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In-vitro efficacy of different fungicides against black mould of onion caused by *Aspergillus niger* (Van Tiegh)

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Abstract
Black mould disease caused by *Aspergillus Niger* Van Tieghem (An) is a limiting factor in onion (*Allium cepa* L.) production worldwide. Nine fungicides were evaluated i*n-vitro* against *Aspergillus Niger*. All the test fungicides at 1000 and 1500 ppm were found effective against the test pathogen and were significantly superior over untreated control. The pathogen was found most sensitive to Carbendazim and Thiram (100% inhibition) followed by Benomyl (99.43% inhibition), Carbendazim (12%) + Mancozeb (63%) (98.99% inhibition) and Mancozeb (96.30% inhibition) among the seven fungicides evaluated *in-vitro* at different concentrations.

Keywords: *In-vitro,* onion, *Aspergillus niger,* fungicides

Introduction
Onion (*Allium cepa* L.) is one of the most important commercial vegetable crop grown in India. Popularly it is also known as 'Queen of kitchen.' It belongs to the family *Liliaceae*. Onion is an important underground vegetable bulb crop of tropical and sub-tropical countries (Thompson and Kelly, 1979) [10]. Vernacularly onion is known as Piyaz, Piaj, Ulli, Vengayan, Erangagam, Earulli, Kanda, Dungli, Ganda, Piaz and Payaz, (Yawalkar, 1992) [12]. Onion is susceptible to numerous foliar, bulb and root pathogens that reduce the yield and quality (Cramer, 2000) [2]. Among post-harvest diseases of onion, black mould rot caused by *Aspergillus Niger* is the predominant one (Rajam, 1982) [4]. *Aspergillus* was first catalogued in 1729 by the Italian priest and biologist Pier Antonio Micheli Bennet (2010) [1]. Samson *et al.*, (2014) [6] reported that the genus *Aspergillus* contains 339 species subdivided into four subgenera and 20 section. Onion black mould rot disease can be caused extensive losses in storage under tropical conditions. (Thamizharasi and Narsimham, 1982) [9]. In order to identify the suitable and most effective fungicides to develop control strategies against the pathogen, some of the available fungicides were evaluated for their efficacy against *Aspergillus Niger*.

Material and Methods
The bio-efficacy of the fungicides earlier reported effective against *Aspergillus Niger* were evaluated *in-vitro* applying Poisoned Food Technique (Nene and Thapliyal 1993) using PDA as basal medium. Eight different systemic and non-systemic fungicides were tested *in-vitro* @ 500, 1000 and 1500 ppm. The experiment was conducted by applying CRD and all treatments were replicated thrice. Plate containing PDA without any fungicide was maintained as untreated control. All treatment plates were inoculated with 5 mm disc of one week old culture of the test pathogen and then incubated at 28 ± 2 °c temperature. Observations on radial growth and sporulation of test fungus were recorded at 24hrs. Interval and will be continued till growth of test pathogen in untreated control plate is fully covered.
Per cent inhibition of test pathogen was calculated by applying formula given by Vincent (1927) [11].

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

Where,
C = Growth of test fungus (mm) in control plates.

T= Growth of fungus (mm) in treatment plates.

Result and Discussion

Results revealed that all seven fungicides were evaluated in-vitro against Aspergillus Niger which exhibited a wide range of mycelial growth inhibition of the test pathogen.

Radial mycelial growth

At 500 ppm, radial mycelial growth of the test pathogen was ranged from 0.0 mm (carbendazim, thiram) to 41.12 mm (blitox) as against 90 mm in untreated control. However, carbendazim, thiram and benomyl were found most effective with least mycelial growth (0.0 mm) and (1.40 mm). Those were followed by fungicides carbendazim (12%) + mancozeb (63%) (02.54 mm), mancozeb (05.96 mm), captan (26.80 mm), blitox (41.12) mm). Among all the fungicides tested captan and blitox were found comparatively less effective against Aspergillus Niger with maximum mycelial growth of 26.80 mm and 41.12 mm, respectively.

At 1000 ppm, all the fungicides tested exhibited similar trend of mycelial growth as that of observed at 500 ppm, but it was comparatively reduced radial mycelial growth and was ranged from 0.0 mm (carbendazim and thiram) to 34.82 mm (blitox), as against 90 mm in untreated control. However, significantly least colony diameter was recorded with fungicides *viz*., carbendazim and thiram (each 0.0 mm). Those were followed by the fungicides *viz*., benomyl (0.077 mm), carbendazim (12%) + mancozeb (63%) (0.093 mm), mancozeb (02.49 mm), captan (22.36 mm) and blitox (34.82 mm). Among all the fungicides tested captan and blitox were found comparatively less effective against Aspergillus Niger with maximum mycelial growth of 22.36 mm and 34.82 mm, respectively.

At 1500 ppm, all the fungicides tested exhibited similar trend of mycelial growth as that of observed at 500 and 1000 ppm, but it was comparatively reduced radial mycelial growth and was ranged from 0.0 mm (carbendazim and thiram) to 28.77 mm (blitox), as against 90 mm in untreated control. However, significantly least colony diameter was recorded with fungicides *viz*., carbendazim and thiram (each 0.0 mm). This was followed by the fungicides *viz*., benomyl (00.05 mm), carbendazim (12%) + mancozeb (63%) (0.06 mm), mancozeb (01.50 mm), captan (18.26 mm) and blitox (28.77 mm). Among all the fungicides tested, captan and blitox were found comparatively less effective against Aspergillus Niger with maximum mycelial growth of 18.26 mm and 28.77 mm, respectively.

At 500, 1000 and 1500 ppm, all the fungicides reduced radial mycelial growth was ranged from 0.0 mm (carbendazim and thiram) to 34.90 mm (blitox), as against 90 mm in untreated control. However, significantly least colony diameter was recorded with fungicides *viz*., carbendazim and thiram (each 0.0 mm). This was followed by the fungicides *viz*., benomyl (00.50 mm), carbendazim (12%) + mancozeb (63%) (0.89 mm), mancozeb (03.31 mm), captan (22.47 mm) and blitox (34.90 mm). Among all the fungicides tested, captan and blitox were found comparatively less effective against Aspergillus Niger with maximum mycelial growth of 22.47 mm and 34.90 mm, respectively.

Per cent mycelial growth inhibition

Results revealed that all the non-systemic and systemic fungicides tested @ 500, 1000 and 1500 significantly inhibited mycelial growth of Aspergillus Niger, over untreated control (0.0%). Further, the percentage mycelial growth inhibition was increased with increase in concentration of the fungicides tested.

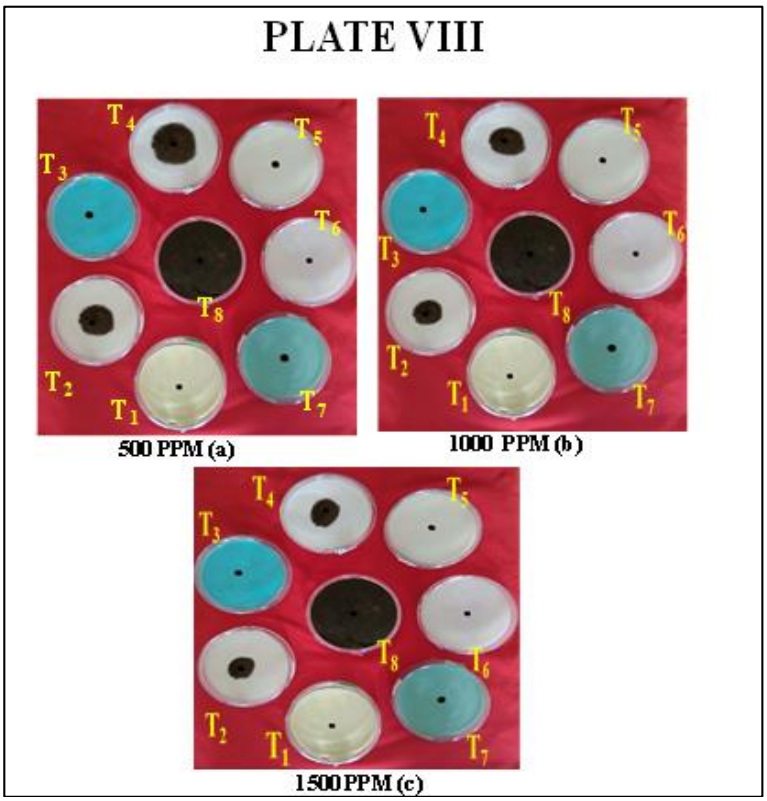
At 500 ppm, mycelial growth inhibition of the test pathogen was ranged from (54.31%) blitox to (100%) carbendazim and thiram. However, significantly the highest mycelial inhibition was recorded with the fungicide, carbendazim and thiram (100%) and it was followed by the fungicide benomyl (98.44%). It was followed by carbendazim (12%) + mancozeb (63%) (97.17%), mancozeb (93.37%), captan (70.21%) and blitox (54.30%) in order to merit. The fungicides, captan (70.21%) and blitox (54.30%) were found comparatively least effective with minimum mycelial growth inhibition.

At 1000 ppm, mycelial growth inhibition of the test pathogen was ranged from (61.30%) Blitox to (100%) Carbendazim and Thiram. However, significantly the highest mycelial inhibition was recorded with the fungicide, Carbendazim and Thiram (100%) and it was followed by the fungicides Benomyl (99.91%). Those were followed by Carbendazim (12%) + Mancozeb (63%) (99.89%), Mancozeb (96.88%), Captan (75.14%) and Blitox (61.30%). The fungicides, Captan (75.14%) and Blitox (61.30%) were found comparatively least effective with minimum mycelial growth inhibition.

At 1500 ppm, mycelial growth inhibition was increased as compared to 500 ppm of the test pathogen and it was ranged from (68.03%) blitox to (100%) carbendazim and thiram. However, significantly the highest mycelial inhibition was recorded with the fungicides, carbendazim and thiram (100%) and it was followed by the fungicides benomyl (99.94%). It was followed by carbendazim (12%) + mancozeb (63%) (99.93%), mancozeb (98.32%), captan (79.70%) and blitox (68.02%). The fungicides, captan (79.70%) and blitox (68.02%) were found comparatively least effective with minimum mycelial growth inhibition.

At 500, 1000 and 1500 ppm, mean mycelial growth inhibition of the test pathogen increased as compared to 500 ppm and 1000 ppm and it was ranged from (61.20%) blitox to (100%) carbendazim and thiram. However, significantly the highest mycelial inhibition was recorded with the fungicide, carbendazim and thiram (100%) and it was followed by the fungicides benomyl (99.43%). Those were followed by carbendazim (12%) + mancozeb (63%) (98.99%), mancozeb (96.19%), captan (75.01%) and blitox (61.20%). The fungicides, captan (75.01%) and blitox (61.20%) were found comparatively least effective with minimum mycelial growth inhibition.

These findings are in agreement with Shekhawat *et al.,* (1986) [7] who reported complete inhibition of the mycelial growth of *A. Niger in-vitro* at 1500 ppm by carbendazim and mancozeb. Similarly, Hayden and Maude (1992) [3] found that thiram as the most effective non-systemic fungicides against *A. Niger* in agar medium. Suryavanshi and Deokar (2001) [8] also noticed maximum inhibition of mycelial growth of *A. Niger* by captan. Raju and Naik (2006) [5] also reported that the pre-harvest spray of carbendazim (0.1%) gave most effective.



T_1. Cub endaum T_2 -Cap tan
T_3 –Benomyl T_4 –Blitox
Ts –Mancozeb T_s -Thiram
T_7 -Carbendazim +14Iancozeb T8 -Control

Fig 1: I naro efficacy of nomptemic and splemic fungicide against Aspergillus Niger

Table 1: *In-vitro* efficacy of non-systemic and systemic fungicides against *Aspergillus Niger*

Tr. No.	Treatments	Colony diameter* (mm)			Mean	% Inhibition* (mm)			Mean
		500 ppm	1000 ppm	1500 ppm		500 ppm	1000 ppm	1500 ppm	
T_1	Carbendazim	00.00	00.00	00.00	00.00	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
T_2	Captan	26.80	22.36	18.26	22.47	70.21 (56.90)	75.14 (60.07)	79.70 (63.20)	75.01 (60.05)
T_3	Benomyl	1.400	0.077	00.05	00.50	98.44 (82.83)	99.91 (88.28)	99.94 (88.56)	99.43 (86.53)
T_4	Blitox	41.12	34.82	28.77	34.90	54.30 (47.44)	61.30 (51.51)	68.02 (55.54)	61.20 (51.49)
T_5	Mancozeb	05.96	2.497	01.50	03.31	93.37 (75.06)	96.88 (79.86)	98.32 (82.53)	96.19 (79.12)
T_6	Thiram	00.00	00.00	00.00	00.00	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
T_7	Carbendazim (12%) + Mancozeb (63%)	02.54	0.093	00.06	0.897	97.17 (80.32)	99.89 (88.09)	99.93 (88.45)	98.99 (85.59)
T_8	Control	90.00	90.00	90.00	90.00	00.00 (00.00)	00.00 (00.00)	00.00 (00.00)	00.00 (00.00)
	SE±	0.30	0.17	0.11	-	0.35	0.30	0.09	-
	C.D.(P=0.01)	0.91	0.53	0.34	-	1.08	0.92	0.27	-

*Mean of three replication, Dia. Diameter, Av- Average, Conc- Concentration., Figures in parenthesis are arc sine transformed value

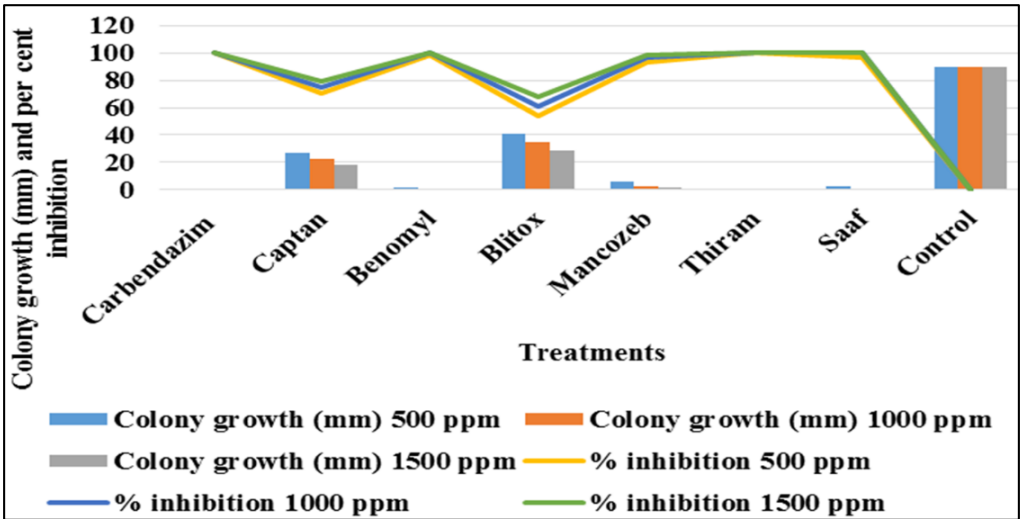


Fig 2: *In-vitro* efficacy of non-systemic and systemic fungicides against *Aspergillus Niger*.

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