Effect of botanicals with carbendazim against anthracnose (*Colletotrichumlindemuthianum*) of black gram (*Vigna mungo* L.)

ABSTRACT

The present study was carried out to evaluate the effect of selected botanicals and carbendazim for the management of anthracnose disease on black gram caused by *Colletotrichumlindemuthianum* under field conditions. Three replications of black gram were planted in a randomized block design at the research plot of the Central Research Field, Department of Plant Pathology, SHUATS, Prayagraj during *Kharif*season of 2023. Carbendazim 50% WP at 2g kg^{-1} was applied for seed treatment of black gram before sowing. Foliar spraywasconductedusingfive botanicals and one fungicide*viz*.T_1-neemoil(2ml L^{-1}), T_2- eucalyptus oil (2ml L^{-1}), T_3- tea tree oil (2ml L^{-1}), T_4- Lavender oil (2ml L^{-1}), T_5- Thyme oil (5%), T_6- mancozeb 75 WP (0.2%) and T_0- control with each treatment replicating three times. It was observedthatalltreatmentssignificantlyreducedtheintensityofdiseaseandincreasedgrowth parameters of garlic. From the study of the results, it was concluded that among all the treatments, the most effective in managing the disease was T_6- Carbendazimat 0.1% ST+FS(22.33%) followedby T_1-Carbendazimat 2g Kg^{-1}(ST) + Neem oil at 0.2% (FS) (23.14%) as compared to T_0- Control (43.48%) and in influencing the yield (t ha^{-1}) T6-Carbendazim at0.1% ST+FS (7.86%) followed by T1-Carbendazimat 2g Kg^{-1}(ST) + Neem oil at 0.2% (FS) (6.76%) as compared to T0- Control (3.15)infieldcondition and maximumcostbenefitratiowasrecordedinT_6-Carbendazimat 0.1% ST+FS(1:2.43)followedbyT_1-Carbendazimat 2g Kg^{-1}(ST) + Neem oil at 0.2% (FS) (1:2.07) as compared to T_0- Control (1:1.03).

Key words:*Anthracnose,Botanicals, Carbendazim, Colletotrichumlindemuthianum,Per cent Disease Intensity, Yield.*

INTRODUCTION

Black gram (*Vigna mungo* L.) commonly known as urd bean, mash or black maple is an annual, semi erect to spreading herb belonging to the family Fabaceae and it is grown as a *Kharif* crop in tropical and sub-tropical countries including India, Nigeria, Thailand, Philippines, Upper Volta, Zambia, Palmira and Columbia. This versatile pulse crop has a relatively short growth duration. As a leguminous crop, black gram not only enriches soil fertility but also contributes to the nitrogen economy of subsequent crops in the rotation **[11].**

The urd bean production of India was 2.78 million tonnes from acreage of 4.63 million hectares with a productivity of 600 Kg ha^{-1}. India is the largest producer and consumer of urd bean. During 2021-22, the total quantity of import of urd bean was 6.12 lakh tonnes, whereas, export of urd bean was 55.18 thousand tonnes. In the case of area, the share of Madhya Pradesh is highest (24 %), followed by Uttar Pradesh (10 per cent) and Maharashtra (7 %) during 2020/21. Among the major producing states, productivity was highest in Andhra Pradesh (915 kg ha^{-1}), followed by Jharkhand (879 kg/ha) during 2020-21 **[4].**

*Colletotrichumlindemuthianum*Lams. Scrib., the causal organism of pulse anthracnose, is a serious soil borne as well as seed borne pathogen of pulse crops throughout the world and has been reported to occur on *Kharif* pulses in several countries **[12]**. Anthracnose disease of mung bean was observed red or brown lesions on leaves, stems, branches and pods of different cultivars of *Vignaradiata* and *V.mungo* in Gurdaspur**[1].** In India, the black gram anthracnose was first reported from Uttar Pradesh state in 1984 **[16].** The pathogen was causing saviour yield losses nearly 80 to 100 % under cool and humid environmental conditions. Black gram yields are highly reduced due to anthracnose disease up to 40-67 % **[7].**

In the present investigation, it is evident that seed treatment + foliar spray of carbendazim gave maximum cost benefit ratio.**[10].** Use of botanicals is the safe alternative control. To prevent anthracnose disease which is caused by different species of *Colletotrichum,* botanicals *viz.* eucalyptus oil, lavender oil, tea tree oil and thyme oil are used as natural fungicides and resulted in effective way **[16].**

MATERIALS AND METHODS

Isolation of fungal pathogen

Prepared PDA was melted and 80 mg of streptomycin, an antibiotic was added during preparation of PDA to each 500 ml preparation of the PDA to inhibit probable bacterial growth. The leaves of black gram showing typical symptoms were collected and the standard tissue isolation procedure was followed to isolate the pathogen. The infected 14 leaf parts were cut into small pieces of two to three mm dimension in a manner so that pieces may have some green portion also. Such leaf bits were surface sterilized with 1% sodium hypochlorite (NaOCl) solution for 30 seconds and washed three times with sterile distilled water to remove any traces of mercuric chloride adhered with leaf bits **[18]**. 2-3 leaf bits were transferred onto PDA medium contained in Petri-plates aseptically with the help of sterilized forceps. These Petri-plates were incubated at room temperature (25±2° C). After 3-4 days mycelia growth was observed around leaf bits from this colony growth, a portion from the periphery that is, single hyphal tip was separated and transferred to other.

Field preparation

An experiment was conducted during *Kharif* season of 2023 at the central research farm of Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The selected field area was prepared by ploughed and harrowing during summer season, Experimental plots were laid out as per statistical Randomized Block design. Total area was divided into 21 plots and plot size 2 x 1 m^2. To evaluate the effect of botanicals with carbendazim against *Colletotrichumlindemuthianum* with Randomized Block Design in three replications. The crop was raised as per recommended package of practices and protective irrigation was given as and when required.

Seed treatment with carbendazim

The seeds of black gram were treated with carbendazim 50% WP at a rate of 2 grams per kilogram of seed. Thoroughly mixed the carbendazim with the seeds. This was done by shaking the seeds in a bag or container to ensure the fungicide coats the seed uniformly. The seeds were soaked in this treatment for 24 hours before sowing to ensure effective coating and absorption of the fungicide. This treatment is designed to protect the seeds from fungal pathogens during germination and early growth stages, promoting healthier seedling development and ensuring better crop establishment.

Preparation of botanicals and spraying

The botanicals *viz.*, neem oil, eucalyptus oil, tea tree oil, lavender oil and thyme oils were mixed in appropriate water quantity to make solution at concentration as per treatments. All the solutions were prepared freshly and being sprayed at 30, 45, and 60 DAS of interval.

Treatmentswereimposedafterappearance ofthefirstdiseasesymptoms.Observationsondiseaseintensity(%)ofanthracnoseofblack gram wererecorded at 15 days interval, yield (t ha^{-1})and C:B ratio datawere obtained aftertheharvest onphysiologicalmaturity.

Assessment of per cent disease intensity (%) of anthracnose of black gram was recorded at 30, 45 and 60 days after sowing using the devised scale (0-9) Table (1). The disease intensity was calculated using the followed formula **[20]:**

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

Table 1.Scale/grade used for treatments

Scale/ Grade	Description
0	No symptoms on leaves
1	Small size lesions covering 1% or less of leaf area.
3	Small size lesions covering 1-10% of leaf area.
5	Lesions size big but not coalescing, covering 11-25% of the leaf area.
7	Lesions on leaves covering 26-50% of leaf area. Cankers on stem and pod infection.
9	Lesions on leaves covering 51% or more of leaf area. Defoliation of leaves, deep cankers on stem and pods, blighting of plant occurs.

Economics:

Gross returns were calculated by multiplying total yield with market price of the produce. Cost of cultivation and cost of treatments were deducted from the gross returns, to find out returns and cost benefit of ratio by following formula **[14].**

$$\text{Cost Bene it Ratio} = \frac{\text{Gross return}}{\text{Total cost of cultivation}}$$

Statistical analysis:

The data recorded during the trial was subjected to be statistically analyzed by randomized block design (RBD) for drawing the conclusion. The significant and non-significant values were evaluated with the help of "F" (variance ratio) table?? What is this??. The calculated values were compared with the tabulated values at 5% level of probability for the appropriate degree of freedom[**3].**

RESULTS

A field study was carried out to assess on various aspects of anthracnose of black gram (*Vigna mungo*L.)caused by *C. lindemuthianum*with referenceto evaluation of disease intensity (%), yield (q ha^{-1}) and cost benefit ratio among the treatments.

The results of the field experiment presented in **Table (2)**two clearly indicate that the disease intensitywassignificantlylowinallthetreatedplotscomparedtotheunsprayedcontrolplotaftertwo sprays.Diseaseintensitywasrecordedthreetimesbeforespray,fifteendaysafterfirstsprayandfifte en days after second spray of botanicals along with carbendazim, respectively.

Per Cent Disease Intensity of anthracnose of black gram

Amongthetreatmentsthesignificantreductioninthediseaseintensity(%)at30,45 and60DASwas recordedinthetreatments.Theminimumdiseaseintensity(%) at 30, 45 and 60 DASofblack gramwasrecordedin T_6- Carbendazimat 0.1% ST+FS (14.37, 18.93, 22.33, respectively), followed by T_1- Carbendazimat 2gKg^{-1}(ST) + Neem oil at 0.2% (FS) (15.23, 21.25, 23.14, respectively), T_2- Carbendazimat 2g Kg^{-1}(ST) + Eucalyptusoil at 0.2% (FS)(16.55, 23.31, 24.70, respectively),T_4- Carbendazim at 2g/Kg(ST) +Lavenderoil at 0.2% (FS)(18.73, 25.29, 29.22, respectively), T_3-Carbendazimat 2g Kg^{-1}(ST) + Tea Treeoilat 0.2% (FS) (22.29,25.93, 33.92, respectively) andT_5-Carbendazimat 2g Kg^{-1}(ST) + Thymeoil at 0.2% (FS)(24.84, 30.07, 35.99, respectively) as compared to non-treated control, T_0- Control (28.14, 36.57, 43.48).

Yield(t ha^{-1})

Accordingtothecurrentfindings,studyofdataon yieldofblack gramreveals that the yield (q ha^{-1}) significantly increased in the treatmentT_6- Carbendazim at0.1% ST+FS (7.86), followed by T_1- Carbendazimat2g Kg^{-1} (ST) + Neem oil at0.2% (FS) (6.76), T_2- Carbendazimat2g Kg^{-1}(ST) + Eucalyptusoil at0.2% (FS)(6.38),T_4- Carbendazimat2g Kg^{-1}(ST) +Lavenderoil at0.2% (FS)(6.25), T_3-Carbendazimat2g Kg^{-1}(ST) + Tea Treeoilat0.2% (FS) (5.48) andT_5-Carbendazimat2g Kg^{-1}(ST) + Thymeoil at0.2% (FS)(4.98) as compared to non-treated check, T_0- Control (3.15).

Cost Benefit Ration of the treatment

Results of cost benefit ratio among the treatments were observed. The cost of cultivation (Rs. 8,258/ha) and the highest gross returns (Rs. 55,826 ha^{-1}), net returns (Rs. 28,856 ha^{-1}) and C:B ratio (1: 2.07) were recorded in T_1- Carbendazimat 2g Kg^{-1}(ST) + Neem oil at 0.2% (FS) (6.76). The lowest gross returns (Rs. 26,013ha^{-1}) and net returns (Rs. 783 ha^{-1}) and C:B ratio (1: 1.29) were recorded in T_0- control (untreated check).

Table.2. Disease intensity

Treatments	Percentdisease intensity* after (days)			Mean	Yield (t ha^{-})	C:B ratio
	30 DAS before spray	45 DAS after 1st spray)	60 DAS after 2nd spray)			
Control (Untreated check)	28.14[a]	36.5[a]	43.8[a]	36.15	3.15	1: 1.03
Carbendazimat 2g kg^{-1}seed (S.T) + Neem oil at 0.2% (F.S)	15.23[f]	21.25[e]	23.14[f]	19.87	6.76	1: 2.07
Carbendazimvat 2g kg^{-1} seed (S.T) + Eucalyptus oil @0.2% (F.S)	16.55[e]	23.31[d]	24.70[e]	21.52	6.38	1: 1.80
Carbendazimat 2g kg^{-1} seed (S.T) + Tea Tree oil @0.2% (F.S)	22.29[c]	25.93[c]	33.92[c]	27.38	5.48	1: 1.47
Carbendazimat 2g kg^{-1} seed (S.T) + Lavender oil at0.2% (F.S)	18.73[d]	25.29[c]	29.22[d]	24.41	6.25	1: 1.73
Carbendazimat 2g kg^{-1} seed (S.T) + Thyme oil at0.2% (F.S)	24.84[b]	30.07[b]	35.99[b]	30.3	4.98	1: 1.24
Carbendazim50WP@2g kg^{-1}seed (S.T)+at0.1% (F.S)	14.37[g]	18.93[f]	22.33[g]	18.54	7.86	1: 2.43
C.D (5%)	0.26	0.80	0.49		0.02	
C.V	0.74	1.75	0.92		0.63	

S.T. – Seed Treatment
F.S. – Foliar spray

DISCUSSION

Theprobablereasonsforsuchfindingsmaybeduetothe antifungal properties of neem oil and carbendazim, a systemic fungicide. Carbendazim disrupts fungal cell division by interfering with DNA biosynthesis, specifically inhibiting the formation of mitotic microtubules, which halts the development of fungal germ tubes and mycelial growth by **Chaudhari and Gohel [2]**. However, its persistence and overuse may lead to the development of resistance by**Purushotham*et al*. [13]**. Neem oil, on the other hand, offers a more sustainable option for managing plant diseases. Its most active component, azadirachtin, along with other compounds like nimbidol, nimbin, sodium nimbinate, and quercetin, exhibits both antifeedant and toxic effects on pathogens. Azadirachtin, a terpene limonoid, inhibits microbial growth by disrupting the cell walls of pathogens by**Vijaykumar *et al*. [19]**. These findings align with the research of **Kulkarni and Raja [8][9]**, **Khan *et al*. [6], Manjunath *et al*. [10], Jagtap *et al*. [5] and Singh *et al*. [17].**This combination of systemic fungicides and botanical oilsrepresents an effective strategy for reducing disease intensity and increasing yield in crops.

CONCLUSIONS

From the present studies it can be concluded that many have been relied on chemicals and this resulted in many undesirable problems. It is necessary to incorporate alternative control components and the use of indigenous sources for the plant disease management that are effective in field and are organically developed for growing concern for bothpublichealthandenvironmenthazardswithlesscost.Thus,useofbotanicalshavebeen taken in consideration for the management of anthracnose of black gram caused by *C.lindemuthianum.* The treatment, T_1- Carbendazimat2g Kg^{-1} (ST) + Neem oil at 0.2% (FS) have shown good result in managing anthracnose disease of black gram compared to other treatments.

DISCLAIMER(ARTIFICIALINTELLIGENCE)

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.

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