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Efficacy of fungicides against alternaria leaf spot disease in safflower (*Carthamus tinctorius*) under the agro-climatic conditions of Arunachal Pradesh

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Abstract
Safflower (*Carthamus tinctorius L.*) is an important oilseed crop whose productivity is severely affected by Alternaria leaf spot disease caused by *Alternaria carthami*. In the following study, fungicidal evaluation against the disease Alternaria leaf spot was carried out both under laboratory and field conditions at college of Agriculture, Pasighat. Disease severity was assessed using the McKinney's 0-5 scale, while fungicidal efficacy was determined by the food poison technique. Miravis Duo (Pydiflumetofen 6.89% + Difenconazole 11.49% SC) was the most effective fungicide treatment with 81.33% mycelial growth inhibition under laboratory while under field conditions, lowest disease severity (24.67%) and highest disease control (68.38%) was recorded determining it's potential to control the Alternaria Leaf Spot disease in Safflower.

Keywords: Disease management, Miravis Duo, alternaria leaf spot, mycelial growth

Introduction

Safflower, one of the oldest crop in oilseeds belonging to Asteraceae family. The crop is rich in oil, containing 30-40% edible oil, 20% protein and 35% fiber (NDSU Extension, 2013) [8]. In India, Safflower occupied about 0.06 million ha with 0.04 million tonnes of production with average productivity of 700 kg/ha (Government of India, 2024) [4]. Due to climatic change in the recent years, the climatic conditions are now favourable for the cultivation of safflower in Arunachal Pradesh but also has high risk of foliar diseases like Alternaria Leaf Spot, Rust, etc due to climatic conditions like humidity (>80%) and temperatures (20-30 °c) that favours the growth of the pathogen (Nikam *et al.*, 2013) [9]. The losses due to diseases is major problem in safflower leading to loss of quality and yield of oil. Among all the diseases one of the major diseases is the Alternaria Leaf Spot Disease that leads to about 25-60% yield losses in India (Singh and Prasad, 2005) [12]. Systematic information related to safflower production and management of diseases is scarce, limiting the adaptability of crop by farmers in this region. So, research on improving disease management strategies in Arunachal Pradesh is essential to improve the production of safflower and wider adaptability of the crop.

Methodology

Experiments related to management of Alternaria Leaf Spot in Safflower were carried in College of Agriculture, Pasighat, and Arunachal Pradesh both in the field and laboratory conditions. The Safflower seeds of variety Annigeri-1 were sown in month of November, 2025[1] using the RBD Design. Severity of disease was noted after each spray of treatments in the plots. After three sprays Disease severity and disease control were calculated. Based on the CRD Design, the Treatments were evaluated at 100 ppm using the Food Poison Technique.

Initially the symptoms appeared as small, round flecks on leaves that later turned into brown necrotic spots with concentric rings and appeared as target board symptom (Maheshwari *et al*., 2010). Observations in the field were noted for Disease Severity using the formula and 0-5 scale given by H.H. McKinney in 1923.

$$\text{Percent Disease Index PDI (\%)} = \frac{\text{Sum of all individual disease ratings}}{\text{Total number of plants observed} \times \text{Maximum grade in the scale}} \times 100$$

The Disease was recorded using 0-5 scale (McKinney, 1923)

0 (0%): No Disease
1 (1-10%): Very slight infection
2 (11-25%): Mild infection
3 (26-50%): Moderate infection
4 (51-75%): Severe infection
5 (76-100%): Very severe infection

The leaves with symptoms were sampled and isolated the pathogen in the laboratory using the subculture method. The efficacy of fungicides was tested at 100 ppm using the food poison technique and recorded the inhibition percentage of mycelial growth after the control reaches the maximum radial growth (Ahad *et al.*,2025) [1]. A standard formula was used to calculate the percentage of mycelial growth that was inhibited compared to control.

$$\text{Percentage of Inhibition} = \frac{C - T}{C} \times 100$$

Where,
C = Radial Growth of Pathogen Colony in control
T = Radial Growth of Pathogen Colony in treatment

Results & Discussion

In vitro Evaluation

Fig 1: Growth of *Alternaria carthami* under different treatments in Culture plates

The results of fungicidal evaluation against *Alternaria carthami* had been done in the laboratory of Plant Pathology department, CoA, Pasighat, shown that Miravis duo (Pydiflumetofen 6.89% + Difenconazole 11.49% SC) was very effective when compared to all other treatments with highest Percent inhibition of mycelial growth with 81.33% followed by Reflect Top (Isopyrazam 11.5% + Difenconazole11.5% SC), SAAF (Carbendazim 12% and Mancozeb 63% WP), Indofil M-45 (Mancozeb 75% W.P), Ridomil Gold (Metalaxyl 4% w/w and Mancozeb 64% w/w), Bavistin (Carbendazim 50%WP), Blitox (Copper Oxy Chloride 50%WP) with 79%, 77%, 71.33%, 68.67%, 67.33%and 64.67% of mycelial inhibition respectively. Similar studies were conducted on copper oxy chloride and SAAF by Hegde *et al*., 2015[5] proving the efficiency of chemicals against Alternaria pathogen in *Jatropa curcas.* A study conducted by Choudhary *et al.*, 2021[2] on efficacy of Carbendazim 50%WP showed the inhibition of 63.6% mycelial growth at 100 ppm. Rani *et al.*, 2018[10] conducted an evaluation of fungicides against *Alternaria alternata* had observed the mycelial inhibition of 76.34%, 78.69% and 76.89% with Ridomil Gold , SAAF and Indofil M-45 respectively.

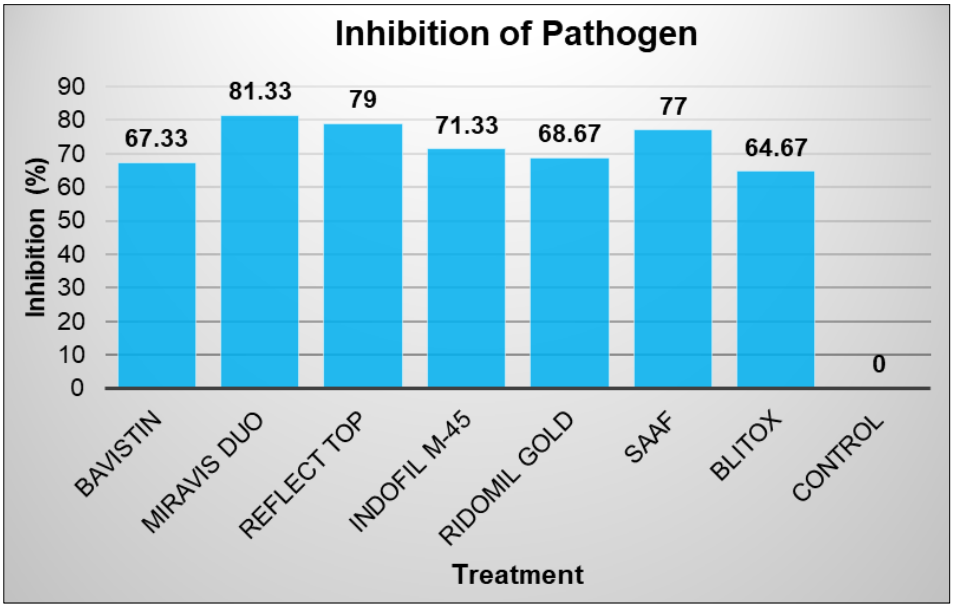

Fig 2: Inhibition of *Alternaria carthami* under different treatments under Laboratory conditions

Table 1: Mycelial growth and Percent Inhibition of *Alternaria carthami* under different treatments

Treatment		Colony diameter (mm)				Inhibition (%)			
		R_1	R_2	R_3	Mean	R_1	R_2	R_3	Mean
T_1	Bavistin	21 (27.27)	24 (29.33)	23 (28.66)	22.67 (28.43)	69 (56.17)	66 (54.33)	67 (54.94)	67.33 (55.14)
T_2	Miravis Duo	7 (15.34)	10 (18.43)	9 (17.46)	8.67 (17.12)	83 (65.65)	80 (63.43)	81 (64.16)	81.33 (64.40)
T_3	Reflect Top	11 (19.0)	10 (8.43)	12 (20.27)	11 (19.37)	79 (62.73)	80 (63.43)	78 (62.03)	79 (62.73)
T_4	Indofil M-45	19 (25.84)	18 (25.10)	19 (25.84)	18.67 (25.60)	71 (57.42)	72 (58.05)	71 (57.42)	71.33 (57.63)
T_5	Ridomil Gold	21 (27.27)	23 (28.66)	20 (26.57)	21.33 (27.51)	69 (56.17)	67 (54.94)	70 (56.79)	68.67 (55.96)
T_6	SAAF	14 (21.97)	12 (20.27)	13 (21.13)	13 (21.13)	76 (60.67)	78(621.03)	77 (61.34)	77 (61.34)
T_7	Blitox	26 (30.66)	23 (28.66)	27 (31.31)	25.33 (30.22)	64 (53.13)	67 (54.94)	63 (52.54)	64.67 (53.53)
T_8	Control	90 (71.57)	90 (71.57)	90 (71.57)	90 (71.57)	0.00	0.00	0.00	0.00
C.D. @5%		1.788				1.473			
S.E(m)		0.591				0.487			
S.E (d)		0.836				0.689			
C.V		3.402				1.643			

***In vivo* Evaluation**

The experimental results of the field showed that the severity of disease was very high in the control plot (untreated plot) with 78%. Lowest severity of disease was noted with plots sprayed with Miravis Duo (Pydiflumetofen 6.89% + Difenconazole 11.49% SC) as 24.67% followed by other fungicide chemicals treated plots like Reflect Top (Isopyrazam 11.5% + Difenconazole11.5% SC), SAAF (Carbendazim 12% and Mancozeb 63% WP), Indofil M-45 (Mancozeb 75% W.P), Ridomil Gold (Metalaxyl 4% w/w and Mancozeb 64% w/w), Bavistin (Carbendazim 50%WP), Blitox (Copper Oxy Chloride 50%WP) with 27.33%, 31.33%, 38.67%, 42.67%, 44%and 47.33% of disease severity respectively. This data shows that Miravis Duo fungicide effectively control the Alternaria Leaf Spot Disease with about 68.38% PDC when compared to other treatments. Study conducted by Mahesh *et al.*, 2022[6] proved the efficacy of Copper oxy chloride 50%WP in the field. Similar studies were conducted by Gairola and Tewari, 2019 [3] on Alternaria blight of mustard proving the disease control with Ridomil and Indofil M-45 against *Alternaria brassicae* pathogen.

Table 2: Disease Severity/ Percent Disease Index and percent Disease Control under field conditions

Treatment		After 3 sprayings				
		R1	R2	R3	Mean	PDC
T_1	Bavistin	42 (40.40)	46 (42.71)	44 (41.55)	44.00 (41.552)	43.59 (42.613)
T_2	Miravis Duo	22 (27.97)	28 (31.95)	24 (29.33)	24.67 (29.751)	68.38 (58.379)
T_3	Reflect Top	28 (31.95)	24 (29.33)	30 (33.21)	27.33 (31.498)	64.96 (59.675)
T_4	Indofil M-45	38 (38.06)	38 (38.06)	40 (39.23)	38.67 (38.45)	50.43 (48.208)
T_5	Ridomil Gold	46 (42.71)	42 (40.40)	40 (39.23)	42.67 (40.778)	45.30 (43.965)
T_6	SAAF	28 (31.95)	34 (35.67)	32 (34.45)	31.33 (34.022)	59.83 (53.024)
T_7	Blitox	44 (41.55)	50 (45.00)	48 (43.65)	47.33 (43.469)	39.32 (39.800)
T_8	Control	80 (63.43)	76 (60.67)	78 (62.03)	78.00 (62.043)	0.00
C.D. @5%					3.011	5.471
S.E(m)					0.983	1.786
S.E (d)					1.390	2.526
C.V					4.237	7.161

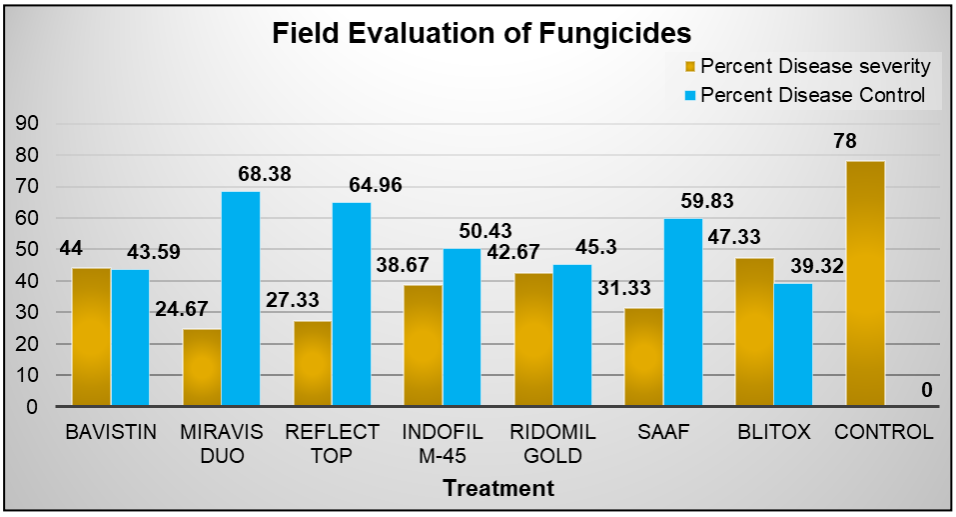

Fig 3: Disease severity and Disease Control with different treatments under field conditions

Conclusion

Among all the fungicides evaluated**,** Miravis Duo a combination fungicide was most efficient against *Alternaria carthami* with highest inhibition of mycelial growth and also had a maximum disease control in the Field when compared to other fungicide treatments in the Agro-climatic region of Arunachal Pradesh.

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