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Integrated management of dry root rot of chilli

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Abstract
Chillies is an important commercial crop. Recently the crop is affected by dry root rot disease caused by *Sclerotium rolfsii* (Sacc.) under rainfed conditions. An attempt was made to manage the disease by holistic approach. Minimum Plant mortality (10.75 and 15.50 per cent) was found in SAAF + Neem cake + *T. viride* at 60 and 90 DAS during the year 2015 and 2016 which is most effective treatment among all the treatments respectively. The next effective treatment was SAAF (34.75 and 40.50 per cent) and Neem cake (40.13 and 43 per cent). While *T. viride* was found least effective treatment with maximum plant mortality of (42 and 46 per cent) at 60 and 90 DAS during the year 2015 and 2016.

Keywords: management of dry root, rot of chilli, commercial crop, plant mortality

Introduction
Dry root rot disease of *C. frutescens* is of serious concern in Udaipur district, where *Capsicum frutescens* is widely cultivated in all season and this disease has been observed to occur every year in most of the fields. *Rhizoctonia solani* a noxious soil borne pathogen that can survive through its sclerotia for several year in the soil. Since, the pathogen remains in the soil for long time and the crop is vulnerable to its attack during all the stages of crop growth.
The soil borne plant pathogen *Thanatephorus cucumeris* (Frank) Donk [anamorph]: *Rhizoctonia solani* (Kuhn) is a basidiomycete that occurs worldwide and causes economically important diseases to a large variety of vegetable and field crops, turfgrasses, ornamentals, fruit and forest trees (Adams, 1988) [1].
Due to soil borne nature & long survival as sclerotial bodies it is difficult to control either by fungicides or resistance breeding. The application of fungicides though effective, but uneconomical, may affect associated beneficial microbiota in soil and has problem of environmental hazards. Thus, the harmful effects of fungicides on soil microflora, possibility of development of resistance against fungicide by pathogenic fungi, high cost of chemicals due to their repeated application for soil borne pathogen and a great demand for residue free product in the domestic and international markets, necessitate development of ecofriendly management system for disease control.
Among the fungal diseases, the dry root-rot incited by *Rhizoctonia solani* Kuhn is a major constraint in the production of chilli seedlings. *R. solani* is essentially soil-borne pathogen which inflicts heavy losses under favorable condition (Mathur and Gurjar, 1995) [3]. The stated disease is distributed worldwide and is a well-known soil pathogen. However, various methods have been suggested for controlling the root rot disease. The management of this disease is difficult owing to long saprophytic survival ability of pathogen in soil. Reduction or elimination of soil borne inoculum is the only effective solution to overcome the problem and this may be achieved through use of effective fungal antagonists. (Harman *et al*., 2004) [2] reported biological and cultural control measures as two alternatives feasible options to synthetic pesticides in an integrated diseases management programme.

Methods and material
Isolation and purification of the pathogen
For isolation of the pathogen, the diseased roots were thoroughly washed first in the running tap water and finally with sterilized water. Then air dried diseased roots were cut in to 0.5 cm long bits. Bits of infected roots were surface sterilized by dipping in 0.1% mercuric chloride solution for 2 minutes followed by three washings in sterilized distilled water and aseptically plated on Potato Dextrose Agar (PDA) medium and the plates were incubated at 28±2 °C and examined daily for any fungal growth.

After five days fungal growth coming from these diseased roots pieces was aseptically picked up on fresh PDA plates. The greyish black culture so obtained, was further purified by employing hyphal tip method.

Identification of the pathogen

The slides were prepared in lacto phenol solution and mounted by DPX mount. These slides were then observed under compound microscope at 10X and 40X power. The morphological, cultural and formation of sclerotia were the principle characters to identify the pure cultures, and compared with the standard reference description an identity was confirmed as *Rhizoctonia solani.*

Pathogenicity test

The pathogenicity of the culture of *R. solani* was tested by growing chilli plants in fresh plastic pots of 20 cm face diameter size. A mixture of garden soil: Farm yard manure (3:1) was sterilized in an autoclave at 1.3 kg per square centimeters pressure at 121.6 ºC temperatures for 2 hrs. The culture of *R. solani* was multiplied on corn meal-sand (1:1) medium at 28±1 ºC for 10 days and mixed with sterilized soil @ 20 g/kg soil. This inoculated soil was filled in the plastic pots and kept in the cage house for 7 days and were irrigated with distilled water to allow establishment of the pathogen. Pots with uninoculated sterilize soil was kept as control. Seedlings of susceptible variety "Pusa Jwala" were transplanted in both inoculated as well as un-inoculated pots, at the rate of 5 seedlings per pots. The pots were kept in the cage house and were watered daily to provide good moisture. The germination and symptoms developing on chilli plants were carefully observed. From the diseased plants, showing root rotting symptoms, reisolation of the most virulent pathogen was attempted and the resultant cultures were re-identified. After proving the pathogenicity of *R. solani* most virulent culture was used for further studies.

Seed treatment with biological agents

In treatment where the biological agent was applied as seed coatings, these were grown on 0.1 per cent malt- extract medium in Petri-dishes. After the development of profuse sclerotia in these cultures, the mycelium and sclerotia were collected with the help of a fine brush and suspended in 10 ml sterile water, to get a mycelial concentration of $2x10^6$ cfu/ml. 10 g seeds of chilli were coated separately with antagonist using 1ml of mycelial suspension. The seed were kept in moist chamber for a day and then sown.

Effect of fungicides against *R. solani*

Relative efficacies of different fungicides were evaluated by using poison food technique. Two concentration *i.e.* 0.1 and 0.2%. Desired quantity of each fungicide was added separately to sterilized medium, mixed thoroughly and poured in sterilized Petri plates and allowed to solidify. Each plate was inoculated with 5 mm disc of fungal culture and incubated at 28±1 °C. The linear growth after 7 days was recorded and per cent inhibition was calculated.

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

Where,
C = Diameter of the colony in control.
T = Diameter of colony in treatment.

A check was also maintained where medium was not supplemented with any fungicide.
In treatments where fungicidal seed treatment was to be given, 150 seeds were dipped in 50 ml stock solution for 30 minutes and then taken out and air dried. This was done 24 hours before sowing, and the treated seeds were stored in clean dry Petri-dishes.

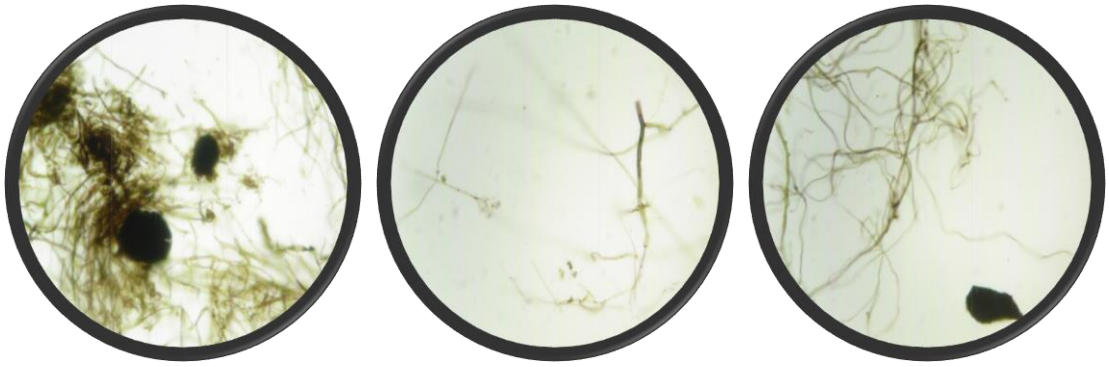
Study of most recommended fungicide and biocontrol agents as well as in combination for suppression of root rot of chilli

Use of the biocontrol agent *Trichoderma viride* as a seed treatment and soil application (mix 2 kg *Trichoderma* and 1qt. FYM with sufficient amount of water and then cover with polythene sheet for 7 days. In these days *Trichoderma* fully grown on FYM, then drench in soil.). Use of the SAAF fungicide as a seed treatment. Use of the neem cake as organic amendment. Use three combination of the treatment (fungicides SAAF, neem cake and *Trichoderma viride*).

1. Seed treatment with fungicide @0.2%
2. Seed treatment with bioagent @10g/kg
3. Soil application of organic amendment (neem cake) @500gm/sqm.
4. Seed treatment with fungicide + bioagent + Soil application of organic amendment
5. Untreated control.

Results

To purify *R. solani* single sclerotia were picked under a stereo-binocular microscope on PDA plates. The pure culture was maintained on PDA slants at 24 °C for further studies. The morphological characters, like cultural growth of mycelium and formation of sclerotia was studied (Plate-1).



Mycelium and Sclerotia **Mycelium branching at 90° angle** **Formation of Sclerotia**

The fungicides, bio-agents and Neem cakes which were found most effective in single applications experiment, further, they were tested in combinations in Random Block designed in the field during 2015 and 2016. Observations on plant mortality were recorded at 60 and 90 days after sowing. The results thus obtained are presented in (Table 2). During 2015, the data reveals that minimum Plant mortality (10 and 15 per cent) was found in SAAF + Neem cake + *T. viride* which is most effective treatment among all the treatments (Table 2) respectively. The next effective treatment was SAAF (33.50 and 40 per cent) and Neem cake (38.25 and 42 per cent). While *T. viride* was found least effective treatment with maximum plant mortality of (40.00 and 45.00 per cent) at 60 and 90 DAS.

Similar results were recorded in the year 2016. The results thus obtained are presented in Table 2.The data reveals that minimum Plant mortality (11.50 and 16 per cent) was found in SAAF + Neem cake + *T. viride* at 60 and 90 DAS which is most effective treatment among all the treatments (Table 2) respectively. The next effective treatment was SAAF (36 and 41 per cent) and Neem cake (42 and 44 per cent). While *T. viride* was found least effective treatment with maximum plant mortality of (44 and 47 per cent) at 60 and 90 DAS.

On the basis of pooled data, that minimum Plant mortality (10.75 and 15.50 per cent) was found in SAAF + Neem cake + *T. viride* at 60 and 90 DAS during the year 2015 and 2016 which is most effective treatment among all the treatments (Table 2) respectively. The next effective treatment was SAAF (34.75 and 40.50 per cent) and Neem cake (40.13 and 43 per cent). While *T. viride* was found least effective treatment with maximum plant mortality of (42 and 46 per cent) at 60 and 90 DAS during the year 2015 and 2016.

However, plant mortality decrease over control was recorded at 60 and 90 DAS during the year 2015 and 2016. It was observed that the treatment SAAF + Neem cake + *T. viride* was found best for decrease in plant mortality. While Maximum decrease in plant mortality was recorded is 83.32 and 78.55 per cent at 60 and 90 DAS, respectively. Next treatment was SAAF 44.17 and 42.85 per cent and Neem cake 36.23 and 39.96 per cent had decrease the plant mortality at 60 and 90 DAS, respectively. The least effective treatment was *Trichoderma viride* had minimum decrease in plant mortality of 33.33 and 35.73 per cent at 60 and 90 DAS, respectively, during the year 2015.

Similar results were recorded in the year 2016. It was observed that the treatment SAAF + Neem cake + *T. viride* was found best for decrease in plant mortality. While Maximum decrease in plant mortality was recorded is (81.44 and 77.77) per cent at 60 and 90 DAS, respectively. Next treatment was SAAF (41.93 and 43.05 per cent) and Neem cake (32.27 and 38.88 per cent) had decrease the plant mortality at 60 and 90 DAS, respectively. The least effective treatment was *Trichoderma viride* had minimum decrease in plant mortality of (29.09 and 34.70 per cent) at 60 and 90 DAS, respectively, during the year 2016.

On the basis of pooled data, It was observed that the treatment SAAF + Neem cake + *T. viride* was found best for decrease in plant mortality. While Maximum decrease in plant mortality was recorded 82.38 and 78.16 per cent at 60 and 90 DAS, during the year 2015 and 2016 respectively. Next treatment was SAAF, 43.05 and 42.95 per cent and Neem cake, 34.25 and 39.42 per cent had decrease the plant mortality at 60 and 90 DAS, respectively. The least effective treatment was *Trichoderma viride* had minimum decrease in plant mortality of 31.17 and 35.21 per cent at 60 and 90 DAS, respectively, during the year 2015 and 2016 (Table 2).

Table 1: *In vitro* evaluation of fungicide against mycelial growth of *R. solani*

S. No.	Fungicides	Mycelial growth (mm)	
		Concentration 0.1%	Concentration 0.2%
1 (T_1)	Hexaconazole	20.0	12.0
2 (T_2)	Bavistin	0.0	0.0
3 (T_3)	Tebuconazole	0.0	0.0
4 (T_4)	Propiconazole	18.0	10.0
5 (T_5)	SAAF	0.0	0.00
	Control	90.0	90.0
	SEm±	0.2408	0.3807
	CD at 5%	0.6986	1.1046
	CV%	18.10	18.10

The fungicides, bio-agents and neem cakes which were found most effective in single treatment experiment, further, they were tested in combinations. During 2015 and 2016 the data reveals that minimum plant mortality was found in SAAF + Neem cake + *T. viride* which is most effective treatment among all the treatments (Table 14) respectively. The next effective treatment was SAAF and Neem cake, while *T. viride* was found least effective treatment with maximum plant mortality.

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