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Good Agricultural Practices for coconut in India: Technological options, field scenario and strategies

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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 five State Centres situated in the states of Orissa, West Bengal, Maharashtra and Andhra Pradesh 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 Readers,

We are passing through a phase of agriculture where changing farming systems has become inevitable in accordance with a changing climate. It has become pertinent for the farmers of this century to undertake activities like climate smart agriculture, innovative food for the changing consumption demands and healthy diets. The environment is to be equally given care with stress on conserving and maintaining the biodiversity and increase carbon sinks. Thrust is on increased use of renewable energy, conservation of water and other resources and recycling. The need for shifting to climate smart agriculture and adoption of good agricultural practices is to provide quality good food for all, without pesticide residues and other microbial contamination. Farmers need to be empowered to be resilient and climate smart.

The circular economic principle of production is based on "grow, make, use, and restore," that is, on material flows through the system based on minimum external inputs, recycling of resources, generating minimum waste, emissions or pollution. Being a crop with multifaceted uses, coconut is ideal for generating healthy, innovative convenience foods. It is very much suited for circular agriculture which integrates the concepts of reduce, reuse and recycling.

The concept of designing better products is an ongoing activity in the coconut sector. For instance, production of coconut oil diversified into production of Virgin Coconut Oil and then later to Medium Chain Triglycerides and even Lauric acid. And even within Virgin Coconut oil, application oriented products like oral rinses, pain balms, mosquito repellants, hand creams, face creams. Lip balms, roll on sprays and a variety of innovative products were developed. Design of new and better products were effected. The concept of reducing process wastage in circular economy is an integral part of coconut processing. The residue after extraction of milk in units producing coconut milk or Virgin coconut oil finds varied uses. Here the process waste is being developed into dietary fibre or flour or similar products which could replace dough or could introduce newer health products to consumers.

Alternative consumption is achieved in coconut when it replaces the dairy milk as a beverage since it is plant based, vegan and suited for people with lactose intolerance. Markets are on the rise for products like straw or pens made of biomass of coconut like coconut leaf or plates and cups from biomass generated after consumption of tender coconut water. Use of utensils and ice cream cups from coconut shell are reusable. The process waste could be further reduced through utilization of the coconut water generated in processing units, reuse of water used for cleaning the equipments by proper treatment and recycling etc. Management of agri-waste with biochar production enables soil remediation, fertility enhancement and thereby carbon sequestration.

The changing world necessitates changing agriculture, and farmers are the forerunners with their capability to preserve and conserve the resources on one side and contribute to food security on the other; let us embrace this transition together to restore Mother Earth and sustain humanity.

Editor

Good Agricultural Practices for coconut in India: Technological options, field scenario and strategies

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Introduction

Good Agricultural Practices (GAP) are a collection of principles to apply for on-farm production and post-production processes, resulting in safe and healthy food and non-food agricultural products, while taking into account economic, social and environmental sustainability (FAO, 2016). It has been well documented that implementation of GAP encourages promotion of the optimum use of resources such as pesticides, fertilizers, water and eco-friendly agriculture. In addition, implementing GAP also helps promote sustainable agriculture and contributes to meeting national and international environmental and social developmental objectives. Coconut (*Cocos nucifera L.*) is an important plantation crop of India with a profound influence on the rural economy by supporting the livelihoods of substantial number of farm families. It not only contributes to the national agrarian economy, it also supports the subsidiary industrial development. In India, the coconut palm is mainly grown in ecologically sensitive geographical areas such as coastal belts, hilly areas and areas with high rainfall and humidity. Coconut is highly amenable for product diversification and is mostly used as a food crop and hence, apart from ensuring sustainable on farm production practices, efforts are also needed for adopting recommended post production practices to achieve food safety standards for the production and marketing of coconut products. In these circumstances, it is highly relevant to evolve and put into practice the set of recommendations on Good Agricultural Practices pertaining to coconut. Research carried out by ICAR- CPCRI and State Agricultural/Horticultural Universities has resulted in substantial number of technologies for coconut aimed at increased productivity, sustainability and increase in income which could finally improve the socio economic status of the farmers and other stakeholders. Recommended coconut production technologies appropriate to the agro-ecological situations in line with the GAP requirements are to be promoted among the farming community. Similarly, post production practices as per the GAP requirements also need to be evolved and applied to the coconut based enterprises to ensure safe and healthy food and non-food coconut products, while taking into account economic, social and environmental sustainability.

Coconut palm is a perennial crop which is committed to land for more than 60 to 100 years and thus it is important to promote sustainable production and processing technologies ensuring conservation and utilisation of natural resources without any exploitation to withstand both biotic and abiotic stress in an uninterrupted longer period of time in the existing climate change scenario. Hence the good agricultural practices for coconut would ensure holistic approach taking into account the plant, animal, environment and human health aspects in an integrated manner.

This paper broadly discusses technological options, field scenario and strategies for promoting Good Agricultural Practices for coconut in India which includes, cropping /farming system, pest and disease management, harvesting and product diversification.

Coconut based multiple and integrated farming systems

Major objective of good agriculture practice is to utilize the available natural resources more effectively. Mono cropping of coconut leads to poor utilization of available resources. Coconut based cropping system is good agriculture practice which helps in effective utilization of natural resources and sustainable production.

Coconut based cropping systems by raising compatible subsidiary crops and/ or integrating with livestock enables to increase the productivity and net returns from unit area of coconut plantations. Farm resources like land, labour, sunlight, water and nutrients can be effectively utilized in such a system and higher productivity could be achieved as a result

of synergistic interaction among the crop and crop-livestock components. Crop diversity involving a number of annual, biennial or perennial crops as inter/mixed crops in perennial stands of coconut also promote the productivity and sustainability of the system. Coconut as a monocrop does not fully utilize the basic resources such as soil and sunlight available in the garden. The growth habit and planting methods of coconut make it highly suitable for intercropping in the interspaces of the coconut garden. Coconut palm like all monocots has a typical adventitious root system. Under favourable conditions, as many as 4000 to 7000 roots are found in the middle-aged palms. About 74 per cent of the roots produced by a palm under good management do not go beyond 2 m lateral distance and 82 per cent of the roots were confined to the 31 to 120 cm depth of soil. Thus, in a coconut garden the active root zone of coconut is confined to 25 per cent of the available land area and the remaining area could be profitably exploited for raising subsidiary crops. The orientation of leaves in the coconut crown helps penetration of sunlight into the soil and provides opportunities for exploitation of land and solar energy for inter/mixed cropping. Inter/ mixed crops are to be selected based on the age of the palms, size of the crown, availability of sunlight in the garden and agro climatic condition of the growing region.

Coconut offers scope for intercropping in the initial stage of the growth of palms and mixed cropping in the later part of life of palms. A variety of intercrops like tubers and rhizomatous speices (tapioca, elephant foot yam, sweet potato, greater yam, lesser yam, chinese potato, colocasia, ginger and turmeric), cereals and millets (paddy, sorghum, maize, pearl millet and finger millet), pulses and oilseeds (cowpea, green gram, black gram, red gram, ground nut, soybean, bengal gram and sunflower), vegetable crops (pumpkin, ash gourd, chillies, potato, french bean, snake gourd, amaranthus, brinjal, bottle gourd, ridge gourd, *Coccinia sp.*, Dolichos bean, annual moringa, curry leaf and tomato), fruit crops (banana, pineapple, and papaya), flowering crops (*Heliconia sp., Anthurium sp.* and *Jasminum sp.*) and fodder grass and legumes can be raised in coconut gardens upto 5 to 7 years. During the second growth phase of palms, *i.e.*, 5-20 years of age, growing of other crops in the interspace may be difficult due to poor sunlight availability. However, crops like colocasia, some varieties of banana like Palayamkodan etc., fodder grass, shade loving medicinal plants etc. which can tolerate shade can be cultivated in this phase. After the palms attain a height of 5 to 6 metres (above 20 years) *i.e.*, in older plantations, the crops mentioned in the initial stage and perennials like cocoa, vanilla, black pepper cinnamon, clove and nutmeg, sapota and medicinal and aromatic crops like Chittadalodakam (*Adhatoda beddomei*), Karimkurinji (*Nilgirianthus ciliatus*), Nagadanthi (*Baliospermum montanum*), Vetiver (*Vetiveria zizanioides*), Indian long pepper (*Piper longum*) can be grown as mixed crops along with the intercrops. Perennials are recommended as intercrops in the third stage only when the spacing adopted is 7.5 to 8.0 m. However, perennials can be grown as intercrops from the initial stage onwards by planting in coconut at a wider spacing of 10 m and above. In places where rainfall is not well distributed, irrigation is necessary during summer months. However, these crops are to be adequately and separately manured in addition to the manures applied to the coconut palms. Package of practices of intercrops should be followed as per the recommendation by Agricultural Universities of the region.

High Density Multispecies Cropping System

High density multispecies cropping system (HDMSCS) involves growing a large number of crops to meet the diverse needs of the farmer such as food, fuel, timber, fodder and cash. This is ideally suited for smaller units of land and aims at maximum production per unit area of land, time and simultaneously ensuring sustainability. This system includes annuals, biennials and perennials. The crops selected include cash crops, food crops and fodder crops. The biomass other than the economic part is recycled within the system. From the experimental plot on HDMSCS maintained at CPCRI Kasaragod, which involves coconut and other crops like banana, pineapple, pepper, clove and nutmeg, it is observed that an average annual net income of 5 to 6 lakh rupees can be obtained per ha. Besides, 25 tonnes of organic wastes are also made available per ha which can be recycled and applied to the crops as vermicompost. In HDMSCS if organic recycling is effectively carried out, we can reduce the chemical fertilizer input for coconut to two third of the recommended dose.

Coconut based integrated farming system

Coconut based integrated farming is an ecologically sustainable system which helps the farmer to realize more income. Sustainability is the objectivity of the integrated farming system

where production process is optimized through efficient utilization of inputs in safeguarding the environment with which it interacts. Mixed farming by raising fodder grasses such as hybrid Napier or guinea grass along with leguminous fodder crops such as *Stylosanthes gracilis* in coconut gardens has been found to be profitable. Raising the above crops in one hectare of coconut garden can support five to six dairy animals. However, if Hybrid Bajra Napier (Co 3, Co 4 and Co 5) is grown as intercrop in coconut garden about 120 tonnes of green fodder per hectare per year can be obtained through which 12 animals can be maintained. In addition to cattle, poultry, pisiculture, goattery and apiculture may also be integrated depending upon the farmer's interest. The cattle and poultry manure generated from the system when applied to coconut garden improves the soil fertility considerably. Maintaining milch cows and other components in coconut garden helps the farmer to enhance his income and provide additional employment to the family. A net income of 6.0 to 6.5 lakhs rupees per year can be obtained from one hectare coconut based mixed farming unit comprising of components such as 10 milch cows, 6 batches of poultry birds of 100 per batch and Co 3 Hybrid bajra Napier fodder grass, 1000 fingerlings and goattery unit. Employment generated from such a unit is about 900 man days per year. By maintaining one coconut based integrated farming system more than 70 tonnes of FYM is produced from the system and cow urine more than 1 lakh liters and these if recycled in to the system can result in improvement of soil physical, chemical and biological properties and ensure the sustainability of the system. More than 75 per cent of the N and K requirement can be substituted through on farm resources and entire phosphorus requirement can be met internally.

Pest and disease management

The basis of pest and disease management in GAP is minimum use of chemical pesticides and ensuring use of eco friendly practices including use of bio control agents. The natural enemies are insect predators (insects that consume part or all of pest insects), parasites (insects that use other insects to produce their offspring, thereby killing pest in the process), and pathogens (diseases that kill or decrease the growth rate of insect pests). Predatory insects include lady bird beetles, lace wings and spiders. Parasitic insects include wasps and flies which lay their eggs on pest insects, such as larvae or caterpillars.

The emphasis on GAP for plantations should ideally be on the use of varieties tolerant to pest and diseases. Neem-based pesticides produced from neem kernel extracts can also be used to repel pests. The extracts derived from the aerial parts (leaves and stem) of *Artimisia vulgaris, Urtica dioica*, Polygonum and *Eupatorium glandulosum* which are profusely growing in the plantations can be used for their anti-feedant action against some leaf eating pests of coconut.

Careful management in both time and space of planting of inter crops not only prevents pests, but also enhances population of natural predators that have natural capability to control insects, diseases and weeds. Other methods that can be generally employed are- clean cultivation, improving soil health to resist soil pathogens and promote plant growth; crop rotation; encouraging natural biological agents for control of diseases, insects and weeds; using physical barriers for protection from insects, birds and animals; modifying habitat to encourage pollinators and natural enemies of pests; and using semi chemicals such as pheromone attractants and trap pests.

About 150 Biopesticides including micro organisms, parasites, predators and natural plant based pesticides from neem and garlic are effective in managing pests of coconut and other intercrops. There are several examples of use of effective bio control agents for suppression of pest and diseases of coconut and other component crops. The important pests and diseases as well as their management practices that are to be followed under GAP is given in Table 1. It will be most ideal if community approach is adopted in the management of various pests and diseases of coconut. Many plants are suitable as botanical pesticides and can be incorporated in the cropping system. Chemicals should be used judiciously and should be applied when the insect population reaches higher than economic threshold level. Spraying should done with utmost care. Workers should wear proper masks and gloves. Correct type of chemical, correct dosage of chemicals and correct type of nozzle should be used. The wind velocity should be minimum when spraying undertaken, preferably during early morning hours or evening hours. Good quality water should be used for mixing with chemical pesticides. Close monitoring and systematic scrutiny of palms for timely detection of pests are critical to execute the correct approaches in pest suppression and reduce crop loss.

Name of pest	Management practices
Rhinoceros beetle (*Oryctes rhinoceros)*  *Fig . Metarhizium majus*	1. Field sanitation 2. Routine palm scrutiny and hooking out the beetle from the infested site reduces the floating pest population. 3. Shielding the spear leaf area of juvenile palms with fish net could effectively entangle alighting rhinoceros beetles and placement of perforated sachets containing 5 g chlorantraniliprole `(0.4 %) / 3 g fipronil or one botanical cake (2 g) developed by ICAR-CPCRI on top most three leaf axils evade pest incursion. 4. Prophylactic treatment of top most three leaf axils with either botanical cake [(Neem cake /marotti cake (*Hydrocarpus sp*) / pongam cake (*Pongamia pinnata* -250 g)] admixed with equal volume of sand or placement of 12 g naphthalene balls covered with sand 5. 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. 6. Treat the manure pits with green muscardine fungus, *Metarhizium majus* @ 5 x 1011 /m3 to induce epizootics on the developing grubs of rhinoceros beetle 7. Release *Baculovirus oryctes* infected adults @ 10-15 I ha 8. Area-wide farmer participatory approach in technology adoption could reduce the pest incidence very effectively and forms an eco-friendly approach in pest suppression.
Red palm Weevil *Rhynchophorus ferrugineus*	1.Field sanitation is very critical and all residual population in crown toppled palms should be destroyed. Prophylactic leaf axil filling suggested for rhinoceros beetle is very essential as this pest pave way for red palm weevil. 2. Avoid causing injury to the palms, as they would attract the weevil to lay eggs. Mechanical injury if any, caused should be treated with coal tar 3. While cutting fronds, petiole to a length of 120 cm is to be left on the trunk to prevent the entry of weevils into the trunk 4. 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. 5. If damage occurs in the crown, the damaged tissue has to be removed and insecticide suspension, imidacloprid (0.02%) @1 ml/L of water may be poured in. In case of entry of weevil through the trunk, the hole in trunk may be plugged with cement/tar and the top most hole is made slanting with the aid of an auger and the insecticide solution is poured through this hole with funnel 6. Set coconut log traps with fermenting toddy or pineapple or sugarcane activated with yeast or molasses to attract weevil 7. Use of pheromone trap for attracting and killing adult weevils (this should be adopted at community level)
Leaf eating caterpillar *Opisina arenosella*	1. Removal and burning of heavily infested 2-3 outer fronds 2. Regular monitoring of palm fronds for pest occurrence in endemic zones. 3. Augmentative release of stage specific parasitoids viz., the larval parasitoids *Goniozus nephantidis* (Bethylidae) @ 20 parasitoids/palm, *Bracon brevicornis* (Braconidae) @ 30 parasitoids/ palm, the prepupal parasitoid, *Elasmus nephantidis* (Elasmidae) @49/100 pre-pupae, and the pupal parasitoid *Brachymeria nosatoi* (Chalcididae) @32/100 pupae at the appropriate time was found effective in the sustainable management of the pest. Combined release of the parasitoids is required in multistage prevalence of the pest in the field. 4. Before releasing, the parasitoids are adequately fed with honey and exposed to host odours (gallery volatiles) for enhancing host searching ability.

Coried bug *Paradasynus rostratus*	1. Spraying of neem oil-soap emulsion (0.5%) on the pollinated bunches. The emulsion can be prepared by adding 5 ml neem oil and 8 g bar soap in one litre water 2. Collect and destroy all the fallen buttons of the affected palm 3. Crown cleaning to destroy eggs and immature stages of the pest 4. Spraying of azadirachtin 300 ppm (Nimbecidene) @ 0.0004% (13 ml / l) reduced the pest incidence at the highest level. Two rounds of azadirachtin spray on young coconut bunches 1-5 months old during May-June and September-October are quite essential for satisfactory control of the pest in the field 5. Among the natural enemies, the weaver ant, Oecophyllas maragdinais found to be the most efficient predator of coreid bug in the field 6. Two egg parasitoids, namely *Chrysochal cissaoviceps* and *Gryonhomeoceri*, were identified as potential egg parasitoids. Forty per cent parasitism was observed in the egg mass collected from the field due to these parasitoids 7. Spraying cholrantraniliprole 0.3 ml/litre or lambda cyhalothrin @ 1.0 ml/litre on the pollinated bunches was found effective.
Coconut eriophyid mite *Aceria guerreronis*	1. Removal and destruction of dried spathes, inflorescence parts and fallen nuts to subdue the pest population 2. Spraying on the terminal five pollinated coconut bunches with neem oil garlic soap mixture @ 2 per cent concentration (neem oil 200 ml, soap 50 g and garlic 200 g mixed in 10 litres of water). 3. or spraying neem formulations containing 1 per cent azadirachtin @ 4 ml per litre of water 4. or spraying palm oil (200 ml) and sulphur (5g) emulsion in 800 ml of water 5. Root feeding azadirachtin 10,000ppm @ 10 ml + 10 ml water is also effective 6. Spraying of talc-based preparation of acaropathogen, *Hirsutella thompsonii*@ 20 g / litre/ palm containing 1.6 x 108cfu three times in synergy with neem formulation on the bunches immediately after pollination 7. Predatory mites, *Neoseiulus baraki* and *Amblyseius sp.* do encourage natural suppression of the pest 8. Kalpaharitha (a selection from Kulasekharam Tall) was found field tolerant to mite damage 9. Application of recommended dose of fertilizers, recycling of biomass, raising of green manure crops in palm basin and incorporation during flowering, summer irrigation including soil and water conservation measures improve the palm health and reduce the pest attack.
Rugose spiraling whitefly (RSW) *Aleurodicus rugioperculatus* .  Fig . *Leiochrinus nilgirianus*	1. Application of 1% starch solution on leaflets to flake out the sooty moulds. 2. In severe case, spray neem oil 0.5% and no insecticide is recommended 3. Installation of yellow sticky traps on the palm trunk to trap adult whiteflies 4. Using the aphelinid parasitoid, *Encarsia guadeloupae* and the chrysopid predator, *Apertochrysa sp.*, lady beetles *Jauravia pallidula*, *Serangium parcesetosum* and *Menochilus sexmaculatus*, cybocepahlid predator, *Cybocephalus sp.* as well as *in situ* preservation of the sooty mould scavenger beetle, *Leiochrinus nilgirianus Kaszab* 5. Use of yellow sticky traps @ 5 per acre 6. In juvenile palms, spraying of water with jet speed could dislodge the whitefly and reduce the feeding as well as breeding potential of the pest 7. Habitat preservation of the sooty mould scavenger beetle, *Leiochrinus nilgirianus* could eat away all the sooty moulds deposited on palm leaflets and cleanse them reviving the photosynthetic efficiency of palms.

Root grub Leucopholis coneophora	1. Soil application of aqua suspension of entomopathogenic nematode, *Steinernema carpocapsae* in the interspaces at 5-10 cm depth @ 1.5 billion IJ/ha and need based repeated application 2. Repeated summer ploughing to expose the immature stages of predation 3. Handpicking of adult beetles during evening of two weeks commencing from the onset of monsoon. 4. Application of neem cake in the palms basin @ 5 kg /palm for regeneration of roots.
Coconut scale, *Aspidiotus destructor*	1. Use of aphelinid parasitoid, *Aphytis sp.* is very successful 2. The lady beetles, *Chilocorus nigritus*, *Sasajiscymnus dwipakalpa*, *Pharoscymnus horni (Coccinellidae)* were found as effective predators
slug caterpillars *(Darna nararia)*	1. Complete destruction of affected palm leaflets with caterpillar at early stages of infestation should be made immediately so that the pest build up is suppressed. Care should be taken as the caterpillars cause extreme itching when contacted with human skin due to the presence of poisonous scoli. 2. Establishment of light traps and spraying *Bacillus thuringiensis* 5 g/litre was found effective along with inundative biological control using the eulophid larval parasitoid, *Pediobius imbrues*
Nut borer *Cyclodes omma*	1. Crown cleaning and removal of immature stages of the pest 2. Application of the entomopathogen, *Bacillus thuringiensis* @ 20 g per litre or neem oil 0.5% (5 ml per litre with 10 g soap powder) using hand sprayers would reduce pest incidence.
Rodents *Rattus rattus wroughtoni*	1. Rats can be controlled by providing mechanical barriers (bands), poison baits and traps. Wrapping the trunk of coconut trees using polythene sheets was found to reduce the damage by rats 2. G.I sheet bands, 40 cm wide, fixed around the trunk of palms at a height of 2 m from the ground serve as mechanical barriers for rats. 3. Planting coconut seedlings in correct spacing as well as destruction of fallen fronds and other palm residues at regular intervals to ward off the rat activity from coconut gardens.

Diseases

Name of disease	Management practices
Bud rot	1. 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 2. Phytosanitation by removing severely affected palms. 3. 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 as prophylactic measure 4. Remove the infected tissues of the spindle completely. Two or three healthy leaves adjacent to the spindle may have to be removed, if necessary, for easy removal of all rotten portions and thorough cleaning. After removing the affected tissues apply 10% Bordeaux paste and cover the wound with a polythene sheet to prevent entry of rain water. The protective covering has to be retained till normal shoot emerges. 5. Spray 1% Bordeaux mixture to the surrounding palms 6. Destroy the infected tissues removed by burning or deep burying in the soil 7. Provide adequate drainage in gardens and avoid overcrowding. 8. For the newly planted seedlings also prophylactic spraying of Bordeaux mixture (1%) can be given to avoid infection. 9. In localities where heavy wind is experienced and leaves of coconut palms got damaged, spraying of Bordeaux mixture (1%) is essential to prevent infection by Phytophthora.

Leaf rot	1. Remove rotten portion of the spindle leaf and 2-3 successive leaves and pour fungicide solution containing 2 ml hexaconazole 5 EC in 300 ml water/ palm or talc based formulation of Pseudomonas fluorescens or *Bacillus subtilis* @ 50 g in 500 ml water/palm into the well around the base of the spindle leaf 2. Undertake prophylactic measures to prevent rhinoceros beetle attack
Stem bleeding	1. Remove water stagnation and apply recommended doses of organic manure to make the palms healthy. 2. Avoid burning of trash and palm residues near the trunk to avoid trunk/root injury 3. The affected tissues should be completely removed using a chisel and smear the wound with 5% hexaconazole (5 ml in 100 ml of water) and drench the basins @ 25 lit. of 0.1% solution 4. Smearing paste of talc based formulation of *Trichoderma harzianum* on the bleeding patches on the stem (The paste can be prepared by adding 50 g of Trichoderma formulation in 25 ml of water) 5. Apply neem cake enriched with *Trichoderma harzianum* @ 5 kg per palm in the basin along with other organics. 6. Use *Trichoderma hamatum* and *Trichoderma harzianum* enriched coir cake for the management of the disease 7. Application of paste of Trichoderma harzianum talc formulation on the bleeding patches on the trunk was also found effective in preventing the spread of stem bleeding
Basal stem rot disease *Ganoderma spp.*	1. Removal of dead palms and palms in advanced stage of the disease as well as destruction of the boles and root bits of the diseased palms to remove disease inoculums 2. Isolation of diseased palms from healthy palms by digging isolation trenches of 2 feet depth and one feet width around the basin 3. Avoiding flood irrigation or ploughing in infected gardens to prevent spread of the inoculum. 4. Application of neem cake (5 kg) fortified with *Trichoderma harzianum* (CPTD 28) talc formulation (50 g) per palm per year at six monthly intervals reduced the disease intensity 5.Root feeding of hexaconazole @ 2% (100 ml soluti oner palm) or soil drenching with 0.2% hexaconazole / 1 % Bordeaux mixture @ 40 litre soluti on per palm

Harvesting

Usually 11-12 month old nuts are harvested. Coconuts are harvested at varying intervals in a year. The frequency varies depending upon the yield of palms. Usually, the nuts are harvested 6 to 10 times in a year. In well maintained and high yielding gardens, bunches are produced regularly and harvesting is done once in a month. Nuts which are 11 months old give fibre of good quality can be harvested in the tracts where husk is utilized for manufacture of coir fibre. Skilled personnel are traditionally employed for climbing palms for harvesting nuts. Nowadays, lack of availability of skilled climbers for harvesting operations is a serious problem experienced by coconut farmers. A simple palm climbing device invented by a farmer from Kannur district of Kerala is gaining popularity and that is the device used by vast majority of climbers. Reducing operational hazard is one of the aspects of GAP which is more applicable for coconut. Harvesting is one of the major operations being done manually. Of late climbing devices have been developed to reduce the drudgery and ensure safety of climbers. However, old generation climbers still prefer manual climbing without using climbing devices. There is always risks involved in the life of climbers since the 60 years old coconut palms of tall varieties attains a height of 15 to 18 m. Hence the climbers need to be sensitized about the risks involved and measures have to be taken to train them to use mechanical climbing devices with safety attachments. Owners of the garden should help to insure them. The young generation climbers need

to be properly trained about the proper usage of mechanical climbing devises.

GAP for post harvest processing

Value addition through product diversification is the important strategy for enhancing income from coconut farming. A variety of food and non food products are prepared by utilizing different parts of coconut palm. Coconut products can be broadly classified as tender coconut based products, inflorescence sap based products, coconut milk based products and mature coconut based products. Adoption of farm level processing of coconut for value addition is very low in India mainly because of the predominance of small and marginal holdings which suffer from various resource constraints to take up processing enterprises. In order to overcome the challenges due to the resource constraints in fragmented holdings group approaches are facilitated and large number of FPOs are formed in coconut sector out of which many are managing enterprises on production and marketing of value added coconut products. Many of the coconut products, especially food products, have quality standards as set by the agencies concerned with regulatory measures. Good Agricultural Practices pertaining to the post harvest processing and marketing of coconut are to be formulated by taking into account the available quality standards and by evolving quality standards for those products which do not have standards fixed. Production protocol for each coconut product including compliance on maintenance of personal hygiene of work force, hygiene to be ensured within the production centre as well as the premises, packaging unit etc are to be compiled and guidelines for GAP for post harvest processing are to be formulated for adoption and certification. Capacity building initiatives to create awareness about GAP pertaining to post harvest processing in coconut are to be conducted at regular intervals to benefit the entrepreneurs, labour and other stakeholders to ensure safe and healthy coconut products.

Field level adoption of GAP in coconut

Though a substantial number of technologies have been evolved by coconut research institutions which are in tune with the principles of GAP, studies conducted by ICAR-CPCRI in Kerala state have indicated that the extent of adoption of recommended production technologies is not at a satisfactory level (Thamban et al, 2021). Optimum spacing for planting is followed only in 30% of the coconut gardens. Similarly, adoption of water conserving irrigation methods such as drip irrigation in coconut holdings is very low. Vast majority of the farmers (99%) do not apply micronutrients to their coconut palms despite the fact that there is widespread deficiency of micronutrients adversely affecting coconut productivity. Coconut based inter/mixed cropping system is followed in about less than 50% of the gardens only which indicates the scope for popularising coconut based inter/mixed cropping through appropriate development/extension interventions, especially in small and marginal holdings. Utilisation of the potential for multiple cropping in coconut gardens to enhance food production assumes much significance. Integrated farming is adopted in 15.73% coconut holdings only. Pest and disease incidence in coconut gardens is very high in farmers' field. However, IPM is adopted in less than one third of coconut gardens and IDM in less than 10% of orchards. Similarly, farm level processing for value addition of coconut is also very low. The low level of adoption of sustainable production technologies by growers indicates the necessity for implementing interventions to promote adoption of GAP in coconut.

Strategies for promoting GAP in coconut

Coconut growers and entrepreneurs experience various technological and socio-economic constraints which result in low level of adoption of recommended practices pertaining to production and processing. Problems experienced by coconut farmers include price crash/fluctuations for coconut and its value added products in the market, fragmentation of holdings, absentee landlordism, lack of awareness/knowledge about GAP for coconut, lack of labour and high wage rate, lack of irrigation facilities, lack of processing infrastructure etc. Hence, it is imperative to implement policies and programmes to support farmers and entrepreneurs for enhancing adoption of GAP in coconut for enhancing productivity and sustainability and to ensure safe and healthy food and non-food coconut products.

Primarily there is a need to map the available technologies in line with principles of GAP for sustainable coconut production in different coconut growing regions in the country so that agro-ecological zone-wise guidelines for adoption of GAP can be evolved. Similarly, protocols made available for production and marketing of coconut products also need to be mapped for formulating guidelines for adoption of GAP to ensure safe and healthy coconut products.

Coconut research institutions, development agencies, FPOs, entrepreneurs, fabricators, input agencies, certification agencies, marketing agencies, credit institutions, and other relevant stakeholders need to be brought together on a common platform to formulate the guidelines for adoption/certification of GAP. Coconut Development Board, the main agency mandated for the integrated development of

coconut industry in the country can be the champion organisation for coordinating the activities to inventorize the recommended technologies and also for evolving policies and programmes to incentivise adoption of the same. Once the guidelines for GAP in coconut is formulated and framework for action prepared for its promotion, suitable agencies for certification of GAP in coconut are to be identified and accredited.

There is a need to strengthen research on GAP with emphasis on climate resilient practices for sustained productivity of coconut. Research intervention is also required to evolve soil health management recommendations to suit agro ecological zones. The need for developing equipments and machinery for tillage/cultural operation/ plant protection/climbing appropriate to fragmented coconut holdings is another area for strengthening research.

Since coconut is predominantly a small holder crop in India, suitable support mechanism is required to empower the resource poor growers to adopt GAP in coconut through group approaches. Organising capacity development programmes for farmers, labourers, entrepreneurs and other stakeholders to create awareness/knowledge about GAP in coconut. Farmers and entrepreneurs are to be made aware about the benefits of adopting GAP in coconut production and processing especially about the potential of realising premium price in marketing GAP certified coconut and its products.

A congenial policy environment is to be created for promoting decentralised community coconut nurseries managed by Farmer Producer Organisations (FPOs) in coconut sector to enhance availability of quality seedlings of suitable varieties. Formulate and implement development/extension interventions for restructuring coconut orchards overcrowded with coconut palms for the maintenance of optimum palm density for sustainable coconut production.

Appropriate interventions are required to promote water conserving irrigation methods such as drip irrigation in coconut holdings. Development/ extension interventions are also needed for evolving and popularising adoption of AEU- wise technology package for soil health management for coconut. FPOs in coconut sector are to be supported for production and marketing of customized fertilizer inputs for coconut and the trained FPOs are to be linked to the Agro-Service Centres. Similarly, interventions are needed to encourage women SHGs/ farmer collectives for production and marketing of organic / bio inputs for sustainable coconut production.

FPOs in coconut sector and women SHGs can be facilitated to take up interventions on inter/mixed cropping with focus on food crops like tuber crops in coconut gardens. Front line demonstration of various coconut based integrated farming system models developed at the research institutions and also successful models adopted by coconut farmers needs to be organised by Krishi Vigyan Kendras and field level units of State Department of Agriculture/ Horticulture with the active involvement of FPOs.

A paradigm shift from individual farmers to group/community based decentralised participatory approach is required for improving efficiency of extension support to enhance adoption of IPM/IDM practices in line with GAP to avoid crop loss. Farm level processing for value addition of coconut is very low and hence, interventions are to be implemented to facilitate FPOs in coconut sector for taking up coconut based enterprises for production and marketing of value added coconut products in line with GAP to enhance income from coconut farming.

Conclusion

Adoption of Good Agricultural Practices for production and post harvest processing is highly relevant under the present climate change scenario to ensure sustainability and safe and healthy coconut food and non-food products. Substantial number of technologies in line with GAP for sustainable production and post-production processing of coconut have been made available by coconut research institutions in the country. Research initiatives on GAP for coconut are to be further strengthened with emphasis on climate resilient practices for sustained productivity, evolving soil health management recommendations to suit agro ecological zones and for developing equipments and machinery appropriate to fragmented coconut holdings. Interventions are needed for creating a congenial policy environment for promoting GAP and for implementing suitable development/extension interventions to benefit growers and entrepreneurs. Effective coordination of activities by research and development/extension institutions, FPOs/SHGs, entrepreneurs/processors and other stakeholders in coconut sector is a pre-requisite for evolving and implementing appropriate guidelines for adoption/ certification of GAP in coconut.

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Nut fall of coconut -Invasive Rugose Spiraling Whitefly (RSW) infestation in Godavari

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Introduction

Coconut (*Cocos nucifera L.*) is a valuable plantation crop in India cultivated for oil and other raw materials. Every component of a coconut tree has a specific usage or application. It is commonly called "Tree of Heaven", "Tree of Abundance", "Tree of Life" and "Kalpavriksha".Andhra Pradesh is one of the most important coconut growing states in India.In the present scenario of climatic change this valuable palm is devastated by incidence of several pests and diseases that not only deteriorate the quality of nuts but also reduced the vigour and yield of palms (Chowdappa *et al.*,2018 and Neeraja *et al.*, 2020). In the recent era, coconut palms are damaged with invasion of many new pests, predominantly whiteflies. Invasion of rugose spiraling whitefly (RSW), *Aleurodicus rugioperculetus Martin* has been reported from India in Tamil Nadu (Sundararaj and Selvaraj, 2017) and Andhra Pradesh (Chalapathi Rao *et al.*,2018). The exotic and invasive RSW feeds and reproduces prolifically on the surface of coconut palm leaves (Sundararaj and Selvaraj, 2017 and Srinivasan *et al.*, 2017) which

General view of experimental plot of coconut at Kalavalapalli village

immature nut fall in coconut was due to incidence of mealy bugs (*Dysmicocus spp.*), scale insects (*Aspidiotus destructor*), mites (*Dolichotetranychus spp.*), *Cyclodes omma* larvae and weevil (*Meridolus spp.*). However, literature on the dropped nuts in coconut palms due to RSW is very meagre. Nut yield reduction must be quantified so as to plan realistically for research and development plans in coconut palms. As a result, the present investigation was carried out to estimate the dropped nuts (%) of coconut in relation to *A. rugioperculatus* infestation at different intensities

Studies on immature nut fall in rugose spiraling whitefly (RSW) infested coconut palms with low (<10 spirals per leaflet), medium (10 – 20 spirals per leaflet) and high (> 20 spirals per leaflet) incidence in Dr. YSRHU - Godavari Ganga hybrid and local East Coast Tall (ECT) variety were undertaken at Horticultural Research Station (HRS), Ambajipeta and Kalavalapalli plantations.

Nut fall in Godavari Ganga hybrid at HRS, Ambajipeta and Kalavalapalli

The overall dropped nuts (%) was 4.84, 27.48 and 35.32 per cent at Dr. YSRHU - HRS, Ambajipeta, whereas it was recorded to be 5.50, 28.11 and 36.01 per cent in Dr. YSRHU - Godavari Ganga hybrid palms with low, medium and high RSW incidence during the year 2020-21 at Kalavalapalli.

Nut fall in local East Coast Tall (ECT) at HRS, Ambajipeta and Kalavalapalli

The average per cent of dropped nuts in ECT variety with low infestation was representing the general dropping with 4.06 and 4.68 per cent at Dr. YSRHU - HRS, Ambajipeta and Kalavalapalli during the year 2020-21. In case of ECT palms with medium and high RSW infestation, the nut dropping (%) was 22.33 and 28.51 per cent (Dr. YSRHU - HRS, Ambajipeta), 23.49 and 30.58 per cent (Kalavalapalli).

The dropped nuts (%) per palm per year was recorded based on the initial button setting and number of dropped nuts in RSW infested palms of Dr. YSR HU - Godavari Ganga hybrid and East Coast Tall variety with low, medium and high RSW incidence at both experimental locations. The nut dropping was recorded to be more in case of palms with high followed by medium RSW incidence, whereas comparatively minimal nut dropping was observed in palms under low incidence of RSW.

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Participatory on Farm Conservation and Utilization of Coconut Ecotypes

Experiences of Interventions Implemented to Popularise 'Bedakam Coconut'

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Introduction

Conservation and utilization of genetic diversity is very important to sustain the productivity of a crop. In coconut, diversity provides characters for yield, adaptation, disease resistance and high value uses. Rich diversity of coconut varieties exists in farmers' field, which are untouched by the conventional research methods employed for the crop improvement in coconut. There exists tremendous scope for utilizing the genetic diversity of coconut available in farmers' fields for providing various options and opportunities while formulating strategies for solving the problems of coconut growers. A thorough understanding about the coconut diversity available in farmers' gardens, characterizing and delineating ecotypes having desirable traits would also enable the stakeholders to utilize these ecotypes for the sustainable production of coconut and enhancing income of farmers. Active participation and convergence of efforts of various stakeholders including the local coconut farming community is very important for the successful implementation of the interventions for conservation and utilization of coconut ecotypes. In this paper, the successful experience of stakeholder convergence in implementing interventions for conserving and popularizing 'Bedakam coconut', a very promising coconut ecotype, is narrated as follows.

Coconut – Genetic diversity and spread

Coconut, *Cocos nucifera L.*, is a monotypic species under the genus Cocos with no known wild or domesticated relatives. It is a diploid species with a chromosome number 2n = 32 and belongs to the family Arecaceae under monocotyledons. Coconut gene pool comprises of cultivars found in the different geographical regions around the tropical world.

Coconut has a long history of cultivation and human association. Natural and human assisted distribution has resulted in its wide spread in the

tropical world as seen today. Floating ability of coconut fruit in sea water without losing viability helped in the dissemination of coconut through sea currents (Harries, 1978). Evolutionary changes as a result of domestication in coconut is difficult to measure in the absence of wild progenitors, perennial character of the species and slow phase of old cultivars with new genotypes (Ramanatha Rao *et al.*, 2005). Population differentiation in coconut was suggested as a result of geographic isolation, introgressive hybridization, mutation, and selection (Perera *et al.*, 2000). During the long history of evolution under domestication, cultivars branched out in different geographical situations, which are now known by the name of the place where it occurs (Ashburner *et al.*, 1997 a, b; Samsudeen *et al.*, 2006). Every coconut growing region now has more or less distinctive populations commonly described as ecotypes with continuous variation, but that can be classified in to Afro-Indian, South East Asian and Polynesian groups (Ramanatha Rao *et al.*, 2005).

Conservation and characterization of coconut genetic resources

Conservation and characterization of coconut resources and their utilization in crop improvement

programmes has resulted in development of improved varieties in the coconut growing regions. In most breeding programmes, the local tall and dwarf coconut populations have been used as the base breeding material owing to their adaptability. As in most crops, germplasm collection, characterization and conservation in coconut has mainly concentrated on the method of *ex-situ* gene banks. Although alternate conservation methods such as cryopreservation are emerging recently, field gene banks are the practical and ultimate usable form of coconut diversity owing to the long juvenile phase and perennial nature. Here, collected accessions are planted systematically in the *ex-situ* gene banks for conservation, characterization and evaluation. Due to the long juvenile period of coconut, this method takes anywhere near fifteen to twenty years for reliable characterization. On the other hand, native in situ populations of such accessions (most times the same identified palms from which the original collections made) are available in the field for more than fifty years due to the long economic life of coconut. By utilizing these populations for characterization, time duration could be effectively reduced to two to three years. By this approach, a paradigm shift in the coconut germplasm characterization has been attempted which would combine the merits of field gene banks and participatory approaches in on farm conservation and utilization.

Participatory characterization of coconut varieties was earlier carried out under the aegis of international coconut genetic resources network (COGENT) in two coconut communities in India and also in other COGENT member countries. Here the aim was to characterize and evaluate coconut varieties according to farmer's perception and also to analyze problems faced by coconut farmers (Thamban *et al.,* 2007). The present concept takes it further to scientific characterization based on coconut descriptors after identification of ecotypes based on participatory methods. Major difference in the two methods is that earlier one was community based while the present one is ecotype based in approach.

West Coast Tall (WCT) –The versatile coconut cultivar

West Coast Tall (WCT) is a known coconut population from the west coast of India and named by the region where it is predominantly cultivated. Though the origin of WCT is not traceable to any progenitor or area from where it has spread, it is obvious that sea journey of nuts had a definite role in the initial establishment of the population. The cultivar migration from coastal region to interior areas and on cultivation over the years, adaptation to new environments and human selection has probably contributed to the present day diversity in the cultivar. Such adapted WCT populations in certain localities were designated with local names by farmers to differentiate it from generic WCT population. Kuttiadi, Jappanam, Komadan, Neduvarayan, Karinthengu, Chenthengu, Pathinettampatta, Arasampatti Tall, Tiptur Tall etc. are a few such ecotypes reported (Arulraj *et al.*, 2002; Remany 2004). Similarly, several ecotypes have been in the knowledge of the farming community in the coconut growing regions of the country.

'Bedakam coconut'- A unique coconut ecotype

Bedakam coconut is a popular cultivar amongst the farmers in Kasargod district which is cultivated under marginal management conditions. Scientists

of CPCRI Kasaragod initially came to know about this ecotype of coconut while interacting with coconut growers in different localities of Kasaragod district in connection with the collection and documentation of Indigenous Technical Knowledge (ITK) in coconut farming. Subsequently, the ecotype was characterized with the active participation of local coconut growers.

Kasaragod is the northern most district of Kerala state bordering Karnataka. On the west is the Arabian sea and east is western ghats. Broadly, the district is divided in to low land, bordering the sea, the mid land consisting of the undulating country and high land on the extreme east. There are five Agro-Ecological Units (AEUs) in the district. The major soil types are sandy, sandy loam and laterite soil. Bedakam coconut is cultivated in different localities of Bedadka grama panchayat comprising mid land almost on the centre of the district in the AEU 11 Northern Laterites, characterized by laterite soil. The climate of the district is warm, humid and tropical. The average maximum temperature is 31.2^{o}C and minimum is 23.6^{o}C. Humidity is very high and rises to about 90 percent during the south-west monsoon. The mean annual rainfall of the district is 3581mm. The south-west monsoon starts towards the end of May or the beginning of June, and lasts till September followed by north-east monsoon during October-November. Out of the total rainfall, the months June, July and August account for 70% of the quantity.

Bedakam ecotype was developed as a result of selection from the West Coast Tall (WCT), which is commonly cultivated along the west coast of Kerala. Continuous selection over the generations and adaptation to the hilly terrain of mid land away from coast contributed to the evolution of bedakam

coconut. The Bedakam coconut is cultivated in dfferent localities of Bedadka gramapanchayat of Kasaragod district. Campared to the generic WCT population Bedakam coconut possess more desirable features including better adaptation to rainfed situation and cultivation under sub optimal input use.

The palms of Bedakam coconut are tall type and at the age of 65 years attain average stem height of 14 m. Average girth circumference at base by that age is about 105 cm. Number of leaves on the crown varied from 21 to 40 with an average of 35 leaves at 50 years of age. Average length of leaf is 452 cm with a petiole length of 108 cm. Average number of leaflets in a leaf is 226. Length and breadth of leaflet are 108cm and 5cm respectively. Number of leaf scars per meter on an average is 15 at 1.5 m from base. Internode length is about 7 cm. Average length of full inflorescence is 97 cm with a stalk of about 41cm. Average number of spikelets in an inflorescence is 32 and the average length of individual spikelet is 37cm. There are 19 female flowers in an inflorescence. On an average 14 inflorescences are produced per annum in a palm. Average number of nut produced in a year is 82 under rainfed condition which increases to 188 under irrigation.

Fruit weight in this cultivar varied from 450 g to 1520 g with an average weight of 819 g. On an average the fruit is 17 cm long and 12 cm broad. Nut weight varied from 200g to 700g with an average weight of 429 g. Percentage husk varied from 23 to 66 with an average of 45 and the average thickness

of husk is 2.7cm. Average weight of husk is 375g per fruit. On an average the nut is 11cm long and 9.6cm broad. Average weight of fresh endosperm is 234g and thickness is 1.2cm. Average weight of shell is 115g and thickness is 0.48cm. Copra weight per nut is about 152g with an oil content of 67%.

Farmer participatory interventions for conservation and utilization

The initiative on farmer participatory characterization of Bedakam coconut ecotype facilitated by ICAR-CPCRI Kasaragod clearly brought out the unique desirable traits of the ecotype. The exercise revealed the necessity for conservation and utilization of the same for sustainable development of coconut especially under rainfed situations. The information thus generated was promptly shared by ICAR-CPCRI with the peoples' representatives of Bedadka gramapanchayat with the aim of formulation and implementation of interventions under the decentralized planning programme of Local Self Governments for the conservation and utilization of Bedakam coconut.

Scientists of CPCRI also held discussions with the peoples' representatives of Kasaragod District Panchayat and also Karadka Block panchayat to support the initiatives of Bedadka gramapanchayat through appropriate schemes under peoples' planning. The initiative for conservation and utilization of Bedakam coconut has been getting financial support from Bedadka grama panchayat, Kardaka block panchayat and Kasaragod district panchayat under the decentralized planning programme since the last two years. Agricultural Officer of Krishibhavan Bedadka under the State Department of Agriculture is the implementing Officer of these interventions under the decentralized planning programme.

Besides, CPCRI facilitated various interventions for creating awareness among coconut farmers of the locality about the importance of conservation and utilization of Bedakam coconut. With the main objective of implementing interventions to conserve and popularise 'Bedakam Coconut', the superior local ecotype of coconut a Farmer Producers Organization viz., 'Bedakam Coconut Growers' Society' was facilitated to be formed and registered with more than 2000 coconut farmers from different localities of the grama panchayat.

The Bedakam Coconut Growers' Society thus formed has taken initiative with the support from

ICAR-CPCRI and local Krishibhavan to register 'Bedakam coconut' with PPV & FRA, New Delhi as a farmer variety of coconut.

Under the technology transfer programme of the institute CPCRI rendered technical support for various activities of 'Bedakam Coconut Growers' Society'. Capacity building programmes including training for the FPO representatives for identification and documentation of mother palms of the 'Bedakam coconut' in farmers gardens, collection of seednuts and raising nursery were conducted as institutional and off campus programmes in collaboration with the FPO, LSGs and Krishibhavan Bedadka.

Convergence of stakeholders

The efforts for conservation and utilization of Bedakam coconut has been very effective mainly due to the convergence of interventions by different stakeholders. Apart from facilitating the formation of FPO and organizing capacity development programmes for farmers and other stakeholders, CPCRI also provided technical support for the Biodiversity Management Committee (BMC) of Bedadka grama panchayat to submit a project proposal seeking financial support for conservation of Bedakam coconut to the Kerala State Biodiversity Board (KSBB). The activity for the documentation of mother palms of the 'Bedakam coconut' in farmers

gardens and conducting capacity development programmes for coconut growers and other stakeholders were the major components of the proposal. The proposal was accepted by KSBB and part of the financial support sought was released for the purpose. Ward members of the gramapanchayat in different localities made efforts to enroll all the coconut growers who cultivate the Bedakam coconut in their respective wards in the FPO. 12 selected members of the 'Karshika Karma Sena' functioning in the grama panchayat facilitated by Department of Agriculture through the local Krishibhavan and the function organized in connection with World Environment Day celebration. Dr K.B. Hebbar, Director ICAR-CPCRI inaugurated the 'Harithasabha' of Bedadka grama panchayat in the inaugural function which was chaired by Smt Dhanya, President of the grama panchayat.

Conclusion

Participatory approaches with convergence of interventions by different stakeholders are highly relevant for the characterization, conservation and utilization of genetic diversity of coconut available

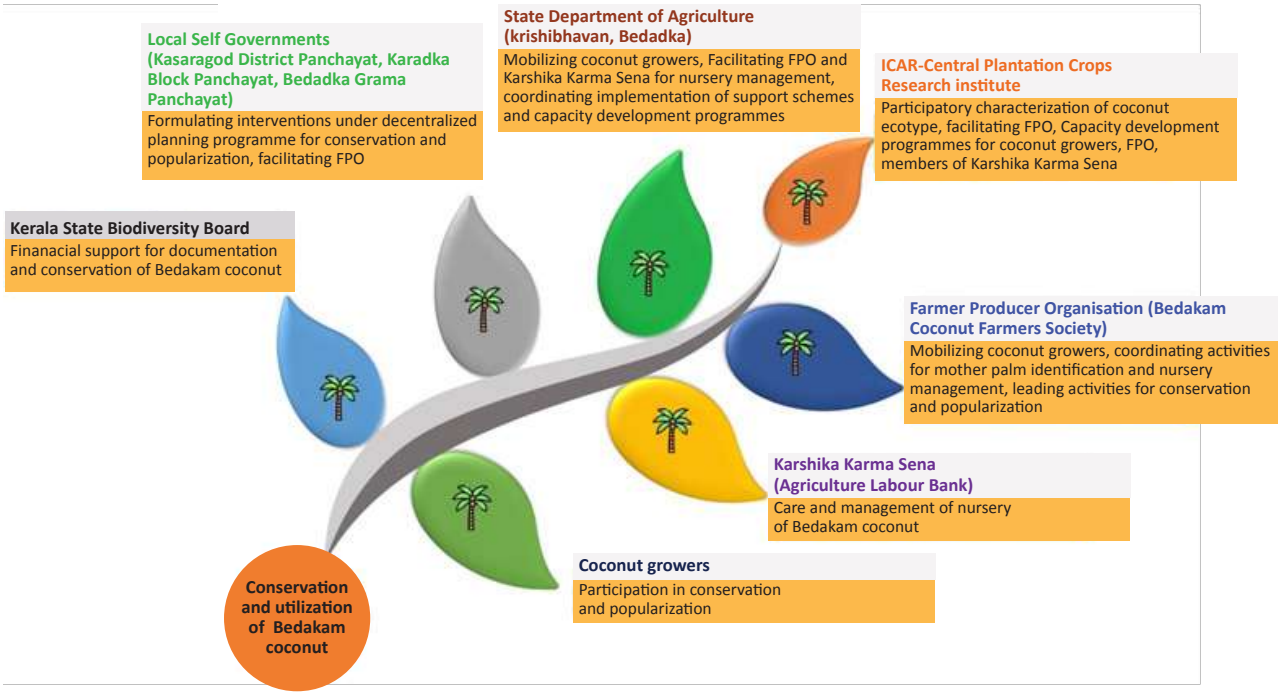

Fig. Convergence of stakeholders for conservation and popularization of Bedakam coconut

registered under charitable societies act with the objective of providing labour support to farmers for taking up agricultural activities were trained in various aspects of mother palm selection, seednut collection, sowing and other nursery management practices. The FPO entrusted the team of 'Karshika Karma Sena' to manage the nursery to produce the seedlings of Bedakam coconut. Nearly 8000 seedlings of Bedakam coconut are ready in the nursery located at Pandikandam for distribution to farmers.

The formal distribution of seedlings of Bedakam coconut was inaugurated by Dr. C. George Thomas, Chairman, KSBB Bedadka in on 5th June 2023 at in farmers' field. Mobilizing farmers and facilitating their active participation in the initiative to conserve the genetic diversity of coconut needs to be effectively integrated into the methodology for crop improvement in coconut. Instead of isolated efforts, convergence of initiatives of different stakeholders would be more relevant for the effective conservation and utilization of coconut ecotypes. The successful implementation of interventions with focus on convergence of stakeholders for conservation and popularization of Bedakam coconut, the promising coconut ecotype, is a testimony for the efficacy of such approaches.

Development and Increasing the Efficiency of Hybrid Macapuno Coconuts Tissue Culture in Thailand

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Abstract

The embryo culture of hybrid macapuno coconuts takes 12-16 months from growing the embryo until developing into a plantlet and the production efficiency of seedlings is still low.The Department of Agriculture has therefore developed and increased the efficiency of hybrid macapuno tissue culture. The objective is to obtain propagation technology by developing embryo culture techniques to increase the number of coconut plantlets to meet the needs of farmers. The research was conducted from 2018-2021 at the Horticulture Research Institute, Bangkok and Chumphon Horticultural Research Center. The result showed that medium and embryo placement characteristics affected embryo germination in the dark, and appropriate formulations for seedling development in five varieties, NamHom x Kathi (NHK), Malayan Dwarf x Kathi (RDK), Thungkled x Kathi (TKK), West African Tall x Kathi (WAK) and Malayan Yellow Dwarf x Kathi (YDK). The research found that 5 varieties of hybrid Kathi coconut embryo germination in the solid medium were better than in liquid mediums. After culturing for 8 weeks in the dark, when they were sub-cultured in a modified Y3 solid medium and transferred to the light, it was found that the percentage of embryos development cultured in both solid and medium were better than those taken from embryos cultured in liquid medium.

For suitable formulations for the development of seedlings of 5 cultivars of hybrid macapuno coconut, from an 11-month-old embryo, it was found that the formula developed by the embryo was the most complete seedling of varieties of Malayan Dwarf x Kathi (RDK), Thungkled x Kathi (TKK), and NamHom x Kathi (NHK), These are MS solid medium with 2,4-D 1 mg L-1or B2 in the dark and B2 or Y3 modified liquid food in the light.West African Tall x Kathi (WAK) and Malayan Yellow Dwarf x Kathi (YDK), is solid and liquid medium B2 in dark and bright places.

Observing the effect of coconut aging and culture medium cut in half of the shoot to the plant of Chumphon 84-2 hybrid macapuno coconut, it was found that the number of shoot halves of the embryo can develop to shoot formation within 2 months. The piece of shoot halves of every fruiting age that were cultured on MS medium with 0.4 mg L-1 IBA and 3.2 mg L-1 kinetin had a higher percentage of seedling development than those cultured on modified Y3 medium. The piece of shoot halves of the fruiting age of 10 and 11 months cultured on both culture mediums had a higher percentage of seedling development than at 9 months. The piece of shoot halves of fruiting aged 10 months that cultured on MS medium with 0.4 mg L-1 IBA and 3.2 mg L-1 kinetin resulted in the highest seedling development.

Keywords – Hybrid Macapuno Coconuts, medium, Placement, Halves, Embryo

Introduction

Coconut (*Cocos nucifera L.*) is a major Thai economic crop. At present, the major growing areas are only in the south, especially in Prachuap Khiri Khan, Chumphon, and Surat Thani provinces. During the period, 2008–2013, the productive area and yield decreased with age and plant conditions, because in most of the area, the coconut plantations were very old. In 2010, the coconut pest outbreak and the drought during the relatively dry weather was suitable for the infestation of such insects. As a result,

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the coconut yield became less. The shortage of raw materials led to high price per fruit. As a result, the demand for good coconut varieties incread among the farmers while the government was having only insufficient production capacity.

Embryo culture is a technique that has been practiced by breeders for a long time. The key benefit is helping the embryos of plants that cross-species or cross-genus and become sterile to grow into a complete plant. Kathi coconut cannot germinate in nature, so the embryo rescue technique was used. But the efficiency of seedling production is still low. Using the Kathi coconut embryo rescue technique, the zygotic embryos were successfully cultured in several laboratories. (Ashburner, 1991, Assy-Bah, 1989, Karunaratne et al., 2009, Rillo and Paloma, 1990) In Thailand, Somchai et al. (2008) successfully made Kathi coconut embryo culture and this technique is currently used as a good Kathi coconut production system by the Department of Agriculture. The result showed that medium and embryo placement characteristics affected 5 varieties, NamHom x Kathi (NHK), Malayan Dwarf x Kathi (RDK), Thungkled x Kathi (TKK), West African Tall x Kathi (WAK), and Malayan Yellow Dwarf x Kathi (YDK), of hybrid Kathi coconut embryo germination.

In addition to trying to increase the number of seedlings produced from a single zygotic coconut embryo by somatic embryo genesis, propagation efficiency can also be increased by developing higher embryo culture techniques and this percentage can be increased up to 95%. The development of techniques at each stage of embryo culture, germination, suitable recipes for each stage of development, and increasing the number of new shoots from a single embryo, etc., are the purposes of this activity.

Materials & Methods

Medium and Embryo Placement Characteristics affected 5 varieties of Hybrid Kathi Coconut Embryo Germination

Embryos of 5 varieties of hybrid Kathi coconut:NamHom x Kathi (NHK), Malayan Dwarf x Kathi (RDK), Thungkled x Kathi (TKK), West African Tall x Kathi (WAK) and Malayan Yellow Dwarf x Kathi (YDK),11 months old fruit, were isolated in Suratthani Seed Research and Development Center Tha Chana District, Suratthani 88170. They were shaken in 70% alcohol for 5 min. followed by 15 and 10% Clorox solution for 15 and 10 min. and then washed with sterile distilled water 3 times in a laminar airflow station.

The experiment used a completely randomized design with 3 treatments, consisting of hybrid Kathi coconut 5 varieties' embryo with 11 months fruiting age and culture medium with Embryo Placement Characteristics; modified Y3 liquid medium (Parinda, 2018) (Figure 1A), modified Y3 solid medium with placed upward (Figure 1B) and Murashige and Skoog (MS) solid medium with the addition of 2,4-Dichlorophenoxyacetic acid (2,4-D) 1 mg L-1(Orathai, 2019) placed upward. Each embryo was cultured in the dark and taken after 8 weeks. The number of embryo's germination and development were observed and recorded every 2 weeks, 2 months after culturing.

Figure 1. Embryo in liquid medium (A)and solid medium placed upward (B)

Eight weeks later when shoots started growing, they were sub-cultured in a modified Y3 solid medium and transferred to the light under the illumination of cool-white, fluorescent tubes of about 37 µmol m-2 s -1 for 16 h/day photoperiods, 25+2 °C about for 8 weeks.The number of shoots and plantlet development were observed and recorded every 2 weeks for 2 months.

Effect of Appropriate Medium on Propagation of 5 Varieties Macapuno Using Plant Tissue Culture Technique

Completely randomized design (CRD) experiments were planned with 5 iterations. (the size of the experimental unit. (experimental unit) 10 vials (embryos) per experimental procedure). 5 varieties of macapuno were selected and the embryos contained in the varieties were cultured under sterile conditions.

Step 1: Induction of embryo germination to form roots and shoots. (Figure 2)

Peel the coconut. Use a knife to open the coconut shell and divide it to half. Use the device to cut the

coconut flesh around the embryo into a square shape. After that, the embryo is bleached and disinfected and washed three times with distilled water.Use a dark slice to remove the embryo from the macapuno. It is carried out in a sterile cabinet. The prepared coconut embryos were cultured with a synthetic medium in sterilized bottles. The 3 mediums are Y3 media, MS with 2,4-D, and B2. The macapuno embryo culture bottles were placed in a dark room with a temperature of 25-27 °C.

Figure 2. Sterilization of endosperm, dissection, and inoculation on the media.

Step 2: Embryo development in the bright room

The seedlings with shoots and roots were taken from the dark room and transferred to solid media Y3 and B2 media and was placed in a room with light 14 hours a day and with temperature 25-30 ° C. Embryos were cultured for 12 weeks, the pulp was removed, and sub-cultured by placing in the original solid media and placed in a bright room. Embryos were cultured for 16 weeks, sub-cultured solid medium to liquid medium. using the original recipe and sub-cultured every month. Seedling survival rate and plant height were recorded.

The effect of coconut aging and culture medium with cut in half of shoot to plant of Chumphon 84-2 hybrid macapuno coconut

The experiment design has a completely randomized design (CRD) with 6 treatments, consisting of the age of fruit being 9, 10, and 11 months (Figure 3A – C)and culture medium namely modified Eeuwens medium (Y3) (Parinda, 2018) and Murashige and Skoog (MS) medium supplemented with 0.4 mg L-1Indole-3-butyric acid (IBA) and 3.2 mg L-1 kinetin (referred from Sisunandar *et al.*, 2015). The fruiting aged 9, 10, and 11 months were selected. The embryo was cultured on a modified Y3 solid medium in the dark condition for 2 months to develop into the germination stage (Figure 4A). Cut in half of shoot (Figure 4B) were cultured on modified Y3 and MS medium supplemented with 0.4 mg L-1 IBA and 3.2 mg L-1kinetin in the light condition, light Intensity 4,000-5,000 Lux and photo period 12 hours per day, for 2 months. The percentage of embryo development in the light was recorded.

Figure 3. Chumphon 84-2 Hybrid Macapuno Coconutembryo, fruit age 9 months (A), 10 months (B) and 11 months (C)

Figure 4. The embryo begins to germinate after 2 months and is ready to be halved (A) The pieces of halves (B) 2 halves of the embryo after 2 months of culture (C).

Results and Discussion

Effect of medium and Embryo orientation on germination.

To study the effect of Medium and Embryo Placement Characteristics on the germination percentage in the dark, the germination rate of solid medium ranged from 69.0 to 99.7 percent while

Treatment	Embryo germinationin the dark (percent)				
	NHK	RDK[1/]	TKK[1/]	WAK	YDK
modified Y3 liquid medium	51.0	53.3 b	50.7 b	60.0	72.3
modified Y3 solid medium placed upward	86.7	74.0 ab	86.7 a	69.0	74.0
MS solid medium with 2, 4-D 1 mgl-1 placed upward	80.0	86.7 a	99.7 a	93.3	82.3
C.V. (%)	44.8	20.0	18.5	29.5	22.7

[1/] The averages in the same column that follow with the same letter were not statistical difference at a 95% confidence level by DMRT

Table 1.Embryo germination percentage of five varieties of hybrid Kathi coconut after 8 weeks of culturing inmedium with embryo placement characteristics in the dark.

the liquid culture was 50.7 - 72.3 percent, embryo germination in a solid medium was better than in liquid mediums. The hybrid coconuts of TKK cultivars grown in both solid mediums, were significantly had greater germination than in the modified Y3 liquid medium (Table 1).

It was found that the hybrid coconuts of RDK, TKK, WAK, and YDK cultivars which were grown in Murashige and Skoog (MS) solid medium with the addition of 2,4-Dichlorophenoxyacetic acid (2,4-D) 1 mgl-1, showed that the germination percentage (86.7, 99.7, 93.3 and 82.3%) was better than in the modified Y3 solid medium (74, 86.4, 69 and 74%). Also, MS solid medium with the addition of 2,4-D 1 mgl-1was found longer shoots than the modified Y3 solid medium (Figure 5). Eight weeks later when shoots started growing, they were sub-cultured in a modified Y3 solid medium and

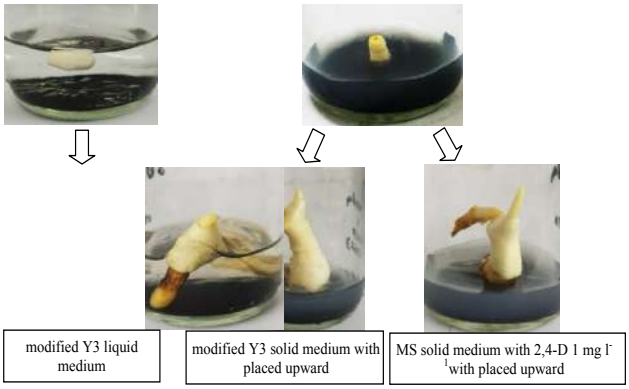

Figure 5. Embryo germination of hybrid Kathi coconut after 8 weeks of culturing in medium with embryo placement

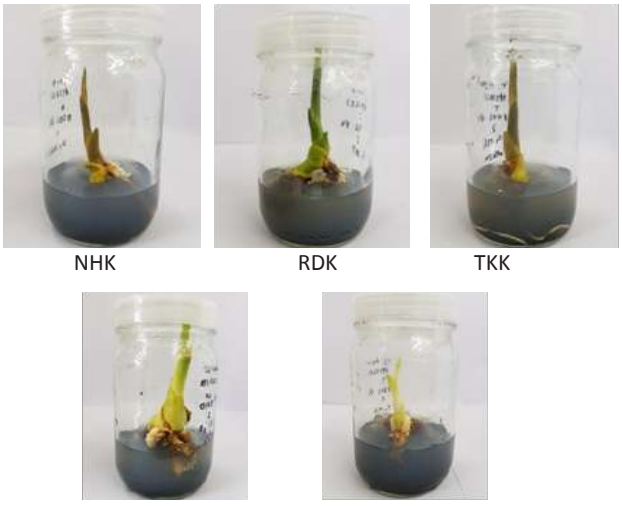

Figure 6 . Embryo development percent of five varieties of hybrid Kathi coconut after 8 weeks of sub-culturing in modified Y3 solid medium and transferring to the light.

transferred to the light. It was found that embryos from the modified Y3 liquid medium had only 28.7 - 53.3 percent of developed plantlets. while embryos from solid medium culture modified Y3 and MS added 2,4-D 1 mgl-1 place upward had 62.7 - 99.7 percent to developed plantlets. (Figure 6)

In the hybrid coconuts of NHK and TKK cultivars from the solid mediums, there was significantly greater plantlet development than in the modified Y3 liquid medium (Table 2).

To study the effect of Medium and Embryo Placement Characteristics on the percent

Treatment	Embryo germination in the light (percent)				
	NHK	RDK[1/]	TKK[1/]	WAK	YDK
modified Y3 liquid medium	28.7 b	45.0	35.7 b	53.3 b	45.3
modified Y3 solid medium placed upward	80.0 a	62.7	86.7 a	69.0 ab	62.7
MS solid medium with 2, 4-D 1 mgl-1 placed upward	73.3 a	86.7	99.7 a	93.3 a	82.3
C.V. (%)	35.5	34.8	27.8	27.5	30.6

[1/] The averages in the same column that follow with the same letter were not statistical difference at a 95% confidence level by DMRT

Table 2. Embryo development percentage of five varieties hybrid Kathi coconut, from a cultured medium with embryo placement characteristics in the dark, after 8 weeks of sub-culturing in modified Y3 solid medium and transferring to the light.

germination in the dark, it was found that 5 varieties of hybrid Kathi coconut embryo germination in the solid medium was better than in liquid mediums (Table 1). After culturing for 8 weeks in the dark, when they were sub-cultured in a modified Y3 solid medium and transferred to the light, it was found that the percentage of embryos development which were cultured in both solid mediums are better than from those which were cultured in liquid medium (Table 2). In accordance with Pech Y Ake *et al.* (2004) studies enhanced aerobic respiration improves *In Vitro* coconut embryo germination and culture. Germination of Malayan Green Dwarf (MGD) coconut embryos was tested in liquid and solid medium. It was found that the percentage of germination increased when the embryo was fed on a solid medium, especially when the embryo with the

micropyle side is placed upward. Causing exposure to the air inside the bottle and embryo proliferation is inhibited when the ambient atmosphere is replaced by N2 or when anaerobic respiration inhibitors are added to the medium. The result showed that embryo proliferation requiring aerobic respiration and germination in an upward position will result in better seedling development. In conclusion, medium and embryo placement characteristics affected 5 varieties of hybrid Kathi coconut embryo Germination, it was found that the embryos cultured in solid medium in the dark showed the best embryo germination and development to plantlet.

Effect of Appropriate Medium on Propagation of 5 Varieties Macapuno Using Plant Tissue Culture Technique

After culturing the embryos of 5 macapuno strains for 19 weeks, it was found that the sprouts had an elongation of shoots and increased development of the main root and branch roots. NHK macapuno hybrids grown on MS (dark)/Y3 (light) (Treatment 3) and B2 (dark)/ Y3 (light) (Treatment 5) mediums were able to develop into seedlings. However, from the embryo culture of RDK macapuno varieties, it was found that MS (dark)/B2 (light) (Treatment 4) and B2 (dark)/Y3 (light) diets (Treatment 5) were able to develop the most mature seedlings at 70 percent. The embryo culture of TKK macapuno varieties showed that MS (dark)/Y3 (light) medium, Treatment 3 and B2 (dark) medium/B2 (Bright) (Treatment 6) was able to develop into mature seedlings at 70 percent. WAK and YDK hybrid macapuno were found the B2 (dark)/ B2 (light) (Treatment 6) were able to develop into seedlings, the most complete, 70 and 80 percent, respectively (Table 3).

The NHK macapuno embryo hybrid varieties were cultured for 32 weeks in dark and light conditions.

Media and conditions	Embryo development (%)				
	NHK	RDK	TKK	WAK	YDK
Treatment 1 Y3 (dark room) /Y3 (lightroom) (control)	70	30	40	30	70
Treatment 2 Y3 (dark room)/B2 (lightroom)	40	60	60	20	50
Treatment 3 MS (dark room)/Y3 (lightroom)	80	50	70	30	40
Treatment 4 MS (dark room)/ B2 (lightroom)	40	70	60	30	50
Treatment 5 B2 (dark room)/ Y3 (lightroom)	80	70	60	40	60
Treatment 6 B2 (dark room)/ B2 (lightroom)	60	60	70	70	80

Table 3. Effects of culture media and conditions on embryo development of 5 varieties of macapuno at 19 weeks of culture under dark condition and transferred to light condition.

There were no statistically significant differences. The mean plant height was 7.6-14.5 cm (Table 4), RDK species had an average plant height of 5.8-11.0 cm (Table 4), but TKK species showed that the mean

Table 4 Effects of culture media and conditions on shoot length of five macapuno hybrid lines at 32 weeks of culture

Treatment	Shoot length (cm.)				
	NHK1/	RDK	TKK1/	WAK1/	YDK1/
Treatment 1 Y3 (dark room)/ Y3 (lightroom) (control)	8.7 b	11	7.0b	10.0 ab	6.0ab
Treatment 2 Y3 (dark room)/ B2 (lightroom)	14.5 a	9.3	13.3 a	17.0 a	5.3b
Treatment 3 MS (dark room)/ Y3 (lightroom)	11.0 ab	8.9	5.8 b	3.0 c	13.3 ab
Treatment 4 MS (dark room)/ B2 (lightroom)	9.8 ab	9.8	13.2 a	9.7 b	0
Treatment 5 B2 (dark room)/ Y3 (lightroom)	11.7 ab	5.8	8.7 b	12.5 ab	7.2 ab
Treatment 6 B2 (dark room)/ B2 (lightroom)	7.6 b	8.4	8.3 b	6.5bc	13.5 ab
C.V. (%)	22.66	32.84	23.41	22.26	46.66

[1/] The averages in the same column that follow with the same letter were not significantly different at a 95% confidence level by DMRT

Table 4. Effects of culture media and conditions on shoot length of five macapuno hybrid lines at 32 weeks of culture

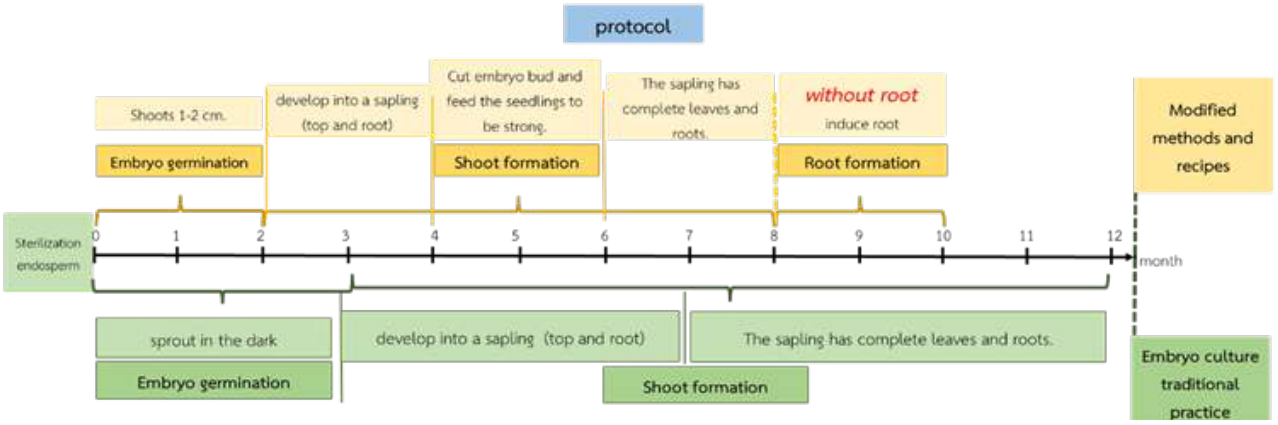

Figure 7. Comparison of the time period of the traditional practice of macapuno embryo culture and modified methods.

plant height was significantly different. Method 2 and Method 4 had the highest mean plant height at 13.3 cm and 13.2 cm, respectively, and Treatment 3 had the lowest mean plant height at 5.8 cm (Table 4), while in the WAK and YDK strains,it was found that the plant height in each treatment was not significantly different. The average plant height is 4.5-17.0 centimeters and 5.3-13.5 centimeters, respectively. (Table 4)

The culture study of 5 varieties of hybrid macapuno embryos was carried out in a single embryo culture. It will be a variety that is harvested at the same time. But each set received different environmental factors, each time of mating, which affects the integrity of the variety due to inbreeding between different parents or some bunches obtained from the same father and mother, not simultaneous maturation according to physiological characteristics. Coconut is a plant with gradual blooming of female flowers which takes about 7-15 days until they are completely bloomed. (Tippayaet *al.*, 2021). The experiment showed that the formula affected shoot formation in the dark and the development of roots in the light. Embryos fed on the B2 formula showed better growth prospects. Due to the micronutrient elements concentration and growth factor,the B2 formula was 10 times higher than that of the Y3 formula and from embryo culture development in the dark, the development in the bright room, and the complete seedling development in each batch. The reduction in development percentage may depend on the management of the parent plot. Fertility and management within the laboratory and from experimental modification of methods and recipes, shoot emergence, and seedling development until the seedlings complete with leaves and roots take 8 months, which can reduce the embryo culture duration from 12 months in traditional culture (Figure7).

The effect of coconut aging and culture medium with cut in half of shoot to plant of Chumphon 84-2 hybrid macapuno coconut.

Feasibility study of double shoots from a single zygotic embryo of Chumphon 84-2 Hybrid Macapuno Coconut (1 embryo can be cut in half to make two pieces. If it can develop into a whole shoot (Figure 4C), it will give two plants or 200% embryo. Observation of the development of new shoots from embryo halves with fruit maturity at 9, 10, and 11 months in a modified Y3 solid medium(Parinda, 2018) and Murashige and Skoog (MS) medium supplemented with 0.4 mg L-1 Indole-3-butyric acid (IBA) and 3.2 mg L-1 kinetin (referred from Sisunandar *et al.*, 2015). It is found that using shoots from embryos with fruit maturity at 10 and 11 months in Murashige and Skoog (MS) medium supplemented with 0.4 mg L-1 Indole-3-butyric acid (IBA) and 3.2 mg L-1 kinetin, makes the percentage of development of a new shoot higher than the Y3 medium.The use of shoots from 9-month-old embryos showed the lowest percentage of new shoot development in both mediums (123.3 and 133.3%) compared to 10 and 11 months of fruiting (Table 5). Somchai (2003) mentioned that coconut embryo culture would be successful depending on the important component that the embryo aging must be between 10-11 months. Sisunandar *et al.* reported used dwarf kopyor-type coconuts isolated from 11-month-old fruit.

Table 5. Embryo development percent of shoot halves of coconut fruiting age at 9, 10, and 11 months after 2 months

Fruiting age	Medium		% Embryo development in the light1/
9 months	modified Y3		123.3 b
9 months	MS with0.4 mg L^{-1} Kinetin	IBAand3.2 mg L^{-1} IBA	133.3 ab
10 months	modified Y3		144.3 ab
10 months	MS with0.4 mg L^{-1} Kinetin	IBAand3.2 mg L^{-1} IBA	161.5 a
11 months	modified Y3		138.3 ab
11 months	MS with0.4 mg L-1 Kinetin	IBA and 3.2 mg L^{-1} IBA	150.0 ab
C.V. (%)			15.7

1/ The averages in the same column that follow with the same letter were not statistical difference at 95% confidence level by DMRT

culturing in medium in the light

The effect of the medium on the development of the embryo is a new shoot by culturing in comparison with both mediums. It is found that the percentage of embryo development at 9-11 months of age fruit on MS medium added 0.4 mg/L IBA plus 3.2 mg/L Kinetin higher when raised on a modified Y3 medium. In accordance with Sisunandar *et al.* (2015), the best protocol is to first incise the germinated embryos at the meristem site, followed by splitting the embryo into two after four weeks of culture and then recovering the embryos in Murashige and Skoog (MS) medium supplemented with 2 µM IBA and 15 µM kinetin. Results from the addition of growth regulators IBA and Kinetin, which are substances in the auxin and cytokinin group assists cell division and budding/new shoots in multi-vegetative culture. Shou *et al.* (2008) reported that the maximum number of shoots was induced from lotus bud explants on MS medium containing agar, sucrose, and BA added with NAA similar to Noraini *et al.* (2014). In addition, Jala (2012) reported that shoot tips of *Curcuma longa L.* were given the highest average number of new shoots when cultured on MS medium supplemented with NAA and BA. The Y3 medium is a specific formula for coconut tissue culture (Somchai, 2003) without the addition of growth regulators. Therefore, the study induced new shoots in the modified Y3 formula with growth regulators. In the embryo halves, the shoot must be cut in half length wise into two equal parts and multiple halves that resulted in the need to cut off the root part (Figure 8A). When cultured in a Y3 liquid medium, the sapling develops into a mature plant and has 2-3 leaves, but is unable to take root(Figure 8B). Therefore, it is necessary to study the root-inducing formula (Figure 8C), which is another experiment in the research project on the development and efficiency of coconut tissue culture (It is not mentioned in this report).

Figure 8. Characteristics of halved fragments (A) embryo

halves No root development (B) and root emergence of embryo halves when cultured in Root medium (C).

Conclusion

1. Medium and embryo placement characteristics affected 5 varieties of hybrid Kathi coconut embryo germination. It was found that the embryos cultured in a solid medium in the dark showed the best embryo germination and development to plantlet.

2. Different varieties of macapuno hybrids affect the response to different recipes. The suitable medium for propagating NHK macapuno hybrids were MS formula with 2, 4-D or B2 formula in the dark and Y3 formula in the lightroom. RDK is MS formulation in the dark and B2 liquid medium in the lightroom. The embryo develops at most 70 percent of the seedling maturity, and the TKK, WAK, and YDK strains are B2 formula in the dark and B2 liquid medium in the lightroom.

3. Embryo incision can be applied to produce double seedlings of Hybrid Macapuno Coconuts. The best protocol is to first incise the germinated embryos at the meristem site, followed by cutting half the embryo into two and then recovering the embryos in Murashige and Skoog (MS) medium supplemented with 2 µM IBA and 15 µM kinetin.

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Retirement

Shri M A Sebastian, Administrative Officer retired from the services of Coconut Development Board on 31st May 2023 after serving the Board for more than 38 years.

National level Training Programme on "Hybridization Techniques in Coconut" at ICAR-CPCRI, Kidu

V Niral V * & Diwakar Y **

*Head Crop Improvement &Principal Scientist, CPCRI, Kasaragod

**Scientist in-charge ICAR CPCRI, RC Kidu

Seven days national level training programme on "Hybridization techniquesin coconut" sponsored by Coconut Development Board (CDB) was inaugurated on 2nd June, 2023 at ICAR-CPCRI, Research Centre, Kidu, Karnataka by Dr. Vikramaditya Pandey, Principal Scientist & Former ADG Hort. , ICAR, New Delhi. Dr. V. Pandey in his inaugural address emphasized about the diverse agro-climatic conditions of India and its tremendous potential for cultivating a wide range of horticultural crops. He also highlighted upon the production of diverse horticultural crops and its crucial role in ensuring food security, nutritional well-being, and aesthetic appeal. Briefing about the significance of horticultural crops, he said that coconut holds a special position among horticultural crops, as it offers economic and livelihood security to a wide population in India and hence referred to as nature's gift to mankind. In response to the growing demand for coconuts, he informed that, cultivation of this crop is expanding to non-traditional areas in India, however, coconut farmers face several challenges such as low yield, vulnerability to pests and diseases, and the impacts of climate change, hence, to address these issues, the adoption of high-yielding improved coconut varieties becomes a crucial strategy for enhancing productivity in India. Therefore, this training program on "Hybridization Techniques in Coconut" is helpful to meet the increasing demand for quality hybrid coconut planting material. Dr. V. Pandey urged the trainees to make the most out of this training program to enhance their knowledge and skills in producing hybrid coconut seedlings and also to utilize these newfound skills to improve their livelihood security and contribute to the overall growth of the coconut industry in India.

Dr. K.B. Hebbar, Director, ICAR-CPCRI, Kasaragod, delivered the presidential address by appreciating the efforts of CDB in funding these need of the hour training programs and called upon the trainees to make best use of this training and ensure the production of quality hybrid planting material.

Dr. Niral V., Head, Crop improvement, ICAR-CPCRI, Kasaragod and the course director, briefed about the the scope and contents of the training programme.

Mrs. Mini Mathew, Assistant Director, CDB, Kochi was the guest of honour on this occasion and elucidated the efforts being taken by Coconut Development Board to address the constraints faced by coconut farmers, especially skilled manpower for coconut harvesting, planting material production and plant protection. She also informed that, this is the first of its kind national level training programme that is being conducted on this important topic "Hybridization techniques in coconut". Mr. Diwakar, Y., Scientist in-charge of CPCRI Research Centre, Kidu one of the co-ordinators of the programme welcomed the chief guest, dignitaries and participants to the programme. A total of 25 trainees participated in the programme, of which about 15 trainees represented CDB farms from the states of Tripura, Chhattisgarh, Kerala, Karnataka and Tamil Nadu. After the inaugural function, pre-evaluation of trainees' knowledge with respect to Hybridization Techniques in Coconut was assessed through oral and practical examination.

As per the approved programme schedule, the technical session on Introduction to Coconut Inflorescence was handled by Dr. Ranjini, Scientist, CPCRI, Kasaragod, followed bytraining session on "Varietal Wealth in Coconut" by Dr. V Niral, V, Head Crop Improvement & Principal Scientist, CPCRI, Kasaragod. During the first day, the trainees were exposed to basic details of coconut inflorescence (Male flowers, female flowers and their reproductive biology) and also about varietal wealth in Coconut (tall varieties, dwarf varieties and hybrids)and their important characters.

The training programme on all subsequent days began with a warm up jogging session followed

by two participants randomly selected to brief about previous days learning *i.e.* Most important lessons learnt yesterday (MILLY). On the second day (03.06.2023), after refreshing about previous day's learning, practical session on climbing was conducted. During the tree climbing practical session, the trainers explained the principle behind the operation of the climbing machine and how it must be used including tying and movement on the coconut trees. Shri. Jeevan, Pro gramme Manager, Bhartiya Vikas Trust, Manipal trained the participants on important aspects of communication skills, time management, decision making etc. In the afternoon session, Dr. Kamal Kumar, Technical Assistant, CPCRI RC Kidu, introduced the participants to the Nursery techniques in Coconut and also conducted practical session on pollen extraction and storage in laboratory condition.

The training programme for the third day (04.06.2023), began with practical session on palm tree climbing handled by master trainers and trainees were trained to climb coconut palms up to 30 feet height. Later, practical session on pollen processing, identification of ideal receptive female flowers and the process of pollinating receptive female flowers using extracted pollen was demonstrated to the trainees. After lunch, participants were trained on important aspects like how to think positively, healthy way of living and building up self-confidence. Later Shri. Gopala Krishna, A. S., Technical officer conducted the practical session on important aspects like crown cleaning, harvesting methods and identification of correct stage of tender and mature nuts on palm.

The training programme for the fourth day (05.06.2023) began with Shri. Diwakar, Y., SIC CPCRI, RC, Kidu educating the participants about the floral biology and reproductive behaviour in coconut and how coconut floral behaviour varies across different seasons. Later, the most important part of the practical session regarding anthesis, sequence of male flower dehiscence, emasculation process (need for emasculation, method of emasculation) and processing of emasculated male flowers was handled by Shri. Diwakar, CPCRI.

Dr. Surekha, Scientist, CPCRI, Kasaragod, educated the trainees about the role of nutrients, methods of application, Bordeaux mixture preparation, pre-requisites / conditions for lime application, method of application and its importance in coconut plantations.

The training programme for the fifth day (06.06.2023), included master trainers who carried out the hands-on training to the trainees on climbing coconut palms, moving onto crown of the coconut palm, undertaking emasculation, labelling the inflorescence and bagging. In the later session, the participants were taken on a field visit to the International Coconut Gene Bank at Kidu. The trainees were exposed to the diversity of coconut available at CPCRI Research Centre Kidu in terms of fruit characters, palm morphology and yield traits. The trainees were impressed by the diversity available at the Centre.

During sixth day (07.06.2023), the trainees were taken on field visit to ICAR-CPCRI Kasaragod. At CPCRI, Kasaragod, the trainees were taken to the different experimental plots viz., high-density multi-species cropping system, germplasm and hybrid evaluation trials, seed production and nursery plots. A session on molecular techniques for hybrid purity testing was handled by Dr. Sudha, R., Senior Sciensist., CPCRI Kasaragod. Dr. Subramanian, Principal Scientist handled the session on Coconut organic farming and water management and educated the trainees about fundamentals of nutrient management, organic manures, nutrient requirement of coconut palm, micro-nutrients and its functions, identification of

nutrient deficiency symptoms, water requirement of coconut palm, different methods of irrigation, water conservation measures and its management. After lunch, Dr. Manikantan, Principal Scientist, exposed the trainees to different value-added products of coconut, different machines, its operative mechanism and output efficiency, and its advantages. During the session, the trainees were educated regarding neera tapping and all the trainees were also provided with an opportunity to taste the KalpaRasa (fresh neera).

During the last day of the training programme (08.06.2023), the trainees were encouraged to participate in group discussion and share their understanding about previous day field and lab visit. This was followed by post evaluation of trainees' knowledge upgradation on hybridization techniques in coconut, which was conducted through oral and practical examination by Shri.Diwakar Y, Scientist in-charge ICAR CPCRI RC Kidu. During the test, each trainee was orally questioned and asked to climb, do emasculation, process male flowers, identify receptive female flowers, bag emasculated inflorescence, remove pollination bags and pollinate using freshly extracted fertile pollen. All the trainees participated enthusiastically and displayed their knowledge gain in oral and practical examination. Average knowledge gain among the trainees ranged between 72 to 95%, with an average knowledge gain to the tune of 83.5% was observed. Many trainees who lacked coconut tree climbing skill at the beginning of the training programme, were also individually made to climb the palms and were able to comfortably climb the palm by using climbing machine through this training programme.

The valedictory function of the national level residential training programme on "Hybridization Techniques in Coconut" was conducted in the presence of the chief guest Dr. K U K Nampoothiri, Former Director, ICAR-CPCRI Kasaragod Dr. K U K Nampoothiri while congratulating the trainees urged them to honestly utilize the skill and knowledge gained from the hybridization training programme in achieving the huge requirement of quality coconut hybrid seedlings in the country. In his address, the chief guest also appreciated the Director CPCRI and his team and also Coconut Development Board for taking the lead in organizing this much needed training programme for overall benefit of the coconut community in the country. On the occasion the chief guest and Director CPCRI distributed Hybridization tool kit (comprising of brass sieve, roller pin, pruning knife and pollen duster), training manual and certificate to the participants.

World Bank Team visited Coconut Development Board

An expert team from the Agri Finance Department of World Bank visited Coconut Development Board on 16th June 2023 and discussed on the various schemes for the financial assistance of the Agricultural Sector of Kerala.

The team consisting of Shri. Frank Hoilinger, Finance Specialist, FAO, Shri Srinivasan, Consultant, World Bank, Kum. Seethal Babu Paul, Agricultural Officer, Elamkunnapuzha and Dr. Yamuna S, Safeguard Specialist, Kera Project Preparation Team had discussion with senior officials of Coconut Development Board. Dr. B. Hanumanthe Gowda, Chief Coconut Development Officer, Coconut Development Board briefed on the various schemes being implemented by Coconut Development Board for the integrated development of coconut sector in the country.

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Cultivation Practices for Coconut-July

Planting

In localities where the onset of south-west monsoon was delayed or received inadequate rainfall, planting of seedlings may be taken up in July. If continuous heavy rain occurs after planting, care should be taken to avoid water stagnation in the pit by providing drainage.

Bund should be made around the planting pit using bottom soil to avoid run-off water entering the pit.

Nursery management

Weeding should be done wherever necessary. Water stagnation should be avoided in the nursery bed by providing adequate drainage.

Plant protection

The active monsoon phase of July month is the period of pest recession and disease escalation. Wetness usually reduces the pest incidence but aggravates the spread of disease propagules. It is therefore a period of critical monitoring to prevent the entry of deadly pathogen such as bud rot disease into the palm system. Any injury due to pest incidence would also favour higher occurrence of disease on palms. Incidences of rugose spiralling whitefly, nesting whitefly and black headed caterpillar would be in the diminishing phase and the attack by red palm weevil would be emerging fast in different localities. Bud rot and leaf rot diseases are common diseases during the period.

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.

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.

Toppling of palm

Black headed caterpillar, *Opisina arenosella*

The coconut black headed caterpillar, Opisina arenosella, is a major pest distributed in almost all coconut growing tracts across the country especially along the water bodies during winter. The infested portions get dried and form conspicuous grey patches on the upper surface of the lower fronds. Severe pest damage results in complete drying of middle to inner whorl of fronds leaving a burnt appearance. Presence of black headed caterpillars, webbing of leaflets and occurrence of dried faecal matter on the leaflets are the characteristic features of pest incidence. In the absence of natural enemies in the new area of emergence, the outbreak becomes faster and expands at high speed. Damage results in tremendous reduction in photosynthetic area, decline in rate of production of spikes, increased premature nut fall and retarded growth. Extensive

Pest-infested field

Black headed caterpillar Goniozus nephantidis

feeding of caterpillars causes a crop loss of 45.4% in terms of nut yield in addition to rendering the fronds unsuitable for thatching and other purposes. Farmers need not panic and this approach is one of the classical examples of successful augmentative biological control suppressed by natural enemies.

▶ *Management*

a) Regular monitoring of palm fronds for pest occurrence in endemic zones.

b) Removal and destruction of 2-3 older and dried leaves harbouring various stages of the pest. The leaflets could be burnt to reduce the caterpillar/ pupal population.

c) Domestic quarantine should be strengthened by not transporting coconut fronds from pest-infested zone to pest free zone.

d) Augmentative release of the larval parasitoids viz., Goniozus nephantidis (20 parasitoids per palm) and Bracon brevicornis(30 parasitoids per palm) if the pest stages is at third-instar larvae and above. The pre-pupal parasitoid (*Elasmus nephantidis*) and pupal parasitoid (*Brachymeria nosatoi*) are equally effective in pest suppression and are released at the rates of 49% and 32%, respectively for every 100 pre-pupae and pupae estimated.

e) Before releasing, the parasitoids are adequately

P.bondari

P. minei

Cybocephalus sp.

fed with honey and exposed to host odours (gallery volatiles) for enhancing host searching ability.

f) Ensure adequate irrigation and recommended application of nutrients for improvement of palm health.

Nesting whiteflies (*Paraleyrodes bondari and Paraleyrodes minei)*

In addition to the rugose spiralling whitefly, two more nesting whiteflies (Paraleyrodes bondari and Paraleyrodes minei) are found associated with palm leaflets. Nesting whiteflies are smaller in size (1.1 mm) than rugose spiralling whitefly (2.5 mm). The nymphs are flatter with fibreglass like strands emerging form dorsum whereas the nymphs of rugose spiralling whitefly are convex in shape. Adult nesting whiteflies construct bird's nest like brooding chamber and sustains in the chamber. P. bondari had X-shaped oblique black marking on wings with two minute projections on rod shaped male genitalia whereas P.minei is devoid of black markings on wings and possesses cock-head like genitalia.

▶ *Management*

- In juvenile palms, spraying of water with jet speed could dislodge the whitefly and reduce the feeding as well as breeding potential of the pest.
- Ensure good nutrition and adequate watering to improve the health of juvenile and adult palms
- Effective nitidulid predators belonging to Cybocephalus sp. were observed on the palm system and pesticide holiday is advised for conservation biological control.

Diseases

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 prominently noticed in the monsoon phase during the month of July-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.

▶ *Management*

- Need based pruning and destruction of affected spear leaf and other adjacent leaves in the terminal region
- Spot application of hexaconazole 2 ml in 300 ml water on the affected spear leaf region
- Soil test based nutrition for improving the health of the palm and ensure adequate irrigation

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

Leaf rot disease affected palm leaflets

of the spindle is completely rotten emitting a foul smell. Temperature range of 20- 24ºC 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.

▶ *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.
- Field sanitation and provide proper drainage during rainy season.
- 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 monthsas prophylactic measure.
- In disease affected palms, 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.

Correct and timely diagnosis of insect pests as well as disease causing pathogens would be the key factors for the implementation of effective management solutions. Delayed detection would take a longer time for recovery from pest invasion. Prophylactic treatment evading diseases are very important during monsoon phase. Hence a close scrutiny of palms through effective scouting and timely diagnosis would form the basis in doubling income through increased production. ■

Withering of spear leaf

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

Market Review – May 2023

Domestic Price

Coconut Oil

During the month of May 2023, the price of coconut oil opened at Rs. 13600 per quintal at Kochi and Alappuzha market and Rs.14700 per quintal at Kozhikode market.

The price of coconut oil closed at Rs. 13050 per quintal at Kochi and Alappuzha market and Rs.14000 per quintal at Kozhikode market with a net loss of Rs. 550 per quintal at Kochi and Alappuzha market and Rs. 700 per quintal at Kozhikode market and it shows a downward trend during the month.

During the month, the price of coconut oil at Kangayam market opened at Rs. 11400 per quintal and closed at Rs. 10667 per quintal with a net loss of Rs. 733 per quintal.

Weekly price of coconut oil at major markets Rs/Quintal)				
	Kochi	Alappuzha	Kozhikode	Kangayam
02.05.2023	13600	13600	14700	11400
06.05.2023	13700	13700	14900	11400
13.05.2023	13500	13700	14600	11067
20.05.2023	13400	13400	14600	11000
27.05.2023	13100	13100	14400	10733
31.05.2023	13050	13050	14000	10667

Milling copra

During the month, the price of milling copra opened at Rs.8800 per quintal at Kochi and Rs.8550 per quintal at Alappuzha and Rs.8700 per quintal at Kozhikode market.

The prices of milling copra closed at Rs. 8200 per quintal at Kochi market, Rs. 8150 per quintal at Alappuzha market and Rs. 8050 per quintal at Kozhikode market with a net loss of Rs.600 per quintal at Kochi, Rs.400 per quintal at Alappuzha and Rs.650 per quintal at Kozhikode market and it shows a downward trend during the month.

*NR-Not reported

During the month, the price of milling copra at Kangayam market opened at Rs.8050 and closed at Rs.7500 with a net loss of Rs.550 per quintal during the month.

Weekly price of Milling Copra at major markets (Rs/Quintal)				
	Kochi	Alappuzha (Rasi Copra)	Kozhikode	Kangayam
02.05.2023	8800	8550	8700	8050
06.05.2023	8900	8650	8800	8100
13.05.2023	8800	8600	8600	7900
20.05.2023	8550	8500	8450	7850
27.05.2023	8250	8200	8150	7600
31.05.2023	8200	8150	8050	7500

Edible copra

During the month the price of Rajpur copra at Kozhikode market opened at Rs. 9000 per quintal expressed a downward trend during the month and closed at Rs. 8400 per quintal with a net loss of Rs. 600 per quintal.

Weekly price of edible copra at Kozhikode market (Rs/Quintal)	
02.05.2023	9000
06.05.2023	9000
13.05.2023	8900
20.05.2023	8600
27.05.2023	8600
31.05.2023	8400

Ball copra

The price of ball copra at Tiptur market opened at Rs. 9000 per quintal and closed at Rs.8800 per quintal with a net loss of Rs. 200 per quintal.

Weekly price of Ball copra at major markets in Karnataka (Rs/Quintal) (Sorce: Krishimarata vahini)	
02.05.2023	9000
06.05.2023	9711
13.05.2023	9800
20.05.2023	8600

Dry coconut

At Kozhikode market, the price of dry coconut opened at Rs. 10100 per quintal and closed at Rs.9500 with a net loss of Rs.600 per quintal during the month.

Weekly price of Dry Coconut at Kozhikode market (Rs/Quintal)	
02.05.2023	10100
06.05.2023	10100
13.05.2023	10100
20.05.2023	10000
27.05.2023	9500
31.05.2023	9500

Coconut

At Nedumangad market in Kerala, the price of coconut opened at Rs. 10000 per thousand nuts and closed at Rs. 14000 per thousand nuts with a net gain of Rs. 4000 per thousand nuts during the month.

At Pollachi market in Tamilnadu, the price of coconut opened Rs. 23500 per ton and closed at Rs. 20500 per ton with a net loss of Rs.3000 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. 25000 per ton with a net loss of Rs.5000 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) ##
02.05.2023	10000	23500	20000	30000
06.05.2023	10000	23500	20000	32000
13.05.2023	10000	22500	20000	32000
20.05.2023	14000	22500	20000	30000
27.05.2023	14000	21000	20000	25000
31.05.2023	14000	20500	20000	25000

International price

Coconut

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

Weekly price of dehusked coconut with water				
Date	Domestic Price (US$/MT)			
	Philippines	Indonesia	Srilanka	India*
06.05.2023	145	150	202	284
13.05.2023	130	149	206	272
20.05.2023	129	134	221	272
27.05.2023	130	140	NR	254
				*Pollachi market

Coconut Oil

International price of coconut oil expressed a downward trend during the month. However domestic price of Srilanka expressed an upward trend during the month.

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*
06.05.2023	1065	1124	NR	2166	1379
13.05.2023	1077	1116	NR	2219	1339
20.05.2023	998	NR	NR	2345	1331
27.05.2023	986	NR	NR	NR	1298
					*Kangayam

Copra

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

Weekly International price of copra in major copra producing countries				
Date	Domestic Price (US$/MT)			
	Philippines	Indonesia	Srilanka	India* * Kangayam
06.05.2023	624	604	1209	980
13.05.2023	630	601	1181	956
20.05.2023	628	595	1231	950
27.05.2023	621	598	NR	919
				* Kangayam

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

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