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In vitro efficacy of different Fungicides against *Fusarium moniliforme* causing Bakanae Disease of Basmati Rice

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ABSTRACT: Bakanae which is caused by the fungus *Fusarium moniliforme* Sheldon (teleomorph: *Gibberella fujikuroi* Sawada), poses a serious danger to basmati output in all nations that grow the rice varieties including India. It is emerging as major problem in basmati rice producing areas of India. This disease is mainly seed borne but this may be soil borne also. Chemical control provides great opportunity for controlling rice diseases and over last two decades a lot of focus has been shifted towards developing new molecules that can be used for controlling rice diseases. Fungicides are an important tool to control bakanae disease. In this investigation seven fungicides were tested *in vitro* against *F. moniliforme* using the poison food technique to determine the inhibitory effect of various chemicals. Each of the fungicide concentrations was to be used: 50 ppm, 100 ppm, 250 ppm, 500 ppm, and 1000 ppm. The four fungicides carbendazim 50 WP (Bavistin), thiophanate methyl 70% WP (Control), trifloxystrobin 25% + tebuconazole 50% WG (Nativo), and carbendazim 12% + manocozeb 63% WP (Crossman) were reported to be the most effective at 50 ppm, with hundreds percent growth inhibition being recorded. At a concentration of 100 ppm, two fungicides tebuconazole 250EC (Tebuzol) and propiconazole 25% EC (Tilt) were very effective. Azoxystrobin 25SC (Amistar) fungicide was shown to be least effective at concentrations of 50 ppm, 100 ppm, 250 ppm, and 500 ppm, inhibiting growth by 46%, 64%, 75% and 88% respectively. At 1000 ppm, it completely prevents the pathogen from growing. According to the results of the current investigation, systemic fungicides effectively control pathogen *in vitro* conditions. Therefore, these fungicides ought to be used to manage this disease in the field as well.

Keywords: Rice, Bakanae, *Fusarium moniliforme*, Fungicides, Efficacy.

INTRODUCTION

An important cereal crop that is being grown worldwide is rice (*Oryza sativa* L.). In India, basmati rice and non-basmati rice are the two main varieties grown. India is the world's largest producer and exporter of basmati rice. By 2025, it's expected that there will be more than 8 billion people on the planet. To accommodate this expanding need, we must produce 50% more food grain (Yadav *et al*., 2017). A severe threat to basmati rice production worldwide, particularly in India, is the growing fungal disease known as bakanae disease. This disease is caused by *Fusarium moniliforme* Sheldon, later identified as *F. fujikuroi* Nirenberg, the teleomorph stage of the pathogen as known as *Gibberella fujikuroi* Sawada (Nirenberg, 1976).

In India, the states of Uttar Pradesh, Assam, Andhra Pradesh, Tamil Nadu, Haryana, and Punjab have all reported yield reductions ranging from 15 to 25 percent (Pannu *et al*., 2012; Sunder *et al*., 2014). For effective disease management, the identification of promising fungicides is a constant process. Various workers in different countries of the world evaluated the efficacy of various fungicides against *Fusarium moniliforme.* Jain *et al.* (2014) reported that carbendazim completely inhibit to pathogen growth at all concentrations (10 ppm, 100 ppm, 500 ppm and 1000 ppm). However fungicides such as hexaconazole, tabuconazole and thiophanate completely inhibited to pathogen growth at (100 ppm, 500 ppm and 1000 ppm) however at 10 ppm they inhibited pathogen growth 75.28%, 97.78% and 57.64% respectively.

Hossain *et al.* (2015) found Companion, WP (63% Mancozeb and 12 % Carbendazim) inhibit 84.26 and 100.00 percent growth at 50 ppm and 100 ppm respectively. Folicur, EC (25% Tebuconazole) Knowin, WP (50% Carbendazim) and Protaf, EC (25% Propiconazole) inhibit 100 percent growth at 50 ppm and 100 ppm respectively. According to (Khilari *et al*., 2019) five fungicides, thiophanate, propiconazole, tabuconazole + trifloxytrobin, carbendazim and carbendazim + mancozeb inhibit the pathogen's full growth at a concentration of 50 ppm.

Considering the economic value of bakanae and the efficacy of fungicides in preventing it the present study was undertaken. In current study the efficacy of different fungicides were tested against *F. moniliforme* under *in vitro* conditions.

MATERIALS AND METHODS

Using the poison food technique, various fungicides were evaluated to determine their efficacy against *Fusarium moniliforme*. Each conical flask with a capacity of 250 ml and 100 ml of sterilized potato dextrose medium had the necessary amount of fungicides added to it to attain concentrations of 50 ppm, 100 ppm, 250 ppm, 500 ppm, and 1000 ppm. Before transferring the solution into sterile Petri plates, it was properly mixed by shaking the flask. After the medium had a chance to set, 3 mm discs from a seven-day-old *F. moniliforme* culture were positioned in the middle of each Petri plate. Without any treatment, control was maintained.

Fungicides were tested

T1: Carbendazim 50 WP (Bavistin)
T2: Thiophanate Methyl 70% WP (Control)
T3: Trifloxystrobin 25% + Tebuconazole 50% WG (Nativo)
T4: Propiconazole 25% EC (Tilt)
T5: Carbendazim 12% + Manocozeb 63% WP (Crossman)
T6: Azoxystrobin 25SC (Amistar)
T7: Tebuconazole 250EC (Tebuzol)
T8: Control

Concentrations to be used: 50, 100, 250, 500 and 1000 ppm

No. of replications: 3

Design: CRD

Observations were recorded: Mycelial growth was recorded when there is 90 mm growth in check plates at 25±2ºC and percent growth inhibition were estimated by using the formula given by (Vincent, 1947) Growth inhibition (%) = [(Growth in control-Growth in treatment)/Growth in control] × 100

RESULTS AND DISCUSSION

Efficacy of systemic fungicides (Tables 1, 2 and Plate 1) indicates that *in vitro* growth inhibition test of seven fungicides *viz.*, carbendazim 50 WP (Bavistin), thiophanate methyl 70% WP (Control), trifloxystrobin 25% + tebuconazole 50% WG (Nativo), propiconazole 25% EC (Tilt), carbendazim 12% + manocozeb 63% WP (Crossman), azoxystrobin 25SC (Amistar), tebuconazole 250EC (Tebuzol) were revealed that out of all, four fungicides, carbendazim 50 WP (Bavistin), thiophanate methyl 70% WP (Control), trifloxystrobin 25% + tebuconazole 50% WG (Nativo), carbendazim 12% + manocozeb 63% WP (Crossman) were found most effective, there was complete growth inhibition of pathogen at 50 ppm. Tebuconazole 250EC (Tebuzol) and propiconazole 25% EC (Tilt), two fungicides, were most effective at 100 ppm, at which there was no mycelium growth. However, at 50 ppm, in the case of these fungicides, 11 mm of mycelium radial growth was seen, which indicates 87% growth was inhibited. Azoxystrobin 25SC (Amistar) fungicide was shown to be least effective at concentrations of 50 ppm, 100 ppm, 250 ppm, and 500 ppm, inhibiting growth by 46%, 64%, 75%, and 88%, respectively. At 1000 ppm, it completely prevents the pathogen from growing.

Similar to our study (Khilari *et al*., 2019) found that after nine days of inoculation, tabuconazole and azoxystrobin 25SC fungicide showed 90.35% and 47.87% inhibition in pathogen growth at 50 ppm, respectively. Ahangar *et al.* (2012) reported that mycelial growth of the fungus was restricted proportionally with the increase in fungicidal concentration with highest reduction noticed at concentration of 300ppm followed by 200 ppm. Similarly fungitoxic effect was observed to be highest for Carbendazim 12% + Mancozeb 63% WP followed by Captan 70% + Hexaconazole 5%WP and Carbendazim 50% WP with non significant difference at all concentrations. However, the lowest impact in inhibiting the mycelia growth of the fungus was demonstrated by fungicide Mancozeb 75%WP.

Bhalli *et al.* (2001) tested *in vitro* application of eight fungicides against *Fusarium moniliforme* and found Benlate and Derosal the most effective fungicides which completely inhibited the growth of the test fungus at 100 ppm. However, (Gaur and Chakrabarti 2009) found Captan and Carbendazim to be most effective in inhibiting the mycelia growth. Iqbal *et al.* (2011) also reported that no fungal mycelia growth was observed in case of Derosol, Daconil and Topsin-M treatment at concentration of 0.25%. Kumar *el al.* (2016) revealed *in vitro* growth inhibition tests of six fungicides that the EC50 values of fungicides varied from 0.34 to 724.43 ppm a.i. Trifloxystrobin 25% + tebuconazole 50% 75 WG was the most inhibitory (EC50 0.34 ppm a.i.). In terms of EC90 values, carbendazim 50 WP was the most toxic (EC90 1.14 ppm a.i.) followed by tebuconazole 250 EC and trifloxystrobin 25% + tebuconazole 50% 75 WG with EC90 values of 3.89 and 4.36 ppm.

Raghu *et al.* (2018) recorded maximum reduction in the mycelial growth of the pathogen in treatments; Carbendazim 12% + mancozeb 63% (Saaf), Trifloxistrobin + Tebuconazole (Nativo), Tebuzonazole (Folicure), Propiconazole 25% EC (Tilt), Carbendazim 50% WP (Bavistin) with 100% reduction at 0.05% (500 ppm) concentration. In case of Azoxystrobin (Amister) 13.70, 27.78, and 27.78 percent growth inhibition at 500 ppm, 750 ppm and 1000 ppm was recorded. Iqbal *et al.* (2011) observed that efficacy of Topsin-M, Derosal and Daconil was found best with no mycelia growth of fungus. Least impact was observed in the case of Aliette by using poisoned food technique.

Table 1: Efficacy of different fungicides against *Fusarium moniliforme.*

Sr. No.	Fungicides	Trade names	Percent growth inhibition at different concentration in (ppm)					
			50	100	250	500	1000	Mean
T_1	Carbendazim 50 WP	Bavistin	99.99 (89.39)*	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)
T_2	Thiophanate Methyl 70% WP	Control	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)
T_3	Trifloxystrobin 25% +Tebuconazole 50% WG	Nativo	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)
T_4	Propiconazole 25% EC	Tilt	87.78 (69.52)	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	97.54 (85.41)
T_5	Carbendazim 12% + Manocozeb 63% WP	Crossman	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)
T_6	Azoxystrobin 25SC	Amistar	46.66 (43.07)	64.44 (53.38)	75.55 (60.34)	88.88 (70.51)	99.99 (89.39)	75.10 (63.34)
T_7	Tebuconazole 250EC	Tebuzol	87.78 (69.52	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	99.99 (89.39)	97.54 (85.41)
T_8	Control		0.01 (0.57)	0.01 (0.57)	0.01 (0.57)	0.01 (0.57)	0.01 (0.57)	0.01 (0.57)
		Mean	77.77 (67.53	83.04 (73.78)	84.43 (74.65)	86.10 (75.92)	87.49 (78.28)	
Factors	C.D.(p=0.05)	SE(d)	SE(m)					
Treatment	0.44 (0.30)	0.22 (0.15)	0.15 (0.10)					
Concentration	0.35 (0.23)	0.17 (0.12)	0.12 (0.08)					
Treatment × Concentration	0.99 (0.67)	0.49 (0.33)	0.35 (0.23)					

*Figures in the parentheses are angular transformed values

Table 2: Radial growth of pathogen in response of different fungicides at different concentrations.

Sr. No.	Fungicides	Trade names	Radial growth (mm) at diff. conc. (ppm)				
			50	100	250	500	1000
1.	Carbendazim 50 WP	Bavistin	0.01	0.01	0.01	0.01	0.01
2.	Thiophanate Methyl 70% WP	Control	0.01	0.01	0.01	0.01	0.01
3.	Trifloxystrobin 25% +Tebuconazole 50% WG	Nativo	0.01	0.01	0.01	0.01	0.01
4.	Propiconazole 25% EC	Tilt	11.00	0.01	0.01	0.01	0.01
5.	Carbendazim 12%+Manocozeb 63% WP	Crossman	0.01	0.01	0.01	0.01	0.01
6.	Azoxystrobin 25SC	Amistar	48.00	32.00	23.00	10.00	0.01
7.	Tebuconazole 250EC	Tebuzol	11.00	0.01	0.01	0.01	0.01
8.	Control		89.99	89.99	89.99	89.99	89.99

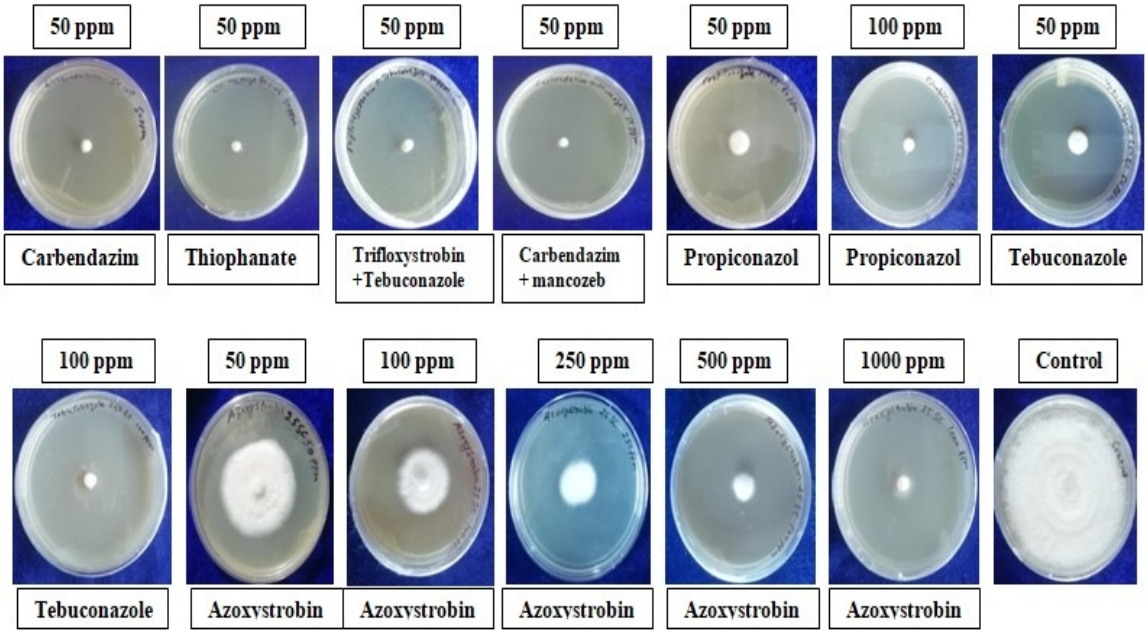

Plate 1: Radial growth of *Fusarium moniliforme* at nine days after inoculation.

CONCLUSION

The four fungicides with the highest efficacy at 50 ppm were carbendazim (Bavistin), thiophanate methyl (Control), trifloxystrobin + tebuconazole (Nativo), and carbendazim + manocozeb (Crossman). At 100 ppm, two fungicides, tebuconazole (Tebuzol) and propiconazole (Tilt), completely prevent the pathogen from growing. Azoxystroin had the least effects, but it was also the efficient at 1000 ppm. According to the results of the current investigation, systemic fungicides effectively control pathogen. Fungicides can therefore be used to treat this disease.

FUTURE SCOPE

In this investigation, we found that the use of fungicides can effectively manage this disease *in vitro*. Fungicides can be very successfully utilized for the management of this disease, and more study with chemicals can be done in cases of this disease in field conditions also. New fungicides will continue to be developed to protect the cultivars species with no genetic disease resistance. Efforts are made develop a new strategy for environmentally friendly control of fungal plant diseases with the development of proteomics-based fungicides.

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Conflict of Interest. None.

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