International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(6): 201-207
www.biochemjournal.com
Received: 12-03-2024
Accepted: 21-04-2024

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Study on integrated disease managment of Anthracnose in chilli (*Capsicum annuum* L.) caused by *Colletotrichum capsici* (Syd.)

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DOI: https://doi.org/10.33545/26174693.2024.v8.i6c.1297

Abstract
The present research work on evaluation of Studies on integrated diseases management of anthracnose *Colletotrichum chilli* (*Capsicum annum* L.) Caused by *capsici* (syed) Butler and Bisby During the period of October 2023 to March 2024 at Agricultural Research farm, Faculty of Agricultural Science and Allied Industries, Rama University Mandhana Kanpur Uttar Pradesh.
The anthracnose of chilli caused by *Colletotrichum capsici* (Syd.) is a wide spread problem limiting the profitable cultivation of chilli throughout the major chilli growing regions of India Present research was aimed to check the efficacy of various physical, botanicals, bio-agents and chemicals *in vitro* as well *in vivo* condition. Two botanicals *viz.,* Garlic and Neem, two chemical fungicides such as captan and mancozeb and four combination treatments *viz.,* Captan + Neem extract, Mancozeb + Garlic extract, *Trichoderma harzianum* + Captan and *Pseudomonas fluorescens* + Carbendazim were tested at different concentrations *i.e.* 50, 100, 200, 400 and 600 ppm and two biocontrol agents *(T. harzianum* and *P. fluorescens)* were observed for their antagonistic against *C. capsici in vitro.* Neem showed maximum inhibition at all concentration *i.e.* 38.96%, 40.99%, 50.00%, 55.17% and 57.20% respectively.

Keywords: Integrated, disease, management, chilli, *Capsicum annuum* L. *Colletotrichum capsici*

Introduction
Chilli (*Capsicum annuum* L.) is an important vegetable as well as spice crop, cultivated worldwide. It has numerous therapeutic benefits in addition to being utilised in a wide variety of cuisines. Chilli is called variously with different names depending on the place *viz*., Pimento (Spanish), Puvre de Guinee (French), Paparika (German), Spaanse Peper (Dutch) etc. Commonly used term is chilli, which refers to hot types of capsicum. It belongs to genus *Capsicum*. *Capsicum* is a genus of flowering plants that belongs to the family Solanaceae originated in the maxico (central America) (Pickersgill, 1997) [14]. India accounts for 25% of the world's total production of chilli. The crop is a significant source of income making in India, the world's single largest producer and exporter to the USA, Canada, UK, Saudi Arabia, Singapore, Malaysia, Germany and many other countries across the world (Ashwini and Srividya, 2014) [2]. India account total production of chilli 1786.81 MT and have a total growing area of 874.87 (000, ha). In Uttar Pradesh chilli account a total growing area of 13.17(000, ha) with the production of 10.30 (000, MT) (NHB, 2023-24). Andhra Pradesh, Orissa, Maharashtra, West Bengal, Karnataka, Rajasthan and Tamil Nadu are found to be important states growing chilli in India. Chilli is an important commercial crop grown in India. Although production is high in India, the average productivity is less (1ton/ha), when compared to other important producers of chilli *viz.*, China, Mexico, Taiwan where the productivity is 3.5 tons/ha (Peter, 1998) [13]. Important contributor for this low productivity is biotic stress resulting in diseases. Chilli is found to be included of many plants derived chemical compounds that promote health. The strong spicy taste comes due to the presence of active alkaloid compounds capsaicin, capsanthin, capsorubin. Chilli contains steam volatile oils, carotenoids, fatty oils, vitamins, mineral elements etc. (Bosland and Votava, 2003) [4]. It reduces platelet aggregation; act as vasodilators, stimulating blood circulation. Chilli reduces risk of cancer by preventing carcinogens from binding to DNA.

Vitamin C is present in more quantities in fresh green chilies than citrus fruits and Vitamin A is high in red chilli than carrots (Martin *et al.*, 2004) [9].

Among bacteria, bacterial wilt caused by *Pseudomonas solanacearum* and physiological disorder due to calcium deficiency like blossom end rot. The most frequent and common illness affecting capsicums is the fungal disease. The yield of chillies is impacted by fungi that cause damping off (*Rhizoctonia solani*, Pythium spp.) and powdery mildew (*Leveillula taurica*). Among all fungal infections, anthracnose of the chilli is a serious one that is mostly caused by the fungus Colletotrichum capsici (Syd.). Genus, *Colletotrichum* is one of the most important plant pathogens causing anthracnose disease on an extensive range of economically important crops including cereals, legumes, and vegetables. Among these, chilli crop is severely affected and up to 85% of yield loss has been reported (Poonpolgul and Kumphai, 2007) [15]. Between all the diseases, anthracnose disease is the major constraint to chilli production global consequential in high yield losses (Than *et al.*, 2008) [18].

In India, severe cases, pre-harvest and post-harvest losses include up more than 50%. Reports of notable yield losses were from Assam (12-30%) and Punjab and Haryana (25-60%). (Pakdeevaraporn *et al.*, 2005) [12]. The word anthracnose is a Greek word meaning 'coal'. It is commonly used for plant diseases which are characterized by dark sunken lesions having spores (Issac *et al.*, 1992) [3] and directly reduces the quantity and quality of the harvested yield. Small lesions on chilli fruits also affect the profits (Manandhar *et al.*, 1995) [8]. Post-harvest damage is more as infection remains latent in plant cells (Bailey and Jegar, 1992) [3] and symptoms appear once the fruit is matured. Sunken necrotic lesions with concentric rings that result in conidial masses are one of the symptoms. Severe circumstances can cause lesions to merge and cause conidial masses to form on lesions in concentric circles.

In particular, the asexual genus Colletotrichum is a member of the Coelomycetes and Ascomycete classes of fungi imperfections. (Dean *et al.*, 2012) [5]. The number of species in this genus varies from 29 to over 700, depending on the criteria chosen for separation, making the systematics of the fungal pathogens still unclear.

Anthracnose disease; *Colletotrichum* species are responsible for causing some other diseases such as red rot of sugar cane, coffee berry disease, crown rot of banana was also reported. *Colletotrichum* comprises a number of plant pathogens, effecting woody to herbaceous plants. *Colletotrichum* species are pathogenic to commercial crops (strawberry, pepper, citrus) and cereals (maize, sugarcane, sorghum) (Dean *et al.*, 2012) [5].

Materials and Methods

Isolation of pathogen

To isolate pathogens, the following two methods were employed Moist chamber method This method helps to induce fungi to form external mycelium, to sporulate, or to form sclerotia. Moist chambers were made by moistening round filter paper towels and placing in the Petri dishes. Then infected seeds from the diseased fruits were placed in the moist chamber at room temperature with diurnal lighting.

PDA plate method: Chilli plant showing symptoms of anthracnose remained collected from the field and were washed thoroughly with water then after placed in between blotting paper to remove excess moisture. Diseased portion along with healthy part of the specimens were cut from the leaves or fruits with the help of sterilized scissors and then surface sterilized by immersing in mercuric chloride (0.1%) or (70%) ethanol for 1 min. After that, the specimens were washed thoroughly in at least three changes of sterilized water. With the help of sterilized forceps, the leaf pieces were transferred to Petri plates containing potato dextrose agar medium and incubated in dark for five day at 28±1 ºC. The incubated plates were observed daily for fungal growth.

Purification and preservation of pathogen

Pathogenic isolates from respective host plant species were isolated from the moist chambers as well as on PDA Petri plates. All the isolates were cultured under sterilized conditions in a laminar air flow and incubated at 28±1 ºC for 5 to 7 days till proper growth. Cultures were then purified from single colonies appearing on PDA after observing under microscope and they were then maintained on PDA slants at 4 ºC in a refrigerator for further used. Sub culturing of the stored cultures were done periodically.

Identification of pathogenic isolates

The study was assumed to confirm the identity of the isolated pathogens. Fungal growth was then observed through the compound research microscope, after making slides in water and cotton blue stain. The shape and size of acervuli, conidia/spore arrangement and sporulation were studied and photographed. The symptoms were noted separately for each isolate and identification of each fungus was done with the help of available expertise and standard monograph.

Observations recorded

1. **Colony:** Fragmentation, Color and shape,
2. **Mycelium:** Shape, color, septation and branching.
3. **Conidia:** Color, shape.

Pathogenicity Test

Artificial inoculation methods *in vitro* are commonly used to test the pathogenicity of a fungal species, as it is easy to control environmental conditions for confirmation of disease caused by the isolated pathogen. Pathogenicity tests were showed according to the Koch‟s postulates. Healthy host plants were thoroughly cleaned with sterilized distilled water. The conidia of the test pathogens harvested from freshly prepared ten days old agar culture were suspended in sterilized water to obtain 10 conidia per ml.

Pathogenicity test was carried out in laboratory. Different inoculation methods were applied on potted plants grown in sterilized soil.

T_1 = Soil inoculation, T_2 = Foliar spray inoculation, T_3 = Syringe inoculation, T_4 = Wound inoculation of branch, T_4 = Wound inoculation of branch, T_5 = Wound inoculation of stem, T_5 = Wound inoculation of stem, T_6 – Control.

Pathogenicity test was conducted on healthy chilli plants in glass house Faculty of Agricultural Sciences and Allied

Industries, Rama University, Mandhana, Kanpur (U.P.) has studied during the session 2023-24 and the accompanied with thesis work on. Different inoculation methods namely soil inoculation, foliar spray inoculation; syringe inoculation, wound inoculation on branch and wound inoculation on stem were applied on potted plants grown in sterilized soil to prove the pathogenicity of isolated pathogen. Un-inoculated healthy chilli plants were kept as control. Observations were made regularly for the appearance and development of symptoms. Within 7-10 days of inoculation leaves showed typical anthracnose symptoms. After appearance of disease symptoms, re-isolation was made from the diseased tissues of artificially infected plants using PDA plate technique. The isolate obtained was compared with the original culture for confirmation of the same pathogenic isolates, which were inoculated. Data analyzed statistically by using Complete Randomized Design (CRD).

In vitro* evaluation of bio agents against *Colletotrichum capsici

Observations recorded

1. **Size of fungal colony (in mm):** The size fungal colony was observed by the radial growth of fungal colony with the help of measuring scale from two different directions and the mean of the observation considered as radial growth of colony.
2. **Per cent mycelium inhibition:** Percent inhibition in growth was calculated in relation to growth in control using the following formula of Vincent (1947).

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

Disease (Die back) incidence

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

$$\text{Die back incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants observed}} \times 100$$

Results and Discussion

Effect of different treatments on per cent mycelium inhibition of *Colletotrichum capsici* at 50 ppm

Among the treatments studied indicated significant difference for mycelium inhibition of pathogen (*Colletotrichum capsici*) at 50 ppm concentration. It ranged from 31.50-65.31%. The general mean of all treatments for this concentration was (45.10). The maximum mycelium inhibition was observed in *Trichoderma harzianum* + Captan (65.31%) followed by, *Pseudomonas fluorescens* + Carbendazim (60.85%) and Captan + Neem extract (56.70%). Whereas, minimum mycelium inhibition was observed in Garlic extract (31.50%) followed by, Neem extract (38.95%) and Mancozeb (48.48%).

Effect of different treatments on per cent mycelium inhibition of *Colletotrichum capsici* at 100 ppm

The observations rerecorded for this trait showed significant differences among all the treatments with control. It ranged from 35.15-68.90%. The highest mycelium inhibition was found in *Trichoderma harzianum*+ Captan (68.90%) and it was founded statistically at par with *Pseudomonas fluorescens*+ Carbendazim (66.22%). Whereas, minimum mycelium inhibition was observed in Garlic extract (35.15%) followed by, Neem extract (40.97%) and Mancozeb (50.03%).

Effect of different treatments on per cent mycelium inhibition of *Colletotrichum capsici* at 200 ppm.

All the treatments studied and showed that significant variation for mycelium inhibition at 200 ppm concentration with control. It ranged from 41.80-71.27%. The general mean of all treatments for this concentration was (54.70%). The maximum mycelium inhibition was found in Captan (71.27%) and it was found statistically as per with *Trichoderma harzianum*+ Captan (70.50%), *Pseudomonas fluorescens*+ Carbendazim (69.58%) and Captan + Neem extract (69.10%). Whereas, minimum mycelium inhibition was observed in Garlic extract (41.80%) followed by, Neem extract (50.08%) and Mancozeb (57.10%).

Effect of different treatments on per cent mycelium inhibition of *Colletotrichum capsici* at 400 ppm

Significant variations amongst all the treatments with control was observed for mycelium inhibition of *C. capsici* at 400 ppm concentration. It ranged from 46.80-74.70%. The general mean of all treatments for this concentration was (57.61%). Six treatments recorded gave higher mycelium inhibition then general mean. The highest mycelium inhibition was founded in Captan (74.70%) and it was found statistically at par with *Trichoderma harzianum*+ Captan (73.60%). Whereas, minimum mycelium inhibition was observed in Garlic extract (46.80%) followed by, Neem extract (55.22%) and Mancozeb (61.82%).

Effect of different treatments on per cent mycelium inhibition of *Colletotrichum capsici* at 600 ppm

All the treatments studied and revealed that significant variation with control for mycelium inhibition at 200 ppm concentration. It ranged from 53.80-79.51%. The general mean of all treatments for this concentration was (61.91%). The maximum mycelium inhibition was found in Captan (79.51%) and it was founded statistically as per with *Trichoderma harzianum*+ Captan (77.25%), *Pseudomonas fluorescens*+ Carbendazim (76.59%). Whereas, minimum mycelium inhibition was observed in Garlic extract (53.80%) followed by, Neem extract (57.23%) and Mancozeb (66.19%).

Evaluation of different treatments on per cent mycelium inhibition of Colletotrichum capsici at 50, 100, 200, 400 and 600 ppm concentration

The significant variation among all the treatments with control at different concentrations (50, 100, 200, 400 and 600 ppm) were observed for mycelium inhibition of pathogen. The observations recorded in the experiment is shown (Plate) *Trichoderma harzianum* + Captan proved the best treatment at 50 and 100 ppm which was significantly inhibit the mycelium growth (65.31%) and (68.90%) respectively. Similarly, at 200, 400 and 600 ppm Captan was found most effective which inhibit the mycelium growth of pathogen *Colletotrichum capsici* (71.27), (74.70) and (79.51%) respectively. Whereas, garlic extract was found least effective at all concentration (50, 100, 200, 400 and 600 ppm) which showed minimum mycelium inhibition (31.50, 35.15, 41.80, 46.80 and 53.80%) respectively.

Disease management (*In vitro*)

Evaluation of botanicals (*In vitro*)

Use of botanicals in an agro ecosystem is now emerging as one of the prime means to protect crop produce and environment from pesticide pollution, which is a global problem. Among the many qualities of botanicals are their antiviral, antibacterial, insecticidal, and antifungal activities against infections.

The study including *in vitro* evaluation of two botanicals (Neem and Garlic) at five concentrations (50, 100, 200, 400 and 600 ppm) against pathogen *Colletotrichum capsici*, Neem extract at all concentrations were showed to be the greatest in inhibiting (38.95, 40.97, 50.08, 55.22 and 57.23%) percent reduction mycelial growth over control. Similar type of study was also carried by Hegde *et al.* (2002) [7].

Evaluation of biological control agents (*In vitro*)

Nowadays, biological control is becoming more and more important as an environmentally responsible way to manage illness. In the present study two biological agents (*Trichoderma harzianum* and *P. fluorescens*) tested for their antagonists against *C. capsici*, by dual culture technique. *T. harzianum* was found effective for inhibition of mycelium growth of pathogen (50.88) percent then *P. fluorescens* (31.99) per cent. Earlier workers like Prabakar (2008) [16], Amin *et al*. (2010) [1], Rajesha *et al.* (2010) [17] and Padder and Sharma (2011) [11] have also observed similar result for per cent mycelium inhibition. Among the different fungal antagonists, a potential species of *Trichoderma* has been extensively used by the plant pathologists due to their high effectiveness, broad-spectrum action and easy in isolation and mass development. Similarly, P. fluorescens has been demonstrated to be a viable biocontrol agent among the bacterial antagonists. (Ganeshan and Kumar, 2009) 6[].

Evaluation of chemical fungicides (*In vitro*)

Evaluation of two chemical fungicides *in vitro* condition (Captan and Mancozeb) at five concentrations (50, 100, 200, 400 and 600 ppm) against pathogen (*Colletotrichum capsici)* by food poisoning technique was done. Evaluation of fungicides found that both the fungicides were effective to suppress the growth of pathogen. Captan was inhibited maximum mycelium growth at all concentration (53.65, 61.90, 71.27, 74.70 and 79.51%). Similar result was also reported by Mesta (1996) [10] and Yadav *et al.* (2014) [19].

Evaluation of treatment combination (*In vitro*)

Four treatment of combinations (Captan + Neem extract, Mancozeb + Garlic extract, *Trichoderma harzianum*+ Captan and *Pseudomonas fluorescens* + Carbendazim) were evaluated after checking their compatibility at five concentration (50, 100, 200, 400 and 600 ppm). Among the all treatment combinations evaluated *in vitro* condition revealed that, *Trichoderma harzianum*+ Captan was found most effective for inhibition of mycelium progress at all concentration *i.e.* 65.31, 68.90, 70.50, 73.60 and 77.25 percent. Whereas, Mancozeb + Garlic extract found least effective for inhibition of mycelium growth at all concentration (50.51, 61.76, 62.86, 64.64 and 70.31 percent respectively.

Field experiment (*In vivo*)

Number of fruits per plant

The observations recorded for number of fruits per plant showed significant differences between check and most of the treatments. The mean performance of the treatments ranged from 46.49-67.50 in (Table 3). General mean for the character was (57.33). Significantly higher numbers of fruits per plant were observed in the treatment *Trichoderma harzianum* + Captan (67.50) which was found statistically at par with *Pseudomonas fluorescens*+ Carbendazim (65.25) and Mancozeb + Garlic extract (60.70). While minimum numbers of fruits per plant were recorded in the check (46.49), which was found statistically at par with Hot water (50.25) and *Pseudomonas fluorescens* (52.57). All the treatment under study was found superior than check for number of fruits per plant.

Average fruit weight (g/plant)

The data presented in (Table 3) revealed significant variations for average fruit weight between check and all the treatments accept hot water treatment. It ranged from 143.85-97.59 g. The general mean for the character observed was (121.05g). Significantly maximum average fruit weight was recorded in the treatment *Trichoderma harzianum*+ Captan (143.85 g.), which was found statistically at par with *Pseudomonas fluorescens*+ Carbendazim (139.30 g), while minimum fruit weight was observed in check (97.59 g), which was found statistically at par with Hot water (103.40 g). All the treatment under study was found superior than check for average fruit weight per plant.

Average fruit weight (kg/plot).

The data presented in (table 3.) and revealed significant variations for average fruit weight between check and all the treatments accept hot water treatment. It ranged from 0.87-1.28 kg. For this parameter, the observed overall mean was 1.09 kg.

Significantly maximum average fruit weight was recorded in the treatment *Trichoderma harzianum*+ Captan (1.28 kg.), which was found statistically at par with *Pseudomonas fluorescens*+ Carbendazim (1.24 kg), while minimum was observed in check (0.87 kg), which was found statistically at par with Hot water treatment (0.92 kg). All the treatments under study were found superior than check for average fruit weight plot.

Table 1: Effect of different treatments on per cent mycelium inhibition of Colletotrichum capsici at different concentrations 50, 100, 200, 400 and 600 ppm, after five days of inoculation

Treatment		Percent mycelium growth inhibition				
		50 ppm	100 ppm	200 ppm	400 ppm	600 ppm
T_1	Captan	53.65* ±0.50 (47.04)	61.90* ±1.95 (51.89)	71.27* ±0.79 (57.50)	74.70* ±0.60 (59.83)	79.51* ±0.63 (63.06)
T_2	Mancozeb	48.48* ±1.38 (44.10)	50.03* ±0.98 (44.99)	57.10* ±1.15 (49.12)	61.82* ±0.62 (51.77)	66.19* ±1.91 (54.45)
T_3	Garlic extract	31.50* ±3.04 (34.10)	35.15* ±0.56 (36.33)	41.80* ±1.37 (40.31)	46.80* ±0.78 (43.17)	53.80* ±1.81 (47.18)
T_4	Neem extract	38.95* ±0.36 (38.61)	40.97* ±0.37 (39.80)	50.08* ±0.85 (44.98)	55.22* ±0.87 (47.95)	57.23* ±0.48 (49.12)
T_5	Captan + Neem extract	56.70* ±0.83 (48.86)	63.45* ±0.55 (52.82)	69.10* ±0.14 (56.23)	70.50* ± 0.33(57.08)	76.30* ±0.44 (60.88)
T_6	Mancozeb + Garlic extract	50.51* ±1.31 (45.24)	61.76* ± 0.96 (51.75)	62.86* ± 1.15 (52.41)	64.64* ± 0.34 (53.49)	70.31* ± 0.78 (56.93)
T_7	*Trichoderma harzianum* + Captan	65.31* ± 2.05 (53.92)	68.90* ±0.92 (56.10)	70.50* ±0.79 (57.08)	73.60* ±1.02 (59.09)	77.25* ±0.50 (61.51)
T_8	*Pseudomonas fluorescens* + Carbendazim	60.85* ±0.98 (51.25)	66.22* ±1.54 (54.44)	69.58* ±0.35 (56.51)	71.21* ±0.87 (57.51)	76.59* ±1.13 (61.04)
T_9	Control	0.00 ±0.00 (0.00)	0.00 ±0.00 (0.00)	0.00 ±0.00 (0.00)	0.00 ± 0.00 (0.00)	0.00 ±0.00 (0.00)
Mean		45.105	49.82	54.698	57.61	61.908
S.E.(d)		0.771	0.769	0.857	0.551	0.892
C.D. (0.05)		1.619	1.616	1.799	1.158	1.873

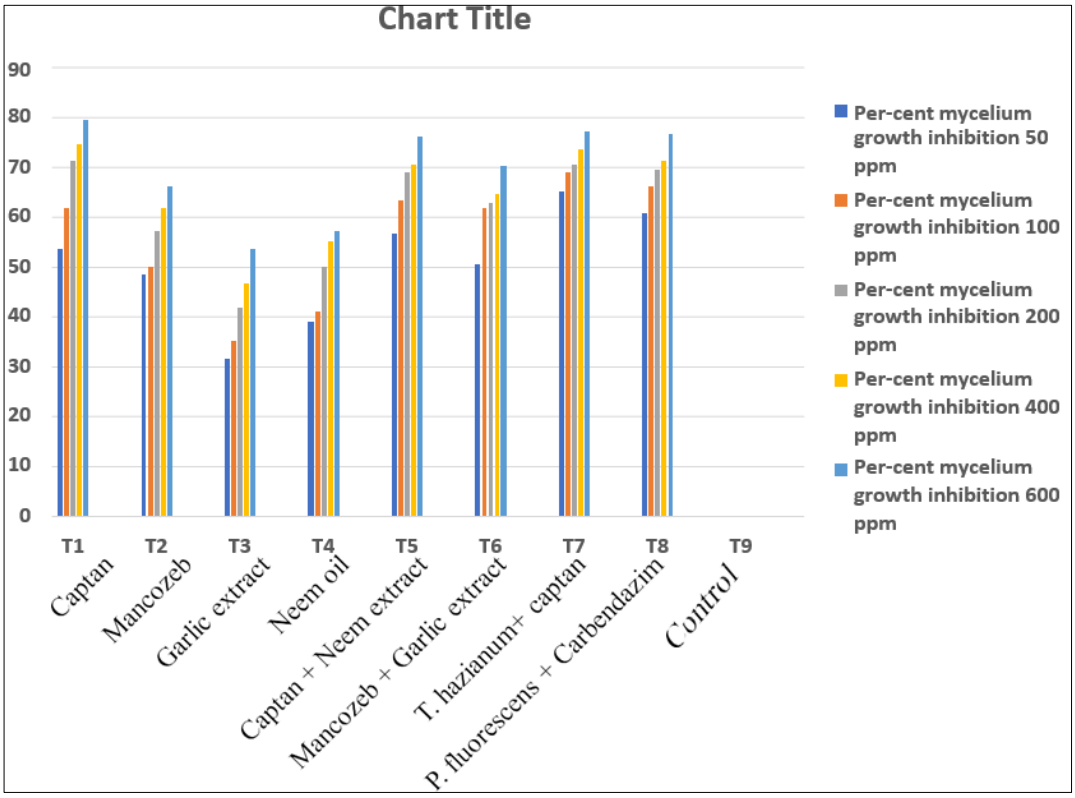

Fig 1: Effect of different treatments on percent mycelium inhibition of Colletotrichum capsici

Table 2: Antagonistic effect of bio agent on pathogen *Colletotrichum capsici*

Treatment		Radial growth	Percent mycelium growth inhibition
T_1	*Trichoderma harzianum*	18.15* ±0.38	50.88* ±0.95 (45.49)
T_2	*Pseudomonas fluorescens*	25.19* ±0.39	31.99* ±0.62 (34.42)
T_3	Control	37.01 ±0.48	0.0 ±0.0 (0.00)
Mean		26.77	
S.E.(d)		0.634	
C.D. (0.05)		1.382	

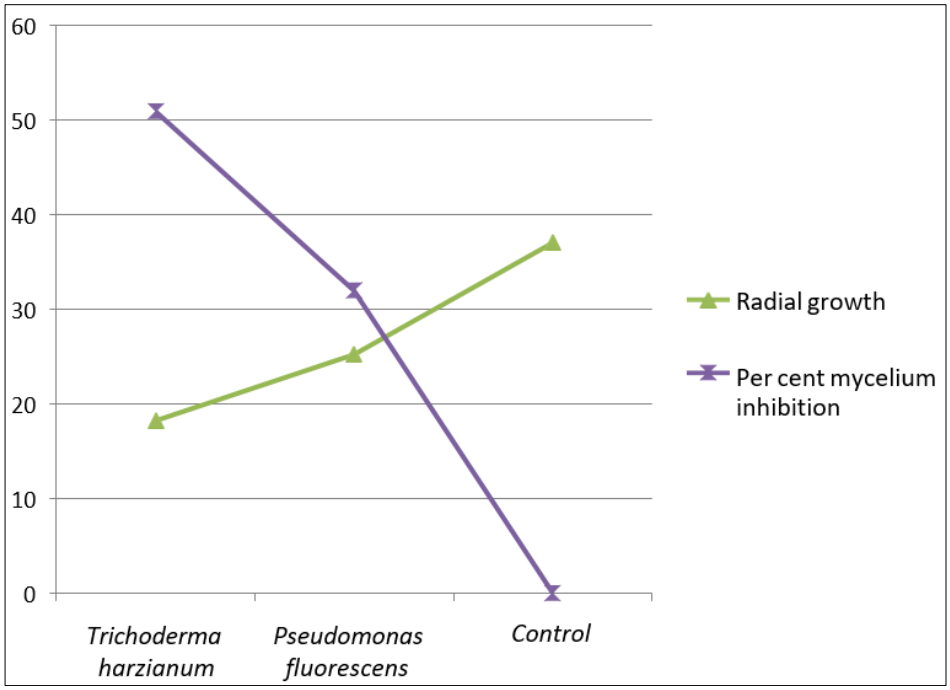

Fig 2: Antagonistic effect of bioagents on pathogen *Colletotrichum capsici*

Table 3: Effect of different treatments on numbers of fruits/plant, average fruit weight (g/plant) and average fruit weight (kg/plot) at different doses

Treatment		Dose (%)	No. of fruits/plan t	Average of fruit weight (g/plant)	Average of fruit weight (kg/plot)
T_1	Captan	2.5g/kg seed	58.70* ±1.85	122.10* ±2.24	1.08* ±0.04
T_2	Mancozeb	2.5g/kg seed	58.23* ±2.71	118.74* ±3.89	1.11* ±0.04
T_3	*Trichoderma harzianum*	5.0g/kg seed	54.40* ±2.40	117.87* ±3.35	1.06* ±0.03
T_4	*Pseudomonas fluorescence*	5.0g/kg seed	52.57 ±1.59	112.05* ±2.24	1.01* ±0.02
T_5	Hot water	55ºC/30 min	50.25 ±2.20	103.40 ±1.52	0.92 ±0.02
T_6	Captan + Neem extract	1.25g/kg seed+1ml/lit	59.38* ±3.74	128.30* ±6.01	1.14* ±0.06
T_7	Mancozeb + Garlic extract	1.25g/kg seed+1ml/lit	60.70* ±3.58	127.41* ±7.52	1.15* ±0.07
T_8	*Trichoderma harzianum*+ Captan	2.5g/kg seed+1g/lit	67.50* ±1.60	143.85* ±1.44	1.28* ±0.02
T_9	*Pseudomonas fluorescens*+ Carbendazim	2.5g/kg seed+0.5g/lit	65.25* ±3.37	139.30* ±7.72	1.24* ±0.07
T_{10}	Control	0.0	46.49 ±2.71	97.59 ±5.69	0.87 ±0.05
Mean			57.33	121.05	1.09
S.E.(d)			0.941	1.440	0.054
C.D. (0.05)			1.977	3.026	0.114

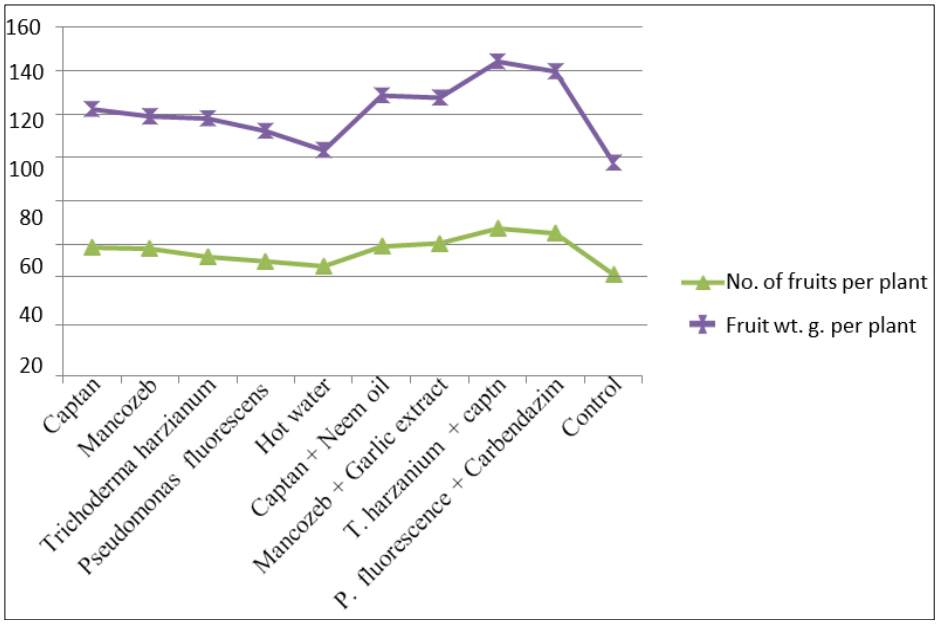

Fig 3: Effect of different treatments on numbers of fruits/plant, average fruit weight (g/plant) and average fruit weight (kg/plot) at different doses

Conclusion

Eleven different treatments were tested against the test pathogen under *in vitro* conditions among these, five different concentrations in which *Trichoderma harzianum*+ Captan was found to inhibit the maximum mycelial growth at 50 and 100 ppm and Captan proved to highly effective at 200, 400 and 600 ppm concentrations.

Two bio control agents (*Trichoderma harzianum* and *Pseudomonas fluorescens*) were evaluated *in vitro* condition by dual culture method the result revealed that *Trichoderma harzianum* was most effective and significantly inhibit the mycelial growth of pathogen.

Combination of four treatments were applied under field condition where *Trichoderma harzianum* + Captan was found highly effective which gave highest of fruits per plant, average fruit yield g per plant and kg per plot, minimum disease index at 75, 90 and 105 days after transplanting (DAT), per cent infected fruits per plant, disease incidence and disease severity followed by, *Pseudomonas fluorescens*+ Carbendazim.

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