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Management of Anthracnose Disease of Chilli Caused by *Colletotrichum capsici*

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ABSTRACT

Chilli crop suffers from various diseases in which anthracnose caused by *Colletotrichum capsici* is a very serious one, causes huge yield losses in India. The present investigation was carried out to find out its suitable control measures by evaluating different fungicides including botanicals and bio-agent first *in vitro* followed by in field at MES, Vegetable Science, ANDUAT, Kumarganj, Ayodhya. *In vitro* propiconazole @ 0.1% and hexaconazole @ 0.1% completely inhibited growth of the fungus followed by copper oxychloride @ 0.4%, garlic bulb extract @5% and NSKE @ 5% and *Trichoderma harzianum* @5% which inhibited (80.88%) mycelial growth of the fungus. In field conditions seed treatment with *T. harzianum* + Foliar spray with propiconazole was found best with minimum disease intensity (9.37%) and highest yield (151.42 q/ha) in comparison to other treatments.

Keywords Chilli, Anthracnose, Management.

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INTRODUCTION

Chilli (*Capsicum annuum* Linn.) is an important extensively grown spice crop. It belongs to the family Solanaceae. Approximately 20-27 species of chilli, five of which are domesticated viz., *C. annuum, C. baccatum, C. chinense, C. frutescens,* and *C. pubescensare* cultivated in different parts of the world. Among them, *C. annuum* is one of the most common cultivated worldwide followed by *C. frutescens* (Bosland and Votava 2013). In India, total area under chilli cultivation is 377 thousand ha with production of 3783 thousand MT during 2019-20 (Anonymous 2019-20). The major chilli growing states are Andhra Pradesh, Karnataka, Maharashtra, Orissa, Tamil Nadu, Madhya Pradesh, West Bengal and Rajasthan that account for more than 80% of the total area and production.

This crop suffers from many diseases caused by fungi, bacteria, viruses and nematodes along with abiotic stresses. Among the fungal diseases

damping off (*Pythium aphanidermatum*), powdery mildew (*Leveillula taurica*), anthracnose of fruit rot (*Colletotrichum capsici*) and Cercospora leaf spot (*Cercospora capsici*) are the major diseases. Out of these fungal disease anthracnose/ dieback/ fruit rot caused by *Colletotrichum capsici* is a major obstacle for successful chilli cultivation. Typical anthracnose symptoms on fruit include sunken necrotic tissues with concentric ring of acervuli. Fruit showing blemishes have reduced marketability (Manandhar *et al.* 1995). During the die back stage of the disease, growing tip shows the start of infection as sunken lesions leading to death of the growing tip and finally the infection proceeds backward on the branch. Severely infected fruits look straw color and bear numerous acervuli in concentric rings. Around 27°C temperature, 80% relative humidity and soil pH 5-6 promote infection and disease progress. The disease has been observed to occur in three phases viz., (i) seedling blight or damping off stage, prevalent in the nursery, (ii) leaf spotting and die back stage which is initiated at different stages of growth and (iii) fruit rot stage in which the ripe fruit are infected. The average disease incidence level ranges between 66% to 84% which results in yield loss up to 12-50% (Thind and Jhooty 1985). Therefore, the study was conducted to evaluate some fungi-toxicants along with neem seed kernel extract, garlic extract and *Trichoderma harzianum* against the pathogen in lab and in field conditions to develop efficient cost- effective management method for anthracnose of chili.

MATERIALS AND METHODS

In vitro evaluation of biocontrol agent

The antagonistic activities of biocontrol agent *Trichoderma harzianum* were evaluated under *in vitro* conditions using dual culture technique as described by Morten and Stroube (1995). Five mm diameter disc of actively growing pathogen (*C. capsici*) taken from the margin of 10 days old culture was placed at one end of petri plates containing solidified potato dextrose agar (PDA) mehdium. The inoculation of mycelia disc (5 mm) of antagonist at the opposite end of petri plate was done 3 days after the placement of pathogen in order to adjust the slow growth rate of pathogen. The experiment was conducted under Completely Randomized design with three replications. The inoculated plates incubated at 27± 1°C and radial growth of the pathogen was recorded. Percent growth inhibition over control was calculated by using the following formula.

$$\text{Growth inhibition} = \frac{\text{Radial growth in control} - \text{Radial growth in treatment}}{\text{Radial growth in control}} \times 100$$

$$\text{PDI} = \frac{\text{C-T}}{\text{C}} \times 100$$

Where,

C= Growth of test fungus in control plate (mm)

T= Growth of test fungus in treatment plate (mm)

Evaluation of fungi toxicants under *in-vitro* conditions

Two systemic fungicides, propiconazole @ 0.1%, hexaconazole @ 0.1%, one contact fungicides copperoxychloride @ 0.4%, garlic bulb extract@5.0% and neem seed karnel extract@ 5.0% were assayed for their efficacy against *C. capsici* under *in vitro* condition using poisoned food technique (Nene and Thapliyal 1993) in three replications. All the glass wares and poisoned media were sterilized properly before use. Each of the test fungicides and its concentration were replicated twice. PDA without fungicides served as control. Observation on sporulation of the test fungus and radial mycelium growth were recorded when whole of the plate in control treatment was finally covered with mycelium growth. Percent inhibition of each treatment was calculated by using formula given by Vincent and Curtis (1927).

$$\text{PDI} = \frac{\text{C-T}}{\text{C}} \times 100$$

Where, C = Growth of test fungus in control plate(mm)

T = Growth of test fungus in treatment plate (mm)

In vivo/ field evaluation of fungicides, botanicals and bioagent

The field experiment was conducted at the MES, Vegetable Science, ANDUA and T, Kumarganj, Ayodhya to evaluate the efficacy of fungicides, botanicals and

bioagent against *C. capsici* during *rabi* 2021. Field experiment was conducted in Randomized Block Design with three replications and seventeen treatments. Plot size was 3M × 2 M and row to row and plant to plant distance were kept 50 × 20 cm.

Fungicides/ botanicals/ bioagents

Four fungicides, namely propiconazole, hexaconazole, azoxystrobin and copperoxychloride; pure culture of bio-control agent *Trichoderma harzianum;* botanicals viz., NSKE and Garlic bulb extract were collected from Department of Plant Pathology and local market that were used *in vitro* and *in vivo* experiments conducted during the studies.

35 days old seedlings of chilli variety Kashi -2 was transplanted in experimental plots seedling were treated with *Trichoderma harzianum* and propiconazole using seedling dip method further the crop was raised as per recommended package of practices and irrigation was done as and when required. The quantity of spray material required per plant was calibrated and first spray of fungicides, bioagent and plant extract was taken immediately after the first appearance of disease. A total of three spaying at the intervals of 40, 60 and 90 days were given starting after first appearance of anthracnose disease. A control plot was also maintained without spraying any fungicides. Observation on foliage anthracnose disease intensity was recorded one day before each spraying and last observation was recorded at 15 days after last spraying. Percent disease intensity is calculated by using following formula:-

$$PDI = \frac{\text{Sum of the numerical value}}{\text{No. of leaves observed} \times \text{maximum disease rating}} \times 100$$

$$PDC = \frac{\text{PDI in control plot} - \text{PDI in treated plot}}{\text{PDI in control plot}} \times 100$$

RESULTS AND DISCUSSION

***In vitro* evaluation of fungi-toxicants for the control of the disease**

Among the six fungitoxicants evaluated against *C. capsici* revealed (Table 1) that all the fungi-toxicants significantly inhibited the mycelia growth of *C. capsici* over control. Two fungicides Propiconazole and Hexaconazole were found the most effective fungicides, both the fungicides completely inhibited growth of the fungus at 0.1% concentration followed by copper oxychloride (0.4%) inhibited 97.33 growth, Garlic bulb extract (5%) with 80.26% inhibition and *T. harzianum* (0.5 %) with 88.88% inhibition. However, NSKE (5%) found less effective (inhibition % 77.29) over control. These results of the present study are in conformity with those reported earlier by Katediya *et al.* (2019) who found Copper oxy- chlorides (0.5%) and Propiconazole (0.1%) as significantly superior over rest of the fungicides. Ngullie *et al.* (2010) evaluated plant extract, antagonists and fungicide and revealed that spraying with *Trichoderma viride* (2%) showed a maximum disease reduction of 61.41%. Lokhande *et al.* (2019) also evaluated various biocontrol agents and found *Trichoderma viride* as best biocontrol agent in inhibiting the growth of *C. capsici* but neem oil and garlic bulb extract were also found effective.

Table 1. *In-vitro* evaluation of various chemical fungicides/ botanicals against *Colletotrichum capsici.*

Sl. No.	Fungitoxicant	Dose	Mean radial growth	Mean percent inhibition
1	Propiconazole	0.1%	00.00	100
2	Hexaconazole	0.1%	00.00	100
3	Copper oxy chloride	0.4%	2.33	97.33
4	Garlic bulb extract	5.0%	17.33	80.26
5	NSKE	5.0%	19.50	77.79
6	*T.harzianum*	0.5%	18.08	80.88
7	Control	00	87.83	00.00
	CD (5%)		**1.03**	
	SEm ±		**0.33**	

Evaluation of fungitoxicants for control of the disease in field conditions.

The data presented in Table 2 seems that all the treatments were effective in controlling the disease intensity as compared to control. In field experiment, seventeen different treatments, in combination of seed treatment with foliar spray of fungicides, were tested for controlling the disease. Treatment T_4 (Seed treatment with *T. harzianum*+ Foliar Spray with Propiconazole) was most effective with lowest PDI

Table 2. Field *(In-vivo*) evaluation of various treatments against *Colletotrichum capsici.*

	Combination	Conc	Percent disease intensity Foliar spray after 40 days	Foliar spray after 60 days	Foliar spray after 90 days	Average PDI	Average PDC	Yield in quintal/ha	Increased yield over control
T_1	ST with *T.harzianum*	0.5	25.93	27.89	26.49	26.77	33.86	106.25	7.13
T_2	ST with propiconazole	0.1	31.77	33.75	32.64	32.72	19.16	102.26	3.14
T_3	T_1+ FS with *T. harzianum*	0.5	20.36	17.72	12.58	16.88	58.30	115.25	16.13
T_4	T_1 + FS with propiconazole	0.1	8.64	10.18	9.31	9.37	76.85	151.42	52.30
T_5	T_1 + FS with hexaconazole	0.1	11.97	9.87	12.83	11.55	71.46	149.87	50.75
T_6	T_1 + FS with NSKE	05	22.87	18.45	12.25	17.85	55.90	111.28	12.16
T_7	T_1 + FS with garlic extract	05	21.67	18.38	12.25	17.43	56.94	112.34	13.22
T_8	T_1 + FS with Copper oxy-chloride	0.4	19.66	15.63	11.37	15.55	61.58	132.89	33.77
T_9	T_1 + FS with Azoxystrobin	0.1	16.94	13.69	10.87	13.83	65.83	142.43	43.31
T_{10}	T_2 + FS with *T. harzianum*	0.5	21.52	16.26	13.98	17.25	57.38	114.32	15.25
T_{11}	T_2 + FS with propiconazole	0.1	17.26	12.36	7.59	12.40	69.36	148.82	49.70
T_{12}	T_2 + FS with hexaconazole	0.1	16.28	13.69	10.72	13.56	66.50	148.56	49.44
T_{13}	T_2 + FS with NSKE	05	23.63	18.55	14.25	18.81	53.53	110.46	11.34
T_{14}	T_2 + FS with garlic extract	05	22.46	18.56	13.37	18.13	55.21	110.48	11.36
T_{15}	T_2 + FS with Copper oxy-chloride	0.4	20.78	15.54	12.82	16.38	59.53	130.16	31.04
T_{16}	T_2 + FS with Azoxystrobin	0.1	19.54	14.66	9.50	14.56	64.03	140.52	41.40
T_{17}	Control	Water	35.87	42.58	44.50	40.48	00.00	99.12	00.00
	CD					**3.41**	**08.81**	**19.85**	**05.40**
	SE±					**1.18**	**3.08**	**06.89**	**01.87**

(9.37%), highest yield (151.42 q/ha), inhibited 76.85% disease severity as compare to control followed by treatment T_4 (Seed treatment with *T. harzianum*+ FS with Hexaconazole) with PDI 11.55% and yield 149.87 q/ha, which disease inhibition percent 71.46 and treatment T_{11}(Seed treatment with Propiconazole + FS with Propiconazole) with PDI 12.40% and yield 148.82 q/ha, which inhibited 69.36% disease severity as compare to control. The next effective treatment in decreasing order were T-12 (seed treatment with Propiconazole + FS with Hexaconazole), T_9 (Seed treatment with *T. harzianum*+ FS with Azoxystrobin), T_{16} (Seed treatment with Propiconazole + FS with Azoxystrobin), T_8 (Seed treatment *T. harzianum* + FS with Copperoxy- chloride), T_{15} (Seed treatment with Propiconazole + FS with Copper oxy-chloride),T_3 (Seed treartment with *T. harzianum*+ FS with *T. harzianum*), T_{10} (seed treatment with Propiconazole + FS with *T. harzianum*), T_7 (seed treatment with *T. harzianum*+ FS with Garlic bulb extract), T_6 (seed treatment with *T. harzianum* + FS with NSKE), T_{14} (seed treatment with Propiconazole + FS with Garlic bulb extract),T_{13} (seed treatment with Propiconazole + FS with NSKE). The least effective treatment was T_1 (seed treatment with *T. harzianum*) with PDI 26.77%, yield 106.25% which inhibited 33.86% disease severity and T_2 (seed treatment with Propiconazole) with PDI 32.72% and yield 102.26% which inhibited 19.16% disease severity as compare to control. Similarly Kumar (2016) found that propiconazole @ 0.1% significantly reduced the fruit rot (72.12%) and increased fruit yield (59.47%) of chilli followed by Azoxystrobin. Anand *et al.* (2020) reported hexaconazole as most effective in reducing fruit anthracnose (PDC 83.3%) and increasing fruit yield (225.50q/ha). Kamble *et al.* (2015) also reported propiconazole (0.1%) most effective against chilli anthracnose, followed by hexaconazole and copper oxychloride whereas *Trichoderma viride* as a bioagent and garlic as a botanical, also effectively managed the disease. Sopialena *et al.* (2018) reported that neem leaves are the most effective organic pesticides to control the chilli pepper disease in Indonesia. Yadav *et al.* (2010) reported propiconazole as best fungicides over hexaconazole. Among botanicals NSKE was most effective. Rashid *et al.* (2015) and Begum and Nath (2015) reported extract of neem and garlic plant extract applied as foliar spray were cost effective, environment friendly and a better option for the management of anthracnose of chilli.

REFERENCES

Anand A, Gupta HB, Chourasia HK (2020) Management of Anthracnose of red chilli caused by *Colletotrichum capsici.* Annals Pl Soil Res 22(4): 390-395. http://dx.doi.org/10.7744/kjoas.20160018

Anonymous (2020) Horticulture Statistics Division, Department of Agriculture, Co-operation and Farmer's welfare, Ministry of Agriculture and Farmers welfare, Government of India.

Begum S, Nath PS (2015) Eco-friendly management of anthracnose of chilli caused by *Colletotrichum capsici*. *J Appl Natural Sci* 7(1): 119-123. DOI: https://doi.org/10.31018/jans.v7i1.574

Bosland PW, Votava EJ (eds) (2013) Peppers: Vegetable and spice capsicums. *New Zealand J Crop Horticult Sci* 41(2): 102-103. http://dx.doi.org/10.1080/01140671.2012.745161

Kamble HN, Dhutraj DN, Utpal D (2015) Field management of anthracnose of chilli (*Capsicum annum*) caused by *Colletotrichum capsici. Ind Phytopathol* 68 (2) : 179-185. https://ebook.icar.gov.in/index.php/IPPJ/article/view/48608.

Katediya MA, Jaiman RK, Acharya SK (2019) Survey and screening of germplasm against chilli anthracnose. *Int J Chem Studies* 7(3): 543-545

Lokhande RD, Tiwari S, Patil RV (2019) Eco-friendly management of anthracnose of chilli (*Capsicum annuum* L.), caused by *Colletotrichum capsici*. *Int J Curr Microbiol Appl Sci* 8 (2) : 1045-1052. https://doi.org/10.20546/ijcmas.2019.802.123.

Manandhar JB, Hartman GL, Wang TC (1995) Anthracnose development on pepper fruit inoculated with *Colletotrichum gloeosporioides*. *Pl Dis* 79: 380-383. https://doi.org/10.1094/PD-79-0380

Morton DT, Stroube NH (1995) Antagonistic and stimulatory effect of microorganism upon *Sclerotium rolfsii. Phytopathology* 45:419-420. https://eurekamag.com/rsearch/030/096/030096313.php

Nene YL, Thapliyal PN (1993) Fungicides in plant disease control (No. Ed. 3). International Science Publisher.

Ngullie M, Daiho L, Upadhyay DN (2010) Biological management of fruit rot in the world's hottest chilli (*Capsicum chinense* Jacq.). *J Plant Prot Res* 50(3) : In prees. DOI: https://doi.org/10.2478/v10045-010-0047-8

Rashid MM, Kabir MH, Hossain MM, Bhuiyan MR, Khan MAI (2015) Eco-friendly management of chilli anthracnose (*Colletotrichum capsici*). *Int J Pl Pathol* 6 (1): 1-11. http://dx.doi.org/10.3923/ijpp.2015.1.11

Sopialena S, Sila S, Rosfiansyah R, Nurdiana J (2018) The role of neem as organic pesticides in chilli pepper (*Capsicum frutescens*). *Nusantara Bio Sci* 10(4): 246-250. http://dx.doi.org/10.13057/nusbiosci/n100408

Thind TS, Jhooty JS (1985) Relative prevalence of fungal disease of chilli fruit in Punjab. *J Mycol Pl Pathol* 15(3): 305-307. https://link.springer.com/article/10.1007/s13205-013-0134-4

Vincent S, Curtis FR (1927) A note on the teleostean adrenal bodies. *J Anatomy* 62(1) : 110.

Yadav AL, Ghasolla RP, Kumhar DR, Meena AK (2010) *In vitro* efficacy of plant extracts and fungicides to control fruit rot of chilli in India. *J Pl Develop Sci* 12(6): 355-360. http://jpds.co.in/wp-content/up loads /2020/07/05.-Arjun-Yadav-1765-9-7-2020.pdf