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Cultivating Excellence:

Coconut Developm ent Board's Demonstration Cum Seed Production Farms

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Articles, research papers and letters on different aspects of coconut cultivation and industry are invited for publication in this Journal. All accepted material will be paid for. The Board does not accept responsibility for views expressed by contributors in this Journal. All remittances and correspondence should be addressed to the Chairman, Coconut Development Board, Kochi - 682 011.

Coconut Development Board

The Coconut Development Board is a statutory body established by the Government of India for the integrated development of coconut cultivation and industry in the country. The Board which came into existence on 12th January, 1981, functions under the administrative control of the Ministry of Agriculture and Farmers Welfare, Government of India, with its headquarters at Kochi in Kerala State and Regional Offices at Bangalore, Chennai, Guwahati and Patna. There are six State Centres situated in the states of Orissa, West Bengal, Maharashtra, Andhra Pradesh, Gujrat and in the Union Territory of Andaman & Nicobar Islands. DSP Farms are located at Neriyamangalam (Kerala), Vegiwada (Andhra Pradesh), Kondagaon (Chhattisgarh), Madehpura (Bihar), Abhayapuri (Assam), Pitapalli (Orissa), Mandya (Karnataka), Palghar (Maharashtra), Dhali (Tamil Nadu), South Hichachara (Tripura) and Fulia (West Bengal) besides a Market Development cum Information Centre at Delhi. The Board has set up a Technology Development Centre at Vazhakulam near Aluva in Kerala.

Functions

❒ Adopting measures for the development of coconut industry. ❒ Recommending measures for improving marketing of coconut and its products. ❒ Imparting technical advice to those engaged in coconut cultivation and industry. ❒ Providing financial and other assistance for expansion of area under coconut. ❒ Encouraging adoption of modern technologies for processing of coconut and its products. ❒ Adopting measures to get incentive prices for coconut and its products. ❒ Recommending measures for regulating imports and exports of coconut and its products. ❒ Fixing grades, specifications and standards for coconut and its products. ❒ Financing suitable schemes to increase the production of coconut and to improve the quality and yield of coconut.

❒ Assisting, encouraging, promoting and financing agricultural, technological, industrial or economic research on coconut and its products. ❒ Financing suitable schemes where coconut is grown on large scale so as to increase the production of coconut and to improve its quality and yield and for this purpose evolving schemes for award of prizes or grant of incentives to growers of coconut and the manufacturers of its products and for providing marketing facilities for coconut and its products. ❒ Collecting statistics on production, processing and marketing of coconut and its products and publishing them. ❒ Undertaking publicity activities and publishing books and periodicals on coconut and its products.

The development programmes implemented by the Board under the project Integrated Development of Coconut Industry in India are- production and distribution of planting material, expansion of area under coconut, integrated farming for productivity improvement, technology demonstration, market promotion and Information and Information Technology. Under the Technology Mission on Coconut, the programmes implemented by the Board are development, demonstration and adoption of technologies for management of insect pest and disease affected coconut gardens, development and adoption of technologies for processing and product diversification and market research and promotion.

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Dear friends,

As we begin the journey of the new financial year, it is with great pleasure that I extend warm greetings and best wishes to all our esteemed readers and stakeholders in the Indian Coconut industry. Let us hope that this is going to be a better period for the coconut sector in India, characterized by new avenues, expanded scope, and exciting initiatives.

The Indian coconut industry has long been an integral part of India's agricultural sector, contributing significantly to both the economy and the socio-cultural status of the country. As we look ahead, it is imperative to recognize the evolving dynamics and emerging opportunities that demand our attention and proactive engagement.

One of the key aspects that warrant our focus is the diversification of the coconut sector beyond traditional uses. While coconut cultivation has been associated with products such as copra, coconut oil, and desiccated coconut, the present day period presents a plethora of new avenues for exploration and expansion. The versatility of coconut presents opportunities for value addition across various industries, including cosmetics, pharmaceuticals, food and beverage, and renewable energy.

In line with this vision, the Coconut Development Board is poised to move forward to new initiatives aimed at catalyzing the growth and development of the sector. These initiatives encompass various facets, ranging from research and development to market expansion and technology adoption. Collaborative efforts with research institutions and industry stakeholders are expected to be instrumental in harnessing the full potential of coconut and leveraging it for sustainable growth and prosperity.

Product promotional strategies are expected to play a pivotal role in enhancing market visibility and consumer engagement. The Coconut Development Board will spearhead targeted campaigns to showcase the diverse range of coconut-based products and their inherent benefits. Leveraging digital platforms, social media channels, and strategic partnerships, these campaigns will seek to create widespread awareness and stimulate demand for Indian coconut products both domestically and internationally.

In addition to promotional activities, a comprehensive media plan will be devised to ensure effective communication and dissemination of information to stakeholders across the value chain. Through a combination of print media, electronic media, and online platforms, the Coconut Development Board will endeavor to keep all stakeholders informed about the latest developments, initiatives, and opportunities in the coconut sector.

Furthermore, capacity building and skill development will remain a priority for the Coconut Development Board, as we recognize the importance of empowering coconut farmers and entrepreneurs with the knowledge and resources needed to thrive in a rapidly evolving scenario. Training programs, workshops, and knowledge exchange initiatives will be organized to equip stakeholders with the necessary skills and insights to adapt to changing market dynamics and leverage emerging opportunities effectively.

As we embark on this journey of transformation and growth, I urge all stakeholders to join hands and work collaboratively towards realizing the full potential of the Indian coconut industry. Together, we can foster innovation, create value, and contribute to the sustainable development of not just the coconut sector, but the entire agricultural ecosystem.

In conclusion, I would like to express my gratitude to the dedicated team at the Coconut Development Board and the industry for their unwavering commitment and support. With collective effort and determination, I am confident that we can overcome challenges, seize opportunities and chart a path of prosperity for the Indian coconut industry.

Chairman,
Editorial Board

Cultivating Excellence:

Coconut Development Board's Demonstration Cum Seed Production Farms

B. Hanumanthe Gowda, Chinnaraj B and Shwetha R
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The Coconut Development Board is entrusted with the integrated development of coconut cultivation and industry in the country. Recognizing the pivotal role of quality coconut seedlings in ensuring robust yields, the Board has established 11 demonstration cum seed production farms across the country.

The strategic distribution of these farms across the country underscores the Board's commitment to reaching coconut farmers in every region, thereby fostering inclusive growth and development. Whether nestled in the lush landscapes of Kerala or in the North east, these DSP farms serve as beacons of progress and prosperity for coconut farmers nationwide.

The 11 Demonstration-cum-Seed Production (DSP) Farms stand as pillars of progress, spanning across 11 states occupying an expansive area of 362 hectares. With a collective plantation of 40,158 palms, these farms are dedicated to the meticulous production of superior quality coconut seedlings, encompassing Tall, Dwarf, and Hybrid varieties tailored to diverse agro-climatic conditions. This initiative falls under the major scheme "Production and Distribution of Quality Planting Material," aimed at enhancing the profitability and sustainability of coconut growers nationwide.

Since its inception with the establishment of the first farm in Mandya (Karnataka) in 1982, the Board has expanded its footprint, strategically locating DSP Farms in Abhayapuri (Assam), Madhepura (Bihar), Kondagaon (Chhattisgarh), Neriamangalam (Kerala), Vegiwada (Andhra Pradesh), Pitapally (Odisha), Palghar (Maharashtra), Dhali (Tamil Nadu), Hichachara (Tripura), and Fulia (West Bengal) over the years, up to 2022.

CDB DSP farms in a nutshell					
State	Location	Area (ha)	Year of establishment	No. of palms	No. of yielding palms
Karnataka	Mandya	20	1982	3616	3200
Assam	Abhayapuri	40	1987	3927	3445
Bihar	Madhepura	40	1987	3185	2892
Chhattisgarh	Kondagaon	40	1987	6556	5166
Kerala	Neriamangalam	20	1991	1799	1092
Andhra Pradesh	Vegiwada	40	1994	4053	3892
Odisha	Pitapally	40	1999	3354	2459
Maharashtra	Palghar	40	2013	5574	2678
Tamil Nadu	Dhali	40	2014	4142	1440
Tripura	Hichachara	22	2016	2368	498
West Bengal	Fulia	20	2018	1584	
Total		**362**		**40158**	**26762**

According to the guidelines outlined in the Mission for Integrated Development of Horticulture (MIDH) for Coconut Development Board (CDB) activities, the expenditure for maintaining DSP Farms is entirely met from the Board's budget. Each DSP Farm receives full support of up to Rs. 27 lakh per year for maintenance purposes. In the case of establishing a new farm, an initial allocation of Rs. 25 lakh is provided during the first year. Any expenditure exceeding the allocated budgetary limit is met from the receipts generated by the Board. This financial framework ensures the continuous operation and development of DSP Farms, enabling them to fulfill their mandate effectively in enhancing coconut cultivation and productivity.

The DSP farms of the Board serve the dual purpose of acting not only as centers for the production of top-notch, high quality seedlings but also as dynamic demonstration hubs for scientific coconut cultivation.

DSP Farm Mandya (Karnataka): Pioneering Excellence in Coconut Cultivation

Mandya Farm stands as a beacon of success, setting the standard for coconut production. Established in 1982 as the first farm, its 20-hectare expanse situated in the heart of Karnataka's coconut belt boasts ideal conditions for cultivation. With an

annual yield ranging from 2 to 2.5 lakh nuts and the production of approximately one lakh seedlings, Mandya Farm consistently generates an impressive income of Rs. 10 million annually.

Strategically located near Mandya, Mysuru, and Bengaluru, the farm benefits from red sandy loam soil enriched by KRS water and five borewells, ensuring optimal irrigation. Its diverse cultivar collection includes Tall, Dwarf, and Hybrid varieties, with notable performers being West Coast Tall and Tiptur Tall, yielding over 90 nuts per palm on average.

Mandya Farm leads the way in hybridization efforts, producing in-demand hybrid seedlings prized by farmers across South India. TThe farm produces between 5,000 to 10,000 hybrid seedlings annually. Shri Vijayakumar from Bangalore planted 600 hybrids during the 2003 season, yielding over 250 tender coconuts per palm. Shri Sunderrajan

Coconut and Coconut Seedlings Produced by DSP Farms in Last 10 Years			
Farm	Coconut Harvested	Seedlings Produced	Income Generated In Lakh Rupees
Mandya	2677580	1135056	656.040
Madhepura	412874	100888	185.500
Abhayapuri	947051	643140	540.119
Kondagaon	1800796	408803	474.970
Neriamangalam	545894	837124	657.690
Vegiwada	2891239	328648	882.800
Pitapally	581515	370531	297.570
Palghar	33210	280772	168.120
Dhali	347061	633770	482.616
Hichachara	3729	195192	115.020
Fulia	0	65658	37.480
Total	**10240949**	**4999582**	**4497.925**

from Pollachi planted 550 hybrids in 2004, also harvesting more than 250 coconuts per palm. Shri Sakthivel from Palladam, Tamil Nadu, planted 200 hybrids in 2018, harvesting 300 tender coconuts per palm. An advanced booking system is in place for the distribution of hybrid seedlings from this farm. Dr. Devarajan from Sethumadai in Pollachi planted 500 Tiptur Tall coconut seedlings, yielding more than 200 coconuts per palm. Thousands of farmers have taken coconut seedlings from the Mandya farm and maintain their farms as monocrops due to the high production rate.

Demonstration plots promote multispecies cropping, enhancing returns from unit areas, while a Parasite Breeding Laboratory combats pests effectively. Over the past decade, Mandya Farm has delivered outstanding results, producing 26.77 lakh coconuts, distributing 11.35 lakh seedlings, and generating an income of Rs. 65.6 million for the Board.

DSP Farm Abhayapuri (Assam): Sustaining Coconut Cultivation in Northeast India

Established in 1986-87, Abhayapuri Farm stands as a cornerstone of coconut cultivation in the Northeast region. Nestled in the picturesque Bongaigaon District of Assam, the 40-hectare farm at Batabari Village fulfills the planting material requirements of the North Eastern states. Located just 3.5 kilometers from Abhayapuri town and 200

kilometers from Guwahati, the state capital, the farm enjoys a strategic location conducive to its mission.

Blessed with alluvial soil and sandy loam, Abhayapuri Farm is having optimal conditions for coconut cultivation. Despite facing challenges such as heavy rainfall exceeding 2500mm per annum and extreme seasonal variations, the farm's robust infrastructure and irrigation facilities ensure consistent yields.

With a total population of 3927 palms, including 3445 bearing palms, the farm prioritizes high-yield varieties such as West Coast Tall and East Coast Tall. These varieties, alongside hybrids, demonstrate remarkable performance, with average nut production exceeding 80 and 100 respectively.

Diversification is key at Abhayapuri Farm, with intercrops including Arecanut, Assam lemon, Cinnamon, Litchi, and Guava supplementing income streams. Additionally, pisiculture serves as a major source of revenue alongside coconut and coconut seedling production.

Over the past decade, Abhayapuri Farm has harvested 8.19 lakh coconuts and produced 6.43 lakh quality seedlings, contributing significantly to the region's agricultural landscape. The farm's endeavors have resulted in a commendable income of Rs. 54.4 million, underscoring its vital role in sustaining coconut cultivation and economic prosperity in Northeast India.

DSP Farm Madhepura (Bihar): Pioneering Coconut Cultivation in Challenging Climates

Established in 1987, Madhepura Farm in Bihar's non-traditional region serves as a pioneering hub for studying coconut performance under adverse climatic conditions. Situated in Singheshwar, Madhepura District, the 40-hectare farm lies 7 kilometers from the district headquarters and 300 kilometers from the state capital, Patna.

Despite facing climatic challenges such as a maximum summer temperature of 46.40ºC and a minimum winter temperature of 4.0ºC, Madhepura Farm adopts innovative practices to thrive. Mound planting is utilized in low-lying areas, ensuring optimal growth conditions for coconut palms.

With a palm population of 3185, including 2892 yielding palms, the farm prioritizes high-performing varieties such as West Coast Tall and DxT hybrids. Additionally, diverse perennial horticultural crops such as litchi, mango, sapota, guava, and pomegranate are cultivated, facilitating intercropping initiatives to maximize agricultural productivity.

Despite challenges posed by extreme climatic conditions, Madhepura Farm is transitioning towards organic farming since 2022, reflecting its commitment to sustainability. Over the past decade, the farm has harvested 4.12 lakh coconuts and produced One lakh quality seedlings, demonstrating its resilience and innovative approach to coconut cultivation in Bihar's challenging climate.

DSP Farm Kondagaon (Chhattisgarh): Exemplary Farming in Unconventional Terrain

Kondagaon Farm stands as a beacon of excellence in coconut cultivation within Chhattisgarh's non-traditional landscape. Spanning over hectares, the farm is strategically located 3 kilometers from Kondagaon town, 80 kilometers from Jagdalpur, and 225 kilometers from Raipur, the state capital.

Nestled amidst red loamy soil with lateral patches, Kondagaon Farm benefits from the Narangi river as its primary water source, facilitating robust agricultural practices. With a palm population of 6556, including 5166 yielding palms, the farm showcases impressive yields and sustainability.

Diversification is key at Kondagaon Farm, with a plethora of perennial and mixed crops such as mango, lemon, litchi, amla, coffee, jackfruit, cashew, cinnamon, black pepper, cocoa, and seasonal intercrops like turmeric and pineapple. Over the past decade, the farm has harvested a remarkable 18 lakh coconuts and produced 4.08 lakh quality seedlings, contributing significantly to the region's agricultural landscape.

DSP Farm Neriamangalam (Kerala): Nurturing Coconut Culture Along Perennial Waters

Established in 1991 on a 20-hectare based land provided by the Government of Kerala, Neriamangalam Farm epitomizes the essence of coconut cultivation along the banks of the majestic Periyar river. Located 70 kilometers from the District Headquarters Kochi, the farm is having a diverse palm population of 1798, with 1105 palms in the yielding stage.

Maintaining a rich biodiversity, Neriamangalam Farm hosts an array of perennial crops including

mango, jackfruit, mangosteen, rambutan, nutmeg, pepper, banana, pineapple, cocoa, and cashew. Additionally, the farm pioneers hybridization programs, aiming to develop disease-resistant hybrid parental combinations.

Over the past decade, Neriamangalam Farm has harvested 5.46 lakh coconuts and produced 8.37 lakh quality seedlings, contributing significantly to Kerala's coconut cultivation sector while preserving its rich agricultural heritage.

DSP Farm Vegiwada (Andhra Pradesh): A Haven of Coconut Diversity

Established in 1994-95 across 71.80 hectares in Vegiwada, West Godavari District of Andhra Pradesh, Vegiwada Farm is a bastion of coconut cultivation diversity. Located approximately 23 kilometers from Eluru town, the farm is having 4053 coconut palms of various cultivars, with 3892 palms currently yielding.

Integrating intercropping practices, Vegiwada Farm emphasizes cocoa as its primary intercrop, with 4747 cocoa plants spanning over in six blocks. Complementing cocoa, the farm is having intercrops such as guava, amla, and custard apple. In rocky patches, 110 cashew plants flourish alongside coconut palms.

Over the past decade, Vegiwada Farm has been instrumental in harvesting 28.91 lakh coconuts and producing 3.29 lakh quality seedlings, fostering sustainable coconut cultivation practices in Andhra Pradesh.

DSP Farm Pitapally (Odisha): Nurturing Coconuts Amidst Challenging Terrain

Established in 1999 along NH-5 between Khurda and Bhubaneswar, Pitapally Farm in Odisha thrives

amidst challenging terrain. The farm encompasses 33.80 hectares of gentle sloping terrain with lateritic murrum soil, presenting pH ranges from 4.5 to 6.5 and meager organic matter.

Despite adverse conditions, Pitapally Farm sustains a palm population of 4138, with 3354 palms yielding. Alongside coconut cultivation, the farm maintains perennial intercrops including mango, guava, sapota, and cashew, bolstering agricultural diversity.

Over the past decade, Pitapally Farm has contributed significantly to coconut cultivation, yielding 5.81 lakh coconuts and producing 3.70 lakh quality seedlings, underscoring its resilience and commitment to agricultural sustainability.

DSP Farm Palghar (Maharashtra): Cultivating Coconuts Amidst Diversity

Established in January 2013, Palghar Farm in Maharashtra stands as a testament to coconut cultivation amidst diverse ecosystems. Situated 70 kilometers from the state headquarters, Mumbai, the farm sprawls across 40 hectares of predominantly black cotton soil with a slight acidic composition.

Dedicated to diversity, Palghar Farm divides its land into 22 plots, accommodating 80% dwarf cultivars and 20% tall varieties and germplasm

collection. Alongside coconut cultivation, the farm maintains intercrops like lemon and sapota, fostering agricultural synergy.

Over the past decade, Palghar Farm has contributed to coconut cultivation, harvesting 0.33 lakh coconuts and producing 2.80 lakh quality seedlings, symbolizing Maharashtra's commitment to sustainable agriculture and biodiversity.

DSP Farm Dhali (Tamil Nadu): Nurturing Coconuts in the Heart of Tamil Nadu

Established in 2014, Dhali Farm stands as a beacon of coconut cultivation, located 21 kilometers from Udumalpet town and nestled just 2 kilometers from Thirumoorthy dam. Encompassing 102 acres, with 65 acres acquired in 2014-15 and the remaining 37 acres in 2016-17, the farm epitomizes Tamil Nadu's coconut belt, with its optimal agroclimatic conditions.

With diverse soil types, including sandy loam and lateritic, Dhali Farm is well-suited for coconut cultivation. Adjacent to the high-level canal of the Parambikulam-Aliyar Project, the farm benefits from ample water resources. Divided into 16 blocks, the farm hosts a total palm population of 4142, with 1440 palms currently yielding.

Over the past decade, Dhali Farm has contributed significantly to coconut cultivation, harvesting 3.47 lakh coconuts and producing 6.34 lakh quality seedlings of different varieties, propelling Tamil Nadu's agricultural legacy forward.

DSP Farm Hichachara (Tripura): Cultivating Coconuts Amidst Serenity

Established in 2016, Hichachara Farm in Tripura spans in 22 hectares, embodying tranquility and agricultural excellence. With planting programs completed in 13 blocks, the farm is having 2368 palms of different varieties, with 484 palms entering the reproductive phase.

Since 2016-17, Hichachara Farm has been instrumental in producing 1.95 lakh quality seedlings of diverse varieties, bolstering coconut cultivation in Tripura. Notable varieties such as WCT, Tiptur Tall,

ECT, and Sakhigopal thrive in comparison to others, underscoring the farm's commitment to excellence.

DSP Farm Fulia (West Bengal): Fostering Coconut Cultivation in the East

Established in 2018 within the District Seed Farm complex in Nadia District, West Bengal, Fulia Farm emerges as a catalyst for coconut cultivation in the East. Spread over 50 acres, the farm prioritizes the supply of quality coconut planting materials and demonstrative cultivation of coconuts with suitable intercrops.

With a focus on banana and other horticultural crops like mango, bel, ber, and jamun, Fulia Farm enriches agricultural diversity while generating revenue through quotation and bidding processes. Since 2019-20, the farm has produced 0.66 lakh quality seedlings of different varieties, contributing to West Bengal's agricultural prosperity.

Embracing tall, dwarf, and hybrid cultivars, these farms collectively demonstrate the resilience and potential of coconut cultivation across diverse agroclimatic regions, fostering sustainable agricultural practices for a prosperous future

Thus in a nutshell, DSP Farms of the board play a pivotal role in fulfilling several mandates, serving as hubs of innovation and productivity in coconut cultivation. By producing one million coconut seedlings annually, these farms contribute significantly to expanding coconut cultivation by 5 to 6 thousand hectares each year. Ensuring the purity and affordability of the seedlings, farmers are supported through subsidy-linked Area Expansion Programs, facilitating their engagement in sustainable agricultural practices.

Moreover, DSP Farms serve as centers for disseminating scientific knowledge and techniques in coconut cultivation to farmers and students alike. Equipped with essential infrastructure, these farms provide comprehensive training programs for unemployed youths, farmers, students, and extension workers, empowering them with the skills and knowledge needed for successful agricultural endeavors.

In addition to their educational role, DSP Farms generate substantial income for the Board, amounting to Rs 50 million annually. This revenue not only sustains the operations of the farms but also contributes to further agricultural research and development, ensuring the continued growth and prosperity of the coconut industry.

Trichoderma for crop protection in coconut

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The coconut palm (*Cocos nucifera L.*, family Arecaceae) has been the most useful plant species to humans and every part of the palm is being used since ancient times. Crop loss incurred due to pest and disease incidence in coconut cultivation accounts for around 20%, leading to decreased yields and economic losses for farmers. To mitigate these losses, integrated pest management (IPM) strategies are crucial. One important component of IPM is the use of bioagents, which are organisms that naturally regulate pest populations and diseases. *Trichoderma* is one such promising bioagent used for the management of diseases in coconut.

Trichoderma is one of the versatile and effective beneficial fungi which not only reduces plant diseases but also increase plant growth, vigour and induces resistance in plants against pathogens. *Trichoderma* are soilborne, green-spored fungi belonging to the phylum Ascomycota and the class Sordariomycetes in the fungal kingdom. *Trichoderma* are beneficial to plants as they can act as biocontrol agents against plant pathogens, promote plant growth, and enhance nutrient uptake. They are known for their ability to produce various enzymes, such as cellulases and chitinases, which help them degrade organic matter in their environment. These antagonistic fungi are the most common fungal bio-control agents due to their multiple modes of action namely mycoparasitism, competition for space and nutrients, production of inhibitory compounds, inactivation of the pathogen's enzymes, induced resistance and plant growth stimulation. *Trichoderma* have the potential to control soil borne plant pathogens, more effective than chemicals. However, the efficacy of *Trichoderma* varies among different strains and target pathogens. ICAR-CPCRI has identified a more effective, potential *Trichoderma harzianum* (CPTD 28) isolate and tested its bio efficacy against major diseases of coconut, also developed new formulation techniques to enhance its effectiveness and shelf-life. These *Trichoderma* formulations were found effective in management of coconut bud rot, stem bleeding and Ganoderma wilt disease.

A full grown culture of Trichoderma harzianum

Trichoderma formulations developed by CPCRI and its application:

1. *Trichoderma* talc formulation

Talc is an inert and cheaply available material. Talc is used as medium for mass production of *Trichoderma harzianum* (CPTD 28).

Trichoderma talc formulation

The maximum storage period is upto 120 days at room temperature.

Preparation procedure:

- Sterilize the talc powder for two successive days.
- Homogenize the *Trichoderma* biomass multiplied in coconut water broth or by using a mixer grinder.
- Thoroughly mix 400ml of homogenized biomass in 1kg of sterilized talc powder and shade dry to 8% moisture.
- Carboxymethyl cellulose (CMC) should be added @5g/kg of talc powder during mixing as binding agent for enhancing shelf life.
- After drying, break the clots and pack the *Trichoderma* talc formulation in polythene bags and seal it with a sealing machine.

Application:

i) Smearing of *Trichoderma* talc paste (100 gm *Trichoderma* talc formulation in 50 ml of water) in coconut trunk bleeding areas for the management of stem bleeding disease.

ii) Mass multiplication of *Trichoderma* in neem cake powder @ 1kg per 100 kg

of neem cake. From this mixture, 5 kg of neem cake *Trichoderma* mix can be applied in coconut root basin every year in stem bleeding and Ganoderma wilt affected coconut.

2. *Trichoderma* coir pith cake formulation

Preparation of *Trichoderma* coir pith cake is easy and low cost technology with a long shelf life of upto one year. It is an eco-friendly formulation with nutrients for the multiplication of *Trichoderma* and is easy to transport from one place to other.

Dried TCPC

TCPC after activation

Procedure:

- Collect coir pith from nearby coir factories, free from long fibers and moisten with water by adding 50% of moisture.
- Sterilize the coir pith for two successive days
- Homogenize the *Trichoderma* biomass multiplied in coconut water broth by blending the entire mycelia mat along with medium using mixer grinder.
- Mix homogenized *Trichoderma* biomass slurry (200 ml) and sterilized coir pith (1kg) thoroughly in a clean plastic tray.
- Place 30 g of the mixture in a kitchen press to prepare a cake manually.
- Dry the cakes at 40˚C for 4 days in an oven.
- Dried cakes can be packed in polythene bags and stored at room temperature.

Application:

i) Two *Trichoderma* coir pith cake can be placed on either side of the growing bud of coconut at bimonthly interval from June to December for the management of bud rot disease.

Prophylactic placement of TCPC cake on either side of the spindle leaf

ii) Placing of moistened *Trichoderma* coir pith cake by tying it onto the bark of stem bleeding affected coconut tree after removal of bleeding patches.

Field view of a bud rot affected coconut garden in Ballal, Kasaragod

The successful application of *Trichoderma* coir pith cake has been demonstrated in bud rot endemic hilly areas of Kasaragod district, particularly in Balal and Konnakkad villages, for the management of bud rot disease of coconut.

General precautions to be taken while handling *Trichoderma* formulations:

Trichoderma harzianum is a beneficial fungus and in general not found harmful to human beings or animals or other plants. However, it is advised to follow all the safety guidelines like that of any toxic chemicals or microbes.

i) Always use hand gloves while touching *Trichoderma* formulations and use face mask.

ii) Store in a safe place away from children and animals.

Commercialization of *Trichoderma* technology

Lack of availability of good quality *Trichoderma* formulations for field level use is a constraint experienced by coconut farmers. As part of technology commercialization CPCRI has transferred technologies pertaining to production of *Trichoderma* coir pith cake and talc formulation to various private and public firms including KVKs in Kannur, Kozhikode, Wayanad, Malappuram, Palakkad, and Thrissur. Among these, KVK Kannur has emerged as a key player, taking the lead in large-scale production of the cake formulation. Hence, the successful commercialization of technology by CPCRI has immensely benefitted the farming community by making available good quality *Trichoderma* formulations for field level use.

Performance of coconut varieties against leaf blight disease

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Introduction

Coconut *(Cocos nucifera L.),* an important oilseed and plantation crop of India, is cultivated in an area of 1.63 million hectares. With as annual production of 17205 million coconuts is reported (CDB, 2023). Various fungal and mycoplasma diseases pose threat for coconut cultivation (*Lakshmanan and Jagadeesan, 2004*). Among them, leaf blight diseases is commonly occurrering in all coconut growing areas throughout the country. Leaf blight caused by *Lasiodiplodia theobromae* is an important foliar disease in coconut. Nut yield reduction of 10–24 per cent is observed in Tamil Nadu (*Pavlic et al., 2004*).

Symptoms

The leaf blight incidence is found only in older leaves of coconut palms. Infected leaflets start drying from the tip downwards and cause a charred or burnt appearance. Reduction in vigour of the coconut seedlings is observed due to leaf blight pathogen. The leaf production is lowered much, tree growth is stunted and nut yield is reduced. Coconut palms heavily infected with leaf blight disease flowered relatively late than less affected ones. At the apex of the nuts, dark brown lesions with wavy margins appear. The disease is more severe during summer months.

Leaf blight symptom

Infection on nuts

Pathogen

The pathogenic characters of leaf blight pathogen was observed as thin, light grey coloured mycelium, which later turns to dark grey. Pathogen is fast growing and dark black pycnidia is observed in fungal colonies. Pycnidia is seen in the periphery of the culture plate (*Wang-Ching, Ho and Wen-Hsiung, Ko, 1997*). Immature conidia are single celled, thick walled, oval shaped and hyaline. Matured conidia are thin walled, dark brown to black in colour and two celled. Shape of Lasiodiplodia conidia is obovoid (Burgess et al., 2006).

Curvularia eragrostidis (C.maculans) causes leaf spots in coconut seedlings during wet months in

West Malaysia (Chan, 1974). Chan, 1974 reported a serious outbreak of leaf blight disease during October-November 1972 in Malayan Yellow dwarf variety. All the nursery seedlings are found to be infected with more than 50% of the leaf area covered with spots (Chan, 1974).

Management strategies

The available chemical control measures using fungicides increase the cost of production and so it is difficult for small and marginal farmers to follow. Moreover, usages of fungicides are not eco-friendly. Host plant resistance is found to be the effective method in plant disease management. Identification of resistant donors is highly essential for incorporation of resistance in breeding methodology. Hence, development of varieties resistant to diseases is needed for which identification of tolerant genotypes is imperative.

Materials and Methods

In the present investigation, field experiments were conducted to evaluate coconut genotypes against leaf blight disease at Coconut Research station, Aliyarnagar, Tamil Nadu Agricultural University. A total number of five dwarf varieties, eight tall varieties and six hybrids of coconut were screened against leaf blight disease using 0-9 scale. Coconut dwarf varieties viz., MYD (Malayan Yellow Dwarf), CGD (Chowghat Green Dwarf), MGD (Malayan Green Dwarf), COD (Chowghat Orange Dwarf) and ALR CN 3 (Kenthali Dwarf); tall varieties viz., WCT (West Coast Tall), ECT (East Coast Tall), ALR CN 1 (Arasampatti Tall), Cochin China Tall, Andaman Giant Tall, Laccadive Ordinary, Laccadive Micro (Ayiramkaachi) and ALR CN 2 (Tiptur Tall); hybrids viz., COD x ALR, ALR x MGD, MGD x ALR, COD x WCT, KTD x ALR and VHC2 were selected for screening against leaf blight disease incidence. Six palms were maintained per treatment (Genotype/hybrid) and the experiment was conducted in Randomized Block Design with seven replications. The genotypes were planted in spacing of 7.5 x 7.5 m. Necessary intercultural operations were carried out as per the standard package of practices. Leaf blight disease intensity was recorded periodically in all the palms. Disease rating scale (0 to 9) was followed for scoring leaf blight disease (Pawelec et al., 2006).

Disease scale Symptoms

Disease scale	Symptoms
0	No visible symptom
1	Less than 5% leaf area damaged
3	5-20% leaf area damaged
5	20-40% leaf area damaged
7	40-60% leaf area damaged
9	Severe defoliation

Table 1. Disease Scale and symptoms

The reaction to leaf blight disease for each coconut genotype was assessed as per the following Table 1. Number of nuts per palm per year was also recorded for each treatment. The following formula was used to calculate Per cent disease index (PDI)

$$PDI = \frac{\text{Sum of numerical ratings}}{\text{Number of leaves observed} \times \text{Maximum disease grade in score chart}} \times 100$$

Disease scale	Per cent infection	Reaction
0	No infection	Immune
1	Less than 5%	Resistant
3	5-20%	Moderately resistant
5	21-40%	Moderately susceptible
7	41-60%	Susceptible
9	61-100%	Highly susceptible

Table 1. Disease reaction against leaf blight disease of coconut

Results and Discussion

Screening of germplasm against plant diseases is very important for identifying resistant lines. However, in the available cultivable germplasm, resistance level is not high for leaf blight disease. Therefore, identification of elite germplasm with both resistant to disease and high yield is highly useful for the development of hybrids. An attempt was made at Coconut Research Station, Aliyarnagar to identify coconut genotypes tolerant to leaf blight disease so that they can be included in the breeding programmes or advocated to the farmers. Five dwarf varieties, eight tall varieties and six hybrids of

coconut were screened against leaf blight disease under field conditions using 0 to 9 scale. From the results of the screening experiments it was found that there was a significant difference in leaf blight disease intensity among the evaluated germplasm. In the seasonal occurrence of leaf blight disease, the disease intensity gradually increased from the month of January and reached the maximum during the month of May and thereafter gradually declined in the varieties and hybrids screened. Among five dwarf coconut varieties screened, minimum leaf blight disease intensity of 13.6 PDI (Percent Disease Index) was observed in CGD (Chowghat Green Dwarf) and the maximum leaf blight disease intensity of 28.9 PDI in COD (Chowghat Orange Dwarf) during the peak season of May. Among the eight tall coconut varieties screened, WCT (West Coast Tall) recorded the minimum disease intensity of 13.6 PDI during the month of May and the maximum leaf blight disease intensity of 26.7 PDI was observed in Andaman Giant Tall. Among the six coconut hybrids screened, leaf blight infection was not observed in the hybrids viz., COD x ALR and MGD x ALR. The minimum leaf blight disease intensity of 8.6 PDI was observed in KTD x ALR and the maximum leaf blight disease intensity of 14.3 PDI in COD x WCT. The hybrid VHC 2 recorded leaf blight disease intensity of 2.6 PDI. Among the dwarf varieties screened for growth and yield parameters, the maximum annual leaf production (12 nos.), number of female flowers per inflorescence (30 nos.), tender nut water (500 ml), total soluble solids (TSS Brix) (5.8) and nut yield (128numbers/palm/year) were observed in ALR (CN)

This was followed by MYD with annual leaf production (11 nos.), number of female flowers per inflorescence (28 nos.), tender nut water (625 ml), total soluble solids (TSS Brix) (5.4) and nut yield (123 numbers/palm/year). The minimum nut yield of 104 nuts/palm/year was recorded in MGD. Among the tall varieties screened for growth parameters, yield parameters and yield attributes, yield and quality were favourable in WCT. The maximum annual leaf production (11 nos.), number of female flowers per inflorescence (30 nos.), duhusked nut weight (640 g), copra content (140 g/nut) and nut yield (122 nuts/palm/year) was recorded in WCT. This was followed by ALR (CN1) which recorded annual leaf production of 11 nos., number of female flowers per inflorescence of 29 nos., duhusked nut weight of 512 g, copra content of 120 g and nut yield of 109 nuts/palm/year. Minimum nut yield of 74 nuts/palm/year was observed in the tall variety Andaman Giant. Among the hybrids screened for growth and yield parameters, annual leaf production of 12 nos., number of female flowers per inflorescence of 38 nos., dehusked nut weight of 702 g, copra content of 155 g/nut and nut yield of 128 nuts/palm/year was recorded in COD x ALR (CN1). The hybrid COD x WCT recorded the minimum nut yield of 85 nuts/plam/year. Chaudhari et al. (2019) reported significant environment and genotype interactions for both leaf spot and rust diseases by combined analysis of variance which indicates differential response of genotypes in different environments.

Conclusion

The results of the present study revealed that resistance to coconut leaf blight disease has been found in some promising varieties and hybrids viz., WCT, MGD, COD x ALR(CN)1 and can be employed in breeding programmes to develop leaf blight resistant genotypes.

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Production protocol of microbial bio agents for the management of diseases in coconut and horticultural crops

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Dr.YSRHU-HRS, Ambajipeta

Introduction

The Coconut (*Cocos nucifera L.*) is glorified as "Kalpavriksha" as each and every part of the palm is useful to mankind in one way or other. The state of Andhra Pradesh stands 1st in productivity and 3rd in production in India. Dr. YSRHU-Horticultural Research Station, Ambajipeta is the only research station in Andhra Pradesh dedicated to the research and development activities in coconut for more than six decades and played a pivotal role in transferring the technology.

In India, coconut is growing predominantly in the states of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh. In Andhra Pradesh erstwhile districts viz., East Godavari, West Godavari, Srikakulam and Visakhapatnam are important coconut growing districts. One of the major factors that contribute to the loss of production and productivity in coconut is the damage due to the insect pests and diseases. Basal Stem Rot (Ganoderma wilt) disease caused by *Ganoderma applanatum (*Pers.) Pat., and *G.lucidum* (Leys) Kant is the most destructive disease of coconut, as the ultimate infection leads to death of palms. The other important diseases are stem bleeding caused by *Thielaviopsis paradoxa* and bud rot caused by *Phytophthora palmivora* and Leaf blight caused by *Lasiodiplodia theobromae* can cause severe yield losses. Except leaf blight other diseases are soil borne in nature. Soil borne pathogens have a broad host range and persist for longer periods in soil by resistant resting structures. Leaf blight is an air borne disease and can survive in leaf debris.

Keeping in view of the severe environmental pollution and food security concerns caused by excessive usage of chemical pesticides and synthetic fertilizers, the biocontrol microorganisms have been attracted extensive attention because of their environmentally friendly characteristics.

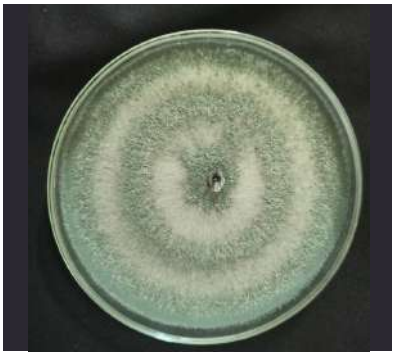
Bio agents distribution to farmers

Trichoderma spp. , *Pseudomonas fluorescens*, *Bacillus subtilis* and many soil microbial organisms are widely used as biological control agents (BCAs). Several *Trichoderma spp* and bacterial strains have been reported to effectively suppress plant pathogens by different mechanisms including mycoparasitism, antibiosis, competing for nutrients and space, and inducing systemic resistance of plant. In addition to the diseases the most problematic pest Rugose spiraling white fly -*Aleurodicus rugioperculatus* in coconut is now being managed by entomopathogenic fungi *Isaria fumasorosea* [NBAIR PFU-5] sprays.

Sl. No	Microbial Bio Agent	Accession No.
1	Trichoderma reesei –CATR 1	NAIMCC-F-04174
2	Trichoderma asperellum –CATA 1	NAIMCC-F-04414
3	Trichoderma harzianum –CATH 1	NAIMCC-F-04415

Dr. YSRHU-HRS, Ambajipeta, centre for the bio control of pest and diseases in India is supplying predators, parasitoids, microbial pesticides on

Pseudomonas fluorescens



Trichoderma isolates

Duel culture test between Pseudomonas vs Ganoderma

large scale to the needy farmers of coconut and other horticultural crops. The centre's research is focusing on mandatory crops viz., coconut and its intercrops. The centre is being supported by ICAR AICRP on Bio control and ICAR-AICRP on Palms. The native promising fungal bio agents-*Trichoderma reesei, T. asperellum* and *T. harzianum* were identified, characterized and culture deposited at NAIMCC, ICAR-NBAIM, Mau, UP.

Production of microbial bio agents: The basic steps for initiating the production of bio agents at small scale or large scale are common.

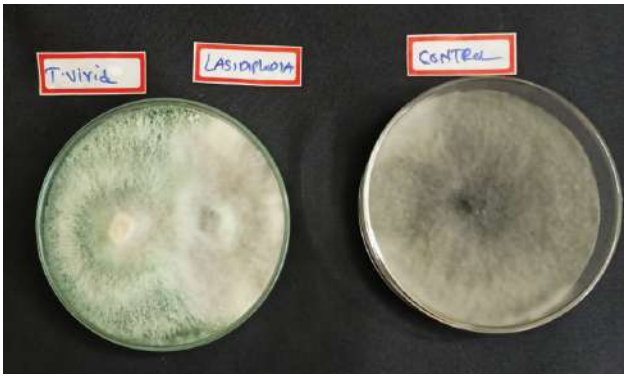
Isolation and identification of native bio control agents from rhizospheric region of coconut: Collection of Soil samples from rhizosphere regions and isolated by adopting serial dilution technique on specific media. Identification and screening against target pathogen.

Antagonistic fungi: Soil samples were collected from rhizospheric region of coconut in mandals of Dr. B. R. Ambedkar Konaseema district, Andhra Pradesh. Serial dilution and plate count method was used for isolation of antagonistic fungi. The collected soil samples were subjected to serial dilutions using sterile distilled water and 0.5 ml of each sample at 10–3 and 10–4 dilutions were spread on petridishes containing Trichoderma specific medium (TSM) Two plates were maintained for each dilution. The plates were then incubated at 28°C and were examined after four days. Hyphal tip method was adopted for pure culture of organisms. The isolated antagonistic fungi were identified up to the level of genus or species based on growth, color, land, philides characters on PDA medium.

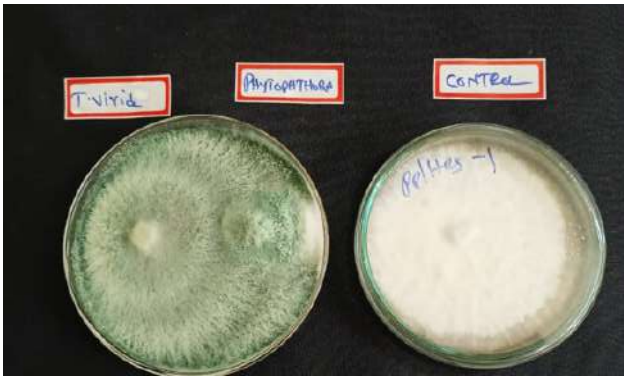
Antagonistic bacteria: Samples were serially diluted and 0.1 ml of sample was spread on plates containing King's B medium to isolate *Pseudomonas fluorescens*. The isolate was purified by streaking and was maintained further. Identification of bacterial bioagent was made as per the description and physiological status.

Antagonism against pathogens [In vitro]: Dual cultures of the fungal and bacterial antagonists and the test pathogens were prepared by inoculating PDA discs from the growing margins of fresh fungal cultures on to petri dishes containing PDA and incubating them. The dual cultures were observed for antibiosis and agar blocks from the regions where the colonies merged were observed for typical interactions under the light microscope. In case of bacterial antagonists, 8 mm mycelia discs of the pathogens were placed individually at the center of the plates and bacterial strain was streaked at three positions 2 cm away from edge of the petri plates with PDA medium and incubated. The mycelia growths of the test pathogens were measured at 48 hrs and subsequently one week after incubation. Mycoparasitism of test pathogen isolates by fungal antagonists was studied using the dual culture technique. The pathogen growth was measured after 4 days of incubation in both the cases at 29.1°c and percent inhibition was calculated.

Mass multiplication of bio agents: Talc formulation of *Trichoderma reesei* NAIMCC-F-04174, *Trichoderma asperellum* NAIMCC-F-04414 and *Trichoderma harzianum* NAIMCC-F-04415 are being employed for the mass multiplication. Trichoderma biomass was prepared using potato dextrose broth. The broth was distributed into 500 ml conical flasks with a quantity



Duel culture test- *T.asperellum vs Lasiodiplodia*



Duel culture test--T.asperellum vs Phytopthora

of 250 ml and plugged tightly with cotton. This was autoclaved at 15 p.s.i. for 20 minutes, cooled to room temperature and inoculated with 5 mm culture disc of three days old. Trichoderma inoculated flasks were incubated for 7 days at room temperature in slanting position so as to get the highest surface area of the medium for fungal growth. Seven days after inoculation, the spent medium with fungal biomass was blended in an electric mixer for 1-2 minutes to homogenize the contents. *Pseudomonas fluorescens* cultures were maintained on NA medium or kings B medium. Under aseptic conditions the bio agents multiplied on sterilized potato dextrose broth / nutrient broth inoculated with desired bio agent and incubated at room temperature [280 c] for 7 days. The cultures were transferred to talc powder (carry material) at 1: 2 ratios along with 1% Carboxy Methyl Cellulose. The mixture need to be dried under shade

Mixing bio agent broth with talc powder

condition to lose the excess moisture. Dried clumps should be pulverized to get fine powder. The fine powder can be weighed for desired quantity and packed with label.

In vitro Production protocol of microbial bio agent

Preparation and sterilization of Potato Dextrose Broth/Nutrient broth

⇩

Inoculation of broth with microbial bio agents

⇩

Incubate at room temperature [28° c] for 7 days [Trichoderma]-4 days [Bacteria]

⇩

Homogenation of broth

⇩

Mix homogenate broth with chalk powder at 1 : 2 ratio, Add Carboxy Methyl Cellulose (5 g/kg)

⇩

Shade dry the mixture at room temperature

⇩

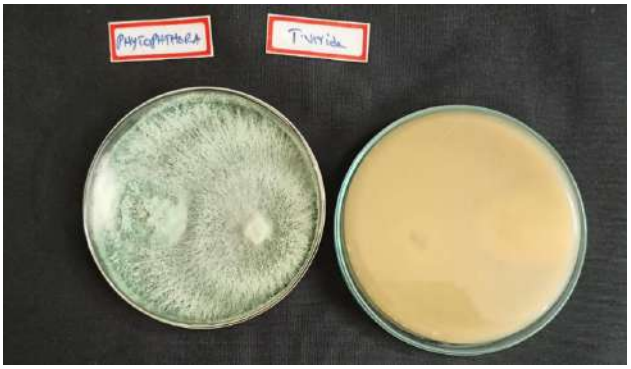
Pulverize the clumps to get fine Talc formulation

⇩

Quality checking-Enumeration of bio agent [CFU]

⇩

Pack and Label



Duel culture between Phytopthora vs T.asperellum

Duel culture test-T.reesei vs Phytopthora

Bio agents production and supply to coconut and other horticultural crops at Dr.YSRHU-HRS, Ambajipeta

During the last five years the promising microbial bio agents were supplied in significant quantity to the coconut and other horticultural farmers.

Supply details of microbial pesticides from Dr.YSRHU-HRS, Ambajipeta

Year	Bio agent	Supply in Kg	No of farmers used
2019-20	*Trichoderma spp*	978	85
	Pseudomonas fluorescens	548	64
	Isaria fumorosorosea [NBAIR-PFU-5]	1725	125
2020-21	*Trichoderma sps*	1056	79
	Pseudomonas fluorescens	890	63
	Isaria fumorosorosea [NBAIR-PFU-5]	1647	114
2021-22	*Trichoderma sps*	1056	95
	Pseudomonas fluorescens	879	74
2022-23	*Trichoderma sps*	1643	89
	Pseudomonas fluorescens	646	34
2023-24	*Trichoderma sps*	2148	134
	Pseudomonas fluorescens	1117	61
	Dr. YSRHU-Coconut IDM Special	14,256	289

The demand is being increased to larger quantity with advanced equipment like Fermentor and its accessories funded by CDB and RKVY projects. During the recent years the bio pesticide production capacity at Dr. YSRHU-HRS, Ambajipeta has increased multi folds with mechanization in bio control unit up to packing level.

Phone in program: It is a virtual interaction forum between farmer and scientist created by Dr. YSRHU to listen the farmer problem and provide the recommendation directly. It is for supporting the farmers who are practicing conventional farming, natural farming and organic farming in Andhra Pradesh and India. Further, it is also paves the way to support the farmers directly for disease management with readily available bio agents as a solution which was recommend as particularly bio intensive management. Farmers felt satisfaction with this programme.

Acknowledgement: On behalf of coconut farmers and Dr. YSRHU, I express my sincere thanks to CDB, Kochi for giving financial assistance to develop the infrastructure to establishment bio control unit at Dr. YSRHU-HRS-Ambajipeta. I also take this opportunity to express deep sense of gratitude to the Project coordinator, ICAR-AICRP on Palms, Kasargod, Kerala for providing this wonderful opportunity to work with bio intensive management of coconut diseases. Achieving this success would not be possible without the support, help and insights by Vice Chancellor, Dr. YSRHU Director of Research, Dr. YSRHU, Venkataramannagudem, West Godavari District and Principal Scientist and Head, Dr. YSRHU-HRS, Ambajipeta.

Management Strategies for the Devastating Root Wilt Disease in Coconut

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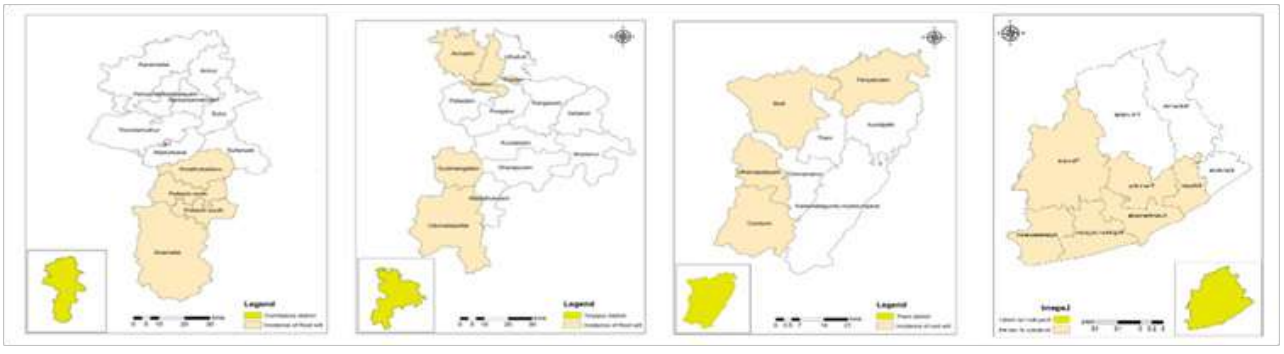
Coconut is an important horticultural crop which has a significant bearing on the livelihood security of small and marginal farmers across the nation. In India, coconut cultivation spreads over an area of 2.15 m.ha of which nearly 89.3% is mainly concentrated in the southern states - Tamil Nadu, Kerala, Karnataka and Andhra Pradesh. This versatile crop, frequently hits the headlines of mass media because of multitude of challenges viz., price fluctuations, water scarcity, labour scarcity, devastating pests and diseases, large stock of senile palms, nutritional disorders etc. In the recent past, root (wilt) is posing a great threat to the very sustainability of coconut farming in the states of Tamil Nadu and Kerala and remains a grave concern for the scientists and the farmers. Although the disease was witnessed as early as 1882 in Kerala (Butler, 1908) it is spreading in a contiguous fashion in isolated patches resulting in a yield reduction of 50 % to complete crop failure in extremities. In India, the annual loss due to this disease was estimated around 968 million nuts per year (*Manimekalai et al., 2010*). Every year the deadly disease engulfs 15 % of the coconut plantations of the state and the death toll is on the rise in all the coconut growing districts of Tamil Nadu. Of the 4.46 lakh hectares of the state of Tamil Nadu, a major segment is found to suffer from the disease.

Root wilt affected garden of Tamil Nadu

Prevalence of the disease inTamil Nadu

In Tamil Nadu, the disease is prevalent in zones representing Tamil Nadu - Kerala junctions of Theni, Kanyakumari, Tirunelveli, Dindigul and Coimbatore Districts. A report on the spread, occurrence and importance of root (wilt) disease in coconut was indicated in Kanyakumari and Tirunelveli Districts of Tamil Nadu as early as 1970s by Tamil Nadu



Intensity of Root wilt Infestation in major coconut growing districts of Tamil Nadu

Agricultural University, Coimbatore, (Subba Raja and Jaleel Ahamed, 1975). Recently, more than 5 lakh coconut trees have been reported to be affected by root (wilt) disease in various districts of Tamil Nadu and in Theni District alone so far 3 lakh coconut trees have been reported to be affected and more than 2,00,000 affected trees have been removed.

Causes of the disease and conditions favouring the spread

Root wilt disease in coconut is reportedly caused by phytoplasma like organism. This debilitating disease is spread by phloem feeders like lace wing bug (*Stephanitis typica*) and plant hoppers (*Protista moesta*). There exists different school of thoughts stating soil to be a source of inoculum. Proximity to river banks and water bodies, waterlogging condition for a profusely longer period, no till scenario resulting in surface crusting of soil and hard pan formation, imbalanced fertilization with negligence towards micronutrient fertilizers, parsimonious application of organic manure and low status of soil organic carbon, unscrupulous use of plant protection chemicals are the factors which favour the spread of the disease.

Root wilt affected garden on the bank of PAP river in Manakkadavu village, TN.

Symptoms of the disease

The first ever disease symptom manifests as yellowing of leaves. As yellowing is attributed to very many causes, it is unable to pinpoint root wilt as the culprit behind. Yellowing is followed by marginal necrosis, flaccidity and bending of the central rachis almost resembling the ribs of mammals. Leaves become shorter and narrower, irregular like rodent bite ending up with severe nut fall. Rotting of roots is one of the widely observed symptoms in the garden. Leaf rot is the secondary infection of the disease which is equally severe as root wilt per se as air may serve as carrier of leaf rot pathogens. Weak spadices, drying of spathe and necrosis of spikelets are the common symptoms associated with the disease.

Leaf rot and root rotting symptoms in root wilt affected palms

Management of the disease

Plethora of evidences ascertain that it is caused due to phytoplasma like organism and as there is no curative or prophylactic measures presently available, identification and management of abiotic factors contributing for the development and dissemination of the disease and soil management approaches to break the pathogen transmission chain is highly imperative to protect the healthy palms from getting infected. Current methods include quarantine, sanitation, conventional plant protection measures such as application of pesticides, chemicals, use of resistant varieties, use of biological methods of control and integrated nutrient management strategies (*Maheswarappa and Anithakumari, 2005*).

• Soil Breeding

Heavy textured soil favours proliferation of any soil pathogen and weakens the immune system of the palms. Hence breeding heavy textured soil with sand / tank silt @ 50 kg per palm per year to facilitate free flow of water can mitigate the intensity of the disease.

• Basin Management with Biofertilizers and Rhizobacteria

Roots can be prevented from senescence by generous application of biofertilizers like Azospirillum, Phosphobacteria, VAM and virulent Plant Growth Promoting Rhizo bacteria (PGPR) @

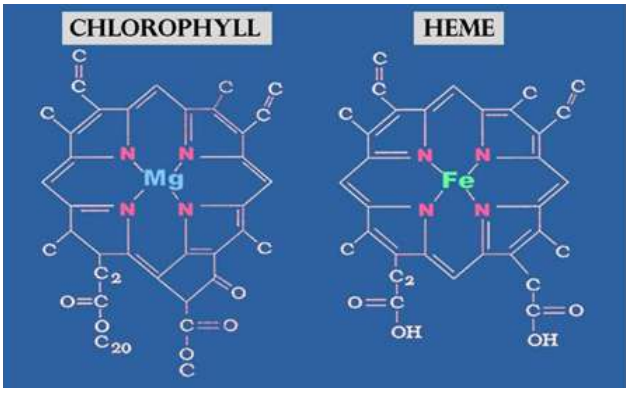
200 g per palm per year. It not only provide nutrition through natural processes like nitrogen fixation and phosphorus solubilization, but the intangible benefits accrued in terms of production of hormones, siderophores, hydrolytic enzymes helps protect the palms from diverse plant pathogens and stress conditions. Biocontrol agents like *Bacillus subtilis* and *Tricohoderma viride* @ 100 g per palm per year helps in waging war against the antagonistic organisms.

• Water Management

Root wilt disease is quite prominent in fields in which irrigation water is stagnated for a quite longer period because of obvious reasons. Controlled irrigation through drip system can be resorted to maintain moisture level at field capacity. Tap system of irrigation should be avoided to prevent leaching loss of nutrients. Trenches or sub surface channels may be excavated to drain off the excess water from the system.

• Balanced Fertilization

Soil test based balanced fertilization with special emphasis to secondary nutrients viz., calcium, magnesium and micronutrients can pay rich dividends in disease tolerance mechanism. In addition to soil test-based application of nitrogenous, phosphatic and potassic fertilizers, application of magnesium sulphate @ 1 kg per palm per year stands imperative. Magnesium is the central atom of porphyrin ring structure of chlorophyll molecule which is almost analogous to Fe in Heme protein. Magnesium is the element prone to leaching losses in soil, which should be replenished in the soil pool through application of magnesium sulphate.



Gypsum application @ 1 kg per palm basin can improve soil flocculation. Fertigation with water soluble fertilizers can aid in better nutrient uptake than conventional fertilization. Quadrupling the application of organic manures viz., FYM @ 200 kg per palm per year and neem cake @ 3 kg per palm (Poultry manure application may be avoided because of ammonia volatilization effects). Need based application of phytohormones like IAA @ 200 ppm can improve root growth. Acidic soil condition favours the spread of any pathogen. Hence application of 40 litres of Bordeaux mixture per palm basin can help in combating the proliferation of fungal pathogens in soil.

• Soil aeration

Ploughing the field twice a year aid in soil solarization. Excavation of trenches to three feet depth in between three coconut rows help to drain off the impounding water and provide aeration to the palms. Need based application of soil amendments like gypsum can help in improving soil structure.

• Phytoremediation

Planting cover crops like horsegram and cowpea in the basins helps in oxygenate the root zone and stimulate rhizospheric microbiome and alter the soil reaction towards pathogens. Sowing green manure seeds viz., sunhemp, daincha @ 100 g per palm basin and incorporation in situ activate the rhizosphere through root exudates.

• Planting tolerant varieties

Although the occurrence of root wilt is ubiquitous irrespective of the varieties, Nair et al. (2004) postulated Chowghat Green Dwarf (CGD) is having higher level of tolerance compared to other cultivars. Even in farmers' holdings hybrids evolved with CGD as one of the parent materials is found to have higher tolerance compared to other cultivars.

Root wilt is a debilitating disease encroaching coconut plantations in the state of Tamil Nadu. 'Prevention is better than cure' and hence amalgamating strict quarantine, field sanitation and appropriate management strategies can go a long way to sustain the productivity of palms.

Eco-friendly management of coconut black headed caterpillar in Konkan region of Maharashtra

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Coconut palm, (*Cocos nucifera*) cultivated extensively in tropical areas for its edible fruit, the coconut. Coconut palms are found in tropical coastal areas nearly worldwide. It is the most economically important palm species, being one of the most predominant crops of the tropics. The slender, leaning, ringed trunk of the coconut palm rises to a height of up to 30 meters from a swollen base and is surmounted by a graceful crown of grant feather like leaves. The coconut trees of all ages are attracted by many insect pests. Among them coconut black headed caterpillar is one of the most important pests which causes serious damage to coconut.

As a serious defoliator of the coconut trees in India, Srilanka, Bangladesh and Myanmar, the black headed caterpillar (CBHC), *Opisina arenosella Walker* has attracted the attention of agricultural scientists right from the beginning of the present century. The pest in its larval stage causes serious damage to the palms. The caterpillars are gregarious in habit and are voracious feeders. Living in galleries made of silk and frass on the under surface of the leaves, they feed from within by scraping out the green parenchyma of the leaflets, leaving a thin parchment like upper epidermis. When dry, they form conspicuous grey patches on the upper surface of the fronds. Generally, the lower whorls of fronds are attacked. However, in severe cases of infestation

Impact of CBHC in Maharashtra, before the application of parasitoids

Impact of parasitoids on CBHC in Maharashtra, after the release of parasitoids

Impact of CBHC in Maharashtra, Before application of parasitoids

Impact of parasitoids on CBHC in Maharashtra, after release of parasitoids

the plants are completely defoliated, leaving only the central shoot unaffected. From a distance the crowns of the severely pest infested palms appear burnt. Nut production may be halved or worse, due to a reduced production of flower spikes, increase in premature nut fall, constriction of the trunk and retardation of growth.

Generally, in Konkan region, infestations of the pest reach serious proportions in the hot months of October - April. After the onset of monsoon, there is a sharp decline in the population of the pest possibly due to the action of fungal and bacterial pathogens. Earlier attempts to control this pest were mostly cultural and biological.

Pruning of infested palms and burning the fronds were advocated. The removal of the leaves affected health and vigour of the trees. Collection and storage of infested leaflets in cages and subsequent release of emerging parasitoids in infested fields were also practiced. Chemical control of the pest is not practicable, as the application of the insecticides is difficult because of the huge height of the palm. Even if a power sprayer is used, the spray fluid does not reach the larvae easily due to the galleries that surround them. Aerial spraying is also not effective as the pest is found only on the under surface of the leaflets. Biological control continues to offer exciting possibilities for pest control on a worldwide basis.

The biocontrol of the leaf-eating caterpillar is done by releasing the parasitoids *Goniozus nephantidis* or Bracon brevicornis once in a fortnight till the menace is cleared. The release rate of the parasitoids is around 20 for Goniozus and 30 for Bracon per palm. The parasites will climb the tree, bite the caterpillars and lay eggs over it. Bio-management of coconut black headed caterpillar has been successfully done in Khalapur village in Raigad district where coconut farm was infested by BHC. Extensive feeding of caterpillars cause a crop loss of 50% in terms of nut yield in the succeeding years. Integrated Pest Management (IPM) has been recommended as the ideal, long-term and sustainable strategy for the bio-management of the pest. A demonstration-cum-technology delivery on IPM of coconut black headed caterpillar with emphasis on biological control was conducted at Khalapur village, Raigad District, Maharashtra by Dr. Santosh Wankhede, Entomologist, RCRS, Ratnagiri where an outbreak of *O. arenosella* was observed in October 2020 with

Retirement

Shri Xavier Gabriel, retired from service of Coconut Development Board on 29th February 2024. He served the Board for 35 years.

Shri K. S. James, retired from service of Coconut Development Board on 31st March 2024. He served the Board for 37 years.

Black headed caterpillar infestation after release of parasitoids

leaf damage to the extent of 80% infesting in about two acre area of coconut garden. The technology options successfully showcased in the affected garden through farmer participatory approaches were removal and burning of heavily infested 2-3 outer fronds, release of stage specific parasitoids (*Goniozus nephantidis* and *Bracon brevicornis*) after three emergence of healthy new leaves in the pest-infested plantation after intervention is so convincing that most of the nearby farmers emulated the technology at the shortest period. Sustainability of the technology was visible by recovery of palms in the adjacent coconut plantations also. Pest infestation showed visible decline in a period of twelve months from an initial leaf damage of 80% during October 2020 to 25% during October 2021. Subsequently, complete recovery of palms was achieved in a period of 15 months by January 2022 and no further pest incidence was noticed in subsequent monitoring done during April 2022 indicating sustainability of the eco-friendly technology. The participating farmers took forward the technology as positive beneficiaries to nearby locations making the entire zone pest free with successful establishment of parasitoids.

A coconut grower from Ramsai village Tal. Khalapur Dist. Raigad named Shri. Ramchandra Dhondiram Jadhav is having 150 coconut palms in 0.60 ha area as border crop. The coconut palms were affected by black headed caterpillar and the same was reported by Agricultural Supervisor, Takuka Agricultural Office, Khalapur. The nut yield reduction due to the pest was also noticed. The scientists from Regional Coconut Research Station, Bhatye visited the place and recorded an yield of around 50 nuts/palm though the garden is under irrigated condition. Then after visiting the farmer, it was recommended to release the parasitoids as he was doing organic farming. For management of CBHC, 3000 Goniozus for first release and after one month 2500 Bracon was provided as second release against the black headed caterpillar. Again, 1000 Goniozus and 2000 Bracon was provided after six months. After one year from the date of first release, palms were completely recovered from the attacked of black headed caterpillar and increased the nuts yield over 80nuts/palm.

One day training programme at CIT

Kerala State Department of Agriculture Development and Farmers Welfare imparted training to selected farmers from 10 Krishi Bhavans of Thrissur, Chowvannoor Block under the ATMA 2023-24 scheme at CDB Institute of Technology, Aluva on 16th April 2024. Training was given for preparation of six types of coconut products such as coconut pickle, chocolate, coconut powder, cookies and other value added products. Smt. Aneeta, Food Technologist and Mr. Sonu, Trainer, CDB gave training to 25 participants. Smt. Resmi D. S, Deputy Director, Coconut Development Board briefed about the programmes and schemes of Coconut Development Board.

Good Management Practices for Pest and Disease Suppression in Coconut

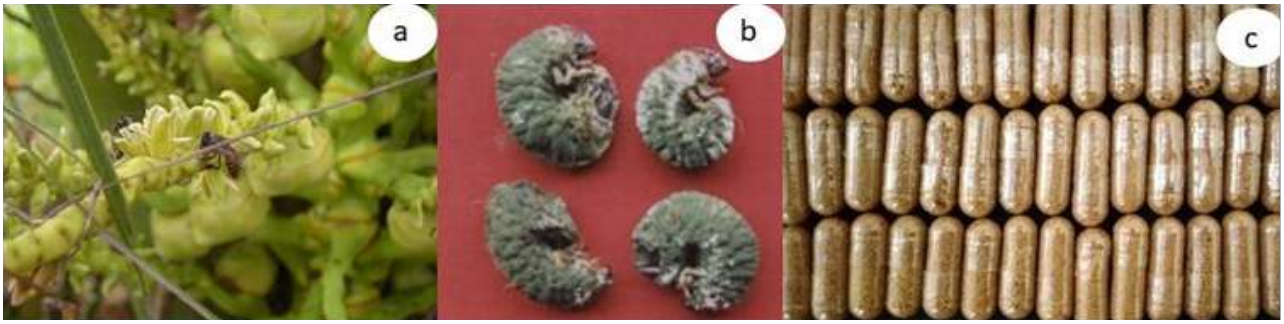
Josephrajkumar A., Anes K.M., Merin Babu, Jilu V. Sajan, Prathibha P.S*., Indhuja S., Shareefa M., Regi J. Thomas, Vinayaka Hegde* and Anithakumari P.

ICAR-CPCRI, Regional Station, Kayamkulam *ICAR-CPCRI, Kasaragod

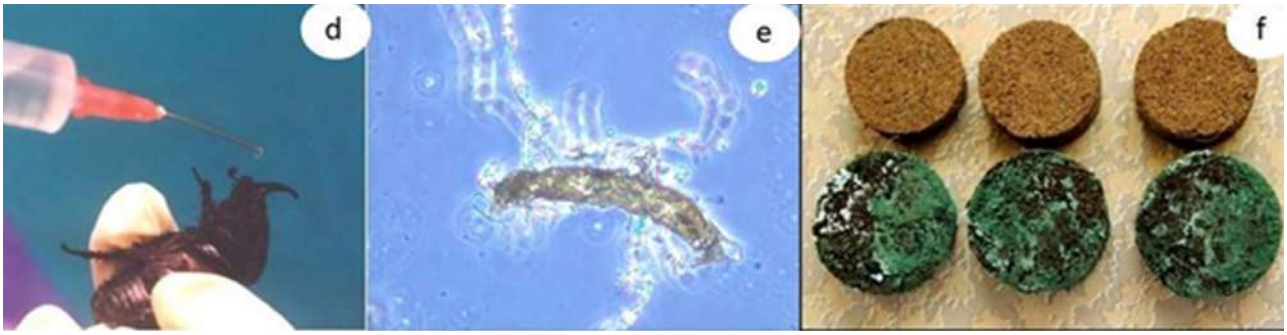
The coconut palm (*Cocos nucifera* Linn.) is one of the most important of all cultivated palms in the world.The palm provides food, fibre, timber, beverage and shelter to millions of people all over the world. Coconut palm is eulogized as 'Kalpavriksha' or "Tree of Life" or "Wish-Fulfilling Tree" since each and every part of the palm is useful to mankind in one way or other. In addition, coconut is an excellent ecological service provider that protects biodiversity and keeps coastline intact as a soil-binder. Palms are crucial and integral part of Island ecosystem. It also provides livelihood security to more than 12 million farm families worldwide and forms a central crux in tourism and trade as well. However, it is depredated by a wide array of pests and pathogens bringing crop loss to as high as 25% to 30%. Irish famine is the resultant of popularization of one potato variety that succumbed to the late leaf blight disease caused by *Phytophthora infestans*. Hence, the modern trend of confining to few crops and varieties leading to genetic erosion is the greatest threat to ecosystem and agriculture per se. Variability through diversity is the key for ecological restoration and coconut is the classic example auguring diversity with immense variability between palms. Homogeneity is always challenged in coconut and heterogeneity always leads to greater adaptability as well. Careful diagnosis and environmentally responsible farming by nature-conserving approaches are imperative for timely management of pests and diseases. Furthermore, climate change has made sporadic insect and disease outbreak calling for climate-smart farming to halt such unprecedented eruptions. Over reliance of chemical pesticides and their ill-effects on environment and mankind are well-known. For tackling such indiscriminate use of chemical pesticides and to mitigate climate-induced gradient outbreaks, good management practices for pests and diseases in coconut are very crucial for ecological well-being and environmental vitality leading to a one-health mission

Field sanitation and crop hygiene

The wisdom behind 'prevention is better than cure' suggests one ought to be more proactive than reactive. Therefore, integrated pest and disease management should strategize from prevention. Sanitation is one of the most effective pest and disease management strategies. Many weeds are known to be potential reservoirs of plant pathogens and insect pests. By controlling weed populations in the fields, one can reduce disease inoculum and vector populations. Crown cleaning at periodic intervals to remove pest debris is the need of the hour. Collection and destruction of disease debris especially those from leaf rot or bud rot, far away from the field is very important to reduce the disease inoculum and arrest the spread. Similarly dead and decaying palm debris should be dispensed properly to avoid as breeding sites for coconut rhinoceros beetles and rodents. In addition, the toppled palms



a) Pollinators on coconut inflorescence b) Rhinoceros grubs by matarhizium majus c) EPN Capsules



d) Per os feeding of OrNV e) Hirsutella infected Mite f) Trichoderma cake

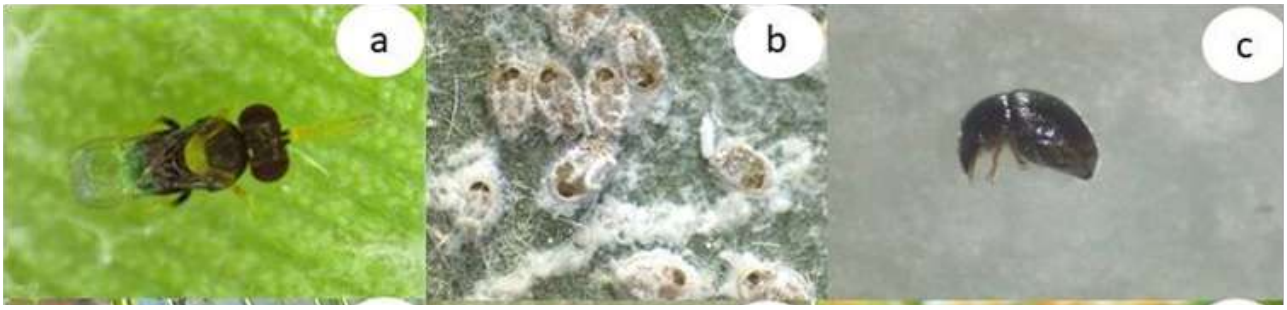
due to the attack by red palm weevil should be destroyed immediately so as to avoid dissemination of weevils to healthy plantations.

Conserve pollinators

The blooming coconut inflorescence attracts many foraging insects and pollinators and serve as an ecological niche for their sustenance. Palms not only provide pollen in abundance but also deliver nectar for the sustenance of bees. The pollinator community recorded from dwarf varieties of coconut alone comprised of 30 insects belonging to six orders and 17 families. Major floral visitors viz., bees, flies, ants, wasps, weevils etc that forage in coconut, deliver countless ecosystem services and aid in pollination and enhance nut set. Bees dominate tall genotypes whereas ants are found predominant on dwarf suggesting effective partitioning for sharing and sparing approach. Results indicate about 5%-7% increase in nut yield in Kalpa Sankara hybrid maintained with five Indian bee colonies in 50 cents. Even though, honey yield is low in coconut plantation, the division of bee colonies is successful, adding additional income to farmers. These foragers need to be conserved in coconut system for which ecological intensification process through crop cafeteria and eco-feast crops like coral vine offer better solution. Though foragers are abundantly present on coconut in Kerala, their remarkable absence in the adjoining states like Tamil Nadu and Karnataka is definitely a matter of concern. Rampant use of banned insecticides in these states upset the foragers and defenders in coconut system and cause ecological setbacks on the floral and faunal assemblages causing irreparable damage to the ecosystem. The pesticide residues will impact human system and cause damage to physiological processes as well because the tender nut water is a common health drink even recommended by physicians during illness. During yesteryears, it was used as an intravenous fluid for war victims and also as a health drink for patients under quarantine with communicable diseases.

Resistant/tolerant varieties

ICAR-CPCRI has released many varieties resistant/tolerant to pests and diseases. Kalpasree (Selection from Chowghat Green Dwarf (CGD)), and Kalparaksha (Selection from Malayan Green Dwarf) were released as resistant to root (wilt) diseases and the tolerant hybrid, Kalpa Sankara (CGD x West Coast Tall). During 2022, Kalpa Vajra (Disease free West Coast TallxWest Coast Tall) was identified for release in root (wilt) disease zone. Field tolerance to coconut eriophyid mite was observed in Kalpa Haritha, a tall selection from Kulasekharam Green Dwarf collected from Kulasekharam, Tamil Nadu. In general, varieties with round nuts viz., Chowghat Orange Dwarf and Malayan Yellow Dwarf are relatively tolerant to coconut



Biocontrols agents a) *Encarsia guadeloupae* b) Exit hole of emerged Parasitoid From RSW pupae c) *Cybocephalus sp.*

Biocontrols agents d) *Leiochrinus nilgirianus* e) *Aphytis sp.* f) *Chilocorus nigritus*

eriophyid mite and coreid bug infestation under field condition. Tall varieties are relatively tolerant to red palm weevil attack than dwarf varieties.

Biological Control, a viable option

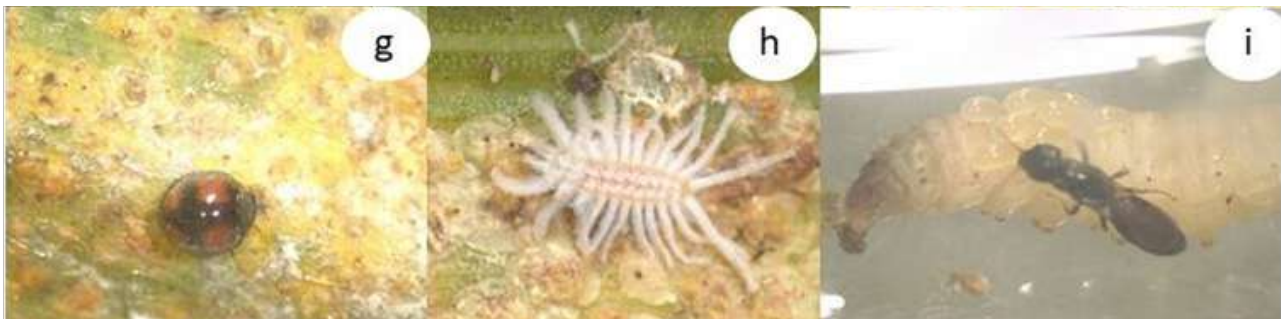
Using living organism for the suppression of another living organism reflects on biological control. Use of birds like Indian Mynah (*Acridotheres tristis*) and weaver ants (*Oecophyllasmaragdina*) in biological control dates as old as history. Coconut palm is so unique that most of the pests are very effectively suppressed by bioagents in the most successful manner. Being a perennial and tall system by itself, biocontrol is a viable option during most pest outbreaks and proved successful. Those pests that ruled sometimes back like black headed caterpillar and scale insects has become a pest of minor significance through biocontrol agents.

Entomopathogens

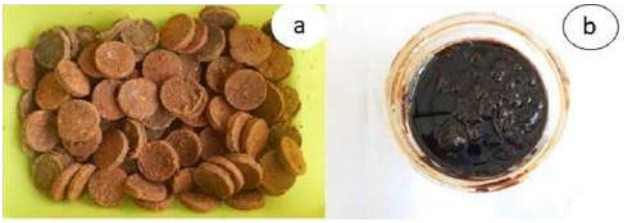
Entomopathogenic fungus invade insects directly by cuticle entry and cause death by producing toxins in to the infected insects and get them mummified. The coconut rhinoceros beetle, *Oryctes rhinoceros* Linn. a ubiquitous pest is effectively managed by the green muscardine fungus, *Metarhizium majus* and its delivery area-wide at the breeding sites is a viable option that reduced pest incidence by 85% and increased nut yield by 13%. Area-wide community extension approach system has successfully proved its effectiveness in Kerala. The release of *Oryctes rhinoceros* nudivirus infected beetles @ 12 /ha could subdue the pest incidence in Bay (Andaman &Nicobar) and Lakshadweep Island systems and forms an autocidal mode of pest suppression with remarkable persistence. Though its success rate is limited in the mainland, its sustenance in Island system is well demonstrated and validated. Emergence of OrNV-resistant Guam haplotype in South-East Asia cause concern and so far such a strain is not documented in our country through molecular studies.

Application of talc-based formulation of *Hirsutellathompsoniion* tender buttons after pollination, three times a year reduced the aggressiveness by the exotic coconut eriophyid mite, *Aceriaguerreronis* Keifer. H. *thompsonii is* not very successful in hot belts of the country including Andhra Pradesh. The compatibility and synergy of H. *thompsonii* with botanical formulations like neem oil, neem azal, *nimbecideneetc* foster field level intervention with ease.

Entomopathogenic nematodes (EPN) kill insect pests through entry of the potent bacterial symbiont they possess in the gut causing septicaemia. EPN are very successful in the management of soil and cryptic pests. Soil application of the entomopathogenic nematode, *Steinernemacarpocapsae* @ 1.5 billion



g) *Pharoscymnus Horni* h) *Sasijiscymnus sp.* i) Goniozus on black headed caterpillar



a) Botanical Cake b) Botanical paste

infective juveniles (IJ)/ha subdued the white grub (*Leucopholisconeophora*) incidence and improved the nut yield of palms. The preliminary use of the *Steinernema sp*. (CPCRISO804) in the bio-suppression of red palm weevil as a prophylactic leaf axil filling using EPN bio-capsules is very encouraging. ICAR-CPCRI is in possession of EPN with higher shelf-life that can sustain more than seven months under ambient condition without any loss in virulence.

Mycopathogens

Use of *Trichoderma harzianum* for the bio-suppression of basal stem rot and stem bleeding diseases and *T. harzianum* based coir pithcakes for the management of bud rot disease is well proven. Any loss of these bioagents, parasitoids, predators and other defenders will have severe repercussions in the perennial system like coconut for which indiscriminate use of chemicals should be dispensed off. All pest management options should centre around the conservation of these bioagents so as to have a biotic balance in the system for pest suppression and inducing nature-protective farming.

Entomophaga

A wide array of parasitoids, predatory insects and other diverse fauna including mites and spiders are recorded in coconut system to tackle key pests. Augmentative release of stage-specific parasitoids, *Goniozusnephantidis* and *Braconbrevicornis* as per norms in the black headed caterpillar infested coconut garden effectively suppressed the incidence of black headed caterpillar and currently the pest has become less significant in most endemic areas. Conservation biological control using the aphelinid parasitoid, *Encarsia guadeloupae*, chrysopid predator *Apertochrysasp.* lady beetles, Cybocephalids and the sooty mould scavenger beetle, *Leiochrinusnilgirianus* could suppress the invasive potential of the exotic rugose spiralling whiteflies in India. Furthermore, conservation biological control using the lady beetles *(Pharoscymnushorni, Chilocorusnigritus, Sasajiscymnussp.)* and the parasitoid, *Aphytissp.* always kept the coconut scale (Aspidiotus destructor) population as minimum as possible. One way or the other these biocontrol agents play a pivotal role in the management of coconut pests. Biological control which commenced as classical by introduction of natural enemies from centre of pest origin, turned into augmentative by mass production and release during pest outbreak has now transformed into conservation biological control in bio-suppression of key pests on coconut.

Botanicals and semiochemicals:- safe and powerful defenders

Application of neem cake admixed with sand as a prophylactic management of rhinoceros beetle is still effective, eco-friendly and widely used. Use of botanical cake and paste containing methanolic and hexane extracts of *Clerodendrum infortunatum* and *Ageratum conyzoides* developed by ICAR-CPCRI is another option for pest repellence / avoidance. Nylon nets tied at the base of the spear leaf would entangle beetles and reduce pest incidence. Aggregation pheromone lures of rhinoceros beetle and red palm weevil and their delivery through nanoporous matrix offer effective and prolonged trapping tools for catching the floating population under right placement of traps. Precaution on community adoption area-wide is mostly preferred.

Crop-habitat diversification

Diversified cropping system with crop cafeteria in coconut plantation (Kalpa sankara hybrid) produce mixed odour cues for pest avoidance (push-pull strategy) and stimulo-deterence which has proved as a successful replicable model in root (wilt) disease endemic tract producing more than 160 nuts per palm per year. Presence of bird perches, fish rearing, eco-feast crops, honey bee colony etc add ecosystem benefit and ecological values towards sustainable development goals. The system turns climate-smart to cope up with weather extremes and this diversified system encounters less than 37°C as soil temperature and minimizes erosion during heavy downpour as well. There is a 2-3-fold reduction of key pests of coconut viz., coconut rhinoceros beetle, red palm weevil and the exotic whiteflies under such heterogenous landscaping resulting in inclusive, climate-smart farming and doubling income as well.

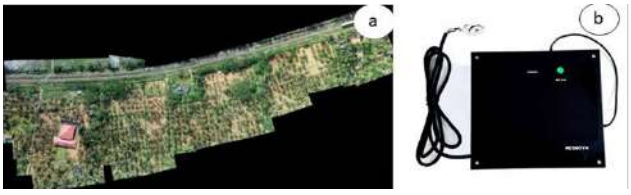
Biomass recycling and soil health management

Nutrient stimulus based on soil-test analysis in managing integrated nutrient regimes would

ensure the availability of critical nutrients such as potassium, calcium, magnesium, boron, silica etc., that are known to confer pest and disease resistance/tolerance. Enriching organic amendments through crop residue mulching and recycling would support diverse soil life forms including beneficial soil microbes. Many heterotrophic bacteria (*Pseudomonassp.*, *Alicaligenes* sp., *Bacillus* sp. etc.) and fungi encountered in coconut plantation soils increases the availability of phosphate, potassium, zinc and silicate from insoluble sources thereby contributing to palm health. Plant growth promoting microorganisms influence palm health by producing antagonistic metabolites, by induced systemic resistance and/or by competing with the pathogen for nutrients and colonization space. Many *Pseudomonas sp*. and plant growth promoting microbes from coconut rhizosphere inhibited soil borne pathogens of coconut such as *Ganoderma* sp. and *Theilaviopsis paradoxa*.

Digital agriculture

Use of digital tools with the support of artificial intelligence and Internet of Things have become so popular and its application in farming has become a reality. Pest surveillance through digital technology using unmanned aerial vehicle could pin point the affected palms in a locality for which targeted application of bioagents would be the good management solution. An acoustic sensor-based detector for timely diagnosis of red palm weevil infestation in coconut palms was developed through public-private partnership mode.



a) Aerial Image of coconut garden
b) Red palm Weevil Detector

Diagnosis is the key

ICAR-CPCRI has evolved successful diagnostic tools using polymerase chain reaction for phytoplasma-associated lethal wilt disease. Such early diagnosis are very important for mother palm selection and production of health and disease-free planting materials. Morphological and molecular identification of exotic whiteflies and their defenders are very important for the sustainable pest management

Farmer-participatory approach:- a viable and successful option

Community mode and farmer participatory area-wise delivery of technologies ensured better adoption among farmers and suppression of pest and diseases in the coconut sector. Area-wise farmer participatory deliverance of *Metarhizium majus* for the bio-suppression of coconut rhinoceros beetle, augmentative release of stage specific parasitoids against black headed caterpillar, integrated pest and disease management of red palm weevil and root (wilt) diseases are success stories that have infused tremendous confidence in technology adoption and sustainable management of pests and diseases in coconut.

With the availability of good eco-friendly options as pest and disease management tools, it is high time such options are being practiced and popularized in the coconut sector to avoid ill-effects of excessive use of chemical pesticides.

Epilogue

Excessive use and misuse of pesticides result in contamination of surrounding soil and water sources, causing loss of biodiversity, destroying beneficial insect populations that act as natural enemies of pests and reduce the nutritional value of food. Unfocussed intervention with hazardous compounds would upset biodiversity particularly the pollinators, defenders and scavengers in the coconut system which otherwise would suppress the pest population in a sustainable manner without harming the environment. So, nature protective farming augmenting the beneficials in the coconut system would have a long way to go. A perennial system should have long lasting solution for which bioagents and defenders are very crucial in pest management programme. Being a dominant fauna, insect population can be tackled by their own natural enemies and providing niches for their survival to timely intervene is the need of the hour. Pesticide holiday approach is widely advised for the bio-suppression of key pests infesting coconut and indiscriminate use of chemical pesticides should be dispensed off to build up the population of pollinators, defenders and scavengers so as to counter pest invasion and to safeguard from pestilence. Diversification of farming system and agriculture-based livelihood is very important to address this matter.

Coconut Yoghurt Smoothie

Smoothie can be defined as non-alcoholic liquid refreshment which can be prepared from both fresh or frozen fruits and vegetables. It is blended and consumed without straining and normally served over crushed ice. Smoothies are ideally suited for markets where consumers prefer the high quality products that are convenient, clean and minimally processed, with fresh flavor and has good taste and aesthetic appeal.

Yoghurt is an ideal ingredient for smoothies because it adds a good amount of protein, which makes it a filling breakfast or snack. It also adds live probiotics, which can aid in gut health. Regular diet containing probiotics is known to impart health benefits such as improved immune responses, maintain the intestinal integrity and reduces intestinal infection.

The Coconut Yoghurt Smoothie is a consistent soft drink prepared with fresh coconut milk, coconut yogurt and fruits blended in a homogenized form. The major ingredient in Coconut Yoghurt smoothie is 'Coconut milk yogurt' which is a healthy alterative that is made with coconut milk. In addition to being dairy free, coconut milk yoghurt also supplies several key vitamins and minerals and can have live and active cultures just like milk-based yoghurts.Coconut Yoghurt is one of the best probiotic rich foods to help support gut health and to build the immune system, and it makes a great addition to a healthy diet.

Ingredients	Quantity
Coconut milk	500 ml
Coconut Milk Yoghurt	250 g
Banana	66 g
Dates	24 g
Cashew	10 g
Sugar	40 g

Method of preparation

• Pour Coconut milk into a blender jar. Add other ingredients like Coconut milk yoghurt, banana, dates, cashew and sugar are added into coconut milk.

• Blend the mixture until it is smooth and slushy texture. The mix is then poured into chilled serving glasses.

• For improving the shelf life, the blended mixture could be packed in airtight glass containers/retort pouches by adding stabilizers like Xanthan gum(0.1%) and sterilized in an autoclave or retort at 121° C for 15 minutes. An autoclave is equipment that uses steam under pressure to kill harmful bacteria, viruses, fungi and spores on items that are placed inside a pressure vessel.

• The bottles/packages are then cooled and the product can be stored for 3 months under ambient condition.

Nutritional Value of Coconut Yoghurt Smoothie	
Parameter	**Value (per 100 g)**
Total Solids	34.79 g
Total fat	10.19 g
Total ash(Mineral content)	0.71g
Total sugar	22.31 g
Protein	1.37g
Crude Fibre	0.25g

(Coconut Yoghurt Smoothie is developed by CDB Institute of Technology)

Cultivation practices for coconut -May

Summer ploughing

Ploughing of interspace of coconut gardens can be taken up depending up on the receipt of summer showers.

Sowing of green manure seeds

• Wherever sufficient pre monsoon showers are received sowing of green manure seeds can be taken up towards the fag end of May. Sowing of green manure crops like Sunhemp (*Crotalaria juncea*) or Daincha (*Sesbania aculeate*) or Cow pea (*Vigna unguiculata*) or Wild Indigo (*Tephrosia purpurea*) can be done. In the interspace of coconut gardens under monocropping the following seed rate of green manure seeds is recommended.

Sunhemp – 20 kg/ha

Daincha – 30 kg/ha

Cow pea -25 kg/ha

Wild Indigo – 15 kg/ha

If intercrops are grown, seeds of green manure crops can be sown in the coconut basin of 1.8 m radius. For Cow pea and Daincha seed rate per basin is 100g while for other green manure crops 75 g seeds can be sown per basin.

Nursery management

Continue irrigation for the seedlings in the nursery until rains set in to provide sufficient moisture. Similarly, if rainfall is not received spray water on the lower surface of leaves of seedlings against spiralling white fly attack. Weeding has to be done wherever necessary. Land preparation is to be done for raising nursery beds.

Making pits for planting

Wherever new planting or gap filling of coconut seedlings are proposed dig pits of size 1m x 1m x 1m for planting. In laterite soils common salt can be applied to the pit @ 2 kg per pit for facilitating proper weathering of the soil. In such areas the pit size can be 1.2 m x 1.2 m x 1.2 m. Two layer of coconut husks can be spread at the bottom of the pit with concave surface up before filling the pit with soil up to 50 -60 cm for moisture conservation.

Generally the recommended spacing is 7.5 m x 7.5 m. However, wherever inter/mixed cropping is to be taken up coconut seedlings are to be planted at a wider spacing of 8-10 m.

Application of fertilizers

If pre monsoon showers combined with early onset of south west monsoon is experienced one third of the recommended dose of chemical fertilizers can be applied to the coconut palms under rainfed situation in the last week of May. Application of 500 g N, 320 g P_2O_5 and 1200 g K_2O

per palm per year is generally recommended for adult plantations. To supply one-third of the above nutrients it is necessary to apply about 0.36 kg urea, 0.5 kg rock phosphate (in acidic soil) or 0.7 kg Super Phosphate (in other soils) and 0.7 kg of Muriate of potash (MOP). After the receipt of summer showers, one-third of the recommended dose of fertilizers may be spread around the palms within the radius of 1.8 m and forked in. It is always advisable to test soil in the coconut garden periodically (once in 3 years) based on the results of which, type and dosage of chemical fertilizers can be decided.

Application of soil amendments

In soils with acidic nature (pH < 7), in addition to the recommended level of fertilizers, 1 kg of dolomite or 1 kg of lime may be applied per palm per year and gypsum can be applied in alkaline soils (pH >8.5) @ 1 kg per palm. Lime/dolomite/gypsum may be broadcasted during April - May in the coconut basins of 1.8 m radius and incorporated into the soil by forking. These soil amendments should be applied at least 15 days before the application of chemical fertilizers.

Irrigation

Irrigation has to be continued in coconut gardens until sufficient pre monsoon showers are received.

Pest and disease management

The month of May initiates with dry phase and during the latter phase the South-West monsoon could set in South India. Dryness of summer is so acute during 2019 and therefore sporadic outbreaks of invasive whiteflies and coconut eriophyid mites could be observed in several regions. Coconut palm not only needs water for its survival but also fills in nut water for quenching thirst for millions of mankind. Any moisture deficit situation could drastically affect the health status of palms as well and could aggravate problems due to pest invasion. The transition to wet period is very crucial for prophylactic treatment of crown cleaning, leaf axil filling with neem cake plus sand as well as application of 1% Bordeaux mixture. If timely prophylactic measures are attended, upsurge of monsoon pests and diseases could be effectively tackled. This period thus marks the beginning of all prophylactic treatments and the age-old practices still turn appropriate and relevant in the changing climate condition. Summer period could dominate with invasive whiteflies and this could significantly be suppressed in the monsoon time. The key pests and diseases of monsoon period would be discussed hereunder.

Leaf and inflorescence damage

Rhinoceros beetle (*Oryctes rhinoceros*)

Being a ubiquitous pest, the incidence of rhinoceros beetle is quite common during all period. However its damage is well felt during the planting season of coconut. Furthermore, coconut seedlings planted during May-June should be customarily shielded from pest incursion during this period. More than 0.5% natural incidence of Oryctes rhinoceros nudivirus (OrNV) was recorded in Peninsular India and therefore the OrNV-insensitive Coconut Rhinoceros Beetle-Guam (CRB-G) strain is not prevalent in our country, as this strain is taking a great toll in South-East Asian region causing great concern among International community making extensive damage. The pest invading juvenile palms and nuts is of greater concern these days. Moreover, the attack by rhinoceros beetle would invariable incite egg laying by red palm weevil as well as entry of bud rot pathogen

▶ *Management*

- Prophylactic treatment of top most three leaf axils with either botanical cake [Neem cake/marotti cake/pongamia cake (250 g)] admixed with equal volume of sand or placement of 12 g naphthalene balls covered with sand.

Shielding by fish net

- Routine palm scrutiny during morning hours along with brushing of teeth and hooking out the beetle from the infested site reduces the floating pest population. This strategy could reduce the pest population significantly.
- Shielding the spear leaf area of juvenile palms with fish net could effectively entangle alighting rhinoceros beetles and placement of perforated sachets containing 3 g chlorantraniliprole /fipronil on top most three leaf axils evade pest incursion.
- Dairy farmers could treat the manure pits with green muscardine fungus, *Metarhizium anisopliae* @ 5 x 1011 /m3 to induce epizootics on the developing grubs of rhinoceros beetle. Area-wide farmer-participatory approach in technology adoption could reduce the pest incidence very effectively and forms an eco-friendly approach in pest suppression.

Metarhizium infected grub

- Incorporation of the weed plant, Clerodendron infortunatum in to the breeding pits caused hormonal irregularities resulting in morphogenetic transformational aberration in the immature stages of the pest.
- Crop diversity induced by intercropping and ecological engineering principles would disorient pests and provide continuous income and employment as well.

Red palm weevil (*Rhynchophorus ferrugineus*)

Reduction in the incidences of rhinoceros beetle, would subsequently suppress the invasive potential of the killer pest, viz., the red palm weevil, which needs an injury for the weevils to orient towards the palm cue and lay eggs. Dwarf genotypes and palms aged between 5-15 years are relatively more susceptible. All life stages of the pest were noticed inside the infested palms. Being a fatal enemy of palms, 1% action threshold has been fixed. Correct geometry is very crucial for accommodating intercrops as well as pest avoidance due to multiple odour cues.

Adult weevils

▶ *Management*

- Field sanitation is very critical and all residual population in crown toppled palms should be destroyed
- Avoiding palm injury is very critical to disorient the gravid weevils away from the field and therefore leave out at least one metre from palm trunk when petioles are cut.
- Crop geometry and correct spacing is very crucial to reduce pest attack.
- Timely and targeted spot application of imidacloprid 0.002% (1 ml per litre of water) or indoxocarb 0.04% (2.5 ml per litre of water) on infested palms would kill the feeding grubs and induces recovery of palms by putting forth new spear leaf.

Toppling of palm

Crown entry

- Crop-habitat diversification (Ecological Bio-engineering) through coconut based cropping system strategy inciting defenders and pollinators would diffuse the palm-linked volatile cues and encouraged pest suppression. Diversified cropping system reduces pest incidence than mono-cropping.

Leaf rot disease (*Colletotrichum gloeosporioides, Exserohilum rostratum*)

It is commonly observed on palms affected by root (wilt) disease wherein foliar necrosis of terminal spear leaf and adjacent leaves are registered. The disease is prominently noticed in the post-monsoon phase during the month of December. Affected leaves turn necrotic and are not detachable from the palm and remain intact. This disease could be initially observed as minute lesions which later enlarge, coalesce and cause extensive rotting affecting the photosynthetic efficiency of palms. The disease is endemic to root (wilt) affected regions of Southern Kerala.

Leaf rot disease in juvenile palm

▶ Management

- Need based pruning and destruction of disease affected regions of spear leaf and other adjacent leaves in the terminal region
- Spot application of hexaconazole 5 EC 2 ml in 300 ml water on the affected spear leaf region

Bud rot or immature nut fall (*Phytophthora palmivora*)

In certain humid locations bud rot occurred regularly killing hundreds of trees. In India, bud rot incidence is recorded as less than one per cent. Pathogen attacks the bud region leading to rotting of bud and death of palms. The first visible symptom is withering of the spindle marked by pale colour. The spear leaf or spindle turns brown and bends down. The affected spear leaf can easily be pulled out as the basal portion of the spindle is completely rotten emitting a foul smell. Temperature range of 20-24°C and relative humidity of 98% - 100% were found optimum for the development of the bud rot disease. Contiguous occurrence of such "favourable days" during rainy seasons determines the development of the disease and the intensity of infection. As Phytophthora diseases are known to be extremely fatal, a close scrutiny is mandatory during monsoon period to assess the health of the palm especially the spear leaf zone.

Withering of spear leaf

Bud rot affected palm

▶ Management

- Regular cleaning of the crown and prophylactic spraying of Bordeaux mixture (1%) to the crown just before the onset of monsoon and one more spray after 35-40 days help in reducing the bud rot incidence.
- Placement of two Trichoderma (*Trichoderma harzianum* CPTD28 isolate) enriched coir pith cakes in the inner most leaf axils just before the onset of monsoon and again after every two months.
- Remove the entire rotten portion of the spindle by cutting with a sharp knife and apply 10% Bordeaux paste to the wound and cover with polythene sheet to prevent entry of rain water. The protective covering has to be retained till normal shoot emerges.

Timely prophylactic application would equip palms to withstand the pressure of pest and diseases during monsoon period. As the adage says 'Prevention is better than cure" so should be our approach to avoid invasion by pest and diseases rather than seeking strategies for curing. ■

(Prepared by: Thamban, C. and Subramanian, P., ICAR-CPCRI Kasaragod and Joseph Rajkumar ICAR-CPCRI Regional Station, Kayamkulam)

Market Review – March 2024

Domestic Price

Coconut Oil

During the month of March 2024, the price of coconut oil opened at Rs. 14200 per quintal at Kochi market, Rs.14400 per quintal at Alappuzha market and Rs.16200 per quintal at Kozhikode market.

The price of coconut oil closed at Rs.14900 per quintal at Kochi, Rs.15100 per quintal at Alappuzha market and Rs.16200 per quintal at Kozhikode market with a net gain of Rs. 700 per quintal at Kochi and Alappuzha market respectively. During the month, the price of coconut oil in Kerala, showed an upward trend.

At Kozhikode market in Kerala, the price of coconut oil opened at Rs. 16200 per quintal and closed at the same price during the month.

During the month, the price of coconut oil at Kangayam market opened at Rs. 10933 per quintal and closed at Rs. 11867 per quintal with a net gain of Rs. 934 per quintal.

Weekly price of coconut oil at major markets Rs/Quintal)				
	Kochi	Alappuzha	Kozhikode	Kangayam
01.03.2024	14200	14400	16200	10933
09.03.2024	14100	14200	16200	11000
16.03.2024	14600	14600	16200	11600
23.03.2024	14800	15000	16200	11667
30.03.2024	14900	15100	16200	11867

Milling copra

During the month, the price of milling copra opened at Rs.9400 per quintal at Kochi, Rs. 9450 per quintal at Alappuzha and Rs.9700 per quintal at Kozhikode market.

The prices of milling copra closed at Rs. 9800 per quintal at Kochi market, Rs. 9700 per quintal at Alappuzha market and Rs. 9900 per quintal at Kozhikode market with a net gain of Rs.400 per quintal at Kochi, Rs. 250 per quintal at Alappuzha market and Rs. 200 per quintal at Kozhikode market respectively.

The price of milling copra at Kangayam market opened at Rs.8400 per quintal and closed at Rs.8700 with a net gain of Rs.300 per quintal.

During the month, the price of milling copra showed an upward trend.

Weekly price of Milling Copra at major markets (Rs/Quintal)				
	Kochi	Alappuzha	Kozhikode	Kangayam
01.03.2024	9400	9450	9700	8400
09.03.2024	9300	9350	9600	8400
16.03.2024	9600	9550	9700	8550
23.03.2024	9700	9650	9900	8600
30.03.2024	9800	9700	9900	8700

Edible copra

During the month the price of Rajpur copra at Kozhikode market opened at Rs. 9800 per quintal expressed an upward trend during the month and closed at Rs. 10400 per quintal with a net gain of Rs. 600 per quintal.

Weekly price of edible copra at Kozhikode market (Rs/Quintal)	
01.03.2024	9800
09.03.2024	10200
16.03.2024	10300
23.03.2024	10300
30.03.2024	10400

Ball copra

The price of ball copra at Tiptur market opened at Rs. 8600 per quintal and closed at Rs.8000 per quintal with a net loss of Rs.600 per quintal.

Weekly price of Ball copra at major markets in Karnataka (Rs/Quintal) (Sorce: Krishimarata vahini)	
01.03.2024	8600
09.03.2024	9100
16.03.2024	8700
23.03.2024	8802
30.03.2024	8000

Dry coconut

At Kozhikode market, the price of dry coconut opened at Rs. 11000 per quintal and closed at the same price during the month.

Weekly price of Dry Coconut at Kozhikode market (Rs/Quintal)	
01.03.2024	11000
09.03.2024	11000
16.03.2024	11000
23.03.2024	11000
30.03.2024	11000

Coconut

At Nedumangad market in Kerala, the price of coconut opened at Rs. 13000 per thousand nuts, expressed an upward trend during the month and closed at Rs. 16000 per thousand nuts with a net gain of Rs. 3000 per thousand nuts.

At Pollachi market in Tamil Nadu, the price of coconut opened Rs. 28500 per ton and closed at the same price during the month.

At Bangalore market in Karnataka, the price of coconut opened at Rs. 20000 per thousand nuts and the price was almost steady during the month.

At Mangalore market in Karnataka, the price of coconut opened Rs. 30000 per ton and closed at Rs. 33000 per ton with a net gain of Rs.3000 during the month.

Weekly price of coconut at major markets				
	Nedumangad (Rs./1000 coconuts)#	Pollachi (Rs./ MT) ##	Bangalore Grade-1 coconut, (Rs./ 1000 coconuts) ##	Mangalore Black coconut (1 tonne) ##
01.03.2024	13000	28500	20000	30000
09.03.2024	13000	29000	20000	32000
16.03.2024	13000	28500	20000	32000
23.03.2024	13000	28500	20000	32000
30.03.2024	16000	28500	20000	33000

International price

Coconut

The price of coconut quoted at different domestic markets in Philippines, Indonesia, Sri Lanka and India are given below.

Weekly price of dehusked coconut with water				
Date	Domestic Price (US$/MT)			
	Philippines	Indonesia	Sri Lanka	India*
02.03.2024	142	204	239	342
09.03.2024	143	205	234	348
16.03.2024	146	205	225	342
23.03.2024	144	203	228	342
30.03.2024	NR	196	234	342
				*Pollachi market

Coconut Oil

International price and domestic price of coconut oil at different international/ domestic markets are given below.

Weekly price of coconut oil in major coconut oil producing countries					
	International Price(US$/MT)	Domestic Price(US$/MT)			
	Philippines/ Indonesia (CIF Europe)	Philippines	Indonesia	Sri Lanka	India*
02.03.2024	1196	1178	NR	1909	1311
09.03.2024	1230	1199	NR	1900	1319
16.03.2024	1272	1210	NR	1966	1391
23.03.2024	1321	1241	NR	1993	1399
30.03.2024	NR	1243	NR	2047	1423
					*Kangayam

Copra

The price of copra quoted at different domestic markets in Philippines, Sri Lanka, Indonesia, and India are given below

Weekly International price of copra in major copra producing countries				
Date	Domestic Price (US$/MT)			
	Philippines	Indonesia	Sri Lanka	India* * Kangayam
02.03.2024	646	678	1116	1008
09.03.2024	649	703	1121	1008
16.03.2024	654	736	1098	1026
23.03.2024	666	722	1137	1032
30.03.2024	NR	722	1148	1044
				* Kangayam

#(Source: Epaper,Kerala Kaumudi), ##(Source: Star market bulletin)

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