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Efficacy of different fungicides against *Erysiphe cichoracearum* DeCandolle causing powdery mildew of Sesame

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Abstract
Field experiments were conducted to test potentiality of ten different systemic and broad spectrum fungicides for management of powdery mildew disease and to increase the seed yield of sesame at Krishi Vigyan Kendra, JAU, Pipalia (Gujarat). All the fungicides tested were found to be superior over control but among the different fungicides tested, propiconazole 25% EC (0.025%) was found to be significantly effective by recording minimum disease intensity (6.48%) coupled with higher seed yield (699 kg/ha) followed by application of azoxystrobin 18.2% + difenoconazole 11.4% SC (0.030%) with 10.92% disease intensity and 688 kg/ha seed yield. The results were significantly superior over other fungicides both in disease reduction and increased seed yields. While, spraying of flucilazole 12.5% + carbendazim 25% SE (0.056%) was found to be least effective in reducing disease with 54.81% disease intensity and 628 kg/ha seed yield.

Keywords: Fungicides, sesame, powdery mildew, yield

1. Introduction
Among the different oilseed crops, sesame (*Sesamum indicum* L.) belongs to family *Pedaliaceae* is one of the most important ancient oil yielding crop in the world for edible oil production. Sesame seed is a rich source of protein (20%), edible oil (50%), oleic acid (47%), linolenic acid (39%) as well as vitamin E, A, B_1 and B_2 and minerals including Ca and P. (Kumaraswamy et al., 2015) [7]. It is also a rich source of natural antioxidants *viz*., sesamoline, sesamin and sesamol (Suja *et al*, 2004) [13]. Although sesame is widely used for different purposes, it has low productivity due to non-availability of high yielding varieties, resistant variety to biotic and abiotic stresses, low harvest index, seed shattering and indeterminate growth habit.
The sesame crop is affected by various biotic and abiotic stresses causing considerable yield losses. Among the different biotic stresses, the damage caused by plant diseases is one of the major constraints. It is affected by a number of diseases *like as;* fusarium wilt, charcoal rot, stem and root rot, bacterial blight, bacterial leaf spot, cercospora leaf spot, alternaria leaf spot, powdery mildew, leaf curl and phyllody etc. Among them, powdery mildew disease incited by fungus *Erysiphe cichoracearum* is one of the economically important disease and becoming major hurdle in sesame production.
The disease is found mainly during cooler spring and early summer periods. It appears at flowering to capsule formation stage as small cottony spots or small patches of white powder on the infected leaves which gradually spread on the lamina. Defoliation of severely infected plant occurred before maturity (Shambharkar *et al*., 1997) [11].
The disease has been observed in moderate to severe forms in fields of Junagadh, Rajkot, Amreli district of Gujarat state and which has become a limiting factor for successful cultivation of sesame.
Most of the sesamum cultivars presently under cultivation are highly susceptible to this disease. Therefore, the chemical control measure appears to be the only suitable alternative for the management of powdery mildew. Hence, the present study was undertaken to test the efficacy of different foliar fungicides to control the powdery mildew disease of sesame.

2. Materials and Methods
This experiment was conducted for two years during *kharif* 2019-20 and *kharif* 2020-21 at Krishi Vigyan Kendra, Junagadh Agricultural University, Pipalia.

The experiment was executed by using Randomized Block Design with twelve treatments and three replications.
A highly susceptible sesame cultivar GT-4 (Gujarat Til -4) was used to evaluate the effectiveness of different fungicides against powdery mildew disease of sesame. The spacing of the plant was maintained at distance of 45 x 15 cm with plot size 5.0 x 2.25 m (5 Rows). First spray of fungicide was given on initiation of disease and second at 20 days after first spray. Control plot was maintained by water spraying (500 lit/ha) and without spraying of any fungicides. Observations of disease intensity was recorded from ten plants randomly selected from each treatment after seven days of last spray by using 0-9 rating scale given by Mayee and Datar (1986) [9]. Seed yield (kg/ha) was also recorded in the experiment.

Table 1: The disease intensity was scored by adopting the 0–9 rating scale/grade (Mayee and Datar, 1986) [9]

Disease grade	Symptoms
0	No symptoms on the leaf
1	Small, white powdery specks on leaf, covering 10% or less area
3	Small powdery lesions, covering 1-10% of the leaf area
5	Powdery lesions enlarging to cover 11-25% of the leaf area
7	Powdery lesions coalesce, become gray colored, covering 26-50% of the leaf area
9	Big gray powdery patches, covering 50% or more of the leaf area. Leaf dropping, infection also on petiole and inflorescence.

On the basis of rating scale/grade, per cent disease intensity (PDI) was calculated by using the following formula (Wheeler, 1969) [15] (Khunt *et al.*, 2017) [6]

$$\text{Disease intensity (\%)} = \frac{\text{Sum of total rating}}{\text{Total plants observed}} \text{ X } \frac{100}{\text{Maximum disease rating}} \quad (1)$$

Similarly, per cent disease control and the per cent deviation in yield were calculated with the help of the following formula (Mathur *et al.*, 1971) [8].

$$\text{Disease control (\%)} = \frac{\text{P.D.I. in check} - \text{P.D.I. in treatment}}{\text{P.D.I. in check}} \text{ x } 100 \quad (2)$$

3. Results and Discussion

The effect of foliar sprays of different fungicides on powdery mildew severity and yield parameters during 2019-20 and 2020-21 crop seasons are presented in Table 2 and Table 3. The data on powdery mildew intensity during both crop seasons indicates that all the fungicides resulted in significant decrease in powdery mildew severity. Minimum disease intensity 7.41 and 5.56 per cent was observed in the plot which was protected with propiconazole 25% EC (0.025%) which was followed by azoxystrobin 18.2% + difenoconazole 11.4% SC (0.030%) with 9.63 and 12.22 per cent mean disease intensity in year 2019-20 and 2020-21, respectively. Tebuconazole 50% + trifloxystrobin 25% WG (0.045%) was found moderately effective with mean disease intensity of 18.89 per cent. The maximum disease intensity (54.81%) was found in the treatment of flucilazole 12.5% + carbendazim 25% SC (0.056%). The water spray and without water spray (control) recorded the maximum 59.99 and 69.07 per cent disease intensity, respectively. Maximum disease control of 90.62 per cent was recorded in the treatment of propiconazole 25% EC (0.025%) followed by treatment azoxystrobin 18.2% + difenoconazole 11.4% SC (0.030%) by 84.18 per cent.
The effectiveness of triazole group of fungicides like propiconazole 25% EC, hexaconazole 5% EC and difenoconazole 25% EC against powdery mildew has been reported by Dhruj *et al.* (2000) [3], Sharmila *et al.* (2004) [12], Shabbir and Yadav (2009) [10], Akbari and Parakhia (2010) [1], Dinesh *et al.* (2011) [4], Vidhate *et al.*, (2013) [14], Dahivelkar *et al.*, (2014) [2] and Jagtap *et al.*, (2019) [5] in various crops.
The data pertinent to sesame seed yield (kg/ha) as affected by foliar sprays of fungicides during 2019-20 and 2020-21 crop season mentioned in Table 3 revealed that all the fungicide treatments resulted in significant increase in seed yield as compared to control. Statistically, mean of both year seed yield was found to be significantly maximum in the treatment of propiconazole 25% EC at 0.025% (699 kg/ha) which was at par with azoxystrobin 18.2% + difenoconazole 11.4% SC at 0.030% (688 kg/ha). Minimum mean seed yield was recorded in the treatment of flucilazole 12.5% + carbendazim 25% SE at 0.056% (628 kg/ha) as compared to control (577 kg/ha). The plot with water spray found also gave higher yield (629 kg/ha) than without water spray (control). Per cent increase in seed yield over control was also higher in the treatment of propiconazole 25% EC (21.14%) followed by azoxystrobin 18.2% + difenoconazole 11.4% SC (19.24%).

Table 2: Effect of different fungicides against powdery mildew of sesame caused by *Erysiphe cichoracearum*

Sr. No.	Fungicides	Conc. (%)	D.I. (%)		Pooled Mean	D.C. (%)
			2019-20	2020-21		
1	Hexaconazole 5% EC	0.005	37.26** (36.66)*	39.22 (40.00)	38.24 (38.33)	44.50
2	Difenoconazole 25% EC	0.025	26.82 (20.37)	29.36 (24.07)	28.09 (22.22)	67.83
3	Propiconazole 25% EC	0.025	15.72 (7.41)	13.59 (5.56)	14.66 (6.48)	90.62
4	Picoxystrobilurin 22.52% EC	0.010	28.35 (22.59)	31.30 (27.03)	29.82 (24.81)	64.08
5	Wettable sulphur 80% WDG	0.2	33.88 (31.11)	36.34 (35.18)	35.11 (33.14)	52.01

6	Azoxystrobin 18.2% + Difenoconazole 11.4% SC	0.030	18.03 (9.63)	20.25 (12.22)	19.14 (10.92)	84.18
7	Hexaconazole 5% + Validamycin 2.5% SC	0.015	31.80 (27.78)	31.54 (27.40)	31.67 (27.59)	60.05
8	Pyraclostrobin 12.5% + Epoxyconazole 4.7% WP	0.018	27.35 (21.11)	29.57 (24.44)	28.46 (22.78)	67.02
9	Flucilazole 12.5% + Carbendazim 25% SE	0.056	46.70 (52.96)	48.84 (56.66)	47.77 (54.81)	20.64
10	Tebuconazole 50% + Trifloxystrobin 25% WG	0.045	23.77 (16.29)	27.58 (21.48)	25.68 (18.89)	72.65
11	Water spray	500 l/ha	48.84 (56.66)	52.76 (63.33)	50.80 (59.99)	13.14
12	Control	-	54.98 (67.03)	57.52 (71.10)	56.25 (69.07)	-
Y	S.Em. +				0.55	
	CD at 5%				1.57	
T	S.Em. +		1.60	2.16	1.35	
	CD at 5%		4.69	6.35	3.83	
	CV%		8.99	11.02	10.17	
YxT	S.Em. +		-	-	1.90	
	CD at 5%		-	-	NS	

**Data were transformed (Arcsine) prior to analysis D.I. = Disease Intensity
*Data given in parentheses are retransformed values D.C. = Disease Control

Table 3: Effect of different fungicide on seed yield of sesame

Sr. No.	Fungicides	Conc. (%)	Seed yield (kg/ha)		Pooled Mean	Yield Increase (%)
			2019-20	2020-21		
1	Hexaconazole 5% EC	0.005	639	645	642	11.27
2	Difenoconazole 25% EC	0.025	674	679	676	17.16
3	Propiconazole 25% EC	0.025	694	704	699	21.14
4	Picoxystrobilurin 22.52% EC	0.010	656	660	658	14.04
5	Wettable sulphur 80% WDG	0.2	647	656	652	13.00
6	Azoxystrobin 18.2% + Difenoconazole 11.4% SC	0.030	682	694	688	19.24
7	Hexaconazole 5% + Validamycin 2.5% SC	0.015	652	658	655	13.52
8	Pyraclostrobin 12.5% + Epoxyconazole 4.7% WP	0.018	662	674	668	15.77
9	Flucilazole 12.5% + Carbendazim 25% SE	0.056	622	634	628	8.84
10	Tebuconazole 50% + Trifloxystrobin 25% WG	0.045	677	684	681	18.02
11	Water spray	500 l/ha	641	617	629	9.01
12	Control	-	580	574	577	-
Y	S.Em. +				10.77	
	CD at 5%				NS	
T	S.Em. +		30.17	43.30	26.39	
	CD at 5%		NS	NS	NS	
	CV%		8.01	11.42	9.88	
YxT	S.Em. +		-	-	37.32	
	CD at 5%		-	-	NS	

T = Treatment YxT = Year x Treatment

4. Conclusions

It is noteworthy that, from present investigation for the management of powdery mildew disease in sesame over the years exhibited that all the evaluated fungicides have shown a promising efficacy as compared to the control against the disease. However, out of the ten tested fungicides propiconazole 25% EC at 0.025% has shown better controlling potential against the disease with 6.48% disease intensity. Similarly, maximum seed yield of 699 kg/ha was also recorded in protected plot of propiconazole 25% EC as compared to 577 kg/ha under unprotected control condition. Therefore, propiconazole 25% EC at 0.025% is recommended for management of powdery mildew disease of sesame.

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