Effect of Plant Extracts against Alternaria Leaf Spot (*Alternaria alternata*) (Fr.) Keissler of chilli (*Capsicum annuum* L.)

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Abstract— *Chilli (Capsicum annuum L.) is one of the most important vegetables in the world, Alternaria leaf spot caused by Alternaria alternata is one of the major diseases of chilli worldwide. It is responsible for causing up to 10-15 % yield losses in chilli. An experiment was conducted using Nilgiri leaf extract, Lemon grass leaf extract, Neem leaf extract, Datura leaf extract and Lantana camara leaf extract and Mancozeb were tested against Alternaria leaf spot (Alternaria alternata) (Fr.) keissler under field condition during Rabi season 2023. Among all treatments, neem leaf extract@10%FS was found highly effective in showing the minimum disease intensity (%) with (18.51%) followed by nilgiri leaf extract @10%FS (20.07%). The maximum plant height (cm) (37.14cm) were found in neem leaf extract @10%FS followed by nilgiri leaf extract @10%FS (35.55cm) , highest number of leaves were found in neem leaf extract @10%FS with (41.66) followed by nilgiri leaf extract @10%FS (40.43) and highest yield (t/ha) of chilli were found in neem leaf extract@10%FS (3.78t/ha)followed by nilgiri leaf extract @10%FS (3.26t/ha) compared to untreated check and treated check (Mancozeb) @0.2%FS and C:B ratio is highest in neem leaf extract @10%FS(1:4.0) followed by nilgiri leaf extract @10%FS (1:3.4).*

Keywords— Alternaria alternata, Alternaria leaf spot, chilli, Disease intensity, Management.

I. INTRODUCTION

Chilli (*Capsicum annuum* L.) is well known for its aroma, pungency and medicinal value. It is a perennial herbaceous plant that belongs to the family Solanaceae having 2n = 24 chromosome number. Both vegetarian and non-vegetarian dishes considered chilli as the most important ingredient for its taste and flavour. According to a report published on Indiastat.com by Professor Jayashankar Telangana State Agricultural University (Agricultural Market Intelligence Centre) showing the area, production, and productivity of chilli in India (2020- 30th June 2021), so as per the report, the chilli covered 7.43 lakh ha area with 19.14 lakh tonnes production and productivity of 2576 kg/ha and for this reason it makes India the world's largest producer, consumer and exporter of chilli. According to Spice Board India report (2019-2020 Est.), chilli growing states in India with their production (lakh Tonnes) are: Andhra Pradesh (6.60 lakh tonnes), Telangana (3.28 lakh tonnes), Madhya Pradesh (2.18 lakh tonnes), Karnataka (1.80 lakh tonnes) and West Bengal (1.04 lakh tonnes) **(Goswami and Mishra, 2022).**

The important diseases are Anthracnose (*Colletotrichum capsici*), Cercospora leaf spot (*Cercospora capsici*), damping off and root rot (*Rhizoctonia solani*, *Pythium* sp., and *Fusarim* sp.), Fusarium wilt (*Fusarium oxysporum* f. sp. c*apsici*), gray mould (*Botrytis cinerea*), powdery mildew (*Leveillula taurica*) etc **(Vidhyasekaran and Thiagarajan 1981; Meon and Nick,1988; Pandey *et al*., 2012).**

Fungi, bacteria, viruses, nematodes and abiotic stress are the causal entities for this. Among fungal diseases, leaf spot caused by *Alternaria alternata* (Fr.) Keissler and *Cercospora capsici.* Heald and Wolf causing damage from seed to seed stage in

chilli. As foliar pathogen they are more severe compared to their seed-borne nature in many regions around the world. These pathogens will cause damage to crop from early stage itself. In later stages pathogens cause damage to fruits also, ultimately less yield and reduction in quality of the produce reported that 70-80 per cent chilli fields are affected with *Alternaria* sp. in Shouguang district. Among the major constraints in the production of chilli biotic factors plays an important role. Leaf spot disease caused by *Alternaria alternata* and *Cercospora capsici* were the very common biotic factors in almost all chilli growing areas around India **(Kumari and Zacharia, 2023).**

A pathogenic fungus is *Alternaria alternata.* Throughout the world Alternaria is caused disease in many plants. Symptoms of this disease is caused by *Alternaria* and development in 1997. *Alternaria* is a genus of Ascomycota fungi. Alternaria species are the leading plant pathogens causing diseases. The Genus *Alternaria* Nees. Ex Fr. Associate to the subdivision Deuteromycotina class Hyphomycetes, family Dematiaceae **(Woudenberg *et al*., 2013)**. The genus is spread all over the world and caused disease in crops **(Bochalya *et al*., 2012).**

Alternaria pathogen attacks on the aerial parts of host. Small circular, dark spots symptoms of Alternaria infections are produced. These spots size is ½ inch and are these spots are usually gray and black in color. Around the spots concentric rings are developed and pathogen growth rate is uniform due to environmental conditions. Lesion are developed on plants parts that appear in a specific pattern **(Spalding and King, 1999).** Spores are appeared on leaf surface of the infected plant. Effected area is covered by fungus spores. Pathogen directly penetrate into the host by stomata, wounds and other open cells. By spores and mycelia, pathogen is survived on host plant **(Anwar and Arshad, 2010).** *Alternaria* pathogen spreads by plant residues and infected seeds. If fungus is seed borne then should appear at seedling stage which is observed in case of *Alternaria*. Leaf spot is most destructive disease of chilli. Spores of this pathogen cause allergies and asthma symptoms in human **(Khan *et al*., 2014).**

Antifungal activity of plant extracts may be more effective than some commercial synthetic fungicides due to presence of naturally occurring substances in plants with anti- microbial properties that have been recognized and tested against a wide range of pathogenic microbes **(Tamuli, 2014)**. Therefore, it has become necessary to adopt ecofriendly management practices for better crop health management and yield. The systematic search of higher plants has shown that the plant extracts have antifungal activity against many species of fungi **(Guerin *et al*., 1984; Natarajan *et al*., 1987; Singh *et al.*, 1987)**. In recent years, plant extracts mainly, neem derivatives gaining importance for the control of plant diseases due to their antifungal and antibacterial properties **(Yin *et al*., 1998).**

Before management of leaf spot disease symptoms of the disease should be identified based on the reports of this pathogen. Usually, disease free seed is used for cultivation ad if there are chances of seed borne pathogens then it must be treated with suitable fungicide. Moisture on the plant surface favors the disease development while during wind there are less chances of disease due to lack of surface moisture. If we keep plant free of injuries and insect, there are very less chances of disease. Disease is reduced by the weed control and crop residue destruction. Incidence of some *Alternaria* species is reduced by the ultraviolet light exposure. Free pathogenic plant stock material should be used. There are number of fungicides which are used against *Alternaria*. Chlorothalonil, captan, fludioxonil, imazalil, iprodione, maneb, mancozeb, thiram, and selected copper. Leaf spot disease is also managed from bio-control, plants extract, and chemical management **(Narain *et al*., 2000).**

Fungicides are the most common tools for controlling the disease losses. In recent years, the indiscriminate use of fungicides is being observed. They are potentially hazardous to public health, environment and increases pollution and it remains in soil for long time. Nowadays an alternative attempt was made in controlling the plant disease management. The use of organic manures, soil amendments, and Plant extracts which are eco-friendly, non-phytotoxic, easy decomposition and does not affect human health. Considering the above-mentioned facts, a study entitled, **"Effect of plant extracts against alternaria leaf spot (*Alternaria alternata*) disease of chilli (*Capsicum annuum* L.)"** was proposed with the following objectives:

II. OBJECTIVES:

1) To evaluate the effect of treatments on disease intensity (%) of Alternaria leaf spot of chilli.
2) To evaluate the effect of treatments on plant growth parameters and yield (t/ha) of chilli.
3) To calculate the cost benefit ratio of treatments.

III. MATERIALS AND METHODS

The experiment was carried out at the Crop Research Farm, Department of Plant pathology, Sam Higginbottom University of Agriculture, Technology, and Sciences Prayagraj, (U.P). The present investigation entitled "**Effect of plant extracts against Alternaria leaf spot (*Alternaria alternata*) (Fr.) Keissler of chilli (*Capsicum annuum* L.)"** was carried out during the rabi season of 2023-2024.

3.1 Isolation of *Alternaria alternata* from collected samples:

In the laminar flow, diseased plant samples along with all the required apparatus such as media plates, distilled water, blade and scissor, were placed at the time of isolation. Tap water was used to wash the samples gently and then air dried properly. The infected leaves including some healthy plant portions of diseased samples was cut into small pieces of 1- 2cm. Surface sterilization of these samples was done by disinfecting them with 70 % Ethanol and then dipped them twice in autoclaved distilled water. After that, for the purpose of drying and soaking samples was blotted on sterilized filter paper. These disinfected samples then placed on nutrient media (PDA) containing Petri plates. Four to five samples were placed on each media plate at equal distance. Cultured plates were placed in an incubator at controlled temperature of 25-30 ºC for 5-7 days so that further growth of fungi occurs in plates. In this way *Alternaria* fungus colonies will be recovered properly **(Maheshwari *et al*., 1999).**

3.2 Preparation of plant extracts:

Fresh plant extract was prepared by grinding the required quantity of leaves (100g) before grinding equal quantity of water was added in the respective plant leaves (1:1 weight/ volume basis). The crude Extract of botanicals was filtered different leaves was sieved through muslin cloth. Then spray the extract to the given plots along with different treatments **(Sasode *et al*., 2012).**

3.3 Identification of pathogen:

Symptoms: The symptoms of these disease appear on leaves, twigs and fruits. The infection on leaf first revealed as dark specks of pin point size scattered over the leaf surface, which slowly enlarge and becomes smoky black colour. The concentric rings are visible in center of the spot. In severe form, spots also seen on twigs and fruits **(Nafade, and Dattatray, 1969).**

Morphology: Conidiophores were short to long, simple or branched, erect simple cylindrical, golden to brown coloured with 2-9 transverses and 0-2 longitudinal septa. Conidia were borne in long chains, they were thick walled, straight or curved body of conidium ellipsoidal tapering to the beaked and brown in colour. With the above characteristics, the pathogen was identified as *Alternaria alternata* in accordance to the report of **Ellis (1971).**

3.4 Recording Disease intensity (%):

After germination, five plants per treatment per replication were randomly selected. Regularly watched for first appearance of disease. The observation on disease intensity was recorded using a progressive 0- 9 scale, as showed in (Table 1 and Plate 1). Numerical rating grade was given on the basis of percentage of area infected by pathogen on the leaves as described below: **Kumari and Zacharia (2023).**

TABLE 1
Disease rating scale

Grade	Reaction	Description
0	Immune	No infection
1	Highly resistant	1 or less than 1% leaf area damage
3	Resistant	1 to 10% leaf area damage
5	Moderately resistant	11 to 25% leaf area damage
7	Susceptible	26 to 50% leaf area damage
9	Highly susceptible	50 or more than 50% leaf area damage

PLATE 1: Disease rating scale

3.5 Economics Analysis:

Cost of cultivation, gross return, net return and benefit cost ratio was worked out to evaluate the economics of each treatment, based on the existing market prices of input and output.

3.5.1 Cost of cultivation (ha^{-1}):

The cost of cultivation for each treatment was work out separately, taking into consideration all the cultural practices followed and costs of inputs used in the cultivation.

3.5.2 Gross return (ha^{-1}):

The gross return from each treatment was calculated by using the following formula: Gross return (ha^{-1}) = Yield (q/ha) × Price (Rs./q).

3.5.3 Net return (ha^{-1}):

The net profit from each treatment was calculated separately by using the following formula: Net return = Gross return (ha^{-1}) – Cost of cultivation (ha^{-1}).

3.5.4 Cost benefit ratio:

The cost benefit ratio was calculated by using the following formula:

Cost benefit ratio = Net return (ha^{-1}) / Total cost of cultivation (ha^{-1})

3.6 Statistical Analysis:

The data obtained were statistically analyzed by the methods suggested by **Fisher and Yates (1986)**. The standard error and critical difference (C. D.) was calculated at 5% level of significance for comparing treatment means.

IV. RESULTS AND DISCUSSION

Under field conditions, three sprays of all the treatments were taken up at 45, 60 and 75 DAT. The results are presented on Table 2 and Figs. 1,2.

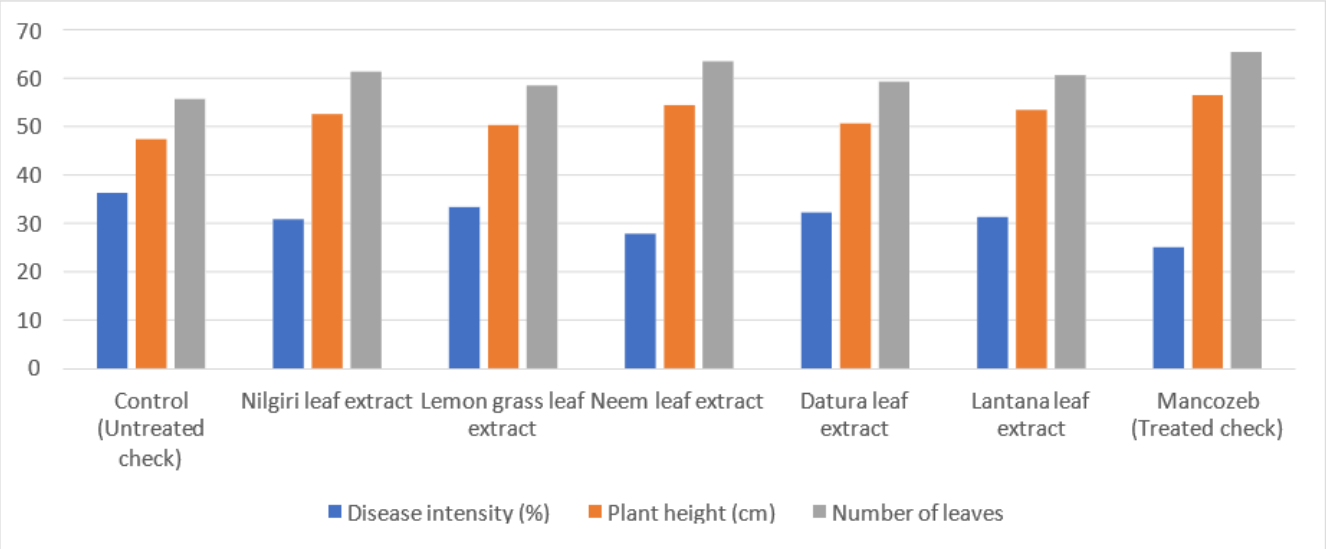

FIGURE 1: Effect of treatments on disease intensity (%) of Alternaria leaf spot, Plant height (cm) and Number of leaves of chilli

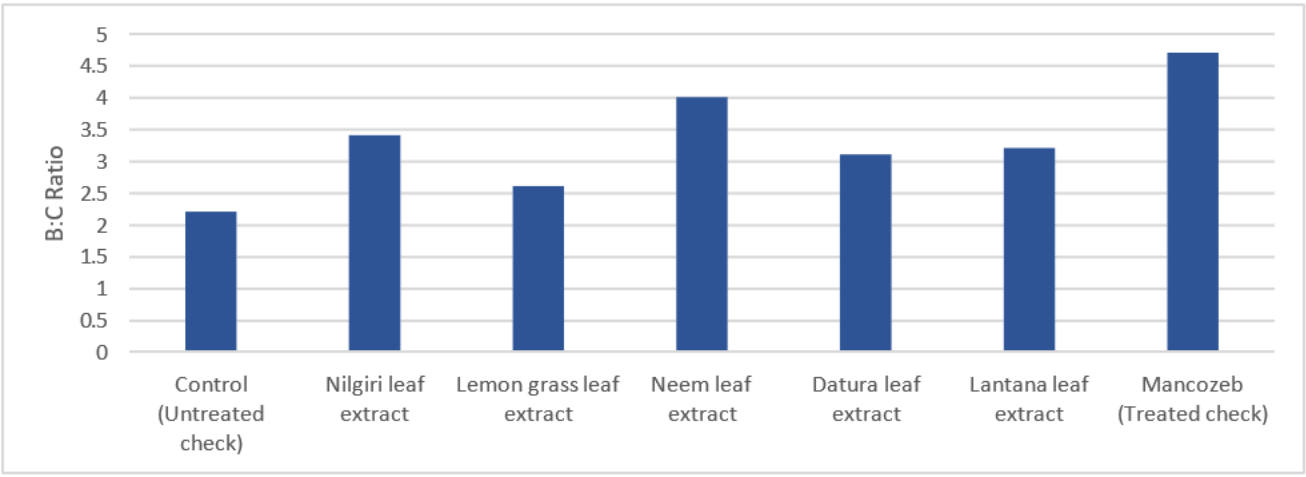

FIGURE 2: Effect of treatments on cost benefit ratio of chilli

TABLE 2
Effect of treatments on disease intensity (%) against Alternaria leaf spot, Plant height (cm) and Number of leaves of chilli

Treatment number	Treatments	Dosage	Disease intensity (%)	Plant height (cm)	Number of leaves	Cost benefit ratio
T_0	Control (Untreated check)	-	36.23^{a}	47.29^{f}	55.50^{f}	1:2.2
T_1	Nilgiri leaf extract	10%FS	30.78^{d}	52.46^{d}	61.18^{c}	1:3.4
T_2	Lemon grass leaf extract	10%FS	33.36^{b}	50.21^{e}	58.29^{e}	1:2.6
T_3	Neem leaf extract	10%FS	27.82^{e}	54.35^{b}	63.26^{b}	1:4.0
T_4	Datura leaf extract	10%FS	32.23^{c}	50.57^{e}	59.13^{de}	1:3.1
T_5	Lantana leaf extract	10%FS	31.29^{c}	53.36^{c}	60.43^{cd}	1:3.2
T_6	Mancozeb (Treated check)	0.20%FS	25.01^{f}	56.41^{a}	65.25^{a}	1:4.7
	CD @ (5%)		0.661	0.46	1.384	

4.1 Disease Intensity (%) of Alternaria Leaf Spot of chilli:

Data recorded in table 2 and Figure 1 showed that the efficacy studies for the management of Alternaria leaf spot of chilli. The data revealed that all the treatments were significantly superior to T_0 (untreated check) in reducing disease severity . The minimum percent disease incident (%) was recorded in T_3- neem leaf extract (27.82%) followed by T_1- nilgiri leaf extract (30.78%) followed by T_5- lantana leaf extract (31.29%) followed by T_4- datura leaf extract (32.23%) followed by T_2- lemon grass leaf extract (33.36%) as compared to T_0 (Untreated check)- control (36.23%) and T6 (Treated check)-mancozeb (25.01%).

Comparing C.D values (0.66) - (T_4 and T_5) were found to be non-significant to each other (T_2, T_1 and T_3) were found to be significant to each other as compared to T_6 (Treated check) and T_0 (Untreated check).

4.2 Plant height (cm):

The data represented in table 2 revealed that the plant height (cm) of chilli was significantly in T3- neem leaf extract (54.35 cm) followed by T_1- nilgiri leaf extract (52.46 cm), T_5- lantana leaf extract (53.36cm), T_4- datura leaf extract (50.57 cm) ,T_2- lemon grass leaf extract (52.46 cm) as compared to T_0(untreated check)- control (47.29 cm) and T_6 (Treated check)- mancozeb (56.41 cm).

Comparing C.D values (0.469) - (T_4 and T_2) were found to be non- significant to each other, (T_3, T_1 and T_5) were found to be significant to each other as compared to T_6 (Treated check) and T_0 (Untreated check).

4.3 Number of Leaves:

The data represented in the table 2 revealed that the number of leaves of chilli was significantly increased in T3- neem leaf extract (63.26) followed by T_1- nilgiri leaf extract (61.18), T_5- *lantana camara* leaf extract (60.43), T_4- datura leaf extract (59.13),T_2- lemon grass leaf extract (58.29) as compared to T_0 (Untreated check)- control (55.50) and T_6 (Treated check)- mancozeb (65.25).

Comparing CD values (1.38) - (T_1 and T_5) and (T_4 and T_2) are found non-significant to each other and (T_3) were found to be significant as compared to T_6 (Treated check) and T_0 (Untreated check).

4.4 C:B Ratio on chilli:

Observations recording the economics of treatments are shown in table high gross return value (Rs3,97,250) recorded in T_3 – neem leaf extract, highest Net return value (Rs2,98,605) recorded in T_3 – neem leaf extract and highest C:B ratio (**1:4.0**) recorded in T_3 – neem leaf extract. Lowest gross return value (Rs2,65,300) and lowest net return value (Rs1,66,655) and lowest C:B ratio (**1:2.6**) recorded in T_2- Lemon grass leaf extract as compared to T_0- control (untreated check) and T_6-Mnacozeb (Treated check).

4.5 Discussion:

As per the present study explores the possibilities of *Alternaria alternata* by using neem leaf extract was found effective in decreasing the disease intensity (%), increasing plant height (cm) and number of leaves. The probable reason for this result may be due to the antifungal activity of *Azadirachta indica* (neem), the presence of different types of tetras terpenoids and phenolis, by this neem may indirectly influence the plant growth. Similar findings, were reported by **Amadioha (2000), Hassanein *et al*. (2008)**, **Jabeen *et al.* (2013), Raza *et al*. (2016**), who tested the effectiveness of different plant extracts against *Alternaria alternata* and found that neem exhibited the most potent inhibition of the pathogen leading to its superiority in all plant parameters including the plant height. But among all the treatments T_6-Mancozeb (Treated check) show the maximum growth of plant. It produces some toxic chemical residues, that may have potential harmful effect to non- targeted organisms. So, considering the ecosystem the plant extracts inhibit the pathogen, the effect may have contributed to holistic well-being of plants, consequently resulting in minimum disease intensity (%), maximum plant height (cm) and number of leaves.

V. CONCLUSION

Neem leaf extract @10% concentration as foliar spray was most effective against Alternaria leaf spot of chilli which causes *Alternaria alternata* in chilli resulted minimum disease intensity (%), Plant height (cm), number of leaves , yield (t/ha) of chilli and C:B ratio . Results of the present study are of one crop season (December 2023 to April 2024) under prayagraj agroclimatic conditions as such to validate the findings more such trials should carried out in future.

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