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Efficacy of different Fungicides against *Erysiphe cichoracearum* DeCandolle causing Powdery Mildew of Okra (*Abelmoschus esculentus* (L.)

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ABSTRACT: Okra is one of the important vegetable grown across the country. It is severely infected by Powdery mildew caused by *Erysiphe cichoracearum* D.C causing yield loss varied from 17.0 to 86.6 per cent). Management of powdery mildew is becoming cumbersome due to development of fungicidal resistance to pathogen with this view, field experiment was conducted to test potentiality of new fungicide molecules against powdery mildew diseases, the fungicides tested were found to be superior over control but among the different fungicides tested, Flupyram 17.7% + Tebuconozole 17.7 % SC (Luna experience) at 0.125 per cent concentration and was found to be significantly effective by recording minimum disease intensity (48.52%) with maximum disease control (38.80%) coupled with higher Okra yield (92.15q/ha). While, spraying wettable Sulphur 80% WP (0.375%) was found to be least effective in reducing disease with 69.17% disease intensity. Hence the Flupyram 17.7% + Tebuconozole 17.7 % SC (Luna experience) at 0.125 per cent concentration can be used for the effective control of powdery mildew in okra.

Keywords: Fungicides, Okra, powdery mildew, *Erysiphe cichoracearum*, Luna experience.

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] popularly known as bhendi or lady's finger in India, it grows well in relatively warmer temperatures. It is grown as most important vegetable due to its nutritional, industrial and medicinal values. It is rich in vitamin A and C, calcium, potassium, phosphorous and iron (Aykroud, 1963; Berry *et al*., 1988; Konstantino *et al*., 2008; Monika *et al*., 2001). India ranks first in global production of okra contributing 70 per cent of world production. Even though, the production and productivity of okra is hampered as it affected by both biotic and abiotic stress. Among the biotic stress the major stress from the diseases like powdery mildew, yellow vein mosaic virus, cercospora leaf spot and fusarium wilt. Among them, Powdery mildew caused by *Erysiphe cichoracearum* D.C is most destructive and explosive disease causing yield loss varied from 17.0 to 86.6 per cent (Sridhar *et al.*, 1989; Gogoi *et al*., 2013; Younes and Abo-Elyousr 2014). At the early stages grayish-white powdery growth appears on upper surface of old leaves, later grayish-white spots spread to younger leaves covering all parts of plants. In severe cases, petiole and stem are also infected and develop necrosis resulting in withering and drying of leaves (Singh, 1984). It is generally seen in July to September every year and first appears with onset of monsoon (Choudhary, 1975). Chemical management through use of fungicides from various chemical groups is the most effective tool for management powdery mildew. Unfortunately, the risk of resistance development is high because of repeated applications of particular chemical group in a season (Panstruga and Kuhn 2019). In addition, powdery mildew fungi are high-risk pathogens and are known to develop resistance to several chemical groups (Fernandez *et al*., 2020). This situation has decreased the efficacy of the major fungicide classes which are available in market, hence the present study was undertaken to study the effect of various groups of fungicides, their combinations and doses for effective management of powdery mildew in Okra.

MATERIALS AND METHODS

The present study was conducted in *kharif*, 2020-21 at Main Agricultural Research Station, Dharwad. Randomized Block Design (RBD) with eight treatments and three replications were adopted. Powdery mildew susceptible okra variety Arka Anamikawas used for the study. The treatments were given after the onset of the disease and the details of treatments are furnished in Table 1.

The symptoms of the disease were periodically observed and described. For recording observations, five plants from each plot were randomly selected and tagged before the incidence of the disease. The total numbers of leaves were counted and each leaf was examined individually. The disease was graded on the basis of intensity of powdery mildew on the leaves given by Mayee and Datar (1986) (Table 2). The per cent disease intensity (PDI) and Per cent diseases control (PDC) was calculated based on the formula given by Mathur *et al.* (1971).

Table 1: Treatment details.

Treatment No.	Treatments	Concentration
T1	Untreated control	-
T2	Flupyram 17.7% + Tebuconozole 17.7 % SC) (Luna experience)	0.1 %
T3	Flupyram 17.7% + Tebuconozole 17.7 % w/w SC (Luna experience)	0.1125 %
T4	Flupyram 17.7% + Tebuconozole 17.7 % SC) (Luna experience)	0.125 %
T5	Fluopyram 41.5% SC	0.0625 %
T6	Folicure - Tebuconazole 25.9 %EC	0.1 %
T7	Sulphur 80% WP	0.375 %
T8	Flupyram 17.7% + Tebuconozole 17.7 % SC) (Luna experience)	0.25 %

Table 2: Disease scale for okra powdery mildew (0-5).

Grade	Per cent disease severity with description
0	No symptom of powdery mildew.
1	Small scattered powdery mildew specks covering 1 - 10 per cent or less leaf area.
2	Small powdery lesions covering 11 - 25 per cent of leaf area.
3	Powdery lesions enlarged covering 26 - 50 per cent of leaf area.
4	Powdery lesions coalesce to form big patches covering 51 -75 per cent of leaf area.
5	Big powdery patches covering > 75 per cent of leaf area and defoliation occur.

$$\text{PDI} = \frac{\text{Sum of the individual disease ratings}}{\text{Total number of leaves observed} \times \text{Maximum disease grade}} \times 100$$

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

RESULTS AND DISCUSSION

The effect of foliar sprays of different fungicides on powdery mildew severity and yield parameters during 2020-21 *kharif* seasons are presented in Table 3 and Table 4. The data on powdery mildew intensity during seasons indicates that all the fungicides resulted in significant decrease in powdery mildew severity.

Table 3: Effect of different fungicides on Powdery mildew of Okra.

Treatment No.	Treatments	Concentration	PDI Before spray	PDI @ 15 DAS	PDI @ 25 DAS	PDI @ 35 DAS	Per cent disease control (%)
T1	Untreated control	-	69.96 (56.80)*	77.75 (61.88)	85.78 (67.87)	90.51 (72.14)	0.00
T2	Flupyram 17.7% + Tebuconozole 17.7 % SC) (Luna experience)	0.1 %	75.01 (60.04)	48.04 (43.88)	50.07 (45.04)	51.45 (45.83)	36.47
T3	Flupyram 17.7% + Tebuconozole 17.7 % w/w SC (Luna experience)	0.1125 %	70.83 (57.31)	45.25 (42.27)	47.45 (43.54)	49.19 (44.54)	38.26
T4	Flupyram 17.7% + Tebuconozole 17.7 % SC) (Luna experience)	0.125 %	70.64 (57.22)	42.48 (40.66)	45.09 (42.18)	48.52 (44.15)	38.80
T5	Fluopyram 41.5% SC	0.062 %	75.97 (60.65)	53.82 (47.20)	60. 90 (51.30)	67.91 (55.50)	23.07
T6	Folicure - Tebuconazole 25.9 %EC	0.1 %	73.75 (59.19)	55.37 (48.09)	61.15 (51.44)	68.16 (55.66)	22.84
T7	Sulphur 80% WP	0.375 %	76.75 (61.21)	62.15 (52.03)	64.97 (53.71)	69.17 (56.28)	21.99
T8	Flupyram 17.7% + Tebuconozole 17.7 % SC) (Luna experience)	0.25 %	70. 21 (56.93)	51. 35 (45.78)	52.5 (46.44)	56.50 (48.73)	32.45
	SEm	-	**0.84**	**0.86**	**0.30**	**0.53**	-
	CD 5%	-	**2.48**	**2.52**	**0.88**	**1.56**	-

Values in bracket are arcsine transformed value

Among the new fungicide molecules and their combi products tested, the combi products has shown good results at different concentrations. At 35 days after spraying (DAS), the minimum disease severity (48.52%) and maximum disease control (38.80%) was observed in the plot which was protected with Flupyram 17.7% + Tebuconozole 17.7 % SC (Luna experience) at 0.125 per cent concentration. which was followed by Flupyram 17.7% + Tebuconozole 17.7 % SC at 0.1125 per cent concentration with 49.19 per cent disease severity and 38.26 per cent disease control, followed by Flupyram 17.7% + Tebuconozole 17.7 % SC (0.1%) was found moderately effective with disease intensity of 51.45 per cent and per cent disease control of 36.47, followed by Flupyram 17.7% + Tebuconozole 17.7 % SC (0.25%) with disease intensity of 56.50 per cent and per cent disease control of 32.45 per cent. Followed by Fluopyram (0.062%) with disease intensity of 67.91 per cent and per cent disease control of 23.07 per cent. Followed by Tebuconozole 25.75 % SC (0.1%) with disease intensity of 68.16 per cent and per cent disease control of 22.84 per cent. The maximum disease intensity (69.17%) and lowest diseases control (21.99%) was found in the treatment of wettable Sulphur 80% WP (0.375%).The water spray (control) recorded the maximum 90.51 per cent disease intensity.

The data pertinent Okra yield (kg/ha) as affected by foliar sprays of new fungicide molecules during 2020-21 mentioned in Table 4 revealed that all the fungicide treatments resulted in significant increase in okra yield as compared to control. Okra yield was found to be significantly maximum in the treatment of with Flupyram 17.7% + Tebuconozole 17.7 % SC (Luna experience) at 0.125 per cent concentration. (92.15 q/ha) which was at par with Flupyram 17.7% + Tebuconozole 17.7 % SC (Luna experience) at 0.1 per cent concentration (90.79 q/ha). Minimum yield was recorded in the treatment of wettable Sulphur 80% WP at 0.375% concentration (85.61q/ha). The plot with water spray (control) recorded the lowest yield of (40.18 q/ha).

The effectiveness of flupyram and its combination with triazole group of fungicides like Tebuconozole 25.75 % SC, propiconazole 25% EC and hexaconazole 5% EC against powdery mildew has been reported by Dhruj *et al*. (2000), Sharmila *et al.* (2004); Shabbir and Yadav (2009); Akbari and Parakhia (2010); Dinesh *et al.* (2011); Saha *et al.* (2012); Vidhate *et al*. (2013); Dahivelkar *et al.* (2014); Jagtap *et al.* (2019) in various crops. The results indicated that the spraying of combi product in all concentrations has increased Okra yield compared to other molecules. This may be due to the decrease in the diseases severity and positive effect on the growth of Okra.

Table 4: Effect of different fungicides on yield of Okra.

Treatment No.	Treatments	Concentration	Yield (Quintal/ha)	Increase in yield over control (%)
T1	Untreated control	-	40.18 (39.33)	0.00
T2	Flupyram 17.7% + Tebuconozole 17.7 % SC) (Luna experience)	0.1 %	90.79 (72.62)	55.74
T3	Flupyram 17.7% + Tebuconozole 17.7 % w/w SC (Luna experience)	0.1125 %	89.27 (71.09)	54.99
T4	Flupyram 17.7% + Tebuconozole 17.7 % SC) (Luna experience)	0.125 %	92.15 (73.76)	56.40
T5	Fluopyram 41.5% SC	0.062 %	86.32 (68.38)	53.45
T6	Folicure - Tebuconazole 25.9 % EC	0.1 %	89.41 (71.11)	55.06
T7	Sulphur 80% WP	0.375 %	85.61 (67.75)	53.07
T8	Flupyram 17.7% + Tebuconozole 17.7 % SC) (Luna experience)	0.25 %	88.44 (70.13)	54.57
	SEm	**-**	**1.18**	
	CD 5%	**-**	**3.48**	
	CV		**2.86**	

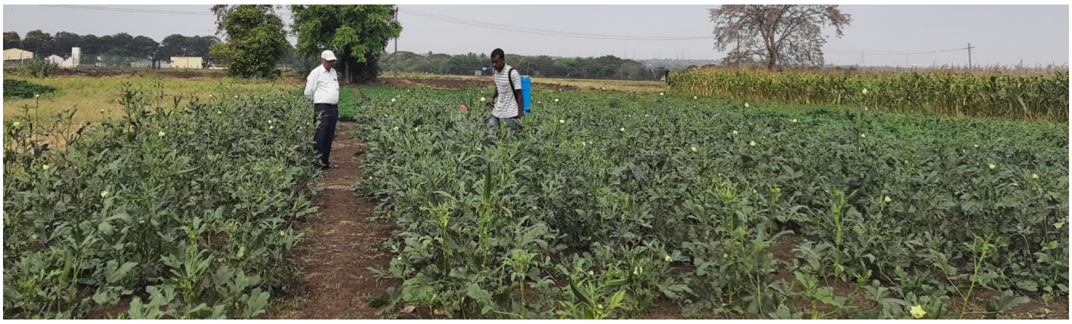

Fig. 1. Experimental view of Okra conducted at UAS, Dharwad.

(A)

(B)

Fig. 2. Powdery mildew diseases severity, (A) Untreated Control, (B) T4: Flupyram 17.7% + Tebuconozole 17.7 % SC) (Luna experience) at 0.125 %.

CONCLUSIONS

It is noteworthy that, from present investigation for the management of powdery mildew disease in Okra exhibited that all the evaluated fungicides have shown a promising efficacy as compared to the control against the disease. However, out of the treatments, the Flupyram 17.7% + Tebuconozole 17.7 % SC (Luna experience) at 0.125 per cent concentration shown better controlling potential against the disease with (38.80 %). with Okra yield of 92.15 q/ha. Therefore, Flupyram 17.7% + Tebuconozole 17.7 % SC (Luna experience) at 0.125 per cent concentration is recommended for management of powdery mildew disease of Okra.

FUTURE SCOPE

The effective fungicides identified in this study can be further tested in multiplications for their efficacy and resistance breakdown and can be recommended to farming community for effective management of okra powdery mildew.

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Conflicts of Interest. None.

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