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Management of powdery mildew of capsicum under protected cultivation

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Abstract
Protected cultivation of high value cash crops is gaining momentum in Karnataka and cultivation of capsicum has become the choice of farmers. Powdery mildew caused by *Leveillula taurica,* is one of the most serious disease of capsicum grown in naturally ventilated polyhouse is affecting the quantity and quality of fruits. An experiment was carried out to know the effect of different fungicides including recommended fungicides against powdery mildew disease of capsicum (F_1 hybrid 'Indra') in polyhouse during 2015. Among the 10 treatments, propiconazole at 0.1% proved to be best for the management of powdery mildew with minimum per cent disease index (9.64%), which was superior over all other treatments with maximum fruit yield of 98.00 t/ha which is followed by 0.1% of myclobutanil (11.90 PDI), tridemefon (13.03 PDI) and hexaconazole (15.86 PDI) with fruit yield of 94.62, 92.33, and 92.15 t/ha. Maximum per cent disease index (76.33%) was recorded in untreated control with less fruit yield (45.83 t/ha).

Keywords: capsicum, *Leveillula taurica,* fungicides, protected cultivation.

Introduction
Capsicum (*Capsicum annuum* L.) is also called as bell pepper or sweet pepper and is one of the most popular and highly remunerative, annual herbaceous vegetable crop. In India, capsicum is extensively cultivated in Andhra Pradesh, Karnataka, Maharashtra, Tamilnadu, Himachal Pradesh, and hilly areas of Uttar Pradesh. In Karnataka capsicum grown in area of about 3.89 thousand ha with a production of about 53.01 thousand tons (Anon, 2015). Under protected cultivation, capsicums are widely grown due to higher productivity and economic feasibility. Production of vegetables under protected cultivation system results in effective use of the land resources, besides being able to increase the production of quality vegetables both for the export and domestic markets by offsetting biotic and abiotic stresses to a great extent that otherwise is prevalent in open cultivation.

Farmers are facing problems of low yield and poor quality marketable produce due to various constrains like diseases, insect pests, lack of planting and management technology. Among these diseases are posing great threat to protected cultivation. The powdery mildew caused by *Leveillula taurica* (Lev.) Arn. (anamorph, *Oidiopsis taurica*), is one of the devastating disease of capsicum that cause significant yield losses up to 30 per cent (Cerkauskas and Brown, 1999 and Amar and Banyal, 2011) [4, 3]. Many systemic and non-systemic fungicides were reported to manage the powdery mildew of capsicum. The information on the efficacy of new fungicides against powdery mildew of capsicum is insufficient. Hence, there is a need to evaluate new fungicides against *Leveillula taurica*. By considering the seriousness of disease and the economic damage/exorbitant losses caused by the disease, the present investigation was carried out by using new different fungicides for its efficacy against powdery mildew diseases of capsicum under polyhouse.

Material and Methods
An experiment was conducted in naturally ventilated polyhouse at Zonal Agricultural and Horticultural Research Station, University of Agricultural and Horticultural Sciences, Shicamogga during *kharif* 2015. The experiment was laid out with 10 treatments *viz*., Azoxystrobin 8% EC (0.1%) , Carbendazim 50% WP (0.1%), Difenconazole 25% EC (0.1%), Hexaconazole 5% EC (0.1%), Iprobenfos 48%EC (0.1%), Myclobutanil 10% WP (0.1%) Propiconazole 25% EC (0.1%), Tridemefon 25%WP (0.1%), Wettable sulphur 80% WP (0.3%) and untreated control. Capsicum F_1 hybrid 'Indra' was sown in pro-trays and the

nursery was raised in polyhouse. The seedlings of 35 days old were transplanted at a spacing of 60×45 cm in nine rows divided into three parts of 20m length and every part considered as one replication. Three replications were used for each particular treatment in complete randomized block design.

All the foliar sprays (treatments) were given as per their doses. The first spray of fungicides was done after first appearance of disease. The same concentration was followed for second and third sprays at 15 days interval with untreated plots served as control. The severity of powdery mildew was scored at 10 days interval after each spray. The disease severity of powdery mildew was recorded on 10 plants and 10 leaves on lower, middle and upper leaves by using 0-9 disease rating scale (Mayee and Datar, 1986) [6] and PDI was worked out as per the standard formula. The yield details were also recorded.

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

Results and Discussion

The result of the experiment is presented in Table 1. It was very clear that all the treatments reduced the disease significantly compared to the unsprayed control plot after second spray. Among all treatments propiconazole was found most effective against powdery mildew which was significantly superior over other treatments. After second spray, minimum PDI of 9.64% was noticed in propiconazole treatment which is significantly superior over all the treatments followed by myclobutanil (11.90%), triadimefon (13.03%) and hexaconazole (15.86%). Maximum per cent disease index (76.33%) was recorded in untreated control. It was also clear that, 0.1% propiconazole spray provided 87.36 per cent control followed by myclobutanil and triadimefon which showed maximum control of powdery mildew (84.41 and 82.93%). Spray of hexaconazole and azoxystrobin were also found effective with 79.22 and 71.80 per cent disease control. Further, iprobenfos and difenoconazole found effective by showing 64.60 and 63.53 per cent reduction of disease over control. Whereas, carbendazim was least effective with 54.26 per cent disease control even after two sprays followed by wettable sulphur (57.67%).

Maximum yield was recorded with propiconazole treatment (98.00 t/ha) which was on par with myclobutanil (94.62 t/ha) and triadimefon (92.33t/ha) and least yield was recorded in unsprayed control (45.83 t/ha). The results after two sprays revealed that, among the 10 treatments 0.1 per cent of propiconazole, myclobutanil and triadimefon were highly superior over other fungicides followed by hexaconazole and azoxystrobin at 0.1 per cent concentration. Whereas, difenoconazole and iprobenfos at 0.1 per cent concentration was moderately effective and remained statistically on par with each other.

Chemicals are the most common and practical method for the management of powdery mildew disease. Foliar spray of propiconazole provided more than 87 per cent control of powdery mildew in bell pepper. Very few reports are available on the management of powdery mildew of capsicum. Propiconazole, hexaconazole and Difenconazole at 0.1 per cent effectively managed the powdery mildew disease. These are sterol inhibiting fungicides. Ergosterol is essential to the structure of cell wall and its absence causes irreparable damage to the cell wall and fungus dies. They will also interfere in conidia and haustoria formation. They change the sterol content and saturation of the polar fatty acids leading to alterations in membrane fluidity and behaviour of membrane bound enzymes (Nene and Thapliyal, 1993) [7]. They affect the cytochrome P- 450 enzymes the inhibitors of sterol C-14 demethylation. Due to this they act against most of the Ascomycota group fungal pathogens, whereas strobulirins act through inhibition of respiration by binding to the Qo center of the cytochrome-b. These strobulirins have very broad and balanced spectrum of activity on the foliage and have very favorable toxicological profile rapidly dissipating from soil and surface water which are unlikely to cause hazard to non target organisms and they have both protective and curative effect (Singh, 2005) [10]. Several workers reported that, propiconazole, myclobutanil, penconazole, triadimefon and hexaconazole were found to be effective in reducing powdery mildew incidence in different crops (Hooda and Parashar, 1985; Sharma, 1991; Singh *et al.*, 2000; Sharmila *et al*.,, 2004; Singh, 2006; Pramod Prasad and Dwivedi, 2007 and Akhileshwari *et al*., 2012) [5, 11, 14, 12, 13, 8, 2]. Some of them found that the efficacy of penconazole against *E. cichoracearum* was due to reduction of ergosterol biosynthesis in pathogen, which interferes with haustoria formation. The non-systemic fungicide, wettable sulphur at 0.2 per cent concentration was found less effective to reduce the powdery mildew incidence significantly over unprotected control and the efficacy of wettable sulphur and carbendizim were less when compared to the other systemic fungicides. Similar results were obtained by Sharma (1991) [11], who observed that mancozeb and wettable sulfur were least effective in managing the powdery mildew (*E. betae*) of sugar beet.

Overall, the use of systemic fungicides for the management of powdery mildew found to be very effective than spraying of non-systemic fungicide wettable sulphur. The present findings also demonstrate that fungicides may have important implications for controlling such diseases especially under protected cultivation regime. With the results reported here, foliar application of fungicides could become effective component of an integrated disease management system for capsicum.

Table 1: Evaluation of fungicides against powdery mildew of capsicum under polyhouse condition

Sl. No.	Treatments	Concentration (%)	Per cent disease index	Per cent disease reduction over control	Yield (tons/ha)
1	Azoxystrobin 8% EC	0.1	21.53 (27.66)*	71.80	91.30
2	Carbendazim 50%	0.1	34.92 (36.24)	54.26	88.44
3	Difenconazole 25% EC	0.1	27.84 (31.86)	63.53	91.00
4	Hexaconazole 5% EC	0.1	15.86 (23.48)	79.22	92.15
5	Iprobenfos 48% EC	0.2	27.02 (31.34)	64.60	90.11
6	Myclobutanil 10% WP	0.1	11.90 (20.19)	84.41	94.62
7	Propiconazole 25% EC	0.1	9.64 (18.10)	87.36	98.00
8	Tridemefon 25%WP	0.1	13.03 (21.17)	82.93	92.33
9	Wettable sulphur 80% WP	0.1	32.31 (34.66)	57.67	87.33

10	Untreated control	-	76.33 (60.92)	-	45.83
	SE.m ±		0.37	-	0.32
	CD (5%)		1.11	-	0.95

*Figures in parenthesis are arc sine transformed values

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