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AH Jadav
Department of Plant Pathology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

B Manoj Kumar
Department of Plant Pathology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

DL Kadvani
Department of Plant Pathology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

TM Patel
Department of Plant Pathology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Correspondence
AH Jadav
Department of Plant Pathology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Efficacy of various fungicides for the management of okra powdery mildew caused by *Erysiphe cichoracearum* DC

AH Jadav, B Manoj Kumar, DL Kadvani and TM Patel

Abstract
Powdery mildew caused by *Erysiphe cichoracearum* DC is one of the major constraints in the production of okra. Farmers have to spray fungicides regularly for disease management. In order to find out the effective fungicides against *Erysiphe cichoracearum* experiment was carried out under *in vivo*. The relative efficacies of six different fungicides were tested in different concentration. Among the different fungicides, propiconazole (0.025%) was the most effective fungicide with 5.67 per cent disease intensity and maximum disease control of 76.46 per cent followed by wettable sulphur (0.2%). The highest yield of 93.25 q/ha was obtained in the treatment of propiconazole closely followed by wettable sulphur with 88.19 q/ha.

Keywords: Fungicides, mildew caused, *Erysiphe cichoracearum* DC

Introduction
Powdery mildew has long been known as important disease of plants in all parts of world. Okra (*Abelmoschus esculentus* (L.) Moench) is the only vegetable crop of significance in the Malvaceae family and it is very popular in the tropical areas including Asia and South America. It has been called "a perfect villager's vegetable" because of its robust nature, dietary fibers and distinct seed protein balanced in both lysine and tryptophan amino acids (Kumar *et al*., 2010) [9]. In India this crop is grown area of about 5.03 lakh hectare with the production of about 5708.7 MT and productivity 11.34 tonne per hactare. In India, major okra growing states are West Bengal, Gujarat, Orissa, Bihar, Jharkhand, Madhya Pradesh and Andhra Pradesh (Anon., 2015) [2]. The okra plant is affected by a number of diseases caused by fungi, nematodes, virus and phytoplasma. Fungal diseases like wilt (*Fusarium oxysporum* f. sp. *vasinfectum*), root rot (*Fusarium solani* (Mart) Sacc.), damping off (*Pythium* spp.), fruit rot (*Pythium aphanidermatum* and *Phytophthora palmivora*), Phyllosticta leaf spot (*Phyllosticta hibiscini* Ell and Ev.), Alternaria leaf spots (*Alternaria hibiscinum*), powdery mildew (*Erysiphe cichoracearum* DC.) (Arden and Alan, 1986; Rangaswami and Mahadevan, 2004) [3, 13], among these, powdery mildew of okra caused by *E. cichoracearum* is an important disease. It is a routine practice for farmers to spray fungicides onward from one month age to maturity of the crop to save fruit yield from the epidemic of disease. There is complete failure of the crop, if disease occurs in epidemic form. Sridhar and Sinha (1989) [15] conducted field trials during 1985-88 to assess the loss caused by powdery mildew (*Erysiphe cichoracearum*) of okra (*Hibiscus esculentus*) and its control. The results indicated that loss in yield of 17-86.6 per cent was directly related to the age of the plant at the time of infection. The disease is air borne in nature and spreads in entire field within short duration under moderately cool and dry weather condition. In such congenial condition, the crop must be protected with frequent applications of fungicides. The conventional fungicides has been recommended earlier and currently used for control of disease but may cause phytotoxic effect under high temperature and residue problems which affect the export of produce. Nowadays, new molecules are available in market with less toxicity used by various workers in different crops. The effectiveness of propiconazole in various crop *viz.*, fenugreek (Dhruj *et al*., 2000) [5], coriander (Singh, 2006) [14], pea (Prasad and Dwivedi 2007) [12], coriander (Akbari and Parakhia 2010) [1], and sunflower (Dinesh *et al*., 2011) [7] has been reported. The wettable sulphur for controlling powdery mildew disease in fenugreek (Dange *et al*., 2003) [4], coriander (Patel *et al*., 2008 [11] and okra (Dhutraj, 2011) [6] has been reported.

However, the effectiveness of new molecules is essential to be tried for management of powdery mildew of okra in Gujarat region of India. Although, chemical control by fungicides may have negative environmental effects and limitations but fungicides still constitute the predominate part of the control measures used against powdery mildew. Use of relatively safe chemicals has become more popular in recent times because of their quick results, less pesticides residue toxicity and especially in absence of resistant varieties.

Methodology

For studying the efficacy of different fungicides against *Erysiphe cichoracearum* of okra *in vivo*, six different fungicides *viz*., Tebuconazole + trifloxystrobin, hexaconazole, propiconazole, azoxystrobin, dinocap and wettable sulphur were tested on okra *cv.* GJO-3 under field conditions during the *kharif*, 2017-18. The first spray of the fungicides was started on initiation of disease and followed by two spraying at fifteen days interval. Control was maintained by water spraying (Average 400 lit/ha) and without spraying of any fungicides. Observation on powdery mildew intensity was recorded seven days after last spray by selecting 10 plants randomly from each plot and plants were rated on 0-5 scale given by Kothari and Shekhawat, (1972) [8]. Each plant was evaluated for its disease reaction by scoring the per cent disease intensity.

Grade	Description
0	Healthy plants free from powdery mildew.
1	Minute scattered spots on leaf.
2	Small spots coalesce with each other and covering nearly one fourth of the leaf surfaces. 25 per cent leaf area of plant infected.
3	Patches covering equal to the half of the leaf surface i.e. 26-50 per cent leaf area of plant infected.
4	More than three fourth of the leaf area under powdery coating. Covering 51-75 per cent leaf area of infected plant.
5	Sever infection, powdery growth covering 75-100 per cent leaf area and defoliation common.

Per cent disease intensity (PDI) was calculated by using the following formula:

$$PDI = \frac{\text{Sum of total rating}}{\text{Total plants observed}} \times \frac{100}{\text{Maximum disease rating}}$$

The per cent disease control and the percentage deviation in yield were calculated with the help of the following formula (Mathur *et al*., 1971) [10].

$$PDC\ (\%) = \frac{\text{P.D.I. in check-P.D.I. in treatment}}{\text{P.D.I. in check}} \times 100$$

Results and Discussion

Effect of different fungicides against *Erysiphe cichoracearum* on okra was tried in field condition during *kharif*, 2017-18. Data presented in table 1 revealed that all fungicides tested reduced the disease significantly as compared to the control. The Propiconazole (0.025%) was the most effective fungicides with 5.67 per cent disease intensity followed by wettable sulphur (0.25%) with 8.82 per cent disease intensity. Tebuconazole + trifloxystrobin, hexaconazole, dinocap and azoxystrobin were found moderately effective with 12.29, 18.85, 26.17 and 36.96 per cent disease intensity, respectively. Maximum disease control of 76.46 per cent was also observed in the treatment of propiconazole followed by treatment wettable sulphur by 70.47 per cent as compared to control.

Table 1: Effect of different fungicides against powdery mildew of okra caused by *E. cichoracearum*

S. No.	Fungicides	Concent-ration (%)	Disease intensity (%) 2017-18	Disease control (%)
1	Tebuconazole 55% + Trifloxystrobin 25% WG	0.025	**20.53 *(12.29)	64.90
2	Hexaconazole 5% EC	0.005	25.73 (18.85)	56.01
3	Propiconazole 25% EC	0.025	13.77 (5.67)	76.46
4	Azoxystrobin 23% EC	0.025	37.44 (36.96)	35.99
5	Dinocap 48% EC	0.048	30.77 (26.17)	47.39
6	Wettable Sulphur 80% WP	0.25	17.27 (8.82)	70.47
7	Control (Water Spray)	-	47.94 (55.13)	18.04
8	Control	-	58.49 (72.68)	-
S.Em. ±			1.72	
C.D. at 5%			5.22	
C.V. %			9.46	

*Data given in parentheses are retransformed values
**Arcsine transformation used
Water was used average 400 lit/ha for spraying

Table 2: Effect of different fungicides on fruit yield

S. No.	Fungicides	Concentration (%)	Fruit yield q/ha 2017-18	Yield increased (%)
1	Tebuconazole 55% + Trifloxystrobin 25% WG	0.025	84.16	30.45
2	Hexaconazole 5% EC	0.005	79.70	26.56
3	Propiconazole 25% EC	0.025	93.25	37.23
4	Azoxystrobin 23% EC	0.025	67.13	12.81
5	Dinocap 48% EC	0.048	72.75	19.55
6	Wettable Sulphur 80% WP	0.25	88.19	33.63
7	Control (Water Spray)	-	63.82	8.29
8	Control	-	58.53	-
	S.Em. ±	-	7.54	-
	C.D. at 5%	-	22.87	-
	C.V. %	-	8.24	-

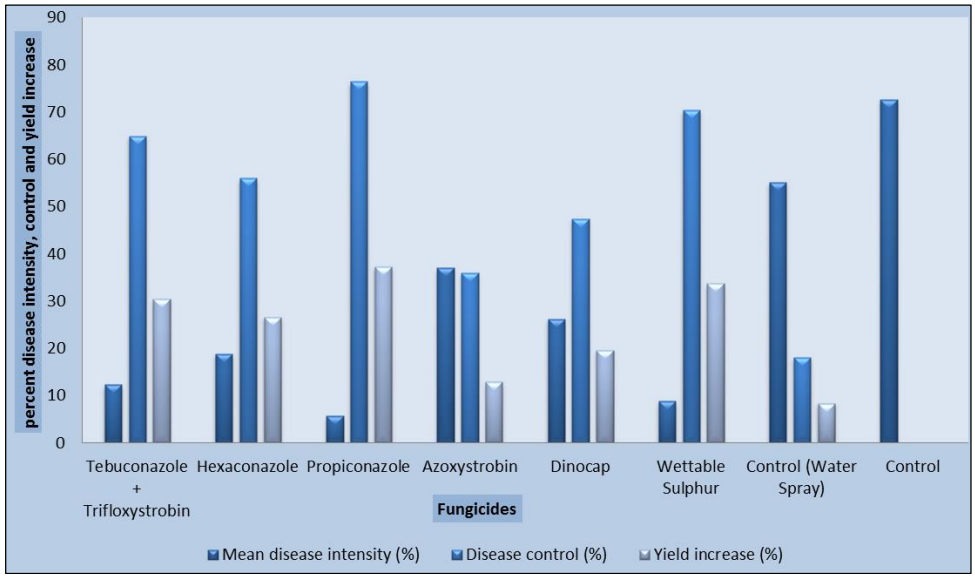

Fig 1: Per cent disease intensity, control and yield increased as influenced by different fungicides *in vivo* during *Kharif* 2017-18

The effectiveness of propiconazole in controlling of powdery mildew in various crop viz., fenugreek (Dhruj *et al*., 2000) [5], coriander (Singh, 2006) [14], pea (Prasad and Dwivedi, 2007) [12], coriander (Akbari and Parakhia, 2010) [1] and sunflower (Dinesh *et al*., 2011) [7] has been reported by several workers. It is evident from the data presented in table 2 that all fungicidal treatments significantly increased the okra yield. The highest okra yield of 93.25 q/ha was recorded in the treatment of propiconazole 0.025 per cent followed by wettable sulphur @ 0.25 per cent (88.19 q/ha). The other treatments *viz.*, tebuconazole + trifloxystrobin, hexaconazole, dinocap and azoxystrobin gave higher yield as compared to control. Maximum per cent yield increased in the propiconazole (37.23%) followed by wettable sulphur (33.63%). The other treatments like tebuconazole + trifloxystrobin, hexaconazole, dinocap, azoxystrobin and water spray gave 30.45, 26.56, 19.55, 12.81 and 8.29 per cent yield increased, respectively over the control (Fig. 1).

It is concluded from the experiment that effect of different fungicides against *Erysiphe cichoracearum* on okra was tried in field condition during *kharif* 2017-18. Propiconazole (0.025%) was the most effective fungicides with 5.67 per cent disease intensity followed by wettable sulphur (0.2%) with 8.82 per cent disease intensity. The highest okra yield of 93.25 q/ha was recorded in the treatment of propiconazole 0.025 per cent followed by wettable sulphur (88.19 q/ha).

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