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Integrated Management of Stem and Root Rot Disease in Sesame Caused by *Macrophomina phaseolina*

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Stem and root rot disease caused by *Macrophomina phaseolina* (Tassi) Goid is the destructive disease in sesame. The effect of bioagents and newer molecules of fungicides were evaluated in managing the stem and root rot disease of sesame under sick plot conditions during 2018 and 2019. Seed treatment was done with bioagent *Trichoderma asperellum* at the rate of 4 g/kg of seed. Furrow application of *T. asperellum* (2.5 kg/ha enriched in 100 kg of FYM) at the rate of 250 kg/ha was also made uniformly in all the treatments. Foliar application of fungicides was done twice one at capsule initiation stage and another at 15 days interval. From the results, it could be inferred that seed treatment with *T. asperellum* at the rate of 4g/kg seed; furrow application of *T. asperellum* (2.5 kg/ha enriched in 100 kg of FYM) at the rate of 250 kg/ha followed by foliar application of Trifloxystrobin + Tebuconazole at the rate of 0.5 g/l at capsule initiation and second spray after 15 days interval was highly effective in managing the stem and root rot disease of sesame as well increased the seed yield also.

Introduction

Sesame (*Sesamum indicum* L.), is one of the oldest oilseed crop grown widely under tropical and subtropical regions in India (Kumaraswamy *et al.*, 2015). The low productivity has been attributed to pests and disease occurrence (Buldeo and Rane, 1978). The stem and root rot disease of *Sesamum indicum* caused by *Macrophomina phaseolina* (Tassi) Goid is the most serious one affecting the crop at the later stages of growth. Yellowing of leaves, discolouration and rotting of roots and dark brown lesions on the stem are the prominent symptoms of root rot disease. High temperature and water stress during growing season favours the pathogen's incidence (Chattopadhyay and Kalpana Sastry, 1998). The pathogen survives in the soil for several years. The yield loss occurred up to 60 per cent due to root rot disease. The pathogen produces pycnidia which are black, flask shaped structures with an ostiole. Numerous pycnidiospores are released from the pycnidium. About one per cent increase in disease intensity reduces its yield by 8.36 kg/ha (Maiti *et al*., 1988).

Plants contribute to the establishment of specific ecological niches of microbes in the rhizosphere by playing key role as ecosystem engineers. The microbial community at the rhizosphere reflects its functional specificity at the level of plant–microbe interactions. It suggests that taxonomically-contrasted plant growth promoting strains may coexist in soil and colonize the same rhizosphere (Asha *et al.,* 2013). Fungicides such as carbendazim were reported to control root rot disease in various crop plants. Management of disease through fungicides alone leads to cause soil residual problem and health hazards, besides involving higher input cost. Biological control through the use of antagonistic microorganisms has recently emerged as a viable disease management strategy. Biocontrol agents work through different modes of action. This helps biocontrol agent to be more durable, more effective and without chemical residues in human food chain. The effectiveness of biocontrol agents in the management of soil-borne diseases had been reported in several crops (Meena *et al*., 2002; Meena *et al*., 2014). In addition, the bioagent, *Trichoderma* also acts as inducer for resistance in treated plants against certain pathogens (Harman, 2006) and can grow with wide range of temperature and other environmental conditions (Singh *et al*., 2010).

Biopesticides are cheaper, ecofriendly and do not pose risk of the pathogen developing resistance. Although some biological control agents may protect seeds from soil borne pathogens, they do not proliferate in the rhizoplane and rhizozphere (Papavizas, 1985). Integrating functional and ecological knowledge on microbial populations in soil will be a prerequisite in developing novel management strategies for sustainable agriculture for which the population abundance of soil microbiome is an important component.

Though root rot disease pathogen is soil borne, the secondary infection caused by pycnidia is very destructive phase in sesame leading to stem rot infection. Hence, the present research work was carried out to manage the stem and root rot disease of sesame using the bioagents, *Trichoderma asperellum, Pseudomonas fluorescens* and various newer molecules of fungicides.

Materials and Methods

Pathogenicity studies

Sesame (*Sesamum indicum* L.) plants showing typical root rot symptoms were collected and the isolation of fungus was done following the standard tissue isolation technique. Those parts of root and stem showing typical symptoms of the disease were washed in running tap water and cut into small bits. These bits were surface sterilized with 0.1 per cent mercuric chloride solutions for 30 seconds and washed thoroughly in sterile distilled water for three times to remove traces of mercuric chloride and then aseptically transferred to sterilized potato dextrose agar (PDA) plates and incubated at 27±1ºC for three days for fungal growth. Later, the bit of fungal growth was transferred to PDA slants. The pure culture of the fungus was obtained by further growing the culture under aseptic conditions by following hyphal tip culture method (Rangaswami, 1972). After seven days of incubation, pure isolates were obtained and maintained at 4ºC for further studies.

The pathogenic ability of *M. phaseolina* (isolated from the diseased stem) was tested in screen house on sesame. Culture of *M. phaseolina* was raised in 250 ml Erlenmeyer flask containing 50 ml of PDB (potato dextrose broth) sterilized at 15 lbs per sq inch pressure for 20 minutes. The bits of 5 mm size were cut with the help of sterilized cork borer from fresh pure culture plates (5 days old) and transferred into flasks with the help of sterilized needle under aseptic conditions. After seven days of incubation in BOD incubator at 27±1˚C, mycelial mats were collected and dried between folds of blotting paper for further use. Five gram of fresh mycelial mat was homogenized in blender for 2 minutes at lowest speed in 1000 ml of sterilized water. The suspension was used to inoculate the pots containing 5 kg of sand: ground sesame seed mixture (9:1) which was sterilized by autoclaving at 15 psi for one and half hours for two consecutive days. On the third day of inoculation, thirty seeds of sesame were sown in pots. Pots were irrigated regularly to maintain moisture. After 8-10 days of sowing, the symptoms appeared and the infected plants exhibited elongated lesions at collar region which will be later converted to dark brown to black and stem was completely girdled by the lesions. The affected plants wilted and dried up later. Diseased plants were brought to laboratory and isolations were made on PDA medium from diseased stem to confirm the identity of pathogen (Riker and Riker, 1936).

Field studies on the management of stem and root rot of sesame using bioagents and fungicides

Field eperiment was conducted in the New Farm, Regional Research Station, Vridhachalam during *kharif* 2018 and *kharif* 2019 to study the effect of bioagent *viz.*, *Trichoderma asperellum* and fungicides for the management of stem and root rot disease of sesame under sick plot conditions. The field experiment was conducted in a plot size of 2.4x3.0 m with eight treatments and three replications in RBD using the susceptible variety VRI-1 for the management of stem and root rot disease of sesame.

The seeds of sesame were treated with *T. asperellum* talc based formulation at 4 g per kg of seed before sowing. Furrow application of *T. asperellum* (2.5 kg/ha enriched in 100 kg of FYM) @ 250 kg/ha was also made uniformly in all the treatments. Seed treatment (ST) with *T. asperellum* at the rate of 4 g/kg seed and furrow application of *T. asperellum* (2.5 kg/ha enriched in 100 kg of FYM) at the rate of 250 kg/ha was common for treatments T_1- T_7. Spraying of bioagent, *Pseudomonas fluorescens* was done at the rate of 5 g/l twice one at capsule initiation and second spray after 15 days interval. Fungicides *viz.*, Trifloxystrobin + Tebuconazole @ 0.5 g/l; Azoxystrobin @ 1.0 ml/l; Pyraclostrobin + Metiram @ 3.0 g/l; Cymoxanil + Mancozeb @ 2.0 g/l; Captan + Hexaconazole @ 2.0 g/l and Carbendazim + Mancozeb @ 2.5 g/l were sprayed at capsule initiation and second spray after 15 days interval. Seeds not treated with bioagent or sprayed with fungicides will be served as the control.

The root rot disease incidence was recorded at the time of physiological maturity (90 days after sowing) by counting the number of infected plants and total number of plants. Seed yield was also recorded for each treatment and the data were statistically analyzed.

Per cent disease incidence was calculated using the formula

$$\text{Disease Incidence (\%)} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

Results and Discussion

In the field trial conducted for the management of root rot disease of sesame during *kharif* 2018, all the treatments were found to be superior over control. Among the treatments, seed treatment with *T. asperellum* at the rate of 4g/kg seed; furrow application of *T. asperellum* (2.5 kg/ha enriched in 100 kg of FYM) at the rate of 250 kg/ha followed by foliar application of Trifloxystrobin + Tebuconazole at the rate of 0.5 g/l at capsule initiation and second spray after 15 days interval recorded the lowest disease incidence of 24.6% (Table 1). This was found to be on par with foliar spraying of Azoxystrobin at the rate of 1.0 ml/l at capsule initiation and second spray after 15 days interval which recorded the disease incidence of 28.3%. The maximum disease incidence of 56.4% was observed in the control (Table 1). Pastrana *et al.* (2016) reported that *Asperellum* was the most effective in reduction of crown and root rot caused by *Fusarium solani* (up to 100% in greenhouse and 81% under field conditions). Fiki and Farouk (2017) reported maximum inhibition of soil borne pathogens *viz*., *Rhizoctonia solani*, *Fusarium solani*, *F. oxysporum* and *M. phaseolina* by *T. harzianum*. The fungicide propiconazole was the most effective fungicide in controlling fruit rot of pomegranate caused by *Alternaria alternata* as reported by Singh and Majumdar (2002). Gohel and Solanky (2011) documented that maximum disease control of chilli leaf spot caused by *Alternaria alternata* was observed under field conditions.

Table.1 Effect of fungicides and bioagents for the management of stem and root rot disease of sesame caused by *Macrophomina phaseolina (kharif* 2018)

S.No	Treatments	Root rot (%)	Yield (kg/ha)
T_1	Spraying of *Pseudomonas fluorescens* @ 5 g/l at capsule initiation and second spray after 15 days interval	44.8 (42.3)	496
T_2	Spraying of Trifloxystrobin + Tebuconazole @ 0.5 g/l at capsule initiation and second spray after 15 days interval	24.6 (26.4)	624
T_3	Spraying of Azoxystrobin @ 1.0 ml/l at capsule initiation and second spray after 15 days interval	28.3 (27.5)	616
T_4	Spraying of Pyraclostrobin + Metiram @ 3.0 g/l at capsule initiation and second spray after 15 days interval	33.4 (31.7)	587
T_5	Spraying of Cymoxanil + Mancozeb @ 2.0 g/l at capsule initiation and second spray after 15 days interval	30.7 (28.3)	596
T_6	Spraying of Captan + Hexaconazole @ 2.0 g/l at capsule initiation and second spray after 15 days interval	35.1 (32.6)	563
T_7	Spraying of Carbendazim + Mancozeb @ 2.5 g/l at capsule initiation and second spray after 15 days interval	39.5 (37.1)	528
T_8	Untreated check	56.4 (53.9)	424
SEd		3.53	16.4
CD(P=0.05)		7.91	34.9

*Mean of three replications

Note: Seed treatment (ST) with *T. asperellum* @ 4 g/kg + furrow application of *T. asperellum* (2.5 kg/ha enriched in 100 kg of FYM) @ 250 kg/ha is common for T_1- T_7.

Table.2 Effect of fungicides and bioagents for the management of stem and root rot disease of sesame caused by *Macrophomina phaseolina (kharif* 2019)

S.No	Treatments	Root rot (%)	Yield (kg/ha)
T_1	Spraying of *Pseudomonas fluorescens* @ 5 g/l at capsule initiation and second spray after 15 days interval	39.7 (39.0)	463
T_2	Spraying of Trifloxystrobin + Tebuconazole @ 0.5 g/l at capsule initiation and second spray after 15 days interval	22.4 (28.1)	618
T_3	Spraying of Azoxystrobin @ 1.0 ml/l at capsule initiation and second spray after 15 days interval	27.1 (31.3)	583
T_4	Spraying of Pyraclostrobin + Metiram @ 3.0 g/l at capsule initiation and second spray after 15 days interval	32.7 (34.8)	556
T_5	Spraying of Cymoxanil + Mancozeb @ 2.0 g/l at capsule initiation and second spray after 15 days interval	30.6 (33.5)	567
T_6	Spraying of Captan + Hexaconazole @ 2.0 g/l at capsule initiation and second spray after 15 days interval	34.9 (36.2)	524
T_7	Spraying of Carbendazim + Mancozeb @ 2.5 g/l at capsule initiation and second spray after 15 days interval	37.3 (37.6)	496
T_8	Untreated check	48.9 (44.4)	428
SEd		2.57	21.78
CD(P=0.05)		5.58	42.31

*Mean of three replications

Note: Seed treatment (ST) with *T. asperellum* @ 4 g/kg + furrow application of *T. asperellum* (2.5 kg/ha enriched in 100 kg of FYM) @ 250 kg/ha is common for T_1- T_7.

Pethybridge *et al*. (2007) highlighted that berries from the cyprodinil+fludioxonil treatment had the lowest incidence of Botrytis fruit rot of strawberry incited by *Botrytis cinerea.* Spraying of *Pseudomonas fluorescens* @ 5 g/l at capsule initiation and second spray after 15 days interval was not effective in managing the root rot disease which recorded 44.8% disease incidence (Table 1).

In addition to disease reduction, the maximum seed yield of 624 kg/ha was observed in the effective treatment of seed treatment with *T. asperellum* at the rate of 4g/kg; furrow application of *T. asperellum* (2.5 kg/ha enriched in 100 kg of FYM) at the rate of 250 kg/ha followed by foliar application of Trifloxystrobin + Tebuconazole at the rate of 0.5 g/l at capsule initiation and second spray after 15 days interval (Table 1). The population dynamics and functional richness of rhizosphere ecosystem in black pepper influenced by the treatment with *T. harzianum* provides the ecological importance of *T. harzianum* in the cultivation of black pepper (Umadevi *et al*., 2018). This was followed by spraying of Azoxystrobin @ 1.0 ml/l at capsule initiation and second spray after 15 days interval with the seed yield of 616 kg/ha (Table 1). Spraying of *Pseudomonas fluorescens* @ 5 g/l at capsule initiation and second spray after 15 days interval recorded the seed yield of 496 kg/ha. The minimum seed yield of 424 kg/ha was observed in the control (Table 1). Anandaraj and Sarma

(2003) reported that the application of *T. harzianum* (MTCC 5179) resulted in enhanced growth in black pepper with increased number of nodes, and consequently the number of cuttings. Treatment with *T. harzianum* (MTCC 5179) individually imparted better growth promotion and disease suppression than that of a consortia of plant growth-promoting rhizobacteria alone or in combination with *T. harzianum* (MTCC 5179) (Sibi, 2013). These studies indicated growth promotion and the organism was recommended as a component of integrated disease management and without a clear understanding of other mechanisms.

In the field trial conducted during *kharif* 2019 for the management of stem and root rot disease of sesame, all the treatments were found to be superior over control. Among the treatments, seed treatment with *T. viride* @ 10 g/kg + furrow application of *T. viride* (2.5 kg/ha enriched in 100 kg of FYM) @ 250 kg/ha + foliar spray of Trifloxystrobin + Tebuconazole @ 0.5 g/l at capsule initiation and second spray after 15 days interval recorded the minimum disease incidence (22.4%) and the maximum yield of 618 kg/ha (Table 2). This was found to be on par with foliar spraying of Azoxystrobin @ 1.0 ml/l at capsule initiation and second spray after 15 days interval which recorded the disease incidence (27.1%) and the yield of 583 kg/ha. The maximum disease incidence of 48.9% and the minimum yield of 428 kg/ha was observed in the control (Table 2).

From the present study, it could be concluded that stem and root rot disease of sesame can be managed effectively using the integration of bioagent, *T. asperellum* (seed treatment and furrow application) and foliar application of fungicides (Trifloxystrobin + Tebuconazole @ 0.5 g/l at capsule initiation and second spray after 15 days interval).

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