

***In vitro* evaluation of fungicides against *Colletotrichum graminicola* causing Anthracnose of sorghum**

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Abstract: Effect of different fungicide were tested against Anthracnose of sorghum caused by *Colletotrichum graminicola* under *in vitro* condition. Among the fungicide (four are systemic viz., Carbendazim, Propiconazole, Hexaconazole, Penconazole each @ 500 and 1000 ppm and Five non systemic and combi fungicide viz. Mancozeb, Copper oxychloride, Mancozeb 63% + Carbendazim 12%, Mancozeb 50% + Carbendazim 25%, Mancozeb 50% + Carbendazim 25% each @ 1500 and 2000 ppm). In systemic fungicide most effective fungicide with highest average mycelial growth inhibition were Propiconazole (100%), followed by Carbendazim (88.88%). These were followed by the fungicides viz., Hexaconazole (84.99%), Penconazole (78.60%) and in non-systemic and combi fungicide most effective fungicide with highest average mycelial growth inhibition were Mancozeb 63% + Carbendazim 12% (80.17%). This was followed by the fungicides viz., Mancozeb (75.94%) and Copper oxychloride (72.26%). Fungicides Hexaconazole 4% + Zineb 68% (66.66) and Mancozeb 50% + Carbendazim 25% were found less effective with less mycelial inhibition of 66.66 and 62.90 per cent, respectively.

Key words: *Colletotrichum graminicola*, fungicide, hexaconazole, carbendazim.

INTRODUCTION

Sorghum (*Sorghumbicolor* (L.) Moench, is an important cereal crop in India popularly known as 'Jowar' and large size of among other grain millets is called 'Great millet'. In India the production is concentrated in the four states Maharashtra, Karnataka, Andhra Pradesh and Gujarat, it is next in importance to rice and wheat and is planted on nearly 5.84 million hectares with an annual production of 5.90 million tones (Anonymous, 2013). Maharashtra contributes 23.81 lakh hectares and 8.82 lakh hectares areas with production of 11.19 and 13.25 lakh tonnes in *Rabi* and *Kharif* respectively (Anonymous, 2013). Powell *et al.* (1977) reported that grain yield was reduced by 70% and more than half the yield loss resulted from incomplete grain fill as verified by 42% decrease in 1000-seed mass and 17.2% decrease in seed density. Uttarakhand has been identified as hot spot for the anthracnose

disease (Singh and Singh 2008). Anthracnose of sorghum was first reported from Togo in 1902 (Mughogho, 1988).

MATERIALS AND METHODS

Applying tissue isolation technique, the test pathogen was isolated aseptically from the infected leaf on Potato dextrose agar (PDA) medium. Pathogenicity of *Colletotrichum graminicola* was proved by soil inoculation (sick soil) with pure culture of *C. graminicola* on anthracnose susceptible sorghum cultivar cv. CSV-8R, in pot culture under screen house conditions.

In vitro efficacy of nine fungicides was evaluated (systemic @ 500, 1000 and non-systemic @ 1500 and 2000 ppm conc) against *C. graminicola*, by Poisoned food technique (Nene and Thapliyal, 1993), using PDA as basal culture medium. Based on active ingredient, the requisite quantity of each

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test fungicide was calculated and mixed thoroughly with autoclaved and cooled (40°C) Potato Dextrose Agar medium (PDA) separately in conical flasks to obtain desired concentrations. Fungicide amended PDA medium was then poured (20 ml/plate) aseptically in Petri plates (90 mm dia.) and allowed to solidify at room temperature. For each test fungicide and its test concentration, three replications were maintained. After solidification of the medium, all the plates were inoculated aseptically with a 5 mm culture disc obtained from a week old actively growing pure culture of *C.graminicola*. The culture disc was placed on PDA in inverted position in the centre of the Petri plate and plates were incubated at 28+2°C. Petri plates filled with plain PDA (without any fungicide) and inoculated with the culture disc of the test pathogen were maintained as control (untreated).

Non-systemic and combi fungicides

Details of the experiment

Design : CRD

Replications : four

Treatments : six (6)

Mancozeb 63% + Carbendazim 12%, Mancozeb, Copper oxychloride, Hexaconazole 4% + Zineb 68%, Mancozeb 50% + Carbendazim 25% , control.

Systemic fungicides

Details of the experiment

Design : CRD

Replications : four

Treatments : five (5)

Carbendazim, Propiconazole, Hexaconazole, Penconazole, control.

Observations on radial mycelial growth/ colony diameter of the pathogen were recorded at 24 hrs. interval and continued till the untreated control plate was fully covered with mycelial growth of the test pathogen. Per cent mycelial growth inhibition of the test pathogen with the test fungicides over untreated control was calculated by applying the following formula (Vincent 1927).

$$\text{Percent Inhibition}(I) = \frac{C - T}{C} \times 100$$

Where,

C = Growth (mm) of test fungus in untreated control plate

T = Growth (mm) of test fungus in treated plates.

RESULTS AND DISCUSSION

Results (Table 1, PLATE-I & II and fig. 1 & 2) revealed that all the systemic fungicide tested exhibited a wide range of radial mycelial growth of *C.graminicola* over untreated control (90.00 mm) and was found to be decreased drastically with increase in the concentrations of the fungicides tested.

Average radial mycelial growth recorded with all the systemic fungicides tested was range from 00.00 mm (Propiconazole) to 15.50 mm (Penconazole). However, significantly least mycelial growth was recorded with the fungicide Propiconazole (00.00 mm). This was followed by the fungicide Carbendazim (6.50 mm) and Hexaconazole (10.12 mm). Penconazole was found comparatively less effective with maximum mycelial growth (15.50 mm).

Average percentage mycelial inhibition recorded with all the systemic fungicide tested ranged from 82.76 (Penconazole) to 100 (Propiconazole). However, significantly highest mycelial inhibition was recorded with the fungicide, Propiconazole which was highly fungistatic and recorded significantly highest average mycelial inhibition (100%). This was followed by fungicide, viz., Carbendazim (91.52%) and Hexconazole (88.74%). Fungicide Penconazole was found less effective (82.76%) inhibition of test pathogen.

Results (Table-2, PLATE-III&IV and fig. 3&4) revealed that all the non-systemic fungicide tested exhibited a wide range of radial mycelial growth of *C.graminicola* over untreated control (90.00 mm) and was found to be decreased drastically with increase in the concentrations of the fungicides tested.

Average radial mycelial growth recorded with the non-systemic and combi fungicide tested (@ 1500 and 2000 ppm each) ranged from 17.75 mm

Table 1
In vitro efficacy of systemic fungicides against *C. graminicola*

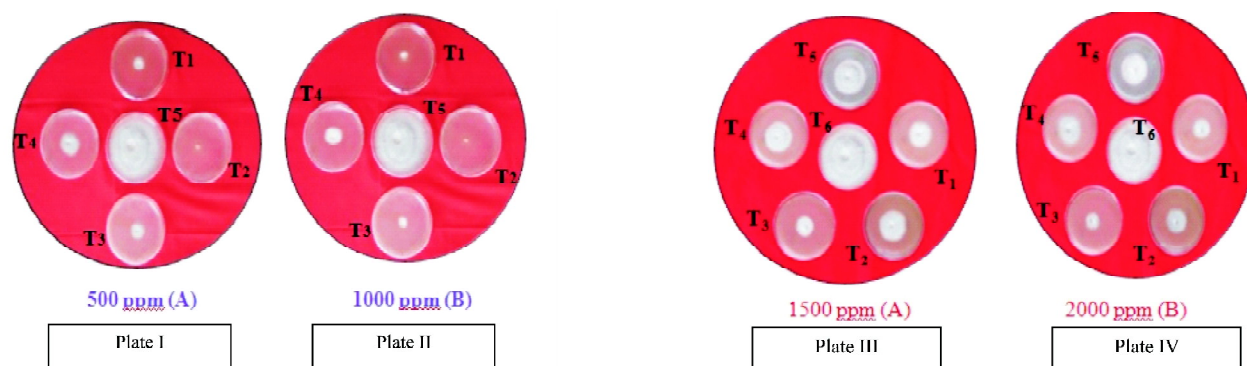
Tr.No.	Treatments	Col. dia. *(mm)at Conc.			% Inhibition*		
		500 ppm	1000 ppm	Av.(mm)	500 ppm	1000 ppm	Av.(%) Inhibition
T ₁	Carbendazim	10.00	5.25	6.50	88.88 (62.76)	94.16 (70.62)	91.52 (66.69)
T ₂	Propiconazole	00.00	0.00	0.00	100.00 (89.98)	100.00 (89.98)	100.00 (89.98)
T ₃	Hexaconazole	13.50	6.75	10.12	84.99 (58.22)	92.49 (67.76)	88.74 (62.99)
T ₄	Penconazole	19.25	11.75	15.50	78.60 (51.89)	86.93 (60.43)	82.76 (56.16)
T ₅	Control (Untreated)	90.00	90.00	90.00	00.00 (00.00)	00.00 (00.00)	00.00 (00.00)
	S.E.±	0.35	0.45	0.4	0.73	1.34	1.03
	C.D. (P=0.01)	1.08	1.40	1.24	2.24	4.13	3.18

*-Mean of four replications, Col. = Colony, Dia. = Diameter, Conc. = Concentration, Av. =Average, Figures in parenthesis are arc sine transformed value

Table 2
In vitro efficacy of non systemic and combi-fungicides against *C. graminicola*

Tr.No.	Treatments	Col. dia. *(mm)at Conc.			% Inhibition*		
		1500 ppm	2000 ppm	Av.(mm)	1500 ppm	2000 ppm	Av.(%) Inhibition
T ₁	Mancozeb	24.25	17.25	20.75	71.11 (46.93)	80.83 (53.99)	75.94 (50.46)
T ₂	Copper oxychloride	30.50	21.25	25.87	68.88 (41.39)	76.38 (49.80)	72.26 (45.59)
T ₃	Mancozeb 63%+ Carbendazim 12%	21.75	14.00	17.75	76.66 (48.85)	83.69 (57.62)	80.17 (53.23)
T ₄	Hexaconazole 4%+ zineb68%	33.75	26.00	29.87	62.22 (38.67)	71.10 (45.33)	66.66 (42.00)
T ₅	Mancozeb50%+ Carbendazim25%	36.25	29.75	33.00	58.88 (36.66)	66.93 (42.02)	62.90 (39.34)
T ₆	Control (Untreated)	90.00	90.00	90.00	00.00(00.00)	00.00(00.00)	00.00(00.00)
	S.E.±	0.53	0.47	0.50	0.71	0.85	0.78
	C.D. (P=0.01)	1.62	1.44	1.53	2.15	2.56	2.35

*-Mean of four replications, Col. = Colony, Dia. = Diameter, Conc. = Concentration
Figures in parentheses are angular transformed values.



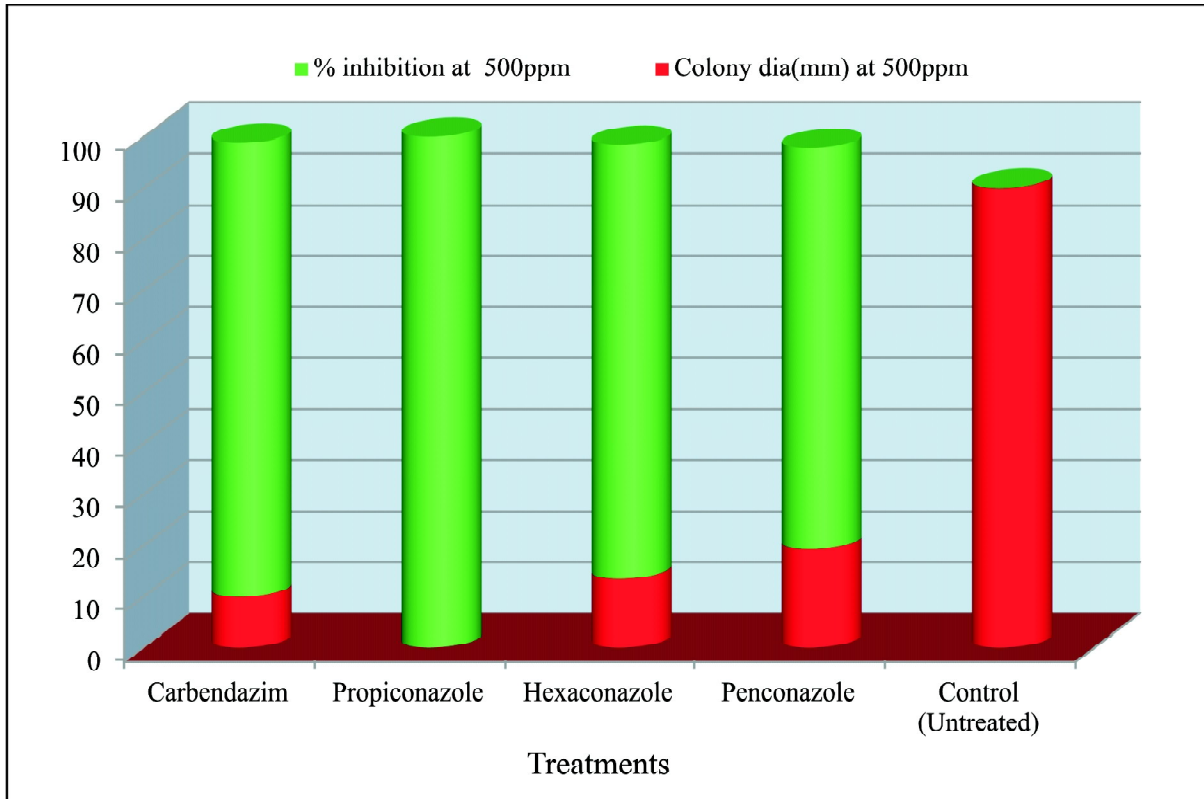


Figure 1 : *In vitro* efficacy of systemic fungicides at 500 ppm on mycelial growth and inhibition of *C. graminicola*

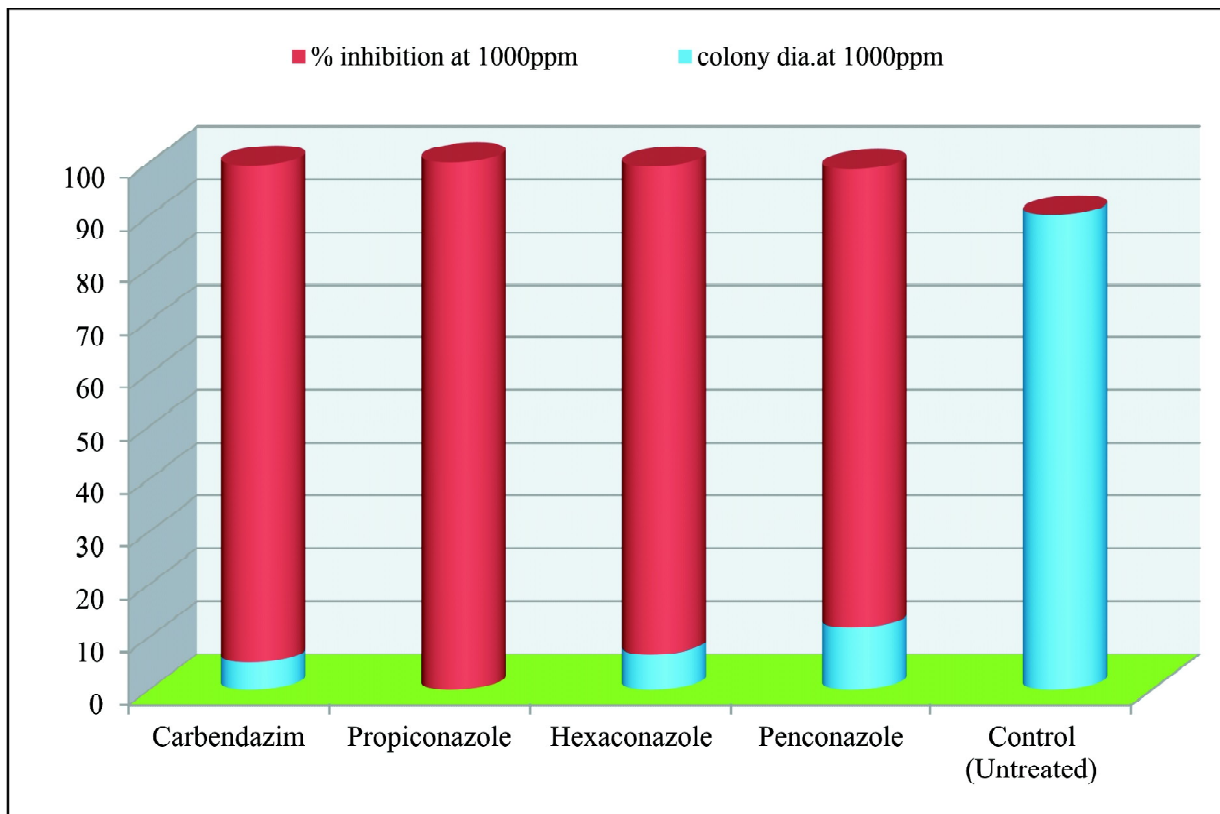


Figure 2 : *In vitro* efficacy of systemic fungicides at 1000 ppm on mycelial growth and inhibition of *C. graminicola*

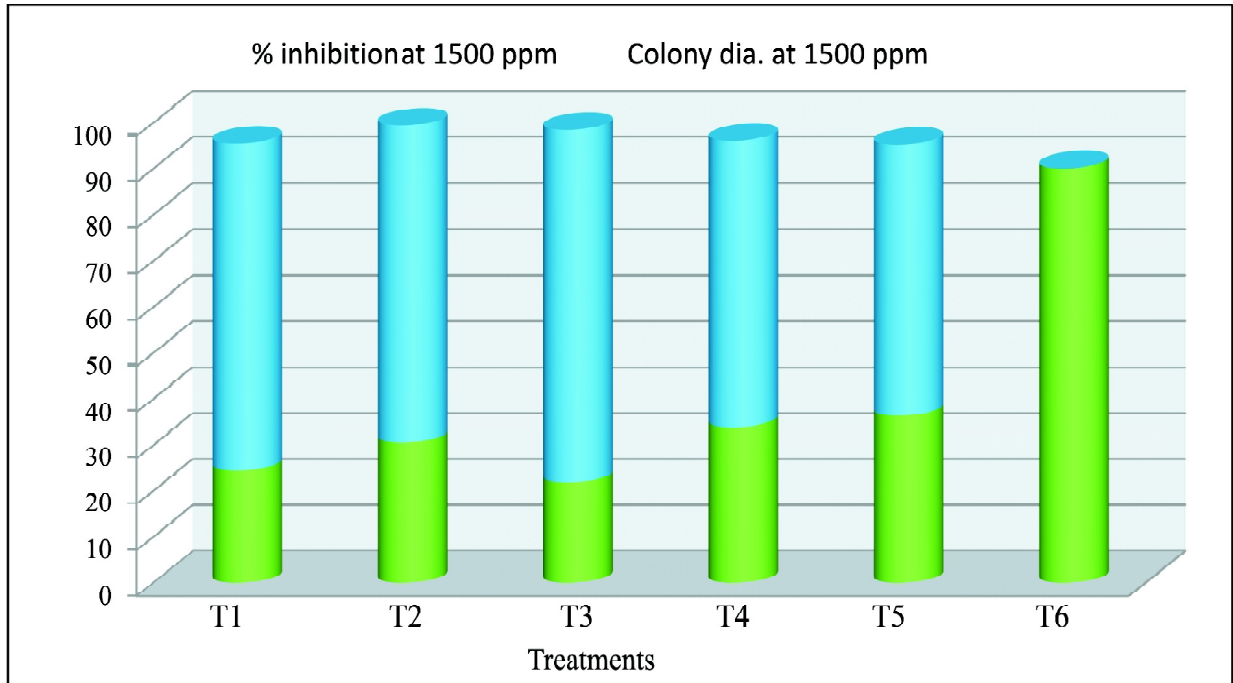


Figure 3 : *In vitro* efficacy of non systemic fungicides at 1500 ppm on mycelial growth and inhibition of *C. graminicola*

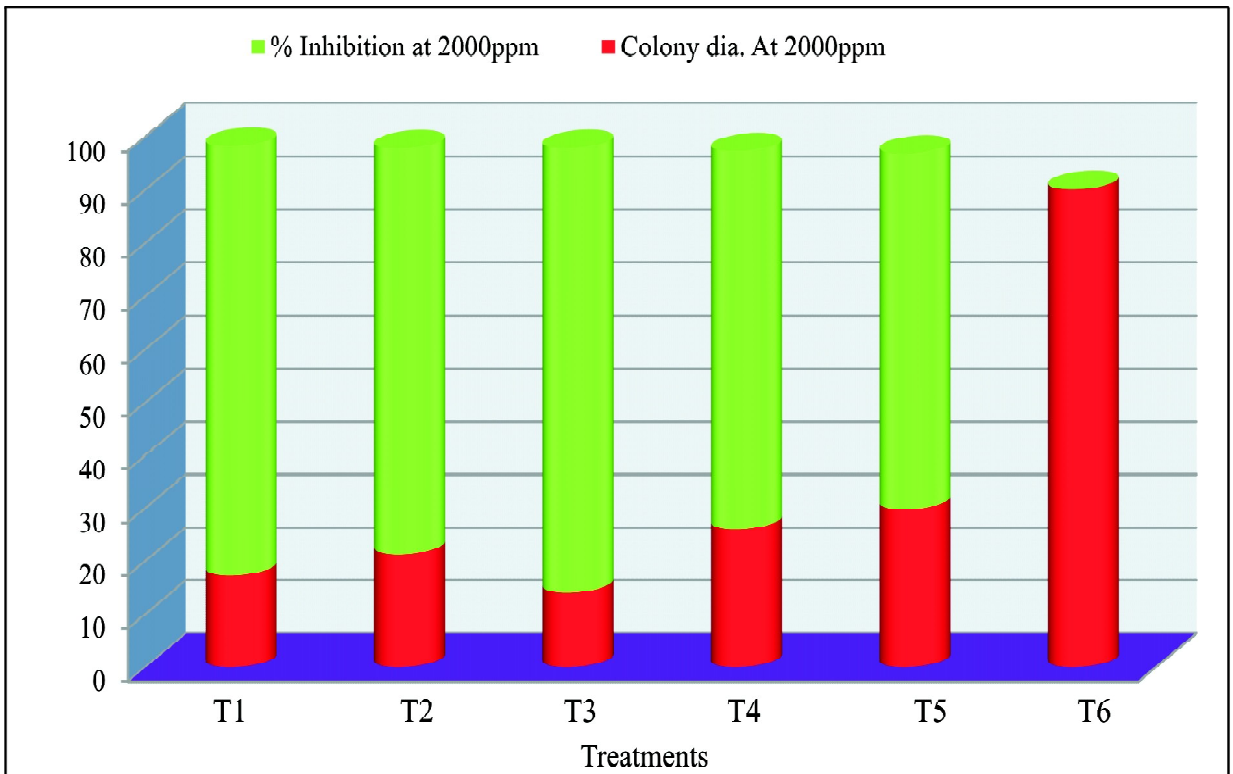


Figure 4: *In vitro* efficacy of non systemic fungicides at 2000 ppm on mycelial growth and inhibition of *C. graminicola*

T₁ : Mancozeb

T₃ : Mancozeb 63% + Carbendazim 12%

T₅ : Mancozeb 50% + Carbendazim 25%

T₂ : Copper oxychloride

T₄ : Hexaconazole 4% + Zineb 68%

T₆ : Control

(Mancozeb 63% + Carbendazim 12%) to 33.00 mm (Mancozeb 50% + Carbendazim 25%). However minimum radial mycelial growth was recorded with Mancozeb 63% + Carbendazim 12% (17.75 mm). The second and third best fungicides were Mancozeb (20.25 mm) and Copper oxychloride (25.87 mm). Fungicides Hexaconazole 4% + Zineb 68% (29.87 mm) and Mancozeb 50% + Carbendazim 25% (33.00 mm) recorded comparatively maximum mycelial growth (Table 2 and PLATE-III & IV).

Average percentage mycelial growth inhibition recorded with all non-systemic and combi fungicide tested (@ 1500 and 2000 ppm each) were ranged from 62.90 (Mancozeb 50% + Carbendazim 25%) to 80.17 (Mancozeb 63% + Carbendazim 12%). However, significantly highest percentage of mycelial growth inhibition was recorded with Mancozeb 63% + Carbendazim 12% (80.17%). This was followed by the fungicides *viz.*, Mancozeb (75.94%) and Copper oxychloride (72.26%). Fungicides Hexaconazole 4% + Zineb 68% (66.66) and Mancozeb 50% + Carbendazim 25% were found less effective with less mycelial inhibition of 66.66 and 62.90 per cent, respectively.

CONCLUSIONS

Anthracoze of sorghum has been reported as a serious threat to bean production in a major sorghum growing region of India and therefore serve as a guide for further field testing in the future. *In vitro* all the four systemic, five non-systemic/combi fungicides tested were found effective against *C. graminicola*. However, systemic fungicides *viz.*, Propiconazole (100%), Carbendazim (91.52%), Hexaconazole (88.74%) and Penconazole (82.76%) recorded significantly highest average mycelial inhibition of the test pathogen. This was followed by the combi fungicide Mancozeb 63% + Carbendazim 12% (80.17%) and Mancozeb (75.54%).

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