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Research Article

Integrated management strategy for *Sclerotium rolfsi* causing wilt of potato

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ABSTRACT

Sclerotium wilt of potato caused by *Sclerotium rolfsii* Sacc. is one of the most important soil borne diseases of potato in Karnataka. Efficacy of five non-systemic and five systemic fungicides were evaluated at different concentrations by 'poisoned food technique'. Among the non-systemic fungicides, emissan, thiram and mancozeb at all concentrations and captan and zineb at 0.3 per cent inhibited the growth of *S. rolfsii* completely (cent per cent). This was followed by zineb at 0.2 per cent (94.00%) concentration. Systemic fungicides *viz.,* carboxin, difenaconazole and hexaconazole at all concentrations and metalaxyl MZ @ 0.2 per cent concentration inhibited cent per cent growth of *S. rolfsii* and were found to be significantly superior over rest of the treatments tested. This was followed by metalaxyl MZ at 0.1 per cent (76.13%) concentration. Six biocontrol agents *viz*., *Trichoderma harzianum* Raifai, *Trichoderma koningii* Oudern, *Trichoderma virens* Miller, *Trichoderma viride* Pers. ex S. F. Gray, *Pseudomonas fluorescens* Migula and *Bacillus subtilis* Cohn Emend Pras were tested against *Sclerotium rolfsii* by dual culture technique. *T. harzianum* showed the maximum inhibition of *S. rolfsii* and it was found significantly superior over rest of the bioagents tested. This was followed by *T. viridae*, *T. koningii* and *T. virens*. However, they significantly differed with one another. Soil solarization in combination with carboxin + *T. harzianum* tuber treatment along with soil application of FYM and neem cake reduced the wilt incidence and increased yield of potato.

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INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the important commercial vegetable crops in India. It is the world's fourth important food crop owing to its great yield potential and high nutritive value and accounts for nearly half of the world's annual output of all root and tuber crops. It supplies at least 12 essential vitamins and minerals, including an extremely high density of vitamin C (Thortan and Sieczka, 1980). Many disease causing agents *viz.,* viruses, fungi, bacteria, nematode, viroids and phytoplasmas are reported on potato. Among the fungal diseases, wilt caused by *Sclerotium rolfsii* Sacc. has attained the economic importance. In recent years, this disease is increasing and causing huge losses in potato (Paul Khurana, 1998). Kulkarni (2007) reported the maximum incidence of wilt of potato caused by *S. rolfsii* in Belgaum (7.25%) and least in Bidar (2.50%) districts. Sclerotium wilt of potato caused by *Sclerotium rolfsii* Sacc. is a soil borne pathogen and infects many host plants which are economically important. Hence, management of this disease is necessary by using fungicides, bioagents in alone or in integration with soil solarization and organic amendments.

MATERIALS AND METHODS

Chemicals:

The efficacy of five non-systemic fungicides (at the concentrations of 0.1, 0.2 and 0.3%) and five systemic fungicides (at the concentration of 0.05, 0.1, 0.2%) were assayed *in vitro*.

Required quantity of individual fungicide was added separately into sterilized molten and cooled Potato dextrose agar so as to get the desired concentration of the fungicides. Later, 20 ml of the poisoned medium was poured into sterilized Petriplates. Mycelial discs of five mm size from actively growing zone of seven days old culture was cut out by a sterile cork borer and one such disc was placed at the centre of each agar plate. Control treatment was maintained without adding any fungicide to the medium. Three replications were maintained for each concentration. Then such plates were incubated at room temperature and radial growth was measured when the fungus attained maximum growth in control plates. Per cent inhibition of mycelial growth over control was calculated by using the following formula given by Vincent (1947) :

$$I = \frac{C - T}{C} \times 100$$

where,

I = Per cent inhibition

C = Growth in control

T = Growth in treatment

Bioagents:

Six biocontrol agents such as *Trichoderma harzianum* Raifai, *Trichoderma koningii* Oudern, *Trichoderma virens* Miller, *Trichoderma viride* Pers. ex S.F. Gray, *Pseudomonas fluorescens* Migula and *Bacillus subtilis* Cohn Emend Pras were tested against *Sclerotium rolfsii*. Both biocontrol agents and test fungus were cultured on Potato dextrose agar in order to get fresh and active growth of fungus. The cultures of antagonistic microorganisms used in the present study were obtained from the National Bureau on Agriculturally Important Insects (NBAII) Bangalore, Karnataka State.

Twenty ml of sterilized and cooled Potato dextrose agar was poured into sterile Petriplates and allowed to solidify. For evaluation of fungal biocontrol agents, mycelial discs of test fungus were inoculated at one end of the Petriplate and antagonistic fungus was placed opposite to it on the other end. In case of evaluation of bacterial antagonist, the bacterium was streaked at the middle of the Petriplates and mycelial discs of the test fungus was placed on either sides at the centre of each half of the plate. The plates were incubated at 27±1°C and zone of inhibition was recorded by measuring the clear distance between the margin of the test fungus and antagonistic organism. The colony diameter of pathogen in control plate was also recorded. The per cent inhibition of the growth of the pathogen was calculated by using the formula suggested by Vincent (1947).

Integrated management of the disease by solarization, fungicides, biorationals and organic amendments:

An experiment was conducted to know the combined effect of soil solarization, chemical, bioagent and organic amendments in controlling (managing) the sclerotium wilt of potato in the farmer's field at Navalur (Dharwad). The details of the treatments are given hereunder.

T_1 – Soil solarization + tuber treatment with (carboxin 0.2% + *T. harzianum* 1%) + soil application of FYM + neem cake and T_2 – Control

Sick plot was prepared by mixing thirty days old culture grown on Sand corn meal medium and was mixed thoroughly with soil to get four per cent sick soil (w/w basis). Solarization was done in sick plot as mentioned earlier. After 45 days of solarization, polythene sheet was removed and amended with organic amendments *viz.,* neem cake 300 kg/ha and FYM 25 t/ha. After 25 days the seed tubers of Kufri Jawahar were treated with fungicide and bioagent found best in *in vitro* studies *i.e.* tuber treatment with carboxin, 0.2 per cent and *T. harzianum* 10 g/kg and planted in the plots. Control plot was planted with tuber without any treatment. Observations like per cent disease incidence and yield were recorded.

Field experiment was conducted as detailed below.

Plot size	:	2.0 m x 2.0 m
Design	:	RCBD
Number of replications	:	13
Number of treatments	:	2

Statistical analysis was carried out as per the procedure given by Panse and Sukhatme (1967). Data in percentage were transformed to arc sine and square route values and analysis was done in M-Stat C.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads:

Chemicals:

The data revealed that, the effect of fungicides on the growth of *S. rolfsii* was significant. Among the non-systemic fungicides (Table 1), emissan, thiram and mancozeb at all concentrations and captan and zineb at 0.3 per cent inhibited the growth of *S. rolfsii* completely (cent per cent) and were found to be significantly superior over rest of the treatments tested. This was followed by zineb at 0.2 per cent (94.00%) concentration. Least inhibition of mycelial growth was recorded in captan 0.1 per cent (75.03%) concentration. Vyas and Joshi (1977) and Choudhury *et al.* (1998) reported that, thiram and mancozeb were most effective fungicides, which have shown 96.02 and 93.02 per cent inhibition, respectively at 2000 ppm concentration. Prabhu (2003) reported that, thiram recorded cent per cent inhibition followed by 86.33 per cent in mancozeb at 0.3 per cent concentration.

Systemic fungicides Table 2 *viz.,* carboxin, difenaconazole and hexaconazole at all concentrations and metalaxyl MZ @ 0.2 per cent concentration inhibited cent per cent growth of *S. rolfsii* and were found to be significantly superior over rest of the treatments tested. This was followed by metalaxyl MZ at 0.1 per cent concentration. Least inhibition of mycelial growth of pathogen was observed in carbendazim at 0.05 per cent (47.00%). Effectiveness of carboxin against *S. rolfsii* was reported by Maiti and Choudhuri (1975), Vyas and Joshi (1977), Nargund (1981), Patil and Rane (1982), El-Wakil and Ghonin (2000), Prabhu (2003), Baswaraj (2005), Kulkarni (2007).

Table 1 : Effect of non-systemic fungicides on mycelial growth of *Sclerotium rolfsii*

Sr. No.	Fungicides	Per cent inhibition of mycelial growth (mm)	
1.	Captan (0.1%)	75.03	*(60.06)
2.	Captan (0.2%)	85.40	(67.76)
3.	Captan (0.3%)	100.00	(90.04)
4.	Thiram (0.1%)	100.00	(90.04)
5.	Thiram (0.2%)	100.00	(90.04)
6.	Thiram (0.3%)	100.00	(90.04)
7.	Emisan (0.1%)	100.00	(90.04)
8.	Emisan (0.2%)	100.00	(90.04)
9.	Emisan (0.3%)	100.00	(90.04)
10.	Mancozeb (0.1%)	100.00	(90.04)
11.	Mancozeb (0.2%)	100.00	(90.04)
12.	Mancozeb (0.3%)	100.00	(90.04)
13.	Zineb (0.1%)	88.00	(69.80)
14.	Zineb (0.2%)	94.00	(75.93)
15.	Zineb (0.3%)	100.00	(90.04)
	S.E.±	0.53	
	C.D. (P=0.01)	2.05	

* Figures in parenthesis indicates arc sin transformed values

Table 2 : Effect of systemic fungicides on mycelial growth of *Sclerotium rolfsii*

Sr. No.	Fungicides	Per cent inhibition of mycelial growth	
1.	Carbendazim (0.05%)	47.00	*(43.30)
2.	Carbendazim (0.1%)	63.83	(53.06)
3.	Carbendazim (0.2%)	75.00	(60.03)
4.	Difencanazole (0.05%)	100.00	(90.04)
5.	Difencanazole (0.1%)	100.00	(90.04)
6.	Difencanazole (0.2%)	100.00	(90.04)
7.	Hexaconazole (0.05%)	100.00	(90.04)
8.	Hexaconazole (0.1%)	100.00	(90.04)
9.	Hexaconazole (0.2%)	100.00	(90.04)
10.	Carboxin (0.05%)	100.00	(90.04)
11.	Carboxin (0.1%)	100.00	(90.04)
12.	Carboxin (0.2%)	100.00	(90.04)
13.	Metalaxyl MZ (0.05%)	53.30	(46.91)
14.	Metalaxyl MZ (0.1%)	76.13	(60.80)
15.	Metalaxyl MZ (0.2%)	100.00	(90.04)
	S.E.±	0.42	
	C.D. (P=0.01)	1.62	

* Figures in parenthesis indicates arc sin transformed values

Johnson and Subramanyam (2000) reported least mycelial inhibition by carbendazim and chlorothalonil. Urany *et al.* (1984), Prabhu (2003) and Kulkarni (2007) reported that, among the systemic fungicides tested, carbendazim was least effective.

Bioagents:

The competitive ability of antagonists against *S. rolfsii* was studied by dual cultural method as described in material and methods (Table 3). There was a significant difference between the bioagents tested with respect to per cent inhibition of mycelial growth of *S. roflsii*. *T. harzianum* showed the maximum inhibition of *S. rolfsii* (53.33%) and it was found significantly superior over rest of the bioagents tested. This was followed by *T. viridae* (46.11%), *T. koningiii* (37.40%) and *T. virens* (33.14%). The least inhibition was observed in case of *B. subtilis* (11.29%) and *P. fluorescens* (13.64%). Similar types of observations were made by Pushpavathi and Rao (1998) and Iqbal *et al.* (1995) who noticed 54.90 per cent inhibition. It may be due to production of antibiotic substance (viridin) as reported by Brain (1951). These results are also in agreement with the findings of Karthikeyan (1996) and Sreenivas Prasad and Manibhusan Rao (1990). It was due to the penetration of the antibiotic into hyphae of pathogen at the place of contact as confirmed by Mukharjee *et al.* (2000).

Table 3 : Effect of biocontrol agents on mycelial growth of *Sclerotium rolfsii*

Sr. No.	Fungicides	Per cent inhibition of mycelial growth	
1.	*Bacillus subtilis* Cohn Emend Pers.	11.29	*(19.65)
2.	*Pseudomonas fluorescens* Migula	13.64	(21.67)
3.	*Trichoderma harzianum* Rifai	53.33	(46.93)
4.	*Trichoderma koningii* Oudern	37.40	(37.72)
5.	*Trichoderma virens* Miller	33.14	(35.16)
6.	*Trichoderma viride* Pers.	46.11	(42.79)
7.	Mean	32.48	(33.99)
	S.E.±	0.3464	
	C.D. (P=0.01)	1.4964	

* Figures in parenthesis indicates arc sin transformed values

Integrated management of the disease by solarization, fungicides, biorationals and organic amendments:

Integration of the soil solarization + seed treatment with (carboxin + *T. harzianum*) + soil application of (FYM and neem cake) for the disease management have given better results (Table 4). In the present study, it was observed the drastic reduction in per cent disease incidence (7.48%) in treated plot, whereas, it was higher in control (16.89%), yield was also more in treated plot (6.47 t/ha) compared to control (4.15 t/ha). Similar findings were reported by Patibanda *et al.* (2002), Thakare *et al.* (2002) and Anahosur (2001) who introduced the integrated disease management approach in controlling *S. rolfsii*. IDM involves the combination of appropriate

Table 4 : Integrated management of *Sclerotium* wilt of potato

Treat. No.	Treatments	Mean per cent disease incidence	Mean yield (t/ha)
T_1	Soil solarization + tuber treatment with (carboxin @ 0.2% and *T. harzianum* @ 10g/kg tubers) + soil application of (FYM @ 25 t/ha and neem cake @ 300 kg/ha	7.48 (15.87)*	6.47
T_2	Control	16.89 (24.28)*	4.15
	S.E.±	0.11	0.06
	C.D. (P=0.05)	0.34	0.18

* Figures in parenthesis indicates arc sin transformed values

techniques that is chemical, cultural and biological to suppress the disease to a tolerable level.

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