25.27%). All the treatments were found less and superior in check for per cent infected fruits per plant in (Fig.2). Suthin Raj and Christopher[14], Choudhary *et al.*[3], and Machenahalli *et al.*[8], have also found similar result.

Disease (die back) incidence: The data has presented in (Table. 2) and revealed significant variations for disease incidence between check and most of the treatments. It ranged from 6.67-60%. Significantly lower percentage of incidence were observed in the treatment *Trichoderma harzianum* + Captan (6.67%) which was found statistically at par with *Pseudomonas fluorescens*+ Carbendazim (13.33%), Mancozeb + Garlic extract (13.33%) and Captan + Neem extract (20.00%). While maximum per cent of incidence were recorded in the check

(60.00%), which was found statistically at par with Hot water treatment (46.67%), *P. fluorescens* (40.00%), *T. harzianum* and Mancozeb (33.33%). All the treatments observed and found that minimum than check for per cent disease incidence in (Fig.2). Ngullie *et al.*[9], the minimum disease incidence was recorded with Bavistin (0.1%) with 9.26%. Among the antagonists i.e. *T. viride* significantly reduced the disease whose incidence was 18.65% compared to 48.33% in the control. Among the plant extracts tested, *A. sativum* (10%) confined the least fruit rot incidence (25.62%). Datar *et al.*[4], found under the field trials for three seasons using Mancozeb (0.25%) which resulted highest yield and lowest incidence of *Colletotrichum capsici* in the susceptible chilli variety. Kumawat[7] reported the use of fungicides such as mancozeb, thiophanate methyl, ziram, carbendazim for the control of anthracnose of chilli. Three sprays of mancozeb @ 0.25% at 15 day intervals gave the highest reduction in disease incidence, followed by thiophanate methyl, ziram and carbendazim.

Disease severity: The observations were recorded for disease severity showed significant differences between check and all of the treatments. The mean performance of the treatments ranged from 5.36-30.54% in (Table 2). Significantly lower percentage of disease severity were observed in the treatment *Trichoderma harzianum* + Captan (5.36%) which was found statistically at par with *Pseudomonas fluorescens*+ Carbendazim (6.14%) and Mancozeb + Garlic extract (8.19%). While maximum per cent of severity were recorded in the check (30.54%), followed by hot water treatment (22.49%), *P. fluorescens* (17.47%) and *T. harzianum* (15.63%). Per cent disease severity have observed maximum in check comparatively other treatments showed in (Fig.2) Suthin and Christopher[14], Kumar and Vyas[6], Choudhary *et al.*[3], and Machenahalli *et al.*[8], have also done similar work.

Table 2: Evaluation of per cent infected fruits/plant, disease incidence and disease severity under field condition

Treatments	**Per cent infected fruit/plant**	**Disease (die-back) Incidence**	**Disease Fruit rot severity**
Captan	18.88 (25.72)	26.67 (30.78)	11.21 (20.56)
Mancozeb	19.25 (25.99)	33.33 (35.00)	12.34 (19.56)
Trichoderma harzianum	23.88 (29.19)	33.33 (34.62)	15.63 (23.28)
Pseudomonas fluorescence	25.27 (30.13)	40.00 (39.22)	17.47 (24.67)
Hot water	33.25 (35.15)	46.67 (42.68)	22.49 (28.19)
Captan + Neem extract	15.17 (22.77)	20.00 (21.92)	10.25 (18.64)
Mancozeb + Garlic extract	12.50 (20.56)	13.33 (13.07)	8.19 (16.62)
Trichoderma harzanium + Captan	9.29 (17.62)	6.67 (8.85)	5.36 (13.36)
Pseudomonas fluorescens+ Carbendazim	10.94 (19.25)	13.33 (17.70)	6.14 (14.33)
Control	39.77 (39.07)	60.00 (51.12)	30.54 (33.49)
C.D. $_{(0.05)}$	**6.35**	**31.14**	**4.37**

( ) = Values in parentheses are angular transformed.

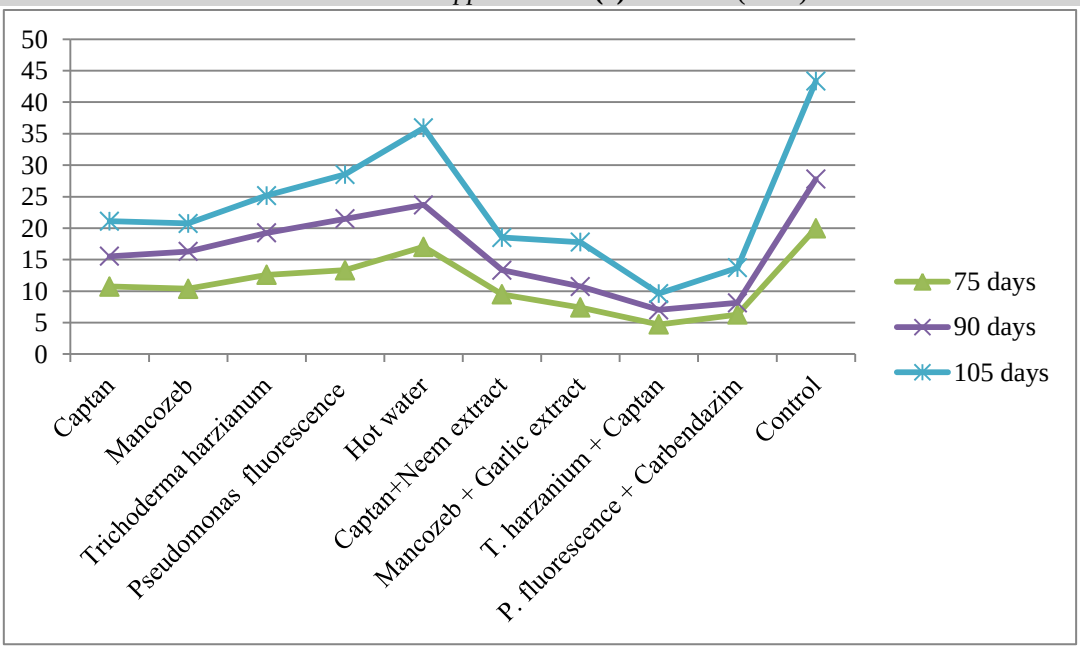

Fig. 1: Effect of different treatments on per cent disease index (PDI) after at 75, 90 and 105 DAT

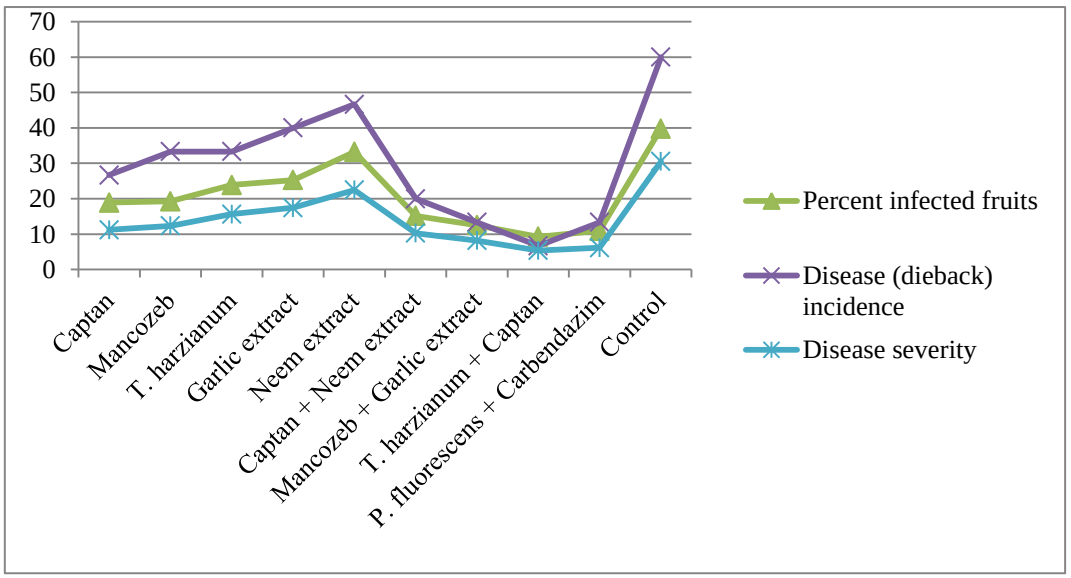

Fig. 2: Evaluation of per cent infected fruits/plant, disease incidence and disease severity under field condition

CONCLUSION

Management of chilli anthracnose in Bharsar, Pauri Garhwal condition. Our recent study was based on different treatments showed that among alone treatment of Captan was found most least per cent infected fruit/plant, disease incidence and disease severity. The bioagents were found economically important options, in combination basis *T. harzianum* + Captan was found most least per cent infected fruit/plant, and also it was found most effective with least disease incidence, disease severity and PDI at 75, 90 and 105 DAT respectively.

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