RESEARCH ARTICLE Legume Research- An International Journal, Volume 47 Issue 9: 1620-1624 (September 2024)

Management of Cercospora Leaf Spot [*Cercospora canescens* Ellis and Martin] of Mothbean [*Vigna aconitifolia* (Jacq.) Marechal] through Fungicides

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10.18805/LR-4891

ABSTRACT

Background: Cercospora leaf spot of mothbean caused by *Cercospora canescens* Ellis and Martin is one of the most important fungal diseases causing damage to the crop. *C. canescens* causes losses to yield in major Mothbean growing areas of Rajasthan. Its affects the foliation and in severe infection damaged entire crop that lead to yield loss up to 50-70%. In this, Check the efficacy of new molecules available in the market should be analyzed with this disease.

Methods: Nine fungicides were tested at four concentrations (50, 100, 150 and 200 ppm) under *in vitro* conditions with CRD design against *C. canescens* and also tested under field conditions. The field experiment was conducted at Research Farm of College of Agriculture, SKRAU, Bikaner, during *Kharif* 2019 in RBD design with the application of foliar spray of nine different fungicides at different concentrations against Cercospora leaf spot disease of mothbean.

Result: Among these new molecule fungicides tested, trifloxystrobin 25% + tebuconazole 50% WG and carbendazim 12% + mancozeb 63% WP was highly effective with maximum inhibition of mycelial growth (100.00%) at 200 ppm concentrations. The results of *in vivo* studies revealed that spraying with 0.15% trifloxystrobin 25% + tebuconazole 50% WG helped to manage the leaf spot successfully and reduced the disease intensity (15.51%) with disease control (72.71%) and recorded highest yield (8.10 q ha^{-1}) effective under field conditions as foliar spray at appropriate time.

Key words: Cercospora leaf spot, Fungicide, Management, Mothbean, Propiconazole, Tebuconazole.

INTRODUCTION

The moth bean, *Vigna aconitifolia* (Jacq.) Marechal, is a short-day crop and one of the most drought-resistant legumes in India and especially in Rajasthan. It is generally cultivated in hot and dry habitats of Northern-Western parts of India. It is grown for human consumption and also used in many industries. Mothbean is native to India, Myanmar and Pakistan, where it grows as a wild and cultivated plant. Ecologically, mothbean is an annual legume crop of dry and warm habitats and is characterized as the most drought hardy annual legume in arid regions. Mothbean with deep and quick penetrating rooting system, can survive up to 30-40 days in open fields (Kumar, 2002). It has the ability to grow under harsh climate, low rainfall and poor and sandy soil conditions and considered as most important pulse crop of arid Rajasthan (Sharma and Ratnoo, 2014).

In India mothbean area was 11.83 lakh hectares and 3.89 lakh tonnes of mothbean production was recorded the 2016-17 (Anonymous, 2016-17). A total of 10.27 lakh hectares and 3.20 lakh tonnes of mothbean production was recorded in the Rajasthan during 2016-17 (Anonymous, 2017-18). Area and production of mothbean highest in Rajasthan contributing (86.81% and 82.26%) followed by Madhya Pradesh (10.99% and 14.65%) respectively. Rajasthan is the largest mothbean growing state contributing about 85 per cent area of the country.

Mothbean crop suffers from many diseases, among the diseases Bacterial leaf spot, Yellow mosaic virus, Leaf crinkle virus, Cercospora leaf spot are more prevalent and destructive in nature. Among the fungal diseases, the Cercospora leaf spot occurs frequently in Asia.

In India, leaf spot caused by *Cercospora canescens* Ellis and Martin was first reported by Munjal *et al.* (1962) from Delhi and has spread to other parts of the humid tropical regions of India (Pandey *et al*., 2009). The reduction in yield due to the Cercospora leaf spot depends upon how early plant are infected (Poehlman, 1978).

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How to cite this article: Kumar, R., Meena, A.K., Kumar, V., Nathawat, B.D.S. and Yadav, A.L. (2024). Management of Cercospora Leaf Spot [*Cercospora canescens* Ellis and Martin] of Mothbean (*Vigna aconitifolia* (Jacq.) Marechal) through Fungicides. Legume Research. 47(9): 1620-1624. doi: 10.18805/LR-4891.

Submitted: 08-02-2022 **Accepted:** 03-05-2023 **Online:** 01-06-2023

In the case of Cercospora leaf spot, infected leaves (especially those more mature) look for brown or rust-colored lesions that vary from circular to angular, are 2-10 mm. Lesions may have a greyish or whitish center with a slightly reddish border. Conidia develop at the center on short conidiophores. Severely affected leaves become chlorotic. Lesions may dry and portions may fall out, giving the leaf a shot-hole appearance. Lesions and blemishes may occur on branches, stems and pods. Maximum loss of 61 percentage was observed in Pakistan in case of grain yield (Iqbal *et al*., 1995).

Has recommended the use of chemicals for more than a decade and the performance of new molecules available in the market should be analyzed with this disease. Information regarding Cercospora leaf spot disease development in relation to other foliar diseases of mothbean is also lacking. Provide necessary information for suitable management of disease and minimize crop losses.

MATERIALS AND METHODS

In vitro evaluation of fungicides

The bio-efficacy of new molecule fungicides and their combinations at the concentration of 50, 100, 150 and 200 ppm were analyzed against *Cercospora canescens* under laboratory conditions by following poisoned food technique. The fungicides used were given here under. In the poisoned food technique, the fungus *C. canescens* was grown on PDA medium in petriplates for 15 days. Fungicidal suspension was prepared by adding required quantity of fungicides in PDA medium to obtain the desired concentration on the basis of active ingredients present in the chemical. Later, 20 ml of poisoned medium was poured in each sterilized petriplates. Mycelial disc of 5 mm size from actively growing zone of 15 days old culture was cut by cork borer and placed at the centre of each agar plate, then incubated at 25°C for 16 days. Control treatment was maintained without adding any fungicides to the medium. Three replications were maintained for each treatment. After the period of incubation, the colony growth of the *C. canescens* were recorded. Per cent inhibition of the colony over control was calculated by using following formula given by Vincent (1947) and data were statistically analyzed with CRD design.

Formula;

$$I = \frac{C - T}{C} \times 100$$

I = Per cent inhibition.

C = Radial growth of *C. canescens* in control (mm).

T = Radial growth of *C. canescens* in presence of fungicides (mm).

The following fungicides were tested *viz;* T_1; T_2; T_3; T_4; T_5; T_6; T_7; T_8; T_9 and T_{10}.

In vivo evaluation of fungicides

A field experiment was laid out at the Research Farm of College of Agriculture, SKRAU, Bikaner, during *Kharif* 2019. The efficacy of nine new molecule fungicides and combinations was evaluated. The experiment was conducted in randomized block design with ten treatments and three replications of mothbean crop. Plot size of 3 × 3 m^2 was maintained per treatment. The sowing was taken up on 19.07.2019. Fertilizers were applied as per package of practices. Spraying was taken up immediately after disease appearance. The observations on per cent disease index was recorded by using scale of 0-9 (Mayee and Datar, 1986). Per cent disease index (PDI) was calculated by using the formula given by Wheeler (1969) formula:

$$\text{Disease control (\%)} = \frac{\text{Disease intensity in control (\%)} - \text{Disease intensity in treatment}}{\text{Disease intensity in control (\%)}} \times 100$$

Fungicides used for lab studies and spraying are as follows:-

Treatments	Dose %
T_1: Mancozeb 50% WP	0.20
T_2: Chlorothalonil 75% WP	0.20
T_3: Propiconazole 25% EC	0.20
T_4: Thiophanate methyl 15% + copper oxychloride 40% WP	0.15
T_5: Pyraclostrobin 20% WG + azoxystrobin 23% SC	0.15
T_6: Fluopyron 250 SC + trifloxystrobin 250 SC	0.15
T_7: Trifloxystrobin 25% + tebuconazole 50% WG	0.15
T_8: hexaconazole 4% + zineb 68% WP	0.20
T_9: carbendazim 12% + mencozeb 63% WP	0.20
T_{10}: Control	-

The data of per cent disease incidence in all the experiments were transformed to their Arcsin values (Fisher and Yates, 1963). The statistical analysis of the data of all the laboratory experiments were done following completely randomized design. The data of field experiments were analyzed following randomized block design (Cochran and Cox, 1957).

RESULTS AND DISCUSSION

In vitro evaluation of fungicides

The effect of nine systemic, contact and combi fungicides were tested at 50, 100, 150, 200 ppm concentrations by poison food technique on growth of *C. canescens* under *in vitro* conditions. Observations on average colony diameter and per cent inhibition of linear growth over control are presented in (Table 1 and Plate 1). The results revealed that all the fungicides were significantly reduced the mycelial growth of *C. canescens* over control. Among the fungicides, the combi fungicide trifloxystrobin 25% + tebuconazole 50% WG was found more effective and inhibited mycelial growth of *C. canescens* (76.40%, 87.34%, 94.84% and 100.00%) at 50, 100, 150 and 200 ppm concentrations followed by carbendazim 12% + mancozeb 63% WP (68.28%, 80.46%, 88.28% and 100.00%) respectively over control. The fungicide propiconazole 25% EC also effective against *C. canescens* and per cent inhibition (67.81%, 76.56%, 85.31%

and 96.71%) at 50, 100, 150 and 200 ppm. Similarly, the next fungicide fluopyram 250 SC + trifloxystrobin 250 SC was also found effective and inhibited the growth of *C. canescens* (50.62%, 63.90%, 75.15% and 85.78%) followed by mancozeb 50% WP (50.46%, 60.15%, 68.59% and 77.25%) respectively at 50, 100, 150 and 200 ppm concentrations. Similarly, hexaconazole 4% + zineb 68% WP, pyraclostrobin 20% WG + azoxystrobin 23% SC and thiophanate methyl 15% + copper oxychloride 40% WP were not effective against mycelial growth of test pathogen at 50 ppm concentration 48.28%, 45.46% and 42.96% respectively but found effective at 100 ppm (58.43%, 54.21% and 50.78%), 150 ppm (68.28%, 61.25% and 61.09%), 200 ppm (74.84%, 71.09% and 70.62%) concentrations respectively. All formulations of fungicides were found highly effective against test pathogen at 200 ppm concentration over control. However, these fungicides were less effective at lower concentration but reversible to increasing concentration of fungicides but chlorothalonil 75% WP fungicides was less effective against the per cent inhibition of mycelial growth of pathogen (14.00%, 21.56%, 31.40 and 42.03%) at 50 and 100, 150 and 200 ppm concentrations.

These findings are conformity with work of Kumar *et al*., (2016) reported that tebuconazole 50% + trifloxystrobin 25% WG, carbendazim 12% + mancozeb 63% WP and propiconazole 25% EC at 200 ppm concentration showed complete (100%) per cent inhibition of mycelial growth of fungus. Another similar findings were also reported by Kavyashree *et al*., (2017) under laboratory conditions evaluation of different fungicides against *Cercospora canescens* of greengram revealed that hexaconazole 5 EC (0.1%), carbendazim (25%) + mancozeb (50%) WS (0.05%) or mancozeb 75 WP (0.1%) and propiconazole 25 EC and trifloxystrobin (25%) + tebuconazole (50%) w/w (0.05%) resulted into 100 per cent inhibition of mycelial growth.

In vivo evaluation of fungicides

In mothbean due to Cercospora leaf spot disease often causes considerable yield losses. Presently, the cultural

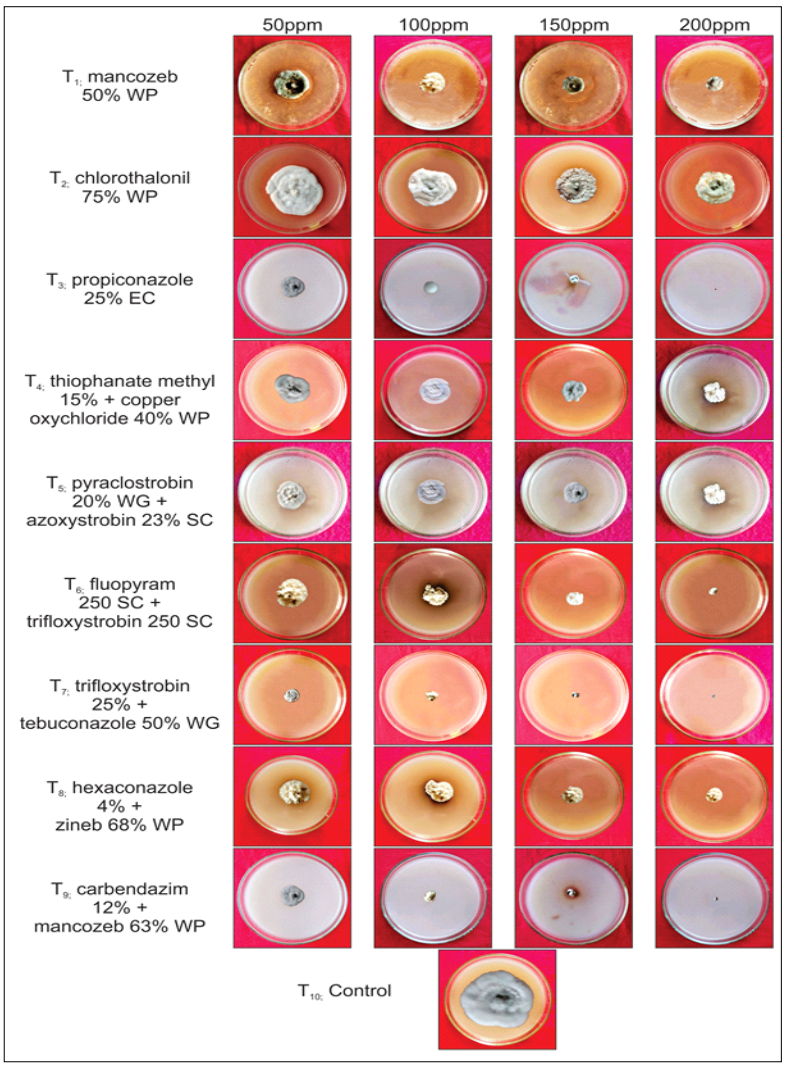

Plate 1: Efficacy of fungicides against *Cercospora canescens* under *in vitro* conditions.

practices along with biological control and resistant varieties considerably reduced the incidence of disease. Similarly, the systemic and contact fungicides also prevent the infection of disease but regularly application may lead to resistance against pathogen. Hence, a field trial on fungicidal control of disease was carried out for *kharif,* 2019.

Based on efficacy of different fungicides evaluated under laboratory conditions, nine fungicides were used against Cercospora leaf spot of mothbean under field conditions. The results of experiment presented in (Table 2) revealed that there was significantly reduction in the disease intensity and increase mothbean yield was recorded compared to the untreated control plots. Ten days after the first spray, maximum per cent disease control (72.71 %) with minimum PDI (15.51%) and maximum 8.10 q ha^{-1} mothbean yield was recorded by application of trifloxystrobin 25% + tebuconazole 50% WG (0.15%) as foliar spray. This was followed by the application of carbendazim12% + mancozeb 63% WP (0.20%) as foliar spray resulted in 17.68 per cent disease intensity and 68.90 per cent disease control and 7.64 q ha^{-1} crop yield. The application of propiconazole 25% EC (0.20%) foliar spray in plots also effective and resulted 20.44 per cent disease intensity and 64.04 per cent disease control and 7.48 q ha^{-1}. Application of fluopyram 250 SC + trifloxystrobin 250 SC (0.15%) foliar spray showed 21.45 per cent disease intensity that accounted 62.26 per cent efficacy of disease control and 7.32 q ha^{-1} followed by mancozeb 50% WP (0.20%) as foliar spray showed 22.28 PDI with 60.80 per cent disease control and 7.18 q ha^{-1} followed by application of hexaconazole 4% + zineb 68% WP (0.20%) as foliar spray resulted in 25.40 per cent disease intensity and 55.32 per cent efficacy of disease control and 6.55 q ha^{-1} crop yield. Similarly, pyraclostrobin 20% WG + azoxystrobin 23% SC (0.15%) and thiophanate methyl 15% + copper oxychloride 40% WP (0.15%) were no more effective as foliar spray resulted per cent disease inensity (25.76% and 27.63%) and efficacy of disease control (54.68% and 51.39%) with mothbean yield (6.27 q ha^{-1} and 6.15 q ha^{-1}) respectively. Among all the treatments, chlorothalonil 75% (0.20%) WP showed lowest disease control (36.79%) and 5.85 q ha^{-1} yield with highest per cent disease intensity (35.93%).

These results are comparable with findings of Banyal *et al*., (2019) reported that two sprays at 10 days interval of trifloxystrobin 25% +tebuconazole 50% (Nativo 75 WG) at 350 g/ha were significantly effective in controlling both the diseases *i.e*. leaf spot and powdery mildew and gave 77.1 and 67.2 per cent disease control with a maximum average increase in the grain yield *i.e*. 20.2 and 19.5 per cent, respectively over the check. Also revealed with findings of Yadav *et al*., (2014) reported that two foliar sprays of two foliar sprays of carbendazim (0.1%) was found most effective with minimum disease intensity (14.45%) followed by topsin-M (15.49%), propiconazole (17.85%), mancozeb (21.67%), copper oxychloride (23.40%) and thiram (28.59%) as compared to control plot (61.57%). These studies are confirmatory to our results.

Table 1: Efficacy of fungicides against *Cercospora canescens* under *in vitro* conditions.

Treatment	Mycelial growth (mm) at different conc.				Per cent growth inhibition at different conc.			
	50 ppm	100 ppm	150 ppm	200 ppm	50 ppm	100 ppm	150 ppm	200 ppm
T_1: Mancozeb 50% WP	31.7 (34.25)*	25.50 (30.31)	20.10 (26.62)	14.30 (22.21)	50.46	60.15	68.59	77.25
T_2: Chlorothalonil 75% WP	56.20 (48.54)	50.20 (45.10)	43.90 (41.48)	37.10 (37.51)	14.00	21.56	31.40	42.03
T_3: Propiconazole 25% EC	20.60 (26.98)	15.00 (22.77)	9.40 (17.84)	2.10 (8.28)	67.81	76.56	85.31	96.71
T_4: Thiophanate methyl 15% + copper oxychloride 40% WP	36.50 (37.15)	31.50 (34.12)	24.90 (29.99)	18.80 (25.68)	42.96	50.78	61.09	70.62
T_5: Pyraclostrobin 20% WG + azoxystrobin 23% SC	34.90 (36.19)	29.30 (32.76)	24.80 (29.85)	18.50 (25.46)	45.46	54.21	61.25	71.09
T_6: Fluopyram 250 SC + trifloxystrobin 250 SC	31.60 (34.19)	23.10 (28.71)	15.90 (23.49)	9.10 (17.55)	50.62	63.90	75.15	85.78
T_7: Trifloxystrobin 25% + tebuconazole 50% WG	15.10 (22.86)	8.10 (16.52)	3.30 (10.44)	0.00 (0.00)	76.40	87.34	94.84	100.00
T_8: Hexaconazole 4% + zineb 68% WP	33.10 (35.11)	26.60 (31.03)	20.30 (26.76)	16.10 (23.64)	48.28	58.43	68.28	74.84
T_9: Carbendazim 12% + mancozeb 63% WP	20.30 (26.77)	12.50 (20.68)	7.50 (15.88)	0.00 (0.00)	68.28	80.46	88.28	100.00
T_{10}: Control	64.00 (53.11)	64.00 (53.11)	64.00 (53.11)	64.00 (53.11)	-	-	-	-
S.Em ±	0.38	0.46	0.29	0.33				
C.D (P=0.05)	1.13	1.36	0.87	0.98				

*Figures in parenthesis are angular transformed values.

Table 2: Effect of different fungicides against Cercospora leaf spot of mothbean under field conditions.

Treatment	Conc. (%)	Disease intensity (%)	Disease control (%)	Yield (q ha^{-1})
T_1: Mancozeb 50% WP	0.20	22.28 (28.13)*	60.80	7.18
T_2: Chlorothalonil 75% WP	0.20	35.93 (36.81)	36.79	5.85
T_3: Propiconazole 25% EC	0.20	20.44 (26.84)	64.04	7.48
T_4: Thiophanate methyl 15% + copper oxychloride 40% WP	0.15	27.63 (31.68)	51.39	6.15
T_5: Pyraclostrobin 20% WG + azoxystrobin 23% SC	0.15	25.76 (30.47)	54.68	6.27
T_6: Fluopyram 250 SC + trifloxystrobin 250 SC	0.15	21.45 (27.56)	62.26	7.32
T_7: Trifloxystrobin 25% + tebuconazole 50% WG	0.15	15.51 (23.17)	72.71	8.10
T_8: Hexaconazole 4% + zineb 68% WP	0.20	25.40 (30.23)	55.32	6.55
T_9: Carbendazim12% + mancozeb 63% WP	0.20	17.68 (24.84)	68.90	7.64
T_{10}: Control	-	56.85 (48.92)	-	5.15
S.Em ±		1.44		0.42
C.D (P=0.05)		4.35		1.27
CV (%)		10.57		10.45

*Figures in parenthesis are angular transformed values.

CONCLUSION

Among nine fungicides, trifloxystrobin 25% + tebuconazole 50% WG and carbendazim 12% + mancozeb 63% WP found most effective with maximum inhibition of mycelial growth (100%) of *Cercospora canescens* as compared to propiconazole 25% EC in inhibiting mycelial growth (96.71%) under *in vitro* condition.

In vivo studies, foliar spray of trifloxystrobin 25% + tebuconazole 50% WG (0.15%) and carbendazim 12% + mancozeb 63% WP (0.20%) were found most effective in reducing disease intensity and increasing crop yield.

ACKNOWLEDGEMENT

The authors are very much thankful to Dr. D.R. Kumhar, Head of Department, Department of Plant Pathology, Swami Keshwanand Rajasthan Agricultural University, Bikaner for providing all necessary things for our research.

Conflict of interest

All authors declared that there is no conflict of interest.

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