Effect of Selected Fungicides, Botanicals and *Trichoderma viride* in Managing Alternaria Leaf Spot of Okra (*Abelmoschus esculentus* L.)

Abstract

Alternaria leaf spot, caused by *Alternaria alternata*, is a significant fungal disease affecting okra (*Abelmoschus esculentus* L.), leading to considerable yield losses. This study investigates the efficacy of selected fungicides, botanicals, and *Trichoderma viride* in managing this disease, while also (remove) assessing their effects on plant growth and the economic viability of the treatments. A field experiment was conducted using a randomized block design with eight treatments, including fungicides like mancozeb and carbendazim, botanicals such as neem oil, garlic, and (remove) ginger extracts, and the biocontrol agent *Trichoderma viride*. The results showed that the combination of mancozeb (12%) and carbendazim (63%) was the most effective, resulting in the tallest plant height of 89.32 cm at 90 DAS, the lowest disease intensity of 8.10% at 45 DAS, and the highest yield of 14.81 t/ha. This treatment also resulted in the highest cost-benefit ratio of 1:2.94. Among the botanicals, neem oil and garlic extract showed moderate effectiveness in disease management. The use of (remove) *Trichoderma viride* also contributed to significant disease suppression and plant growth enhancement. The cost-benefit analysis indicated that chemical fungicides provided the highest economic return, although botanicals and biocontrol agents offer sustainable alternatives. This study demonstrates that integrating chemical, biological, and botanical treatments can effectively manage Alternaria leaf spot in okra, with *Trichoderma viride* offering a promising eco-friendly option.

Keywords (remove space): *Abelmoschus esculentus,* Alternaria leaf spot, Botanicals, Carbendazim, Mancozeb, *Trichoderma viride,* Yield.

1. Introduction:

Okra (*Abelmoschus esculentus* L. *Moench*), commonly referred to as lady's finger or bhindi, is a significant crop belonging to the Malvaceae family, thought to have originated in present-day Ethiopia. It flourishes in tropical and subtropical regions, particularly in nutrient-rich, well-drained sandy loam soils. Poor drainage and acidic conditions can hinder okra growth and nutrient absorption. For optimal seed germination, temperatures above 16°C are required. India ranks as the largest global producer of okra, with key cultivation areas in Maharashtra, Andhra Pradesh, and West Bengal **(Choudhary and Panchouli, 2024; Iderawumi, 2018; Hurule, 2019).** Okra is a low-calorie vegetable packed with essential minerals such as potassium, magnesium, calcium, and dietary fiber. Its pods are a rich source of phenolic compounds, including quercetin, hydroxycinnamic acids, and catechin oligomers, which provide various health benefits, such as lowering cholesterol and promoting heart health. Additionally, okra seeds are rich in protein, vitamins A and B, phosphorus, and iodine **(Sarangi and Tiwari, 2023; Arain *et al*., 2012).** Despite its benefits, okra cultivation is challenged by biotic and abiotic stresses, notably diseases like Alternaria leaf spot, which can reduce yields by up to 50%. The disease begins with brown spots on leaves that expand, causing necrosis and impairing photosynthesis. Effective control measures include fungicide use, crop rotation, and selecting resistant varieties. However, overuse of fungicides can lead to resistance and environmental damage. Eco-friendly alternatives, such as biocontrol agents like *Trichoderma*, along with neem and garlic extracts, help combat pathogens and strengthen plant defenses without the negative side effects of chemical treatments **(Gao and Chen, 2020; Mishra and Dubey, 2018; Abbasi *et al*., 2003; Rinaldi *et al*., 2019; Harman *et al*., 2004).**

2. Materials and methods:

The study was conducted at SHUATS during the 2023 *Kharif* season. The randomized block design (RBD) experiment was set in a semi-arid, subtropical climate with sandy loam soil in Prayagraj, which experiences temperatures ranging from 47°C in summer to 2.5°C in winter, and annual rainfall of 1013 mm.

Laboratory procedures involved cleaning borosilicate glassware, sterilizing equipment, and preparing Potato Dextrose Agar (PDA) (each word capital first time). Diseased okra leaves were surface sterilized, incubated on a PDA medium, and examined microscopically to identify *Alternaria alternata*, which formed fast-growing, velvety colonies.

Table 1 Detail of treatment

Sr. No.	Treatment number	Treatment details
1	T_0	Control (uncheck)
2	T_1	Copper oxychloride 50% WP @ 4 ml/l (F.S)
3	T_2	Neem oil 0.3% @ 3ml/l (F.S)
4	T_3	*Trichoderma viride* 0.7% @ 7g/l (F.S)
5	T_4	Mancozeb 75 % WP @ 0.25% (F.S)
6	T_5	Ginger (Rhizome) extract @ 10% (F.S)
7	T_6	Garlic clove extract @ 10% (F.S)

8	**T_7**	Mancozeb 12% + Carbendazim @ 63 % (WP) 0.2 % (F.S)

WP- Wettable Powder
F.S- Foliar Spray

The experiment included eight treatments (*e.g.,* copper oxychloride, neem oil, *Trichoderma viride*, mancozeb, ginger extract, garlic clove extract, and a combination of mancozeb and carbendazim) and a control. Seeds of the VNR Super Green variety were sown in lines with 30 cm row spacing, and growth parameters like plant height and disease intensity were measured. Disease intensity was calculated using Percent Disease Incidence (PDI) based on Wheeler's formula.

$$\textbf{Disease intensity}\ (\%) = \frac{\textbf{Sum of all numerical rating}}{\textbf{Number of leaves observed} \times \textbf{maximum disease grade}} \times \textbf{100}$$

Statistical analysis using ANOVA was applied to determine the significance of treatment effects, with hypotheses testing the differences between treatments and replications.

Table 2 Ratings/grade based on percent leaf area infected

Rating scale	Symptoms description	Severity index
0	No symptoms on the leaves	0
1	Small, brown spots covering > 1 % or less of the leaf area.	0.1-1%
3	Lesions small, scattered, brown to black with concentric rings, covering 1- 10% of the leaf area.	1-10%
5	11-25% of the leaf area affected	11-25%
7	26-50% of leaf area affected with lesions enlarging, slightly sunken in the centre with concentric rings.	26-50%
9	Lesions enlarging (10 mm), coalescing to form bigger patches covering >50 % leaf area	>50%

(Mayee and Datar, 1986)

3. Results and Discussion:

The findings of the experiment titled "Effect of Selected Fungicides, Botanicals, and *Trichoderma viride* in Managing Alternaria Leaf Spot of Okra (*Abelmoschus esculentus* L.)" conducted at the Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, during the *Kharif* season of 2023. This study aimed to evaluate the efficacy of various treatments in controlling Alternaria leaf spot disease. The experiment utilized a randomized block design (RBD), comparing the effectiveness of essential oils, bio-agents, and fungicides against a control plot. The VNR super green variety of okra was selected for cultivation, and disease intensity was recorded at regular intervals following the onset of symptoms. The impact of treatments on plant height at 30, 60, and 90 days after sowing (DAS) is summarized.

Table 3. Effect of treatments on Plant height (cm) at 30, 60 and 90 DAS

	Treatments	Plant Height (cm)		
		30 DAS	**60 DAS**	**90 DAS**
T_0	Control (untreated check)	19.72^{f}	34.04^{f}	69.98^{f}
T_1	Copper oxychloride 50% WP @ 4 ml/l (F.S)	24.73^{c}	42.82^{b}	80.21^{c}
T_2	Neem oil 0.3% @ 3ml/lit (F.S)	23.20^{d}	41.01^{c}	75.36^{d}
T_3	*Trichoderma viride* F. S (0.7%) @ 7g/l	22.36^{de}	38.44^{d}	76.40^{d}
T_4	Mancozeb 75 % WP @ 0.25% (F.S)	26.25^{b}	44.18^{b}	84.03^{b}
T_5	Ginger extract @ 10% FS	21.56^{e}	37.29^{e}	72.96^{e}
T_6	Garlic extract @ 10% (F.S)	21.29^{e}	36.69^{e}	72.59^{e}
T_7	Mancozeb 12% + carbendazim 63 % WP @ 0.2% (F.S)	28.12^{a}	46.15^{a}	89.32^{a}
	CD (0.05) (ADD CV of the experiment)	**1.34**	**1.37**	**2.26**

WP- Wettable Powder
F.S- Foliar Spray

At 30 DAS, plant height significantly increased in treatment T_7 (mancozeb 12% + carbendazim 63% WP @ 0.2% F.S), which achieved the tallest average height of 28.12 cm. This was followed by T_4 (mancozeb 75% WP @ 0.25% F.S) at 26.25 cm, T_1 (copper oxychloride 50% WP @ 4 ml/l F.S) at 24.73 cm, T_2 (neem oil 0.3% @ 3 ml/l F.S) at 23.20 cm, T_3 (*Trichoderma viride* S.T + F.S 0.7% @ 7 g/l) (*T.viride* don't repeat genus name and add formulation details with CFU)at 22.36 cm, T_5 (ginger @ 10% F.S) at21.56 cm, and T_6 (garlic clove @ 10% F.S) at 21.29 cm. The control showed the shortest height at 19.72 cm.

Statistical analysis revealed all treatments to be significant compared to the control Among the treatments, T_1, T_4, and T_7 showed significant differences, while T_2, T_3, T_5, and T_6 were non-significant among each other.

At 60 DAS, treatment T_7 recorded a height of 46.15 cm, followed by T_4 (44.18 cm), T_1 (42.82 cm), T_2 (41.01 cm), T_3 (38.44 cm), T_5 (37.29 cm), and T_6 (36.69 cm). The control measured 34.04 cm.

All the treatments were statistically significant over the control (C.D value: 1.37), with T_2, T_3, and T_7 showing significant differences. However, treatments T_1 and T_4, as well as T_5 and T_6, were non-significant among each other.

At 90 DAS, T_7 achieved the tallest height of 89.32 cm, followed by T_4 (84.03 cm), T_1 (80.21 cm), T_2 (76.40 cm), T_3 (75.36 cm), T_5 (72.96 cm), and T_6 (72.59 cm). The control measured 69.98 cm.

All treatments were statistically significant compared to the control. Treatments T_1, T_4, and T_7 were statistically significant among themselves, while T_2, T_3, T_5, and T_6 showed non-significance. Overall, the findings illustrate that various fungicides, biocontrol agents, and plant extracts significantly influenced the height of okra plants at 30, 60, and 90 DAS. The combination of mancozeb 12% and carbendazim 63% WP (T_7) resulted in the highest plant heights, attributed to the broad-spectrum activity of these fungicides against various fungal pathogens, including Alternaria spp. Mancozeb disrupts enzymatic activities in fungal respiration, while carbendazim interferes with mitosis in fungi by binding to tubulin **(Meena *et al.,* 2020; Kantwa *et al.,* 2014).**

The application of treatments like mancozeb and carbendazim effectively reduced disease incidence and enhanced both plant height and yield (Gupta and Misra, 2019). Similarly, copper oxychloride (T_1) and mancozeb (T_4) also significantly improved plant height by disrupting fungal growth. Although biocontrol agents and plant extracts enhanced plant height, they were less effective than chemical fungicides. *Trichoderma viride* (T_3) acts through competition and the production of antifungal metabolites, promoting plant growth **(Harman *et al.*, 2004),** while neem oil (T_2) inhibits spore germination and disrupts fungal membranes **(Srinivasan and Narayanan, 2020).** Ginger (T_5) and garlic (T_6) extracts, while containing antifungal properties, were less consistent in their effectiveness compared to synthetic fungicides.

Table 4 Effect of treatments on Disease Intensity (%) at 45, 60 and 75 DAS

	Treatments	Disease Intensity (%)		
		45 DAS	**60 DAS**	**75 DAS**
T_0	Control (uncheck)	27.24[a]	36.69[a]	53.85[a]
T_1	Copper oxychloride 50% WP @ 4 ml/l (F.S)	11.62[e]	17.07[e]	28.49[f]
T_2	Neem oil 0.3% @ 3ml/lit (F.S)	16.06[d]	21.46[d]	33.80[e]
T_3	*Trichoderma viride* F.S (0.7%) @ 7g/l	19.06[c]	24.36[c]	37.14[d]
T_4	Mancozeb 75 % WP @ 0.25% (F.S)	10.24[f]	16.64[e]	28.69[f]
T_5	Ginger extract @ 10% FS	21.54[b]	32.24[b]	44.07[c]
T_6	Garlic extract @ 10% (F.S)	22.64[b]	32.21[b]	46.24[b]
T_7	Mancozeb 12% + carbendazim 63 % WP @ 0.2% (F.S)	8.10[g]	14.36[f]	26.37[g]
	CD (0.05) (ADD CV of the experiment)	**1.28**	**2.31**	**1.71**

WP- Wettable Powder
F.S- Foliar Spray

The impact of treatments on disease intensity (%) at 45, 60, and 75 DAS is illustrated. At 45 DAS, treatment T_7 exhibited the lowest disease intensity at 8.10%, followed by T_4 (10.24%), T_1 (11.62%), T_2 (16.06%), T_3 (19.06%), T_5 (21.54%), and T_6 (22.64%). The highest disease intensity was recorded in the control at 27.96%.

All treatments were statistically significant compared to the control, with T_1, T_2, T_3, and T_7 showing significant differences. However, T_5 and T_6 were non-significant among each other.

At 60 DAS, T_7 again showed the lowest disease intensity at 14.39%. This was followed by T_4 (16.98%), T_1 (17.06%), T_2 (21.46%), T_3 (24.36%), T_5 (32.21%), and T_6 (32.26%). The control had a maximum disease intensity of 36.97%.

All treatments were statistically significant over the control with T_2, T_3, and T_7 showing significant differences, while T_1 and T_4, as well as T_5 and T_7, were non-significant among each other.

At 75 DAS, treatment T_7 recorded the lowest disease intensity at 25.70%. This was followed by T_4 (28.69%), T_1 (28.49%), T_2 (33.80%), T_3 (37.14%), T_5 (44.07%), and T_6 (46.24%). The control showed the highest disease intensity at 52.85%.

All treatments remained statistically significant compared to the control T_2, T_3, T_5, T_6, and T_7 demonstrated significant differences, while treatments T_1 and T_4 were non-significant.

The results highlight the significant reduction of disease intensity in okra due to various treatments at different stages (45, 60, and 75 DAS). The combination of mancozeb and carbendazim (T_7) consistently exhibited the lowest disease intensity, supported by research indicating their effectiveness against fungal pathogens **(Meena *et al.*, 2020; Kantwa *et al.*, 2014).**

Mancozeb, a multi-site fungicide, inhibits various enzymes within fungi, preventing their growth and infection **(Thind, 2012).** Carbendazim's systemic properties disrupt fungal mitosis, significantly lowering disease incidence **(Gupta and Misra, 2019).** The performance of copper oxychloride (T_1) also reaffirmed its role in managing Alternaria through its ability to inhibit spore germination **(Shah *et al.*, 2021),** While neem oil (T_2) showed moderate efficacy,

Table 5 Effect of selected fungicides, botanicals and *Trichoderma viride* on Yield (t/ha) of okra (*Abelmoschus esculentus* L.

	Treatments	Yield (t/ha)
T_0	Control (uncheck)	7.41^{f}
T_1	Copper oxychloride 50% WP @ 4 ml/l (F.S)	12.21^{b}
T_2	Neem oil 0.3% @ 3ml/lit (F.S)	10.63^{c}
T_3	*Trichoderma viride* F.S (0.7%) @ 7g/l	10.18^{cd}
T_4	Mancozeb 75 % WP @ 0.25% (F.S)	13.25^{b}
T_5	Ginger extract @ 10% FS	9.25^{de}
T_6	Garlic extract @ 10% (F.S)	8.84^{e}
T_7	Mancozeb 12% + carbendazim 63 % WP @ 0.2% (F.S)	14.81
	CD (0.05) (ADD CV of the experiment)	**1.04**

WP- Wettable Powder
F.S- Foliar Spray

The impact of different treatments illustrated T_7 showed maximum yield per hectare (14.81 t/ha) followed by T_4 (13.25 t/ha), T_1 (12.21 t/ha), T_2 (10.63 t/ha), T3 (10.18 t/ha), T5 (9.23 t/ha) T6 (8.84 t/ha) minimum fruit yield per hector (7.41 t/ha) was observe in T_0 (Control).

All the treatments were found to be statistically significant over control. Among the treatments (T1 and T4), (T2 and T3), (T3 and T5) and (T7 and T1) were found statistically non-significant.

Bio-agents such as neem oil (T2), *Trichoderma viride* (T3), ginger extract (T5), and garlic extract (T6) demonstrated moderate efficacy compared to chemical fungicides, with yields ranging from 8.84 to 10.63 t/ha. Neem oil contains azadirachtin, a compound that disrupts the hormonal systems of pests and diseases, while *Trichoderma viride* is known for its ability to compete with pathogenic fungi, enhance nutrient availability, and induce systemic resistance in plants **(Jayalakshmi *et al.*, 2019)**. Ginger and garlic extracts contain antifungal compounds such as allicin and zingiberene, which inhibit fungal growth **(Kumar and Singh, 2021)**. However, their effectiveness was lower than synthetic fungicides, indicating that bio-agents may require higher concentrations or more frequent applications to achieve comparable results.

Table 6 Cost benefit ratio (C:B)

Treatments	Yield (t /ha)	Selling price	Gross return	Total cost of Cultivation	Net profit	C:B ratio
T_0	7.41	17000	125970	75000	50970	1: 1.67
T_1	12.21	17000	207570	95600	111970	1: 2.17
T_2	10.63	17000	180710	90500	90500	1: 1.99
T_3	10.18	17000	173060	84975	88085	1: 2.03
T_4	13.25	17000	150033	83300	66733	1: 1.80
T_5	9.23	17000	156910	82000	74910	1: 1.91
T_6	8.84	17000	150280	86300	63980	1: 1.74
T_7	14.81	17380	251770	85400	166370	1: 2.94

Among the treatments the economics of treatments.with higher return value (Rs. 251770) and C: B Ratio (1: 2.94) was observed in T_7-as compared to T_0 – control recorded lowest return value (Rs. 125970) and C: B Ratio (1: 1.67).

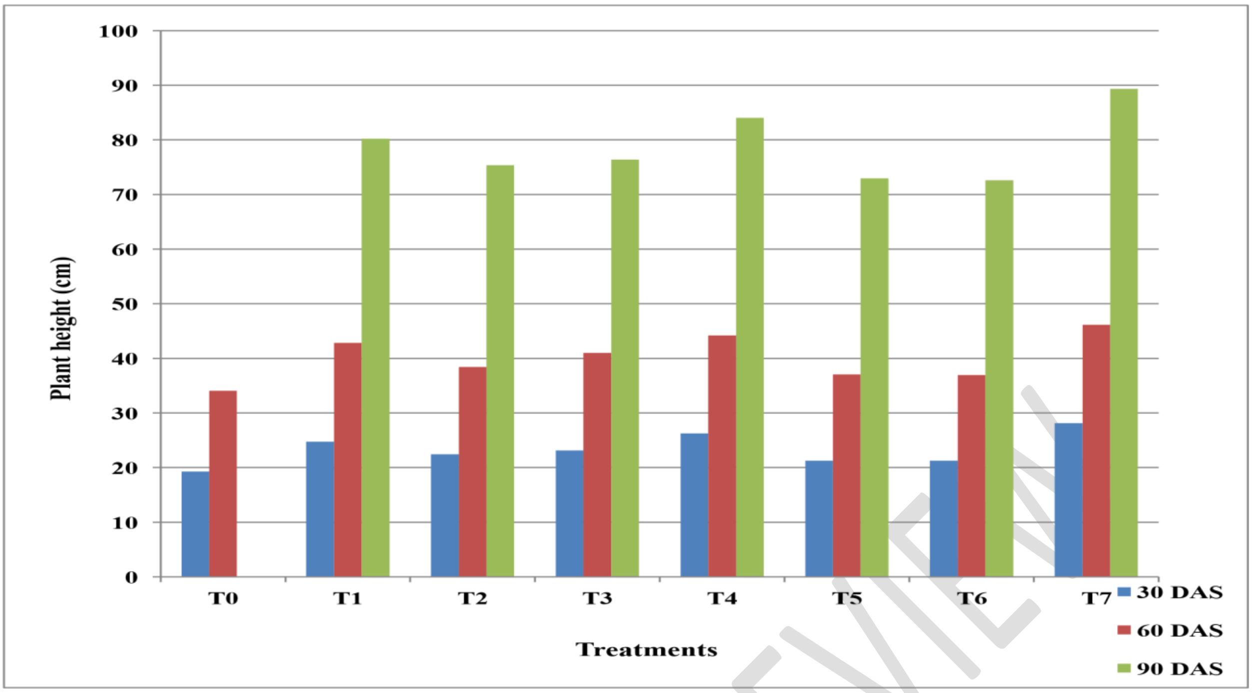

Fig 1 Effect of the treatments on plant height

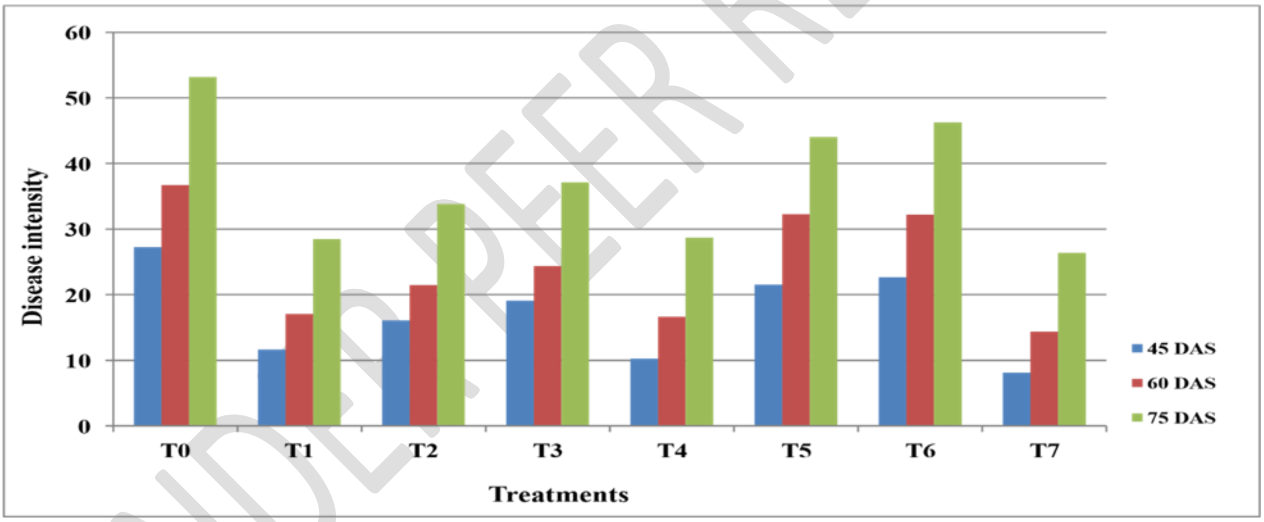

Fig 2 Effect of the treatments on disease intensity

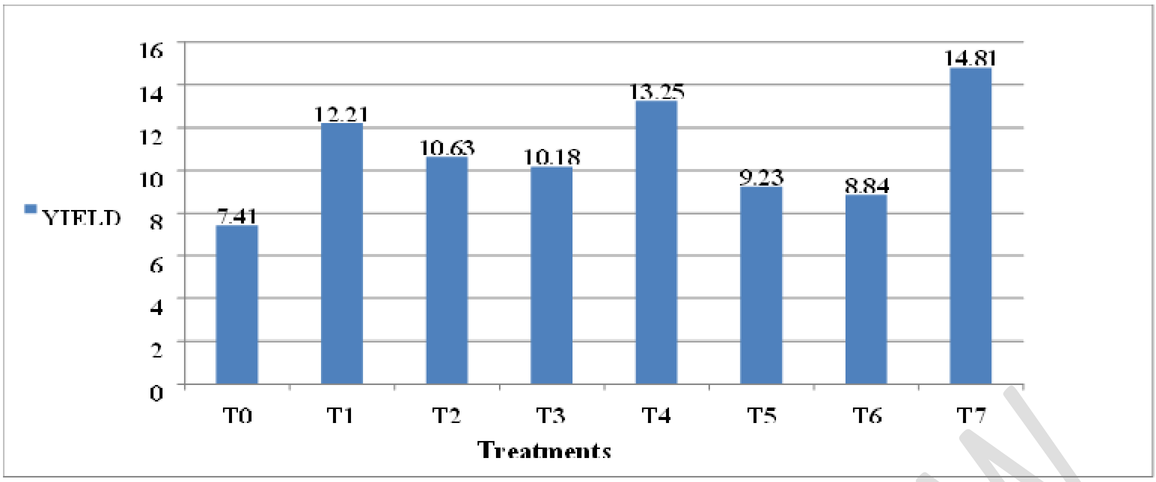

Fig 3 Effect of the treatments on yield

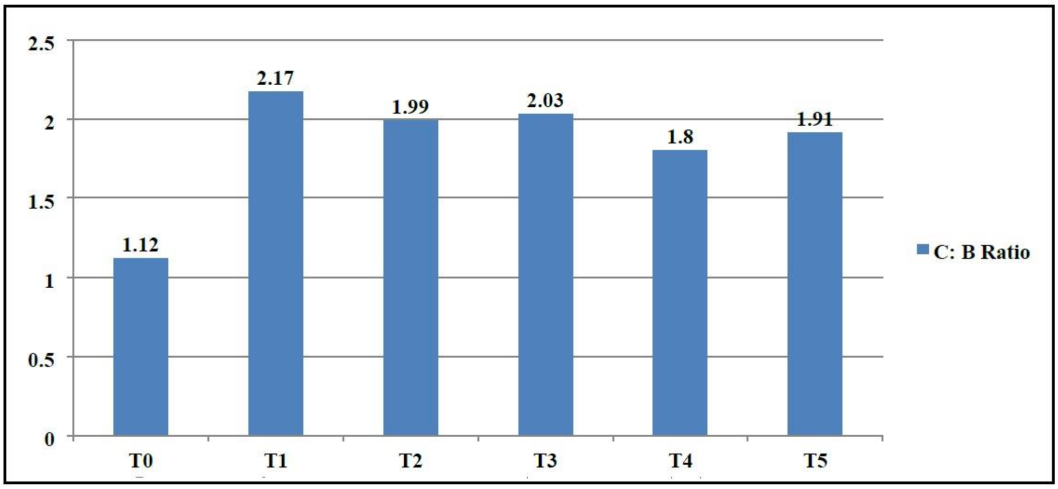

Fig 4 Cost benefit ratio (C:B)

4.Conclusion:

This study, titled **"Effect of selected fungicides, botanicals and *Trichoderma viride* in managing Alternaria leaf spot of okra (*Abelmoschus esculentus* L.)"** underscores the vital role of effective disease management in boosting crop productivity. Among all the treatments, chemical fungicides, particularly mancozeb 12% + carbendazim 63% WP @ 0.2% (F.S), showed the most promising outcomes for okra growth, disease control, and yield. Consistently resulted in the tallest plants, the lowest disease intensity at all observation points, and the highest yield per hectare. The next best-performing treatments were mancozeb 75% WP @ 0.25% (F.S) and copper oxychloride 50% WP @ 4 ml/l (F.S), which also provided significant benefits in terms of plant height, disease control, and yield. Biological treatments, like

Trichoderma viride and neem oil, demonstrated moderate effects but were less effective compared to the chemical fungicides.

While also resulted in the highest cost-benefit ratio, suggesting better financial returns compared to other treatments. Bio-agents, though less potent than chemical fungicides, present an eco-friendly alternative that can be further developed to reduce dependency on chemicals. With more research and refinement, bio-agents like *Trichoderma viride* and botanical extracts like neem oil could become viable options for integrated disease management in okra. However, further trials are necessary to optimize their efficacy and understand their potential as standalone treatments or as part of a broader integrated disease management strategy. It's important to note that further trials are necessary before these treatments can be confidently recommended to farmers. This study provides valuable insights, but more research is required across different seasons, environmental conditions, and disease pressures to ensure consistent and long-term efficacy.

Disclaimer (Artificial Intelligence)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of manuscripts.

References

1. **Abbasi, A. P., Cuppels, A. D and Lazarovits, G. (2003**). Effect of foliar applications of neem oil and fish emulsion on bacterial spot and yield of tomatoes and peppers. *Canadian Journal of Plant Pathology.* 25: 41-48.
2. **Arain, R. A., Jiskani, M., Wagan, H. K., Khuhro, N. S. and Khaskheli, I. M (2012).** Incidence and chemical control of okra leaf spot disease. *Pakistan Journal of Botany*. 44 (5): 1769-1774.
3. **Choudhary, A. and Panchouli, K. L. (2024).** *In vitro* assessment of fungicides against *Alternaria alternata* Causing leaf Spot of okra. *Journal of Experimental Agriculture International.* 46 (6): 946-953.
4. **Gao, Y. and Chen, J. (2020).** Fungicide resistance and environmental impact of agricultural practices: A review. *Journal of Environmental Management*. 260: 110-152.
5. **Gupta, P. K. and Misra, S. (2019).** Efficacy of fungicides and biocontrol agents against early blight (*Alternaria solani*) of tomato. *Journal of Plant Pathology*. 101 (4):1047-1056.

6. **Gupta, P. K. and Misra, S. (2019).** Efficacy of fungicides and biocontrol agents against early blight (*Alternaria solani*) of tomato. *Journal of Plant Pathology*. 101 (4): 1047-1056.
7. **Harman, G. E., Howell, C. R., Viterbo, A., Chet, I. and Lorito, M. (2004).** *Trichoderma* species opportunistic, avirulent plant symbionts. *Nature Reviews Microbiology*. 2 (1): 43-56.
8. **Hurule, S. S., Suryawanshi, A. P., Khatal, M. P. and Raner, R. B. (2019).** Integrated management of okra leaf spot caused by *Alternaria chlamydospora*. *International Journal of Chemical Studies*. 7 (5): 2600-2607.
9. **Iderawumi, M. A. (2018).** Growth and yield responses of okra (*Abelmoscus esculentum* L.) as influenced by sawdust ash and ammonium nitrate. *Sumerianz Journal of Agriculture and Veterinary*. 1 (1): 8-13.
10. **Jayalakshmi, S., Gnanamanickam, S. S. and Ramesh, M. (2019).** *Trichoderma viride* as a potential biocontrol agent against plant pathogenic fungi. *Journal of Plant Pathology*. 101 (4): 1097-1106.
11. **Kantwa, S. L., Tetarwal, J. P. and Shekhawat, K. S. (2014).** *In vitro* effect of fungicides and phyto-extracts against *Alternaria alternata* causing leaf blight of groundnut. *IOSR Journal of Agriculture and Veterinary Science*. 7 (6): 2319-2380.
12. **Kumar, P. and Singh, V. (2021). Antifungal activity of plant-based extracts: A comprehensive review. *Journal of Applied Biology and Biotechnology*. 9 (2): 27-34.**
13. **Meena, R. L., Gaur, R. B. and Rathore, A. K. (2020).** Efficacy of fungicides and bioagents against early blight (*Alternaria solani*) of tomato in arid western Rajasthan. *Journal of Pharmacognosy and Phytochemistry*. 9 (2): 60-63.
14. **Mishra, A. and Dubey, N. K. (2018).** Biocontrol potential of Trichoderma species and plant extracts for the management of phytopathogens: A review. *Biocontrol Science and Technology*. 28 (3): 241-256.
15. **Rani, N., Lal, H. C., Kumar, P., Ekka, S. and Kumar, N. (2018).** *In vitro* evaluation of fungicides, bioagents and plant extracts against *Alternaria* sp. infecting pigeon pea. *International Journal of Current Microbiology and Applied Sciences*. Vol 7: 5112-5118.
16. **Rinaldi, S., Casorri, L., Masciarelli, E., Ficociello. B., Visconti, U., Papetti, P., Neri, U. and Beni, C. (2019)** prospect of using garlic extracts for pest control in sustainable agriculture. *Fresenius Environmental Bulleti.* 28 (2): 535-540.
17. **Sarangi, D. and Tiwari, S. (2023).** Estimation of disease intensity against Cercospora leaf spot of okra (*Abelmoschus esculentus* L.) moench through bio-control agents with chemical fungicides under Prayagraj condition of India. *International Journal of Environment and Climate Change*. 13 (11): 883-888.

18. **Shah, A. R., Bhavani, R. N. and Das, P. (2021).** Comparative efficacy of different fungicides against *Alternaria alternata* in potato and tomato crops. *Indian Journal of Plant Protection*. 49 (1): 47-50.

19. **Srinivasan, R. and Narayanan, S. (2020).** Evaluation of neem oil for the control of early blight (*Alternaria solani*) in tomatoes. *International Journal of Pest Management*. 66 (2): 98-105.

20. **Surekha, C. H., Neelapu, N. R. R., Kamala, G., Prasad, B. S. and Ganesh, P. S. (2013**). Efficacy of *Trichoderma viride* to induce disease resistance and antioxidant responses in legume *Vigna mungo* infested by *Fusarium oxysporum* and *Alternaria alternata*. *International Journal of Agricultural Science and Research*. 3 (2): 285-294.

21. **Thind, T. S. (2012).** Fungicide resistance in crop protection*: Risk and management*. CABI.

22. **Zade, S. B., Ingle, Y. V. and Ingle, R. W. (2018).** Evaluation of fungicides, botanicals and bioagents against *Alternaria alternata* incitant of leaf spot of soybean. *Journal of Pharmacognosy and Phytochemistry*. 7 (5): 1687-1690.