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Efficacy of non-systemic fungicides against *A. macrospora* causing leaf spot of *Bt* Cotton.

ID Raut, CV Ambadkar and DN Dhutraj

Abstract
Seven non-systemic fungicides *viz.*, Chlorothaonil 75WP, Propineb 70WP, Mancozeb 75WP, Copper oxychloride 50WP, Captan 50WP, Thiram 75WP and Ziram 27EC each @ 1500 and 2000 ppm concentration were evaluated *in vitro* against *Alternaria macrospora* causing leaf spot of *Bt* cotton. All the treatments significantly inhibited mycelial growth of *Alternaria macrospora* over untreated control. Among seven non-systemic fungicides maximum per cent inhibition was observed with Mancozeb (86.95 %), followed by Thiram (84.68 %), Ziram (81.76%), Propineb (80.23 %) and Copper oxychloride (75.57%), whereas, it was comparatively minimum with Chlorothaonil (55.29 %) and Captan (73.10%).

Keywords: Bt Cotton, leaf spot, fungicides

Introduction
Cotton (*Gossypium* spp.) is the most extensively cultivated commercial crop and is a major fibre crop of global importance. It is an important raw material of economy in term of both employment generation of foreign exchange and hence it is popularly known as "White gold or friendly fibre". India is the largest cotton growing country in the world. The top five producers in the world are China, India, USA, Pakistan and Uzbekistan. India occupies first rank in area and having second position in production. In India cotton is grown over an area 105 lakh hectares with production of 351 lakh bales and productivity 568 kg lint ha^{-1} (Anonymous, 2017).

Cotton crop in India is known to suffer from number of fungal, bacterial and viral diseases. Amongst the several factors responsible for reduction in yield and quality deterioration of cotton in India, diseases occupy a vital place. Amongst all the diseases of cotton *Alternaria* leaf blight poses an alarming situation.

Several factors responsible for reduction in yield and quality deterioration of cotton in India, diseases occupy a vital place. Amongst all the diseases of cotton *Alternaria* leaf blight poses an alarming situation, but very scanty work has been done on this disease. Considering occurrence and losses caused by *Alternaria macrospora* in cotton, the present investigation was carried out with a view to find out the efficacy of non-systemic fungicides against *A. macrospora.*

Material and Methods
Seven non-systemic fungicides *viz.*, Chlorothaonil 75WP, Propineb 70WP, Mancozeb 75WP, Copper oxychloride 50WP, Captan 50WP, Thiram 75WP and Ziram 27EC were reported effective against *Alternaria macrospora* causing leaf spot in cotton, were evaluated *in-vitro* by applying poisoned food technique (Nene and Thapliyal, 1993) [4] and using Potato dextrose agar as basal medium. The pathogen *A. macrospora* was grown on PDA medium in petriplates for fifteen days prior to setting the experiment. Fungicide suspension was prepared in PDA by adding required quantity of fungicide to obtain the desired concentration on the basis of active ingredient and whole product present in the chemical. 20 ml of poisoned medium was poured in each of the sterilized Petriplates. For this 20 ml of sterilized and cooled medium (PDA) was poured in each petriplate (90 mm diameter) and was allowed to solidify. A 5 mm disc of *A. macrospora* was placed at centre of the medium with the help of sterilized cork borer. For this a week old culture of *A. macrospora* in petridishes on sterilized PDA medium were used. Three replications for *A. macrospora* and control i.e. without addition of any fungicides were maintained. Petriplates were incubated at 28 ± 2^0C temperature in inverted position. Observations on radial mycelial growth and sporulation of the test fungus were recorded at 24 hrs interval

and continued till growth of the test pathogen in untreated control plate is fully covered. Per cent inhibition of the test pathogen was calculated by applying formula given by Vincent (1927) as follows.

$$\text{Per cent inhibition} = \frac{C - T}{C} \times 100$$

Where,
C = Growth of the test fungus in untreated control plates
T = Growth of the test fungus in treated plates

Results and Discussion

All seven non systemic fungicides evaluated *in vitro* were found to influence significantly mycelial growth and its corresponding inhibition of *A. macrospora* at various concentrations i.e. 1500 and 2000 ppm. Mycelial growth and its inhibition were found inversely and directly proportional, respectively to concentrations of the fungicides tested.

Effect of non-systemic fungicides on mycelial growth of *A. macrospora*

At 1500 ppm, radial mycelial growth was ranged from 15.23 mm (Mancozeb) to 43.20 mm (Chlorothaonil). However, it was significantly least in the treatment of Mancozeb (15.23 mm). The next fungicides with significantly least mycelial growth were Thiram (13.75mm), followed by Ziram (19.36 mm), Propineb (20.26 mm) and Copper oxychloride (24.50 mm). The fungicides Chlorothaonil and Captan recorded comparatively maximum mycelial growth of 43.20 and 26.20 mm, respectively.

At 2000 ppm, similar trend as that of at 1500 ppm was observed and radial mycelial growth was ranged from 8.25 mm (Mancozeb) to 37.27 mm (Chlorothaonil). It was significantly least in the treatment of Mancozeb (8.25 mm). The next fungicides with significantly least mycelial growth were Thiram (10.22 mm), followed by Ziram (13.46 mm), Propineb (15.31 mm) and Copper oxychloride (19.47 mm). The fungicides Chlorothaonil and Captan recorded comparatively maximum mycelial growth of 37.27 and 22.21 mm, respectively.

Average radial mycelial growth of the test pathogen was ranged from 11.74 mm (Mancozeb) to 40.23 mm (Chlorothaonil). However, there was lowest average mycelial growth with Mancozeb (11.74). The fungicides with next lowest average mycelial growth were Thiram (13.78 mm), followed by Ziram (16.82), Propineb (17.78 mm) and Copper oxychloride (21.98); where as Chlorothaonil and Captan recorded comparatively maximum average mycelial growth of 40.23 and 24.20 mm, respectively.

Effect of non-systemic fungicides on mycelial growth inhibition of *A. macrospora*

Results presented in Table 1 revealed that all non-systemic fungicides tested (each @ 1500 and 2000 ppm) significantly inhibited mycelial growth of *A. macrospora*, over untreated control. Further, per cent mycelial inhibition was increased with increase in concentrations of the fungicides tested.

At 1500 ppm, mycelial growth inhibition was ranged from 51.99 (Chlorothaonil) to 83.07 (Mancozeb) per cent. However, Mancozeb (83.07 %) gave maximum per cent mycelial inhibition. The next best fungicides found were Thiram (80.72 %), followed by Ziram (78.49 %), Propineb (77.48 %) and Copper oxychloride (72.77 %). However, Chlorothaonil and Captan were found less effective with minimum mycelial inhibition of 51.99 and 70.88 per cent, respectively.

At 2000 ppm, the trend was same as at 1500 ppm and mycelial growth inhibition was ranged from 58.59 (Chlorothaonil) to 90.83 (Mancozeb) per cent. It was maximum per cent with the fungicides Mancozeb (90.83 %). In the order of merit the next most effective fungicides with significantly maximum mycelial inhibition were Thiram (88.64 %), followed by Ziram (85.64 %), Propineb (82.99 %) and Copper oxychloride (78.37 %). However, Chlorothaonil and Captan were found less effective with minimum mycelial inhibition of 58.59 and 75.32 per cent, respectively.

Average mycelial growth inhibition recorded with the test non systemic fungicides was ranged from 55.29 (Chlorothaonil) to 86.95 (Mancozeb) per cent. However, it was maximum per cent with Mancozeb (86.95 %), followed by Thiram (84.68 %), Ziram (81.76%), Propineb (80.23 %) and Copper oxychloride (75.57%), whereas, it was comparatively minimum with Chlorothaonil (55.29 %) and Captan (73.10%). Thus, all the non systemic fungicides tested were found fungistatic against *A. macrospora* and significantly inhibited its mycelial growth, over untreated control. However, the contact/non systemic fungicides found most effective in the order of merit were Mancozeb, Thiram, Ziram, Propineb, Copperoxy chloride, Captan and Chlorothaonil.

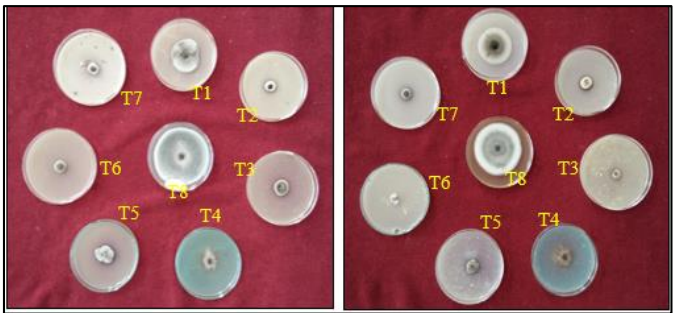
The result of present studies are found similar to the result of previous workers, Deshmukh *et al*. (2008) [2] *in vitro* evaluated the fungicides *viz*., Mancozeb, Thiram, Copper hydroxide, Copper oxy chloride, Chlorothalonil, Zineb and Sulphur each @ 500, 100, 1500 and 2000 ppm concentration against *Alternaria porri*, causing purple blotch of onion. Thaware *et al.* (2010) [5] evaluated different fungicides *in vitro* against *Alternaria alternata*, causing leaf blight of cowpea and reported that Mancozeb @ 0.2% and Propiconazole @ 0.05% completely inhibited mycelia growth of the test fungus, followed by Difenconazole @ 0.05% and Copper oxy chloride @ 0.2% with 87.00 per cent and 86.33 per cent inhibition, respectively. Gholve *et al.* (2012) [3] evaluated six fungicides *viz.*, Mancozeb (75% WP); Carbendazim (50WP), Copper oxychloride (50WP), Captan (50 WP), Thiram (75 % WP), Chlorothalonil (75 WP) *in vitro* against *A. macrospora* and found that Thiram was most effective and recorded significantly highest mean mycelial inhibition (90.42%).

Table 1: *In vitro* efficacy of non-systemic fungicides against *A. macrospora*

Tr. No.	Treatments	Colony Dia. *(mm) at ppm		Av. (mm)	% Inhibition* at ppm		Av. inhibition (%)
		1500	2000		1500	2000	
T_1	Chlorothaonil 75WP	43.20	37.27	40.23	51.99 (46.14)	58.59 (49.94)	55.29 (48.03)
T_2	Propineb 70WP	20.26	15.31	17.78	77.48 (61.66)	82.99 (65.64)	80.23 (63.60)
T_3	Mancozeb 75WP	15.23	8.25	11.74	83.07 (65.70)	90.83 (72.37)	86.95 (68.82)
T_4	Copper oxychloride 50WP	24.50	19.47	21.98	72.77 (58.54)	78.37 (62.28)	75.57 (60.37)
T_5	Captan 50WP	26.20	22.21	24.20	70.88 (57.34)	75.32 (60.21)	73.10 (58.75)

T_6	Thiram 75WP	17.35	10.22	13.78	80.72 (63.95)	88.64 (70.30)	84.68 (66.95)
T_7	Ziram 27EC	19.36	13.46	16.42	78.49 (62.36)	85.04 (67.24)	81.76 (64.71)
T_8	Control	90.00	90.00	90.00	00.00 (00.00)	00.00 (00.00)	00.00 (00.00)
	S.E.±	0.18	0.17	-	0.20	0.19	-
	C.D.(P=0.01)	0.74	0.70	-	0.82	0.78	-

*: Mean of three replications, Dia: Diameter, Av.: Average Figures in Parentheses are arcsine transformed values



(A) 1500 ppm **(B) 2000 ppm**

Fig 1: *In vitro* efficacy of Non-systemic fungicides at 1500 ppm (A) and 2000 ppm (B) on radial mycelial growth and inhibition of *A. macrospora*

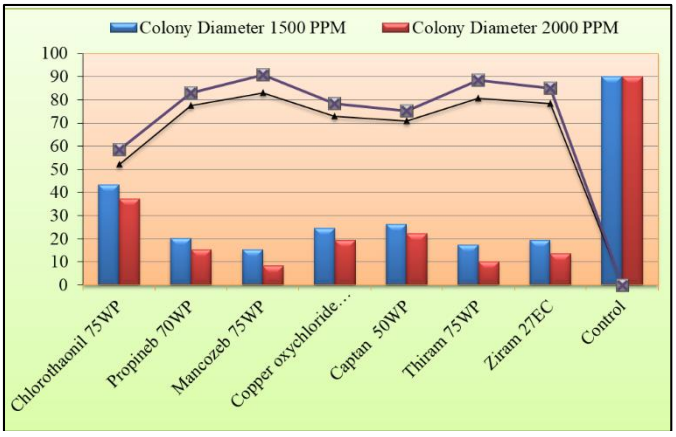


Fig 2: *In vitro* efficacy of non-systemic fungicides against *A. macrospora*

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