EFFICACY OF FUNGICIDES, BIOCONTROL AGENTS AND BOTANICALS AGAINST ALTERNARIA LEAF BLIGHT (Alternaria sesami) IN SESAME CROP

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ABSTRACT

Seed borne fungus, Alternaria sesami associated with sesame is the most destructive pathogen. Laboratory experiment was carried out during Dec.,2017 to Nov., 2018. The fungicides viz., hexaconazole @ 0.2% and combination product of carbendazim 12% + mancozeb 63% @ 0.2%, bio-control agents viz., Trichoderma viride @ 10 g/kg and Pseudomonas fluorescens @ 10 g/kg seed and botanicals viz., garlic clove extract 10% and neem leaf extract 10% against Alternaria blight of sesame var. YLM-17 in pot culture showed that seed treatment with combination product of carbendazim 12% + mancozeb 63% @ 0.2% was effective in reducing the per cent disease index (PDI) of Alternaria blight by 63.20 per cent and improving plant height (44.11 cm), number of capsules per plant (12.53), seed yield per plant (2.23 g) and harvest index (14.17%) when compared to control (without seed treatment). Hexaconazole, T. viride and garlic clove extract recorded 53.12%, 47.48% and 35.90% decrease in PDI, respectively. Sesame seed collected from the pots treated with carbendazim 12% + mancozeb 63% @ 0.2% recorded highest seed germination (99.33%), seedling length (17.37 cm), seedling vigour index-I (1725) and seedling vigour index-II (3.97) followed by T. viride with 98.33%, 16.75 cm, 1647 and 3.54, respectively.

Keywords: Alternaria leaf blight, biocontrol agents, botanicals, fungicides, sesame

INTRODUCTION

Sesame (Sesamum indicum L.) is an important oil seed crop being cultivated in the tropics as well as temperate zone of the world. India, China and Mexico are the major sesame exporters, while Japan is the single largest buyer of sesame seed. India is the largest producer of sesame catering to the world market. Seed borne pathogens cause considerable damage both at early and late stages of sesame crop. Different fungi viz., Alternaria, Curvularia, Fusarium, Helminthosporium, Penicillium, Mommoniella and Rhizopus sp. were associated with sesame seed (ISTA, 1999, Nagaraja et al., 2009, Bharathi et al., 2013). Among these, Alternaria is the most destructive pathogen of sesame and causes leaf blight which is one of the major seed borne fungal disease in sesame. Seed borne microflora are carried over by infected seed and cause seed deterioration, reduced germination resulting in reduction of plant population in the field and ultimately yield to the extent of 28.9 percent (Prasad et al., 1997).

Chemical methods involving seed treatment with fungicides have been employed to improve germination, vigour, crop establishment, crop
stands and yield. In some cases, farmers in developing countries cannot afford high cost of chemical fungicides. This has resulted in the employment of botanicals and bio-control agents for the control of seed borne pathogens for which integration of various cultural, biological and chemical methods might be the solution (Barnwal et al., 2011). During the investigation, fungicides, biocontrol agents and botanical extracts were tested to manage the major seed borne pathogen of sesame, *Alternaria sesami* in pot culture.

**MATERIALS AND METHODS**

The investigation was carried out in the laboratory of Plant Pathology, Regional Agricultural Research Station, Lam and Department of Seed Science and Technology, Advanced Post Graduate Centre, Guntur, Andhra Pradesh between Dec., 2017 and Nov., 2018. Seeds of sesame var. YLM-17 susceptible to Alternaria blight was subjected to six seed treatments, comprising two each of fungicides (hexaconazole @ 0.2% and combination product of carbendazim 12% + mancozeb 63% @ 0.2%), bio-control agents (*Trichoderma viride* @ 10 g/kg and *Pseudomonas fluorescens* @ 10 g/kg seed) and botanicals (garlic clove extract 10% and neem leaf extract 10%). Ten g seed was soaked in the 100 ml fungicidal solution (0.2%) for two hours and then shade dried. For bio-control seed treatment, seed were shaken with the formulations of *T.viride* and *P.fluorescens* for 20 min in mechanical shaker for uniform application and then stored in separate boxes for two hrs. For botanical seed treatment, seed was soaked in 100 ml of 10% plant extract for two hours and then dried in shade for two hours. Seed soaked in sterile distilled water served as control. Treated seed along with untreated seed (control) of sesame was tested initially for germination and seedling quality parameters as per the standard procedures before sowing the seed in the pots.

The pot culture experiment was conducted in Completely Randomized Design (CRD) and replicated thrice. Each replication consisted of three pots and each pot contained five plants. Earthen pots of size 30 cm x 25 cm were used for raising the seedlings of sesame. One part of sand, two parts of clay soil and one part of red soil were used as potting medium. The required quantity of fertilizers was mixed with soil before sowing the seed. Necessary plant protection measures were taken against sucking pests. Since the seed treatment gives protection during early growth stage (upto 30 days) of crop, to manage the disease during flowering and pod formation stages, foliar application of fungicide (combination product of carbendazim 12% + mancozeb 63% @ 2 g/l) selected based on *in vitro* studies was taken up at 30 DAS and 45 Days after sowing (DAS). Harvesting was done at physiological maturity stage. Five representative plants of each treatment were selected randomly and tagged for recording various observations viz., percent disease index (PDI), plant height at maturity (cm), dry weight of plant (g), number of capsules per plant, seed yield per plant (g) and harvest index (%). Harvested seed obtained from different treatments from pot culture was analysed for seed germination, seedling length, dry weight of seedlings and seedling vigour index-I and II as per the standard procedures.

**Seed quality parameters**

**Germination (%):** On the day of final count (6th day), all the normal seedlings were counted. Based on the number of normal seedlings, the germination percentage from each sample in each replication was computed as per the formula mentioned here under:

\[
\text{Germination} (\%) = \frac{\text{Number of normal seedlings}}{\text{Total number of seed sown}} \times 100
\]

**Seedling length (cm):** Ten normal seedlings were taken from the each replication at random on the 6th day and the seedling length was measured from tip of the primary leaf to the tip of the primary root with the help of the scale and mean seedling length was expressed in centimeters.

**Seedling dry weight (g):** Ten normal seedlings chosen for measuring seedling length were also used to determine seedling dry weight.
The seedlings were kept in brown paper bags and dried in hot air oven at 75±1 °C for 48 h. After drying, they were cooled in a desiccator for 30 minutes and weighed on an electronic balance and mean dry weight was expressed in grams.

**Seedling Vigour Indices**

a) **Seedling Vigour Index I:** Seedling vigour index was computed using the following formula given by Abdul-Baki and Anderson (1973).

\[
\text{Seedling vigour index I} = \text{Germination (\%)} \times \text{Mean seedling length (cm)}
\]

b) **Seedling Vigour Index II:** Seedling vigour index II was computed as per the formula suggested by Reddy and Khan (2001) as given below:

\[
\text{Seedling vigour index II} = \text{Germination (\%)} \times \text{Seedling dry weight (g)}
\]

**Disease severity:** Disease was scored on five randomly selected plants at seedling stage and 15 days after each spray following 0-5 scale (Shrestha et al., 2005), where 0 = no infection, 1 = up to 5% area covered by the disease, 2 = 6-10% area covered by the disease, 3 = 11-20% area covered by the disease, 4 = 21-30% area covered by the disease, 5 = 31-100% area covered by the disease. Percent Disease Index (PDI) was calculated by using the formula:

\[
\text{Percent Disease Index (PDI)} = \frac{\text{Sum of all the numerical ratings}}{\text{Total number of leaves scored}} \times \frac{\text{100}}{\text{Maximum disease grade}}
\]

The data were subjected to statistical analysis after subjecting the data to appropriate transformation.

**RESULTS AND DISCUSSION**

**Effect of seed treatment on initial seed quality parameters of sesame**

Significant differences in germination (%), seedling length (cm) and seedling vigour index-I were observed among different seed treatments. Seedling vigour index-II was not significantly influenced by different seed treatments.

Sesame seed treated with combination product of carbendazim 12% + mancozeb 63% @ 0.2% recorded significantly higher seed germination (98.75%), seedling length (16.80 cm), seedling vigour index-I (1659) and seedling vigour index-II (2.94) (Table 1) when compared to control (untreated seeds) (90.00%, 10.41 cm, 938 and 2.21, respectively). The lowest seed germination (95.00%), seedling length (12.52 cm), seedling vigour index-I (1191) and seedling vigour index-II (2.42) were recorded with neem leaf extract 10% among the seed treatments.

The results are in conformity with findings of Bharathi et al. (2013) who reported that seed treatment with a mixture of fungicides and bio-control agents in sesame was found superior in controlling the seed borne mycoflora, increasing the seed germination and seedling vigour index.

Similar results on seed quality parameters with seed treatment using fungicides, bio-control agents and botanicals were observed in soybean by Koche et al. (2009), Sajeees (2012); in safflower by Gayathri (2012). Seeds treated with bioagents showed beneficial effects on germination which resulted in increased root-shoot length and seedling vigor and also reduced the mycofloral species that impede the seed germination (Margaret et al., 2013).

**Evaluation of efficacy of seed treatments in controlling Alternaria blight in sesame**

Data on percent disease index before spray, after first spray (30 DAS) and second spray (45 DAS) revealed that the seed treatment with combination product of carbendazim 12% + mancozeb 63% @ 0.2% was significantly superior(4.1, 10.8 and 12.4 PDI, respectively) to other treatments. This treatment reduced Alternaria blight PDI by 63.2%. The highest PDI of 15.2, 28.5 and 33.7, respectively, was recorded before spray and second spray in the control. Between the biocontrol agents, seed treatment with *T. viride* @...
10 g/kg seed was found to be the best which showed disease reduction of 47.48%. Neem leaf extract 10% was the least effective against the disease which reduced the PDI only to the extent of 27.2% (Table 2).

Seed treatment with combination product of carbendazim 12% + mancozeb 63% @ 0.2% recorded higher plant height (44.11 cm), number of capsules per plant (12.53), seed yield per plant (2.23 g), dry weight of the plant (15.72 g) and harvest index (14.17%), when compared to control (27.73 cm, 5.77, 0.84 g, 11.48 g and 7.36%, respectively) (Fig.1). High seed yield per plant and harvest index noticed in seed treatment with combination product of carbendazim 12% + mancozeb 63% @ 0.2% indicated that more food reserves might have been partitioned towards reproductive structures in the post anthesis period. Among the seed treatments, seed treatment with neem leaf extract 10% recorded lower plant height (36.17 cm), number of capsules per plant (9.27), seed yield per plant (1.79 g) dry weight of the plant (14.48 g) and harvest index (12.35%).

The results of the study revealed that, the combination product of carbendazim 12% + mancozeb 63% @ 0.2% significantly reduced the incidence of Alternaria blight. Deshmukh and Karve (1983) suggested an indirect effect of carbendazim in activating the natural mechanism of resistance. Fungicidal treatment induced metabolic changes leading to development of toxic factors, resulted in the internal environment unfavorable for pathogens growth and activity, ultimately inducing the resistance and protection against infection (Singh et al., 2002).

Trichoderma viride was found effective over control in the management of Alternaria sesami in the present investigation next to the combination product of carbendazim 12% + mancozeb 63% @ 0.2%. Most of the antagonists inhibited the growth of pathogen, by their fast and over growing nature as observed in vitro. Trichoderma species produces inhibitory substances or acetaldehyde compound against the test pathogens (Pawar et al., 2013).

The results are in accordance with Mallaiah et al. (2016) who found that seed treatment with T. viride (0.4%) and soil application of T. viride @ 2.5 kg/ha followed by spray of carbendazim + mancozeb 0.2% recorded highest disease control and yield over control in sesame. Seed treatment with carbendazim + mancozeb at 3 g/kg seed + two sprays of same combination@ 0.2% at 30 and 45 DAS recorded highest disease control and highest seed yield in sunflower (Waghe et al., 2015). Thakur and Zacharia (2018) found that seed treatment and foliar spray with mancozeb 63% + carbendazim 12% was most effective against early blight of mustard with minimum disease intensity and maximum yield over control. Similar results were obtained by Deokar et al. (2014) in sunflower and Singh et al. (2014) in linseed.

Garlic clove extract 10% was found effective over control among the botanicals tested for the management of A. sesami in the present investigation. Similar result of antifungal effect of botanicals / plant extracts against A. carthami and Alternaria spp. were reported earlier by several workers, Mesta et al. (2009), Ranware et al. (2010) and Taware et al. (2014).

Effect of seed treatment on seed quality parameters of harvested seed of sesame

The observations on various seed quality parameters of harvested seed revealed that significant differences were observed in the germination (%), seedling length (cm) and seedling vigour indices of harvested seed from different treatments in pot culture. The combination product of carbendazim 12% + mancozeb 63% @ 0.2% showed an increase in germination (%), seedling length (cm), dry weight and seedling vigour indices and was significantly superior to all other treatments. Sesame seed harvested from the plants raised from the seed treated with combination product of carbendazim 12% + mancozeb 63% @ 0.2% recorded highest seed germination (99.33%), seedling length (17.37 cm), seedling vigour index-I (1725) and seedling vigour index-II (3.97) (Table 3). Harvested seed from control (without seed
Table 1. Efficacy of different seed treatments on initial seed quality parameters of sesame sample of YLM-17 (prior to pot culture)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Treatments</th>
<th>Germination (%)</th>
<th>Seedling length (cm)</th>
<th>Seedling Vigour Index-I</th>
<th>Seedling dry weight (g)</th>
<th>Seedling Vigour Index-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>Seed treatment with hexaconazole @ 0.2%</td>
<td>98.00 (81.97)</td>
<td>15.59b</td>
<td>1530b</td>
<td>0.03</td>
<td>2.72</td>
</tr>
<tr>
<td>T₂</td>
<td>Seed treatment with combination product of carbendazim 12% + mancozeb 63% @ 0.2%</td>
<td>98.75 (84.47)</td>
<td>16.80a</td>
<td>1659a</td>
<td>0.03</td>
<td>2.94</td>
</tr>
<tr>
<td>T₃</td>
<td>Seed treatment with <em>Trichoderma viride</em> (isolate-2) @ 10 g/kg seed</td>
<td>98.25 (82.57)</td>
<td>15.52b</td>
<td>1526b</td>
<td>0.03</td>
<td>2.88</td>
</tr>
<tr>
<td>T₄</td>
<td>Seed treatment with <em>Pseudomonas fluorescens</em> (isolate-1) @ 10 g/kg seed</td>
<td>96.00 (78.48)</td>
<td>13.73d</td>
<td>1318d</td>
<td>0.03</td>
<td>2.61</td>
</tr>
<tr>
<td>T₅</td>
<td>Seed treatment with garlic clove extract 10%</td>
<td>96.75 (79.67)</td>
<td>14.56c</td>
<td>1411c</td>
<td>0.03</td>
<td>2.47</td>
</tr>
<tr>
<td>T₆</td>
<td>Seed treatment with neem leaf extract 10%</td>
<td>95.00 (77.08)</td>
<td>12.52e</td>
<td>1191e</td>
<td>0.03</td>
<td>2.42</td>
</tr>
<tr>
<td>T₇</td>
<td>Control</td>
<td>90.00 (71.55)</td>
<td>10.41f</td>
<td>938f</td>
<td>0.03</td>
<td>2.21</td>
</tr>
</tbody>
</table>

Mean: 79.40 14.16 1368 0.03 2.61
SEm+: 1.00 0.15 16.62 0.001 0.25
CD @ 5%: 3.43 0.50 57.22 NS NS
CV (%): 2.51 2.05 2.43 6.38 6.63

*Mean of three replications; Values in the parenthesis indicate angular transformed values
Values followed by same alphabet in the same column do not differ significantly at 5% level of significance; NS: Non-significant at 5% level of probability.

Efficacy of fungicides and botanicals against Alternaria leaf blight in sesame

<table>
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<th>Treatment</th>
<th>Germination (%)</th>
<th>Seedling length (cm)</th>
<th>Seedling Vigour Index-I</th>
<th>Seedling dry weight (g)</th>
<th>Seedling Vigour Index-II</th>
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Mean of three replications; Values in the parenthesis indicate angular transformed values.

Values followed by same alphabet in the same column do not differ significantly at 5% level of significance; NS: Non-significant at 5% level of probability.

Treatment) recorded lowest germination (91.42%), seedling length (11.44 cm), seedling vigour index-I (1046) and seedling vigour index-II (1.83). Among the seed treatments, lowest seed germination (96.58%), seedling length (15.30 cm), seedling vigour index-I (1478) and seedling vigour index-II (2.35) was recorded in seed treatment with neem leaf extract 10%.

Lower seed infection (7.04 % and 9.21 %) of *A. porri* and higher seed germination (88.48 % and 85.64 %) of seed samples harvested from Dithane M–45 and Rovral 50 WP treated plots as against untreated control (17.44% and 67.62%), respectively, was reported by Uddin et al. (2006). Application of Dithane M-45 and *T. harzianum* significantly reduced the seed-borne infection of *Alternaria* spp. as compared to control in mustard.
Plant extracts, Bojho powder and Neem powder were found better than control to check the disease. Furthermore, highest germination (76.75%) was observed in *Trichoderma* treatment, whereas, lowest germination (65.0%) was recorded in control (Prashant Rijal *et al.*, 2020).

**CONCLUSIONS**

Combination product of carbendazim 12% + mancozeb 63% @ 0.2% was effective in reducing the seed borne infection besides improving the plant growth, yield and seed quality parameters in sesame. Seed treatment with *T. viride* @ 10 g/kg seed was found to be effective in reducing the percent disease index of Alternaria blight in sesame sample of YLM-17.
Table 3. Effect of seed treatment on seed quality parameters of seed harvested from YLM-17 sesame under pot culture

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Treatments</th>
<th>Germination (%)*</th>
<th>Seedling length (cm)*</th>
<th>Seedling Index-I*</th>
<th>Seedling dry weight (g)*</th>
<th>Seedling Vigour Index-II*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T₁</td>
<td>Seed treatment with hexaconazole @ 0.2%</td>
<td>98.50 (82.93)ᵇ</td>
<td>15.74ᶜ</td>
<td>1551ᶜ</td>
<td>0.03ᵇ</td>
<td>2.97ᶜ</td>
</tr>
<tr>
<td>T₂</td>
<td>Seed treatment with combination product of carbendazim 12% + mancozeb 63% @ 0.2%</td>
<td>99.33 (85.35)ᵃ</td>
<td>17.37ᵃ</td>
<td>1725ᵃ</td>
<td>0.04ᵃ</td>
<td>3.97ᵃ</td>
</tr>
<tr>
<td>T₃</td>
<td>Seed treatment with Trichoderma viride (isolate-2) @ 10 g kg⁻¹ seed</td>
<td>98.33 (82.55)ᵇ</td>
<td>16.75ᵇ</td>
<td>1647ᵇ</td>
<td>0.04ᵃ</td>
<td>3.54ᵇ</td>
</tr>
<tr>
<td>T₄</td>
<td>Seed treatment with Pseudomonas fluorescens (isolate-1) @ 10 g kg⁻¹ seed</td>
<td>97.42 (80.72)ᶜ</td>
<td>15.39cd</td>
<td>1499ᵈ</td>
<td>0.03ᵇ</td>
<td>2.44ᵈ</td>
</tr>
<tr>
<td>T₅</td>
<td>Seed treatment with garlic clove extract 10%</td>
<td>97.17 (80.28)ᶜ</td>
<td>15.55cd</td>
<td>1511ᵈ</td>
<td>0.04ᵃ</td>
<td>3.40ᵇ</td>
</tr>
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<td>T₆</td>
<td>Seed treatment with neem leaf extract 10%</td>
<td>96.58 (79.33)ᵈ</td>
<td>15.30ᵈ</td>
<td>1478ᵈ</td>
<td>0.02ᶜ</td>
<td>2.35ᵈ</td>
</tr>
<tr>
<td>T₇</td>
<td>Control</td>
<td>91.42 (72.93)ᵉ</td>
<td>11.44ᵉ</td>
<td>1046ᵉ</td>
<td>0.02ᶜ</td>
<td>1.83ᵉ</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>80.59</td>
<td>15.36</td>
<td>1494</td>
<td>0.03</td>
<td>2.93</td>
</tr>
<tr>
<td>SEM+</td>
<td></td>
<td>0.27</td>
<td>0.13</td>
<td>12.53</td>
<td>0.001</td>
<td>0.06</td>
</tr>
<tr>
<td>CD @ 5%</td>
<td></td>
<td>0.59</td>
<td>0.32</td>
<td>31.20</td>
<td>0.002</td>
<td>0.16</td>
</tr>
<tr>
<td>CV (%)</td>
<td></td>
<td>0.68</td>
<td>1.43</td>
<td>3.86</td>
<td>3.83</td>
<td></td>
</tr>
</tbody>
</table>

*Mean of three replications; Values in the parenthesis indicate angular transformed values; Values followed by the same alphabet in the same column do not differ significantly at 5% level of significance

Fig. 1. Evaluation of fungicides, bio-control agents and botanicals against seed borne Alternaria blight in sesame sample of YLM-17 under pot culture
can be recommended as an ecofriendly sustainable disease management strategy for Alternaria blight in sesame crop.

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