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Application of *Pseudomonas* sp. and Bio-Resources in Controlling Alternaria Leaf Spot Disease of Brinjal (*Solanum melongena* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. Author PJ conducted the research. Author SS guided and author PJ for smooth flow of research. Authors PJ, KP, BSM, PV examined and analyzed the results and author PJ edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

This study was conducted during the *Kharif* season 2022-2023 at the Central Research farm, Department of Plant Pathology, SHUATS, Allahabad, U.P to conclude the Application of *Pseudomonas* sp. and Bio-Resources in Controlling Alternaria leaf spot disease of brinjal (*Solanum melongena* L.). Seedling treatment with bioagent viz., *Pseudomonas* sp. at 0.25% and bio-

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resources applied as a foliar spray viz., Neem extract + Clove extract (5 + 5%), Neem oil + Clove oil(5+5%), Neem extract (10%), Clove extract(10%), Neem oil(0.2%), Clove oil(0.2%) and Bavistin(0.1%, treated check) for their effectiveness to manage Alternaria leaf spot of brinjal caused by *Alternaria alternata*. All the treatments were significantly reduced the severity of the disease and increased growth parameters. Among all the treatments *Pseudomonas* sp. + Neem extract + Clove extract (32.37%) was most effective followed by *Pseudomonas* sp. + Neem oil + Clove oil (34.39%) were significantly superior over other treatments in reducing the leaf spot infection of brinjal. The highest cost benefit ratio was obtained in the treatment *Pseudomonas* sp. + Neem extract + Clove extract (1:6.72). While other treatments also showed significant eff/efficacy to check the disease intensity (PDI) and yield over control in the field condition.

Keywords: Brinjal; Pseudomonas sp; seedling treatment; bioresources; foliar spray; Alternaria alternata.

1. INTRODUCTION

Brinjal or Eggplant (*Solanum melongena* L.) is an important vegetable crop grown in varied parts of the world and is the second major vegetable crop next to potato in India. It is considered as the "King of Vegetables". "It is a perennial, herbaceous, erect or semi-spreading plant that is usually grown as a seasonal crop in almost all the seasons" [1].

"Brinjal fruits are an excellent source of starch, proteins, minerals, vitamins, dietary fibers and low- fat content. It is one of the richest sources of antioxidants mainly ascorbic acid which has been reported to successfully suppress the development and growth of tumors, inhibit inflammation and cardiovascular diseases. The higher ascorbic acid content of the fruits not only helps in better r etention of colour and flavour but also affects fruit ripening and stress resistance" [2].

"Total production of Brinjal is about 32 million tonnes in the world where in India is world's second largest producer after China" [3]. "In India total brinjal cultivation area (730.4 ha), production (12800.8MT) and productivity (17.5 t/ha). Uttar Pradesh covered the cultivated area of 8.01 thousand hectares with an annual production of 275.40 thousand MT and productivity of 34.40MT per hectare and in Andhra Pradesh total cultivated area is 14.60 ha) and production (380.03 MT)" (Horticulture Statistics Division, 2018).

"Brinjal is also a popular vegetable in China, Japan, Egypt, Italy, USA, Syria, Philippines, Thailand, Indonesia, France and Turkey" [4]. The major brinjal producing states in India are Andhra Pradesh, Maharashtra, Karnataka, Orissa, Madhya Pradesh and West Bengal.

"The disease first makes its appearance in young seedlings. It attacks leaves and then spreads to fruits which subsequently rot and become unfit for consumption" [5,6]. "Genus *Alternaria* belongs to deuteromycetes having different species, which are destructive plant pathogen to the families such as Solanaceae, cucurbitaceae, brassicaceae. Species of the *Alternaria* genus are cosmopolitan, surviving both as saprophytes as well as weak parasites. In several cases, small dark-coloured spots are formed on tender twigs. *Alternaria* sp. is one of the most important and frequently occurring disease of the crop nation and worldwide. Alternaria leaf spot was a minor disease, but due to climatic changes, it emerged moderately to severe form. It was reported up to 25% yield losses due to leaf spot of brinjal" [7].

"Pseudomonas fluorescens @2.5% was found the most effective treatment which gave recorded minimum disease intensity (%) and yield (q/ha), as compared to other treatments" [8]. "It has been previously reported that the active ingredients of neem constitute mostly of titerpenoids, eg, Nimbin, Nimbicidine, Azadirachtin etc" [9]. **"**It has been concluded that *Azadirachta indica*, a common medicinal plant could be exploited as the source of a potent biocide that have immense fungi toxic effect to fungal pathogen. The anti-fungal action of garlic clove is due to the compound allicin. It has strong anti-microbial and anti-fungal activities. Thus, inhibition of fungi observed in this study may be related to allicin or ajoene which crubs the performance of some enzymes that are important to fungi" [10].

"Vermi-compost consistently promote biological activity which can cause plant to germinate, to

produce flower and yield better than in commercial containing media, independent of nutrient availability" [11].

Bio-agent and bio-resources belonging to various groups recommended for the management of Alternaria leaf spot of brinjal. Generally, farmers are using only the chemicals for managing the disease, but it has negative impact on the environment and causes resistance in the pathogen.

2. MATERIALS AND METHODS

The present investigation on "Application of *Pseudomonas* sp. and Bio-Resources in Controlling Alternaria leaf spot disease of brinjal (*Solanum melongena* L.)." an experiment was carried out at Central Research Field of Sam Higginbottom University of Agricultural, Technology and Sciences, Prayagraj during *kharif* season 2022-2023. Field experiment was laid out in Randomised block design with three replications. The materials and methods adopted during the studies are described here in this chapter.

2.1 Identification

The species identification was confirmed by National Fungal Culture Collection of India (NFFCI), Pune. And identified as *Alternaria alternata* (Fr.) Keissler.

The periphery of the colony was olive-green, with a black centre and dull white spots. The growth of the fungus was smooth. The conidiophores were short, arising singly. In shape, the conidia were obclavate but few were oval or pyriform with a rather short, broadly rounded base with 3-8 transverse septa and several longitudinal septa with variable size and shape.

2.2 Application of Treatments

Seedlings of brinjal are treated with *Pseudomonas* sp. in 1 lit of water for 30mins @ 2.5% Application of vermicompost before flowering @ 5 ton/ha and with some of neem and clove products namely, neem oil @ 0.2%, neem extract 10%, clove oil @ 0.2%, clove extract @ 10%, neem oil + clove oil @ 0.1%, neem extract + clove extract @ 5% + 5% and Bavistin @ 0.1% were sprayed as foliar spray. As the water and oil do not mix with each other, an emulsifier was used to mix them. An emulsifier creates even consistency between oils and water. Potassium silicate is a good oil emulsifier and is approved for organic use as a foliar spray. Potassium silicate @ 0.2gm was used for mixing oil and water. The subsequent spray was given at 15 days intervals.

Plate 1. Microscopic view of *Alternaria alternata* under 40x

2.3 Observations

Observations were recorded on plant height (cm), number of branches at 30, 60 and 90 DAT and percentage of disease intensity recorded at 60, 75, 90 DAT.

Disease severity was measured by using 0-5 scale with modification described by Jaima**n** et al. [6].

Disease intensity (%) =
(Sum of all disease ratings / Total number of rating × Maximum disease grade) x 100

2.4 Benefit Cost Ratio

Gross returns will be calculated by multiplying total yield with the market price of the produce. Cost of cultivation and cost of treatment imposition will be deducted from the gross returns, to find out net returns and cost benefit ratio by the following fobelow;

B:C = (Net returns / Total Cost of Cultivation)

Where,

B: C = Benefit Cost Ratio

List 1. Disease rating scale (Wheeler, [12])

Disease rating	Percent leaf area covered
0	Free from infection
1	One or two necrotic spots on few lower leaves of plant, covering nearly 1-10% surface area of plant.
2	A few isolated spots on leaves covering 11-25% surface area of plant.
3	Many spots coalesced on the leaves covering 26-50% of the surface area of the plant.
4	Concentric rings on the stem petiole, fruit covering 51-75% leaf area of plant.
5	Whole plant blighted leaf and fruits starting to fall coving more than 75% leaf area of the plant.

3. RESULTS AND DISCUSSION

The data presented in Table 1 and depicted in Fig. 1 reveals the response of selected treatments on Alternaria leaf spot disease intensity (%) of brinjal at 60, 75 and 90 DAT under field conditions.

Disease intensity (%) at 60, 75, 90 DAT was significantly reduced in the treatment T_6-Bavistin (11.08%, 22.34%, 32.66%) followed by T_7-*Pseudomonas* sp. + Neem extract + Clove extract (12.88, 22.53, 32.37) as compared to other treatments including control.

The data presented in Table 2 and depicted in Fig. 2 reveals the response of selected treatments on Alternaria leaf spot disease intensity (%) of brinjal at 60, 75 and 90 DAT under field conditions.

Table 1. Effect of selected treatments on *Alternaria alternata* disease intensity (%) of brinjal at 60, 75, 90 DAT

	Treatments	Disease intensity (%) Mean of three replications		
		60DAT	75 DAT	90 DAT
T0	Control	18.67	31.57	41.43
T1	*Pseudomonas* sp. + Neem oil @0.2%	15.20	27.38	37.56
T2	*Pseudomonas* sp. + Neem extract @10%	14.10	25.42	36.24
T3	*Pseudomonas* sp. + Clove oil @0.2%	17.45	28.44	39.42
T4	*Pseudomonas* sp. + Clove extract @10%	14.96	26.20	36.61
T5	*Pseudomonas* sp. + Neem oil @0.1%+ clove oil @0.1%	13.45	24.48	34.39
T6	Bavistin (treated check)	11.08	22.34	32.66
T7	*Pseudomonas* sp. + Neem extract @5%+ clove extract @5%	12.88	22.53	32.37
	CD(5%)	0.77	1.32	1.05
	SE d±	0.37	0.65	0.35
	CV	3.46	3.64	1.98

Table 2. Effect of treatments on yield (q/ha)

Treatments	Yield q/ha	Cost of yield Rs./q	Total cost of yield (Rs.)	Total cost cultivation (Rs.)	C:B ratio
T_0-Control	152.38	2000	304000	65400	1: 4.64
T_1-Neem oil	185.46	2000	370000	67380	1: 5.49
T_2-Neem extract	208.23	2000	416000	66400	1: 6.26
T_3-Clove oil	174.34	2000	348000	67650	1:5.14
T_4-Clove extract	198.56	2000	396000	67000	1;5.90
T_5-Neem oil + Clove oil	216.02	2000	432000	67600	1:6.39
T_6-Bavistin	233.00	2000	466000	66540	1;7.0
T_7-Neem extract+Clove Extract	225.03	2000	450000	66900	1:6.72

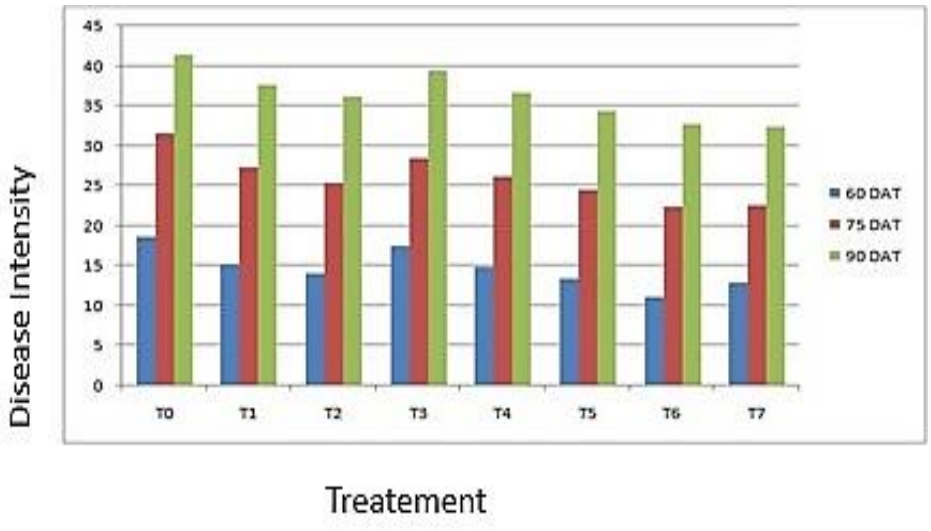

Fig. 1. Effect of treatments on Disease intensity (%)

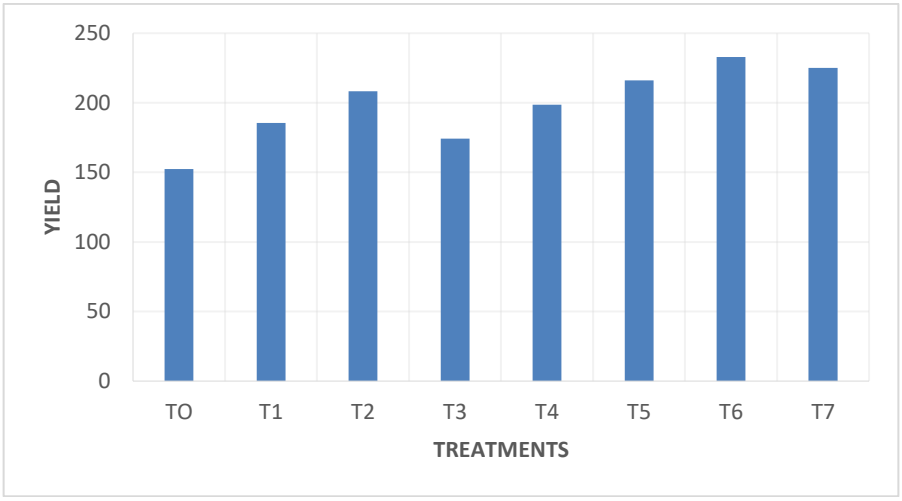

Fig. 2. Effect of treatments on Yield (q/ha)

Highest yield was obtained in the treatment T_6- Bavistin (236.16q/ha) followed by *Pseudomonas* sp. (229.16q/ha) as compared to other treatments including control.

4. CONCLUSION

Pseudomonas sp. + Neem extract + Clove extract applied as foliar spray thrice at 15 days interval against Alternaria leaf spot of brinjal significantly reduced disease intensity (%), increased plant height, number of branches, yield and highest benefit cost ratio. Results shows that all the treatments are statistically significant over control and *Pseudomonas* sp. + Neem extract + Clove extract was superior and significant in reduction percent of Alternaria leaf spot of brinjal as compared to control.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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