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Yashika Srivastava
M.Sc. (Agri.), Department of Plant Pathology, Naini Agricultural Institute, (Formerly Allahabad Agricultural Institute), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Prayagraj, Uttar Pradesh, India

Abhilasha A Lal
Professor, Department of Plant Pathology, Naini Agricultural Institute, (Formerly Allahabad Agricultural Institute), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Yashika Srivastava
M.Sc. (Agri.), Department of Plant Pathology, Naini Agricultural Institute, (Formerly Allahabad Agricultural Institute), Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Prayagraj, Uttar Pradesh, India

Effect of botanicals and carbendazim against anthracnose (*Colletotrichum lindemuthianum*) of green gram (*Vigna radiata* L.)

Yashika Srivastava and Abhilasha A Lal

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Abstract
A research trial was carried out during *Kharif* season of 2023 at the Central Research Field, Department of Plant Pathology, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh. The experiment was conducted to evaluate the effect of different botanicals and fungicide on anthracnose of green gram caused by *Colletotrichum lindemuthianum*. The trial was conducted using seven treatments viz. T_1- Carbendazim @ 2 g/kg seed (S.T.) + Neem oil @ 0.2% (F.S.), T_2- Carbendazim @ 2 g/kg seed (S.T) + Eucalyptus oil @ 0.2% (F.S), T_3- Carbendazim @ 2 g/kg seed (S.T) + Tea tree oil @ 0.2% (F.S), T_4- Carbendazim @ 2 g/kg seed (S.T) + Lavender oil @ 0.2% (F.S), T_5- Carbendazim @ 2 g/kg seed (S.T) + Thyme oil @ 0.2% (F.S), T_6- Carbendazim @ 2 g/kg seed (S.T) + @ 0.1% (F.S.) and T_0- Control with each treatment replicating three times. It was observed that all treatments significantly reduced the intensity of disease of green gram as compared to T_0- Control. From the study of results, it was concluded that among all the treatments, the most effective for managing the disease was T_1- Carbendazim + Neem oil (26.62%) followed by T_2- Carbendazim + Eucalyptus oil (30.49), T_4- Carbendazim + Lavender oil (35.37), T_3- Carbendazim + Tea tree oil (38.10) and T_5- Carbendazim + Thyme oil (39.97) as compared to treated check T_6- Carbendazim (S.T) + Carbendazim (F.S.) (20.03%) and non-treated check T_0- Control (41.77%).

Keywords: Anthracnose, botanicals, *Colletotrichum lindemuthianum*, fungicide

Introduction

Green gram (*Vigna radiata* L.) commonly known as mung bean, belonging to the family Fabaceae is an important pulse crop of India cultivated mainly in *Kharif* season. It has originated in South Mexico and Central America [11]. The crop is one of the third most important pulse crop of India after chickpea and pigeon pea. It is quite versatile crop grown for seeds, green gram manure and forage and it is also considered as "Golden Bean". It contains about 25 to 28% protein, 1 to 1.5% oil, 3.5 to 4.5% fibre, 62 to 65% carbohydrate [8]. The crop is grown for its green pods while dry seeds are used in various food preparations [5].

This crop has become third most important food legume after soybean and peanut in production and is also the most utilized crop for direct consumption in the world. The average production of mung bean is globally split between India and Myanmar. China, Indonesia, Thailand, Kenya, and Tanzania are other significant producers [9].

Mung bean production in India was 5.5 million hectares in 2022 and yield 3.17 million tonnes at a productivity of 570 kg/ha. The mung bean alone accounts for 10% of production and 16% of area for all pulses. The dominant contributors to mung bean cultivation in terms of area and production are Rajasthan (46% and 45% respectively), with Madhya Pradesh (9% and 14%), Maharashtra (9% and 8%), Karnataka (9% and 6%), Odisha (5% and 4%), Bihar (4% and 5%), Tamil Nadu (4% and 3%), Gujarat (3% and 4%), Andhra Pradesh (3% for both), and Telangana (2% for both) also playing significant roles, as stated in the Annual Report (2022-23) by AICRPR on *kharif* pulses [3].

The crop suffers from many diseases caused by fungi, bacteria, viruses, nematodes and abiotic stresses [2]. Generally, in green gram, powdery mildew, blight, root rot, anthracnose, leaf spot, rust, dry root rot, mung bean yellow mosaic disease, leaf crinkle disease, leaf curl, ascochyta leaf spot and bacterial blight diseases are found. Anthracnose (*Colletotrichum lindemuthianum*), the most economically significant of all diseases [4].

The first case of the anthracnose on green gram in India was discovered in 1951 in Jorhat, Assam [6]. Anthracnose disease in green gram is caused by multiple species of the fungus *Colletotrichum* sp. and severity of disease depends on the weather conditions and reduces green gram yield notably [7]. The average grain yield loss of 39.98% and stalk yield loss of 47.19% is due to anthracnose [5].

Materials and Methods

The field investigations were carried out at the Central Research Field of the Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) during *Kharif*, 2023. The seeds were sown in August, 2023 maintaining a distance of 45 cm row to row and 10 cm plant to plant.

Isolation of pathogen

Diseased leaves were first collected from infected plants and thoroughly washed under running tap water. The diseased portion of the leaves were then cut into small bits and surface sterilized with 1% NaOCl solution for 1 minute followed by washing three times with sterile distilled water and placed on media. The petri plates were wrapped and incubated at 27±2 °C in an incubator. To avoid bacterial contamination streptomycin @ 100 ppm, was added to the media at lukewarm stage before pouring PDA into petri plates. Hyphal tip method was used for subculturing the fungus in media slants/petri plates. To obtain pure culture of fungus, single spore technique was used [10].

Identification of pathogen

Morphological studies of the pathogen were conducted from infected leaf by placing the half-infected portion and healthy portion on a slide, later stained using lactophenol and cotton blue and morphological characters were noted with help of microscope. Using a sterile needle, a small portion of the culture is taken and placed on a sterile glass slide, stained using lactophenol and cotton blue. Then the microscope is used for the examination of morphology and culture characteristics of fungi [1].

Symptoms

The symptom can be observed in all aerial parts of the plants and at any stage of crop growth. The fungus produces dark brown to black sunken lesions on the hypocotyl area and cause death of the seedlings. Small angular brown lesions appear on leaves, mostly adjacent to veins, which later become greyish white centre with dark brown or reddish margin. The lesions may be seen on the petioles and stem. The prominent symptom is seen on the pods. Minute water-soaked lesion appears on the pods initially and becomes brown and enlarges to form circular, depressed spot with dark centre with bright red or yellow margin. Several spots join to cause necrotic areas with acervuli. The infected pods have discoloured seeds [4].

In order to assess the effect of various treatment, seven treatments applied *viz*. T_1- Carbendazim @ 2 g/kg seed (S.T.) + Neem oil @ 0.2% (F.S.), T_2- Carbendazim @ 2 g/kg seed (S.T) + Eucalyptus oil @ 0.2% (F.S), T_3- Carbendazim @ 2 g/kg seed (S.T) + Tea tree oil @ 0.2% (F.S), T_4- Carbendazim @ 2 g/kg seed (S.T) + Lavender oil @ 0.2% (F.S), T_5- Carbendazim @ 2 g/kg seed (S.T) + Thyme oil @ 0.2% (F.S), T_6- Carbendazim @ 2 g/kg seed (S.T) + @ 0.1% (F.S.) and T_0- Control with each treatment replicating three times to manage the disease of green gram.

Disease intensity (%) at 30, 45 and 60 days after incidence of anthracnose was recorded under field condition.

Percent disease index was calculated by using the following formula [12].

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of individual ratings}}{\text{Total number of ratings} \times \text{Maximum disease grade}} \times 100$$

Results and Discussion

Effects of botanicals and carbendazim were assessed on plant disease intensity of green gram. The data presented in Table 1 and depicted in Figure 1 revealed that at 30 DAS the disease intensity of anthracnose of green gram significantly decreased in the treatment T_6- Carbendazim (S.T) + Carbendazim (F.S.) (12.22), followed by T_1- Carbendazim + Neem oil (17.33), T_2- Carbendazim + Eucalyptus oil (22.55), T_4- Carbendazim + Lavender oil (25.74), T_3- Carbendazim + Tea tree oil (27.43) and T_5- Carbendazim + Thyme oil (30.41) as compared to non-treated check, T_0- Control (33.47).

At 45 DAS the disease intensity of anthracnose of green gram significantly decreased in the treatment T_6- Carbendazim (S.T) + Carbendazim (F.S.) (18.77), followed by T_1- Carbendazim + Neem oil (24.06), T_2- Carbendazim + Eucalyptus oil (28.62), T_4- Carbendazim + Lavender oil (30.32), T_3- Carbendazim + Tea tree oil (32.53) and T_5- Carbendazim + Thyme oil (34.54) as compared to non-treated check, T_0- Control (37.48).

At 60 DAS the disease intensity of anthracnose of green gram significantly decreased in the treatment T_6- Carbendazim (S.T) + Carbendazim (F.S.) (20.03), followed by T_1- Carbendazim + Neem oil (26.62), T_2- Carbendazim + Eucalyptus oil (30.49), T_4- Carbendazim + Lavender oil (35.37), T_3- Carbendazim + Tea tree oil (38.10) and T_5- Carbendazim + Thyme oil (39.97) as compared to non-treated check, T_0- Control (41.77).

Table 1: Effect of treatments on disease intensity of green gram at 30, 45 and 60 DAS

Treatments		Disease Intensity (%)		
		30 DAS*	45 DAS*	60 DAS*
T_0	Control	33.47^{a}	37.48^{a}	41.77^{a}
T_1	Carbendazim + Neem oil	17.33^{e}	24.00^{e}	26.62^{e}
T_2	Carbendazim + Eucalyptus oil	22.55^{d}	28.62^{d}	30.49^{d}
T_3	Carbendazim + Tea tree oil	27.43^{c}	32.53^{c}	38.10^{b}
T_4	Carbendazim + Lavender oil	25.74^{c}	30.32^{d}	35.37^{c}
T_5	Carbendazim + Thyme oil	30.41^{b}	34.54^{b}	39.97^{ab}
T_6	Carbendazim (S.T) + Carbendazim (F.S.)	12.22^{f}	18.77^{f}	20.03^{f}
C.D. (0.05)		2.46	1.83	2.18
(SEM±)		1.13	0.84	1.00

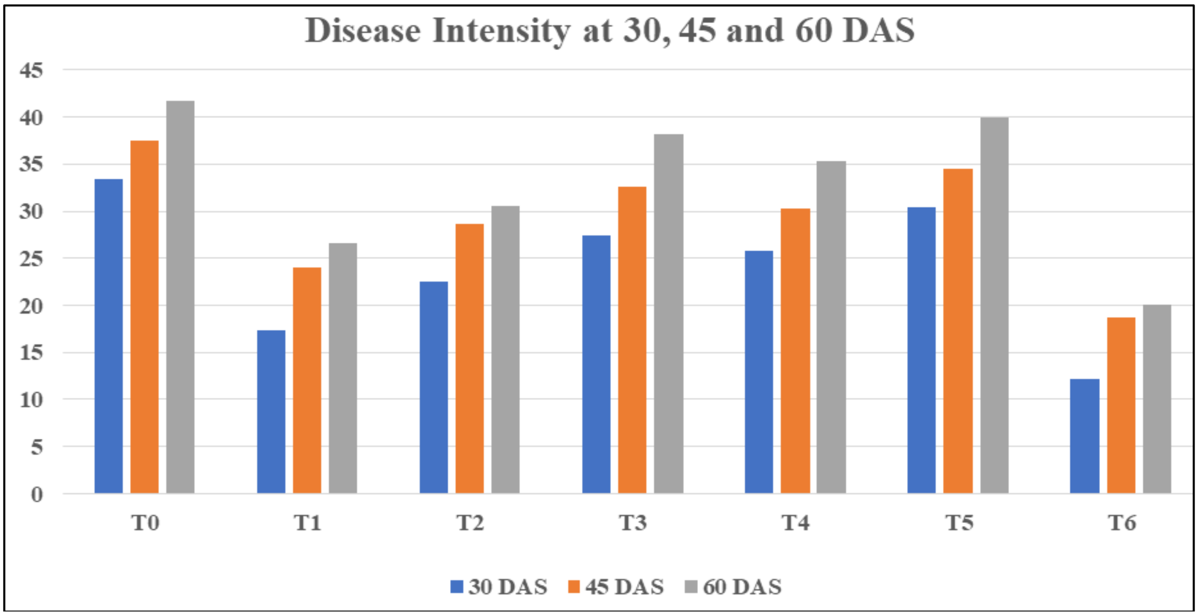

Fig 1: Effect of treatments on disease intensity (%) of green gram at 30, 45 and 60 DAS

Conclusions

Based on the results obtained from present studies it was concluded that from years, many have been relied on chemicals and this resulted in many undesirable problems therefore, it was necessary to incorporate alternative control components and the use of indigenous sources for the management of the plant disease that are effective in field and are organically developed for growing concern for both public health and environment hazards with less cost. Thus, use of essential oils have been taken in consideration for the management of anthracnose of green gram caused by *Colletotrichum lindemuthianum*. As it is beneficial and eco-friendly, easy to get for farmers therefore it may be recommended for the better management of purple blotch disease of garlic. Results of the present study were found to be significantly effective under Prayagraj agro-climatic conditions. It may vary with region and climatic conditions, therefore for validation of the results more such trials should be carried out in future for further recommendations.

The treatment T_6- Carbendazim @ 2 g/kg seed (S.T) + @ 0.1% (F.S.) was found most effective against anthracnose of green gram resulting in inhibition of 87.78% at 30 DAS, 81.23% at 45 DAS and 79.97% at 90 DAS.

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