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EVALUATION OF NEWER FUNGICIDES AGAINST *ALTERNARIA* LEAF SPOT OF BRINJAL

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ABSTRACT

The present investigation was taken into consideration for the management of Alternaria leaf spot of brinjal by using newer fungicides were evaluated for their efficacy under *in-vitro* and *in-vivo* against *Alternaria alternata* causing leaf spot disease. In laboratory study among different fungicides, lowest colony diameter of 5.0 mm and highest colony growth inhibition over control of 94.42 per cent was recorded in Kasugamycin plus Copper oxychloride (0.15%) followed by Mancozeb (0.2%), which recorded colony diameter of 7.3 mm and inhibition over control of 91.86%. *In-vivo* evaluation of newer fungicides against leaf spot of brinjal, two sprays of Kasugamycin plus Copper oxychloride (0.15%) gave lowest percent disease Index (PDI) (9.70%), This treatment also recorded per cent disease control of 77.9 per cent, highest fruit yield of 310.33 q/ha and increase in yield over control of 47.0 per cent followed by two sprays of Mancozeb, recorded PDI of 12.1 per cent and per cent disease control over control of 72.4 per cent, fruit yield of 303.33 q/ha and increase in yield over control of 43.7 per cent. Highest B:C ratio of 1:18.53 was recorded in plots having two sprays of Mancozeb was given followed by two sprays of Kasugamycin plus Copper oxychloride (1:11.1).

Key words : *Alternaria alternata*, Alternaria Leaf spot, Brinjal, Fungicides, Management, Disease severity.

Introduction

Brinjal (*Solanum melongena* L.) is an important vegetable crop grown in India. It is also known as eggplant or aubergine and belonging to the family solanaceae. It is believed to have originated from India (Zeven and Zhukovsky, 1975). It is also very rich source of protein, dietary fiber and highly productive and called as a “poor man’s crop” (Rajan and Markose, 2002). Brinjal encompasses three primary botanical varieties within the species *melongena* the round or egg-shaped cultivars classified as var. *esculentum*, the long slender types categorized under var. *serpentinum*, and the dwarf brinjal plants identified as var. *depressum*. In India, Brinjal is a mainly grown in the states like West Bengal, Odisha, Gujarat, MP, Bihar, Maharashtra, AP and Karnataka and Jharkhand. In India, it is grown throughout the country as a *Rabi* season crop but in Jharkhand, it is as grown round the year. India is the second largest producer of brinjal in world next to China. In India, it is cultivated over with an area of 744 thousand hectares and production of 12,768 thousand metric tons and productivity of 17.16 MT/ha (Anonymus, 2022). Brinjal crop is attacked by a number of fungal, bacterial, viral, and phytoplasma diseases like Alternaria leaf spot (*Alternaria alternata* (Fr.) Kessler), Damping off (*Pythium aphanidermatum* (Eds.) Fitz.; *Phytophthora* spp. (*Rhizoctonia* spp.); Phomopsis blight (*Phomopsis vexans* Sacc. and Syd.) Harter; Cercospora leaf spot (*Cercospora solani melongenae Chupp. C. solani*.); Verticillium wilt (*Verticillium dahliae* Kleb), Fusarium wilt (*Fusarium solani* (Mart.) App and Wollenw), Bacterial wilt (*Ralstonia solanacearum* Smith), Little leaf (Phytoplasma), Mosaic virus, and Root-knot nematodes (*Meloidogyne javanica* (Treub) Chitwood) during various growth stages. Among them leaf spot of Brinjal caused by *Alternaria* spp. is a serious disease. In india, particularly in Jharkhand state which reduce its yield and quality of fruits (Bochalya *et al*., 2012). Therefore, the present investigation was made to evaluate the

efficacy of newer fungicides against Alternaria leaf spot of brinjal.

Materials and Methods

In-vitro study

A laboratory experiment was conducted in the Department of Plant pathology, BAU, Ranchi during 2023-24 to know the efficacy of one non-systemic fungicide *viz*., Mancozeb 75WP (Dithane M-45) and six combi-product fungicides *viz*., Pyraclostrobin 5% + Metiram 55% (Clutch), Tebuconazole 50% + Trifloxystrobin 25% (Nativo), Azoxystrobin 14% + Epoxiconazole 9% SC (Crystal Mentor), Mancozeb 50% + Thiophanate methyl 25% WG (Juniper), Kasugamycin 5% + Copper oxychloride 45%WP (Dhanuka Conika), Picoxystrobin 7.05% + Propiconazole 11.7% SC (Galileo Way) against *Alternaria alternata* for colony growth on the potato dextrose agar media using poisoned food technique, described by Nene and Thapliyal (1979). From the stock double-strength potato dextrose medium, multiple batches, each containing 60 ml of the medium in a 100 ml conical flask, were sterilized at 15 psi (1.05 kg/cm²) pressure at 121.6°C for 20 minutes. Meanwhile, fungicide solutions were prepared by dissolving the fungicides in 60 ml of sterilized distilled water to achieve the desired concentrations after mixing with the double-strength medium. The required amount of fungicide solution was added separately to 60 ml of the PDA medium under aseptic conditions before being poured into Petri plates. Culture discs (Dia- 3 mm) taken from the edges of ten-days-old actively growing culture of the test pathogen were placed in the centre of each prepared petri plate. A control was also set up, in which only plain sterilized water was added to the PDA. Each treatment was replicated thrice and the inoculated plates were incubated at 25 ± 2°C in a BOD incubator. The design was CRD and the colony diameter of the *Alternaria alternata* was measured until the control plates were fully covered with mycelial growth. The percentage inhibition of mycelial growth of the pathogen over control was also worked out by using Vincent's (1947) formula.

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

Where, I = Mycelial growth inhibition (%)

C = Mycelial growth in control plate (mm)

T = Mycelial growth in treatment plate (mm)

In-vivo study

To evaluate the effect of six fungicides on leaf spot disease in brinjal, a field trial was carried out at the Research Farm of the Department of Plant Pathology, B.A.U., Kanke during *Rabi* season of 2023-24. In this trial the most susceptible variety (Pusa purple long) was used. Twenty-six days old seedlings were transplanted at a spacing of 50 cm × 50 cm in a randomized block design (RBD). The plot size was 3.0 m × 2.5 m with three replications. Fertilizers (N: P_2O_5: K_2O) were applied at a rate of 100: 50: 50 kg/ha, along with 20 tons per hectare of farm yard manure (FYM). The study involved seven treatments, including a control. Thirty days after transplanting (DAT), the plants were inoculated with a spore suspension of *Alternaria alternata* containing 1×10v spores per ml. The spore suspension was sprayed in the evening to ensure a 24-hour humid environment for optimal pathogen establishment. Before this field was irrigated one day earlier. The first spraying of fungicide was applied three days after inoculation of pathogen second was sprays were administered 10 days interval of each. Ten plants were randomly selected in each plot, and observations on disease severity and fruit infection percentage were recorded ten days after the second spray of fungicide by using a 0-5 scale (Pandey *et al*., 2003). The percentage of disease control (PDC) over the control was calculated using the formula:

$$\text{PDC in control} = \frac{\text{PDI Control} - \text{PDI in Treatment} \times 100}{\text{PDI in Control}}$$

The fruit yield in each plot was recorded separately and increase in yield over control (IYOC) was also worked out by using following formula

$$(\text{IYOC}) = \frac{T_y - C_y}{C_y} \times 100$$

Where, T_y = Yield of treatment plot

C_y = Yield of control plot

Results and Discussion

In-vivo evaluation of newer fungicides against leaf spot disease and yield of brinjal

In order to evaluate the efficacy of seven fungicides *viz*., Pyraclostrobin plus Metiram (Clutch), Tebuconazole plus Trifloxystrobin (Nativo), Azoxystrobin plus Epoxiconazole (Crystal Mentor), Mancozeb plus Thiophanate methyl (Juniper), Kasugamycin plus Copper oxychloride (Dhanuka Conika), Mancozeb (Dithane M-45), Picoxystrobin plus Propiconazole (Galileo Way) excluding one control against *Alternaria alternata* obtained from leaf spot of brinjal a laboratory trial was conducted by using poision food techniques in three replication in Post graduate laboratory of Plant Pathology at BAU, Ranchi.

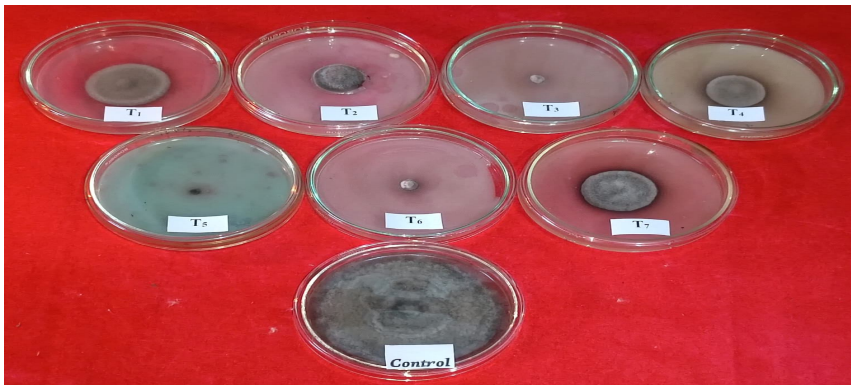

Fig. 1 : *In-vitro* evaluation of newer fungicides against *Alternaria alternata* (Leaf spot of brinjal).

of mycelia growth followed by Propineb 70% WP (94.5%). Shekhada *et al.* (2023) found that among non-systemic fungicides, maximum mycelial growth inhibition of *A. alternata* was recorded in copper oxychloride 50 WP at 2000 ppm (80.37%) followed by Mancozeb 75 WP at 2000 ppm (75.93%). Whereas, among systemic fungicides, Propiconazole 25EC at 2000 ppm concentrations completely inhibited the mycelial growth followed by Azoxystrobin 23SC at 500 ppm (33.33%).

Table 1 : *In-vitro* evaluation of newer fungicides for management of *Alternaria alternata* (Leaf spot of brinjal).

Treatments		Dose (%)	*Colony diameter of pathogen (mm)	Colony growth inhibition over control (%)
T_1	Pyraclostrobin (5%) + Metiram (55% WG)	0.1	34.7	61.31
T_2	Tebuconazole (50%) + Trifloxystrobin (25%)	0.04	20.0	77.70
T_3	Azoxystrobin (14%) + Epoxiconazole (9% SC)	0.15	8.3	90.74
T_4	Mancozeb (50%) + Thiophanate methyl (25% WG)	0.2	28.0	68.78
T_5	Kasugamycin (5%) + Copper oxychloride (45% WP)	0.15	5.0	94.42
T_6	Mancozeb (75WP)	0.2	7.3	91.86
T_7	Picoxystrobin (7.05%)+ Propiconazole (11.7% SC)	0.2	40.7	54.62
T_8	**Control**	-	89.7	-
		SEm (±)	0.91	
		CD at 5%	2.72	
		CV (%)	6.16	

*Mean of three replications.

The data presented in Table 1 revealed that all fungicides were capable in reducing the mycelial growth over control. However, Kasugamycin plus Copper oxychloride @ 0.15% recorded lowest colony diameter of 5.0 mm and highest colony growth inhibition over control of 94.42 per cent. This treatment was followed by Mancozeb (0.2%) which recorded colony diameter of 7.3 mm and colony growth inhibition over control 91.86 per cent. The next best treatment was Azoxystrobin plus Epoxiconazole (0.15%), which recorded colony diameter of 8.3 mm and colony growth inhibition over control of 90.74 per cent. Whereas, the Control plate showed colony diameter of 89.7 mm.

Jakatimath (2016) reported that Tebuconazole @ 0.1%, Carbendazim @ 0.1% and Propiconazole (0.1%) were found most effective in inhibiting the mycelial growth of the *Alternaria alternata*, isolated from leaf spot of brinjal. Sharma *et al.* (2020) showed that Thiophanate methyl 70%WP exhibiting the highest inhibition (100%) Yadav *et al.* (2024) screened five chemical fungicides of three concentration *i.e.* 500, 1000, 2000 ppm and revealed that Thiophanate methyl 70%WP showed complete mycelial growth inhibition (100%).

In-vivo evaluation of newer fungicides against leaf spot disease and yield of brinjal

All the test fungicides significantly reduce the PDI in comparison to control. The lowest PDI of 9.70 per cent was recorded when brinjal crops were sprayed with two sprays of Kasugamycin plus Copper oxychloride (0.15%). This treatment also showed per cent disease control (PDI) of 77.9 per cent, fruit yield of 310.33 q/ha and increase in yield over control of 47.0 per cent. This treatment was followed by two sprays of Mancozeb (0.2%), which recorded PDI of 12.1 per cent and per cent disease over control of 72.4 per cent, fruit yield of 303.33 q/ha and increase in yield over control of 43.7 per cent. The next best treatment was two sprays of Mancozeb plus Thiophanate methyl (0.2%) recorded PDI

Table 2 : *In-vivo* evaluation of newer fungicides for management of leaf spot and fruit yield of brinjal.

Treatments		Dose (%)	*PDI (%)	PDOC (%)	*Fruit yield (q ha^{-1})	IYOC (%)
T_1	Two sprays of Tebuconazole (50%) + Trifloxystrobin (25%)	0.04	22.8 (28.5)	48.1	244.33	15.7
T_2	Two sprays of Azoxystrobin (14%) + Epoxiconazole (9% SC)	0.15	14.7 (22.5)	66.6	260.67	23.5
T_3	Two sprays of Mancozeb (50%) + Thiophanate methyl (25% WG)	0.20	12.7 (20.8)	71.1	280.00	32.6
T_4	Two sprays of Kasugamycin (5%) + Copper oxychloride (45% WP)	0.15	9.70 (18.1)	77.9	310.33	47.0
T_5	Two sprays of Mancozeb (75WP)	0.20	12.1 (20.3)	72.4	303.33	43.7
T_6	Two sprays of Picoxystrobin (7.05%) + Propiconazole (11.7% SC)	0.20	25.6 (30.3)	41.8	240.00	13.7
T_7	**Control**	-	43.9 (41.5)	-	211.11	-
		S Em (±)	2.47		19.9	
		CD at 5%	7.59		61.2	
		CV (%)	16.6		13.0	

*Mean of three replications PDOC- Per cent disease over control IYOC- Increase in yield over control
Figures in parentheses are transformed are transformed into arc sine values.

Table 3 : Cost-benefit ratio of effect of fungicides for management of Alternaria leaf spot of brinjal under field condition.

Treatments		Dose (%)	Yield (q/ha)	Additional yield over Control (q/ha)	Value of Additional Yield (Rs/ha)	Cost of input (Rs/ha)	Net Return (Rs/ha)	B:C Ratio
T_1	Two sprays of Tebuconazole (50%) + Trifloxystrobin (25%)	0.04	244.33	33.22	33220	6928	26292.0	1:3.79
T_2	Two sprays of Azoxystrobin (14%) + Epoxiconazole (9% SC)	0.15	260.67	49.56	49560	9100	40460.0	1:4.44
T_3	Two sprays of Mancozeb (5%) + Thiophanate methyl (25% WP)	0.20	280.00	68.89	68890	7408	61482.0	1:8.29
T_4	Two sprays of Kasugamycin (5%) + Copper oxychloride (45% WP)	0.15	310.33	99.22	99220	8200	91020.0	1:11.1
T_5	Two sprays of Mancozeb (75 WP)	0.20	303.33	92.22	92220	4720	87500.0	1:18.53
T_6	Two sprays of Picoxystrobin (7.05%)+Propiconazole (11.7% SC)	0.20	240.00	28.89	28890	7909.6	20980.4	1:2.65
T_7	Control	-	211.11	-	-	-	-	

Cost of inputs

Tebuconazole (50%)+Trifloxystrobin (25%)	-	Rs.860/100g	Brinjal sale price	-	Rs.1000/q
Azoxystrobin (14%)+Epoxiconazole (9%)	-	Rs.3500/ lit	Labour required/spray	-	3 man days/ha
Mancozeb(5%)+Thiophanate Methyl (25%)	-	Rs.960/500 g	Labour charge	-	Rs. 400/day
Kasugamycin (5%)+Copper Oxychloride (45%)	-	Rs.300/100 g	Hiring charge of sprayer	-	Rs.100/day
Mancozeb (75 WP)	-	Rs.80/100 g	Miscellaneous	-	Rs.100/ha
Picoxystrobin (7.05)+Propiconazole (11.7%)	-	Rs.2129/ lit			

of 12.7 per cent and per cent disease over control of 71.1 per cent, fruit yield of 280 q/ha and increase in yield over control of 32.6 per cent. The control plot recorded PDI of 43.9 per cent and fruit yield 211.11 q/ha (Table 2). When cost benefit ratio was taken into consideration then highest B:C ratio of 1:18.53 was recorded in treatment T_5 *i.e.*, two sprays of Mancozeb followed by two sprays of Kasugamycin plus Copper oxychloride (1:11.1), two sprays of Mancozeb plus Thiophanate methyl (1:8.29), whereas lowest B:C ratio (1:2.65) was recorded in T_6 *i.e.*, two sprays of Picoxystrobin plus Propiconazole (0.2%). When net return was taken into consideration then two sprays of all treatments gave positive net return. Highest net return of Rs. 91020.0/ha was recorded when two sprays of Kasugamycin plus Copper oxychloride (0.15%) was sprayed (T_4) followed by two sprays of Mancozeb (0.2%), which recorded net return of Rs. 87500.0/ha (Table 3).

Kumar (2017) reported that propiconazole was most effective against leaf spot of brinjal under field condition followed by Hexaconazole. Kumar (2019) reported that the application of four foliar sprays of Hexaconazole 5 EC (0.05%) at 10 days interval, starting with the initiation of disease proved most efficacious (80.53%) in limiting the *Alternaria* leaf spot of brinjal and enhancing the fruit yield (156.93 q/ha) followed by Tebuconazole (0.05%) with 75.34 per cent disease control. Yadav *et al*. (2020) concluded that Propiconazole (0.1%) gave best result in controlling the *Alternaria* leaf spot of tomato disease with minimum per cent disease intensity (5.00% at 60 DAT and 23.50% at 90 DAT) followed by Trifloxystrobin (50) + Tebuconazole (25 WG) at 0.1 per cent (7.80% at 60 DAT and 27.90% at 90 DAT) concentration. Kumari and Zacharia (2023) found that Mancozeb (1g/L) + Carbendazim (1g/L for foliar spray) was found most effective against *Alternaria alternata*. The minimum disease intensity (11.21%, 14.42% and 18.97%) was obtained in Mancozeb (1g/L) + Carbendazim (1g/L as foliar spray) in three consecutive years.

Conclusion

Among different newer fungicides, Kasugamycin plus copper oxychloride (0.15% gave best result for management of *Alternaria alternata* followed by Mancozeb (0.2%) under field and laboratory condition. When cost benefit ratio was taken into consideration then highest B:C ratio (1:18.53) was recorded in treatment T_5 *i.e.*, two sprays of Mancozeb (0.2%) followed by two sprays of Kasugamycin plus Copper Oxychloride (1:11.1), Highest net return of Rs. 91020.0 /ha was recorded when two sprays of Kasugamycin plus Copper Oxychloride (0.15%) were sprayed (T_4) followed by two sprays of Mancozeb (Rs. 87500.0 per ha).

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