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Biological management of Sclerotium rot of chilli

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ABSTRACT

Sclerotium rot of chilli caused by *Sclerotium rolfsii* Sacc. is one of the most devastating soil-borne diseases which pose a problem for the successful cultivation of the crop. The present field investigation was carried out for the biological management of Sclerotium rot of chilli during the rabi seasons of 2019-20 and 2020-21. It was found that all the modules effectively reduced the incidence of the disease. Among the biological modules, seed treatment with *T. viride* + *P. fluorescens* @ 10.0 g/kg of seed and soil application of *T. viride* and *P. fluorescens* @ 2.5 kg/ha and soil application of neem cake @ 5 q/ha + drenching with *T. viride* and *P. fluorescens* @ 10 g/l of water each twice at 10 days interval starting from 30 DAT was most effective in reducing the incidence of the disease by 56.2% and increasing the fruit yield by 66.7% in comparison to untreated control. The treatment also improved soil microbial status and achieved the highest plant growth promotion in plant height, leaf number, and maximum B: C ratio of 2.26.

Keywords: *Capsicum annuum* L., Fungicide, Bioagents, Amendment, Seed treatment.

INTRODUCTION

Chilli (*Capsicum annuum* L.) a rich source of vitamins A and C is one of the important vegetables as well as spice crops of India. Chilli belongs to Solanaceae family and is a native of tropical America. It is grown throughout the world for its green and red ripe fruit**.** It is a valuable spice crop cultivated by many of small farmers, because of its economic value. The fruits are used as fresh, cooked, pickled and canned in sauces and as powder for hot spices (Azad *et al.,* 2). India is one of the major chillies producing countries in the world and cultivated over an area of 780 thousand hectares with an annual production of 1743 thousand tonnes and productivity of 2.2 metric tonnes per hectare (www.agricoop.nic.in). The crop is affected by many biotic constraints leading to a reduction in yield and quality. Sclerotium rot caused by *Sclerotium rolfsii* Sacc. is one among the most devastating soil borne diseases which pose a problem for successful cultivation of the crop (Mathur and Gurjar, 9). It is mostly prevalent in warm, temperate, and subtropical region having wide geographical diversity. The pathogen produces sclerotia which remain in the soil as a primary inoculum and are capable of initiating infection in the field. Nowadays, greater emphasis is given for biological control of soil-borne diseases that can be done by using biocontrol agents such as *Trichoderma* sp. (Sharma *et al.,* 13) or by using organic amendments to reduce the cost of cultivation, environmental hazards and to avoid the development of resistant strains (Abbott *et al.,* 1). Additions of organic amendments also found to increase antagonistic population in soil and thereby decrease the inoculum of soil borne pathogens (Bonanomi *et al.,* 3).

The present investigation was carried out for the biological management of Sclerotium rot of chilli by using organic amendment in combination with biocontrol agents against the disease under field conditions.

MATERIALS AND METHODS

Field experiments were conducted during *rabi*, 2019-20 and 2020-21 at a research farm of Regional Research and Technology Transfer Station, Chiplima, Sambalpur, Odisha. The station is situated at $20^0$21'N latitude and $80^0$55'E longitude in Dhankauda block of Sambalpur district at an altitude of 178.8 m above mean sea level. The experiment was laid out in a plot size 5 m x 2 m following a randomized block design (RBD) with three replications. Six modules along with one chemical module for comparison with biocontrol modules and a suitable control constituted a total of seven different modules of the experiment. Different modules that are used in the present experiment with details are as follows: M_1=Seed treatment with *T. viride* @10.0g/kg of seed + soil application of *T. viride* @2.5kg/ha + drenching with *T. viride* @10g/l of water twice at 10 days interval; M_2=Seed treatment with *P. fluorescens* @10.0g/kg of seed + soil application of *P. fluorescens* @2.5 kg/ha + drenching with *P. fluorescens* @10g/l of water twice at 10 days interval; M_3=M_1 + soil application of neem cake @5q/ha; M_4=M_2

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+ soil application of neemcake @5q/ha; M_5=Seed treatment with *T. viride* + *P. fluorescens* @10.0g /kg of seed + soil application of *P. fluorescens* and *T. viride* @2.5kg/ha + soil application of neem cake @5q/ha + drenching with *T. viride* and *P. fluorescens* @10g/l of water twice at 10 days interval; M_6=Seed treatment with Carboxin 37.5% + Thiram 37.5% @2g/l of water + spraying of Tebuconazole @1ml/l of water at the base of the plant; M_7=Untreated control.

The hybrid variety (Siam Hot) was transplanted at a spacing of 50 cm x 30 cm spacing in January, 2019-20 and 2020-21. Recommended fertilizer dose was applied in all the plots and standard agronomic practices were followed as and when necessary to raise the crop. The organic amendment neemcake @5q/ha was applied at the time of final land preparation. The formulations of biocontrol agents were obtained from Multiplex Bio-Tech Pvt. Ltd., Bangaluru, India. The inoculum loads during field application were $1x10^8$ CFU/g for both *T. viride* and *P. fluorescens*. Seeds were treated with *T. viride* @10g/kg of seed or *P. fluorescens* @10g/kg of seed before sowing. The inoculum *S. rolfsii* was multiplied in sand maize medium and then applied in the field to increase disease pressure at the time of transplanting @10g/m^2 area. Rhizosphere soil mycofloral populations were counted by dilution plate method. Soil dilutions were made by suspending 1g of rhizosphere soil of each sample in 10 ml of sterile distilled water. Then dilutions of 10^{-3}, 10^{-4} and 10^{-5} were made to enumerate fungal population to avoid over-crowding of the fungal colonies. 1ml of suspension of each concentration was added to sterile petri plates, in triplicates of each dilution, containing sterile rose bengal agar medium. 1% streptomycin solution was added to the medium for preventing bacterial growth, before pouring into petri plates. The plates were incubated at 28±1°C for 3-5 days. Fungal colonies were appeared and easily counted as they formed surface colonies that were well dispersed, particularly at higher dilutions. From each plot 10 plants were selected for taking observation on plant height and leaf number excluding the border rows.

Observations on plant growth parameters (Plant height and leaf number per plant) and disease incidence percentage were taken. Rhizosphere soil mycofloral population (CFU/g dry soil) were recorded before transplanting and 60 days after transplanting (DAT). Dry chilli fruit yield and B:C ratio were also recorded.

RESULTS AND DISCUSSION

Plant height is one of the key growth parameters that ultimately influences the total growth and output of the growth. From the pooled data (Table 1) it was observed that at 60 days after transplanting (DAT), module M_5 recorded significantly maximum plant height (73.70 cm) followed by M_6 (67.67 cm) and M_3 (65.80 cm). A rise of 28.6% in plant height was observed in M_5 over untreated control. Significantly highest number of leaf (213.33) was found in module M_5 at 60 DAT followed by M_6 (198.50) and M_3 (191.43).

Pooled mean revealed that percent disease incidence were significantly reduced in all the modules with comparison to untreated control (Table 2). Minimum disease incidence was observed in chemical treated module (M_6) i.e., seed treatment with Carboxin 37.5% + Thiram 37.5% @2g/l of water + spraying of Tebuconazole @1ml/l of water at the base of the plant during both the years but it was statistically at par with module M_5. Among the non chemical modules, lowest disease incidence was observed in M_5 module i.e., seed treatment with *T. viride* + *P. fluorescens* @10.0g/kg of seed + soil application of *P. fluorescens* and *T. viride* @2.5kg/ha + soil application of neem cake @5q/ha + drenching with *T. viride* and *P. fluorescens* @10g/l of water each twice at 10 days interval. Percent reduction of disease incidence over control was

Table 1. Effect of different modules on growth of chilli plant (60 DAT), dry chilli yield and B:C ratio (Pooled of 2019-20 and 2020-21).

Treatments	Plant height (cm)	Leaf number/plant	Dry chilli yield (q/ha)	% yield increase over control	B:C
M_1	64.10*	178.68*	14.89	18.6	1.67
M_2	59.05	166.23	13.11	4.4	1.47
M_3	65.80	191.43	18.0	43.3	1.94
M_4	62.13	179.28	14.33	14.1	1.55
M_5	73.70	213.33	20.94	66.7	2.26
M_6	67.67	198.50	22.67	80.5	2.56
M_7	55.65	161.23	12.56	-	1.40
SEm(±)	1.44	3.93	1.70	-	-
CD (0.05)	4.47	12.23	5.30	-	-

*Average of 10 replications

Table 2. Effect of different modules on disease incidence and soil mycofloral population (CFU/g dry soil) in chilli.

Treatment	Disease incidence %		Pooled	Disease control (%)	Soil mycofloral population (CFU /g dry soil)	
	2019-20	2020-21			Initial	60DAT
M_1	29.08 (32.53)*	19.41 (26.04)	24.25 (29.47)	33.9	5.67 (0.72)**	19.33 (1.29)
M_2	32.41 (34.65)	24.96 (29.95)	28.69 (32.34)	21.8	5.33 (0.69)	17.33 (1.24)
M_3	26.22 (30.69)	16.64 (24.04)	21.43 (27.52)	41.6	3.33 (0.49)	18.33 (1.26)
M_4	30.98 (33.76)	22.88 (28.50)	26.93 (31.21)	26.6	3.67 (0.53)	17.0 (1.23)
M_5	23.83 (29.04)	8.32 (16.68)	16.08 (23.56)	56.2	4.67 (0.65)	25.33 (1.40)
M_6	18.11 (25.0)	7.63 (15.78)	12.87 (20.82)	64.9	5.0 (0.67)	14.67 (1.16)
M_7	42.90 (40.86)	30.51 (33.41)	36.70 (37.27)	-	4.33 (0.63)	15.00 (1.17)
SEm(±)	2.30	1.70	1.48	-	0.11	0.03
CD (0.05)	7.17	5.31	4.61	-	N.S	0.08

*Figures in parentheses are angular transformed values, **Figures in parentheses are log transformed values, N.S: Non significant

also calculated. Among the non chemical modules, maximum disease control (56.2%) was achieved by M_5 module.

Effect of various modules on quantative nature of soil mycofloral population of chilli plants were studied during both the years. It was observed that the initial (before transplanting) mycofloral population did not differ significantly with each other in different treatments (Table 2). The mycofloral population increased in all the modules at 60 days after transplanting. The highest mycofloral population counts (25.33 X 10^4 CFU/g soil) at 60DAT were recorded in M_5 module and the lowest population was recorded in M_7 module i.e., in untreated control plot.

Fruit yield data also increased on different modules as compared to untreated control (Table 1). Maximum dry chilli yield was recorded in M_6 module (chemical treated module) which was statistically at par with M_5 module. Among the non chemical module, the highest yield (20.94q/ha) was obtained from M_5 module which recorded 66.7% yield increase over control plot and showed highest B:C ratio (2.26).

The results of the present investigation were in line with the findings of Kumar *et al.* (7) who found that application of different isolates of *Trichoderma* sp. not only significantly contributed to foliage of the chilli plant but they also enhanced the yield component of chilli. It was also reported by Krishnaraj *et al.* (5) that neem cake amended with *T. viride* and *P. fluorescens* significantly increases the vegetative growth as well as yield of tomato crops over untreated control.

Present study is also in close agreement with the findings of earlier workers (Thilagavathi *et al*., 14; Bonanomi *et al.*, 3) who reported the incorporation of biocontrol agents with organic amendments like neem and their efficacy for management of fungal root rot disease in several crops. Different isolates of *Trichoderma* spp. and *P. fluorescens* were identified as biocontrol agents against groundnut stem rot and other soil-borne diseases (Podile and Kishore, 10; Mandal and Pal, 8; Kubicek *et al*., 6).

Application of organic amendment significantly influenced the soil microflora. Several reports (Girvan *et al.,* 4; Wada and Toyota, 16) found that organic amendment may enhance soil functional stability mediated by soil microbial community. The result was confirmed with the finding of Sarkar *et al.* (11) where the dual inoculation of *Trichoderma* sp and *P. fluorescens* had a positive impact on plant vigour, as it increased the microbial activity in the soil.

The present study revealed that the antagonistic property of *Trichoderma* sp. and *P. fluorescens* along with neem cake promoted biological activity by providing nutrients and also release inhibitory substances during decomposition. This led to the inhibition of the growth of *S. rolfsii*. *Pseudomonas* and *Trichoderma* have gained considerable importance as potential antagonistic microorganisms to reduce the plant disease caused by fungal pathogens. These bio-control agents were also found to produce growth promoting substances, thereby enhancing the growth and bio mass of the crop (Vij *et al*., 15). These bacteria and fungi are not toxic to other organisms; they pose a low risk to the environment. This study will be able to provide information on efficient disease management of chilli crop which are very cost effective and eco-friendly and also increase the soil microbial activity in the present contest of sustainable agriculture (Sateesh and Sivasakthivelan, 12).

The present study reveals that stem rot disease of chilli caused by *Sclerotium rolfsii* can be managed by seed treatment with *T. viride* + *P. fluorescens* @10.0g /kg of seed and soil application of *T. viride* and *P. fluorescens* @2.5kg/ha and soil application of neem cake @5 q/ha + drenching with *T. viride* and *P. fluorescens*@10g/l of water each twice at 10

days interval starting from 30 DAT. The treatment also improved soil microbial status and gave highest plant growth promotion and maximum fruit yield under field condition.

AUTHORS' CONTRIBUTION

Conceptualization of research (DM, RP); Designing of the experiment (DM, AKM); Execution of field experiment and data collection (DM, RP); Analysis of data and interpretation (DM, AKM); Preparation of the manuscript (DM).

DECLARATION

The authors do not have any conflict of interest.

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