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Biopriming and integrated management of *Cercospora* leaf spot of Sesame caused by *Cercospora sesamicola*

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Abstract
Among the foliar diseases of Sesame, *Cercospora* leaf spot caused by *Cercospora sesamicola* was destructive disease infecting all parts of the plant from seedling to physiological maturity leading to seed borne and further serves as primary source of inoculum for next season. At present management through chemicals are the first choice for the farmers to combat diseases because of their visibility of results immediately after application. The focus has been shifted to safer alternatives to chemical fungicides in recent years. Biological management had attained importance in modern Agriculture to curtail the hazards of intensive use of chemicals. Hence, an attempt was made to assess the effect of IDM modules *viz*., Biointensive (M_1), Chemical (M_2) and Adaptive (M_3) on disease severity and yield of sesame in comparison with untreated check (M_4). The study revealed that Module 3 : Seed treatment with *Trichoderma viride* @ 10 g/kg - furrow application of enriched *Trichoderma* (2.5 kg *Trichoderma viride* + 100 kg Vermicompost) @ 250 kg/ha-spray of combi product (Tebuconazole 50 % + Trifloxystrobin 25 % WG) @ 0.5 g/l at 30-35 and second spray at 50-60 days after sowing recorded least *per cent* disease index (44.8 PDI) for *Cercospora* leaf spot and highest yield of 872 kg/ha with a net returns of ₹ 25,268 and cost benefit ratio of 1:1.80 under transitional climatic situations.

Keywords: Biopriming, integrated management, modules, *Cercospora sesamicola*

Introduction
Sesame (*Sesamum indicum* L.) is one of the oldest important oil seed crop and is under cultivation from ancient times (Weiss, 1971) [11]. India accounts for 12-15% of oilseeds area, 7-8 % of oilseeds production, 6-7% of vegetable oil production, 9–12% of vegetable oil import and 9-10% of edible oils consumption (Jha *et al*., 2014) [5]. In Karnataka sesame is cultivated with an area of 0.35 lakh hectares and annual production of 0.31 lakh tonnes with a productivity of 924 kg/ha (DES, 2017-18) [3]. The productivity of Sesame is low due to its low harvest index, indeterminate growth habit, shattering, susceptibility to pests and diseases (Ashri, 1998) [1]. The low productivity is attributed to poor crop management and exposure of the crop to a number of biotic and abiotic stresses (Madhuri and Karuna Sagar, 2018) [8]. It is generally known as til, popularly as "Queen of Oilseeds" due to its stabilized keeping quality contributed by high degree of resistance to oxidation (Bedigian and Harlan, 1986) [2]. At present chemical fungicides are the first choice for the farmers to combat diseases because of their easy adaptability and immediate therapy. Due to health risk and pollution hazards by use of chemical fungicides in plant disease control, it is considered appropriate to minimize their usage. Since sesame seed and oil are in high demand for export due to their high unsaturated fat and methionine content, focus has been shifted out safer alternatives to chemical fungicides in recent years. Bio-control had attained importance in modern agriculture to restrain the hazards of intensive use of chemicals for disease control. Due to fluctuations in environment, the efficacy of bio-control agents is inconsistent due to their inability to colonize and multiply in Rhizosphere (Gupta KN *et al.*, 2018) [6]. Integrated disease management (IDM) has emerged as the promising approach for management of foliar diseases of sesame. Due to non-availability of resistant sources, only management option is through chemicals to avoid considerable yield losses. To combat the disease and maximize the production, the present investigation was undertaken to manage the *Cercospora* leaf spot of sesame through integrated approach as there is an urgent need.

Materials and methods
The experiment was conducted during *Kharif* 2019-20 at AICRP on Sesame and Niger, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka using

a susceptible cultivar DSS-9. The experiment was executed on 03.07.2019 by using randomized complete block design of plot size 2.4m X 3.0m with five replications with four modules *viz.*, Biointensive (M_1), Chemical (M_2), Adaptive (M_3) and Untreated Check (M_4) to know the efficacy of bioagents and chemicals on disease severity and yield of sesame. The treatments were imposed 35 days after appearance of the disease and subsequent spray was given at 15 days after first spray.

Table 1: Efficacy of modules in the integrated management of *Cercospora* leaf spot of Sesame

Modules	Treatments
Biointensive (M_1)	Seed treatment with *Trichoderma viride* @ 10 g/kg furrow application of enriched *Trichoderma viride* (2.5 kg *Trichoderma viride* + 100 kg Vermicompost) @ 250 kg/ha. Spray of *Pseudomonas fluroscenes* @ 10 g/l at 30-35, Wettable sulphur @ 2g/l at 50-60 days after sowing
Chemical (M_2)	Seed treatment with Carbendazim 50 % WP @ 2 g/kg, spray of combi product (Tebuconazole 50 % + Trifloxystrobin 25 % WG) @ 0.5 g/l at 30-35 and second spray at 50-60 days after sowing
Adaptive (M_3)	Seed treatment with *Trichoderma viride* @ 10 g/kg furrow application of enriched *Trichoderma viride* (2.5 kg *Trichoderma viride* + 100 kg Vermicompost) @ 250 kg/ha Spray of Combi product (Tebuconazole 50 % + Trifloxystrobin 25 % WG) @ 0.5 g/l at 30-35 and second spray at 50-60 days after sowing
Untreated Check (M_4)	Untreated check

The observations were recorded at physiological maturity. The observations on disease severity was recorded by 0-5 scale (Kushwaha and Kaushal, 1970) [7] for *Cercospora* leaf spot and presented in Table 2 and per cent disease index (PDI) was calculated by following AICRP (Sesame and Niger) disease ratings. The seed yield with net returns and B:C ratio was presented. The data were analysed using standard statistical procedures.

Table 2: Disease rating scale

Disease grade	Description	Disease Reaction
0	No infection	Immune
1	1-10% of leaf area infected	Resistant
2	11-25% of leaf area infected	Moderately Resistant
3	26-50% of leaf area infected	Moderately Susceptible
4	51-70% of leaf area infected	Susceptible
5	>70% of leaf area infected	Highly Susceptible

$$\text{Per cent disease index} = \frac{\text{Sum of numerical ratings}}{\text{Total number of leaves scored}} \text{ X } \frac{100}{\text{Maximum grade}}$$

Results and Discussion

It is evident from Table 3 that all integrated disease management modules were found to be superior over untreated check (M_4) in reducing the per cent disease index and increasing grain yield. Among the treatments, seed treatment with *Trichoderma viride* @ 10 g/kg and furrow application of enriched *Trichoderma viride* (2.5 kg *Trichoderma viride* + 100 kg Vermicompost) applied @ 250 kg/ha followed by spray of combi product (Tebuconazole 50 % + Trifloxystrobin 25 % WG) @ 0.5 g/l at 30-35 and second spray at 50-60 days after sowing recorded minimum disease severity index for *Cercospora* leaf spot (44.80) with higher grain yield (872 kg/ha). *i.e.*, Adaptive module (M_3) followed by Biointensive (M_1) and Chemical module (M_2) *i.e.*, Seed treatment with Carbendazim 50 % WP @ 2 g/kg followed by spray of combi product (Tebuconazole 50 % + Trifloxystrobin 25 % WG) @ 0.5 g/l at 30-35 and second spray at 50-60 days after sowing recorded minimum disease severity index for *Cercospora* leaf spot (45.00) with grain yield (800 kg/ha), whereas M_3 and M_2 were on par with each other for disease and found significant for yield. Biointensive module (M_1), higher disease severity index was observed for *Cercospora* leaf spot (72.50) with reduction in grain yield of 600 kg/ha when seeds are treated with *Trichoderma viride* @ 10 g/kg and furrow application of enriched *Trichoderma viride* (2.5 kg *Trichoderma viride* + 100 kg Vermicompost) @ 250 kg/ha followed by spray of *Pseudomonas fluroscenes* @ 10 g/l at 30-35, Wettable sulphur @ 2g/l at 50-60 days after sowing. Similar study reported by (Jeyalakshmi *et al.*, 2013) [4] in Sesame. The present investigation is in line with the report of (Palakshappa *et al.*, 2020) [10]. Among the modules, M_2 was found to be the next best and recorded grain yield of 800 kg/ha, when seeds treated with Carbendazim 50 % WP @ 2 g/kg followed by spray of combi product (Tebuconazole 50 % + Trifloxystrobin 25 % WG) @ 0.5 g/l at 30-35 and second spray @ 50-60 days after sowing. Palakshappa *et al. (*2012) [9] reported usage of (Carbendazim 25 % WP + Iprodion 25 % WP) at 0.1 per cent for effective management of *Cercospora* leaf spot of Sesame.

Table 3: Integrated management of *Cercospora* leaf spot of Sesame caused by *Cercospora sesamicola*

Modules	Treatments	Per cent disease index	Yield (kg/ha)
Biointensive (M_1)	Seed treatment with *Trichoderma viride* @ 10 g/kg furrow application of enriched *Trichoderma viride* (2.5 kg *Trichoderma viride* + 100 kg Vermicompost) @ 250 kg/ha, Spray of *Pseudomonas fluroscenes* @ 10 g/l at 30-35, Wettable sulphur @ 2g/l at 50-60 days after sowing	72.50 (58.60)*	600
Chemical (M_2)	Seed treatment with Carbendazim 50 % WP @ 2 g/kg, spray of combi product (Tebuconazole 50 % + Trifloxystrobin 25 % WG) @ 0.5 g/l at 30-35 and second spray at 50-60 days after sowing	45.00 (42.15)	800
Adaptive (M_3)	Seed treatment with *Trichoderma viride* @ 10 g/kg furrow application of enriched *Trichoderma viride* (2.5 kg *Trichoderma viride* + 100 kg Vermicompost) @ 250 kg/ha, Spray of Combi product	44.80 (42.00)	872

	(Tebuconazole 50 % + Trifloxystrobin 25 % WG) @ 0.5 g/l at 30-35 and second spray at 50-60 days after sowing		
Untreated Check (M_4)	Untreated check	92.12 (73.32)	481
	S.Em± CD at 5% C.V(%)	1.77 5.45 7.33	13.42 37.33 4.36

*Figures in parenthesis indicate angular transformation values.

Table 4: Economics for biopriming and integrated management *Cercospora* leaf spot on Sesame

Modules	Treatments	Income in treatment (₹)	Additional Income (₹)	Total cost of production (₹)	Net returns (₹)	B:C ratio
Biointensive (M_1)	Seed treatment with *Trichoderma viride* @ 10 g/kg furrow application of enriched *Trichoderma* (2.5 kg *Trichoderma viride* + 100 kg Vermicompost) @ 250 kg/ha, Spray of *Pseudomonas fluroscenes* @ 10 g/l at 30-35, Wettable sulphur @ 2g/l at 50-60 days after sowing	38935	7735	24448	14487	1.59
Chemical (M_2)	Seed treatment with Carbendazim @ 2 g/kg, Spray of combi product (Tebuconazole 50 % + Trifloxystrobin 25 % WG) @ 0.5 g/l at 30-35 and second spray at 50-60 days after sowing	51935	20735	30600	21335	1.69
Adaptive (M_3)	Seed treatment with *Trichoderma viride* @ 10 g/kg furrow application of enriched *Trichoderma* (2.5 kg *Trichoderma viride* + 100 kg Vermicompost) @ 250 kg/ha, Spray of Combi product (Tebuconazole 50 % + Trifloxystrobin 25 % WG) @ 0.5 g/l at 30-35 and second spray at 50-60 days after sowing	56680	25488	31412	25268	1.80
Untreated Check (M_4)	Untreated check	31200	-	23400	7800	1.33

Fig 1: Module 3: Seed treatment with *Trichoderma viride* @ 10 g/kg furrow application of enriched *Trichoderma viride* (2.5 kg *Trichoderma viride* + 100 kg Vermicompost) @ 250 kg/ha, Spray of Combi product (Tebuconazole 50 % + Trifloxystrobin 25 % WG) @ 0.5 g/l at 30-35 and second spray at 50-60 days after sowing Module 4: Untreated check

The present findings revealed that the module (M_3) was found effective for the management of *Cercospora* leaf spot with higher net returns of Rs. 25,268 and cost benefit ratio of 1:1.80 followed by chemical module with net returns of 21,335 and B: C ratio of 1:1.69 (Table 4).

The economics of modules on severity of *Cercospora* leaf spot with seed yield, Adaptive module (M_3) and B: C ratio of 1:1.80 followed by Chemical module (M_2) with seed yield of 800 kg/ha and B: C ratio 1:1.69 by considering the average APMC market price prevailed for 3 months. Highest income in treatment (Rs. 56,680), additional income (Rs. 25,488), net returns (Rs. 25,268) and B:C ratio 1:1.80 have encouraged the recommendation of adaptive module for the effective management of *Cercospora* leaf spot of Sesame.

Conclusion

From the study, it is concluded that for the management of *Cercospora* leaf spot of sesame, Adaptive module (M_3) was found to be superior in reducing the *Cercospora* leaf spot severity and increasing the seed yield coupled with higher net returns and cost benefit ratio under the transitional climatic situations favourable for pathogen development and secondary spread.

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