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Management of basal stem rot disease in coconut through fungicides

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Coconut plays a major role in the agrarian economy of India and being a predominant plantation crop in the southern states and coastal tracts, it contributes to the livelihood security of millions of farmers in the country. India ranks third in area, first in production and productivity in World coconut scenario and being grown in an extent of 20.9 lakh ha area with a production of 23798 million nuts (coconutboard.nic.in/Statistics.aspx). Southern states of India such as Tamil Nadu, Kerala, Karnataka and Andhra Pradesh are the major producers of coconut contributing for 88.8 per cent of total area and 91.2 per cent of total production in the country.

Coconut is infected by many deadly and debilitating diseases in India *viz*., bud rot (*Phytophthora palmivora*), basal stem rot (BSR) (*Ganoderma* spp.), stem bleeding (*Thielaviopsis paradoxa*), grey leaf spot (*Pestalotiopsis palmarum*), leaf blight (*Lasiodiplodia theobromae*) and root (wilt) (*Phytoplasma*). Among them, basal stem rot disease caused by *G. applanatum* and *G. lucidum* is one of the lethal diseases, which is distributed and accounting to severe yield loss in all coconut growing tracts of southern parts of India. The disease is also known as *Ganoderma* wilt (Andhra Pradesh) or Tanjavur wilt (Tamil Nadu) or Bole rot or *Anabe roga* (Karnataka) in different areas (Naik, 2001). Severe incidence as high as 31 per cent in some of the coconut gardens in Thanjavur district has been reported (Bhaskaran and Ramanathan, 1984). Exudation of viscous, reddish-brown coloured fluid from the stem (referred to as 'bleeding') is the first sign of the disease which progresses upwards. Drooping, drying and falling of leaves, extensive root rot and death of the palms are the characteristic symptoms of the basal stem rot. Sporophores of *Ganoderma* spp. form at the base of the trunk before wilting or immediately after the death of the palm (Bhaskaran, *et al.,* 1989). In recent years, the disease has become a big menace, especially in poorly managed coconut gardens.

$$\text{Per cent inhibition over control (PI)} = \frac{Dc - Dt}{Dc} \times 100$$

Dc = mean diameter (cm) of fungal growth in control

Dt = mean diameter (cm) of fungal growth in treatment

Field evaluation of fungicides against BSR disease

Based on the results of *in vitro* evaluation of fungicides, new molecules *viz*., Tebuconazole 25.9 per cent EC, Tetraconazole 3.8 per cent, Propiconazole 25 per cent EC and Hexaconazole 5 per cent EC were tested for the management of BSR disease in field conditions. The field experiment was carried out from 2015 to 2018 at Avanam village of Pudukkottai district in Tamil Nadu under ICAR-All India Co-ordinated Research on Palms. The field was affected by similar symptoms as reported by Bhaskaran, *et al.* (1989) in East Coast

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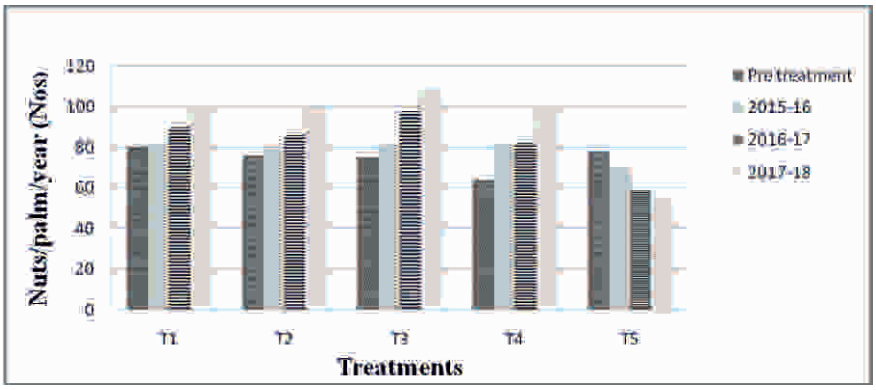

Fig. 1. Influence of fungicides on the yield of coconut in basal stem rot affected gardens

Tall variety of 8 to 24 years old palms growing in red sandy loam soil. Soil application of the recommended dose of fertilizers and ring basin method of irrigation was followed. The trial was laid out in RBD (randomized block design) with the following five treatments and four replications. For each replication, four coconut palms were selected and the fungicides were applied at quarterly intervals as root feeding.

T1: Root feeding of Tebuconazole @ 2 ml + 100 ml water at quarterly interval

T2: Root feeding of Tetraconazole @ 2ml + 100 ml water at quarterly interval

T3: Root feeding of Propiconazole @ 2ml + 100 ml water at quarterly interval

T4: Root feeding of 1 ml of Hexaconazole in 100 ml water at quarterly interval

T5: Control

The disease index technique given by Bhaskaran and Karthikeyan (1994) was used to measure the severity of the disease.

Table 1. Screening of fungicides against the growth of *Ganoderma lucidum* under *in vitro* condition

Tr. No.	Fungicides (0.1% concentration)	*Mycelial growth (cm)	Inhibition over control (%)
1.	Azoxystrobin 23% SC	4.0 (11.53)	55.93
2.	Kresoxim methyl 44.3% SC	1.8 (7.71)	80.37
3.	Tebuconazole 25.9% EC	0.0 (0.28)	100.00
4.	Tetraconazole 3.8% EW	0.0 (0.28)	100.00
5.	Tebuconazole + Trifloxystrobin 50% + 25% WG	0.0 (0.28)	100.00
6.	Difenoconazole 25% EC	0.0 (0.28)	100.00
7.	Hexaconazole 5% EC	0.0 (0.28)	100.00
8.	Propiconazole 25% EC	0.0 (0.28)	100.00
9.	Thiram + Carboxin 37.5 + 37.5 WS	0.0 (0.28)	100.00
10.	Thiophanate methyl 70% WP	8.4 (16.84)	6.67
11.	Pencycuron 22.9%SC	7.8 (16.24)	9.30
12.	Famoxadone 16.6% SC + Cymoxanil 22.1 % SC	3.6 (10.92)	58.13
13.	Control	9.0 (17.45)	-
	SEd.	0.16	-
	CD (P=0.05)	0.34	-

*Mean of three replications: Data in the parenthesis are arcsine transformed values

Table 2. Influence of fungicides on the incidence of basal stem rot disease of coconut

Tr. No.	Details	*Disease Index (%)		
		Initial		Increase over initial
		2015	2018	
T1	Root feeding of Tebuconazole @ 2ml + 100 ml water at quarterly interval	18.63(25.57)	23.14(28.75)	4.51(12.26)
T2	Root feeding of Tetraconazole @ 2ml + 100 ml water at quarterly interval	17.46(24.69)	22.32(28.19)	4.86(12.73)
T3	Root feeding of Propiconazole @ 2ml + 100 ml water at quarterly interval	16.53(23.99)	19.26(26.03)	2.73(9.51)
T4	Root feeding of 1 ml of Hexaconazole in 100 ml water at quarterly interval	19.68(26.33)	22.96(28.63)	3.28(10.43)
T5	Control (without fungicide)	16.35(23.85)	33.77(35.53)	17.42(24.66)
	CD (P=0.05)	NS	0.66	-

*Mean of four replications: Data in the parenthesis are arcsine transformed values

Disease Index (DI) = 23.6 + 17.7 h + 3.6 r-0.6 l

Where,

H- height (m) up to which bleeding has spread in the trunk

R- reduction in leaf size (in 0-4 scale)

L- number of functional leaves in the crown

Accordingly, an index score of 15 and below was taken as mild, 15 to 40 as moderate and more than 40 as severely infected. Observations were taken at quarterly intervals from October 2015 to October 2018.

In vitro screening of fungicides against *Ganoderma lucidum*

Among the twelve fungicides tested, 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 per cent EC has recorded 100 per cent inhibition of *Ganoderma lucidum* and showed superiority over other tested fungicides under *in vitro* (Table 1). In a similar study, Tridemorph at 500 ppm was found effective in inhibiting the spread of *G. lucidum in vitro* by Anbalagan and Shanmugam (1984). Srinivasulu *et al.* (2002) observed that the fungicides *viz*., Bordeaux mixture, Tridemorph, Copper oxychloride and Hexaconazole were effective in inhibiting the growth of *G. lucidum* and *G. applanatum* under *in vitro* conditions.

Field evaluation of fungicides against basal stem rot disease

The results revealed that in general, all the four treated fungicides were effective in reducing the intensity of BSR disease of coconut. Among the fungicides treated, Propiconazole was the most effective in containing the disease registering only 2.73 per cent increase in disease incidence as against 17.4 per cent in control (Table 2). With regard to nut yield, there was increased nut yield under fungicide treated palms compared to control. The nut yield obtained during 2017-18 was 115 nuts per palm per annum (Fig. 1) in BSR affected coconut palms treated with Propiconazole @ 0.2 per cent as compared to 58 nuts in control without fungicide.

The earlier recommendations for the management of BSR were disinfection of soil with the use of carbon-di-sulphide emulsion or formalin and application of iron sulphate (Narasimhan, 1920-21). Among the several chemicals tried for the control of the disease, Bordeaux mixture (1%), Aureofungin-sol (0.2%) chemicals alone or in combination were reported as effective chemicals by several workers (Bhaskaran *et al.*, 1982, Bhaskaran and Ramanathan, 1984). Drenching

with 10 litres of Benomyl (0.1%) was reported by Kolandaisamy and Arjunana (1977). Other studies reported that Aureofungin-sol (2 g) + 1% Bordeaux mixture (40 litres) + neem cake (5 kg) checked further spread of the disease. Naik (2001) reported that root feeding of Tridemorph (2%) + soil drenching (0.3%) recorded the least basal stem rot disease index followed by root feeding of Hexaconazole (l%) + soil drenching (0.2%), Tridemorph (0.3%) soil drenching and Hexaconazole soil drenching (0.2%) in comparison to root-feeding alone.

Basal stem rot is a soil-borne, occurs at the interface of soil and root, thus the management of soil-borne pathogen is highly complicated and difficult. Chemical method of management is found to be effective if applied in a judicious manner and systemic fungicides were recorded to be highly effective as they can penetrate and spread to different parts of the plant. Hence, the present study indicated that, root feeding of triazole fungicides *viz*., Tebuconazole 25.9 per cent EC or Tetraconazole 3.8 per cent EW or Propiconazole 25 per cent EC or Hexaconazole 5 per cent EC @ 2 per cent at quarterly interval was found effective in reducing the basal stem rot disease intensity in coconut and resulted in increase in the yield of coconut.

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