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Diksha Nayak
Department of Plant Pathology, College of Agriculture, OUAT, Bhubaneswar, Odisha, India

MK Mishra
Department of Plant Pathology, College of Agriculture, OUAT, Bhubaneswar, Odisha, India

Kishan Kumar Sharma
Department of Plant Pathology, College of Agriculture, Raipur, Chhattisgarh, India

Bipin Pradhan
AICRP on fruits, OUAT, Bhubaneswar, Odisha, India

Corresponding Author:
Diksha Nayak
Department of Plant Pathology, College of Agriculture, OUAT, Bhubaneswar, Odisha, India

In vitro efficacy of different chemicals against radial growth of *Fusarium oxysporum* f.sp *cubense*, an incitant of panama wilt of banana

Diksha Nayak, MK Mishra, Kishan Kumar Sharma and Bipin Pradhan

Abstract
Global banana production is seriously threatened by the re-emergence of a Fusarium Wilt. The disease, caused by the soil-borne fungi *Fusarium oxysporum* f. sp. *cubense* (Foc) and also known as "Panama disease". Keeping in view the severity of Panama wilt, Screening of efficacy of fungicides by poision food technique against causal organism. Out of ten fungicides tested *in vitro*, Carbebdazim +Mancozeb (0.2%), Thiophanate methyl (0.15%), Tebuconazole (0.1%), Carbendazim (0.1%) and Propiconazol (0.1%) completely checked (100%) the radial growth of *Fusarium oxysporum* f. sp. *cubense* (Foc) followed by Carboxin +Thiram (0.2%) which checked 90% radial growth. Azoxystrobin was least effective (65.1% reduction) in reducing radial growth of pathogen.

Keywords: Panama wilt, fungicides, management

Introduction
Banana (*Musa* sp.) is one of the oldest fruits known to mankind. Banana crop is affected by a number of diseases like panama wilt, bacterial wilt moko disease, sigatoka leaf spot, bunchy top of banana top virus bract mosaic and other infestation caused by many disease and insects. Global banana production is seriously threatened by the re-emergence of a Fusarium Wilt. The disease, caused by the soil-borne fungi *Fusarium oxysporum* f. sp. *cubense* (Foc) and also known as "Panama disease". Fusarium wilt of banana, popularly known as Panama disease, is a lethal fungal disease caused by the soil-borne fungus *Fusarium oxysporum* f. sp. *cubense* (*Foc*). The fungus enters the plant through the roots and colonizes in the xylem vessels thereby blocking the flow of water and nutrients (Ploetz and Churchill, 2011). In Odisha the disease has been causing considerable damage in coastal light soil and other area also a number of coastal districts are affected by panama wilt. Keeping in view the severity of Panama wilt in coastal Odisha, an investigation was undertaken to test efficacy of different chemicals against causal organism.

Materials and Methods
The efficacy of ten different chemicals was tested on PDA medium against Foc by poisoned food technique. Required quantity of individual fungicide was added separately into molten and cool potato dextrose agar so as to get the desired concentration of fungicide. Later 20 ml of the poisoned medium was poured into sterile Petri plates. Mycelial discs of 5 mm size from actively growing culture of the fungus were cut by sterile cork borer and one such disc was placed at the centre of each agar plate. Control was maintained without adding any fungicide to the medium. Each treatment was replicated thrice. Then such plates were incubated at room temperature for ten days and radial growth was measured. The efficacy of a fungicide was expressed as per inhibition of mycelial growth over control that was calculated by using the formula suggested by Vincent (1947).

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

Where,
I = Per cent inhibition
C = Radial growth in control
T = Radial growth in treatment
Further, angular transformations were made for data and analysed statistically.

Results and Discussion

In vitro studies against different chemicals was undertaken for the growth of Foc in different concentration as per material methods. Result indicated that, there was significant difference among all the fungicides in reducing mean radial growth of Foc. Carbebdazim +Mancozeb, Thiophanate methyl, Tebuconazol, Carbendazim and Propiconazol completely checked (100%) the radial growth of pathogen. Carboxin +Thiram reduced the mycelial growth upto 90%. Copper Oxychloride and Chlorothalonil reduced the radial growth in a similar way (76.3%, 75.1% respectively). Azoxystrobin was least affective (65.1% reduction) in reducing radial growth of pathogen.

Table 1: *In vitro* effect of antagonists against pathogen

Treatments	Chemicals	Concentration (%)	Dose(gm or ml/l)	Mean Colony diameter (mm)	Percent inhibition over control
T_1	Copper oxychloride	0.2	2g	42.7 (4.67)*	76.3
T_2	Carbendazim+mancozeb	0.2	2g	0 (0.71)	100
T_3	Chlorothalonil	0.2	2g	22.3 (4.78)	75.1
T_4	Tebuconazole	0.1	1g	0 (0.71)	100
T_5	Thiophenatemethyle	0.15	1.5g	0 (0.71)	100
T_6	Carboxin +Thiram	0.2	2g	8.3 (2.97)	90
T_7	Matalaxyl+Mancozeb	0.2	2g	38 (6.20)	57.7
T_8	Carbendazim	0.1	1g	0 (0.71)	100
T_9	Propiconazol	0.1	1ml	0 (0.71)	100
T_{10}	Azoxystrobin	0.1	1ml	31.3 (5.64)	65.1
T11	Control	0	0	90 (9.51)	0
SEm ±				0.04	
CD at 5%				0.11	

*Figure in the parentheses indicate corresponding √(x+0.5) transformed mean.

In vitro studies were conducted against radial growth of *Fusarium oxysporum f.sp. cubense* (Foc) with eleven number of fungicides in combination including control. Carbebdazim +Mancozeb, Thiophanate methyl, Tebuconazol, Carbendazim and Propiconazol completely checked (100%) the radial growth of pathogen. Carboxin +Thiram reduced the mycelial growth upto 90% and Azoxystrobin was least effective (65.1% reduction). The current study was supplemented by the study of Singh and Jha (2003), Soma *et al.* (2008) [9, 11] who have reported Carbendazim to be the best fungicide for *Fusarium oxysporum* f.sp. *cubense* (Foc). R Somu *et al.* (2014) [12] reeported 100% control of *Fusarium oxysporum* f.sp. *cubense* (Foc) by Carbebdazim, Carboxin, Propiconazol and Benomyl. Azoxystrobin showed moderate growth inhibition which was also found in the current study. Metalaxyl + Mancozeb 0.2% recorded lowest effect on *Fusarium oxysporum f. sp. cubense* (Foc) (57.7% inhibition) among all the fungicides tested.

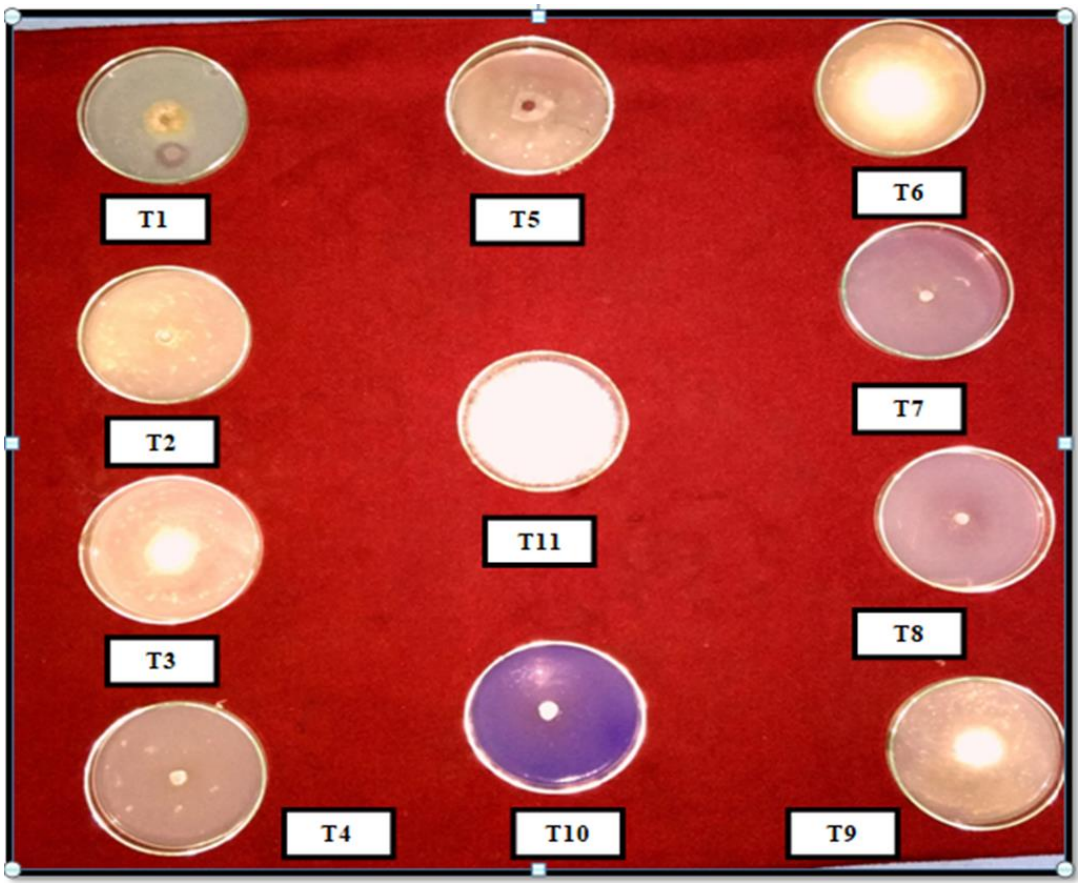

Plate 1: Effect of antagonists against the pathogen *in vitro*

Treatments

T1: Copper oxychloride (0.2%)	**T2: Carbendazim + mancozeb (0.2%)**
T3: Chlorothalonil (0.2%)	**T4: Tebuconazole (0.1)**
T5: Thiophenatemethyle (0.15%)	**T6: Carboxin + Thiram (0.2%)**
T7: Matalaxyl + Mancozeb (0.2%)	**T8: Carbendazim (0.1%)**
T9: Propiconazol (0.1%)	**T10: Azoxystrobin (0.1%)**

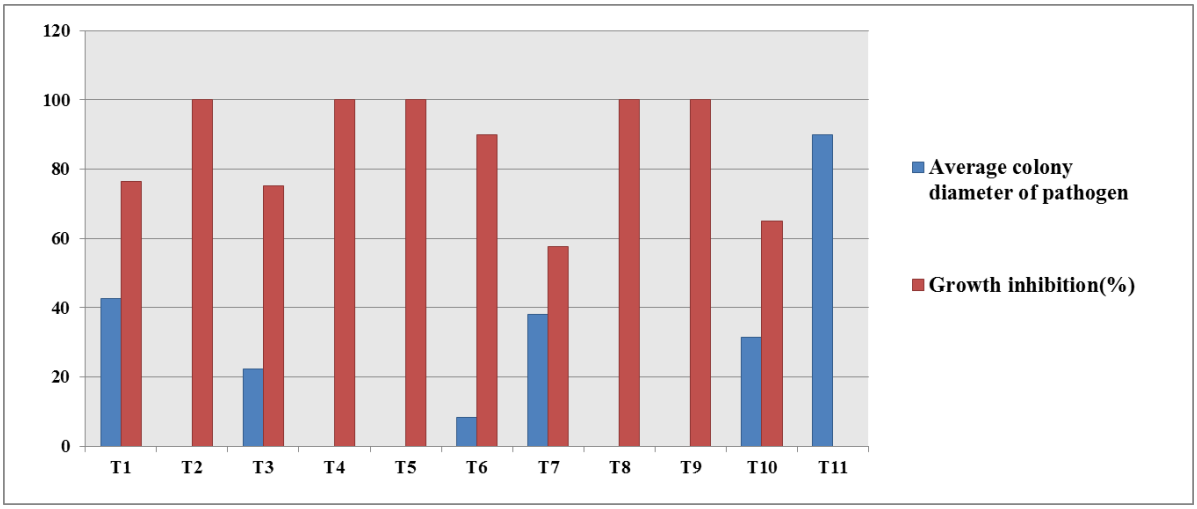

Fig. 1: Effect of antagonists against pathogen *in vitro*

Treatments

T1: Copper oxychloride (0.2%)	**T2: Carbendazim + mancozeb (0.2%)**
T3: Chlorothalonil (0.2%)	**T4: Tebuconazole (0.1)**
T5: Thiophenatemethyle (0.15%)	**T6: Carboxin + Thiram (0.2%)**
T7: Matalaxyl + Mancozeb (0.2%)	**T8: Carbendazim (0.1%)**
T9: Propiconazol (0.1%)	**T10: Azoxystrobin (0.1%)**

Conclusion

Carbebdazim + Mancozeb (0.2%), Thiophanate methyl (0.15%), Tebuconazol (0.1%), Carbendazim (0.1%) and Propiconazol (0.1%) completely checked (100%) the radial growth of *Fusarium oxysporum* f. sp. *cubense* (Foc) followed by Carboxin +Thiram (0.2%) which checked 90% radial growth. Azoxystrobin was least effective (65.1% reduction) in reducing radial growth of pathogen.

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