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ECO-FRIENDLY STRATEGIES FOR THE MANAGEMENT OF CERCOSPORA LEAF SPOT IN GROUNDNUT (*ARACHIS HYPOGAEA* L.)

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ABSTRACT

Groundnut is an important oilseed crop in India. It is a multipurpose and highly nutritious crop containing oil, food and its foliage or haulm provides a valuable fodder for livestock. Globally India ranks first in groundnut acreage and second in production. This crop suffers from various diseases, among them Cercospora leaf spot disease caused by *Cercospora arachidicola* and *Cercospora personatum* causes huge losses in India and abroad. Effects of treatments were evaluated on the disease intensity (%) of groundnut under field conditions. Among the treatments the disease intensity (%) at 45, 60 and 90 Days After Sowing recorded minimum in treatment T_4 – Seed treatment with *Pseudomonas fluorescens* + Foliar Spray with neem oil (12.54%), (18.06%) and (21.44%), followed by treatment T_1 – Seed treatment with *Pseudomonas fluorescens* @5g/kg of seed + Foliar Spray with Clove oil @1% (16.87%), (21.55%) and (24.48%), least disease intensity in treatment T_3- Foliar Spray with *P. fluorescens* @5% (20.28%), (26.56%) and (29.20%).

Keywords **:** *Cercospora arachidicola, Cercospora personatum,* cercospora leaf spot, essential oils, groundnut, neem oil, *pseudomonas fluorescens*.

Introduction

Groundnut (*Arachis hypogaea* L.) is a vital oilseed crop around the world. With a chromosome number of 2n=40, it stands out among legumes for its versatility and nutrition. It's not only a key source of oil and protein but also produces carbohydrate-rich seeds and valuable foliage that serves as livestock fodder. Typically, groundnuts contain approximately 48% oil, 22–25% protein, 20% carbohydrate, along with about 5% fiber and ash, and are rich in vitamins B and E. They rank as the 13th most significant food crop globally.

India cultivates the largest area of groundnut in the world, while China takes the lead in production volume. During the 2020–21 period, global production reached approximately 54 million tonnes, with China producing around 18.4 million tonnes (about 34%), India 10.2 million tonnes (19%), Nigeria 0.46 million tonnes (9%), the USA 2.9 million tonnes (5%), and Sudan 2.36 million tonnes (4%) (www.apeda.gov.in)

In India's arid and semi-arid regions particularly Eastern Uttar Pradesh and Bundelkhand groundnut is mostly grown as a rainfed kharif crop. Among its fungal diseases, Cercospora leaf spot is the most prevalent, appearing in early (ELS, caused by *Cercospora arachidicola*) and late (LLS, caused by *Cercospora personatum*) (Kumar *et al*., 2017). Symptoms typically appear when plants are 1–2 months old. ELS lesions are irregular, 1–10 mm in size, dark reddish-brown to black on the upper leaf surface, often surrounded by a yellow halo, and lighter

on the lower side. LLS lesions are smaller and more circular (1–6 mm), appearing darker without the yellow halo. LLS tends to be more widespread and damaging, often persisting throughout the crop cycle (Ramesh *et al.*, 2017).

These leaf-spot diseases, along with others like root rot, stem rot, wilts, blight, and seed rots, can severely harm groundnut crops. Cercospora leaf spots alone can reduce yields by up to 50% or more, mainly by causing defoliation, reducing photosynthesis, and leading to fewer and poorer-quality pods (Aslam *et al*., 2018). Losses worsen if the crop isn't treated with fungicides or biocontrol agents, and when combined with rust caused by *Puccinia arachidis*, yield losses can plummet to 70% (Pooniya *et al*., 2020).Overall, early and late leaf spots are among the most damaging diseases affecting groundnut globally, responsible for annual yield losses ranging from 15% to 50% (Wu *et al.,* 1999 and Maninderpal, 2011).

Materials and Methods

Experimental site

Field experiment was laid-out in Randomized block design with three replications and six treatments at Central research field of the Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, India during the *Kharif* season of 2023. Research field is situated at 25°27'North latitude 80°50' East longitudes and at an altitude of 98 meter above sea level. The climate is typically semi-arid and sub-tropical. The maximum temperature reaches up to 48°C in summer and drops down to 2.5°C in winter. The site selected was uniform, cultivable with typical sandy loam soil having good drainage. The Prayagraj region has sub-tropical and semi-arid climate with the monsoon commencing from July and with drawing by the end of September. The temperature goes up to 48° C during summers and goes down up to 3-5°C in winter.

Field preparation

Field was prepared by ploughing, removing the plant debris and stubbles of the previous crop during *Kharif* season 2023. The total given area was divided into sub-plots with irrigation channel according to the statistical design.

Table 1 : Details of Treatments

S. No.	Treatment No.	Treatment Name
1.	T_0	Control (Untreated)
2.	T_1	Seed treatment with *Pseudomonas fluorescens* @ 5gm/kg seed + Clove oil spray @ 1%
3.	T_2	Seed treatment with *P. fluorescens* @ 5gm/kg seed + Eucalyptus oil spray @ 1%
4.	T_3	*P. fluorescens* foliar spray @5%
5.	T_4	Seed treatment with *P. fluorescens* @ 5gm/kg seed + Neem oil spray @ 1%
6	T_5	Seed treatment with carbendazim (12%) + mancozeb (63% WP) @ 2gm/kg seed (check)

Application of bio-agent

Pseudononas fluorescens was used for seed treatment applied @ 5g/kg of seeds.

Application of fungicide

Sparsh (Carbendazim 12% + Mancozeb 63%) manufactured by India chemicals and fertilizers, Muzaffarnagar, Uttar Pradesh was used for seed treatment applied @ 2g/kg of seed.

Spraying of essential oils

A foliar spray was prepared using:

- **Neem oil** at 4 ml/L
- **Eucalyptus oil** at 1 ml/L
- **Clove oil** at 1 ml/L
- **Water** to make up the volume
- **Liquid soap** added as an emulsifier to help the oils mix with water

This mixture was applied three times through foliar spraying at the following crop growth stages: 45, 60, and 75 days after sowing.

Table 2 : Applications of foliar spray:

S. No.	Number of applications	Date of application
1	Disease appeared on 30 DAS and first application was done after 15 days of disease appearance	25th September 2023
2	After 15 days of first application second application was done	10th October 2023
3	After 15 days of second application third application was done	25th October 2023

Identification of the Pathogen

Collection of disease sample:

Plants showing typical symptoms in the field, that is identified as infected plant part of groundnut. The disease materials were brought to the lab for further investigation.

Symptoms:

Cercospora leaf spots begin to appear in one to two months old plants. Early leaf spot are sub-circular to irregular, 1 to 10 mm diameter. Lesions are commonly dark (reddish) brown to black on the upper surface and light brown on the lower leaf surface. Leaf spot on upper surface is commonly surrounded by a yellow chlorotic halo (Amol, 2017).

Plate 1: Symptoms on leaves

Identification of the fungus by slide preparation:

A small piece of the infected leaf was gently picked up with a sterile needle and placed onto a clean glass slide, taking care to avoid any contamination. A drop of lactophenol mixed with cotton blue stain was added to help highlight the fungal structures. The sample was then gently covered with a cover slip. After preparation, the slide was observed under a compound microscope to study the shape and structure of the fungi present.

It consists of both external and internal hyphae. The internal hyphae are both intercellular and intracellular. The haustoria are absent. Asexual reproduction takes place by means of long, cylindrical, hyaline and multiseptate conidia. Conidiophores are dark, straight to slightly curved, produced in acropetal succession from short sympodially extending dark conidiophores. Conidiophores arise in tufts form a stroma lying in a sub stomata cavity and emerge by rupturing the overlying epidermis. The conidiophores are geniculate (knee joint like) and 1-2septate Hori, (1911).

Plate 2: Identification of fungus under the compound microscope

Disease intensity

Disease intensity was recorded in five randomly selected plants tagging in each plot at 45, 60 and 75 days after sowing, disease intensity was observed as per the scale of Mayee and Datar (1986).

Table 3 : Disease intensity scale (Mayee and Datar, 1986)

Rating	Leaf covered area
0	No symptoms on leaf
1	Few small necrotic spots covering 1% or less of leaf area
3	Few small necrotic spots covering 1-5% or less of leaf area
5	Spots coalescing enlarging 6-20% of the leaf area
7	Spot enlarging, coalescing to cover 21-50% of the compound of leaf area
9	Spot enlarging, coalescing to cover 51% or more of the leaf area

$$\text{Disease Intensity (\%)} = \frac{\text{Sum of all disease ratings}}{\text{Total number of leaves observed} \times \text{Maximum disease grade}} \times 100$$

(Wheeler, 1969)

Results and Discussion

Effect of treatments on Plant disease intensity at 45, 60 and 75 DAS

At 45 Days after sowing data presented below in Table 4 and figure 1 reveal that the disease intensity (%) of groundnut significantly decreased in T_4 – *Pseudomonas fluorescens* @ 5gm + neem oil @ 1% (12.54%) followed by T_1 _ *P. fluorescens* @ 5gm + clove oil @ 1% (16.87%), T_2 – *P. fluorescens* @ 5gm + eucalyptus oil @ 1% (17.48%) and was observed in T_3 – *P. fluorescens* @ 5% (20.28%) as compared to T_5 – treated check (10.68%) and T_0 – control (30.45%).

All the treatments are significant over control. Among the treatments T_3, T_4 and T_5 were statistically significant with each other, however treatment (T_1 and T_2) were non-significant with each other.

At 60 Days after sowing data presented below in Table 4 and figure 1 reveal that the disease intensity (%) of groundnut significantly decreased in T_4 – *Pseudomonas fluorescens* @ 5gm + neem oil @ 1% (18.06%) followed by T_1 - *P. fluorescens* @ 5gm + clove oil @ 1% (21.55%), T_2 – *P. fluorescens* @ 5gm + eucalyptus oil @ 1% (23.77%) and was observed in T_3 – *P. fluorescens* @ 5% (26.56%) as compared to T_5 – treated check (14.66%) and T_0 - control (37.80%).

All the treatments are significant over control. Among the treatments T_1, T_2, T_3, T_4 and T_5 were statistically significant with each other.

At 75 Days after sowing data presented below in Table 4 and figure 1 reveal that the disease intensity (%) of groundnut significantly decreased in T_4 – *Pseudomonas fluorescens* @ 5gm + neem oil @ 1% (21.44%) followed by T_1 _ *P. fluorescens* @ 5gm + clove oil @ 1% (24.48%), T_2 – *P. fluorescens* @ 5gm + eucalyptus oil @ 1% (26.69%) and was observed in T_3 – *P. fluorescens* @ 5% (29.20%) as compared to T_5 – treated check (17.74%) and T_0 – control (47.71%).

All the treatments are significant over control. Among the treatments T_1, T_2, T_3, T_4 and T_5 were statistically significant with each other.

In the present study, significant results were obtained with the treatment T_4 – *Pseudomonas fluorescens* @ 5gm + neem oil @ 1%. The severity of the disease was noticeably reduced at 45, 60, and 75 days after sowing when this treatment was used. This improvement is likely due to the beneficial effects of *Pseudomonas fluorescens*, which supports plant health by fixing nitrogen, making phosphorus more available, chelating iron, producing growth-promoting hormones, and enhancing the plant's natural disease resistance. Additionally, neem oil played a key role, as it contains powerful compounds like azadirachtin, salanin, meliantriol, and nimbin—known for their antifungal and insect-repelling properties. Constituents such as Nimbin, Nimbidín, Nimbolide, and Limonoids enhance disease resistance. The current finding are consistent with the research conducted by Faisal and Tiwari (2015), Kumar *et al.* (2017), Senapati *et al.* (2017), Ramesh and Zacharia (2017), Mahmoud *et al.* (2021) and Patel *et al.* (2025), who tested the effectiveness of different essential oils and bio-agents against Cercospora leaf spot and found that *P. fluorescens* and neem oil exhibited the most potent inhibition of the pathogen leading to its superiority in all parameters including the disease resistance. But among all the treatments (treated check) has shown the highest disease resistance with strong fungicidal effect against pathogen. In order to reduce the pathogen, it may produce some toxic chemical residues, they may have potential harmful effects to non-targeted organism. Taking the entire ecosystem into account, the combined use of *P. fluorescens* and neem oil likely played a key role in suppressing the disease-causing pathogen. This combined effect not only helped control the infection but also supported the overall health and resilience of the plants. As a result, there was a noticeable reduction in disease severity.

Table 4: Effect of treatments on Plant disease intensity at 45, 60 and 75 Days after Sowing

Tr. No.	Treatments	Disease intensity (%)		
		45 DAS	60 DAS	75 DAS
T_0	Control	30.45	37.80	47.71
T_1	*Pseudomonas fluorescens* (ST) @5g/kg of seed +Clove oil (FS) @1%	16.87[a]	21.55	24.48
T_2	*P. fluorescens* (ST) @5g/kg of seed + Eucalyptus oil (FS) @1%	17.48[a]	23.77	26.69
T_3	*P. fluorescens* (FS) @5%	20.28	26.56	29.20
T_4	*P. fluorescens* (ST) @5g/kg of seed + Neem oil (FS) @1%	12.54	18.06	21.44
T_5	Carbendazim(12%) + Mancozeb (63%) (ST) @2g/kg of seed (treated check)	10.68	14.66	17.74
S.Ed. (±)		0.60	0.48	0.36
C.D. (5%)		1.27	1.02	0.76

DAS- Days after Sowing

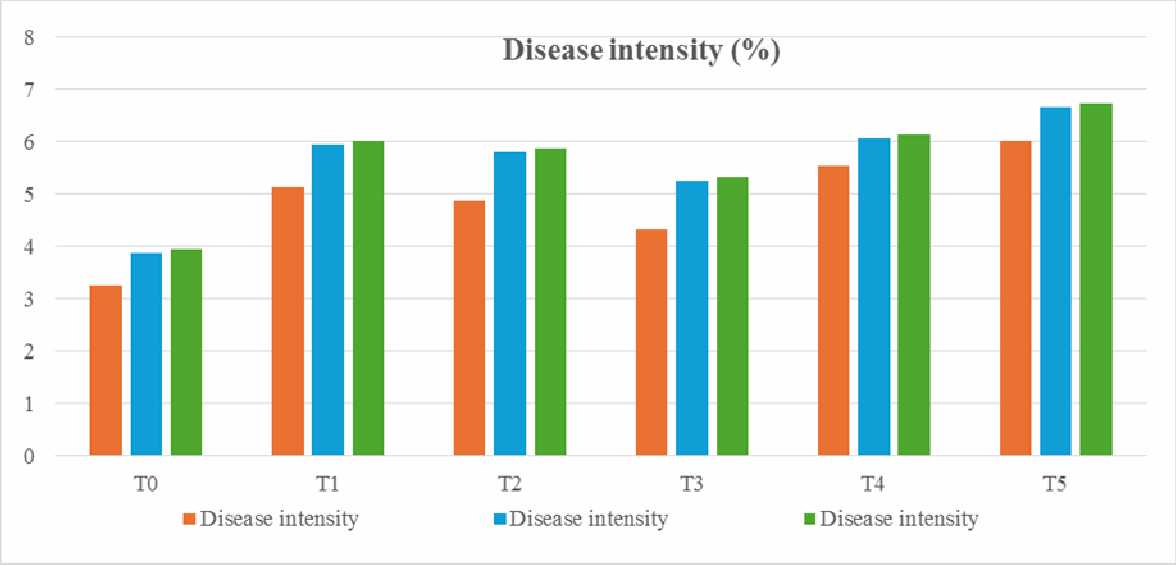

Fig. 1: Effect of treatments on Plant disease intensity at 45, 60 and 75 DAS

Conclusion

In the present study based on the observations in the field condition results concluded that treatment having *Pseudomonas fluorescens* + Neem oil was found most significant in managing the disease of Cercospora leaf spot of groundnut. As the human population is heading towards the organically produced and organically managed agriculture products, so it is concluded that the above findings will be useful for safe and environment friendly future. The results of this experiment showed promising effectiveness under the agro-climatic conditions of Prayagraj. However, to confirm and strengthen these findings, it is recommended that similar trials be conducted in the future across different locations and seasons.

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Authors Contribution

BK planning of study, review and editing of manuscript. SZ Conceptualization of idea and Head of Department and supervision of the study. DK, BS and PSH Conceptualization of idea and writing the original draft of manuscript and collection of review of literature and compilation. SS and ASB review and editing of manuscript and correction as per suggestion from reviewer and editor.

Conflict of Interest

The authors declare that there is no conflict of interest.

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