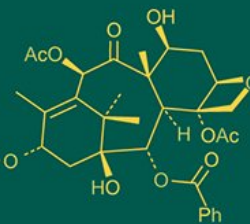
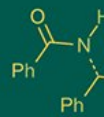


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Management of Stem bleeding disease caused by *Thielaviopsis paradoxa* (de Seynes) von Hohnel in coconut under *In-vitro* and field condition

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Abstract

Coconuts Stem bleeding disease caused by *Thielaviopsis paradoxa* is an important disease of coconut in India, especially in states of southern India (Kerala, Karnataka, Andhra Pradesh and Tamil Nadu) where major production of coconut was recorded. The disease is unable to manage efficiently due to either non-availability of promising fungicide or due to restriction use of such promising molecule. Hence it is challenging to identify the newer fungicides against this disease. Hence, fourteen new fungicides were screened under *in-vitro* against the causal agent *T. paradoxa*. Among them, T7 (Azoxystrobin 11% + Tebuconazole 18.3% SC W/W), T9 (Carbendazim 12% + Mancozeb 63% WP) and T14 (Hexaconazole 5% + Validamycin 2.5% SC) were found to inhibit cent per cent of the pathogen growth at 500ppm concentration. However, (Hexaconazole 5% + Validamycin 2.5% SC) recorded highest inhibition even at its lower concentration i.e. 250ppm. Wherein, T12 Carbendazim 50% WP (98.15) and T11 Mancozeb 75% WP (97.41%) were found next superior which recorded inhibition of 98.15% and 97.41% respectively in 500 ppm concentration. *The fungicides performed better under in-vitro were selected to evaluate under field condition with varied method of application over two years.* At the end of 24 months, revealed that root feeding of (Hexaconazole + Validamycin) @ 4ml in 100 ml water) and soil drenching (Hexaconazole + Validamycin) (@30 ml in 15 liter water/ palm) recorded maximum disease reduction of 50.84 per cent over initial and found significantly superior to other treatments followed by the positive control i.e. Root feeding of only Hexaconazole (4 ml in 100 ml of water/Palm) with 30.39 per cent reduction over initial. The next best treatment was Root feeding (@4 ml in 100 ml water) and soil drenching (@30 ml in 15 liter water/ palm) of (Azoxystrobin 11% + Tebuconazole-18.3% SC W/W) with 30.71 per cent reduction over initial. However, in untreated control the disease has been progressed to 32.96 PDI with 20.24% increase.

Keywords: Coconut stem bleeding disease, *Thielaviopsis paradoxa*, Karnataka, fungicide, AICRP palms

Introduction

Coconut palm (*Cocos nucifera*, L.) is an important plantation crop of India and often described as 'Kalpavriksha' because of the multifarious uses of every part of it in the commercial sector. Coconut is grown in almost 94 countries in the world of which 90% of the production comes from Asian and Pacific countries and India accounts for over 30% of total world production. India is the second largest producer of coconut in the world; contributed 24.24 per cent in production, first in productivity and third in area under cultivation (16%). But recent data on 2023-24 says, India has 2.165 million hectares under coconut production, producing 21.37 billion nuts with an average productivity of 9871 nuts per hectare, according to the Ministry of Agriculture and Farmers Welfare (coconut development Board, desagri.gov.in). The four southern states of India, viz., Kerala (34.37%), Tamil Nadu (26.46%), Karnataka (21.17%) and Andhra Pradesh (7.6%) account for 90 per cent of country's coconut production. Karnataka ranks third in India for both coconut area and production, after Kerala and Tamil Nadu. Coconut provides livelihoods for over 12 million people and contributes significantly to GDP through nuts, copra, and coir exports. Through coconut crop, large people are getting direct or indirect employment. From last decade, the coconut farmers are facing problems in India in general and particularly in Karnataka state. Coconut palms are normally affected by various insect pests and diseases

Resulting into reduction in yields. Among the various fungal diseases affecting coconut palm, Stem bleeding disease of coconut caused by *Thielaviopsis paradoxa* (de Seynes) von Hohnel is most destructive disease and is widely prevalent in all coconut growing areas of the state.

The stem bleeding disease of coconut palm has its origin in the Old World, having first been reported from Ceylon by Petch in 1906 (Menon and Pandalai, 1958) [8, 12], India by Sundararaman in 1922 (Sundararaman, 1922) [8, 21], the Philippines by Lee in 1922 (Menon and Pandalai, 1958), Malaya by Sharples in 1923 (Salgado, 1942) [19], Adaman Islands by Mitra in 1929 (Mitra, 1929) [9], and Trinidad by Britton-Jones (1941) [3] in 1940 (Britton-Jones, 1941) [3]. In India, the disease is prevalent in almost all coconut growing states. The disease has been found to occur in all soil types, but more in laterite soils and sandy soils on seashore or backwater areas (Nambiar, 1988) [10].

Symptoms

The characteristic symptom of the disease is the exudation of a dark brown gummy fluid from the growth cracks in the trunk, mostly at the lower portion of the trunk. The lesion traverse upwards and sometimes many lesions coalesce together forming larger patches, which may turn blackish when dried. The tissues lying beneath the affected bark also show decay. In later stages, the symptoms are also seen on the crown of the affected palm. reduced frequency of leaf emergence; reduced size of young leaves; stem thinning near the canopy as disease progresses. The outer whorl of leaves turn yellow gradually spreading to the inner whorl. The leaves droop one by one and fall prematurely. The stem apex gradually tapers and crown size is reduced (Lekha *et al.*, 2015) [6]. In young palms tissues rot internally and on piercing is widely prevalent in all coconut growing regions in the tropics. The necrotic breakdown progresses in both directions in the stem, moving very rapidly in young palms and producing a soft, watery, tan-colored rot, which yields to slight pressure when applied to the rind. Cross-section of a diseased coconut stem with the dark surface area made up of black, moistened masses of fungus chlamydospores and indicating the site of entry of the fungus; the light-colored area exhibiting the grey, vigorously growing fungus. The fungus *Thielaviopsis paradoxa*, a weak pathogen, spreads through soil and enters the trunk only through wounds/growth cracks. Later, the same fungus was reported from Sergipe (Franco & Franco Filho, 1986) [5], causing inflorescence necrosis and affecting coconut production. Further studies showed reduction of the photosynthetic activity on diseased plants, probably owing to a reduction in the activity of absorption and/or translocation of nutrients and water (Warwick *et al.*, 2004) [25]. Coconut stem bleeding, caused by the fungus *Thielaviopsis paradoxa*, is the main concern of producers, researchers, and monitoring agencies, due to its rapid spread. In addition, very limited extent the methods are currently available for disease control. The earliest recommendation for the control of the disease was chiseling of the affected tissues and application of hot coal tar. This did not always results in giving effective control of the disease (Nambier and Kalpana sastry, 1988). Soil drenching with calixin 0.1% (Radhakrishnan, 1990) [13] and root feeding with Bavistin 5% or Calixin 5% have been found to reduce the disease to some extent. Biological control through the use of antagonistic microorganism and locally available botanicals

for the development of integrated management strategy against the disease has emerged as available option *Trichoderma* spp., is considered to be antagonistic to many soil borne and plant pathogenic fungi Ramanujam *et al.* (2005) [15] and Ranjana *et al.*, 2013). Soil application of Neem cake to the affected palms was found to reduce the population of *T. paradoxa* and encourage the antagonistic population in soil. Locally available botanicals secrete antifungal metabolites that substantiate their action against certain fungi.

However, the present recommended chemical fungicide molecules though found effective against this disease to some extent, it is necessary to undergo screening of newer molecules to enhance the extent of disease reduction. The prolonged use of a single fungicide and the emerging issue of fungicide resistance raised concerns regarding disease control in this region. An integrated disease management strategy, incorporating new generation fungicides could help resolve these challenges. Therefore, the present study was carried out to investigate the efficacy of new components in inhibiting the growth of the fungus in *in vitro* and subsequent evaluation of effective treatment under field condition against the disease.

Materials and Methods

The study was carried out at Horticulture Research Station, Arsikere under All India coordinated research project. The fungus *Thielaviopsis paradoxa* was isolated from diseased sample collected from stem bleeding affected coconut palm on potato dextrose agar.

In-vitro

The New fungicide molecules with combi-products were tested against mycelial growth of *Thielaviopsis paradoxa* at three concentrations (100, 250 and 500 ppm) replicated thrice under *in-vitro* condition. Fourteen new systemic fungicides viz., Famoxadone 16.6% + Cymoxanil 22.1% SC, Cyazafamid 34.5% SC, Difenconazole 250 EC, Thifluzamide 24% SC, Kitazin 48% EC, Hexaconazole 4% + Carbendazim 16% SC, Azoxystrobin 11% + Tebuconazole 18.3% SC W/W, Carbendazim 50% WP, Carbendazim 12% + Mancozeb 63% WP, Mancozeb 75% WP, Hexaconazole 5% EC, Hexaconazole 4% WG + Zineb 68% and Hexaconazole 5% + Validamycin 2.5% SC tested against *Thielaviopsis paradoxa* under *in vitro* by employing food poison technique. The sterile Potato Dextrose Agar (PDA) medium was amended with required concentrations of fungicides and dispensed into individual sterile Petri plates for each concentration under sterile environment. The fungal mycelial disc (8mm) from 7 days old culture of the virulent isolate of *T. Paradoxa* (mycelial disc) was used for the inoculation and the Petri plates were incubated at 28±2 °C. For each concentration, a control had been maintained by simultaneous inoculation of well grown target fungus in the Petri plate without amending the fungicide in the PDA medium. Nine days after the fungus inoculation, measurements of the target fungus's mycelial growth diameter were taken. The radial growth of the test fungal colony recorded on 9th day when maximum growth was observed in untreated control plates. The percent inhibition of the mycelia growth over control was calculated using formula given by Vincent (1942).

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

I = % inhibition of mycelia growth

C = radial growth of fungus in control

T = radial growth of fungus in treatment

Field condition:

The management of stem bleeding disease on coconut under field conditions was initiated during oct-2020 to oct- 2022 with the effective treatments in the infected garden at Horticulture Research and Extension Centre Arsikere, Hassan District, Karnataka (variety: Tiptur tall) under All India Co-ordinated Research Project on Palms which is situated at 13.150 N latitude and 76.51° E longitudes and at an altitude of 800 m above mean sea level. The experiment was carried out with 8 treatments (including untreated control), based on the *in vitro* evaluation of new systemic fungicides, effective combination fungicides viz., (Azoxystrobin 11% + Tebuconazole 18.3% SC W/W) and (Hexaconazole 5% + Validamycin 2.5% SC) were selected and compared with Hexaconazole 5% from oct-2020 to oct-2022. The trial was laid out with these fungicides in randomized block design with four replications. For each replication, four coconut palms were selected. Trees showing typical symptoms were randomly selected with low, medium and high infection range and each tree was considered as a replication, like wise four replications were maintained for each treatment.

The effective fungicides were given as root feeding @ 4% and soil drenching @ 0.2% in 15 liters/palm at quarterly intervals. Pre and post treatment data on disease index of Stem bleeding was recorded from the treated palms at regular intervals by recording the linear spread of the stem bleeding disease in coconut palms and also nut yield. The data was analyzed statistically as per the procedure. A method for indexing the disease severity in stem bleeding affected coconut palms based on lesion size and the score for tapering was developed by Mathew *et al.* (1989)^[7] at the Central Plantation Crops Research Institute. The initial disease index of all the palms were worked out using the formula, $DI = 1.8 l + 4.3 t$, where, *l* is the lesion size expressed in 1000cm² and *t* is the score for tapering ranging from 0 to 4 (Mathew, *et al.*, 1989)^[7]. The index developed has a range of 0-100. Subsequently the disease index was recorded at the end of first, second and third year. Nut yield of the palms was also recorded before and every year after imposing the treatments.

Result and discussion

In-vitro evaluation of fungicides molecules against *Thielaviopsis paradoxa*

The results obtained for the evaluation of fungicides against *Thielaviopsis paradoxa* is presented in the table 2. Among the fourteen new systemic fungicides tested, T7 (Azoxystrobin 11% + Tebuconazole 18.3% SC W/W), T9 (Carbendazim 12% + Mancozeb 63% WP) and T14 (Hexaconazole 5% + Validamycin 2.5% SC) were found to inhibit cent per cent of the pathogen at 500ppm concentration. However, (Hexaconazole 5% + Validamycin 2.5% SC) recorded highest inhibition even at its lower concentration i.e. 250ppm. Wherein, T12 Carbendazim 50% WP (98.15) and T11 Mancozeb 75% WP (97.41%) were found next superior which recorded inhibition of 98.15% and 97.41% respectively under *in vitro* in 500 ppm concentration (Table 3). In untreated control it was 90mm growth was recorded after 9 days of inoculation.

The results under *in-vitro* obtained are in conformity with reviewed works of Neeraja, *et al.*, 2018^[11] Ramanujam *et al.* (2005)^[15], Ranjan *et al.* (2013) and Rao *et al.* (2024)^[17] related to efficacy of fungicides on *Thielaviopsis paradoxa*. The fungicides, Calixin (Tridemorph 80EC) @ 0.3% showed 100 per cent inhibition over control whereas Ridomil MZ-72, Blitox-50 and Bavistin showed 92.00, 91.55 and 91.44 per cent inhibition over control after 144h of incubation respectively (Ramanujam *et al.*, 2005)^[15]. As the tridemorph 80 EC and other efficient fungicides are restricted to use, it is mandatory to find alternate fungicide molecules against the dangerous disease. Among the chemical fungicides tested *in-vitro* against *Thielaviopsis paradoxa*, the most effective combi fungicide viz., carbendazim 12% + mancozeb 63% WP, (Hexaconazole 5% + validamycin 2.5% SC) and (Azoxystrobin 11% + Tebuconazole 18.3% SC) recorded maximum inhibition of at all the three tested concentrations 100 ppm, 250 ppm, and 500 ppm (Rao *et al.*, 2024)^[17].

In vitro suppression of *G. lucidum* and *G. applanatum* by some fungicides viz., Bordeaux mixture, tridemorph, copper oxychloride and hexaconazole (Srinivasulu *et al.*, 2002)^[20]. Study revealed that (difenoconazole + propiconazole), hepridion and carbendazim inhibited the growth of *Phytophthora palmam* grey leaf spot of coconut even at low concentrations (Rahman *et al.*, 2013)^[14]. Six fungicides were evaluated against BSR of Arecanut and tridemorph 80 EC was reported as superior fungicide in controlling the disease and followed by carbendazim 50 WP (Chakrabarty, *et al.*, 2013)^[4, 16]. Difenoconazole inhibited the mycelia growth and sporulation of *Thielaviopsis punctulata* pathogen of Date palm (Saeed, *et al.*, 2016)^[18]. A study confirmed that *Botrydiplodia theobromae* was significantly inhibited by the fungicide (tebuconazole 50% + trifloxystrobin 25% WG) over other fungicides *in vitro* (Thangeswari *et al.*, 2019)^[23]. The fungicide (tebuconazole + trifloxystrobin) was found to inhibit *Lasiodiplodia theobromae* growth at 100 ppm (Baloch *et al.*, 2017)^[2]. The inhibitory effect of fifteen fungicides on *L. theobromae* growth was showed at different concentrations and systemic fungicide carbendazim showed 100% inhibition the over control even at lower concentration of 50 ppm under room temperature (Ushamalni, *et al.*, 2019)^[24].

Field evaluation of fungicides molecules against *Thielaviopsis*

The field experiment results were recorded and presented in the table 4. The pretreatment data were recored on October - 2020 which were on par with each other by selection of low, medium and high infection ranges in the trees. However, the two effective fungicides (combi-products) were treated in different methods as root feeding and soil drench and root feed + soil drench as separate treatments in order to know their efficacy. The experiment has been continued with quarterly application of treatments for two years from October-2020- to oct-2022. The result at end of October-22, revealed that T6: RF + SD- Hexaconazole + Validamycin recorded maximum disease reduction of 50.84 per cent over initial and found significantly superior to other treatments followed by the positive control T7: Root feeding of only Hexaconazole (4 ml in 100 ml of water/Palm) with 30.39 per cent reduction over initial. The next best treatment was T3: Root feeding (4 ml in 100 ml water) and soil drenching (30 ml in 15 liter water/ palm) of (Azoxystrobin 11% +

Tebuconazole-18.3% SC W/W) with 30.71 per cent reduction over initial. However, in untreated control the disease has been progressed to 32.96 PDI with 20.24% increase. The experiment was concluded and effective treatment was tested in multi-location trials.

Multiplication Trials: Two year Farm trials have been conducted in farmers' field at four locations viz., Arsikere(ASK), Hassan(HSN), Tiptur(TPT), and Kunigal (KGL) on the efficacy of (Hexaconazole + Validamycin) as Root feeding of (Hexaconazole 5% SC + Validamycin 25% SC) 4 ml in 100 ml of water/palm + Soil drenching of Hexaconazole 5% SC + Validamycin 25% SC 30 ml in 15 Lit of water/palm against check, i.e. root feeding of Hexaconazole (4 ml in 100 ml of water/Palm (POP). At the first year trial, the result revealed that root feeding of (Hexaconazole 5% SC + Validamycin 25% SC) 4 ml in 100 ml of water/palm + Soil drenching of (Hexaconazole 5% SC + Validamycin 25% SC) 30 ml in 15 Lit of water/palm recorded maximum disease reduction (50.61%, 48.71%, 56.12% and 54.07% respectively) at the end of 9 months after treatment over initial compared to positive control (33.55%, 35.77, 46.56 and 44.16% respectively). The yield of 102,106,103 and 99 nuts per palm per year has been recorded from all the four locations respectively in the tested treatment. The result revealed that root feeding of (Hexaconazole + Validamycin) recorded maximum disease reduction (68.87%, 72.83%, 75.92% and 67.44% respectively) at the end of 9 months after treatment over initial compared to positive control (56.12%, 57.57, 48.22 and 61.23% respectively). The results were showing similar trend with the first year results. The yield of 108,112, 105 and 108 nuts per palm per year has been recorded from all the four locations respectively in the tested treatment. Where in palms treated with POP treatments recorded higher disease PDI with lesser yield comparatively. One of the suggested recommendations for control of the stem bleeding disease under filed condition is to completely excise the infected areas on the stem, followed by dressing with tar or Bordeaux paste. The use of steel climbing spikes should be avoided whenever possible and a ladder be used in their stead, in order to reduce the mechanical wounds which serve as the primary means of entry for the fungus. Moreover, where economically feasible, applications of a fungicide to the stems of coconut may provide adequate protection (Alfieri, 1967)^[1]. Chisel out the rotten portion. Treat the area with

Bordeaux paste or coal tar. *L. sidoides* oil contained 42.33% thymol and 4.56% carvacrol, while *L. gracilis* oil contained 10% thymol and 41.7% carvacrol. Mycelial growth and conidial production of *T. paradoxa* were completely inhibited by thymol at a 0.3 µL m⁻¹ concentration. The results suggest that thymol could potentially be used for controlling coconut stem bleeding (Rajane, 2013). Ever since this disease was described from India, Sundararaman (1922)^[21] had prescribed removal of affected bark tissue and painting the trunk with hot coal tar. This measure is even now practiced with limited success. The use of systemic fungicides like Calixin, Bavistin, and Aureofungin-sol, and organic amendments like neem-cake were also tried by various workers. At Pilicode, Kerala, a field trial involving systemic fungicides like Bavistin, Calixin, Benlate, Vitavax and Aureofungin-sol, and Bordeaux mixture + neem cake, and coal tar application was in progress during 1984-87 period. The treatments were applied once in two months to the experimental palms. The systemic fungicides except Aureofungin-sol was applied through stem injection (Radhakrishnan, 1990)^[13]. At the end of four years, calixin was found to be superior in alleviating the disease incidence. Bavistin, Benlate, Vitavax, coal tar application and neem cake + Bordeaux treatment were on par. Coal tar application and aureofungin-sol were also on par (Nambiar *et al.*, 1988)^[10]. However, the same experiment was replicated in HREC, Ambajipeta, Andhra Pradesh on stem bleeding disease and at HRS, Vappankulam, Tamil Nadu on basal stem rot disease under AICRP Palms (Surulirajan *et al.*, 2025)^[22] and found similar trend of result which recorded after 27 months of quarterly treatment with root feeding of (hexaconazole 5% + validamycin-2.5% SC) @4 ml in 100 ml water + soil drenching (@2ml litre⁻¹) 15 litre palm⁻¹ (at quarterly interval) has been recorded 42.00% reduction over initial followed by the positive check with root feeding with hexaconazole @4 ml in 100 ml of water palm⁻¹ with 36.05% reduction over initial. The next best treatment was root feeding of (hexaconazole + validamycin) @ 4 ml in 100 ml of water palm⁻¹ showed 31.17% reduction over initial. The treatment with root feeding of (azoxystrobin 11% + tebuconazole-18.3% SC) @ 4 ml in 100 ml water + soil drenching (@ 2ml litre⁻¹) 15 litre palm⁻¹@ quarterly interval) recorded 24.75% reduction over initial (Rao *et al.*, 2024)^[17]

Table 1: Treatments imposed at *in-vitro* condition

Treatment	Chemical name	Trade name
T1	Famoxadone 16.6% + Cymoxanil 22.1% SC	EQUATION PRO®
T2	Cyazafamid 34.5% SC	RANMAN®
T3	Difenconazole 250 EC	SCORE®
T4	Thiifluzamide 24% SC	PULSOR®
T5	Kitazin 48% EC	KITAZIN®
T6	Hexaconazole 4% + Carbendazim 16% SC	SOFIA®
T7	Azoxystrobin 11% + Tebuconazole 18.3% SC W/W	CUSTODIA®
T8	Carbendazim 50% WP	ZOOM®
T9	Carbendazim 12% + Mancozeb 63% WP	SAAF®
T10	Mancozeb 75% WP	INDOFIL M-45®
T11	Carbendazim 50% WP	BENMAIN®
T12	Hexaconazole 5% EC	CONTAF®
T13	Hexaconazole 4% WG + Zineb 68%	AVTAR®
T14	Hexaconazole 5% + Validamycin 2.5% SC	VALIDEX®
T15	Control (No chemical used)	

Table 2: Treatments imposed at field condition

T1- Root feeding of Azoxystrobin 11% + Tebuconazole-18.3% SC W/W (4 ml in 100 ml water/ palm) @ quarterly
T2- Soil drenching of Azoxystrobin 11% + Tebuconazole-18.3% SC W/W (30 ml in 15 liter water/ palm) @ quarterly
T3- T1 + T2@ quarterly
T4- Root feeding of Hexaconazole 5% + Validamycine 25% SC (4 ml in 100 ml water/ palm) @ quarterly
T5- Soil drenching of Hexaconazole 5% + Validamycine 25% SC (10 ml in 5 liter water/ palm) @ quarterly
T6- T4 + T5 @ quarterly
T7 - Root feeding of Hexaconazole 5% SC (4 ml in 100 ml water/ palm) @ quarterly
T8 – Control

Table 3: *In-vitro* evaluation of new fungicide molecule against *Thielaviopsis paradixa*

Treatment	Chemical name	Trade name	100 ppm% Reduction	250 ppm% Reduction	500 ppm % Reduction
T1	Famoxadone 16.6% + Cymoxanil 22.1% SC	EQUATION PRO®	3.33	5.56	7.04
T2	Cyazafamid 34.5% SC	RANMAN®	4.44	4.81	5.19
T3	Difenconazole 250 EC	SCORE®	30.75	49.63	51.85
T4	Thifluzamide 24% SC	PULSOR®	10.74	11.48	20.37
T5	Kitazin 48% EC	KITAZIN®	15.93	16.30	17.04
T6	Hexaconazole4% + Carbendazim 16% SC	SOFIA®	53.70	54.81	56.67
T7	Azoxystrobin 11% + Tebuconazole18.3% SC W/W	CUSTODIA®	94.81	99.63	100.00
T8	Carbendazim 50% WP	ZOOM®	62.22	65.19	70.74
T9	Carbendazim 12% + Mancozeb 63% WP	SAAF®	94.07	98.15	100.0
T10	Mancozeb 75% WP	INDOFIL M-45®	87.04	94.44	97.41
T11	Carbendazim 50% WP	BENMAIN®	88.89	94.44	98.15
T12	Hexaconazol 5% EC	CONTAF®	7.78	9.26	19.63
T13	Hexaconazol 4% WG + Zineb 68%	AVTAR®	7.41	9.26	11.11
T14	Hexaconazol 5% + Validamycin 2.5% SC	VALIDEX®	100	100	100
T15	Control (No chemical used)		0.00	0.00	0.00

Table 4: Effect of fungicides against stem bleeding disease of coconut @ arsikere (2022)

Treatments	PDI									% reduction over initial
	Pre-Treat ment Oct-2021	Jan-2021	April 2021	July-2021	Oct-2021	Jan 2022	April-2022	July2022	Oct-2022	
T1- RF	26.72 (31.12)	26.81 (31.17)	27.32 (31.51)	26.77 (31.15)	25.69 (30.45)	24.52 (29.66)	23.27 (28.83)	21.31 (27.47)	20.55 (26.96)	23.09
T2- SD	26.01 (30.65)	26.37 (30.89)	26.84 (31.20)	25.98 (30.65)	25.46 (30.30)	23.67 (29.11)	22.44 (28.26)	19.23 (26.01)	18.80 (25.70)	27.72
T3- RF + SD	25.82 (30.54)	26.25 (30.82)	26.13 (30.74)	25.09 (30.06)	23.18 (29.45)	20.42 (26.82)	19.95 (26.47)	18.27 (25.20)	17.89 (24.90)	30.71
T4- RF	26.88 (31.23)	27.00 (31.30)	27.45 (31.59)	26.79 (31.17)	25.42 (30.27)	24.10 (29.39)	22.15 (28.06)	20.79 (27.11)	19.89/ (26.46)	26.04
T5 T T5- SD	27.72 (31.76)	27.93 (31.89)	28.35 (32.16)	27.85 (31.85)	26.38 (30.89)	24.07 (29.38)	23.49 (28.99)	21.25 (27.45)	20.29 (26.77)	28.80
T6- RF + SD	25.64 (30.42)	25.86 (30.57)	26.03 (30.68)	25.22 (30.13)	22.71 (28.44)	16.60 (24.03)	15.69 (23.32)	13.29 (21.36)	12.86 (20.99)	50.84
T7-standard POP	28.43 (32.20)	28.69 (32.37)	28.97 (32.55)	27.92 (31.88)	26.41 (30.92)	23.06 (28.70)	22.14 (28.07)	20.69 (27.05)	19.79 (26.41)	30.39
T8 – control	27.42 (31.57)	28.86 (32.48)	29.14 (32.66)	29.40 (32.83)	29.66 (32.98)	30.74 (33.67)	31.74 (34.29)	32.61 (34.82)	32.96 (35.04)	-20.24
SEM	0.67	0.61	0.47	0.49	0.51	0.6	0.63	0.68	0.69	
CD 5%	1.96	1.98	1.38	1.45	1.49	1.77	1.86	2.01	2.04	

PDI; Per cent Disease Index: *Data in the parentheses are arcsine transformed values; RF-root feed; SD- Soil drench

Table 5: Effect of fungicides against stem bleeding disease of coconut (2023-24)

	SB-Disease index (PDI)												
	Location 1 (ASK)					Yield	Location 2(HSN)					Yield	
	Pretreat	3 MAT	6 MAT	9MAT	%red	(Total No. of nuts/palm/yr)	Pre treat	3 MAT	6 MAT	9MAT	% red	(total No.of nuts/palm/yr)	
T1	35.35	32.00	21.51	17.46	50.61	102	32.66	31.33	23.33	16.75	48.71	106	
T2	29.87	27.21	22.68	19.85	33.55	91	27.79	25.67	20.13	17.85	35.77	98	
	Location 3(TPT)					Yield	Location 4(KGL)					Yield	
	Pre treat	3 MAT	6 MAT	9MAT	% red	(Total No.of nuts/palm/yr)	Pre treat	3 MAT	6 MAT	9MAT	% red	(Total No.of nuts/palm/yr)	
T1	26.57	24.33	19.11	11.66	56.12	103	31.66	29.26	21.33	14.54	54.07	99	
T2	27.79	25.12	22.33	14.85	46.56	95	30.66	28.33	23.12	17.12	44.16	92	

Table 6: Effect of fungicides against stem bleeding disease of coconut (2024-25)

	SB-Disease index (PDI)											
	Location 1 (ASK)					Yield	Location 2(HSN)					Yield
	Pre treat	3 MAT	6 MAT	9MAT	% red	(Total No.of nuts/palm/yr)	Pretreat	3 MAT	6 MAT	9MAT	% red	(Total No.of nuts/palm/yr)
T1	29.33	27	20.33	9.13	68.87	108	28.16	22.33	15	7.65	72.83	112
T2	31.13	21.33	18.67	13.66	56.12	94	30.33	21.67	18.66	12.87	57.57	97
	Location 3(TPT)					Yield	Location 4(KGL)					Yield
T1	Pre treat	3 MAT	6 MAT	9MAT	% red	(Total No.of nuts/palm/yr)	Pre treat	3 MAT	6 MAT	9MAT	% red	(Total No.of nuts/palm/yr)
T2	27.66	20.67	14.12	6.66	75.92	105	29.67	21.33	17.33	9.66	67.44	108
T2	21.88	18.33	13.66	11.33	48.22	95	31.6	26.5	15.66	12.25	61.23	98

*MAT-Months after Treatment

T1-Root feeding @4 ml in 100 ml water/ palm + Soil drenching of (Hexaconazole 5% + Validamycine 25% SC) (@ 30 ml in 15 litre water/ palm at quarterly interval), T2-POP: Root feeding of Hexaconazole 5% SC (@4 ml in 100 ml water/ palm) @ quarterly interval

Conclusion

The result revealed that for the management of stem bleeding disease on coconut, root feeding of (Hexaconazole + Validamycin@4 ml in 100 ml of water/Palm) and soil drenching (15 litre @2ml per litre) quarterly interval recorded maximum reduction of stem Bleeding disease over initial with highest yield compared to present Package of practice i.e root feeding of only Hexaconazole (4 ml in 100 ml of water/Palm).

Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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Competing Interests

Authors have declared that no competing interests exist.

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