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In vivo efficacy of fungicides against powdery mildew of chilli caused by *Leveillula taurica* (Lev) Arn.

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Abstract

Powdery mildew of chilli incited by *Leveillula taurica* is one of the most serious diseases of chilli. Field experiment was carried out to know the effect of different fungicides against powdery mildew of chilli during *kharif*, 2015 at Research Farm, Horticulture Research Scheme (Vegetable), VNMKV, Parbhani (M.S.) India. Seven fungicides *viz.*, Carbendazim, Hexaconazole, Propiconazole, Penconazole, Wettable sulphur, Tridemorph and Mancozeb were tested against powdery mildew of chilli. Among the seven treatments minimum per cent disease severity recorded in Wettable sulphur (T₅) (15.51%) followed by Penconazole (T₄) (15.66%), Hexaconazole (T₂) (16.28%), Propiconazole (T₃) (18.08%), Carbendazim (T₁) (22.10%), Tridemorph (T₆) (23.30%) and Mancozeb (T₇) (25.31%). Highest per cent disease incidence recorded in control (T₈) (37.56%).

Keywords: chilli, *Leveillula taurica*, powdery mildew, fungicides, wettable sulphur, penconazole

Introduction

Chilli (*Capsicum annum* L.), is an important solanaceous vegetable cum spice crop. It is also known as 'Red Pepper'. Chilli, the native of New World of tropics and sub-tropics was introduced into India from Brazil in 16th century by the Portuguese. It is good source of vitamin A, vitamin C and thiamine. Pungency, one of important quality attributes of *Capsicum species* is due to the presence of alkaloid 'capsaicin' in the fruit and also contains capsanthin and oleoresin. India is the largest producer of chillies in the world. The area, production and productivity of chilli were 774.87 thousands hectares, 1492.14 thousands MT and 1.93 MT/ha respectively (Indiastat, 2013-2014) [2]. The major growing states of the country and the major growing states in terms of production share are Andhra Pradesh, Karnataka, Orissa, Maharashtra, West Bengal, Rajasthan and Tamil Nadu.

In Maharashtra, chillies are grown on an area of 99.50 thousands hectares with the production of 45.60 thousands MT and productivity 0.46MT/ha (Indiastat, 2013-2014) [2]. Chilli crop suffers with many fungal, bacterial, viral and nematode diseases resulting huge yield losses. Major diseases of chilli are: damping off, anthracnose or fruit rot or dieback, wilt, leaf spots, powdery mildew and root rot. Among these diseases fungal disease powdery mildew caused by *Leveillula taurica* (Lev.) Arn. is a major constraint in chilli production in India causing heavy yield loss ranging from 14 to 24% due to severe defoliation and reduction in photosynthesis, size and number of fruits per plant (Mathur, *et al.* 1972, and Gahokar and Peshney, 1981) [3, 1]. Considering economic importance of powdery mildew of chilli different fungicides were tested under field condition.

Materials and Methods

The field trial was conducted during Kharif, 2015 at Research Farm, Horticulture Research Scheme (Vegetable), VNMKV, Parbhani (M.S.) India. The experiment was laid out in Randomized Block Design (RBD) with three replications and eight treatments with control. The seeds of chilli cv. Pusa Jwala were sown in small beds and the nursery was raised. The seedlings of 35 days old were transplanted to the main field by following spacing of 60×45 cm and with plot size of 2.4×3.15 m. The recommended package of practices was followed for the trial.

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 spray at 7 days interval with untreated plots served as control. The severity of powdery mildew was scored at 7 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) [4] and expressed as Percent Disease Index (PDI) (Wheeler, 1969) [10].

$$\text{PDI} = \frac{\text{Summation of numerical ratings}}{\text{Total number of plants observed} \times \text{Maximum rating}} \times 100$$

Further, per cent disease control (PDC) was worked out by applying the formula:

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

Grade	Percent Infection
0	0%
1	1-10%
3	11-25%
5	26-50%
7	51-75%
9	>75%

Statistical analysis

All the data related to diseases incidence and yield was statistically analyzed. Calculations were made after applying the test of significance of the means (Panse and Sukhatme, 1978) [7].

Experimental details

List of fungicides used

Sr. No.	Common name	Trade name, Active ingredient	Conc. Used	Price (Rs)	Manufacturer
1.	Carbendazim	Bavistin 50% WP	0.1%	800/kg	BASF India Ltd, Mumbai
2.	Hexaconazole	Contaf 5%EC	0.1%	572/ lit	Syngenta Ltd, Mumbai
3.	Propiconazole	Tilt 10%EC	0.1%	1328/lit	Syngenta Ltd, Mumbai
4.	Wettable sulphur	Sulfex 80% WP	0.3%	200/kg	Syngenta Ltd, Mumbai
5.	Mancozeb	Dithane M-45 75%WP	0.05%	1800/lit	Syngenta Ltd., Mumbai
6.	Penconazole	Topas 10% EC	0.1%	1700/lit	Rallis India Ltd, Mumbai
7.	Tridemorph	Calixin 80%EC	0.05%	700/kg	BASF India Ltd, Mumbai

Results and Discussion

Effect of fungicides on severity of chilli powdery mildew

Results (Table 1) revealed that all fungicides significantly reduced the powdery mildew severity. The per cent disease severity recorded before spray treatments was ranged from (7.5%) Wettable Sulphur to 10.9% (control) respectively, which was statistically non significant. The per cent powdery mildew disease severity recorded after first spray treatments ranged from 17.31% to 44.31% respectively. The highest disease severity of 44.31% recorded from the plots receiving untreated control plots which was followed Mancozeb (34.30%), Tridemorph (31.20%), Carbendazim (30.00%), Propiconazole (24.50%), Hexaconazole (21.13%), Penconazole (19.31%) and Wettable sulphur (17.31%), respectively. The lowest disease severity after first spray was recorded in plot receiving sprays of Wettable Sulphur (17.31%), followed by Penconazole (19.31%), Hexaconazole (21.13%), Propiconazole (24.50%), Carbendazim (30.00%), Tridemorph (31.20%) and Mancozeb (34.30), respectively. After second spray, the disease severity was in the range of 16.9% to 45.81%. The highest disease severity of 45.81% was recorded in plots receiving control which was statistically at par with the disease severity recorded in untreated control plots.

The plots receiving sprays of Wettable Sulphur (T₄) exhibited lowest disease severity of 16.91% followed by Hexaconazole

(T₂) (19.35%), Penconazole (20.71%) Propiconazole (T₃) (21.40), Carbendazim (T₁) (26.66%) and Tridemorph (T₅) (27.86%) and Mancozeb (T₇) (31.41) respectively.

The highest per cent disease severity after third spray (47.50%) was recorded in the untreated control plots (T₈) which was significantly higher than other treatments. It was followed by the plots receiving Mancozeb (27.13%) Tridemorph spray (23.97%), Carbendazim (22.77%), Propiconazole(17.93%), Wettable sulphur and Hexaconazole (16.40%) respectively. The plots receiving sprays Penconazole recorded lowest disease severity (14.90%), Third spray followed by Wettable Sulphur (16.35%), Hexaconazole (16.40%), Propiconazole (17.93%) and Carbendazim (22.77%), respectively.

The highest mean per cent disease severity of (37.56%) was observed in untreated control plots. In the plots receiving fungicidal spray, the highest mean per cent disease severity of (25.31%) was observed in the plots receiving Mancozeb spray followed by the plots receiving sprays of Tridemorph (23.30%), Carbendazim (22.10%), and Propiconazole (18.08%) respectively. The lowest mean per cent disease severity was recorded from the plots receiving the sprays of Wettable Sulphur (14.51%) which was followed by the plots receiving sprays Penconazole (15.66%) and Hexaconazole (16.28%), respectively.

Table 1: Effect of fungicides on severity of chilli powdery mildew

Sr. No.	Treatment	Disease severity (%)*				
		At first appearance	After spray first	After spray second	After spray third	Mean P S
T ₁	Carbendazim	9.05 (17.48)	30.00 (32.21)	26.66 (31.08)	22.77 (28.50)	22.10 (28.04)
T ₂	Hexaconazole	8.25 (16.70)	21.13 (23.37)	19.35 (26.10)	16.40 (23.90)	16.28 (23.28)
T ₃	Propiconazole	8.50 (16.95)	24.50 (29.68)	21.40 (27.56)	17.93 (25.06)	18.08 (25.17)
T ₄	Penconazole	7.75 (16.17)	19.31 (26.08)	20.71 (27.08)	14.90 (22.71)	15.66 (23.32)
T ₅	Wettable sulphur	7.5 (15.90)	17.31 (24.59)	16.91 (24.29)	16.35 (23.86)	14.51 (22.4)
T ₆	Tridemorph	10.25 (18.68)	31.20 (33.97)	27.86 (31.87)	23.97 (29.28)	23.30 (28.87)

T ₇	Mancozeb	8.40 (16.84)	34.3 (35.86)	31.41 (34.10)	27.13 (31.40)	25.31 (30.21)
T ₈	Control	10.9 (19.28)	44.31 (41.85)	45.81 (41.61)	47.50 (43.58)	37.56 (39.67)
	SE±	0.23	0.32	0.26	0.29	0.33
	CD@5%	0.72	0.98	0.80	0.87	1.02

*Mean of three replication, PDS- Per cent disease severity

Figures in parentheses are angular transformed values.

Effect of fungicides on disease intensity

Results (Table 2) revealed that all treatments significantly reduced the powdery mildew intensity (Plate-6) The per cent disease intensity recorded before spray treatments was in the range of 9.50% to 19.16% respectively.

The lowest per cent disease intensity after first spray (31.55%) was recorded in the plots receiving sprays of Wettable Sulphur (T₄) which was significantly lower than

other treatments and untreated control (79.75%). The plots receiving sprays of Carbendazim recorded the per cent disease intensity of (30.00%) which followed Tridemorph (31.20%), Penconazole (34.75%), Hexaconazole (38.03%), Propiconazole (44.09%), and Mancozeb (61.3%), respectively. The highest per cent disease intensity after first spray (79.75%) was recorded in the plots receiving untreated control.

Table 2: Effect of fungicides on intensity of chilli powdery mildew

Sr. No.	Treatment	Disease intensity (%)*				
		At first appearance	After spray first	After spray second	After spray third	Mean P I
T ₁	Carbendazim	9.50 (17.95)	30.00 (33.21)	26.67 (31.09)	22.71 (28.46)	22.10 (28.04)
T ₂	Hexaconazole	14.85 (22.67)	38.03 (38.06)	34.82 (36.12)	29.51 (32.88)	29.30 (32.78)
T ₃	Propiconazole	15.3 (23.03)	44.09 (41.61)	38.50 (38.28)	32.27 (34.59)	32.56 (34.81)
T ₄	Penconazole	13.94 (21.93)	34.75 (36.08)	37.27 (37.61)	26.81 (31.05)	28.19 (32.08)
T ₅	Sulfex	13.50 (21.56)	31.55 (33.85)	30.43 (33.40)	29.43 (32.75)	26.22 (30.8)
T ₆	Tridemorph	10.25 (18.68)	31.20 (33.97)	27.86 (31.87)	23.91 (29.28)	23.30 (28.87)
T ₇	Mancozeb	15.12 (22.88)	61.3 (51.53)	56.53 (47.48)	48.83 (44.32)	45.54 (42.44)
T ₈	Control	19.16 (25.95)	79.75 (63.25)	82.45 (63.23)	85.5 (67.61)	66.71 (39.65)
	SE ±	0.29	0.22	0.23	0.24	0.27
	CD@5%	0.89	0.69	0.70	0.72	0.82

*Mean of three replications

PI- Per cent Disease incidence

Figures in parentheses are angular transformed values

The lowest per cent disease intensity after second spray (27.86%) was recorded in the plots receiving sprays of Tridemorph which was significantly lower than other treatments and untreated control (82.45%). The plots receiving sprays of Wettable sulphur recorded the per cent disease intensity of 30.43% and Hexaconazole (34.82%) respectively. The highest per cent powdery mildew intensity after second spray was recorded from untreated control plot (82.45%) which was followed by plots receiving of Mancozeb (56.33%), Penconazole (37.27%), Propiconazole (38.50), Hexaconazole (34.82), Wettable sulphur (30.43%), and Tridemorph (27.86%), respectively.

The highest per cent disease intensity after third spray (85.50%) was recorded in the untreated control plot which was significantly higher than other treatments. After third spray, the plots receiving sprays of Carbendazim recorded per cent disease intensity of 22.71% which was statistically at par with plots receiving sprays Tridemorph (23.91), Penconazole (26.81%), Wettable Sulphur (29.43%), Hexaconazole (29.51%), Propiconazole (32.27%) and Mancozeb (48.83%) respectively. The fungicide Tridemorph (23.91) was statistically at par with Propiconazole (32.27%), and Mancozeb (48.83%).

The highest mean per cent disease intensity after third spray was observed in untreated control plots (85.5%). The plots receiving sprays of Mancozeb recorded per cent disease intensity of (48.83%) which was statistically at par with disease intensity recorded in the plots receiving third spray Propiconazole (32.27%), and Hexaconazole (29.51%). The lowest mean per cent disease intensity was recorded from the plots receiving the sprays Carbendazim (22.71%) which was statistically at par with the plots receiving sprays Tridemorph (23.91), Penconazole (26.27%), Wettable Sulphur (29.43%),

Hexaconazole (29.51%) and Propiconazole (32.27%), respectively.

Effect of fungicides on per cent disease control

Data obtained on per cent disease control revealed that after first spray highest per cent disease control of 60.44% was recorded in the plots receiving the sprays of Wettable Sulphur (Table 3).

The next best fungicide in controlling the disease after first spray was Penconazole which gave (56.42%) disease control over untreated control. This was followed by Hexaconazole (53.31%), Propiconazole (44.71%), Tridemorph (29.59%), Carbendazim (28.31) and Mancozeb (23.13%), respectively.

The highest per cent disease control after second spray (63.09%) over untreated control was recorded in the plots receiving sprays of Wettable sulphur, followed by the plot receiving the fungicidal sprays of Hexaconazole (57.77%), Penconazole (54.79%),

Propiconazole (53.85%), and Tridemorph (39.18%), Carbendazim (37.8%) and Mancozeb (31.43%), respectively.

After third sprays the scenario of per cent disease control in the plots receiving fungicidal sprays of Penconazole proved to be effective (68.43%), followed by Wettable sulphur (65.58%), Hexaconazole (65.49%), Propiconazole (62.26%), Tridemorph (50.33%), Carbendazim (49.12%) and Mancozeb (42.89%), respectively.

When the mean per cent disease control is taken in to consideration it was observed that plots receiving fungicidal sprays of Wettable sulphur gave per cent disease control 63.03% per cent over untreated control which followed by Penconazole (59.88%), Hexaconazole (58.85%) and Propiconazole (53.60%).

Lowest mean disease control observed in plot spraying Tridemorph (39.70%) respectively. Mancozeb (32.48%) followed by Carbendazim (28.39%),

Table 3: Effect of fungicides on chilli powdery mildew disease control

Sr. No.	Treatment	Disease control (%)*			
		After first spray	After second spray	After third spray	Mean PDC
T ₁	Carbendazim	28.39 (32.19)	37.80 (37.93)	49.12 (44.49)	38.87 (39.56)
T ₂	Hexaconazole	53.31 (46.89)	57.77 (49.47)	65.49 (54.02)	58.85 (50.09)
T ₃	Propiconazole	44.71 (41.96)	53.85 (47.20)	62.26 (52.09)	53.6 (47.06)
T ₄	Penconazole	56.42 (48.64)	54.79 (47.74)	68.43 (55.81)	59.88 (50.69)
T ₅	Wettable sulphur	60.44 (51.02)	63.09 (52.58)	65.58 (54.07)	63.03 (52.55)
T ₆	Tridemorph	29.59 (32.95)	39.18 (38.75)	50.33 (45.18)	39.7 (39.05)
T ₇	Mancozeb	23.13 (28.74)	31.43 (34.09)	42.89 (40.91)	32.48 (34.74)
T ₈	Control	-----	-----	-----	-----
	SE ±	0.37	0.28	0.23	0.26
	CD @ 5%	1.13	0.86	0.71	0.80

*Mean of three replications, PDC- Per cent disease control
Figures in parentheses are angular transformed values

Result of the present study obtained on efficacy of the fungicides in the management of powdery mildew of chilli caused by *Leveillula taurica* revealed that the Wettable sulphur significantly superior to rest of the treatments. Similar results were reported by several workers like Moghal *et al.* (1977) [5], Nema *et al.* (1982) [6], Singh and Lodha (1985) [8], Sridhar and Poonam Sinha (1989) [9] who proved that the powdery mildew was effectively controlled by Wettable sulphur (0.3%).

Conclusion

Among the seven tested fungicides *viz.*, Carbendazim, Hexaconazole, Propiconazole, Penconazole, Wettable sulphur, Tridemorph and Mancozeb against chilli powdery mildew caused by *Leveillula taurica* (Lev) Arn. Wettable sulphur @0.3% significantly controls the disease.

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