**Use of Fungicides for Management of *Alternaria* Leaf spot of Asalio (*Lepidium sativum* Linn; Family: Brassicaceae)**

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**ABTRACT**

 The current study tests the efficacy of various fungicides for controlling the Alternaria leaf spot disease of Asalio. The field experiment was conducted during *Rabi-Summer* 2018-19, 2019-20, 2020-21 and 2021-22 for management of *Alternaria* leaf spot of Asalio through fungicides. The results indicated that the treatment T5 *i.e* seed treatment with combi fungicides, Carbendazim 12 % + Mancozeb 63 % WP @ 0.30 % + three foliar sprays with Tebuconazole 25.9 % EC @ 0.1 % recorded significantly lowest PDI (27.89%) of *Alternaria* leaf spot with 58.39 % reduction in disease over control. Moreover the same treatment also recorded significantly highest seed yield (20.89) q/ha and highest B: C ratio (2.43) as compared to rest of the treatments.

*Keywords*: *Fungicides, Asalio, Alternaria*, *leaf spot*

**1. INTRODUCTION**

 “Asalio (*Lepidium sativum* Linn; Family: Brassicaceae) is a medicinal plant. Lepidium name derives from Greek word 'lepidion' means small scale probably it refers to the form of fruits and sativum is derived from 'serere' meaning to cultivate, to plant or to sow. It is known as “Common cress”, “Land cress”, “Haliv”, “Garden cress” or “Chandrasur” in some regions of India” (Gokavi *et al*., 2004). “It has been estimated that 14-28% of higher plant species are used medicinally and that 74% of pharmacologically active plant derived components were discovered after following up on ethano medicinal use of the plants” (Ncube *et al*., 2008). “In the year 1967 the Alternaria leaf spot of Asalio was first reported from Kaffa province, Ethiopia and the pathogen was identified as *Alternaria brassicae* (Berk.) Sacc.” (Stewart and Dagnalechew, 1967). Melkania (1980) reported that “*Alternaria alternata* caused Alternaria leaf spot on leaves of cress at Almora (H.P.) for the first time in India”. “Alternaria is included in order Hyphomycetes, family Dematiaceae, genus dictyosporic and it is Fungi Imperfecti. Alternaria genus” was first reported by Nees (1816). “*A. alternata* belongs to Longicatenatae” according to Neergaard (1945). Melkania (1980) reported that “Alternaria leaf spot on leaves of Asalio was caused by *A. alternate”* and Utikar and Padule (1980) described its morphology, They reported that “conidiophores of *A. alternata* were simple, light brown, variable in length ranging from 17.10 to 61.56 μm and mostly 2-3 septate rarely 4-5 septate. Conidia were found light to dark brown in colour, uniform with 0-2 longitudinal septa and 1-6 transverse septa, and variable in shape and size, mostly oval shape with rudimentary beak and in size measuring about 10.26-77.52 x 4.56 14.82 μm”. Simmons and Roberts (1993) observed “three-dimensional sporulation patterns of *A. alternata* in electron microscope at 50 magnification”. Melkania (1980) reported that “Alternaria leaf spot on leaves of Asalio was caused by *A. alternata*. The first initiation of symptoms were small, discoloured oval lesions, irregular in shape which later increase in size and brown in colour. The initial infection starts when lower leaves of plant touch the irrigation channels. Later on these symptoms are also seen on the seed coat and stem. The disease is initially seed borne but the inoculum is also contributed by infected plant debris for reoccurrence of disease. The severity of the disease increases up to mid January. At this stage, the stem and floral parts of plant also become diseased. Finally, whole plant shows typical blight symptoms. Fungal colonizes in xylem of the host plant, and as a result, blockage and breakdown of the xylem lead to wilt disease symptoms such as, leaf wilting, yellowing and eventually the death of the plant”. “Diseases especially caused by fungal pathogens are the main biological constraints in Asalio production and Alternaria leaf spot disease caused by *Alternaria alternata* is one of the most economically important diseases of Asalio” (Kumari, P., et al., 2020). The current study tests the efficacy of various fungicides for controlling the Alternaria leaf spot disease of Asalio.

**2. METHODOLOGY**

 The experiment was conducted during *Rabi-Summer* 2018-19, 2019-20, 2020-21 and 2021-22 at the Experiential Farm of AICRP on Medicinal, Aromatic Plants and Betelvine, M.P.K.V., Rahuri. The experiment was laid out in randomized block design with four replications. The treatments comprised of six (five fungicides including control) *viz*., T1 : Seed treatment with (Carbendazim 12 % + Mancozeb 63 %) WP @ 0.30 % + three foliar sprays with Mancozeb 75 WP @ 0.25 %, T2 : Seed treatment with (Carbendazim 12 % + Mancozeb 63 %) WP @ 0.30 % + three foliar sprays with Ridomil MZ 72 WP @ 0.25 %, T3 : Seed treatment with Metalaxyl 35 SD @ 8 g/kg seeds + three foliar sprays with Copper oxychloride 50WP @ 0.30 % T4 : Seed treatment with (Carbendazim 12 % + Mancozeb 63 %) @ 0.30 % + three foliar sprays with Tebuconazole 50%+ Trifloxystrobin 25% @ 0.05 % , T5 : Seed treatment with (Carbendazim 12 % + Mancozeb 63 %) WP @ 0.30 % + three foliar sprays with Tebuconazole 25.9 % EC @ 0.10 %, T6 : Control. Spraying schedule **:** First spray was given on the appearance of disease symptoms and the thereafter subsequent two sprays followed by 15 days interval. Disease intensity was recorded on a standard (0-5) disease rating scale (Gawande and Patil 2003). The Per cent Disease Index (PDI) was computed from the above scale by using the following formula (Wheeler, 1969).

PDI = Sum of all the numerical ratings

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 Number of observations × Maximum disease grade

**3. RESULTS AND DISCUSSION**

 The four years (2018-19, 2019-20, 2020-21 and 2021-22) pooled data presented in Table 1, 2 and 3 indicated that, statistically significant differences were observed in respect of per cent intensity of *Alternaria* leaf spot disease and seed yield of Asalio. As regards the *Alternaria* leaf spot disease intensity, the significantly lowest intensity 27.89 % with maximum 58.39% reduction of disease was observed in the treatment T5 i.e Seed treatment with combi fungicide Carbendazim 12 % + Mancozeb 63 % WP @ 0.30 % + three foliar sprays with Tebuconazole 25.9 % EC @ 0.1 %. The maximum seed yield of 20.89 q/ha was significantly recorded by the treatment T5 i.e Seed treatment with combi fungicide Carbendazim 12 % + Mancozeb 63 % WP @ 0.30 % + three foliar sprays with Tebuconazole 25.9 % EC @ 0.1 %. However, the treatment T1 i.e. ST with Carbendazim 12 % + Mancozeb 63% 75 WP @ 0.30 % + three foliar sprays with Mancozeb 75 WP @ 0.25 % was statistically at par, which recorded seed yield of 18.86 q/ha. As regards the economics of Asalio, the highest B:C ratio of 2.43 with highest monetary returns was recorded by T5 i.e Seed treatment with combine fungicide Carbendazim 12 % + Mancozeb 63 % WP @ 0.30 % + three foliar sprays with Tebuconazole 25.9 EC % @ 0.1 %. These research findings are in agreement with the earlier workers. Li and Wu (2002) reported that triazole group fungicides gave better control of *Alternaria* blight in Carnation. Chandel *et al*. (2003 and 2010) reported that the treatment of sulfur fungicide (Mancozeb) gave better disease control of *Alternaria* leaf spot and flower blight in marigold. Nutsugah *et al*., (2007) found that when Tebuconazole applied alone was effective in reducing leaf spot severity and it yielded significantly higher biomass and pod yields compared to most of the treatments. Nath, *et al*., (2013) tested three fungicides with their prefix concentrations in *in vitro* condition. Among three, Tebuconazole (0.15%) gave best results and decrease per cent disease to 52.42 % and increased yield up to 67 % as compared to 37 % increase by Tebuconazole (0.10%). Waghe *et. al* (2015) has conducted a management trial on Alternaria leaf spot disease under *in vivo* conditions and among eight treatments imposed, the treatment *i.e*. seed treatment with fungicide (Carbendazim 12% + Mancozeb 63%) @ 3g / kg seed + two sprays of (Carbendazim 12% + Mancozeb 63%) @ 0.2% at 30 and 45 DAS recorded higher disease control (82.82%) with good seed yield (16.86 q/ ha). Shindhe *et al*. (2018) reported that Hexaconazole (0.1%) was found effective in reducing the incidence of leaf spot and flower blight of marigold and increased flower yield followed by Mancozeb. Anand, (2021) evaluated different fungicides for their efficacy against leaf spot and flower blight of marigold under field conditions. Among the fungicides tested, seed treatment (0.2%) + foliar spray of Hexaconazole + Zineb (0.2%) was found effective in reducing the incidence of both diseases and recorded higher flower yield.

Table 1. Effect of fungicidal treatments on disease intensity of *Alternaria* leaf spot of Asalio

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treat.No. | Treatment details | Per cent Disease Intensity( PDI) of *Alternaria* leaf spot  | Pooled Mean | PDC |
| 2018-19 | 2019-20 | 2020-21 | 2021-22 |
| T1 | ST with Carbendazim 12 % + Mancozeb 63% – 75 WP @ 0.30 % + three Foliar sprays with Mancozeb 75 WP @ 0.25 % | 36.22(37.00) | 45.56(42.45) | 30.56(33.54) | 31.97(37.22) |  36.08(37.55) | 46.17 |
| T2 | ST with Carbendazim 12 % + Mancozeb 63 % 75 WP @ 0.30 % + three Foliar sprays with Ridomil MZ 72 WP @ 0.25 %  | 39.78(39.10) | 53.34(46.92) | 40.22(39.33) | 39.10(37.72) |  43.11(40.77) | 35.69 |
| T3 | ST with Metalaxyl 35 SD @ 8 g/kg seeds + three foliar sprays with Copper oxychloride 50WP @ 0.30 %  | 49.56(44.75) | 55.56(48.22) | 41.34(39.99) | 39.87(35.65) |  46.58(42.15) | 30.51 |
| T4 | ST with Carbendazim 12 % + Mancozeb 63 % WP @ 0.30 % + three Foliar sprays with Tebuconazole 50%+ Trifloxystrobin 25% @ 0.05 %  | 52.22(49.15) | 58.89(50.23) | 40.78(39.67) | 30.69(34.41) |  45.65(43.37) | 31.90 |
| T5 | ST with Carbendazim 12 % + Mancozeb 63 % WP @ 0.30 % + three Foliar sprays with Tebuconazole 25.9 EC @ 0.10 %  | 27.56(31.15) | 35.56(36.60) | 26.78(32.37) | 21.65(27.51) |  27.89(31.91) | 58.39 |
| T6 | Control | 75.78(60.52) | 77.78(61.93) | 59.89(50.81) | 54.66(47.39) |  67.03(55.16) | --- |
|  |  SE ± | 1.16 | 1.97 | 1.17 | 1.72 | 1.45 |  |
|  |  CD at 5% | 3.48 | 5.95 | 3.53 | 5.19 | 4.40 |  |

Table 2. Effect of fungicidal treatments on seed yield of Asalio

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Tr.No. | Treatment details | Seed yield ( q/ha) | Pooled Mean | % Seed yield increased over control |
| 2018-19 | 2019-20 | 2020-21 | 2021-22 |
| T1 | ST with Carbendazim 12 % + Mancozeb 63% @ 0.30 % + three Foliar sprays with Mancozeb 75 WP @ 0.25 % | 18.58 | 20.25 | 18.63 | 17.99 | 18.86 | 38.97 |
| T2 | ST with Carbendazim 12 % + Mancozeb 63 % @ 0.30 % + three Foliar sprays with Ridomil MZ 72 WP @ 0.25 %  | 17.40 | 17.92 | 18.48 | 18.40 | 18.05 | 36.23 |
| T3 | ST with Metalaxyl 35 SD @ 8 g/kg seeds + three foliar sprays with Copper oxychloride 50WP @ 0.30 %  | 15.70 | 16.42 | 18.00 | 17.77 | 16.97 | 32.17 |
| T4 | ST with Carbendazim 12 % + Mancozeb 63 % WP @ 0.30 % + three Foliar sprays with Tebuconazole 50%+ Trifloxystrobin 25% @ 0.05 % | 17.34 | 17.22 | 17.72 | 17.56 | 17.46 | 34.08 |
| T5 | ST with Carbendazim 12 % + Mancozeb 63 % WP @ 0.30 % + three Foliar sprays with Tebuconazole 25.9 EC @ 0.10 %  | 20.76 | 22.43 | 20.45 | 19.93 | 20.89 | 44.90 |
| T6 | Control | 11.44 | 10.60 | 12.10 | 11.90 | 11.51 | --- |
|  |  SE ± | 0.37 | 0.33 | 1.11 | 1.04 | 0.73 |  |
|  |  CD at 5% | 1.12 | 1.01 | 3.35 | 3.14 | 2.20 |  |

Table 3. Effect of fungicidal treatments on economics of Asalio

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Tr.No. | Treatment details | Cost of cultivation | Seed yield (q/ha) | Gross monetary returns (Rs./ha) | Net monetary returns (Rs./ha) | B:C ratio |
| T1 | ST with Carbendazim 12 % + Mancozeb 63% WP @ 0.30 % + three Foliar sprays with Mancozeb 75 WP @ 0.25 % | 63696 | 18.86 | 150880 | 87184 | 2.37 |
| T2 | ST with Carbendazim 12 % + Mancozeb 63 % WP @ 0.30 % + three Foliar sprays with Ridomil MZ 72 WP @ 0.25 %  | 72508 | 18.05 | 144400 | 71892 | 1.99 |
| T3 | ST with Metalaxyl 35 SD @ 8 g/kg seeds + three foliar sprays with Copper oxychloride 50WP @ 0.30 %  | 68466 | 16.97 | 135760 | 67294 | 1.98 |
| T4 | ST with Carbendazim 12 % + Mancozeb 63 % WP @ 0.30 % + three Foliar sprays with Tebuconazole 50%+ Trifloxystrobin 25% @ 0.05 % | 71758 | 17.46 | 139680 | 67922 | 1.95 |
| T5 | ST with Carbendazim 12 % + Mancozeb 63 % WP @ 0.30 % + three Foliar sprays with Tebuconazole 25.9 EC @ 0.10 %  | 68908 | 20.89 | 167120 | 98212 | 2.43 |
| T6 | Control | 57485 | 11.51 | 92080 | 34595 | 1.60 |
|  |  SE ± |  | 0.73 |  |  |  |
|  |  CD at 5% |  | 2.20 |  |  |  |

**4. CONCLUSION**

 For the management of *Alternaria* leaf spot disease as well as to obtain maximum seed yield and monetary returns the **s**eed treatment with combi fungicide Carbendazim 12 % + Mancozeb 63 % WP @ 0.30 % + three subsequent foliar sprays at an interval of 15 days with Tebuconazole 25.9 % EC @ 0.1 % was found to be effective in Asalio crop.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE**)

 We hereby declare that NO generative AI technologies such as Large Language Models (Chat GPT, COPILOT, etc) and text to image generators have been used during writing or editing of manuscripts.

**REFERENCES**

Anand, T. (2021). Chemical and biological management of leaf spot and flower blight of Marigold. *International Journal of Agriculture, Environment and Biotechnology,* *14* (3), 399-403.

Chandel, S.S., Kaur M. & Pathania,N. (2003). Effect of fungicide treatment on seed viability, seed mycroflora and plant health of marigold, *J. Hill Res*., *16*(1), 29-31.

Chandel, D., Silva, J.A.T. & Sharma, C. (2010). Management of Alternaria leaf spot and flower blight of Marigold (Tagetes erecta L.) cv. Crackerjack by application of fungicides and neem formulation. *Floriculture Ornamental Biotech*., *4* (1), 79-83.

Gawande V.L. & Patil J.V. (2003). Genetics of powdery mildew (*Erysiphe polygoni* D.C.) resistance in mungbean (*Vigna radiata* (L.) Wilczek). Crop Prot., 22, 567-571

Gokavi S.S., Malleshi N.G. & Guo, M. (2004). Chemical composition of garden cress (*Lepidium* *sativum*) seeds and it fractions and use of bran as a functional ingredient. *Journal of Plant Food and Human Nutrition*, *59*, 105 - 111.

Li, Y.L. & Wu, W.S. (2002). A new seed-borne pathogen *Alternaria dianthicola* on Dianthus in Taiwan. Plant Pathology Bulletin, 11, 165-167.

Melkania, N. P. (1980). *Lepidium sativum* L. - A new host record for *Alternaria alternata*. (Fr.) Keissler. *Curr. Sci*, *49* : 27-28.

Nath, B. C., Singh, J. P., Srivastava, S. & Singh, R. B. (2013). Management of late leaf spot of groundnut by different fungicides and their impact on yield. *Plant Pathology Journal*., 12(2) , 85-91.

Ncube, N.S., Afolayan, A.J. & Okoh A.I. (2008). Assessment techniques of antimicrobial properties of natural compounds of plant origin: Current methods and future trends. *Afr. J Biotechnol.,* *7*, 1797-1806.

Neergaard, P. (1945). Danish spp. of Alterneria and Stemphylium taxonomy, parasitism, economical significance. Oxford University Press, London / Oxford.. pp, 559.

Nees, V.E.(1816). Das System der Pilze und Schwamme. Stahelsche, Wurzberg, 329.

Nutsugah, S. K., Abudulai, M., Oti, B. C., Brandenburg, R. L. & Jordan, D. L. (2007). Management of leaf spot diseases of peanut with fungicides and local detergents in Ghana. *Plant Pathology Journal*. 6, 248-253.

Shindhe, M., Narayanaswamy, H., Nagaraja, H. & Murali, R. (2018). Management of leaf spot and flower blight of marigold caused by *Alternaria tagetica* (Shome and Mustafee) under field condition. *Int. J. Chem. Stud*., 6(3), 3082-3084.

Simmons, E.G, & Roberts R.G. (1993). Alternaria themes and variations. *Mycotaxon*, *48*, 109-140.

Stewart, R.B. & Dagnalechew Y. (1967) . Index of plant diseases in Ethiopia. Exp, Station Bull, No, 30, College of Agriculture, Alenaya, Ethiopia (Spicies, condiments and medicinal plants in Ethiopia, their taxonomy and agricultural significance, Ed. Jansen, P.C.M., Centre for Agricultural Publishing and Documentation, Wageningen, 216-224.

Utikar, P.G, and Padule D.N. (1980). A virulent species of Alternaria causing leaf blight of onion. *Indian Phytopathol*., 33, 335-336.

Waghe, K P, Wagh S S., Kuldhar, D.P. & Pawar, D.V. (2015). Evaluation of different fungicides, bioagents and botanicals against *Alternaria* blight caused by  *Alternaria helianthi* (Hansf) of Sunflower. *Afr. J. Agric Res*, *10*, 351-358.

Wheeler B. E. J. (1969). An Introduction to Plant Diseases. John Wiley, London. 301

Kumari, P., Trivedi, A., Kumar, V., & Anupriya (2020). Evaluation of different Fungicides, botianicals and Combi Products Efficacy for the Management of Alternaria Leaf Spot Disease on Asalio. International Journal of Current Microbiology and Applied Sciences, 11, 3759-3766

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