Research Article

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Studies on different formulations of the bioagent *Trichoderma* in the management of stem bleeding disease in coconut

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Abstract

Stem bleeding disease is the most common and well-known disease of coconut and is prevalent in almost all coconut growing countries. *Thielaviopsis paradoxa* is the pathogen causing stem bleeding disease. The symptoms of the affected trunk areas exhibit dark discolouration and a reddish-brown or rust-coloured liquid bleeding from different points. Affected plants die within 3 to 4 months after stem symptoms first appeared, if corrective measures are not taken properly. Keeping in view the severity of disease and the need for managing the disease with effective biocontrol formulation, the current experiment was initiated during 2014 at Mukkamala village of East Godavari district of Andhra Pradesh State, India. The treatments like *Trichoderma harzianum* cake formulation, *Trichoderma reesei* paste formulation along with paste application of copper oxychloride were tested in the field conditions. Among the treatments tested, application of *T. harzianum* cake formulation completely brought down the disease index from 12.91 to 0 per cent within 50 days of cake application. Disease index of 17.70 was reduced to 2.05 in case of paste application of copper oxychloride, and disease index of 14.02 was reduced to 3.69 in case of paste application of *T. reesei* against stem bleeding disease of coconut over three years from 2015-2018. Thus, the cake formulation of *Trichoderma* was found very effective in managing the disease at the field level, which is a bioagent and safer for environment protection.

Keywords: Bioformulation, disease index, *Trichoderma*

Introduction

Coconut (*Cocos nucifera* Linn.) farming and allied activities provide livelihood security to millions of people in India. Every part of a coconut tree has its own use or applications. It is generally called "Tree of Heaven", "Tree of Abundance", "Tree of Life" and "Kalpavriksha". Andhra Pradesh is one of the most important coconut growing states in India. In Andhra Pradesh, the major area under coconut is confined to East Godavari (52,301 ha), West Godavari (22,092 ha), Visakhapatnam (8,547 ha), Srikakulam (8,130 ha) and Chittoor (3,224 ha) districts. (CDB 2018-19).

In the present scenario of climatic change, coconut trees are severely affected by several fungal, bacterial, viral, viroid and phytoplasmal diseases that not only deteriorate the quality of fruits but also reduce the vigour and yield of palms. A wide range of fungi attacks different parts of the coconut, namely, crown, stem and root. Among the 173 fungal species reported on coconut (Joseph and Radha, 1979), only a few cause serious disease problems and are difficult to control effectively. The major devastating diseases prevalent on coconut in Andhra Pradesh are basal stem-end rot caused by *Ganoderma lucidum,* stem bleeding disease caused by *Thievolopsis paradoxa*, bud rot caused by *Phytophthora palmivora*, grey leaf spot caused by *Pestalotiopsis palmarum* and leaf blight caused by *Lasiodiplodia theobromae*.

Stem bleeding is the most common and well-known disease of coconut and is prevalent in almost all the coconut growing countries. *T. paradoxa* is a soil-borne wound parasite that can affect all parts

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of the plant associated with the stem bleeding disease in coconut (Petch, 1906). Infection usually occurs at the basal portion of the trunk and starts with the exudation of dark reddish liquid from the longitudinal cracks in the bark. Subsequently, the liquid dries up and turns black. The tissues below the lesions become water-soaked and get discoloured. The lesion spread upwards as the disease progresses. In advanced stages, production of the bunch is affected, nut shedding takes place. Presence of growth cracks on the trunk, severe summer followed by water stagnation and imbalanced nutrition act as predisposing and disease aggravating factors. Control of the disease through phytosanitation and application of hot coal tar did not offer adequate control (Nambiar and Sastry, 1988). Due to soil-borne origin of these fungal diseases, the plants are infected from seedling to older stage and thereby affecting the growth and yield of coconut trees. Hence, it is customary for the farmers to efficiently manage these setback diseases, for getting a reasonable income.

Biological control using antagonistic microorganism for the development of an integrated management strategy against the disease has emerged as a viable option (Alvindia and Natsuaki, 2008). *Trichoderma* spp. is considered to be antagonistic to many soil borne and plant pathogenic fungi (Prasad *et al*., 2002; Ramanujam *et al*., 2005; Suleman *et al*., 2008). Srinivasulu *et al*. (2006) reported that basal application of organic manure fortified with *Trichoderma viride* was effective in managing stem bleeding disease of coconut. Keeping this in view, the present investigation was taken up to develop an eco-friendly disease management practice against the stem bleeding disease by testing the efficacy of native biocontrol agents formulations under field conditions.

Materials and methods

The trial was conducted in Mukkamala village of East Godavari district for three years from 2015 to 2018. Under All India Co-ordinate Research Project on Palms, Horticultural Research Station, Ambajipeta centre, situated at 16.4^0 N latitude and 81.5^0 E longitudes and at an altitude of 34 m above mean sea level. The soils are of the coastal alluvial type with pH 7.8 with impeded drainage. The mean maximum temperature ranged from 26.7 to 36.8 ^{0}C, and the minimum temperature ranged from 22.7 to 44.5 ^{0}C. The average rainfall and relative humidity during experimentation varied between 1000 to 1250 mm and 65 to 90 per cent, respectively. Three acres of East Coast Tall coconut palms of more than 20 years age affected by stem bleeding were selected. Total 28 palms were selected for treatment imposition with seven palms per replication in randomized block design for the management of the stem bleeding disease.

T_1 - *T. harzianum* cake application

T_2 - *T. reesei* paste application (As swabbing)

T_3 - Copper oxychloride paste application

T_4 - Control

T. harzianum cakes were obtained from CPCRI, Kasargod. *T. reesei* was the native isolate of Horticulture Research Station, Ambajipeta. Molecular sequencing and confirmation by using blast analysis were done by scientists of Ambajipeta. Earlier results indicated that it was very effective against Ganoderma wilt disease in coconut (Neeraja *et al*., 2018). Before applying the treatments, the initial disease index of all the palms was worked out during September 2014 using the formula,

$$DI = 1.8\ l + 4.3\ t$$

where, l is the lesion size expressed in 1000 cm^2 and t is the score for tapering (ranging from 0 to 4) (Mathew *et al.,*1989). Subsequently, the disease index was recorded at the end of the first, second and third year. Nut yield of the palms was also recorded before and every year after imposing the treatments. The yield data of three years from 2015-2018 were used to draw conclusions. The data was analyzed statistically as per the procedure given by Gomez and Gomez (1984).

Results and discussion

Among the treatments tested, application of *T. harzianum* cake formulation completely brought down the disease index of 0.71 to 0 per cent within 50 days of cake application. Disease index of 3.55 was reduced to 0.46 in case of paste application of copper oxychloride, and disease index of 0.43 was

Table 1. Field evaluation of cake and paste formulations of *Trichoderma spp.* against stem bleeding disease of coconut

Sl. No.	Treatment details	2015-16		2016-17		2017-18	
		Disease index before treatment	Disease index 50 DAT	Disease index before treatment	Disease index 50 DAT	Disease index before treatment	Disease index 50 DAT
1.	*Trichoderma harzianum* cake application (T_1)	0.71	0.00	6.30	0.00	5.90	0.00
2.	*T. reesei* paste application (as swabbing) (T^2)	0.43	0.23	7.07	5.14	6.52	5.12
3.	Copper oxy chloride paste application (T_3)	3.55	0.46	7.33	4.24	6.82	4.69
4.	Control (T_4)	4.63	4.63	7.07	23.01	7.52	24.50
	CD (P=0.05)	N.S	N.S	1.12	5.37	1.12	5.37
	SEM	2.16	2.08	3.33	15.45	3.33	15.45

reduced to 0.23 in case of paste application of *T. reesei* against stem bleeding disease of coconut during 2015-2016.

During 2016-2017, application of *T. harzianum* cake formulation completely brought down the disease index of 6.30 to 0 per cent within 50 days of cake application. Disease index of 6.82 was reduced to 4.69 in case of paste application of copper oxychloride and disease index of 6.52 was reduced to 5.12 in case of paste application of *T. reesei* against stem bleeding disease of coconut.

During 2017-2018, application of *T. harzianum* cake formulation completely brought down the disease index of 5.9 to 0 per cent within 50 days of cake application. Disease index of 7.33 was reduced to 4.24 in case of paste application of copper oxychloride, and disease index of 7.07 was reduced to 5.14 in case of paste application of *T. reesei* against stem bleeding disease of coconut.

Thus, the cake formulation of *Trichoderma* was found very effective in managing the disease at the field level, which is a bioagent and safer for environment protection. Earlier results revealed that when coir pith was used to grow *T. harzianum,* there was only scanty growth of the fungus (Rini and Sulochana, 2007). But, when coir pith was mixed with neem cake at 1:1 ratio, superior growth and sporulation of the fungus were observed.

Among the treatments tested, application of *T. harzianum* cake formulation completely brought down the disease index of 12.91 ± 3.95 to 0 per cent within 50 days of cake application. Disease index of 17.70 ±2.05 was reduced to 9.39 ± 2.32 in case of paste application of copper oxychloride, and disease index of 14.02 ± 3.69 was reduced to 10.49 ± 3.47 in case of paste application of *T. reesei* against stem bleeding disease of coconut over three years from 2015 to 2018. Thus, the cake formulation of *Trichoderma* was found very effective in managing the disease at the field level, which is a bioagent and safer for environment protection.

In respect of nut yield, the pooled analysis of nut yield from 2015 to 2017 (Fig. 1) clearly showed an increase in nut yield in cake formulation applied treatments. Among all the treatments evaluated, T_1 treatment, application of *T. harzianum* cake formulation, *i.e.,* one cake per palm per year showed

Table 2. Pooled data of field evaluation of cake and paste formulations of *Trichoderma spp.* against stem bleeding disease of coconut over the years 2015-2018

Sl. No.	Treatment details	2015-2018	
		Disease index before treatment	Disease index 50 DAT
1.	*T. harzianum* cake application (T_1)	12.91 ± 3.95	0.00 ± 0.00
2.	*T. reesei* paste application (As swabbing) (T_2)	14.02 ± 3.69	10.49 ± 3.47
3.	Copper oxychloride paste application (T_3)	17.70 ±2.05	9.39 ± 2.32
4.	Control (T_4)	19.22 ± 1.73	52.14 ± 11.07

Means of pooled disease index data of stem bleeding ± SE are shown

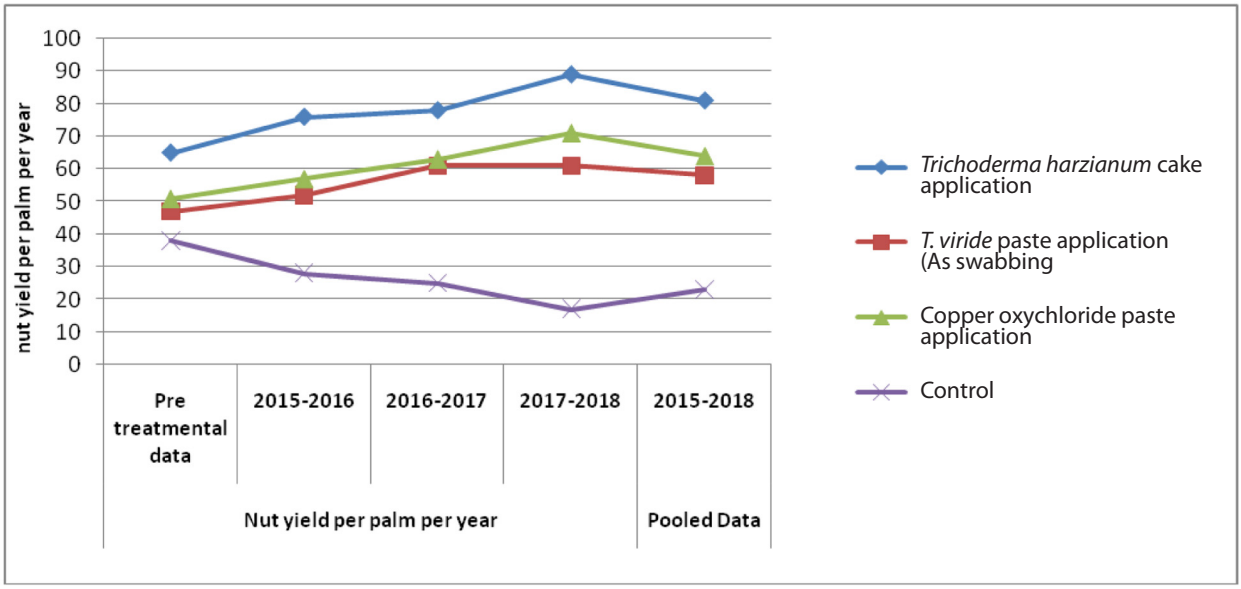

Fig. 1. Field evaluation of cake and paste formulations of *Trichoderma spp.* against stem bleeding disease of coconut over the years 2015-2018 on nut yield

the highest nut yield (81 nuts palm^{-1}year^{-1}) followed by T_3 treatment, paste application of copper oxychloride, which was recorded 64 nuts palm^{-1} year^{-1}. The lowest nut yield was recorded in T_4 (Control) treatment (23 nuts palm^{-1} year^{-1}).

Conclusion

Delivery of *Trichoderma* spp. in an effective way to significantly reduce the incidence of the diseases caused by different pathogens in the field is of great importance in biocontrol of soil-borne phytopathogens. Application of *Trichoderma* cake formulation on the infected trunk portion facilitates an increase in *Trichoderma* population with a longer shelf life of the organism, which can prevent the spread of the disease within the palm. Being a simple and feasible biocontrol method, farmers could manage the disease themselves without depending on skilled labour for the purpose.

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