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Evaluation of different fungicides against *Alternaria cucumerina* causing leaf blight of bottle gourd (*Lagenaria siceraria* (Mol.) Standl.)

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Abstract
Different contact and systemic fungicides were evaluated *in vitro* against *Alternaria cucumerina*. Amongst contact (non-systemic) fungicides evaluated maximum inhibition in mycelial growth was observed in mancozeb (99.98%) and thiram (99.98%) followed by copper oxychloride (87.60%). Among the different concentrations tried, Mancozeb and thiram showed strong inhibition at all concentration, while copper oxychloride gave 88.51% growth inhibition followed by copper hydroxide (85.51%) at 2500 ppm concentration. Out of seven systemic fungicides, propiconazole, difenoconazole and azoxystrobin found best with 99.98% mycelial growth inhibition followed by picoxystrobin (70.64%). Similarly, propiconazole, difenoconazole and azoxystrobin showed maximum inhibition of mycelial growth (99.98%) of the test fungus at all concentration.

Keywords: Fungicides, *Alternaria cucumerina*, leaf blight, bottle gourd.

Introduction
The bottle gourd (*Lagenaria siceraria*) is an important vegetable crops. This crop is mainly grown in tropical as well as subtropical regions of different countries on commercial scale. It is popularly grown throughout India. In Gujarat; Ahmedabad, Vadodara, Sabarkantha, Jamnagar, Junagadh, Surat, Navsari and Valsad are the leading district for its cultivation and production.
Bottle gourd is affected by many diseases like as fruit rot, root rot, wilt, leaf spot, powdery mildew, bottle gourd mosaic virus *etc*. Among all diseases, leaf blight caused by *Alternaria cucumerina* is a major problem in India and it has now become a limiting factor in stepping up the bottle gourd yield. *Alternaria cucumerina* is a fungus of worldwide occurrence which can infect most of the cucurbits crops. The disease appeared initially in the field just after the seedling emergence. There are small, scattered, water soaked yellowish and circular to oval shaped spots on leaves. Later, these spots are turned into brownish in colour surrounded by chlorotic area with typical concentric rings, which coalesced to form big irregular patches on leaves exhibited blighted look which can resulted into withering and shedding of leaves. Economic yield losses caused by the disease are 20 to 60% (Bruce 2013) [2]. Several workers have attempted to control *Alternaria cucumerina* by use of different systemic fungicides and contact fungicides. The main objective of this study was to evaluate the different fungicides at different concentrations for testing their efficacy against mycelial growth inhibition of *Alternaria cucumerina* under *in vitro* condition.

Materials and Methods
Isolation and Pathogenicity of the Pathogen
The disease causing fungus was isolated by using tissue segment method. Fresh infected leaves of bottle gourd showing well developed dark brown spots with concentric rings were used to isolate the pathogen. The fungus *Alternaria cucumerina* was frequently isolated from leaf blight affected bottle gourd plant and pathogenicity was proved by the method described by Tuite, 1969 [11]. The cultures were purified by hyphal tip method described by Dasgupta, 1988 [4].

In vitro evaluation of fungicides
The efficacy of six non-systemic and seven systemic were evaluated against *Alternaria cucumerina* at different concentration by using potato dextrose agar medium employing

poisoned food technique (Nene and Thapliyal, 1982) [9]. The required quantities of these fungicides were incorporated aseptically in sterilized potato dextrose agar medium separately at the time of pouring. The medium and flasks were rotated briskly so as to get uniform dispersed of the fungicide. The twenty ml medium was then poured separately into each sterilized petri plates with three replications. After solidification, the plates were inoculated with mycelial discs of 4 mm diameter of five days old culture of test pathogen. The mycelium disc which was placed in the centre of the plates, put it in an inverted position to make a direct contact with the poisoned medium. Later it was incubated at 28 ± 1^0 C for seven days.

The linear growth of the fungal colonies was measured from two different angles in millimetre (mm) and average values were calculated. The per cent inhibition of growth of the fungus in each treatment was calculated by using the following formula described by Bliss (1934) [1].

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

Where,

I = Per cent inhibition

C = Colony diameter (mm) of control

T = Colony diameter (mm) of treatment

Result and Discussion

The growth inhibition of *Alternaria cucumerina* causing leaf blight in bottle gourd has been tested at various concentration of non-systemic and systemic fungicides *in vitro* recorded in Table 1 & 2.

The perusal result (Table 1) showed that among all the non-systemic fungicides tested, mancozeb and thiram completely inhibited the mycelial growth at all the four concentrations tested and thus appeared significantly superior over rest of the treatments with a mean mycelial growth inhibition 99.98 per cent. The next best treatments in order of merit were copper oxychloride at 1000, 1500, 2000 and 2500 ppm concentration (86.69, 87.22, 88.00 and 88.51 per cent) and copper hydroxide at 1000, 1500, 2000 and 2500 ppm concentration (83.14, 84.21, 84.94 and 85.51 per cent). While chlorothalonil was found least effective at all concentration. The growth inhibition of fungus increased with the increase in concentration.

There was found positive correlation between concentration and inhibition of growth of pathogen. It is also observed that with increasing concentration of all fungicides, inhibition of pathogen also increased except mancozeb and thiram (1000 ppm) which gave almost cent per cent inhibition at lower concentration.

This finding is in consonance with the results of Chethana *et al.* (2012) [3] who reported that mancozeb proved best for the growth inhibition of *Alternaria* sp. Similarly, Ganie *et al*. (2013) [5] also reported mancozeb with irrespective of concentration was most effective and inhibited a maximum mycelial growth inhibition over check. These results are also supported by finding of Kumar *et al*. (2013) [7] and Kantwa *et al.* (2014) [6]. They reported that mancozeb proved to be the most effective fungicide in inhibiting the mycelial growth of *Alternaria alternata.*

Out of seven systemic fungicides tested, propiconazole, difenoconazole and azoxystrobin completely inhibited the mycelial growth at all the three concentrations and thus appeared significantly superior over rest of the treatments with a mean inhibition of fungal growth 99.98 per cent. The next best treatments in order of merit were picoxystrobin at 100, 250 and 500 ppm concentration (66.75, 70.65 and 74.51 per cent). Dimethomorph, thiophanate methyl and carbendazim were found least effective against test pathogen. It is also observed that with increasing concentration of all fungicides, inhibition of growth of pathogen also increased except difenoconazole, azoxystrobin and propiconazole (100 ppm) which gave almost cent per cent inhibition at lower concentration.

The similar result has been obtained by Mane *et al*., (2011) [8] who reported cent percent mycelial growth inhibition of *A. alternate* with propiconazole. Likewise, Thejakumar and Devappa (2016) [10] recorded that Propiconazole at all concentration completely inhibit mycelial growth of *Alternaria alternata*.

The present results indicates that mancozeb, thiram, propiconazole, difenoconazole and azoxystrobin were quite effective in controlling bottle gourd leaf blight pathogen. The alternate application of these chemicals reduced the risk of development of resistant in pathogen. Such information will be helpful in formulation of schedule for management of this disease.

Table 1: Growth inhibition of *Alternaria cucumerina* at different concentrations of various non-systemic fungicides after seven days of incubation at 28±2 °C.

Sr. No.	Fungicides	*Growth inhibition percentage(ppm)				*Mean inhibition (%)
		1000	1500	2000	2500	
1	Mancozeb (75 WP)	89.19 (99.98)	89.19 (99.98)	89.19 (99.98)	89.19 (99.98)	89.19 (99.98)
2	Thiram (75 WP)	89.19 (99.98)	89.19 (99.98)	89.19 (99.98)	89.19 (99.98)	89.19 (99.98)
3	Copper Oxychloride (50 WP)	68.61 (86.69)	69.06 (87.22)	69.75 (88.00)	70.21 (88.51)	69.41 (87.60)
4	Copper Hydroxide (50 WP)	65.76 (83.14)	66.59 (84.21)	67.17 (84.94)	67.63 (85.51)	66.79 (84.45)
5	Propineb (70 WP)	61.82 (77.69)	66.03 (83.47)	66.20 (83.69)	66.70 (84.33)	65.19 (82.29)
6	Chlorothalonil (75 WP)	37.99 (37.89)	41.54 (43.98)	45.36 (50.63)	46.15 (52.00)	42.76 (46.12)
Mean		68.76 (80.89)	70.26 (83.14)	71.14 (84.53)	71.51 (85.05)	-
		Between Fungicide (F)		**Within fungicide Concentration(C)**		**F × C**
S. Em. ±		**0.35**		**0.29**		**0.71**
C.D at 5%		**1.02**		**0.83**		**2.04**
CV%		**1.49**				

**Data in parenthesis is arcsine transformed.

Table 2: Growth inhibition of *Alternaria cucumerina* at different concentrations of various systemic fungicides after seven days of incubation at 28±2 °C.

Sr. No.	Fungicides	* Growth inhibition percentage (ppm)			*Mean inhibition (%)
		100	250	500	
1	Propiconazole (25 EC)	89.19 (99.98)	89.19 (99.98)	89.19 (99.98)	89.19 (99.98)
2	Difenoconazole (25 EC)	89.19 (99.98)	89.19 (99.98)	89.19 (99.98)	89.19 (99.98)
3	Azoxystrobin (23.5 SC)	89.19 (99.98)	89.19 (99.98)	89.19 (99.98)	89.19 (99.98)
4	Picoxystrobin (25 EC)	54.80 (66.75)	57.20 (70.65)	59.68 (74.51)	57.23 (70.64)
5	Dimethomorph (50 WP)	38.71 (39.13)	41.21 (43.40)	42.98 (46.49)	40.97 (43.00)
6	Thiophanate methyl (70 WP)	27.89 (21.91)	32.24 (28.48)	49.39 (57.62)	36.51 (36.00)
7	Carbendazim (50 WP)	20.66 (12.52)	28.32 (22.54)	48.29 (55.72)	32.42 (30.26)
Mean		58.51 (62.89)	60.93 (66.43)	66.49 (76.32)	-
		Between Fungicide(F)		**Within fungicide Concentration(C)**	**F × C**
S. Em. ±		**0.36**		**0.23**	**0.63**
C.D at 5%		**1.04**		**0.68**	**1.80**
CV%		**1.76**			

**Data in parenthesis is arcsine transformed.

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