Promising combination systemic fungicides in combating basal stem rot disease of coconut

ABSTRACT

Basal stem rot disease is the most challenging disease in coconut crop, caused by *Ganoderma lucidum*. Combating the disease with new generation fungicides is a viable strategy for the promising disease control. Single and combination of new systemic fungicides in different commercial formulations were tested against the *Ganoderma lucidum.* under *in vitro* study at 100, 250 and 500 ppm concentrations. The results revealed that Hexaconazole 4% + Carbendazim 16% SC, Hexaconazole 5% + Validamycin 2.5%SC and Azoxystrobin 11% + Tebuconazole 18.3% SC W/W were found superior in inhibiting the mycelial growth of *Ganoderma* as compared to other fungicides. Per cent inhibition indicated the effectiveness of potent fungicides against the pathogen even at lower concentration.

Keywords: Basal stem rot, Coconut, *Ganoderma lucidum,* Fungicide, Hexaconazole and *in vitro*

INTRODUCTION

"Coconut (*Cocos nucifera* Linn.) is the most important successful tropical plantation crop and it provides food, oil, health drink, medicine, fiber, timber, fuel, and varieties of products of commercial importance. Indonesia, Philippines, India and Sri Lanka are the major coconut growing countries. The cultivation of coconut in India during 2016-17 was 2.09 million hectares area with the production of 15339.10 million nuts" (CDB, 2016). "The state Tamil Nadu occupies an area of 0.44 million hectares with production of 4097.23 million nuts" (Saxena, 2017).

"Coconut is affected by various fungal diseases viz., bud rot (*Phytophthora palmivora)*, Thanjore Wilt (or) basal stem end rot (*Ganoderma lucidum)*, grey blight (*Pestalotiopsis palmarum*) and stem bleeding disease (*Thievolopsis paradoxa*) occurring in Tamil Nadu. Among them, basal stem rot disease caused by *Ganoderma lucidum* and *G.applanatum* is the most serious disease limiting the coconut production and productivity predominantly occurs in traditional coconut growing areas in East Coastal region, also known as Thanjavur

wilt recorded the incidence up to 31 per cent" (Baskaran and Ramanathan, 1984). Naik (2001) mentioned that this disease is also known as *Ganoderma* wilt (Andhra Pradesh) or Tanjavur wilt (Tamil Nadu) or Bole rot or anabe roga (Karnataka) in different parts of India.

"The vertical spread of stem bleeding seen as exudation of reddish-brown viscous fluid is the first sign of the disease. Drooping, drying and falling of leaves, excessive root rot and death of palms are the characteristic symptoms of the basal stem rot. The severely infected palm becomes wilt and unproductive with the formation of sporophore at the base of the palm" (Baskaran *et. al.,* 1989). This disease spreads quickly in the ill-maintained coconut gardens.

Snehalatharani *et al.* 2014a assessed "the incidence and spread of coconut basal stem rot disease in different districts of Andhra Pradesh, Karnataka and Tamil Nadu during 2010-15. It was confirmed that Thanjavur district recorded maximum mean per cent incidence of BSR (6.5) followed by Nagapattinam and Thiruvarur in Tamil Nadu".

Although, many investigations on the field application of disease management practices were tried against this disease, the use of systemic chemicals is highly promising (Naik, 2001, Karthikeyan *et.al.* 2005, Karunanidhi, *et.al.* 2007, Surulirajan, *et.al.* 2014 and Snehalatharani *et al.* 2016). Recently, the aggravation of the disease after the cyclone – Gaja, severe yield reduction and the quest for new systemic chemicals were viewed seriously by the state agriculture research and extension system and coconut growers. This necessitates the *in vitro* evaluation of fungicides to find out the effective new fungicide against *Ganoderma lucidum* for field application. The result of the present work will provide a base to manage basal stem rot of coconut effectively.

2. MATERIAL AND METHODS

The present study was done in Coconut Research Station, Veppankulam in 2020. The commercial formulation of thirteen fungicides *viz.,* Famoxadone16.6%+ Cymoxanil22.1%SC, Cyazafamid 34.5% SC, Mancozeb35%SC, Kitazin 48% EC, Hexaconazole 4% + Carbendazim 16% SC, Azoxystrobin 11% + Tebuconazole-18.3% SC W/W, Thifluzamide24%SC, Carbendazim 46.27% SC, Isoprothiolone 40% EC, Difenoconazole 25% EC, Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC, Hexaconazole 5% + validamycin 2.5%SC, Hexaconazole 5% + validamycin 2.5%SC and Pencycuron 23.9 % SC were used for the study.

The poisoned food technique (Schmitz, 1930) was followed to test the efficacy of different fungicides under *in vitro* conditions. The inhibitory effect of thirteen fungicides at 100, 250 and 500 ppm concentrations on the growth of virulent isolate of *Ganoderma lucidum,*(VPM) causing basal stem rot disease on coconut under *in vitro* condition was evaluated by poisoned food technique. Each chemical was replicated four times with proper control.

"The required quantities of fungicides were added into the sterilized Potato Dextrose Agar (PDA) medium to give required concentration and poured separately into each sterilized Petri plates under aseptic conditions. The Petri plates were inoculated with 8 mm mycelia disc from seven days old culture of the fungus and incubated at 28 ± 2ºC. Simultaneously, a control was maintained without adding fungicide by growing the fungus only on PDA medium. Three replications were kept for each treatment. The observations were made on the diameter of mycelial growth of the fungus. The per cent inhibition in mycelial growth was calculated by using the following formula: Each treatment was replicated four times in a completely randomized design. The data obtained were statistically analyzed (Gomez and Gomez, 1984) and the treatment means were compared by Duncan's Multiple Range Test (DMRT)".

Per cent inhibition over control =DC – DT / DC x 100 C
Where,
PI = Per cent inhibition
DC = Mean diameter (cm) of fungal growth in control
DT = Mean diameter (cm) of fungal growth in treatment

3. RESULTS AND DISCUSSION

The inhibitory effect of thirteen fungicides *viz.,* Famoxadone16.6%+ Cymoxanil22.1%SC, Cyazafamid 34.5% SC, Mancozeb35%SC, Kitazin 48% EC, Hexaconazole 4% + Carbendazim 16% SC, Azoxystrobin 11% + Tebuconazole-18.3% SC W/W, Thifluzamide24%SC, Carbendazim 46.27% SC, Isoprothiolone 40% EC, Difenoconazole 25% EC, Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC, Hexaconazole 5% + validamycin 2.5%SC, Hexaconazole 5% + validamycin 2.5%SC and Pencycuron 23.9 % SC tested against *Ganoderma lucidum* causing basal stem rot disease on coconut under *in vitro* by poisoned food technique at 100, 250 and 500 ppm concentrations and the growth of *Ganoderma lucidum,* was evaluated.

The results revealed that among thirteen fungicides tested, Hexaconazole 4% + Carbendazim 16% SC, Azoxystrobin 11% + Tebuconazole-18.3% SC W/W and Hexaconazole 5% + validamycin 2.5%SC were found superior recording 100 per cent inhibition of *Ganoderma lucidum* at all the concentrations tested and showed superior over the other fungicides tested under *in vitro.*

Anbalagan and Shanmugam (1984) evaluated the fungicide Tridemorph at 500 ppm against *G. lucidum in vitro and* was found effective in inhibiting the spread of the fungus. Srinivasulu *et al.* (2002) conducted *in vitro* screening of the fungicides *viz*., Bordeaux mixture, Tridemorph, Bitertenol, Copper oxychloride and Hexaconazole against *G. lucidum* and were found effective in inhibiting the growth of *G. lucidum* and *G. applanatum* and also found inhibitory to *Trichoderma viride*.

Baloch *et al.* (2017) reported that “the fungicide tebuconazole + trifloxystrobin inhibited the mycelial growth of *L. theobromae* mycelium at 100 ppm. showed structural abnormalities in response to fungicide treatment which resulted in shriveling. Ushamalini *et.al.* (2019) also screened fifteen fungicides for their inhibitory effect on the mycelial growth of *L. theobromae* at different concentrations and reported that systemic fungicide carbendazim, recorded 100 percent inhibition over control even at lower concentration of 50 ppm”. The present study of in *vitro* experiment evaluated the fungicide chemicals in new combination against *Ganoderma*
lucidum and all the treatments are found significant at 5% in three concentrations *viz.,* 100ppm (F-Probablity is 3.5 & Co-efficient of Variation is 9.146), 250ppm (F-Probablity is 1.04 & Co-efficient of Variation is 0.706) and 500ppm(F-Probablity 3.26 & Co-efficient of Variation is 0.852). Hundred per cent mycelial inhibition was achieved by three new combinations fungicides *viz.,* Hexaconazole 4% + Carbendazim 16% SC, Azoxystrobin 11% + Tebuconazole-18.3% SC W/W and Hexaconazole 5% + validamycin 2.5%SC (Table-1). Similar results were recently reported by Thangeshwari *et.al.* (2019) with the screening of twelve fungicides and new fungicide combinations against *Ganoderma lucidum* and found that Tebuconazole 25.9 per cent EC, Tetraconazole 3.8 per cent EW, Tebuconazole + Trifloxystrobin 50 per cent + 25 per cent WG, Hexaconazole 5 per cent EC, Difenoconazole 25 per cent EC, Thiram + Carboxin 37.5 + 37.5 WS and Propiconazole 25 EC have recorded 100 per cent inhibition of *Ganoderma lucidum* and showed superiority over other tested fungicides under *in vitro.* Karunanithi *et al.* (2007) also conducted *in vitro* studies and recorded the suppression of the fungus by 29 botanicals.

Table-1. *In-vitro* evaluation of combination systemic fungicides against *Ganoderma lucidum*

Treatments	Fungicides	Mycelial growth of *Ganoderma spp.* 9 days after inoculation (in mm)			% Inhibition over control
		100ppm	250ppm	500ppm	
T_1	Famoxadone16.6%+ Cymoxanil22.1%SC	90.00[a] (71.67)	90.00[a] (71.67)	89.68[a] (71.26)	0.361
T_2	Cyazafamid 34.5% SC	90.00[a] (71.67)	90.00[a] (71.67)	90.00[a] (71.67)	00.00
T_3	Mancozeb35%SC	68.75[b] (56.01)	68.13[b] (55.63)	66.38[b] (54.56)	26.25
T_4	Kitazin 48% EC	15.38[f] (23.09)	11.20[f] (19.55)	10.39[f] (18.80)	88.46
T_5	Hexaconazole 4% + Carbendazim 16% SC	00.00[fh] (00.00)	00.00[f] (00.00)	00.00[f] (00.00)	100.00
T_6	Azoxystrobin 11% + Tebuconazole-18.3% SC W/W	1.50[gh] (7.03)	00.00[i] (0.00)	00.00[i] (0.00)	100.00
T_7	Thifluzamide24%SC	18.06[f] (25.15)	10.31[g] (18.73)	12.31[e] (20.54)	86.32
T_8	Carbendazim 46.27% SC	6.13[g] (14.33)	4.13[h] (11.73)	0.81[h] (5.16)	99.10
T_9	Isoprothiolone 40% EC	35.13[d] (36.35)	23.43[d] (28.95)	15.19[d] (22.94)	83.13
T_{10}	Difenoconazole 25% EC	56.44[c] (48.70)	46.49[c] (42.99)	35.50[c] (36.57)	60.56
T_{11}	Azoxystrobin 18.2% w/w + difenoconazole 11.4% w/w SC	25.19[e] (30.13)	21.00[e] (27.27)	3.78[g] (11.21)	95.81
T_{12}	Hexaconazole 5% + validamycin 2.5%SC	00.00[fh] (00.00)	00.00[f] (00.00)	00.00[f] (00.00)	100.00
T_{13}	Pencycuron 23.9 % SC	90.00[a] (71.67)	90.00[a] (71.67)	90.00[a] (71.67)	00.00
T_{14}	Control	90.00[a] (71.67)	90.00[a] (71.67)	90.00[a] (71.67)	00.00
	CD@5%	**5.465**	**0.391**	**0.437**	
	CV	**9.146**	**0.706**	**0.852**	

Figures in parenthesis are transformed values

4. CONCLUSION

In vitro experiment evaluated the fungicide chemicals in new combination against *Ganoderma lucidum*. The hundred per cent mycelial inhibition of *Ganoderma lucidum* was achieved by three new fungicide combinations *viz.,* hexaconazole 4% + carbendazim 16% sc, azoxystrobin 11% + tebuconazole-18.3% sc w/w and hexaconazole 5% + validamycin 2.5%sc

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COMPETING INTERESTS

Authors have declared that no competing interests exist

AUTHORS' CONTRIBUTIONS

All authors read and approved the final manuscript

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