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In vitro evaluation of fungicides, organic amendments and botanical against powdery mildew of chilli caused by *Leveillula taurica*

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Abstract
Powdery mildew of chilli incited by *Leveillula taurica* (Lev.) Arn. is the major problem in chilli production. *In vitro* experiment was conducted to evaluate the efficacy of different fungicides, botanical and organic amendments against powdery mildew of chilli caused by *Leveillula taurica* (Lev.) Arn. Among all the fungicides Propiconazole 25% EC significantly cause maximum 100, 100 and 99.28% inhibition of spore germination with minimum 0, 0 and 0.58% spore germination at 0.2, 0.1 and 0.05% concentration. Among the botanical the Neem oil was observed most effective with 26.17, 28.75, 35.17, 36.90, and 45.52% spore germination and 67.48, 63.51, 56.30, 54.16 and 43.45% inhibition of spore germination at 15, 10, 7, 5 and 2% concentrations respectively and in the organic amendments Panchgavya was found most effective with 30.65,32.25, 36.80, 41.10 and 47.80% spore germination and 61.92, 59.31, 54.29, 48.94 and 40.62% inhibition of spore germination at 15, 10, 7, 5 and 2% concentrations respectively.

Keywords: *Leveillula taurica*, fungicides, botanicals, organic amendments, *in vitro*

Introduction
Chilli (*Capsicum annum* L. and *Capsicum frutescens*) is a widely commercial horticulture crop all over the world. Chilli is originated from South America during 15th Century (Pickersgill, 1997) [11]. China, India, Mexico, Morocco, Pakistan, Thailand and Turkey are important and main countries well known for production and export of this wonderful crop (Lakshmi *et al*., 2014) [9]. 25% of world's chilli is produce by India. India is not only largest producer of chilli but also takes foremost position in terms of consumption and export of chilli (Chandra Nayaka *et al*., 2009) [4] with the 4% contribution in total export. (Gutpa and Naik, 2005) [7]. Fungi, bacteria, viruses and nematodes are easily infested the chilli crop and become the cause of many diseases. Mostly seen fungal diseases in this crop are powdery mildew, leaf spot and anthracnose or fruit rot (Khodke *et al*., 2009). Among all these powdery mildews proven major obstacle in chilli production in India. Causal agent of powdery mildew is *Leveillula taurica* (Lev.) causing heavy yield loss ranging from 14 to 30%, due to severe defoliation and reduction in photosynthesis, size and number of fruits per plant In India, powdery mildew of chilli occurs in endemic form on a severe scale become the major factor in economic loss of chilli crop (Singh and Lodha, 1985) [13]. Fungal diseases like powdery mildew and other disease are major fear for farmer in chilli production because some time powdery mildew cause drastic crop loss if proper management method and chemical control method are not adopted. Primary source of infection are infected seeds, volunteer plants and infected plant debris. Secondary spread is through air borne conidia. A variety of fungicide are available in market that are fall into two major categories popularly known as systemic and non-systemic fungicides were reported to management of the powdery mildew of capsicum. Adequate information about the efficacy of new fungicides against powdery mildew of capsicum are not available. So, there is a need to evaluate new fungicides against powdery mildew.

Materials and Methods
The experiment was conducted in the laboratory to standardized the effective and economical sustainable dose of five fungicides *viz*., Propiconazole 25% EC, Azoxystrobin 8% EC, Hexaconazole 5% EC, Myclobutanil 10% WP and Wettable Sulphur 80% WP at 0.05%, 0.1% and 0.2% concentrations, two botanical *viz.*, Neem (*Azadirachta indica*) leaf extract and Neem

(*Azadirachta indica*) oil and three organic amendments *viz.*, Vermiwash, Panchgavya and Butter milk at 2%, 5%, 7%, 10% and 15% concentrations against the chilli powdery mildew pathogen *Leveillula taurica* by the help of spore germination technique (Anonymous, 1957)[1]. The efficacy of different treatments tested for their ability to inhibit germination of conidia of *Leveillula taurica.* The different fungicides, organic amendments and botanical solution was prepared with help of sterilized distilled water in desired concentrations in water blanks. The conidia were obtained from freshly infected leaves of chilli from the field. The equal concentration of conidial suspension ($10x10^6$spore/ml) was mixed in different test treatments having desired concentration of each treatment that was prepared in sterilized distilled water. The conidia were counted from prepared conidial suspension by hemocytometer and then one ml of this homogenized conidial suspension was taken by automatic measuring pipette placed in each concave cavity bearing glass slides. The slides were kept in petri plates lined sterilized tooth pick on moist blotting papers and incubation at (25 °±2 °C) and a control treatment was also maintained for comparison. After 24 hour of incubation in controlled condition data on % spore germinated was collected by counting the germinated conidia under microscope at 40x magnification. % conidial germination was determined by the help of following formula:

$$\% \text{ germination} = \frac{\text{Total number of germinated conidia}}{\text{Total number of observed conidia}} \times 100$$

% inhibition of spore germination was observed by the help of following formula according to Vincent (1927) [16].

$$\% \text{ inhibition of spore germination} = \frac{C - T}{C} \times 100$$

Where
C = Number of germinated spores in control.
T = Number of germinated spores in treatment.

Results and Discussion

In the present study 5 fungicides, 2 botanicals and 3 organic amendments were tested at various level of concentrations *in vitro* for measuring their efficacy against powdery mildew of chilli (*Leveillula taurica*) by spore germination technique. Five fungicides Propiconazole, Myclobutanil, Hexaconazole, Azoxystrobin and Wettable sulphur were tested at 3 concentrations *viz*., 0.05%, 0.1% and 0.2%. Among the fungicides Propiconazole 25% EC significantly caused maximum 100, 100 and 99.28% inhibition with minimum 0, 0 and 0.58% spore germination at 0.2, 0.1 and 0.05% concentrations, respectively. Myclobutanil was found most effective at all concentrations and causes 97.26% inhibition with 2.20% spore germination followed by Hexaconazole 95.09% inhibition with 3.95% spore germination at 0.1% concentration. Propiconazole, Myclobutanil and Hexaconazole fungicides are extensively used for control many causal organism of pathogens and foliar disease *in vitro* condition as well as *in vivo* condition (Channamma *et al*., 2015) [5]. Hebasur *et al*., (2018) [8] also observed that Propiconazole percent was most effective against the inhibition of the conidial germination followed by Azoxystrobin and Myclobutanil were most significantly better in comparison of other treatments against powdery mildew of chickpea pathogen *Leveillula taurica in-vitro.*

Two botanicals [Neem (*Azadirachta indica*) oil and Neem (*Azadirachta indica*) leaf extract] and 3 organic amendments biorationals-Butter milk, Panchgavya, and Vermiwash were tested *in vitro* condition at 2, 5, 7, 10 and 15% concentrations. In both botanicals, maximum inhibition of conidial germination over control was recorded in neem oil at all concentration. Neem oil found best effective at 5% concentration with 54.16% spore inhibition and 36.90% spore germination. Azadirachtin- 0.5% and NSKE- 5% were found most effective in inhibition of conidial germination of sunflower powdery mildew (Dinesh *et al*., 2011) [6].

In organic amendments application of Panchgavya- 15% in diluted liquid suspension was caused highest spore inhibition % (61.92) with 30.65% conidial germination followed by Buttermilk 15% inhibition % (58.35) with 33.52% conidial germination. Panchgavya of 10% concentration found most superior in all biorationals with maximum (59.31%) conidial inhibition and minimum 32.25% conidial germination. Similar results were reported by Ashlesha and Paul (2014) [3] that the 5 organic inputs-panchgavya, vermiwash, biosol, cow urine and butter milk. Among organic amendments, fermented cow urine observed maximum 100 and 99% inhibition in the conidial growth of the testing pathogens at-10% conc. followed by Panch Gavya inhibited conidial inhibition of *S. sclerotiorum* and 99.0% inhibition in mycelial growth of the *Sclerotium rolfsii.* Same as the vermiwash and biosol observed more than 99.0% myceliam inhibition of all tested fungus. Sugha (2005) [14] also described that the effectivity of panchgavya against *Sclerotium rolfsii* observed that the conidial bits dipped for 6 hour in use of panchgavya caused by complete suppression of the conidial growth of *Rhizoctonia solani*.

Table 1: The Effect of different fungicides on suppress of conidial germination of powdery mildew of chilli in *in vitro*

S. No.	Treatments	0.05% concentration		0.1% concentration		0.2% concentration	
		Conidial germination %	Inhibition %	Conidial germination %	Inhibition %	Conidial germination %	Inhibition %
1.	Azoxystrobin	9.40 (17.82)	88.32 (70.01)	6.00 (14.13)	92.55 (74.17)	4.50 (12.19)	94.41 (76.35)
2.	Propiconazole	0.58 (4.31)	99.28 (85.15)	0 (0.0)	100 (90.00)	0 (0.0)	100 (90.00)
3.	Hexaconazole	5.10 (13.03)	93.66 (75.40)	3.95 (11.46)	95.09 (77.18)	3.15 (10.19)	96.08 (78.59)
4.	Wettable Sulphur	12.32 (20.54)	84.69 (66.94)	8.57 (17.00)	89.35 (70.94)	6.92 (15.22)	91.40 (72.95)
5.	Myclobutanil	4.00 (11.53)	95.03 (77.09)	2.20 (8.35)	97.26 (80.64)	1.30 (6.41)	98.38 (82.82)

6.	Control	80.50 (63.77)	-	80.50 (63.77)	-	80.50 (63.77)	-
	S.Em±	0.305	0.342	0.519	0.581	0.516	0.578
	CD (P= 0.05)	0.912	1.025	1.554	1.740	1.545	1.731

Mean of four replications; Figures given in parentheses are arcsine√ % angular transformed values

Table 2: Effect of different botanical and organic amendments on suppress of conidial germination of powdery mildew of chilli in *in vitro*

S. N.	Treatments	2% concentration		5% concentration		7% concentration		10% concentration		15% concentration	
		Conidial Germination %	Inhibition %	Conidial Germination %	Inhibition %	Conidial Germination %	Inhibition %	Conidial Germination %	Inhibition %	Conidial Germination %	Inhibition %
1.	Neem Leaf Extract	47.12 (43.33)	41.46 (40.06)	38.24 (38.18)	52.50 (46.42)	36.0 (36.85)	55.28 (48.01)	30.15 (33.27)	61.30 (51.52)	29.55 (32.91)	63.29 (52.69)
2.	Neem oil	45.52 (42.41)	43.45 (41.22)	36.90 (37.39)	54.16 (47.37)	35.17 (36.36)	56.30 (48.60)	28.75 (32.39)	63.51 (52.83)	26.17 (30.75)	67.48 (55.21)
3.	Vermiwash	49.87 (44.91)	38.04 (38.05)	42.92 (40.91)	46.68 (43.08)	39.7 (39.03)	50.68 (45.37)	37.77 (37.907)	53.88 (47.21)	35.32 (36.44)	56.12 (48.50)
4.	Panchgavya	47.8 (43.72)	40.62 (39.58)	41.1 (39.85)	48.94 (44.38)	36.8 (37.33)	54.29 (47.44)	32.25 (34.587)	59.31 (50.35)	30.65 (33.60)	61.92 (51.8)
5.	Butter milk	48.35 (44.04)	39.94 (39.18)	41.97 (40.37)	47.86 (43.75)	37.82 (37.94)	53.01 (46.71)	35.35 (36.466)	57.05 (49.04)	33.52 (35.36)	58.35 (49.79)
6.	Control	80.50 (63.77)	-	80.50 (63.77)	-	80.50 (63.77)	-	80.50 (63.77)	-	80.50 (63.77)	-
	S.Em±	0.426	0.540	0.520	0.636	0.496	0.605	0.579	0.627	0.423	0.502
	CD (P= 0.05)	1.276	1.617	1.558	1.904	1.485	1.811	1.733	1.876	1.267	1.504

Mean of four replications; Figures given in parentheses are arcsine√ % angular transformed values

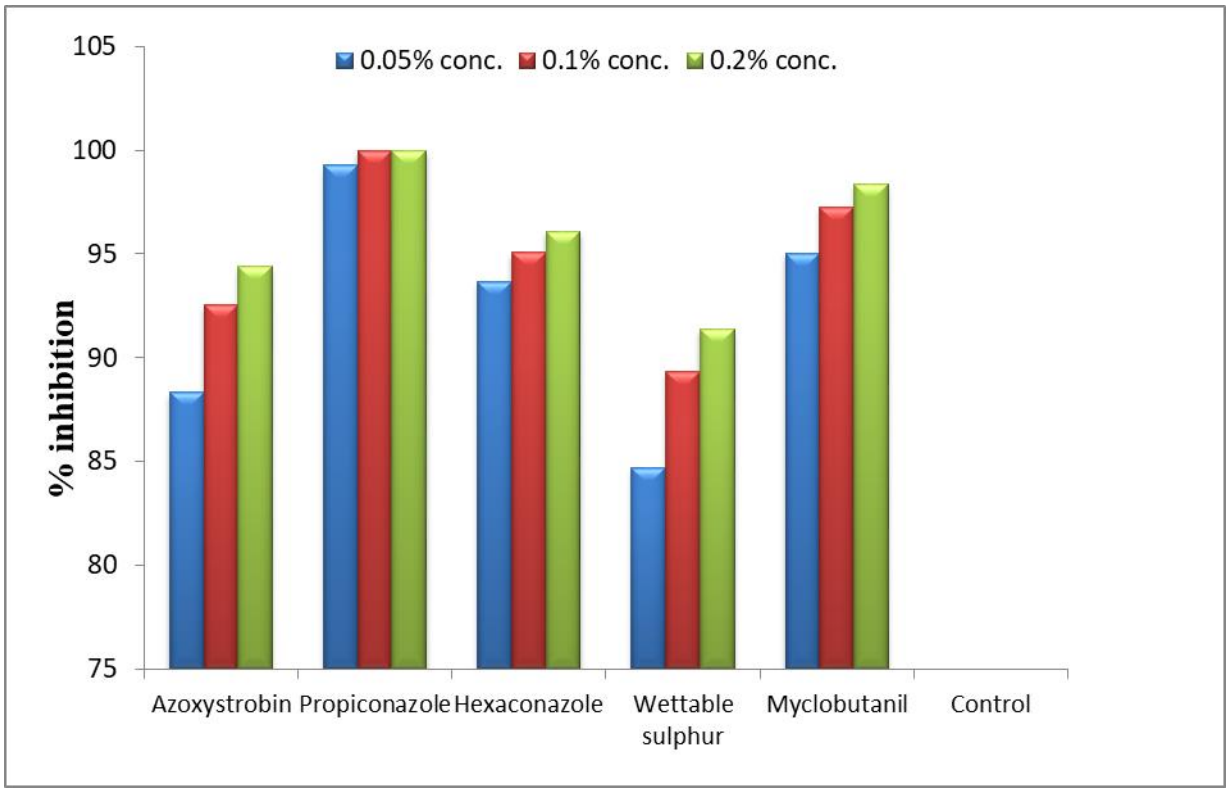

Fig 1: The efficacy of different fungicides on inhibition of powdery mildew of chilli *In vitro*

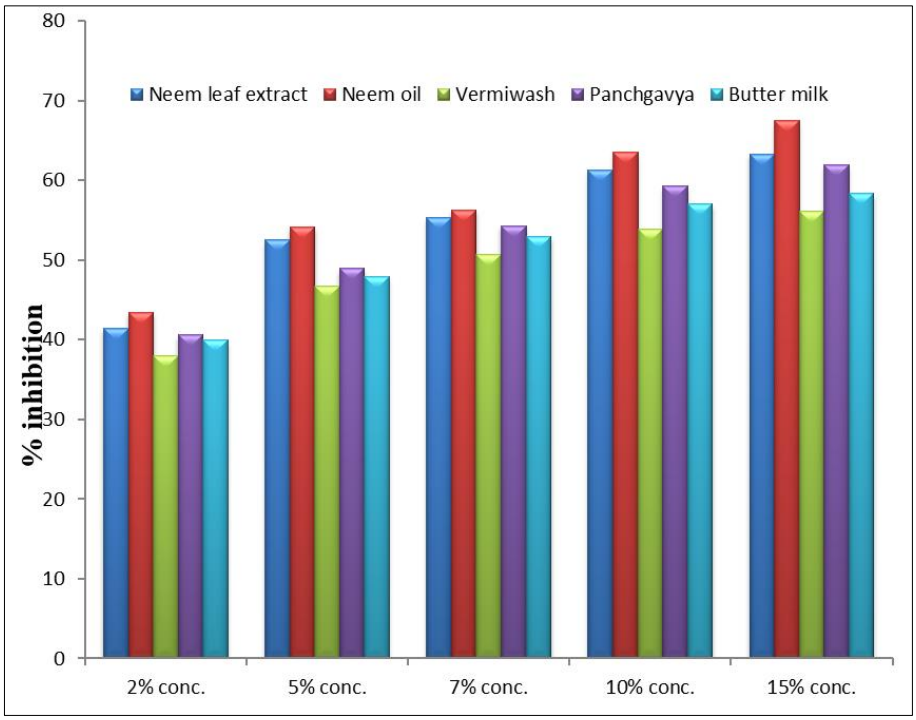

Fig 2: Comparative efficacy of fungicides on inhibition of powdery mildew of chilli *In vitro*

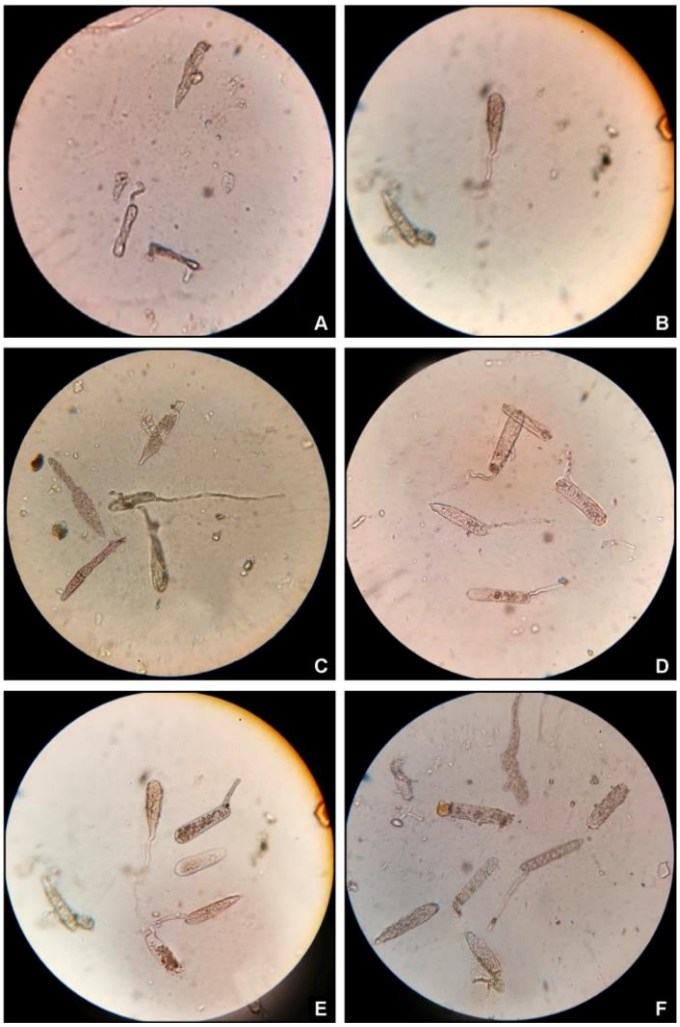

Plate 1: Effect of fungicides against powdery mildew (*L. taurica*) of chilli in In vitro condotions

A. Propiconazole (0.1%) B. Myclobutanil (0.1%)
C. Hexaconazole (0.1%) D. Azoxystrobin (0.1%)
E. Wettable sulphur (0.1%) F. Control

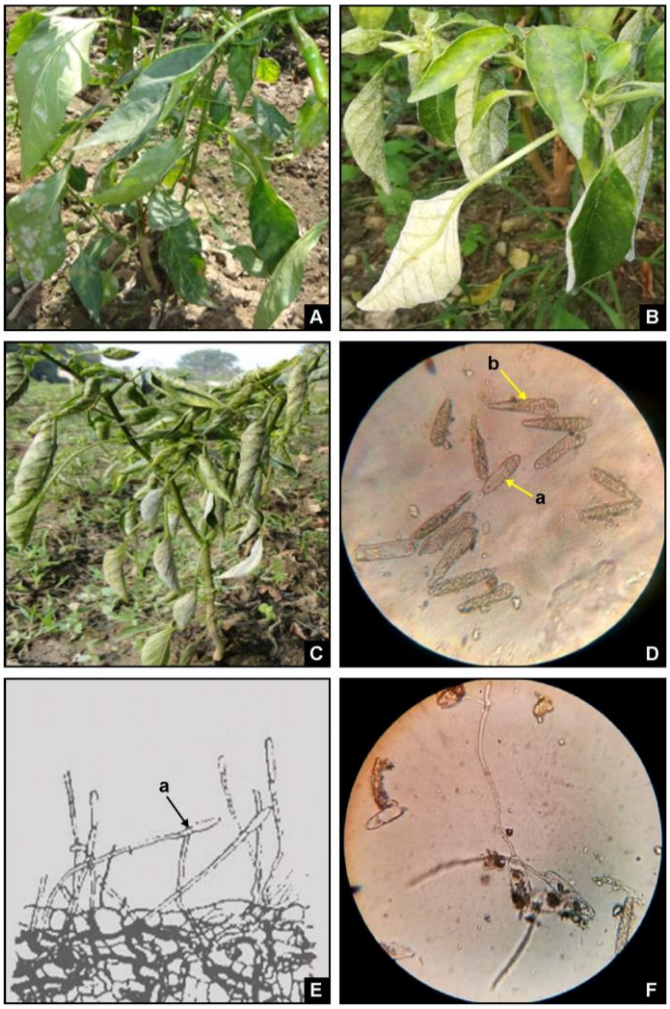

Plate 2: Symptoms and morphological characters of powdery mildew and pathogen *L. taurica.* (A) Initial symptoms of powdery mildew of chilli. (B) Symptom on lower surface of leaves. (C) Infected and defoliated plant. (D) Conidia (a. cylindrical b. Pyriform) of *L. taurica.* (E) Leaf section to show mycelium & a. Conidiophore bearing conidia. (F). Germination of conidia of *L. taurica.*

Conclusion

The experiment was conducted to evaluate the efficacy of different fungicides, botanical and organic amendments against powdery mildew of chilli caused by *Leveillula taurica* (Lev.) Arn. On the basis of this experimentation concluded that Propiconazole 25% EC, Neem oil and Panchgavya were found most effective against spore germination of *Leveillula taurica*.

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