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Tolfenpyrad 15 % EC: New Broad Spectrum Pesticide to Manage Thrips and Powdery mildew in Chilli Ecosystem

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ABSTRACT: Chilli is an important commercial spice crop, in which sucking pests and powdery mildew are the major impediments. In this context, a field experiment was conducted at main agricultural research station Raichur, during *kharif* 2011-12 and 2012-13, to evaluate the bio-efficacy of new and third generation neonicotinoid group molecule tolfenpyrad 15 % EC at various dosages against chilli thrips, (*Scirtothrips dorsalis*) and powdery mildew (*Leveillula taurica)*. Results revealed that, tolfenpyrad 15 % EC at 150 g a.i/ha was found superior as it recorded less number of thrips (3.33/leaf) which resulted in higher dry chilli yield of 26.24 q/ha. Further, when its efficacy was tested separately against powdery mildew the compound at same dosage could able to reduce the disease with PDI of 25.47 and 29.11 (mean 22.56 %) together with maximum yield. *In vitro* evaluation of tolfenpyrad 15 % EC at different concentration revealed that, 150 g a.i/ha was able to inhibit spore germination up to 82.66 per cent. Further to check its efficacy, *In vitro* evaluation of systemic fungicides was done during 2019-20 by spore germination technique against powdery mildew, tolfenpyrad 15 % EC inhibited 85.58 per cent spore germination is boon to chilli farmers. Overall, field and lab studies revealed that, tolfenpyrad 15 EC @ 150 g a.i/ha provided wide spectrum and unique action in managing both thrips and powdery mildew of chilli with maximum yield.

Keywords: Chilli, Tolfenpyrad, Thrips and Powdery Mildew

INTRODUCTION

Chilli (*Capsicum annuum* L.) is an important commercial spice belongs to the genus *Capsicum* and it is grown for its fruits, which are used in green as well as dried form for its pungency. In India, the major chilli growing states are Andhra Pradesh, Karnataka, Maharashtra, Orissa, Rajasthan, Tamil Nadu and West Bengal (Geetha and Selvarani, 2017). In Karnataka, the major chilli growing districts are Belgaum, Haveri, Ballari, Dharwad, Raichur and Shivamogga. Even though the area under chilli cultivation in Karnataka is more, its production is low as compared to the other states because of the poor management of economically important pest and diseases.

The crop is attacked by many pests and diseases right from the seedling stage to till harvest. Among the sucking pests the major ones are thrips (*Scirtothrips dorsalis* Hood.) and mites (*Polyphagotarsonemus latus* Bank.) these two are the most persisting concealed, non visible pests and disperse by wind hence making their control very difficult followed by whiteflies (*Bemisia tabaci* Genn.) and fruit borer (*Helicoverpa armigera* Hub.) are of minor importance. 2004). Chilli thrips feeds on all plant parts but prefers young leaves, buds and fruits. Initial damage causes leaf distortion with older damage turning bronze to black (Venette and Davis, 2004). Heavy infestation causes stunted or dwarfed and totally defoliated plants. Chilli thrips is also capable of transmitting peanut necrosis virus, peanut chlorotic fan virus, and tobacco streak virus (Rao *et al*., 2003). Thrips alone may cause yield loss upto 11-75 % quantitatively and 60-80 % qualitatively under serious infestation (Ghosh *et al*., 2009). Equally crop also suffers from many diseases, among them powdery mildew [*Leveillulla taurica* (Lev.) Arn.] is a major constraint in chilli production in India causing heavy yield loss ranging from 14 to 30%, which causes severe defoliation and reduction in photosynthesis, size and number of fruits per plant (Smith, 2000; Sudha and Lakshmanan, 2009). Specially powdery mildew under irrigated eco-systems co-inciding with winter season will aggravate the disease severity and force the farmers to take 3-4 rounds of systemic fungicide spray (Gohokar and Peshney, 1981).

To manage these pests and diseases earlier workers have made several efforts in screening systematic and contact pesticides, which were narrow spectrum and species specific but none have lasted long rather it led to increased cost of cultivation, reduced soil health apart from polluting environment. Hence, chilli is known for high pesticide consumption in country happens to be number one among vegetables. In this context, developing new molecule having different mode of action with broad spectral activity is need of the hour. Therefore, it is essential to have a single chemical which can take care of both thrips and powdery mildew of chilli. So in the present experimental trial, tolfenpyrad 15 % EC [{4-chloro-3-ethyl-methyl-N-[4-(p-tolyloxy) benzyl) pyrazole-5-carboxamide}, a novel molecule belonging to pyrazole class of insecticides, was tested along with different pesticides for effective control of both thrips and powdery mildew.

MATERIALS AND METHODS

Field experiments were conducted under irrigated situation at Main Agricultural Research Station, Raichur during *kharif* 2011-12 and 2012-13 to evaluate the bio–efficacy of tolfenpyrad 15% EC at different dosages along with different group of insecticides and fungicides against chilli powdery mildew and thrips respectively. Popular chilli variety Byadagi dabbi was transplanted in the plots at row to row and plant to plant spacing of 75 cm × 45 cm, respectively.

Two separate field trials were conducted for thrips and powdery mildew, which were laid out in a randomized block design (RBD) with different treatments and three replications (Table 1). All the agronomic practices were adopted as per package of practices recommended by University of Agricultural sciences, Raichur except insecticidal and fungicidal sprays.

A. Bioefficacy of Tolfenpyrad 15 % EC against Thrips, Scirtothrips dorsalis

New chemistry tolfenpyrad 15 % EC was tested at three different doses *viz*., 100, 125 and 150 g a.i/ha and these treatments were compared with standard check treatments *viz*., imidacloprid 17.8 % SL, fipronil 5 % SC, clothianidn 50 % WG and thiamethoxam 25 % WG and the details were given in Table 1. Treatments were imposed when the crop was infested with thrips population sufficiently with knapsack sprayer. Prior to imposition of treatments, population of thips per leaf were recorded on five randomly selected plants in each replication per treatment. Similarly, post count on 3rd, 7th, 10th and 14th days after imposition was documented. Further, to confirm the data second application of treatments was made after a gap of 15 days and post count of the pest was registered as said above. Finally, dry chilli yield from individual treatments were harvested, weighed and converted to hectare basis before statistical analysis and analyzed for treatment superiority. The data generated on pest population was transformed to square root values before subjecting it for statistical analysis.

Table 1: Treatment details followed against Chilli thrips.

Treatments	Thrips (*Scirtothrips dorsalis* Hood.)	
	Treatments Details	**Dose (g a.i/ha)**
T_1	Tolfenpyrad 15 % EC (Kefun)	100
T_2	Tolfenpyrad 15 % EC (Kefun)	125
T_3	Tolfenpyrad 15 % EC (Kefun)	150
T_4	Imidacloprid 17.8 % SL (Confidar)	22.5
T_5	Fipronil 5 % SC (Regent)	50.0
T_6	Clothianidn 50 % WG (Dantap)	21.78
T_7	Thiamethoxam 25 % WG (Actara)	25.0
T_8	Untreated control	--

B. Bioefficacy of Tolfenpyrad 15 % EC against powdery mildew, Levilulla taurica

New molecule tolfenpyrad 15 % EC was tested at three different doses *viz*., 100, 125 and 150 g a.i/ha and these treatments were compared with standard check treatments *viz*., wettable sulphur 80% WP, myclobutanil 10% WP, hexaconazole 5% EC, the details of which is given in Table 2. Treatments were imposed with the onset of disease with knapsack sprayer. Disease severity was recorded using 0-9 scale (Mayee and Datur, 1986) on five randomly selected plants in each replication per treatment one day prior to imposition and at 7th day after imposition. The spray was repeated at 15 days interval. Subsequently the dry chilly yield obtained from individual treatments were harvested, weighed and converted to hectare basis before statistical analysis. The per cent disease index of powdery mildew of chilli was calculated using the formula:

$$\text{Per cent Disease Index (PDI)} = \frac{\text{Sum of the individual disease ratings}}{\text{Number of leaves observed}} \times \frac{100}{\text{Maximum disease grade}}$$

Disease Scale (0-9) followed is

Sr. No.	Scale	Reaction
1	0	No powdery mildew symptoms
2	1	<1% leaf area coverage by powdery mildew
3	3	1-10% leaf area coverage by powdery mildew
4	5	11-25% leaf area coverage by powdery mildew
5	7	26-50% leaf area coverage by powdery mildew
6	9	>51% leaf area coverage by powdery mildew

Table 2: Treatment details followed in the management of powdery mildew.

Treatments	Powdery Mildew (*Leveillulla taurica*)	
	Treatments Details	Dose (g a.i/ha)
T_1	Tolfenpyrad 15 % EC (Kefun)	100
T_2	Tolfenpyrad 15 % EC (Kefun)	125
T_3	Tolfenpyrad 15 % EC (Kefun)	150
T_4	Wettable sulphur 80% WP (Sulfex)	108
T_5	Myclobutanil 10% WP (Cygnet)	20
T_6	Hexaconazole 5% EC (Contaf)	25
T_7	Propiconazole 25 % EC (Tilt)	125
T_8	Difenconazole 25 % EC (Score)	125
T_7	Unsprayed control	--

C. In-vitro evaluation of different fungicides against conidial germination inhibition of Levellulla taurica

The sensitivity of *L. taurica* to different molecules at different concentrations was assessed under *In vitro* conditions by spore germination technique as given below. The same treatments which were used in *In-vivo condition* were evaluated *in vitro* at various dosages against *L. taurica*. The required concentrations of fungicides were prepared by dissolving known quantity of fungicides in known quantity of sterile distilled water separately under aseptic conditions. Twenty five microliter of each fungicide was pipetted out on cavity slides and powdery mass was added. Three replications were maintained for each treatment. Effect of fungicides and their concentrations on the germination of conidia were observed after 24 h of incubation in a moist chamber (Hundekar, 1999). A control was maintained with distilled water. Further to check its efficacy, *In-vitro* evaluation of ten systemic fungicides *viz.,* azoxystrobin 23% SC, carbendazim 50% WP, difenconazole 25% EC, hexaconazole 5% EC, myclobutanil 10% WP, penconazole 100% EC, propiconazole 25% EC, tolfenpyrad 15% EC, thiophenyte methyl 41.7% SC and tebuconazole 25.9 % EC were evaluated *In-vitro* at different concentrations were evaluated during 2019-20 against powdery mildew of chilli by spore germination technique. Per cent inhibition over the control was calculated by using the formula given by Vincent (1947) and later data was analyzed statistically.

$$I = \frac{C-T}{C} \times 100$$

Where, I = Percent inhibition

C = Germination of conidia in control

T = Germination of conidia in treatment

RESULTS AND DISCUSSION

A. Efficacy of different pesticides against thrips, Scirtothrips dorsalis

The results showed significant difference among all the treatments in both the consecutive years (2011-12 and 2012-13). Among the different treatments newer molecule tolfenpyrad 15% EC recorded least population of thrips with maximum marketable yield of chilli. The pooled data analysis showed that, test compound tolfenpyrad 15 % EC at 150 g a.i/ha. recorded least population of 2.86, 2.77, 3.37 and 3.73 thrips per leaf at 3, 7, 10 and 14 days after spraying, respectively and it was statistically on par with its lower dosage at 125 g a.i/ha which registered 2.95, 3.46, 3.91 and 4.44/leaf at 3, 7, 10 and 14 days after spraying, respectively. These two treatments differed significantly with all other treatments. However, the standard check treatments have followed the next order of merit as clothianidin 50 % WG at 21.78 g a.i/ha, thiamethoxam 25% WG at 25 g a.i/ha and fipronil 5 % SC at 50 g a.i/ha. All these treatments differed significantly over untreated control which suffered heavily from thrips population (Table 3).

Table 3: Efficacy of Tolfenpyrad 15 % EC against Chilli thrips (pooled data of 2011-12 and 2012-13).

Tr. No.	Treatment Details	Dose (g a.i/ha)	Pre - count	No. of thrips/ leaf				Mean	Dry chilli yield (q/ha)	B:C ratio
				3 DAA	7 DAA	10 DAA	14 DAA			
T_1	Tolfenpyrad 15 % EC	100	6.70 (2.67)*	4.44 (2.21)	5.01 (2.34)	5.62 (2.46)	6.41 (2.62)	**5.37**	**21.67**	1: 4.00
T_2	Tolfenpyrad 15 %	125	6.50 (2.65)	2.95 (1.85)	3.46 (1.98)	3.91 (2.08)	4.44 (2.20)	**3.69**	**24.92**	1: 4.60
T_3	Tolfenpyrad 15 % EC	150	6.56 (2.65)	2.86 (1.72)	2.77 (1.80)	3.37 (1.94)	3.73 (2.05)	**3.33**	**26.24**	1: 4.78
T_4	Imidacloprid 17.8 % SL	22.5	6.50 (2.62)	4.44 (2.22)	5.04 (2.35)	5.41 (2.42)	6.38 (2.61)	**5.31**	**18.99**	1: 3.69
T_5	Fipronil 5 % SC	50.0	6.46 (2.69)	5.40 (2.43)	5.91 (2.53)	7.46 (2.63)	7.11 (2.74)	**6.47**	**16.15**	1: 3.06
T_6	Clothianidin 50 % WG	21.78	6.60 (2.67)	3.75 (2.18)	3.98 (2.11)	4.36 (2.19)	4.60 (2.25)	**4.17**	**21.07**	1: 4.05
T_7	Thiamethoxam 25 % WG	25.0	6.74 (2.69)	4.31 (2.18)	5.52 (2.45)	5.38 (2.45)	6.10 (2.56)	**5.32**	**19.15**	1: 3.72
T_8	Untreated control	--	6.45 (2.63)	7.16 (2.74)	7.30 (2.78)	7.52 (2.69)	8.05 (2.91)	**7.50**	**9.50**	1: 1.88
	S.Em (±)		0.13	0.08	0.10	0.09	0.08	**0.09**		
	CD at 5 %		0.39	0.24	0.30	0.26	0.25	**0.26**	**1.88**	
	CV (%)		6.39	9.43	10.68	11.49	11.24	**10.71**	**10.14**	

DAS – Days after spray; NS: Non-Significant
*Figures in parentheses are square root transformed $\sqrt{x+1}$ values

Highest dry chilli yield of 26.24 qt/ha was realized from tolfenpyrad 15 % EC at 150 g a.i/ha with highest benefit cost ratio 1:4.78 and this showed non significance with next lower dosage of 125 g a.i/ha (24.92 q/ha) with 1:4.60 B:C ratio as compared to the other treatments with the lowest yield in untreated control. Standard check treatments *viz.*, clothianidin 50 % WG at 21.78 g a.i/ha (21.07 q/ha with 1:4.05), thiamethoxam 25 % WG at 25 g a.i/ha (19.15 q/ha with 1:3.72), imidacloprid 17.8 % SL at 22.50 g a.i/ha (18.99 q/ha with 1:3.69), and fipronil 5 % SC at 50 g a.i/ha (16.15 q/ha with 1:3.06) were followed next order of merit. Untreated control recorded lowest yield of 9.50 q/ha with 1:1.88 benefit cost ratio (Table 3).

Chemicals are the most common and practical method for the management of pest and diseases. Kalyan *et al*. (2014) studied the bioefficacy of tolfenpyrad 15% EC against sucking pests of cotton. They observed that, the doses of tolfenpyrad 15% EC at 125 and 150 g a.i./ha were significantly superior to imidacloprid 17.8 SL and thiamethoxam 25 WG in suppressing the population of sucking pests in cotton. Similarly, (Bajpai *et al*. 2013) who reported that maximum reduction in aphid population after third, seventh and 14^{th} days after sprays ranged from 24.45 to 97.14 % in tolfenpyrad at 150 and 125 g a.i/ha. Similar report of Mandal, (2013) showed the doses ranging from 125 to 150g a.i./ha, of tolfenpyrad effectively controlled sucking pest complex in okra and cotton particularly thrips and capsule borers of chilli and onion. Bajpai and Singh, (2010) also found tolfenpyrad 15EC at 150 g a.i./ha was very effective against sucking pests of okra. Patil *et al*. (2009) also confirmed the effectiveness of tolfenpyrad 15 EC against sucking pests compared to other chemicals.

B. Efficacy of different pesticides against powdery mildew (Levilulla taurica) of chilli

The powdery mildew severity differed significantly with respect to all the treatments at all stages of observations. It was very clear that all treatments reduced the disease significantly compared to standard check and unsprayed control plot. Among different treatments propiconazole 25% EC was found most effective and it was significantly superior to other treatments against powdery mildew. The pooled analysis of two years data showed that minimum per cent disease index (PDI) of 20.95 per cent was noticed in propiconazole 25% EC treatment, followed by difenconazole 25% EC (21.30%) and tolfenpyrad 15% EC at 150 (22.56%). Rest of the treatments showed comparatively more disease severity, particularly in tolfenpyrad 15% EC at 125 g a.i./ha (31.52 %) hexaconazole 5 % EC (31.54 %), myclobutanil 10% WP (36.27%), wettable sulphur 80 % WP (38.78%) and tolfenpyrad 15% EC at 100 g a.i./ha (39.19%). Maximum disease severity (60.80%) was noticed in untreated control plot (Table 4).

At the end of the two seasons when we observe yield with powdery mildew incidence, highest yield was recorded in tolfenpyrad 15 % EC at 150 g a.i/ha (24.94 q/ha) with least powdery mildew severity and it is significantly superior over all the treatments. This was followed by propiconazole (23.45 q/ha), tolfenpyrad 15 % EC 125 g a.i/ha (22.67 q/ha) and difenconazole 25% EC (22.22 q/ha). Yield of 21.97, 21.71 and 21.61 q/ha was harvested from the plot sprayed with Hexaconazole 5 EC and tolfenpyrad 15% EC at 100 g ai/ha respectively and which were on par with each other. In myclobutanil 10% WP (19.33 q/ha) and wettable sulphur 80% WP (17.29 q/ha) very less yield was recorded when compared to the other treatments. Minimum yield of 11.64 q/ha was recorded from the untreated control plot (Table 4). The highest benefit-cost ratio was recorded in propiconazole 25 EC (1: 4.56) and tolfenpyrad 15% EC at 150 g ai/ha (1:4.37) followed by other treatments.

Sterol biosynthesis inhibiting triazole fungicides *viz*., propiconazole, hexaconazole and difenconazole effectively managed the powdery mildew disease as ergosterol is essential to the structure of cell wall and its absence makes damage to the cell wall and it dies. They mainly interfere in conidia and haustoria formation (Nene and Thapliyal, 1993). The present results are comparable with observation made by earlier workers who reported that, propiconazole, myclobutanil, triadimefon and hexaconazole were found to be effective in reducing powdery mildew incidence in different crops *viz*., powdery mildew of sugarbeet (Sharma, 1991); chilli powdery mildew (Sharmila *et al.* 2004); Powdey mildew of sunflower (Akhileshwari *et al*. 2012); chilli powdery mildew (Daunde *et al.* 2018) who indicated that foliar spray of propiconazole provided 88.00 per cent control over powdery mildew and Raju *et al.* (2017) showed that propiconazole at 0.1% recorded maximum yields of 36.13 q/ ha in chilli.

C. In vitro efficacy of systemic fungicides against L. taurica by spore germination technique

The management of diseases by chemical means demands judicial usage accordingly to the kind of organism involved and its severity. Hence, to know the field efficacy of any new fungicide molecules, there is need to test chemical under laboratory condition which provides useful and preliminary information regarding efficacy of fungicides against pathogen within a shortest period of time.

Conidial germination and per cent conidial inhibition of the pathogen were tested *in vitro* and the results were summarized in Fig.1. It was evident from the results that out of six chemicals tested in laboratory, propioconazole 25% EC and difenconazole 25% EC showed the lowest conidial germination (11.86 % and 10.77 %) and conidial germination inhibition (85.15 and 86.52 %) respectively.

Table 4: Efficacy of tolfenpyrad 15 % EC against chilli powdery mildew during 2011-12 and 2012-13.

Sr. No.	Treatments	Dosage (g. a. i or ml or g /l)	Powdery mildew (PDI)			Yield (q/ha)			B: C Ratio
			2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	
1	Tolfenpyrad 15 % EC	100	46.51 (39.85)	51.13 (41.97)	39.19 (36.36)	22.42 (27.42)	20.99 (26.34)	21.71 (26.80)	1:3.94
2	Tolfenpyrad 15 % EC	125	38.67 (36.10)	36.95 (35.25)	31.52 (32.45)	24.23 (28.34)	21.11 (26.42)	22.67 (27.40)	1:4.04
3	Tolfenpyrad 15 % EC	150	25.47 (29.07)	29.11 (31.14)	22.56 (27.33)	26.44 (29.64)	23.44 (27.87)	24.94 (28.77)	1:4.37
4	Tolfenpyrad 15 % EC	300	41.40 (37.43)	52.22 (42.47)	36.54 (35.04)	21.83 (26.88)	21.38 (26.59)	21.61 (26.74)	1:3.42
5	Wettable sulphur 80 % WP	108	50.28 (41.59)	38.93 (36.23)	38.78 (36.16)	17.31 (23.90)	17.26 (23.86)	17.29 (23.88)	1:3.25
6	Myclobutanil 10 % WP	20	43.20 (38.29)	43.06 (38.23)	36.27 (34.91)	20.15 (25.81)	18.51 (24.72)	19.33 (25.27)	1:3.67
7	Hexaconazole 5% EC	25	40.05 (36.78)	26.66 (29.76)	31.54 (32.45)	24.81 (28.69)	19.12 (25.13)	21.97 (26.97)	1:4.23
8	Propiconazole 25 % EC	125	24.47 (28.49)	24.22 (28.34)	20.95 (26.32)	25.47 (29.08)	21.42 (26.62)	23.45 (27.88)	1:4.56
9	Difenconazole 25 % EC	125	28.19 (30.63)	24.15 (28.30)	21.30 (26.55)	23.81 (28.09)	20.42 (25.98)	22.22 (27.12)	1:3.80
10	Untreated Control	-	71.21 (51.01)	73.57 (52.10)	60.80 (46.32)	11.13 (19.14)	12.14 (19.98)	11.64 (19.57)	1:2.30
S. Em (±)			1.69	4.00	2.97	0.76	1.43	0.86	
CD at (P 0.05)			5.02	11.88	8.82	2.26	4.26	2.55	

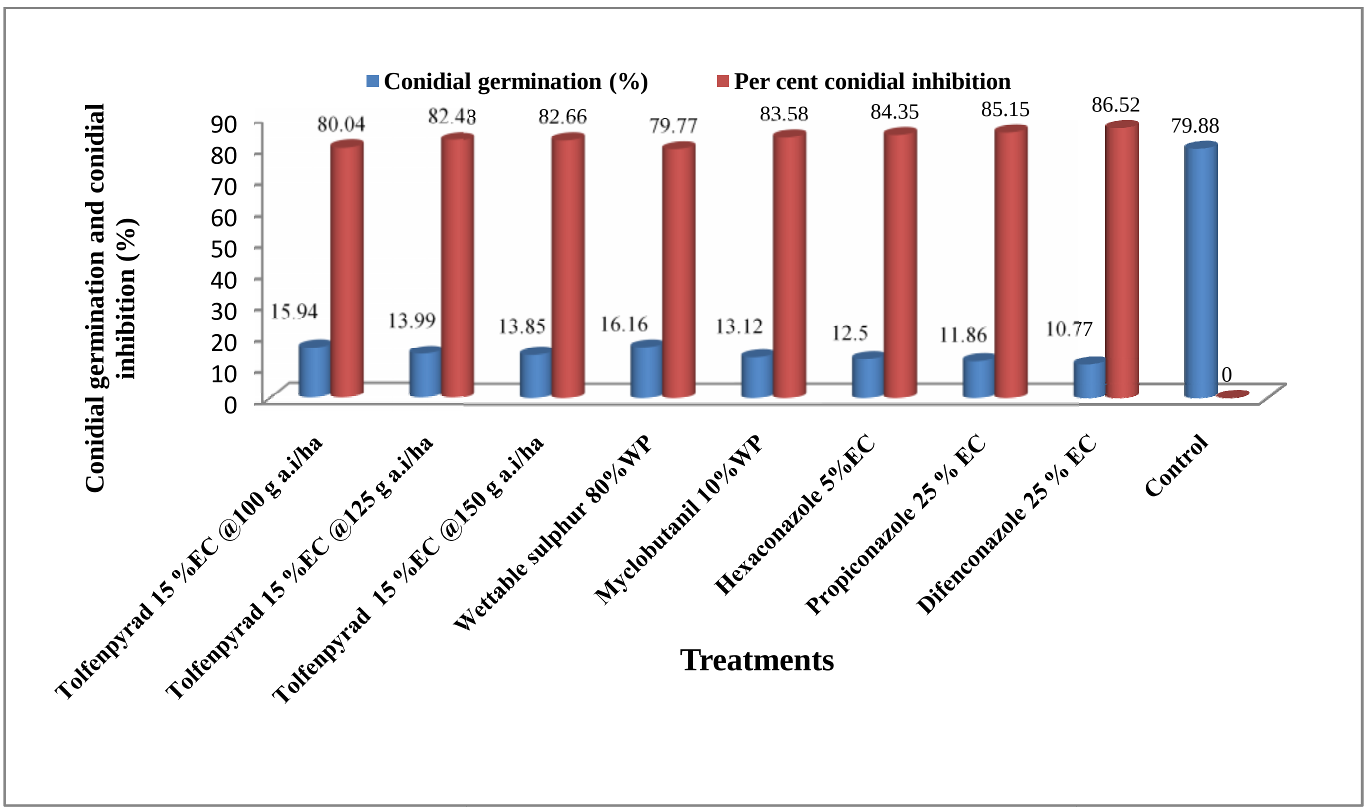

Fig. 1. *In vitro* evaluation of different fungicides against conidial germination of *Levellulla taurica* causing chilli powdery mildew during 2012-13.

Among different concentrations of tolfenpyrad 15% EC at 150 g a.i/ha minimum germination of conidia (13.85 %) was recorded followed by other dosages.

Further, to check its efficacy different systemic fungicides were evaluated *In vitro* during 2019-20 by spore germination technique. The results revealed that, all the fungicides were significantly superior over the control (Fig. 2). Among the ten systemic fungicides, difenconazole 25 %EC was most effective with mean spore germination inhibition of 88.98 per cent found significantly superior when compared to other systemic fungicides, which is on par with penconazole 10% EC with mean spore germination inhibition of 87.74 per cent followed by propiconazole 25 % EC with mean spore germination inhibition of 86.80 per cent. The next best fungicides were tolfenpyrad 15 % EC with 90.15 per cent inhibition at 0.15 per cent concentration with mean spore germination inhibition of 85.58 per cent which was on par with tebuconazole 25.9 % EC with mean spore germination inhibition of 84.08 per cent (Fig. 3).

Similar results were noticed by Swetha (2016) who noticed that maximum inhibition of conidial germination of *Golovinomyces cichoracearum* was in difenconazole (99.26 %), myclobutanil (98.66 %) and propiconazole (97.67 %) which were significantly superior over rest of fungicides. Biju, 2000 and Bheemaraya *et al*. (2015) reported that, propiconazole at 0.1 per cent concentration as found to be effective in reducing the conidial germination of pea and sunflower powdery mildew, respectively. Channamma (2015) who found that maximum inhibition of conidial germination of *L. taurica* was observed in propiconazole (100 %) followed by penconazole (100 %) and myclobutanil (99.21 %) and least inhibition was observed in carbendazim (91.68 %) against gaur powdery mildew. Amaresh *et al*. (2013) who reported that maximum inhibition of conidial germination of *Erysiphe cichoracearum* was noticed in difenconazole (99.78 %), penconazole (98.81 %), propiconazole (98.36 %) and triadimefon (97.94 %).

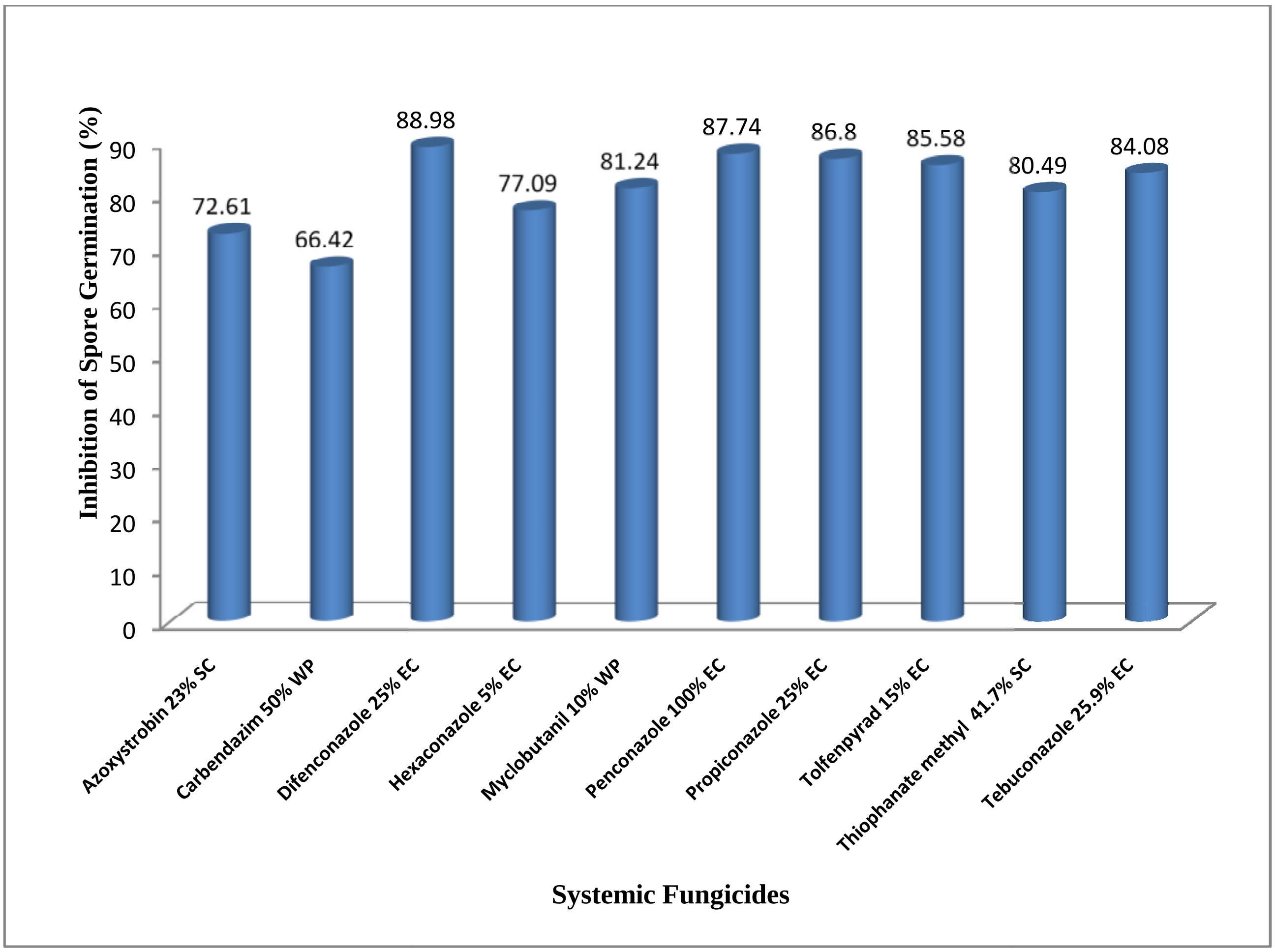

Fig. 2. *In vitro* evaluation of different fungicides against conidial germination inhibition of *Levellulla taurica* causing chilli powdery mildew during 2019-20.

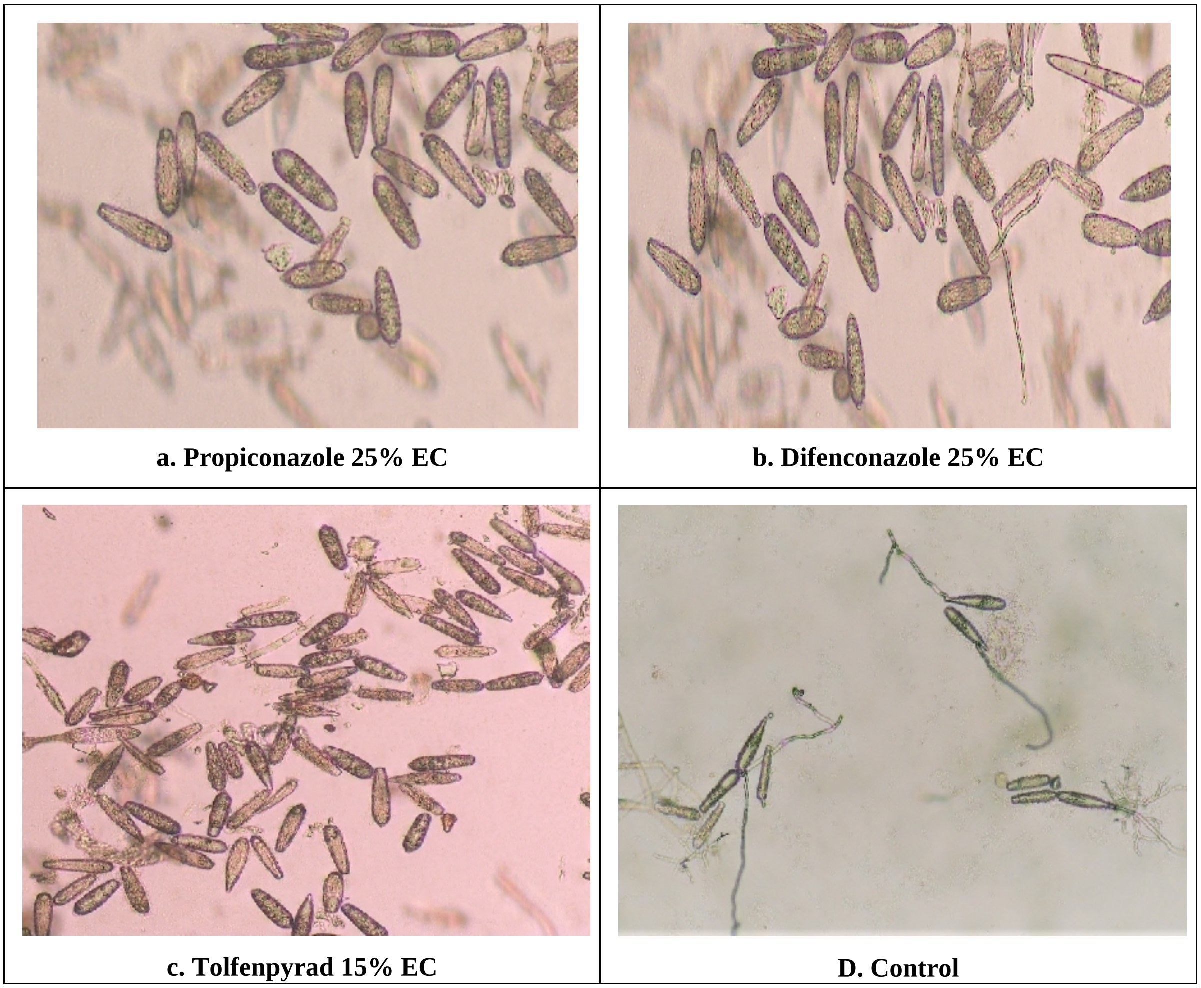

Fig. 3. Microscopic view of *in vitro* evaluation of different fungicides against conidial germination of *Levellulla taurica* causing chilli powdery mildew.

CONCLUSIONS

Tolfenpyrad 15 % EC at 150 g a.i/ha could effectively manage both thrips and powdery mildew which aided in getting maximum dry chilly yield. Being a broad spectrum pesticide works very well in curbing the menace of insect pests and diseases. Its usage is like a double edge sword whereby at one stroke two major ailments can be managed which reduces the plant protection cost hence such tools fit very well in IPM system particularly in chilli ecosystem.

FUTURE SCOPE

It has broad spectrum activity as insecticide and fungicidal activity. It can be used to manage insect pests of order Hemiptera, Thysanoptera, mites and powdery mildew. Pesticides having different mode of action is need of the hour to combat wide range of pests which savings the cost of plant protection as well as pollution problems

Conflict of Interest. None of the authors of this paper poses a financial or personal relation with people or organizations that would inappropriately influence or bias the content of the paper. We assure you that the content of the paper is never been published.

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REFERENCES

Akhileshwari, S. V., Amaresh, Y. S., Naik, M. K., Kantharaju, V., Shankergoud, I., and Ravi, M. V. (2012). Field evaluation of fungicides against powdery mildew of sunflower. *Karnataka Journal of Agriculture Sciences*, *25*(2): 278-280.

Amaresh, Y. S., Naik, M. K., Patil, M. B., Siddappa, B., & Akhileshwari, S. V. (2013). Management of sunflower powdery mildew caused by *Erysiphe cichoracearum*. *Journal of Plant Disease Sciences*, *8*(2), 174-178.

Bajpai, N. K., Swami, H., and Tripathi, N. N. (2013). Bioefficacy of tolfenpyrad 15% EC against aphid, *Brevicoryne brassicae* L. infesting cabbage in Rajashtan. *Indian Journal of Entomology, 75*(3): 208-211.

Bajpai, N. K. and Singh, H. (2010). Bioefficacy of tolfenpyrad (PII 405 15% EC) against sucking pest of okra during *Kharif* in South East Rajasthan. In:

Proceedings of National Conference on "Plant protection in agriculture through eco-friendly techniques and traditional farming practices". February 18-20, held at ARS, Durgapura, 95-98.

Bheemaraya, A., Jamadar, M. M. and Huligol, S. (2015). Sensitivity of sunflower powdery mildew pathogen, *Golovinomyces cichoracearum* to different fungicidal formulations. *Indian Journal of Plant Protection, 43*(2): 392-394.

Channamma, (2015). Studies on major diseases of gaur with special reference to powdery mildew caused by *Leveillula taurica* (lev.) Arn. M. Sc. (Agri.) Thesis, University of. Agricultural. Sciences., Raichur. pp : 1-132.

Daunde, A. T., Khandare, V. S., & Wadikar, R. N. Management of Chilli Powdery Mildew Caused by *Leveillula taurica* (Lev.) Arn. using Fungicides. *International Journal of Current Microbiology Applied. Sci*ences, *6*: 388-392.

Geetha, R., and Selvarani, K. (2017). A study of chilli production and export from India. *International Journal of Advance Research*, *3:* 205-10.

Ghosh, A.A., Chatterjee, M.L., Chakraborti, K., and Samant, A. (2009). Field evaluation of insecticides against chilli thrips (*Scirtothrips dorsalis* Hood). *Annals of Plant Protection Sciences*, *17*: 69-71.

Gohokar, R. T. and Peshney, N. L. (1981). Chemical control of powdery mildew of chilli. *Indian Journal of Agriculture Sciences*, *51*(1): 663-665

Hundekar, A. R. (1999). *Studies on some Aspects of Soybean Rust Caused by Phakopsora pachyrhizi Syd* (Doctoral dissertation, University of Agricultural Science, Dharwad).

Kalyan, R. K., Saini, D. P., Babu, S. R. and Urmila. (2014). Evaluation of different doses of tolfenpyrad against aphids and thrips in cotton. *Journal of Cotton Research Development*, *28*(2): 293-296.

Mandal, S. K. (2013). Tolfenpyrad 15% EC, a new pyrazole insecticide for agricultural pest management. *New Horizons in Insect Science*, 14-17.

Mayee, C. D., & Datar, V. V. (1986). Phytopathometry Technical Bull-I. *MAU, Parbhani*, 88-89.

Nene, Y. L., and Thapliyal, P. N. (1993). Fungicides in plant disease control. Third Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India, pp.311-348.

Patil, S. B., Udikeri, S. S., Matti, P. V., Guruprasad, G. S., Hirekurubar, R. B., and Shaila, H. M. (2009). Bioefficacy of new molecule fipronil 5% SC against sucking pest complex in *Bt.* cotton. *Karnataka Journal of Agriculture Sciences*, *22*(5): 1029- 1031.

Raju, J., Nagarajappa, A. and Jayalakshmi, K. (2017). Management of powdery mildew of capsicum under protected cultivation. *International Journal of Chemical Studies*, *5*(5): 1213-1215.

Rao, R. D., Reddy, V. J. P., Reddy, A. S., Reddy, S. V., Thirumala-Devi, K., Rao, S.C., Kumar, V. M., Subramaniam, K., Reddy, T. Y., Nigram, S. N. and Reddy, D. V. R. (2003). The host range of tobacco streak virus in India and transmission by thrips. *Annals of Applied Biology*, *142*, 365–368.

Sharma, I. M. (1991). Field evaluation of fungicides for post-infection control of powdery mildew of sugar beet. *Indian Phytopathology*., *44:* 133-134.

Sharmila, A. S., Kachapur, M. R., and Patil, M. S. (2004). Field evaluation of fungicides against powdery mildew *Leveillula taurica (Lev.) Arn*.of chilli (*Capsicum annuum* L.). *Journal of Mycology and Plant Pathology, 34:* 98-99.

Smith, K. L. (2000). Peppers. Ohio vegetable production guide Columbus, Ohio. *672*: 166-17 south east Rajasthan. In: Proceedings of National Conference on "Plant protection in agriculture through eco-friendly techniques and traditional farming practices". February 18-20, held at ARS, Durgapura. 2010, 95-98.

Sudha, A. and Lakshmanan, P. (2009). Integrated disease management of powdery mildew (*Leveillula taurica* (Lev.) Arn.) of chilli (*Capsicum annum* L.). *Archives of Phytopathology and Plant. Protection*, *4*: 299-317.

Swetha, T. (2016). Studies on epidemiology and management of sunflower powdery mildew caused by *Golovinomyces cichocearum* (DC.) V. P. Heluta. *M. Sc. (Agri.) Thesis*, University of Agriculture Sciences, Raichur. pp: 1-134.

Venette, R. C., and Davis, E. E., (2004). Chilli thrips/yellow thrips, *Scirtothrips dorsalis* Hood (Thysanoptera: Thripidae) mini pest risk assessment. University of Minnesota, St. Paul, MN, USA, p. 31.

Vincent, J. M., (1947). Distortion of fungal hyphae in presence of certain inhibitors, *Nature*, *159*: 50.

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