

## IN VITRO EFFICACY OF PLANT EXTRACTS AND FUNGICIDES TO CONTROL FRUIT ROT OF CHILLI IN INDIA

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**Abstract:** Fruit rot caused by *Colletotrichum capsici* (Sydow) Butler and Bisby is one of the most destructive diseases of chilli in India. The study on used of fungicides and different plant extracts as control measure for the fruit rot disease. The fungal inhibition capacity of six leaf extracts from different plants and six systemic and non systemic fungicides was used under laboratory condition. Among six plant extracts, NSKE was found most effective in inhibiting mycelial growth at 5 and 10 per cent (49.80 and 62.40 %, resp.) of *C. Capsici* followed by garlic (41.40 and 57.60%). Among six fungicides, propiconazole was found cent per cent inhibitory at 250 as well as at 500 ppm. This was followed by hexaconazole (84.80, 94.40, 98.00 and 100 % at 50,100, 250 and 500 ppm, respectively). Most of work on management of fruit rot of chilli has been done through fungicide alone. In view of the increasing disease incidence in chilli and prolonged and repeated use of fungicides may also result in environmental pollution and non-acceptability of the produce and also development of resistance in pathogen.

**Keywords:** Fruit rot, Chilli, *In vitro*, Plant extracts, Fungicides

### INTRODUCTION

Chilli (*Capsicum annum* L.) is vernacularly known as “Mirchi”. It occupies an important place in daily diet and can be used in a variety of ways. Chilli fruits are used as pickles, sauces, ketchup, essence, oleoresins and are an inevitable ingredient in Indian dishes. Chilli is a good source of capsaicin, vitamin A, vitamin C, riboflavin and thiamine. It contains about 8.8 g carbohydrates, 5.3 g sugar, 1.9 g protein and 534 micro g beta carotene per 100 g chilli (Panda *et al.*, 2010). Alkaloid capsaicin is extracted from chilli, which has medicinal values. These properties increase the demand for chilli all over the world.

One of the important factors which limit the production of chilli in Rajasthan state in comparison to other states is the poor health of seeds. Most of the farmers are using seeds collected from their own field that take heavy toll of the crop at all the stages right from sowing to harvest and also in transit, marketing and storage.

The chilli crop is subjected to attack by various diseases caused by fungi, bacteria, viruses, nematodes and physiological disorders at different stages of development and important are fruit rot: *Colletotrichum capsici* (Syd.) Butler and Bisby, damping off: *Pythium aphanidermatum* (Edson) Fitz, powdery mildew: *Leveillula taurica* (Lev.) Arn., bacterial leaf spot : *Xanthomonas campestris* pv. *vesicatoria* (Doidge) Dye, Cercospora leaf spot : *Cercospora capsici* Cooke, leaf curl (chilli leaf curl virus), root knot ( *Meloidogyne* sp.) and dry root rot : *Rhizoctonia solani* Kuhn. Among these diseases, fruit

rot or anthracnose or die-back of chilli caused by *Colletotrichum capsici* (Sydow) Butler and Bisby is one of the most destructive diseases of chilli in India. It causes severe damage mostly to ripened fruits and reduce the quality and quantity of un-ripened and ripened fruits. This was reported first time in India by Sydow in 1913 from Coimbatore of Madras Presidency (Sydow, 1913). Due to this disease, more than 50 per cent crop loss has been reported from different parts of India (Ramchandran *et al.*, 2007). Poonpolgul and Kumphai (2007) reported that anthracnose disease caused by *Colletotrichum* species is one of the most economically important diseases reducing marketable yield from 10 to 80 per cent of the crop production in Thailand. It has been reported to cause 8-27 per cent yield loss in Maharashtra, 20-60 per cent in Punjab and Haryana and 30-76 per cent in Tamil Nadu (Datar, 1995; Bansal and Grover, 1969 and Sujathabai, 1992).

Chowdhury (1957) found that red ripening stage fruits are most affected with a small black circular, sharply defined spot, which later spread more in the direction of the long axis of the fruit. Badly affected fruits lose their normal red colour and turn straw coloured and pale white. Generally the acervuli are densely scattered than concentric and they projected little above the surface of the fruit and were bristly with carbonaceous nature. The spores are oozed out of the acervuli in pink masses under moist conditions the disease starting in the field may continue even after the fruits have been picked and put for drying and storage. The market value and nutritive value is degraded in the infected fruits resulting in poor quality of seeds. Certain biochemical constituents of

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chilli fruits are also known to be reduced by infection (Azad, 1991).

The pathogen is seed and soil borne in nature and affects seed germination and vigour to a greater extent (Perane and Joi, 1986, Mesta, 1996 and Asalmol *et al.*, 2001). The pathogen, *C. capsici* is seed transmitted in chilli in the form of acervuli and micro sclerotia (Perenzny *et al.*, 2003) and can also survive on other solanaceous or leguminous crops, plant debris and rotten chilli fruits in the field (Pring *et al.*, 1995). The disease starting in the field may continue even after the fruits have been picked and put for drying and storage. Correct and accurate identification of the pathogen is crucial for effective disease management (Whitelaw-Weckert *et al.*, 2007). Host plant resistance is considered as most practical, feasible and an economical method of plant disease management. Estimation of biochemical constituents helps in detecting their role in the resistance mechanism.

## MATERIALS AND METHODS

### Efficacy of plant extracts *in vitro*

An experiment was carried out in the laboratory of the department to find out the fungi toxicity of six plant extracts following poisoned food technique against the pathogen. One hundred gram leaves except garlic

and NSKE from each was collected and washed 2-3 times with water and allowed to dry at room temperature ( $25 \pm 1$  °C) for six hours. Before extraction, leaves of each plant (100 g) were crushed separately with 100 ml sterilized water. The leaf extract was filtered through muslin cloth and centrifuged at 5000 rpm for 30 minutes. The extract of each plant species was diluted in order to achieve two concentrations viz., 5 and 10 per cent. Petri plates containing PDA supplemented with different plant extracts, was inoculated with 5 mm disc of 7 days old culture of *Colletotrichum capsici* with the help of sterilized cork borer.

The inoculated Petri plates were incubated at  $28 \pm 1$  °C for 8 days. A suitable check (without plant extract) was also maintained.

The experiment was conducted in completely randomized design with three replications. Radial growth of the fungus was measured with metric scale in mm. The per cent inhibition of mycelium growth was calculated by using the formula of Vincent (1947).

$$C - T$$

$$\text{Per cent inhibition (PI)} = \frac{\text{-----}}{C} \times 100$$

Where,

C = Average of two diagonals in control (mm)

T = Average of two diagonals in treatment (mm)

**Table 1.** Plant extracts tested against *Colletotrichum capsici* are as under

S. No.	Common Name	Botanical Name	Part used	Concentration (%)	
				<i>In vitro</i>	<i>In vivo</i>
1	Neem	<i>Azadirachta indica</i>	Leaf	5 and 10	10
2	Datura	<i>Datura stramonium</i>	Leaf	5 and 10	10
3	NSKE	<i>Azadirachta indica</i>	Seed kernel	5 and 10	10
4	Marigold	<i>Tagetes spp.</i>	Leaf	5 and 10	10
5	Garlic	<i>Allium sativum</i>	Clove	5 and 10	10
6	Alstonia (Devil's tree)	<i>Alstonia scholaris</i>	Leaf	5 and 10	10

### Efficacy of fungicides *in vitro*

Six systemic and non-systemic fungicides were evaluated with four (50, 100, 250 and 500 ppm) concentrations against the *Colletotrichum capsici* under laboratory conditions by poisoned food technique (Schmitz, 1930). Required quantity of each fungicide was incorporated in sterilized 2 per cent PDA medium, thoroughly mixed by shaking prior to

pouring in sterilized Petri plates and were allowed to solidify. These Petri plates were inoculated with 5 mm dia. disc of 8 days old culture in the centre of the plate and incubated at  $28 \pm 1$  °C. Each treatment was replicated three times with suitable control. The per cent mycelial growth inhibition was calculated by following formula given in Efficacy of plant extracts *in vitro*.

**Table 2.** Fungicides tested against *Colletotrichum capsici* are as follows

S.No.	Common Name	Trade Name	Concentrations	
			<i>in vitro</i> (ppm)	<i>in vivo</i> (%)
1.	Propiconazole	Tilt	50, 100, 250 and 500	0.1

2.	Tebuconazole	Raxil	50, 100, 250 and 500	0.1
3.	Captan 70% + Hexaconazole 5% WP	Steam	50, 100, 250 and 500	0.1
4.	Carbendazim 12% + mancozeb 64% WP	Companion	50, 100, 250 and 500	0.1
5.	Hexaconazole	Sitara	50, 100, 250 and 500	0.1
6.	Chlorothalonil	Kavach	50, 100, 250 and 500	0.1

## RESULTS

### Efficacy of plant extracts *in vitro*

The efficacy of six plant extracts (Table 1) was tested *in vitro* at two concentrations viz., 5 and 10 per cent against *C. capsici* on PDA by poisoned food technique. Among six plant extracts, NSKE was found most effective in inhibiting mycelial growth at 5 and 10 per cent (49.80 and 62.40 %, resp.) of *C. Capsici* followed by garlic (41.40 and 57.60%) and both were found significantly superior at tested concentrations but highly effective at higher concentration (10%). Extract of neem leaf, marigold, datura and *Alstonia* were found less effective in inhibiting mycelial growth (37.60 and 51.20 %, 39.20 and 45.60%, 27.40 and 36.30 %, 16.02 and 24.05%), at 5 and 10 per cent concentration, respectively of *C. capsici* and differ significantly over control.

At mean level (5 and 10 % conc.), maximum mycelia growth inhibition (56.10%) was recorded with NSKE followed by garlic extract (49.50%). The mean value of other extracts were ranged from 20.04 to 44.40%.

### Efficacy of fungicides against *Colletotrichum capsici* (*in vitro*)

The efficacy of six fungicides was evaluated against *C. capisi* at 50, 100, 250 and 500 ppm concentration on PDA by poisoned food technique. The data suggested (Table 2) that increase in concentration of the fungicides caused increased inhibition of mycelial growth of the fungus and all the fungicides were found significantly superior over control. Among these, propiconazole was found cent per cent inhibitory at 250 as well as at 500 ppm. This was followed by hexaconazole (84.80, 94.40, 98.00 and 100 % at 50,100, 250 and 500 ppm, respectively), tebuconazole (86.30, 91.00, 96.60 and 100%) and captan+ hexaconazole (82.20, 92.00, 97.40 and 100%) while chlorothalonil was found to be least effective at all the tested concentrations against *C. capsici*.

At mean level (50, 100, 250 and 500 ppm), maximum mycelia growth inhibition (95.30%) was recorded with propiconazole followed by hexaconazole (94.30%). The mean value of other extracts were ranged from 64.32 to 93.48 %.

## DISCUSSION

Excessive use of chemicals in plant disease management has resulted in number of problems related to fungicides resistance, damage to non target flora and fauna and other useful organisms along with hazardous effects on environment have become the main concern of scientist at present (Singh, 2006). Plant extracts against fungal plant pathogens have been tested by various workers. However, meager information is available on plant extracts against fruit rot of chilli caused by *Colletotrichum capsici*. In the present study, six plant extracts were tested, among these neem (NSKE) gave maximum growth inhibition (56.10%) of *Colletotrichum capsici* followed by garlic *in vitro* conditions. Our results are in agreement with the findings of Singh *et al.* (1997) who reported that extracts of garlic bulb at 3 per cent concentration completely inhibited the growth and spore germination of *Colletotrichum capsici* whereas, 4 per cent extracts of onion bulbs, *Azadirachta indica* leaf, *Pongamia pinnata* leaf and *Tagetes erecta* leaf gave complete inhibition of fungal mycelial growth and spore germination. Similarly Gomathi and Kannabiran (2000) have also been reported that leaf extract of *Datura* and *Solanum* inhibited the conidial germination and mycelial growth of *Colletotrichum capsici*. The findings of Meena *et al.* (2004) with garlic and Kumar (2008) with datura are also in agreement of present results. Prakash (2011) has been observed that marigold at 50 per cent concentration was significantly effective for reducing mycelial growth (67.38%) and 100 per cent spore germination inhibition of *Colletotrichum capsici in vitro* conditions.

**Table 3.** Efficacy of plant extracts against *C. capsici* by poisoned food technique at 28±1 °C for 8 days (*In vitro*)

Common name of plant	Botanical name	Plant part used	Per cent growth inhibition at different concentration (%)*		
			5	10	Mean
Alstonia (Devil's tree)	<i>Alstonia scholaris</i>	Leaf	16.02 (23.59)	24.05 (29.37)	20.04 (26.59)
Datura	<i>Datura stramonium</i>	Leaf	27.40 (31.56)	36.30 (37.05)	31.85 (34.36)

Garlic	<i>Allium sativum</i>	Clove	41.40 (40.05)	57.60 (49.37)	49.50 (44.71)
Marigold	<i>Tagetes</i> spp.	Leaf	39.20 (38.76)	45.60 (42.48)	42.40 (40.63)
Neem (Leaf extract)	<i>Azadirachta indica</i>	Leaf	37.60 (37.82)	51.20 (45.69)	44.40 (41.78)
Neem (NSKE)	<i>Azadirachta indica</i>	Seed kernel	49.80 (44.89)	62.40 (52.18)	56.10 (48.50)
Control	-	-	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Mean	-	-	30.20 (33.34)	39.59 (38.99)	- -
				S <sub>Em</sub> ±	CD (p=0.05)
				P	0.45
				C	0.24
				PxC	0.64
					1.31
					0.70
					1.86

\* Average of three replications

\*\* Values in parenthesis are angular transformed

**Table 4.** Efficacy of fungicides against *C. capsici* by poisoned food technique at 28±1 °C for 8 days (*In vitro*)

Fungicides	Per cent growth inhibition at various concentration (ppm)*				
	50	100	250	500	Mean
Propiconazole	88.00 (69.73)	93.20 (74.88)	100.00 (90.00)	100.00 (90.00)	95.30 (77.48)
Tebuconazole	86.30 (68.28)	91.00 (72.54)	96.60 (79.37)	100.00 (90.00)	93.48 (75.20)
Hexaconazole	84.80 (67.05)	94.40 (76.31)	98.00 (81.87)	100.00 (90.00)	94.30 (76.19)
Captan + Hexaconazole	82.20 (65.05)	92.00 (73.57)	97.40 (80.72)	100.00 (90.00)	92.90 (74.55)
Carbendazim + mancozeb	79.20 (62.87)	82.40 (65.20)	88.00 (69.73)	96.02 (78.49)	86.41 (68.36)
Chlorothalonil	55.20 (47.98)	60.40 (51.00)	66.06 (54.37)	75.60 (60.40)	64.32 (53.32)
Control	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Mean	67.96 (55.52)	73.34 (58.92)	78.01 (62.03)	81.66 (64.64)	- -
		S <sub>Em</sub> ±	CD (p=0.05)		
		F	0.44	1.25	
		C	0.33	0.94	
		FxC	0.88	2.50	

\* Average of three replications

\*\* Values in parenthesis are angular transformed

Several workers have studied the management of disease through chemicals. In the present investigation, screening of fungicides was done with a view to find out the suitable fungicides for the inhibition of the growth of *Colletotrichum capsici* *in vitro*. Among six fungicides tested *in vitro*, propiconazole was found to be most effective in giving complete inhibition of growth at 250 ppm. This was followed by hexaconazole which gave 100 per cent inhibition of growth at 500 ppm. Our results are in conformity with the findings of Tanwar and Bunkar (2013), Jagtap *et al.* (2013) and Singh *et al.* (2008) who reported tebuconazole as significantly superior in inhibiting mycelial growth of *Colletotrichum* sp. while, Hegde *et al.* (2002) and Gopinath *et al.* (2006) reported that hexaconazole and propiconazole were significantly superior in inhibiting mycelial growth of *C. capsici*.

## CONCLUSION

The NSKE was found significantly superior with maximum per cent growth inhibition of *Colletotrichum capsici* followed by garlic. All the fungicides significantly inhibited the mycelial growth of *Colletotrichum capsici* as compared to check at 50, 100, 250 and 500 ppm concentration. Propiconazole was found significantly superior at 250 and 500 ppm with maximum inhibition of mycelial growth followed by hexaconazole. As the concentration of fungicides increased, the inhibition of mycelial growth was also increased and maximum inhibition was observed at 500 ppm concentration. Chlorothalonil was found least effective.

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