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In vitro evaluation of fungicides against *Leveillula taurica* (Lev.) Arnaud causal agent of powdery mildew of chickpea

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Abstract
A study was conducted at the Department of Plant Pathology, College of Agriculture, Vijayapur during 2014-15 to find out the efficacy of ten systemic fungicides *viz.* penconzole 10EC, tebuconazole 25.9EC, difenconazole 25EC, carbendazim 50WP, propiconazole 25EC, hexaconazole 5EC, thiophanate methyl 70WP, myclobutanil 10WP, azoxystrobin 23EC, tridemephon, two non systemic fungicides *viz.* cholothalonil 75WP, sulphur 80WP, chlorothalonil and three combip roducts Captan 70 %+ Hexaconazole 5% 75 % WP, Hexaconazole 4% + Zineb 68% WP under *in vitro* conditions against chickpea powdery mildew caused by *Leveillula taurica*. Among the systemic fungicides at 0.1 and 0.15 Per cent concentrations complete inhibition of conidial germination was in all the fungicides tested. But at 0.05 Per cent concentration complete inhibition of conidial germination was observed in myclobutanil and azoxystrobin and were significantly superior over other treatments. In all non systemic and combi products complete inhibition was observed at 0.2, 0.25 and 0.3 per cent concentrations.

Keywords: Fungicides, powdery mildew, *Leveillula taurica*, chickpea

Introduction
The origin of chickpea (*Cicer arietinum* L.) is thought to have been in the area of present-day South Eastern Turkey and neighboring Northern Syria. Among the pulses, chickpea is the third leading grain legume after bean (*Phaseolus vulgaris*) and pea (*Pisum sativum*) in the world and first in the South Asia. Ninety two per cent of the area and eighty nine per cent of the production of grain are concentrated in semi-arid tropical countries. In India chickpea is cultivated over an area of 8.52 m ha and with a production of 8.83 mt and average productivity level of 1036 kg/ha. Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Gujarat, Andhra Pradesh and Karnataka are the major chickpea producing states sharing over 95 per cent area. In Karnataka, chickpea is grown in an area of 0.92 million hectare with a production of 0.57 million tonnes with productivity of 622 kg/ha (Anon., 2014). Among the different fungal diseases affecting chickpea production, recently appearance of powdery mildew was observed. It is caused by *Leveillula taurica* (Lev.) Arnaud. In India occurrence of powdery mildew (*Leveillula taurica*) on chickpea was first reported in Maharashtra by Mandhare *et al*. (2005). Powdery mildew epidemic begins late in the season so yield components are usually less affected by the infection. However, early infections lead to more yield loss. Keeping in the view the importance of chickpea and severity of the disease, the present investigation was carried out to know the effective fungicides against the powdery mildew of chickpea and results were documented in this paper.

Material and Methods
The sensitivity of *L. taurica* to different molecules of fungicides, at different concentrations was assessed under *In vitro* conditions by spore germination technique as given below. Ten systemic fungicides such as penconzole 10EC, tebuconazole 25.9EC, difenconazole 25EC, carbendazim 50WP, propiconazole 25EC, hexaconazole 5EC, thiophanate methyl 70WP, myclobutanil 10WP, azoxystrobin 23EC, tridemephon, (at the concentration of 0.05, 0.1 and 0.15 percent), two non-systemic fungicides *viz.* cholothalonil 75WP, sulphur 80WP and three combo products Captan 70 %+ Hexaconazole 5% 75 % WP, Hexaconazole 4% + Zineb 68% WP (at the concentrations of 0.1, 0.2, 0.25 and 0.3 percent).
The efficacy of above mentioned systemic, contact and combi product fungicides at the different concentrations were tested against conidial germination of *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. Per cent inhibition over the control was calculated by using the formula given by Vincent (1947). Later data was analysed using the design CRD method.

$$I = \frac{(C-T)}{C} X\ 100$$

Where, I = Percent inhibition
C = Germination of conidia in control
T = Germination of conidia in treatment

Results and Discussion

Among the systemic fungicides evaluated (Table 1) under *in vitro* conditions, At 0.1 and 0.15 Per cent concentrations complete inhibition of conidial germination was in all the fungicides tested. But at 0.05 Per cent concentration, cent Per cent inhibition of conidial germination was observed in myclobutanil and azoxystrobin and were significantly superior over other treatments, followed by tebuconazole (91.12%), penconazole (86.65), tridemephon (86.19 %) and hexaconazole (85.29 %). Least inhibition (80.90%) was observed in carbendazim at 0.05 per cent.

Table 1: *In vitro* evaluation of systemic fungicides on inhibition of conidial germination of *L. taurica.*

S. No	Fungicides	Per cent inhibition over control			
	Systemic fungicides	0.05%	0.1%	0.15%	Mean
1	Tebuconazole (Folicur) 43SC	91.12 (72.70)*	100.00 (90.00)	100.00 (90.00)	97.04 (84.23)
2	Difenconazole (Score) 25 EC	81.52 (64.56)	100.00 (90.00)	100.00 (90.00)	93.84 (81.52)
3	Hexaconzole (Contaf) 5EC	85.29 (67.46)	100.00 (90.00)	100.00 (90.00)	95.09 (82.48)
4	Propiconazole (Tilt) 25 EC	83.83 (66.31)	100.00 (90.00)	100.00 (90.00)	94.61 (82.10)
5	Penconazole (Topas) 10EC	86.64 (68.59)	100.00 (90.00)	100.00 (90.00)	95.54 (82.86)
6	Carbendazim (Bavistin) 50 WP	80.90 (64.09)	100.00 (90.00)	100.00 (90.00)	93.63 (81.36)
7	Azoxystrobin (Amistar) 23EC	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
8	Thiophanate methyl (Topsin M)70WP	85.18 (67.40)	100.00 (90.00)	100.00 (90.00)	95.06 (82.46)
9	Myclobutanil (Boon) 10WP	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
10	Tridemephon (Benomyl)	86.19 (68.23)	100.00 (90.00)	100.00 (90.00)	95.39 (82.74)
	S. Em±	0.78			
	C.D. at 1%	3.17			

* Angular transformation.

In all non systemic and combi products complete inhibition was observed at 0.2, 0.25 and 0.3 per cent concentrations. At 0.15 Per cent concentration maximum conidial germination inhibition was recorded in Captan 70 % + Hexaconazole 5%75WP (89.83%) followed by Chlorothalonil (88.45%), Hexaconazole 4% + Zineb 68% (88.73%), Carbendazium 12% + Mancozeb 63% (87.26%) and wettable sulphur (87.32) which were on par with each other (Table 2).

Table 2: *In vitro* evaluation of non systemic and combi-products fungicides on inhibition of conidial germination of *L. taurica.*

S. No	Fungicides	Per cent inhibition over control				
	Non systemic fungicides	0.15%	0.2%	0.25%	0.3%	Mean
1	Chlorothalonil (Kavach) 75WP	88.45 (70.14)*	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	97.11 (85.03)
2	Wettable Sulphur (Sulfex) 80WP	87.32 (69.15)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	96.83 (84.78)
	Combi products					
3	Saff (Carbendazium 12% + Mancozeb 63%)	87.26 (69.18)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	96.81 (84.79)
4	Taqat (Captan 70 % + Hexaconazole 5%75WP)	89.83 (71.45)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	97.45 (85.36)
5	Avtar (Hexaconazole 4% + Zineb 68%)	88.73 (70.55)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	97.18 (85.13)
	S. Em±	1.01				
	C.D. at 1%	4.24				

* Angular transformation.

These findings in agreement with Raghavendra (2005) who reported that among different fungicides tested *In vitro*, myclobutanil (0.1%) was found to be most effective in reducing conidial germination of *L. taurica*. Sanjivareddi (2012) reported that irrespective of fungicide concentration, hexaconazole (83.52%) was found to be the best and followed by Myclobutanil (82.70%) and propiconazole (79.27%) but all are on par with each other.

The triazole fungicides are sterol inhibitors that interfere with sterol biosynthesis in fungal membrane and are absorbed in to the leaf tissue and like Azoxystrobin moves in a translaminar manner through the leaf (Miles, 2007).

In general, the treatments containing triazole fungicides performed more consistently than other fungicides. The strobulurins interfere with the spore germination and germ tube development (Sauter *et al.*, 1999).

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