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MANAGEMENT OF BASAL STEM ROT OF ARECANUT (*ARECA CATECHU* L.) UNDER ASSAM CONDITION

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ABSTRACT

Among the various factors causing considerable loss in production of arecanut in the state, basal stem rot disease caused by the fungus *Ganoderma lucidum* (Curtis Ex. Fr.) Karst, is the most dreaded. Survey indicated that in different parts of Assam, disease incidence of 0.1-65% was observed. Studies were undertaken to develop an effective management practices both *in vitro* and *in vivo* against the disease at CPCRI Research Centre, Kahikuchi. Among the fungicides tried *in vitro*, calixin (Tridemorph, 80EC) @ 0.3% completely inhibited the growth of the fungus, followed by bavistin (Carbendazin, 50WP) @ 0.3% with 91.33% inhibition over control after 144 hrs of incubation. Dual culture study carried out with three different species of *Trichoderma* revealed that *T. viride* was most effective, followed by *T. harzianum* and *T. virens* with 66.55, 63.99 and 62.12 per cent inhibition over control after 96 hrs of incubation. Based on the *in vitro* study, a field trial was undertaken to develop location-specific, farmers'-friendly management practices to reduce the severity and spread of the disease. The treatment, T_1 - soil drenching with calixin (0.3%) @ 10 l/palm at quarterly interval was most effective followed by T_4 - application of neem cake (2 kg/palm/ year) fortified with *T.viride* (100g/palm/year) in controlling the disease.

INTRODUCTION

The arecanut palm (*Areca catechu* L.) is one of the most important plantation crops in Assam grown in an area of 70,542 ha with an annual production of 64,948 metric tonnes and a productivity of 921 kg chali/ha. It is commonly known as betelnut or *supari* and used in various religious and social ceremonies. Assam occupies third position in area and production next to Karnataka and Kerala. Although, India is the largest producer of arecanut its productivity is very low, 1214kg/ha. Besides, arecanut cultivation is beset with recurring problems due to reduced productivity, delayed commercial yield, soil fertility depletion, small holding size, price fluctuation and pests and diseases. Among the various minor and major diseases, basal stem rot caused by *Ganoderma lucidum* (Curtis Ex. Fr.) Karst is the most dreaded since it causes damage to the product as well as the crop. It is a slow decline disease with a history of more than 100 years. It has not only affected the productivity but has also wiped out areca plantations in certain localities. Occurrence of this disease in Karnataka was reported as early as 1807 (Buchanan, 1807). The disease has also been reported from Tamil Nadu, Kerala and Assam (Anonymous, 1960), Bengal (Sharples, 1928) and Nicobar Island (Sangal *et al.*, 1961). Survey conducted by CPCRI, RC, Kahikuchi in different district of Assam *viz*., Kamrup, Darrang, Goalpara, Nagaon, Morigaon, Kokrajhar, Bongaigaon and Barpeta revealed that the disease incidence ranged from 1.00-65.00 per cent. The disease is severe in neglected, ill drained and overcrowded gardens. Bhaskaran, 2000 reported that fungicides does not offer a permanent cure to the affected tree. Biological control with *T.* harzianum and phosphobacteria offers some scope for containing the disease but organic amendments are essential to encourage antagonistic microflora. Ganesha Naik and Venkatesh, 2001, reported that among all the fungicides tested in farmer's garden, the lowest disease index was achieved with Aureofungin-sol root feeding (1.3%) + Bordeaux mixture (1%) soil drenching at quarterly interval along with soil application of neem cake at 5kg/palm/year followed by tridemorph root feeding (2%) + soil drenching (0.1%) at quarterly interval along with soil application of neem cake at 5kg/palm/year. Meena and Jeyalakshmi, 2006 revealed that basal stem rot disease of coconut can be effectively controlled by soil application of neem cake @5kg/palm/year + soil application of *T. viride* @ 250g/palm/year + root feeding of hexaconazole 1% @ 100ml/palm at quarterly intervals. Rajappan and Vaithilingam, 2009, reported that Integrated management system consisiting of cultural and chemical control methods against basal stem rot in coconut significantly inhibited the spread of the disease, and enhanced plant vigour, nut yield and returns. It has also increased the rhizosphere populations of *T. viride* and *P. flourescens*. No systematic efforts were made earlier to develop an effective integrated management practices against the disease with special reference to the type of damage, climatic condition and severity of the disease in Assam. Considering the economic loss of the crop, present study was undertaken to elucidate the efficacy of fungicides and biocontrol agents in effectively controlling the disease.

MATERIALS AND METHODS

The study was carried out in an arecanut plantation spaced at 2.7m × 2.7m distance at Central Plantation Crops Research

Institute, Research Centre, Kahikuchi, Guwahati, Assam, located in sub-humid area at 20° 18' N latitude and 91° 78' E longitude. Kahikuchi receives an average annual precipitation of 2500–3000 mm. The mean maximum temperature ranges between 15°C and 34°C and mean minimum temperature varies from 8°C to 22°C. The relative humidity ranges between 67 to 96 per cent. The soil of the experimental site was clay loam in nature with a pH range of 4.5-5.5

Isolation of the pathogen and antagonistic fungi

The basal stem rot pathogen, *Ganoderma lucidum* was isolated from the fruiting body collected from infected arecanut palm on PDA medium. Antagonistic fungi, *Trichoderma* spp. were isolated from the rhizosphere of healthy arecanut palm by serial dilution plate technique using *Trichoderma* specific media (TSMC).

***In vitro* assay of antagonistic fungi**

In vitro antagonism of the antagonists against the pathogen was tested by dual culture technique (Dhingra and Sinclair, 1985). Both the pathogen, *G. lucidum* and the antagonistic fungi were grown on PDA medium. The plates were inoculated with the pathogen at the centre and the antagonistic fungi at the periphery of the plates. Petriplates inoculated only with *G. lucidum* served as control. Each experiment was replicated three times and incubated at 28 ± 2⁰C. Observation on mycelial growth of the pathogen was recorded upto 96 hr of incubation. The inhibition per cent was calculated (Vincent, 1927).

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

Where,

I = Per cent inhibition over control

C = Radial growth in control

T = Radial growth in treatment

***In vitro* assay of fungicides and its antagonistic fungi**

Six fungicides *viz.,* Calixin (Tridemorph 80 EC), Bavistin (Carbendazim 50 WP), Ridomil MZ 72 (Metalaxyl 8% + Mancozeb 64% WP), Captaf (Captan 50WP), Dithane M-45 (Mancozeb 75 WP) and Blitox-50 (Copper Oxychloride 50WP) @ 0.3% were tested for their efficacy against the pathogen and its antagonistic fungus on PDA medium by poisoned food technique (Nene, 1971). The fungicides in the required concentration were incorporated into the medium and the plates were inoculated with seven mm disc of four days old *G. lucidum*/antagonistic fungi in three replications. Radial growth of the fungus after 48, 72 and 96 hr of incubation at 28 ± 2°C were recorded and compared with the growth in control plates.

Field trial evaluation

The Field trial was conducted at basal stem rot disease infested garden of CPCRI, RC, Kahikuchi, Assam during 2005-06 and 2006-07 with six treatments replicated 12 times (single palm replication). The treatments are: T_1-soil drenching with Calixin (0.3%) @ 10l/palm at quarterly interval, T_2-soil drenching with Bavistin (0.3%) @ 10l/palm at quarterly interval, T_3-soil application of neem cake @ 2 kg/palm/year, T_4-soil application of neem cake @ 2 kg/palm/year fortified with *Trichoderma viride* @ 100g/palm, T_5-soil application of neem cake @ 2 kg/palm/year fortified with *Trichoderma harzianum* @ 100 g/palm and T_6-control. The recommended dose of chemical fertilizer (100:40:140 g NPK/palm/year) along with 10 kg of decomposed FYM was applied invariably to all the experimental palms. *Trichoderma* spp were mass multiplied on cowdung for field application.

The growth parameters *viz*., number of functional leaves, number of drooping leaves, reduction in leaf size (score-0, 1, 2, 3, 4) and yield of the palms were recorded at six-monthly interval and analyzed statistically for comparison (Panse and Sukhatme, 1961).

RESULTS AND DISCUSSION

The pathogen, *Ganoderma lucidum* was confirmed according to the identification key (Seo and Kirk, 2000) based on morphological and cultural characteristics. The antagonistic fungi, *viz., Trichoderma harzianum, T. viride* and *T. virens* isolated from the rhizosphere of arecanut palms were confirmed according to the identification key (Rifai, 1969) based on the branching of conidiophores, shapes of phialides, emergence of phialospores and shape of phialospores.

***In vitro* assay of antagonistic microorganisms**

Dual culture test with *Trichoderma* spp. revealed that *T. viride* recorded maximum inhibition, followed by *T. harzianum* and *T. viride* with 66.55, 63.99 and 62.12 per cent inhibition over control after 96h of incubation. Akrami *et al*., 2011 reported that *Trichoderma harzianum* T 149 and *T. asperellum* T 90 strains were capable of influencing the growth of all the tested pathogens, *Fusarium* spp. in dual culture and through production of volatile and non-volatile inhibitors under controlled condition, and may be used as broad spectrum biological control agents under field condition.

***In vitro* assay of fungicides**

From among the six fungicides tested for their efficacy on the fungus, Calixin (Tridemorph 80EC) completely inhibited the growth of the fungus, followed by Bavistin (Carbendazim 50WP) with 91.33 per cent inhibition over control after 144h of incubation. Saraswathy *et al*., 1975 reported that of 13 fungicides tested *in vitro*, benomyl (0.1%), captan (0.25%), thiram (0.25%) and phenyl Hg urea formulation (0.1%) were highly fungicidal to mycelial growth of the causal agent, *Glomerella cingulata*. In field trial the disease was effectively controlled by DMOC (0.1%), heptanes antibiotic (50ppm) + $CuSO_4$ (50ppm) and zineb (0.4%) in order of effectiveness.

Among the bio-agenst, the three fungal cultures viz., *Trichoderma harzianum* (63.99%), *T. viride* (66.55%) *and Gliocladium virens* (62.12%) have shown inhibitory effect on the mycelial growth of *Ganoderma lucidum* after 96h of incubation (Chakrabarty and Ray, 2007).

Compatibility study of the fungicides with the antagonists showed that Calixin, Bavistin and Mancozeb @0.3% completely inhibited the growth of *Trichoderma* spp. whereas Captan and Blitox-50 showed 61.67 and 41.89 per cent inhibition over control respectively. Therefore, calixin, bavistin and mancozeb cannot be integrated with *Trichoderma* spp. for development of IDM practices against basal stem rot of arecanut.

Field trial evaluation against basal stem rot disease

The field trial was carried out to develop an efficient management practices against basal stem rot of arecanut based on the result obtained in the *in vitro* experiment. The most effective fungicides, Calixin and Bavistin; antagonists, *T. viride* and *T. harzianum* along with neem cake, were tried in different combinations during 2005-06 to 2006-07. The data on

Table 1: Effect of different antagonists on mycelial growth of *Ganoderma lucidum*

S.No.	Antagonistic organisms	Per cent inhibition over control		
		48 h	72 h	96 h
1.	*Trichoderma harzianum*	27.09(31.36)	42.47(40.47)	63.99(53.12)
2.	*T. viride*	35.96(36.85)	44.69(41.95)	66.55(54.66)
3.	*T. virens*	32.51(34.76)	40.49(39.52)	62.12(52.01)
SEd ±	0.12	0.15	0.12	
CD(0.05)	0.28	0.37	0.28	

Data within parenthesis are the angular transformed values

Table 2: Efficacy of fungicides against *Ganoderma lucidum*

S.No.	Fungicides(@0.3%	Per cent inhibition over control		
		48h	96h	144h
1	Calixin	100.00 (89.33)	100.00 (89.33)	100.00 (89.33)
2	Bavistin	77.15 (61.44)	86.93 (68.81)	91.33 (72.88)
3	Captaf	76.85 (61.17)	79.6 9 (62.77)	85.78 (67.81)
4	Ridomil MZ-72	70.62 (57.24)	81.91 (64.88)	85.89 (67.97)
5	Dithane M-45	75.67 (60.58)	80.90 (64.09)	86.33 (68.28)
6	Blitox-50	73.89 (59.35)	82.08 (65.00)	85.89 (67.97)
SEd (±)	0.39	0.49	0.28	
CD (0.05)	0.86	1.06	0.62	

Data within parenthesis are the angular transformed values

Table 3: Field trial on management of basal stem rot of arecanut

Treatments	No. of functional leaves in the crown			No. of drooped leaves in the crown			No. of leaves with reduced size		
	Pre-treatment (2005)	2006	2007	Pre-treatment (2005)	2006	2007	Pre-treatment (2005)	2006	2007
T_1	6.7	8.1	8.8	2.2	2.2	1.0	0.6	0.4	0.3
T_2	6.4	6.7	5.9	2.3	2.3	2.7	0.4	0.4	0.6
T_3	6.9	7.4	7.8	2.5	2.6	1.8	0.4	0.4	0.3
T_4	6.6	7.9	8.3	2.8	2.1	1.2	0.5	0.4	0.2
T_5	6.3	7.8	8.3	2.9	1.9	1.6	0.5	0.5	0.2
T_6	6.2	6.3	5.5	3.2	2.6	3.5	0.3	0.5	2.0
SEd	0.22	0.89	1.13	0.22	0.40	0.40	-	-	0.21
CD (0.05)	0.44	1.77	2.24	0.44	0.79	0.79	NS	NS	0.42

Table 4: Field trial on management of basal stem rot of arecanut

Treatments	No. of functional leaves in the crown			No. of drooped leaves in the crown			No. of leaves with reduced size		
	Pre-treatment (2005)	% increase (2006)	% increase over pre-treatment 2007	Pre-treatment (2005)	% increase (2006)	% increase over pre-treatment (2007)	Pre-treatment (2005)	% increase (2006)	% increase over pre-treatment (2007)
T_1	6.7	20.9	31.3	2.2	0	(-) 54.5	0.6	(-) 33.3	(-) 50.0
T_2	6.4	4.7	(-) 7.8	2.3	0	17.4	0.4	0	50.0
T_3	6.9	7.2	13.0	2.5	4.0	(-) 28.0	0.4	0	(-) 25.0
T_4	6.6	19.7	25.7	2.8	(-) 25.0	(-) 57.1	0.5	(-) 20.0	(-) 60.0
T_5	6.3	23.8	31.7	2.9	(-) 34.5	(-) 44.8	0.5	0	(-) 60.0
T_6	6.2	1.6	(-) 11.3	3.2	(-) 18.7	9.4	0.3	66.7	566
SEd	0.22	0.89	1.13	0.22	0.40	0.40	-	-	0.21
CD (0.05)	0.44	1.77	2.24	0.44	0.79	0.79	NS	NS	0.42

Table 5: Influence of management practices on yield of palms

Treatments	No. of nuts per palm				Chali yield (kg/palm)			
	Pre-treatment (2005)	2006	2007	2008	Pre-treatment (2005)	2006	2007	2008
T_1	148.00	157.78	210.00	222.60	1.23	1.31	1.75	1.85
T_2	145.00	147.07	179.20	187.50	1.21	1.22	1.49	1.65
T_3	149.53	149.71	191.30	204.20	1.25	1.25	1.59	1.70
T_4	141.27	151.08	200.30	215.80	1.18	1.17	1.67	1.80
T_5	140.27	149.77	194.00	209.30	1.17	1.18	1.61	1.74
T_6	140.47	141.09	92.60	90.00	1.17	1.18	0.77	0.75
SEd	-	-	3.81	0.03	-	-	3.26	0.03
CD (0.05)	NS	NS	7.63	0.06	NS	NS	6.53	0.05

vegetative character reveals that irrespective of the treatments, there was gradual improvement in the growth of the treated palms as compared to control. However, palms treated with Calixin performed better in terms of total number of leaves in the crown (8.8) and number of drooped leaves (1.0) after two years of treatment imposition. The other two treatments showing good results are T_4-application of neem cake @ 2kg/palm/year fortified with *T. viride* @ 100g/palm and T_5-application of neem cake @ 2kg/palm/year fortified with *T. harzianum* @ 100g/palm with 8.3 number of leaves in the crown in T_4 and T_5; 1.2 and 1.6 number of drooped leaves in T_4 and T_5 respectively (Table 3). Moreover, all these treatments showed at par result. The untreated palms showed gradual increase in number of drooped leaves and decrease in number of functional leaves in the crown. The per cent increase in functional number of leaves over two years in T_1, T_4 and T_5 are 31.3, 25.7 and 31.7 respectively. Per cent increase in number of drooped leaves are (-) 54.5, (-) 57.1 and (-) 44.8 in T_1, T_4 and T_5 respectively (Table 4). There was similar trend in increase in chali yield, T_1-1.23 to 1.85 kg/palm; T_4- 1.18 to 1.80 kg/palm and T_5- 1.17 to 1.74 kg/palm (Table 5). Srinivasulu *et al.*, 2004 reported that fungicides *viz*. Bordeaux mixture, Triademifon, Tridemorph, Bitertanol, Copper oxychloride, Hexaconazole and garlic extract were found to inhibit the test pathogens and also *T. viride*. An IDM package with a combination of *T. viride* (50g) and neem cake @ 5kg/palm/year was found to be highly effective treatment. Application of neem cake (5 or 10kg/palm/year) encouraged the saprophytic soil microflora especially *Trichoderma* in coconut basins and was effective in control of Ganoderma wilt (Bhaskaran, 1990; Gunasekharan *et al*., 1986).

Data presented in Table 4 revealed that greater yield was obtained in the palms treated with fungicides and antagonists both in terms of fresh and dry weight. Calixin treated palms showed comparatively better result with a production of 222.6 number of nuts/palm/year and 1.85kg chali/palm/year after two years of treatment.

CONCLUSION

Basal stem rot caused by *G. lucidum* is the most destructive disease of arecanut in Assam. The control of soil borne pathogens is particularly complex, because the disease occur in dynamic environment at the interface of the root with the soil. Although systemic fungicides are effective but the contact fungicides has not given much control as the disease is systemic. For immediate control of the disease, farmers are advised to apply calixin or bavistin. But for IDM practices, the above fungicides cannot be integrated with *Trichoderma* spp. as they are not compatible. *Trichoderma* can be integrated only with captan and blitox-50 for developing IDM of the disease. Thus, hygienic cultural practices along with biological control *viz*., *Trichoderma viride* and *T. harzianum*, and organic amendment are being explored to control the disease.

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