



Implementation of Integrated Strategy for Effective Management of Sesame Diseases

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Abstract: Field trial with one module each of chemical, bio-intensive and adaptive approach was followed to control *Macrophomina* stem and root rot and *Alternaria* leaf spot disease of sesame. The experiment was conducted during kharif seasons of 2019, 2020 and 2021. The treatments were evaluated for disease severity and crop loss viz a viz control. Of these modules, seed treatment with *Trichoderma viride* @ 10 g kg⁻¹, furrow application of enriched *Trichoderma* (2.5 kg *Trichoderma viride* + 100 kg vermicompost) @ 250 kg ha⁻¹ and two sprays of combi-product (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.5 g L⁻¹ first between 30 to 35 days after sowing (DAS) and second between 50 to 60 DAS substantially decreased both *Macrophomina* stem and root rot and *Alternaria* leaf spot and increased grain yield. The module was also economical.

Key words: Sesame, stem & root rot, *Alternaria* leaf spot, management.

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Sesame, also known as the “Queen of oilseed crops,” is a highly revered crop that has been cultivated for centuries across all continents of the world and is believed to have originated in Africa, with some wild relatives also in India (Komivi *et al.*, 2018). The crop is cultivated for its edible seeds which are a rich source of dietary protein (20%) and edible oil (50%). The oil is rich in oleic acid (47%) and linolenic acid (39%) (Kumaraswamy *et al.*, 2015). Oxidative rancidity in this oil is very slow due to the presence of endogenous antioxidants like sesamin, sesamol, and tocopherols (Wan *et al.*, 2015). Sesame oil serves as a valuable raw material in a wide range of industries, including paints, varnishes, soaps, perfumes, and pharmaceuticals. Additionally, it acts as a synergist, increasing the strength of insecticides such as pyrethrum (Myint *et al.*, 2020; Wang *et al.*, 2013; Mujtaba *et al.*, 2020). During 2020-21 area under sesame cultivation in India was 1.63 mha, with a total production of 0.812 mt and an average productivity of 500 kg ha⁻¹. Madhya Pradesh, Uttar Pradesh, Rajasthan, and West Bengal together contributed 78% of the total sesame area in the country under irrigated conditions (Anonymous, 2020-21). Despite its impressive profile, the productivity of the sesame crop is often low, leading to poor crop management and exposure to various biotic and abiotic stresses (Madhuri and Karuna Sagar, 2018). *Macrophomina* stem and root rot, powdery mildew, phyllody, *Alternaria* leaf spot, *Cercospora* leaf spot, bacterial leaf spot and blight

are considered as important biotic stresses of sesame in whole of the sesame growing areas. To mitigate these challenges, farmers need to employ proper crop management techniques to improve productivity.

Macrophomina stem & root rot and *Alternaria* leaf spot cause significant losses in sesame production and reduce yield drastically. Symptoms of *Macrophomina* stem and root rot typically include irregular, dark lesions on the stem, sudden wilting of plants, chlorosis, early defoliation, and blackening of the stem and roots as the disease progresses and finally plant death (Khamari *et al.*, 2016). This disease requires a day temperature of at least 30°C and a delayed dry spell followed by ample irrigation to infect plants. On the other hand, *Alternaria* leaf spot affects sesame plants at all growth stages and produces small, round to irregular, dark brown lesions with concentric rings that are water-soaked (Choi *et al.*, 2014; Naik *et al.*, 2017). In severe cases, the plant may experience defoliation and premature splitting of infected capsules with shrivelled seeds. The fungus *Alternaria sesami* that causes *Alternaria* leaf spot is both seed and soil-borne and remains dormant in infected plant debris. This disease requires a temperature range of 25-30°C, high relative humidity (89-95%) more rainfall (1.2 to 13 mm in a meteorological week), and cloudy weather to cause infection (Pawar *et al.*, 2019).

These diseases are reported to cause a considerable yield loss elsewhere in the world. Thirunarayanan *et al.* (2017) reported *M. phaseolina* as very destructive pathogen in all sesame growing areas and causes 15-100% yield loss. *Macrophomina phaseolina* (Tassi), soil inhabiting pathogen, attacks many host plants including oilseeds, pulses, vegetables and ornamentals (Bandopadhyay *et al.*, 2022). *Alternaria* leaf spot was reported to cause a significant yield loss of 22-53%, depending upon the severity level (Shambharkar *et al.*, 1997; Nayyar *et al.*, 2017). Seed and soil borne nature of these fungi and their survival on left over trashes in the field, make their management difficult by applying a single approach. Fungicides are commonly used to manage these diseases, but their indiscriminate use can lead to environmental pollution, resistance development in pathogens, and health hazards for farmers and consumers. Therefore, the

integration of biocontrol agents (BCAs) with fungicides has emerged as a promising strategy for sustainable disease management in sesame. Biopriming, the process of coating seeds with beneficial microorganisms, is another promising technique for disease management in sesame. Biopriming enhances seed germination, seedling vigour, and plant growth, and protects the seedlings from soil-borne pathogens. Integrated disease management (IDM) is an eco-friendly approach that combines several strategies to manage crop diseases. IDM not only reduces the amount of fungicide used per season but also enhances the efficacy of disease management by combining different modes of action. Therefore, the present study was aimed to evaluate the impact of biointensive, chemical, and adaptive (a combination of biointensive and chemicals) strategies on the incidence of *Macrophomina* stem and root rot as well as *Alternaria* leaf spot disease severity, while also considering their influence on the yield of sesame crops.

Materials and Methods

A field trial was conducted at Agricultural Research Station, Mandor, during three consecutive kharif seasons of 2019-20, 2020-21 and 2021-22 in randomized block design in plot size 2.4 m x 3.0 m with five replications. Three modules viz., biointensive (M_1), chemical (M_2), adaptive (M_3) were compared against untreated check (M_4) to know the efficacy of bioagents and chemicals on disease severity and yield of sesame (Table 1). Variety RT 351 was used for this experiment. Seeds were sown by hand in rows 30 cm apart and plant to plant distance was maintained at 10 cm. Seed rate was 2-2.5 kg ha⁻¹. A general recommended dose of nitrogen and phosphorus were 40 kg N and 25 kg P₂O₅ ha⁻¹, and applied through diammonium phosphate (DAP) and urea.

The incidence of *Macrophomina* stem and root rot was recorded by counting the infected plants at random quadrat selection in each plot replication wise and based on infected and total number of plants, percent disease incidence (PDI) was calculated. The seed yield was also recorded and B:C ratio was worked out. Percent disease incidence (PDI) was calculated using the formula:

The observation on disease severity was recorded by 0-5 scale for *Alternaria* leaf spot

Table 1. Details of the disease control modules tested

Modules	Treatment
Biointensive (M ₁)	Seed treatment with <i>Trichoderma viride</i> @ 10 g kg ⁻¹ , furrow application of enriched <i>Trichoderma</i> (2.5 kg <i>Trichoderma viride</i> + 100 kg vermicompost) @ 250 kg ha ⁻¹ , spray of <i>Pseudomonas fluorescens</i> @10 g L ⁻¹ at 30-35 DAS, wettable sulphur @ 2 g L ⁻¹ at 50-60 DAS
Chemical (M ₂)	Seed treatment with Carbendazim @ 2g kg ⁻¹ , Spray of combi-product (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.5 g L ⁻¹ at 30-35 DAS and second spray 2 g L ⁻¹ at 50-60 DAS
Adaptive (M ₃)	Seed treatment with <i>Trichoderma viride</i> @ 10 g kg ⁻¹ , furrow application of enriched <i>Trichoderma</i> (2.5kg <i>Trichoderma viride</i> + 100 kg vermicompost) @ 250 kg ha ⁻¹ and spray of combi-product (Tebuconazole 50 % + Trifloxystrobin 25%) @ 0.5 g L ⁻¹ at 30-35 DAS and second spray at 50-60 DAS
Untreated Check (M ₄)	Control

and per cent disease index (PDI) was calculated (McKinney, 1923) (Table 2). 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 for *Alternaria* leaf spot

Disease grade	Description	Disease Reaction
0	No infection	Immune
1	1-10% leaf area infected	Resistant
2	11-25% leaf area infected	Moderately Resistant
3	26-50% leaf area infected	Moderately Susceptible
4	51-70% leaf area infected	Susceptible
5	71-100% leaf area infected	Highly Susceptible

Results and Discussion

In our present study, integrated management of both stem and root rot and *Alternaria* leaf spot diseases was done with the use of different modules. It is evident that treatment with all integrated disease management modules (M₁, M₂ and M₃) reduced disease incidence and severity and increased seed yield over untreated check (M₄) (Table 3). Among all the treatments,

M₃ reduced PDI of both *Macrophomina* stem and root rot (13.66%) and *Alternaria* leaf spot (4.85%) diseases and gave maximum seed yield (405 kg ha⁻¹) followed by M₁ and chemical module M₂. Maximum net return (12377 Rs. ha⁻¹) and benefit:cost ratio (1.72) was also observed with module M₃. Maximum per cent disease index of *Macrophomina* stem & root rot and *Alternaria* leaf spot was recorded in untreated check (control) which reflects the sufficient disease pressure in experimental plots. Minimum yield was recorded (301 kg ha⁻¹) in untreated control plots (Table 3). Similar results were also reported by Meena (2021). Rajendra *et al.* (2022) also reported that minimum root rot percent disease incidence (13.2%) was recorded when seed treatment with *Trichoderma viride* @ 10 g kg⁻¹ + furrow application of *T. viride* (2.5 kg ha⁻¹ enriched in 100 kg of FYM) @ 250 kg ha⁻¹ and foliar application of Trifloxystrobin + Tebuconazole @ 0.5 g L⁻¹ at capsule initiation and second spray after 15 days interval was done. Similarly, Choudhary *et al.* (2014) also reported that first spray of carbendazim 50 WP (0.05%) + second spray of *T. viride* were most economical for stem and root rot disease management. Mahalakshmi (2020) reported that among the different treatments tested in field condition, the minimum incidence of *Alternaria* leaf spot with higher yield were

Table 3. Management of stem & root rot and *Alternaria* leaf spot disease of sesame (pooled data of three years)

Modules	Stem & root rot (% incidence)	<i>Alternaria</i> leaf spot (PDI)	Seed yield (kg ha ⁻¹)	Net return (Rs. ha ⁻¹)	BC ratio
Biointensive (M ₁)	21.33 (27.51)*	8.48 (16.93)	385	11417	1.68
Chemical (M ₂)	17.66 (24.85)	7.28 (15.65)	398	10866	1.60
Adaptive (M ₃)	13.66 (21.69)	4.85 (12.72)	405	12377	1.72
Untreated Check (M ₄)	38.99 (38.64)	15.78 (23.41)	301	5782	1.36
S Em±	0.16	0.07	3.66		
CD (p=0.05)	0.49	0.20	11.29		

*Figures in parenthesis indicate angular transformation values.

recorded in seed treatment with *T. viride* @ 10 g kg⁻¹ + furrow application of *T. viride* (2.5 kg ha⁻¹ enriched in 100 kg of FYM) @ 250 kg ha⁻¹ + foliar spray of myclobutanil @ 1 g L⁻¹. Results are in agreement with the findings of Singh and Verma (2005) who reported the good compatibility of fungicides carbendazim, neem products and biocontrol agents (*T. harzianum* and *T. viride*), for control of soybean root-rot. Lakhran and Ahir (2020) reported that seed treatment with *Trichoderma viride*, neem cake and carbendazim independently were most effective in reducing the incidence of chickpea dry root rot caused by *Macrophomina phaseolina*.

Our results are in close conformity with those of Rahman *et al.* (2021) who recorded that integrated use of bio-agent (*T. harzianum*), seed treating fungicide (Provax 200WP), and organic amendment (mustard oil cake) were the effective control measure against charcoal rot disease of soybean caused by *M. phaseolina*.

Conclusion

Macrophomina stem and root rot and foliar disease *Alternaria* leaf spot cause qualitative as well as quantitative losses to sesame crop. Our results showed that minimum *Macrophomina* stem & root rot incidence and *Alternaria* leaf spot severity and maximum seed yield was recorded when seed treated with *Trichoderma viride* @ 10 g kg⁻¹ were sown, enriched *Trichoderma* (2.5 kg *Trichoderma viride* + 100 kg vermicompost) @ 250 kg ha⁻¹ and spray of combi-product (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.5 g L⁻¹ were applied in furrow at 30-35 DAS and this combination was also used for pray at 50-60 DAS.

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