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In vitro evaluation of fungicides against *Fusarium equiseti* causing blight of tuberose

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Abstract
The tuberose (*Polianthes tuberosa* L.), is one of the most important commercial cut flower and loose flower crop and highly praised favourite flower belongs family Amaryllidaceae which is mainly grown in tropical and subtropical regions of the world. Studies on *in vitro* evaluation of non-systemic, systemic and combi fungicides against *Fusarium equiseti* were carried out in the department of Plant Pathology, College of Agriculture, Shivamogga during 2020-2021. Among the non-systemic fungicides evaluated maximum per cent inhibition (100%) was recorded in mancozeb and propineb which was followed by captan (98.32%). Least per cent inhibition of fungus was recorded in chlorothalonil (77.25%). Among the systemic fungicides evaluated maximum per cent inhibition (95.81%) was recorded in hexaconazole followed by tebuconazole (87.71%) and pyraclostrobin (84.37%). Least per cent inhibition was recorded in propiconazole (72.94%). Among the combi products cent per cent inhibition of growth of fungus was recorded in all the combi products like tebuconazole + trifloxystrobin, pyraclostrobin + epoxiconazole, carbendazim + mancozeb and metalaxyl-M + mancozeb and least per cent inhibition of fungus was recorded in propiconazole + difenoconazole (92.32%) against *Fusarium equiseti* at all the three concentration 250, 500 and 1000 ppm.

Keywords: Tuberose, *Fusarium equiseti*, Blight, fungicides

Introduction
Tuberose is one of the most valuable flower crops commercially grown in different regions of India and has export value too. West Bengal leads in tuberose production in country [1]. Tuberose cultivation covers 18.12 thousand hectares in India, with 109.78 thousand MT of loose flowers and 91.47 thousand MT of cut flowers produced [2]. In recent years, tuberose crop is affected by severe diseases resulting into decreased productivity and quality. Anthracnose is a severe disease caused by *Colletotrichum truncatum*. The market value of flowers is affected by stem rot and blight diseases that are caused by pathogens like *Sclerotium*, *Lasiodiplodia*, *Phoma*, *Fusarium*, *Alternaria*, *Botrytis*, *Curvularia* etc. [3].

Durgadevi and Sankaralingam [4] noted that peduncle blight of tuberose caused due to *L. theobromae*. Mahinpoo *et al*. [5] revealed that foot and tuber rot of tuberose due to *F. oxysporum* and Rahman *et al*. [6] reported blossom blight of tuberose caused by *F. equiseti*. There is only a little information available on the management of fungal blight of tuberose, but now a days there are large number of chemicals available in the market and their bio-efficacy and suitability needs to be verified by *in vitro* studies and later it should be extended to field condition. Keeping in view of the economic importance of the flower and destructive nature of fungal blight disease and extent of losses caused to tuberose in the state, the present study was undertaken.

Material and Methods
The efficacy of five non-systemic, five systemic and five combi fungicides were tested against *F. equiseti* for radial growth inhibition on the potato dextrose agar media using poisoned food technique under *in vitro* condition [7]. The non-systemic, systemic and combi fungicides were tried at 250, 500 and 1000 ppm concentrations. The calculated quantities of fungicides were thoroughly mixed in the molten medium before pouring into Petri plates so as to get the desired concentration of active ingredient of each fungicide separately. Twenty ml of fungicide amended medium was poured in each of 90 mm sterilized Petri plates and allowed to solidify. The plates were inoculated centrally with 8 mm disc of 10 days old young sporulating culture of *F. equiseti*. Controls without fungicides were also maintained.

The experiment was conducted in Completely Randomised Design (CRD) with three replications in each treatment. The inoculated Petri plates were incubated at 25 ± 2°C. The colony diameters were measured after 10 days when the control plates were full of fungal growth. Per cent inhibition of growth was calculated by using formula given by Vincent [8].

$$I = [(C - T)/ (C)] X 100$$

Where

I=Per cent inhibition; C=Colony diameter in control; T=Colony diameter in treatment

Statistical analysis

The experimental data collected were analyzed statistically for its significance of difference by the normal statistical procedure adopted for completely randomized design and interpretation of data was carried out. The level of significance used in 'F' and 'T' test was P = 0.05 and P = 0.01. Critical differences were calculated wherever 'F' test was significant. The values percent disease index was subjected to angular transformation according to the table given by Sundarraj *et al*. [9].

Results and Discussion

Among the non-systemic fungicides evaluated cent per cent inhibition of growth of *F. equiseti* was recorded in mancozeb and propineb which was followed by captan (98.32%). Least per cent inhibition of fungus was recorded in chlorothalonil (77.25%). Mancozeb and propineb were significantly superior over all other fungicides evaluated in inhibiting the growth of fungus. At 1000 ppm, cent per cent inhibition of growth of fungus was recorded in mancozeb, propineb, captan and copper oxychloride and least per cent inhibition (85.77%) was recorded in chlorothalonil. At 500 ppm, mancozeb, propineb, captan and copper oxychloride gave cent per cent inhibition while least per cent inhibition was recorded in chlorothalonil (75.34%). At 250 ppm, mancozeb, propineb gave cent per cent inhibition which was followed by captan (94.96%) (Table 1). Chlorothalonil gave least per cent inhibition (70.66%). The results were in conformity with the work of Mamun *et al*. [10], Rahman *et al*. [6] and Yadav [11]. Mancozeb was most effective in controlling *F. equiseti* because of its multi-site activities, such as inactivation of sulfhydryl groups of amino acids and enzymes, lipid metabolism and respiration disruption. Propineb inhibit the germination, growth and multiplication of the fungus or they are directly toxic.

Table 1: *In vitro* evaluation of non-systemic fungicides against *F. equiseti*

Sl. No	Fungicides	Inhibition (%) Concentration (ppm)			
		250	500	1000	Mean
1	Captan 50% WP	94.96# (77.06)*	100 (90.05)	100 (90.05)	98.32 (82.59)
2	Mancozeb 75% WP	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
3	Copper oxychloride 50% WP	74.96 (60.01)	100 (90.05)	100 (90.05)	91.65 (73.24)
4	Propineb 70% WP	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
5	Chlorothalonil 75% WP	70.66 (57.23)	75.34 (60.25)	85.77 (67.87)	77.25 (61.54)
		Fungicides (F)	Concentration (C)	F×C	
S.Em. ±		0.58	0.45	0.34	
CD @ 1%		1.62	1.25	0.93	

Mean of four replications

*Figures in parenthesis are arcsine transformed values

Among the different systemic fungicides evaluated maximum per cent inhibition (95.81%) of growth of *F. equiseti* was recorded in hexaconazole followed by tebuconazole (87.71%) and pyraclostrobin (84.37%). Least per cent inhibition was recorded in propiconazole (72.94%). At 1000 ppm, hexaconazole gave cent per cent inhibition Whereas propiconazole recorded least per cent inhibition (83.51%). At 500 ppm, hexaconazole gave cent per cent inhibition followed by tebuconazole (87.22%). Least per cent inhibition (71.37%) was recorded in propiconazole. At 250 ppm, maximum per cent inhibition (87.44%) was recorded in hexaconazole followed by tebuconazole (83.51%) (Table 2). Least per cent inhibition (63.96%) was recorded in propiconazole. The results are in similarity with the work of Bagga [12]. Among the different combi products evaluated maximum per cent inhibition (100%) was recorded in all the combi products evaluated like tebuconazole + trifloxystrobin, pyraclostrobin + epoxiconazole, carbendazim + mancozeb and metalaxyl-M + mancozeb against *F. equiseti* at all the three concentration 250, 500 and 1000 ppm concentrations (Table 3). Least per cent inhibition (63.96%) was recorded in propiconazole + difenoconazole (92.32%). The results are in similarity with the earlier work of Nisa [13], Sahoo [14], Spolti *et al*. [15] and Zaman [16]. Farooqkhan [17] reported that Trifloxystrobin + Tebuconazole was next best effective fungicide in the management of blight of tuberose after Carbendazim + Mancozeb. The effectiveness of the triazole fungicides like hexaconazole and tebuconazole may be attributed to their interference with the biosynthesis of fungal sterols and inhibit the ergosterol biosynthesis and they also act as demethylase inhibitor interferes in process of building the structure of fungal cell wall. Finally, it's going to inhibit the reproduction and further growth of fungus. In many fungi, ergosterol is essential to the structure of cell wall and its absence cause irreparable damage to cell wall leading to death of fungal cell whereas strobilurins act through inhibition of respiration by binding to the Qo center of the cytochrome b. These strobilurins are very broad and balance spectrum of activity. Strobilurins also works by interfering with the respiration of pathogenic fungi and site of action of Strobilurin compound is located in the mitochondrial respiration pathway.

Table 2: *In vitro* evaluation of systemic fungicides against *F. equiseti*

Sl. No	Fungicides	Inhibition (%)			
		Concentration (ppm)			
		250	500	1000	Mean
1	Pyraclostrobin 23.6% EC	82.88# (65.60)*	83.97 (66.44)	86.25 (68.27)	84.37 (66.74)
2	Difenoconazole 25% EC	80.22 (63.62)	82.03 (64.95)	85.74 (67.85)	82.66 (65.42)
3	Tebuconazole 25.9% EC	83.51 (66.07)	87.22 (69.10)	92.40 (74.04)	87.71 (69.51)
4	Hexaconazole 5% SC	87.44 (69.28)	100 (90.05)	100 (90.05)	95.81 (78.23)
5	Propiconazole 25% EC	63.96 (53.13)	71.37 (57.68)	83.51 (66.07)	72.94 (58.68)
		Fungicides (F)	Concentration (C)	F×C	
	S.Em.±	0.89	0.69	0.51	
	CD @ 1%	2.46	1.90	1.42	

Mean of four replications
*Figures in parenthesis are arcsine transformed values

Table 3: *In vitro* evaluation of combi products against *F. equiseti*

Sl. No	Fungicides	Inhibition (%)			
		Concentration (ppm)			
		250	500	1000	Mean
1	Carbendazim 12% + Mancozeb 63% WP	100# (90.05)*	100 (90.05)	100 (90.05)	100 (90.05)
2	Propiconazole 13.9% + Difenoconazole 13.9% EC	87.19 (69.06)	93.59 (75.37)	96.18 (78.77)	92.32 (73.95)
3	Metalaxyl – M 4% + Mancozeb 64% WP	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
4	Tebuconazole 50% + Trifloxystrobin 25% WG	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
5	Pyraclostrobin 23.6% EC + Epoxiconazole 7.5% SE	100 (90.05)	100 (90.05)	100 (90.05)	100 (90.05)
		Fungicides (F)	Concentration (C)	F×C	
	S.Em.±	0.30	0.23	0.17	
	CD @ 1%	0.84	0.65	0.48	

Conclusion

Among the non-systemic fungicides evaluated, mancozeb and propineb completely inhibited the growth of *F. equiseti*. Among the systemic fungicides evaluated maximum per cent inhibition (95.81%) was recorded in hexaconazole. Among the combi product evaluated maximum per cent inhibition (100%) was recorded in tebuconazole + trifloxystrobin, pyraclostrobin + epoxiconazole, carbendazim + mancozeb and metalaxyl-M + mancozeb against *F. equiseti*.

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