Original Research Article

Efficacy of fungicides and commercially available organic products against *Alternaria macrospora*

ABSTRACT

Cotton is referred to as “King of Fibres” and also known as “White Gold”. From time immemorial, India is the only country known for its cotton fabrics, the rest of the world being clad mostly in wool, flax and silk. An attempt was made to test available formulation of fungicides and commercially available organic products for their efficacy under laboratory condition was carried out at Department of Plant pathology, Raichur by using poison food technique. Among the commercially available organic products tested, fatty alcohol and diluents was found most effective which has recorded significantly higher mean mycelial inhibition of 100 per cent at the concentration of 5 and 10 per cent. In case of contact fungicides propineb 70 % WP, metiram 70% WP and mancozeb 75 % WP, with respect to systemic fungicides hexaconazole 5 % EC, propiconazole 25 % EC and difenoconazole 25 % WP, among the combi fungicides azoxystrobin 8.3 % + mancozeb 66.7 % WG were most effective in complete inhibition of mycelial growth of *Alternaria macrospora*.

Keywords: *in vitro, commercially available organic product, fungicides, Alternaria macrospora*

1. INTRODUCTION

Cotton (*Gossypium* spp.) is the most important commercial crops of the world providing fibre for clothing for the mankind, which belongs to the botanical family Malvaceae. Cotton is referred to as “King of Fibres” and also known as “White Gold”, from time immemorial, India is the only country known for its cotton fabrics, the rest of the world being clad mostly in wool, flax and silk. This was particularly from Asiatic *Gossypium arboreum* and *Gossypium herbaceum*, which were indigenous to India. Cotton is not only a world’s leading textile fibre and oilseed crop, but also a crop that is of significance for fuel energy and bioenergy production. It plays an important role in the Indian economy both in terms of providing employment directly or indirectly to about 60 million people and in terms of production of wealth and earning foreign exchange for the country.

Among the various diseases, *Alternaria* blight caused by *Alternaria macrospora* Zimm. is a major foliar disease of cotton which results in heavy defoliation and reduced seed cotton yield (Amaresh and Nargund , 2004 ; Gowdar *et al* 2007)) . The disease in field condition can be managed by using various fungicides and commercially available organic products. Recently, the available formulation of fungicides and commercially available organic products need to be tested for their efficacy under laboratory condition before its application in the field. In this view, the present investigation was carried out to study the

effectiveness of various fungicides and commercially available organic products in inhibition of mycelial growth of the fungu *Alternaria macrospora.* .

2. MATERIALS AND METHODS

The present investigation was carried out to evaluate different fungicides and commercially available organic products their fungitoxicant properties against *A. macrospora* by poisoned food technique. Eight contact fungicides were tested against *A. macrospora* at 0.1,0.2 and 0.3 per cent concentration, nine systemic fungicides at 0.05,0.1 and 0.15 per cent concentration and eight combination fungicides at 0.1,0.15 and 0.20 per cent concentration were tested.The required quantities of individual commercially available organic products were added separately into molten and cooled potato dextrose agar to get the desired concentration of 5 and 10 per cent. Later 20 ml of such poisoned medium was poured into sterile Petri plates. Mycelial discs of 5 mm size from actively growing culture of the test fungus was cut out by a sterile cork borer and one such disc was placed at the centre of each agar plate. Control was maintained without adding any fungicides and commercially available organic products into the medium and each treatment was replicated thrice. Then such plates were incubated at room temperature for 12 to 15 days and diameter colony growth (mm) was measured. Per cent inhibition of mycelial growth in treated plates was calculated by using the formula given by Vincent (1947).

$$I = \frac{C - T}{C} \times 100$$

Where,

I= Per cent mycelial inhibition of test pathogen (%)
C= Mycelial growth of the pathogen in control
T= Mycelial growth of the pathogen in treatment

3. RESULTS AND DISCUSSION

The commercially available organic products are cost effective means of management, an effort was made to know the efficacy of different plant extracts against *A. macrospora*. The results revealed that, from (Table 1 and fig. 1) among the commercially available organic products tested, fatty alcohol and diluentswere found most effective which has recorded significantly higher mean growth inhibition of 100 per cent at the concentration of 5 and 10 per cent. (Green miracle) completely inhibited the growth of fungus by 100 per cent. Whereas, at 10 per cent concentration, Amino acid and peptide derivatives (Isobian) and Activated *P. fluorescens* + Karanja extract+ natural Bi-carbonates (Organic fungicide) both the products inhibited mycelial growth of100 and 100 per cent, respectively. other commercially available organic products such as, *P. fluorescens* 0.5 % WP (Spot) did not show mycelial inhibition at the concentration of 5 and 10 per cent, respectively. The quantities, interactions, and differences across various commercially available organic products were quite varying. The organic products at 10 per cent were notably better than

at 5 per cent concentration. According to literature, the phenolic compound eugenol, in addition to other chemical compounds such as β-caryophyllene, αhumulene, caryophyllene oxide and eugenyl acetate were effective at lower concentrations (Razafimamonjison *et al*., 2014), fungitoxicity of eugenol and other compounds has been reported in some studies (Elsalam and Khorkhlov, 2015). The mechanism of action associated with its hydrophobicity, which provides interaction with the wall and lipids of the cell membrane and mitochondria, altering cellular permeability and causing disturbances in fungal cell structures.

The efficacy of eight contact fungicides were tested against *A. macrospora,* out of which propineb 70 % WP, metiram 70 % WP and mancozeb 75 % WP showed complete inhibition of *A. macrospora* at all the three concentrations (0.1, 0.2 and 0.3 %) followed by chlorothalonil 75 % WP showed 87.04 per cent inhibition at 0.3 per cent concentration, cyazafamid 34.5 % SC (55.93 %) recorded least per cent mycelial inhibition of *A. macrospora*. Increase in inhibition of mycelial growth of the fungus was observed with increase in concentration (Table 2 and fig. 2). Among nine systemic fungicides evaluated, triazole group of fungicides like, difenoconazole 25 % EC, hexaconazole 5 % SC, propiconazole 25 % EC and tebuconazole 25 % EC and triadimefon 25 % EC recorded complete mycelial inhibition of *A. macrospora* at all the three concentrations (0.05, 0.1 and 0.15 %), least effective was thiophanate methyl 50 % SC with 47.40 per cent inhibition at 0.15 per cent concentration (Table 3 and fig. 3). Development of resistance in many pathogens to fungicides with single point of action has led way to the development of new fungicides where chemicals with two different mode of action, which showed synergistic effect for the control of pathogens. So, evaluation of such fungicides for their efficacy to control the disease was important. Out of eight tested combi fungicide, azoxystrobin 8.3% + mancozeb 66.7 % WG inhibited 100 per cent mycelial growth at all the three concentration (0.1, 0.15 and 0.2 %), followed by azoxystrobin 18.2 % + difenoconazole 11.4 % SC, azoxystrobin 4.8 % + chlorothalonil 40 % SC, azoxystrobin 8.3 % + mancozeb 66.7 % WG and hexaconazole 4 % + zineb 68 % WG also inhibited 100 per cent growth at 0.3 per cent concentration, least per cent inhibition was recorded by penflufen 13.28 % + trifloxystrobin 13.28 % SC (68.52 %) at 0.1 per cent concentration. Increase in inhibition of mycelial growth of the fungus was observed with increase in concentration (Table 4 and fig. 4).

Mancozeb reacts and inactivates the sulfhydryl groups of amino acids and enzymes within fungal cells resulting in disruption of lipid metabolism, respiration and production of adenosine phosphate. Tebuconazole is demethylase inhibitor interferes in process of building the structure of cell wall, finally inhibits the reproduction and further growth of fungus and trifloxystrobin interferes with respiration in plant pathogenic fungi. Azoxystrobin inhibit mitochondrial respiration by blocking electron transport and difenoconazole fungicides interfere with biosynthesis of sterols.The results are also in agreement with findings of several workers like Amaresh and Nargund (2002_) , Hussain *et al.* (2018); Sreenivasalu *et al*. (2019) and Pranaya *et al*. (2020) evaluated eight fungicides against *Alternaria macrospora,* propiconazole, hexaconazole and tebuconazole at 500 and 1000 ppm recorded maximum inhibition with 100 per cent inhibition and no radial growth of mycelium was observed. Pyraclostrobin and azoxystrobin at 1000 ppm showed 91.0 and 87.2 per cent inhibition respectively. Carbendazim + mancozeb (SAAF) at 1500 ppm and 2000 ppm showed 96.1 and 96.9 per cent inhibition, respectively.

Table 1. Efficacy of commercially available organic products against *Alternaria macrospora*

Sl. No.	Organic product	Per cent inhibition of mycelial growth over control		
		Concentration (%)		
		5	10	Mean
1	Neem peptide (Azardictin)	28.88 (32.51)	44.44 (41.81)	36.66 (37.26)
2	Sea weed extract (Biozyme)	20.00 (26.57)	33.33 (35.26)	26.67 (31.09)
3	*Lantana camara* plant extract (BI-OVIS)	40.00 (39.23)	82.22 (65.06)	61.11 (51.42)
4	Humic acid + fulvic acid (Humicil)	4.44 (12.17)	73.33 (58.91)	38.89 (38.58)
5	Amino acid and peptide derivatives (Isobian)	97.00 (80.03)	100.00 (90.00)	98.50 (82.97)
6	Fatty alcohol and diluents (Green miracle)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
7	Activated *P. fluorescens*+ *K*aranja extract + natural Bi-carbonates (Organic fungicides)	82.22 (65.06)	100.00 (90.00)	91.11 (72.65)
8	*P. fluorescens*0.5% WP (Spot)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
9	Eugenol 0.10 % W/W+ potassium salt of fatty acids 2 % W/W+ sodium salt 97.90 % W/W (Ecofit)	0.00 (0.00)	28.88 (32.51)	14.44 (22.33)
	Mean	41.39 (40.04)	62.46 (52.22)	
		SEm±	**CD at 1%**	
	Organic product (O)	0.77	2.94	
	Concentrations (C)	0.36	1.39	
	O×C	1.09	4.16	

* Original value **Arc sine transformed value

Table 2. Efficacy of contact fungicides against *Alternaria macrospora*

Sl. No.	Fungicides	Per cent inhibition of mycelial growth over control			
		Concentration (%)			
		0.1	0.2	0.3	Mean
1.	Propineb 70 % WP (Antracol)	100* (90.00)**	100 (90.0)	100 (90.00)	100 (90.00)
2.	Chlorothalonil 75% WP (Kavach)	74.81 (59.80)	79.63 (63.17)	87.04 (68.9)	80.49 (63.79)
3.	Copper oxychloride 50% WP (Blitox 50)	63.70 (52.95)	69.63 (56.56)	77.41 (61.62)	70.24 (56.94)
4.	Mancozeb 75 % WP (Dhanuka M 45)	100 (90.00)	100 (90.0)	100 (90.00)	100 (90.00)
5.	Copper hydroxide 77% WP (Kocide)	60.00 (50.77)	74.81 (59.88)	83.70 (66.19)	72.84 (58.59)
6.	Metiram 70% WP (Sanit)	100 (90.00)	100 (90.0)	100 (90.00)	100 (90.00)
7.	Cyazafamid 34.5 % SC (Ranman)	55.93 (48.40)	66.67 (54.74)	75.93 (60.62)	66.17 (54.44)
8.	Mandipropamid 23.4 % SC (Revus)	57.04 (49.05)	76.30 (60.87)	86.67 (68.58)	73.33 (58.91)
	Mean	85.14 (67.33)	83.38 (65.94)	99.26 (85.07)	
				SEm±	**CD at 1%**
Fungicide (F)				0.36	1.37
Concentration (C)				0.22	0.84
F×C				0.63	2.38

* Original value **Arc sine transformed value

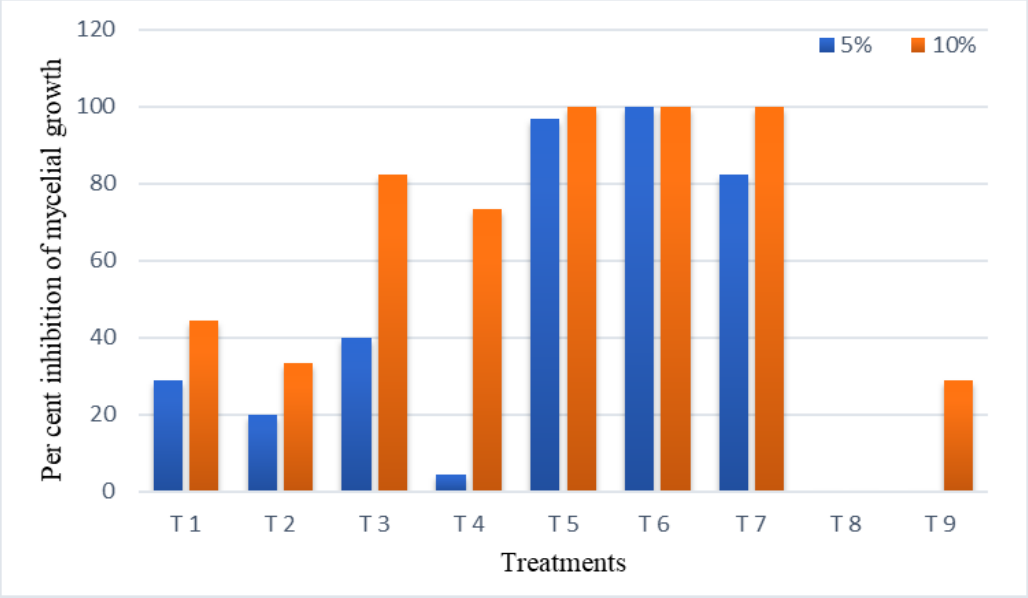
Table 3. Efficacy of systemic fungicides against *Alternaria macrospora*

Sl. No.	Fungicides	Per cent inhibition of mycelial growth over control			
		Concentration (%)			
		0.05	0.10	0.15	Mean
1	Azoxystrobin 23 % SC (Amistar)	53.33* (46.91)**	67.54 (55.27)	89.62 (71.21)	70.16 (56.89)
2	Hexaconazole 5 % EC (Contaf)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
3	Propiconazole 25 %EC (Tilt)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
4	Tebuconazole 25 % EC (Folicure)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
5	Thiophanate methyl 50 % SC (Topsin M)	22.96 (28.63)	35.55 (36.60)	47.40 (43.51)	35.30 (36.45)
6	Difenoconazole 25 % WP (Score)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
7	Triadimefon 25 % WP (Clash)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
8	Pyraclostrobin 5 % WP (Headline)	91.11 (72.65)	96.29 (78.89)	100.00 (90.00)	95.80 (78.17)
9	Isoprothiolane 40 % EC (Blaster)	84.44 (66.77)	94.81 (76.83)	100.00 (90.00)	93.08 (74.75)
	Mean	83.53 (66.06)	88.24 (69.94)	92.00 (74.66)	
				SEm±	**CD at 1%**
Fungicide (F)				0.88	3.31
Concentration (C)				0.51	1.91
F×C				1.52	5.73

Table 4. Efficacy of combi fungicides against *Alternaria macrospora*

Sl. No.	Fungicides	Per cent inhibition of mycelial growth over control			
		Concentration (%)			
		0.1	0.15	0.2	Mean
1.	Azoxystrobin 18.2 % + Difenconazole 11.4 % SC (Amistar)	94.81* (76.84)**	96.67 (79.48)	100 (90.00)	97.16 (80.30)
2.	Carbendazim 12 % + Mancozeb 63 % WP (SAAF)	89.26 (70.87)	94.07 (75.91)	100 (90.00)	94.44 (76.37)
3.	Azoxystrobin 8.3 % + Mancozeb 66.7 % WG (Logic (	100 (90.00)	100 (90.0)	100 (90.00)	100 (90.00)
4.	Metiram 55 % + Pyraclostrobin 5% WG (Cariotop)	88.52 (70.19)	92.96 (74.62)	96.30 (78.90)	92.59 (74.21)
5.	Tebuconazole 18.3 % + Azoxystrobin 11 % SC (Custodia)	88.15 (69.86)	91.11 (72.65)	94.81 (76.84)	91.36 (72.90)
6.	Hexaconazole 4 % + Zineb 68 % WG (Avitar)	88.89 (70.53)	95.96 (77.83)	100 (90.00)	94.81 (76.84)
7.	Azoxystrobin 4.8 % + Chlorothalonil 40 % SC (Azostar)	92.59 (74.21)	95.53 (78.36)	100 (90.00)	96.17 (78.72)
8.	Penflufen 13.28 % + Trifloxystrobin 13.28 % SC (Ever Gol Xtend)	68.52 (55.87)	82.59 (65.34)	92.96 (74.62)	81.36 (64.42)
	Mean	88.78 (70.43)	84.36 (66.71)	98.01 (81.89)	
				SEm±	**CD at 1%**
Fungicide (F)				0.34	1.29
Concentration (C)				0.21	0.79
F×C				0.59	2.23

* Original value **Arc sine transformed value



T1 - Neem peptide	T6 - Fatty alcohol and diluents
T2 - Sea weed extract	T7 - Activated *P.fluorescens*+ karanja extract + natural Bi-carbonates
T3 - *Lantana camara* plant extract	T8 - *P.fluorescens* 0.5% WP
T4 - Humic acid + fulvic acid	T9 - Eugenol 0.10 % w/w+ potassium salt of fatty acids 2 % w/w+ sodium salt 97.90 % w/w
T5 - Amino acid and peptide derivatives	T10 - control

Fig. 1. Bio efficacy of commercially available organic products against *Alternaria macrospora*

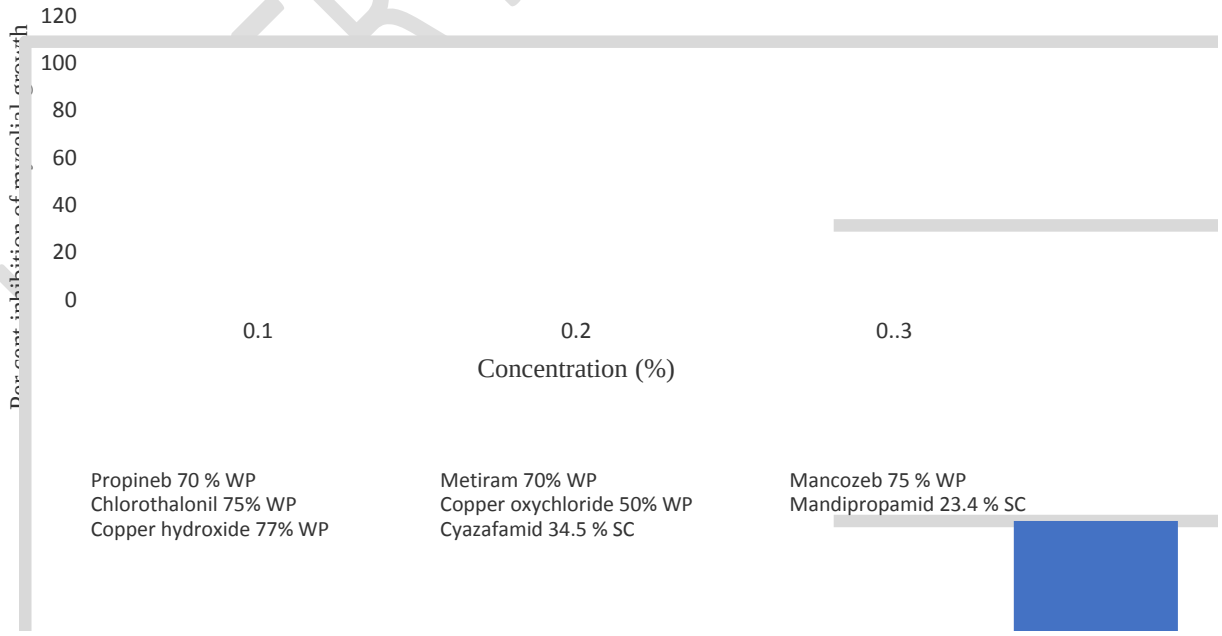


Fig. 2. Bio efficacy of contact fungicides against *Alternaria macrospora*

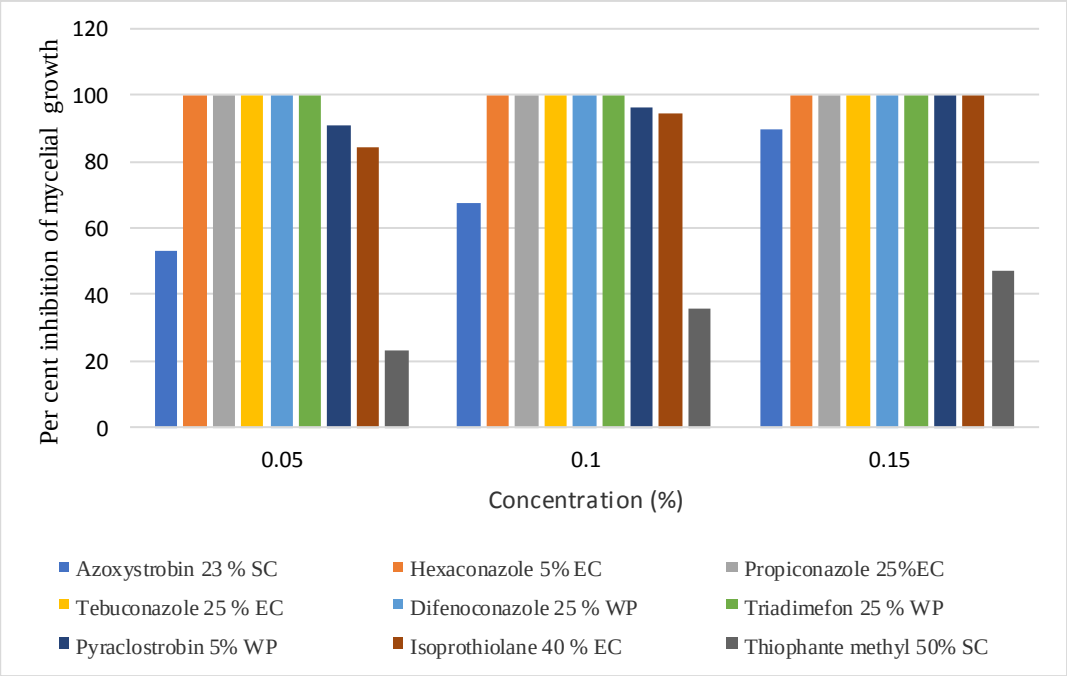


Fig. 3. Bio efficacy of systemic fungicides against *Alternaria macrospora*

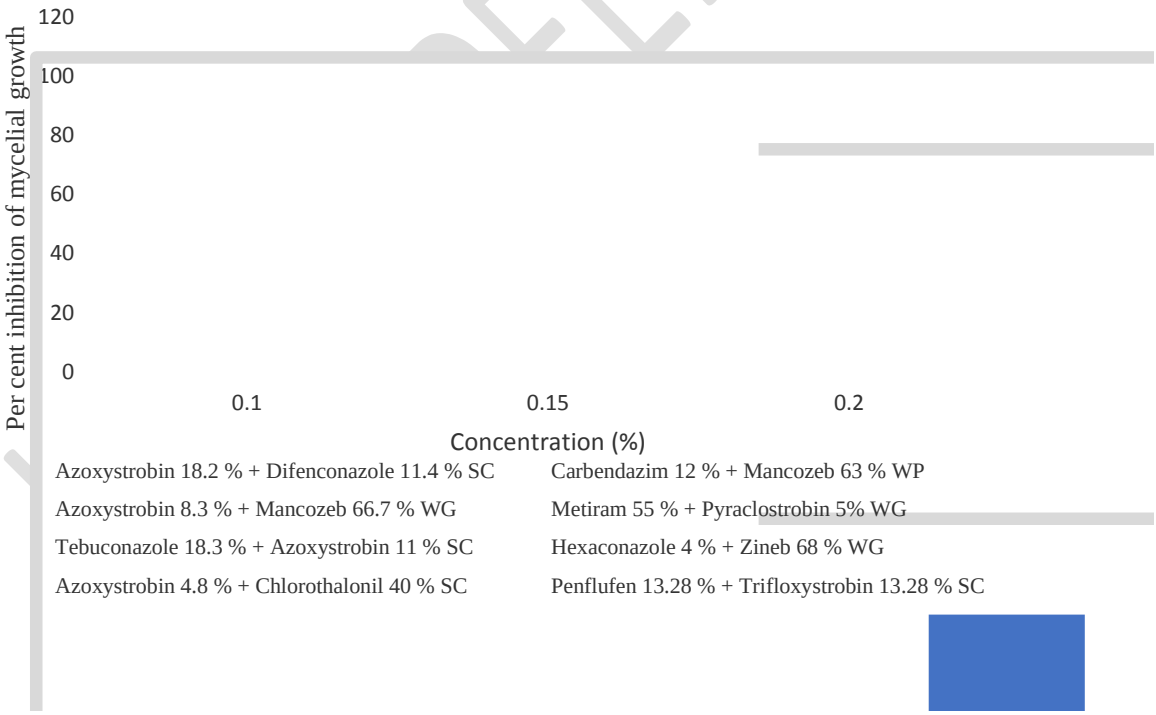


Fig. 4. Bio efficacy of combi fungicides against *Alternaria macrospora*

4. CONCLUSION

Among the commercially available organic products tested, fatty alcohol and diluents was found most effective which has recorded significantly higher mean mycelial inhibition of 100 per cent at the concentration of 5 and 10 per cent. In case of contact fungicides propineb 70 % WP, metiram 70 % WP and mancozeb 75 % WP, with respect to systemic fungicides hexaconazole 5 % EC, propiconazole 25 %EC and difenoconazole 25 % WP, among the combi fungicides azoxystrobin 8.3 % + mancozeb 66.7 % WG were most effective in complete inhibition of mycelial growth of *A. macrospora*. The resistant cultivars may not reach the maximum cultivable area as that of susceptible but high yielding cultivars. Hence, use of fungicides may be the only suitable option when risk of outbreak of epidemics arises under field conditions.

REFERENCES

Amaresh, Y.S, and Nargund V.B. 2002. Field evaluation of fungicides in the management of *Alternaria* leaf blight of Sunflower. *Annals of Plant Protection Sciences*. **10:** 331-336.

Amaresh, Y.S, and Nargund V.B. 2004. Assessment of yield losses due to Alternaria leaf blight and rust of sunflower. *Journal of Mycology and Plant Pathology*. **34**: 75–79

Elsalam, A. K. A. and Khorkhlov, A. R. Eugenol oil nanoemulsion: Antifungal activity against *Fusarium oxysporum*f. sp*. vasinfectum* and phytotoxicity on cotton seeds. *Appl. Nanosci.* 2015; 5(2): 255-265.

Gowdar, S.B, Nargund, V.B**,** Amaresh, Y.S, Sreenivas, A.G, and Patil B .V. 2007. Correlation of cotton Alternaria blight incidence with weather variables. *Research on Crops.* **8**: 488-457.

Hussain, S., Ayub, M., Rasheed, M., Hassan, S., Hussain, K., Hussain, S., Hussain, S. I., Hassan, M., Hussain, A., Hussain, T. and Imtiyaz, M. Efficacy of different fungicides against *Alternaria tusi* cause leaf blight of peas (*Alternaria tusi*) was first time discovered from Kharmang Olding and Skardu Baltistan. *J. Entomol. Zool. Stud*. 2018; 6(5): 2255-2260.

Razafimamonjison, G., Jahiel, M., Duclos, T., Ramanoelina, P., Fawbush, F. and Danthu, P. Bud, leaf and stem essential oil composition of *Syzygiumaromaticum* from Madagascar, Indonesia and Zanzibar. *Int. J. Basic Appl. Sci.* 2014; 3(3): 224-233.

Sreenivasulu, R., Reddy, M. S. P., Tomar, D., Sanjay, M. S. S. and Reddy, B. B. Managing of early blight of tomato caused by *Alternaria solani* through fungicides and bioagents. *Int. J. Curr. Microbiol. App. Sci.* 2019; 8(6): 1442-1452.

Pranaya, K., Bhat, B. N., Devi, G. U. and Triveni, S. *In vitro* evaluation of fungicides against *Alternaria* leaf spot of cotton. *Int. J. Chem. Stud*. 2020; 8(4): 3571-3575.

Vincent, J. M., 1947, Distortion of fungal hyphae in the presence of certain inhibitors. *Nature*. 1947 ;159(4051): 850-855.