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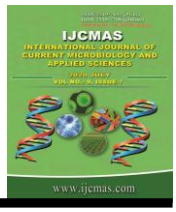

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Integrated Strategy for Management of Stem and Root Rot Disease of Sesame (*Sesamum indicum* L.) caused by *Macrophomina phaseolina* (Tassi) Goid in Odisha

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A B S T R A C T

An experiment was conducted to manage the stem and root rot disease of sesame incited by *Macrophomina phaseiolina* by a combination of new generation fungicides and biocontrol agents. Seven chemicals and a bio-agent, *Pseudomonas fluorescens* were tested separately in combinations with seed and soil treatments of *Trichoderma viride vis-a-vis* untreated control. Seed treatment with *Trichoderma viride* @ 10g/kg +furrow application of *T. viride* (2.5 kg enriched in 250 kg FYM /ha combined with foliar application of azoxystrobin @ 1ml/l at 45 DAS and 60 DAS was found to be significantly effective in sustaining minimum disease incidence (5.25 %), maximum yield (431.55 kg/ha, 45.05 % increase over control) and highest B:C ratio (1.54). It was followed by seed treatment and furrow application of *Trichoderma* combined with chemical sprays of carbendazim + mancozeb @ 2.5g/l (6.77 % disease incidence, 417.85 kg/ha of yield, 40.45 % increase in yield over control, B:C ratio of 1.40). All treatments significantly minimized infection and sustained higher seed yield compared to untreated control. Highest incidence (16.21 %) and minimum yield (297.50 kg/ha) were recorded in the untreated crop. Spraying with chemical fungicides was found more effective *vis-a-vis* bio-control agent, *Pseudomonas fluorescens*, in managing the disease.

Introduction

Known as the 'Queen of oilseeds', sesame (*Sesamum indicum* L.) is one of the major oilseed crops of India. Among oilseeds, it ranks first in oil content with 6335kcal/kg of dietary energy in seeds (Kumar and Goel, 1994). The seed is rich in protein (20%) and

edible oil (50%) and contains 47% oleic acid and 39% linolenic acid (Shyu and Hwang, 2002). Moreover, certain biologically active and health promoting phyto-chemicals such as sesamin, sesamolin, tocopherols, PUFA, phytosterols, phytates and other phenolics were also present (Pathak *et al*., 2014).

Sesame seeds contain magnesium which has anti-cancer properties. India contributes the highest sesame acreage of above 17.73 lakh hectare with an estimated production 8 lakh tones and productivity of 445kg/hectare (Gupta *et al*., 2019).

In Odisha, sesame is cultivated in an area of 203.19 thousand hectares with a production of 79.49 thousand tonnes (Anonymous, 2016). There are many biotic and abiotic stresses which are limiting sesame production and productivity. Among various biotic stresses, stem and root rot of sesame caused by *Macrophomina phaseolina* is reported as the most predominant disease in Odisha (Anonymous, 2018-2019). In India, the disease is prevalent in almost all sesame growing tracts.

The symptom of the disease starts with the yellowing of lower leaves, followed by drooping and defoliation. The stem portion near the ground level shows dark brown lesions and bark at the collar region shows shredding. The sudden death of plants is often seen in patches. In the older plants, the stem near the soil level shows large number of black pycnidia.

The stem portion can be easily pulled out leaving the rotten root portion in the soil. In case of severe infection, pods open prematurely, become shrivelled and black in colour.

Minute pycnidia are also seen on the infected capsules and seeds. The rotten root as well as stem tissues contains a large number of minute black sclerotia which may also be present on infected pods and seeds.

Macrophomina infects a wide host range of nearly 500 species occurring in more than 100 families around the world (Reznikov *et al*., 2016). Seed-borne nature of the pathogen and its ability to survive on left over crop residues make it difficult to manage the disease by any single approach (Choudhury *et al*., 2014). Therefore, an integrated approach was undertaken to manage stem and root rot disease of sesame in Odisha which included seed treatment with bio-agents and/or foliar application of different chemicals and a bio-agent.

Materials and Methods

A field experiment was conducted at All India Co-ordinated Research Project on Sesame, Mahisapat, Dhenkanal during two consecutive *kharif* seasons of 2018 and 2019 involving a susceptible variety VRI-1 with eight treatments. Seeds treated with *Trichoderma viride* @ 10g/kg + furrow application of *T. viride* (2.5 kg enriched in 250 kg FYM/ha were common in all treatments except the untreated control. Foliar spray with biocontrol agent *Pseudomonas fluorescens* @ 5g/l was made at capsule initiation stage (45 DAS) and second spray was made after 15days.

The chemical treatments include new generation fungicides like trifloxystrobin (25 %) + tebuconazole (50%) WG @ 0.5 g/l, azoxystrobin (23 % SC) @ 1ml/l, pyraclostrobin (5 %) + metiram (55 %) WG @ 3 g/l, cymoxanil (8 %) + mancozeb (64%) WP @ 2 g/l, captan (70 %) + hexaconazole (50 %) WP @ 2g/l, carbendazim (12 %) + mancozeb (64 %) WP@ 2.5g/l which were used as foliar spray at capsule initiation (45 DAS) and second spray was made after 15days (60 DAS).

The experiment was carried out in

randomized block design and three replications were maintained for each treatment. A roving survey was carried out in *kharif*, 2019 at different places of Dhenkanal district of Odisha to record the major diseases affecting the crop.

Results and Discussion

Survey conducted during *kharif* 2019 in five centres of All India Co-ordinated Research Project on Sesame across the country including AICRP on Sesame, Mahisapat, Dhenkanal, Odisha revealed that stem and root rot of sesame incited by *Macrophomina phaseiolina* was the major disease of sesame and the incidence ranged from 4.6 to 32.7 per cent (Table 1).

A perusal of pooled data (Table 2) revealed that all treatments significantly reduced stem and root rot infection and sustained higher seed yield in comparison to untreated control. Seed treatment with *Trichoderma viride* @ 10g/kg + furrow application of *T. viride* (2.5 kg enriched in 250 kg FYM/ha) combined with foliar spray of azoxystrobin @ 1ml/l at capsule initiation (45 DAS) and second spray after 15days (60 DAS) was found to be significantly effective in sustaining minimum disease incidence (5.25 %) and maximum seed yield (431.55 kg/ha). It sustained 45.05 per cent higher yield compared to control and recorded the highest B:C ration of 1.54.

The next effective treatment included seed treatment and furrow application with *Trichoderm*a combined with chemical sprays of carbendazim + mancozeb @ 2.5g/l (6.77 % disease incidence with a corresponding seed yield of 417.85 kg/ha).The effectiveness of *Trichoderm*a sp. as an antagonist to *M. phaseolina* has earlier been reported (Wuike *et al.*, 1995).

Sankar and Jeyrajan (1996) reported that *T. harzianum* significantly reduced root rot incidence, increased root and shoot length as well as yield and oil content. Highest incidence of *Macrophomina phaseolina* (16.21 %) and minimum yield (297.50 kg/ha) were recorded in the untreated crop. It was further observed that spraying with chemical fungicides was more effective *vis-a-vis* bio-control agent, *Pseudomonas fluorescens*, in reducing the infection and increasing the yield which corroborates earlier findings (Adhikary *et al*., 2019)

The use of bio-agents for plant disease management as a single approach is not much effective due to its inability to maintain a critical population density for sustained biological activity.

On the other hand, the chemical fungicides are preferred for effective disease management due to their easy adaptability and immediate curative action.

In the present investigation, the combination of *T. viride* (both as seed and soil treatment) coupled with a foliar application of azoxystrobin could effectively reduce *Macrophomina* infection and induce higher seed yield.

It is inferred from the study that an integrated approach involving seed treatment with bio-control agent, *Trichoderma viride* @ 10g/kg + furrow application of *T. viride* (2.5 kg enriched in 250 kg FYM/ha) and subsequent foliar application of azoxystrobin @ 1ml/l at capsule initiation and second spray at 15days could be successfully adopted during sesame cultivation in Odisha for minimizing *Macrophomina* infection and maximizing yield.

Table.1 Survey of sesame diseases in different AICRPs on Sesame conducted during Kharif 2019

Name of AICRP on Sesame centre	*Macrophomina* stem and root rot (%)	Phyllody (%)	Leaf curl (%)	*Cercospora* leaf spot (0-5 grade)	*Alternaria* leaf spot (0-5 grade)	*Phytophthora* blight (0-5 grade)	Bacterial leaf blight (0-5 grade)	Powdery mildew (0-5 grade)
RRTTS, Mahisapat, Dhenkanal, Odisha	4.6-18.6	-	-	0 -2	0 -1	0 -1	-	0 -1
Vridhachalam, TNAU, Tamilnadu	9.5-23.6	3.8-14.6	-	-	1 -3	-	-	1 -3
JNKVV Campus, Jabalpur, M.P.	12.0-18.0	-	-	2 -3	2 -3	2 -3	-	-
RAU, Mandor, Rajasthan	25.2-32.7	18.4-30.2	3.0 -5.2	1 -2	0 -1	-	1 -2	0 -1
UAS, Dharwad, Karnatak	-	5-10	-	2 -3	-	2 -3	-	-

(Source: Annual Report of AICRP on Sesame, 2019-20)

Table.2 Management of stem and root of sesame caused by *Macrophomina phaseolina*

Treatments	MSR incidence (%)			Seed yield (Kg/ha)				B:C ratio
	2018	2019	Pool Mean	2018	2019	Pool Mean	Per cent increase over control	
T1: Seed treatment with *Trichoderma viride* @ 10g/kg (ST) + furrow application of *T. viride* (2.5 kg/ha enriched in 100 kg of FYM) @ 250 kg/ha (FA) + spraying of *Pseudomonas fluorescens* @ 5g/l at 45 DAS and 60 DAS	12.80 (20.92)	14.82 (22.60)	13.81 (29.77)	350.00	361.60	355.80	19.59	1.26
T2: ST +FA + spraying trifloxystrobin + tebuconazole @ 0.5 g/l at 45 DAS and 60 DAS	9.50 (19.93)	10.16 (18.52)	9.83 (18.24)	399.60	381.66	390.63	31.30	1.33
T3: ST +FA + spraying azoxystrobin @ 1ml/l at 45 DAS and 60 DAS	4.70 (12.57)	5.80 (13.93)	5.25 (13.24)	428.10	435.00	431.55	45.05	1.54
T4: ST +FA + spraying pyraclostrobin + metiram @ 3g/l at 45 DAS and 60 DAS	6.60 (14.88)	7.74 (16.13)	7.17 15.52	405.00	405.00	405.00	36.13	1.20
T5: ST +FA + spraying cymoxanil + mancozeb @ 2 g/l at 45 DAS and 60 DAS	7.50 (15.89)	8.12 (16.50)	7.81 (16.21)	401.30	403.33	402.31	35.23	1.11
T6: ST +FA + spraying of captan + hexaconazole @ 2 g/l at 45 DAS and 60 DAS	7.20 (15.56)	7.93 (16.35)	7.56 (15.96)	405.00	410.00	407.50	36.97	1.15
T7: ST +FA + spraying carbendazim + mancozeb @ 2.5 g/l at 45 DAS and 60 DAS	6.40 (14.64)	7.14 (15.49)	6.77 (15.07)	415.70	420.00	417.85	40.45	1.40
T8: Water spray (Untreated check)	14.60 (22.41)	17.82 (24.97)	16.21 (23.73)	290.00	305.00	297.50	-	1.13
SE(m)	0.62	0.59	0.50	10.97	6.05	5.31		
CD(0.05)	**1.89**	**1.78**	**1.52**	**33.28**	**18.34**	**16.11**		

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