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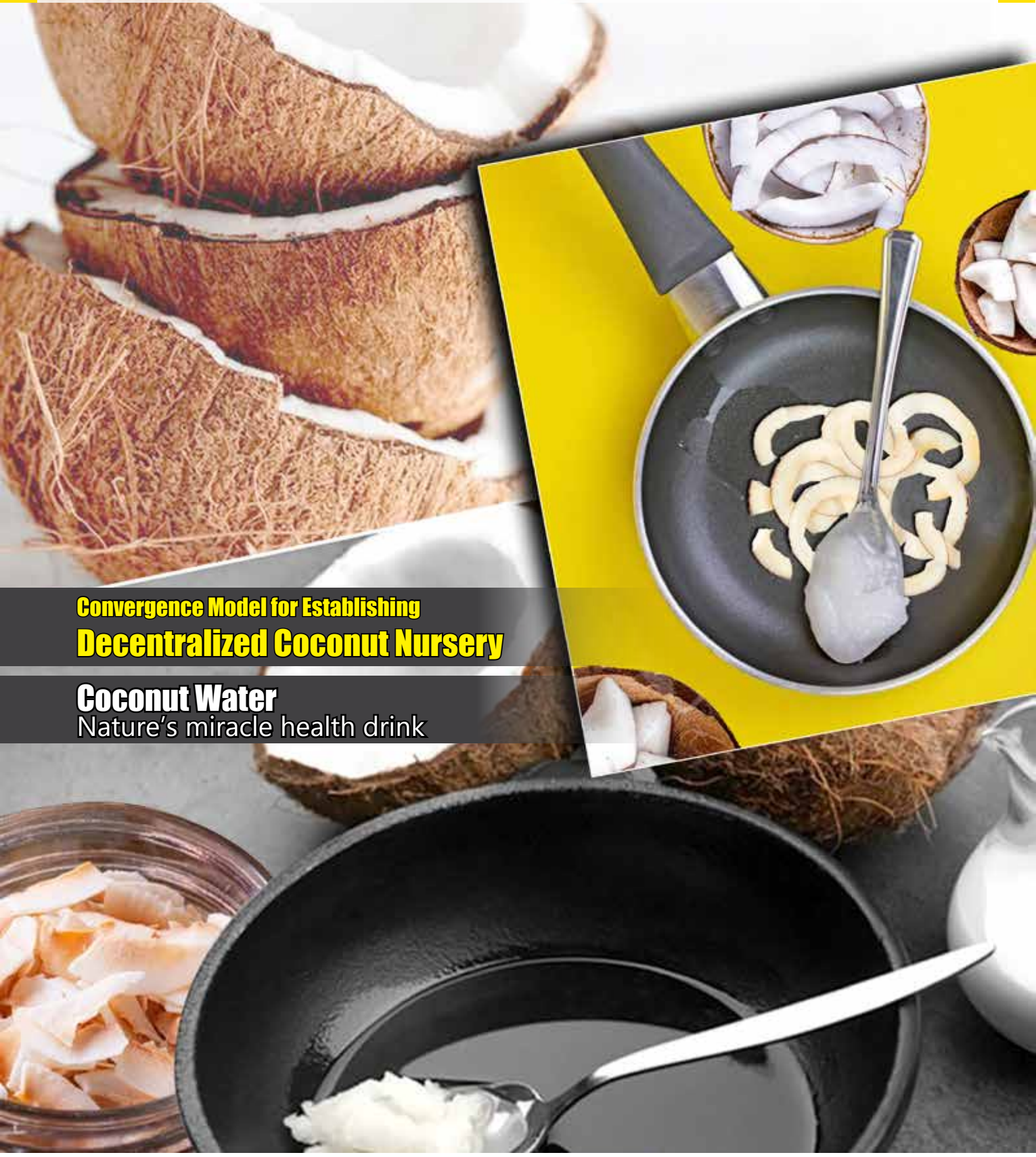

Convergence Model for Establishing Decentralized Coconut Nursery

Coconut Water
Nature's miracle health drink

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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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Message from the Chairperson's desk

Dear Readers,

Senility of coconut palms is a major challenge faced by coconut growers across the country. Timely replanting of coconut with quality planting material is vital for sustaining the increasing demand from the industry which in turn will help in realising a remunerative return for the coconut farmer. Taking note of the same, Coconut Development Board has been giving priority to the replanting and rejuvenation of coconut gardens since 2009.

To attain this, production and distribution of quality coconut seedlings is given thrust by Coconut Development Board. Through its 11 Demonstration cum Seed Production Farms, Board is targeting the production of five lakh coconut seedlings during this year. Establishment of Small Coconut Nursery is implemented by the Board in various states on project basis to encourage private sector and other agencies in coconut seedling production by providing financial assistance for establishing coconut nurseries. Through this scheme, Board is targeting the production of 31.25 lakh seedlings during 2020-21. Farmer Producer Organisations in coconut sector can make use of this opportunity for producing quality coconut seedlings. Establishment of nucleus seed gardens is another programme of the Board for the large scale production of coconut seedlings of promising hybrid combinations and cultivars established under Government, Quasi Government and private sector.

I call upon the coconut farmer fraternity to make use of these opportunities for enhancing and stabilizing the coconut cultivation and industry in the country.

G Jayalakshmi IAS

Chairperson

Convergence Model for Establishing Decentralized Coconut Nursery: The Kallara Experience

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The coconut palm (Cocos nucifera L.) is referred to as 'Kalpavrisksha' because of its manifold uses and it is an integral part of India's culture. Coconut productivity in Kerala, which accounts for 36.5% of production in India, is low (7778 nuts/ha) - (*2nd estimate 2019-20, Department of Agriculture, Co-operation and Farmers Welfare, Government of India*) compared to other major coconut producing states. Predominance of senile and unproductive palms is one of the reasons attributed for the low productivity of coconut in Kerala. Large scale removal of unproductive palms and replanting with quality seedlings is the ideal strategy suggested for making coconut farming profitable.

A number of improved coconut varieties with high yield potential have been released by ICAR-CPCRI and Kerala Agricultural University. However, lack of availability of quality seedlings of released varieties is the major constraint experienced by farmers to adopt improved coconut varieties. There is a huge gap between demand and supply of coconut seedlings in Kerala. It is estimated that governmental agencies are able to supply only 30-35% of the requirement of coconut seedlings. This huge gap allows many 'profit minded' coconut nurseries to exploit the situation by selling inferior quality seedlings, which would adversely affect productivity of coconut.

Establishment of decentralized coconut nurseries utilizing superior coconut genotypes available in farmers' gardens is the solution to enhance production of quality coconut seedlings. Decentralized coconut nurseries established and managed by Farmer Producer Organizations can produce and supply quality coconut seedlings of locally adapted coconut varieties.

To combat the shortage of quality seedlings especially of dwarf varieties of coconut, Department of Agriculture (Govt. of Kerala) joined hands with the ICAR-CPCRI to execute a project titled 'Technology Support for production of quality planting materials of dwarf and semi-tall varieties of coconut' during 2018-20 in 12 districts of Kerala.

Decentralized coconut seedling production programme

Identification of superior mother palms of dwarf varieties with farmer participation was the focal point of this project. The impact of the project included empowering the local farming community for mother palm selection, cross pollination for hybrid (D X T) production and community management of coconut nursery.

As part of the project, 35 community coconut nurseries have been established throughout Kerala

to produce quality planting materials of dwarf varieties from locally selected dwarf parental palms. The support extended by the ICAR-CPCRI to raise the community nursery included identification of mother palms and geo-tagging, seed nut collection from the selected parental palms, financial assistance for meeting transportation charges and labour charges for nursery bed preparation and sowing of seed nuts. The coconut seedlings produced were labeled after inspection by the ICAR-CPCRI officials to check the quality before distribution to the farmers at a nominal rate.

Thus, this project aimed at ensuring that coconut farmers get easy access to quality seedlings of dwarf varieties of coconut through community nurseries. This could be achieved by providing financial assistance and technical support to enthusiastic FPOs which needed necessary motivation and support to establish coconut nursery. Such decentralized coconut nurseries are expected to provide steady supply of quality planting materials of coconut for that locality. The profit obtained after the sale of coconut seedlings will be utilized as seed money in the subsequent years for the purchase of seed nuts and related cost involved in coconut nursery establishment.

Unique initiatives of Kallara Federation

Nalikera Ulpadaka Federation, Kallara in Kottayam district, Kerala started their initiatives during 2016. Eight coconut producer societies, with a total of 870 members, have registered under the Federation which is operational throughout Vaikom Taluk. Of the 870 members of the Federation, about 160 members are currently active under Kallara Coconut Producers Society. The objective of Kallara Federation was (1) to rehabilitate senile and unproductive coconut palms in Kallara Panchayat (2) to provide quality planting materials of coconut to farmers in and around Vaikom Taluk (3) to provide necessary inputs to coconut farmers at subsidised rate using the financial assistance from Coconut Development Board (CDB) (4) and insuring the skilled coconut climbers under 'Kera Suraksha Insurance Scheme' of CDB

Mr.Sugunan, Secretary, CPS & workers engaged in sowing

During the initial phase, the Federation came up with a proposal for training the farmers for Neera Production. But the need for huge initial investment in establishing neera units forced them to drop the idea. They then started the concept of 'Coconut Point' where the Federation members could purchase value added products of coconut produced by Kottayam Coconut Producers Company. This enterprise also could not fetch the expected profit for the Federation as the villagers preferred low cost alternatives.

Since 2016, the Federation used to procure coconut seedlings from the DSP Farm, CDB, Neriamangalam (Ernakulam District) and distributed the same among farmers. But the entire process was hectic and laborious. However, they could facilitate implementing 'Coconut Palm Insurance Scheme' among farmers who bought atleast ten seedlings. Some farmers who had joined the insurance scheme got even upto Rs. 14,000 towards settlement of claims. Federation also distributed Indian Nalikera Journal at subsidised rate to members and also technical leaflets and pamphlets among farmers. They also conducted seminars on topics like 'Cultivation of intercrops in coconut' and 'Integrated Pest and Disease Management in coconut gardens'. Skill development for the members for coconut palm climbing and tractor training were also conducted at Kallara as well as at Krishi Vigyan Kendra, Kumarakom. Agriculture Officers of Vaikom Taluk and the Technical personnel from Coconut Development Board supported and encouraged activities of the Federation.

Implementation of Technology Support project at Kallara

ICAR-CPCRI's Technology Support project was launched in Kallara Village during 2018 and was whole heartedly received by members of the Federation. A tripartite MoU was signed by Kallara Nalikera Ulpadaka Federation, ICAR-CPCRI and Department of Agriculture (Government of Kerala). Healthy and

Inaguration of seedling distribution by Soumya Anoop, Kallara Panchayat President

MNREGS group and Kallara Nalikera Ulpadaka Federation members

high yielding typical dwarf mother palms, identified from Kudamaloor, Kummanam, Kumarakom, Velloor areas, were selected by the project team. Seed nuts were harvested from the selected mother palms and subsequently transported to Federation's nursery located at Kallara. Though there was provision to utilize project funds for establishing coconut nursery, the Federation utilized the unskilled daily wage workers under the MGNREGS of Local Self Government Department for preparation and maintenance of coconut nursery. The MGNREGS members were identified and selected based on their previous experience in raising nursery seedlings of fruit plants under LSGD scheme. Necessary training on 'Coconut nursery establishment' was provided to the selected MGNREGS members. Mr. Joseph Refin Jefri, Agricultural Officer took the initiative for linking Technology Support project of ICAR-CPCRI with MGNREGS of LSGD.

Technology Support project implemented by ICAR-CPCRI had provision for financial assistance for coconut nursery related activities. This is where Kallara stood ahead of other 34 decentralized coconut nurseries. They arranged labourers for 30-40 man days by effectively using MGNREGS for nursery activities and saved the financial assistance provided under Technology Support project. Manual irrigation of coconut nursery during summer months was laborious for the women labourers engaged under MGNREGS. They managed to install an irrigation pump through the government schemes with the help of Kallara Krishi Bhavan. Federation could purchase an electric pump availing 50% subsidy offered by Department of Agriculture. The cost involved in maintenance of coconut nursery could be saved by convergence of MGNREGS with the Technology Support project implemented by ICAR-CPCRI. This savings on labour charges is very relevant as labour cost is very high in a state like Kerala. Similar convergence of various governmental schemes can be carried out in other decentralised coconut nurseries.

During June 2020, Kallara Federation could produce and distribute more than 1000 coconut seedlings to farmers. Kallara Krishi Bhavan also played a pivotal role in helping the Federation by registering the farmers who needed coconut seedlings. The seedlings raised at the Kallara decentralized coconut nursery were constantly monitored by the project team from ICAR-CPCRI. Besides, there was regular coordination between the project team, officials of Kallara Krishi Bhavan and Kallara Nalikera Ulpadaka Federation which ensured the quality of the coconut seedlings.

Way forward

Though COVID-19 slowed down the activities of Federation, rising demands for seedlings of tall coconut varieties among farmers in Kaduthuruty and Vaikom areas are encouraging the Federation to procure seed nuts of West Coast Tall variety from selected mother palms. The Federation is planning to produce about 10,000 seedlings (6000 Talls, 3500 Dwarfs and 500 Hybrids) during next year by availing financial assistance from Coconut Development Board and Department of Agriculture. For continuing the activities initiated and for sustaining the coconut seedling production after expiry of the project, flow of funds needs to be ensured. Towards this, integrating sustainability aspects like developing partnerships and linkages with relevant key stakeholders can be an effective approach. Also, searching for alternate funding sources by involving local self government (LSGD), R&D organizations and line departments will ensure improved access to government initiatives. Such diversifications especially for funding will help in sustaining the project activities in the long run. ■

Balanced fertiliser application-

A critical analysis for ensuring better productivity in coconut

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Coconut, the 'Kalpa Vriksha' is bestowed with the unique quality among all the tree crops to sustain mankind with all its plant parts –providing food, fodder, fuel, medicine, nourishment, housing and so on. The tender coconut provides a refreshing drink. The raw kernel is a major part of our diet. The oil is used for cooking as well as in soap and toiletries. The oil cake is a valuable cattle feed. The husk is used in the manufacture of coir ropes, mats and matting. The trunk is used in house construction and furniture making. The leaves are used for thatching houses. The inflorescence sap is used for making neera, sugar jaggery etc. Each and every part of the crop finds its application in our daily life. So, no part is there remaining to be wasted and it is the same uniqueness of the crop that make it prone to all sort of 'nutritional vagaries'. As the productivity of the palm increase, the quantity of nutrient removed from the soil also increases. During its productive period spanning for six to seven decades, it removes a huge quantity of nutrients from the soil. The palm parts are rich source of nutrients and hence when these palm parts are removed from the coconut production system, it removes with it a major chunk of nutrients from the soil. Based on a study conducted at ICAR-CPCRI RS, Kayamkulam, it has been found that the magnitude of nutrient uptake in an apparently healthy adult palm is of the order 889 gram nitrogen 389.7 gram calcium, 1075 g potassium, 71.6 g magnesium, 229.69 g sulphur, 321.63 mg boron, 2304 mg zinc, 569 mg copper and 1784 mg manganese. On the other hand, if these palm parts are properly incorporated, it will add up to the soil quality so that a multitude of microbes can thrive upon it, sustain the above and below ground biodiversity making it possible for the growth of wide array of crops in the cropping system. Hence all nutrients which are removed from the system through the different palm parts, needs to be replenished with adequate quantity of nutrients through the external supply of inputs, in the right proportion at the right time.

In this background, let us see the necessity of ensuring balanced nutrient management in coconut. Being the basic necessity to ensure the optimum soil reaction for ensuing the nutrient use efficiency of added nutrients, soil pH should be maintained at the optimum level. Hence the factors affecting soil reaction should be looked upon.

Soil reaction

Soil acidity is a major chemical constraint in tropical soils wherein the rainfall is of such a magnitude to leach appreciable amounts of calcium and magnesium from the surface layers of soil. Correction of soil reaction forms the foremost step towards adequate nutrient management in coconut. This implies that the pH of the soil should be in the optimum range for ensuring optimum growth and productivity. The pH range for the growth is in a wide range between 5.2 and 8.0, most ideal being between 6.0 to 6.5. Soil acidity hence needs to be managed for effecting the nutrient use efficiency of added nutrients.

Formation of soil acidity

Heavy rainfall in the tropical regions can cause the leaching down of bases such as calcium, magnesium, sodium and potassium and a resultant rise in soil acidity will occur. Humus, formed by the microbial

decomposition of organic matter in soils is capable of reacting with iron and aluminium ions and form complexes which may undergo hydrolysis to give hydrogen ions. Also, the hydrous oxides of iron and aluminium occurring as amorphous particles of colloidal dimensions undergo hydrolysis giving rise to hydrogen ions. Application of soluble fertilisers with residual acidity also can intensify the soil acidity.

Amelioration of soil acidity

For rectifying the soil acidity, the added material should contain the metallic ion which could reduce the hydrogen ion concentration in the soil solution. It also should not be too caustic to handle nor its reaction with soil shall be too rapid. The metallic cation supplied should encourage aggregation of soil colloid and should not leach out from the soil. Hence potassium and sodium compounds could not be used as ameliorant for soil acidity instead calcium and magnesium compounds are to be used for the amelioration of soil acidity. The anion associated with calcium and magnesium is also important. Hence calcium and magnesium salts of strong acids are not suitable for liming, as it may cause the release of free acids and hence will aggravate soil acidity. Calcium and magnesium salts of weak acids such as carbonates and basic compounds such as oxides or hydroxides are used.

The chemical reaction in the acidic soil while applying liming material

When lime is applied to soil, there will be rise in percentage base saturation, increase in active calcium and magnesium which will lower the hydrogen concentration in soil solution.

The important liming materials in soil include agricultural lime (CaO) which is produced by the heating of limestone (CaCO3), dolomite (Carbonate of calcium and magnesium), and lime hydroxide.

The effectiveness of liming material is decided by the purity of limestone and its fineness. If the material is finely powdered, its reaction will be very fast and if it is coarse the reaction will be very slow.

Effect of lime material on soil and plant health

Liming can enhance the availability of phosphorus under extreme acid conditions as it precipitates out its available forms during the raising of pH. Liming can reduce the toxicity of micronutrients such as iron, manganese, copper and zinc. It can increase the availability of boron and molybdenum. The microorganism responsible for nitrification need large amounts of active calcium and therefore liming to raise the pH values to 6 or 6.5 helps increasing the nitrification. Decomposition of organic matter other than plant residues will be rapid. Symbiotic and non symbiotic nitrogen fixation is favoured by adequate liming. The growth of leguminous plants is increased due to higher amounts of nitrogen fixed and larger amounts of organic matter and nitrogen are therefore returned to the soil. The greater nitrogen fixation by non symbiotic microbes makes possible the more rapid conversion of carbonaceous crop residues to humus in adequately limed soils. Thus, soil fertility status of limed land will be improved.

In coconut, burnt lime and dolomite are effective liming material, the neutralising value of which is 179 and 109 respectively. Liming @ 1 kg/palm/year with the help of lime or dolomite is the recommendation for coconut. The time of application of liming material is important. Approximately two weeks gap is essential between the fertiliser application and liming. If the gap is not there under aqueous alkaline condition, the volatilisation loss of nitrogen will occur and hence the applied nitrogen will be lost as ammonia to the atmosphere. Also, there will be antagonistic displacement of potassium and magnesium from the root zone by calcium in the liming material if they are applied together.

Enriching soil organic matter status in soil

Soil organic matter, forming the core of soil health management need to be maintained for sustaining the palm productivity. Organic matter can increase the nutrient exchange capacity of the soil, its buffering capacity, moisture holding capacity, and can enhance the activity of microbes so that mineralisation can occur resulting in nutrient cycling in the soil ecosystem. In coconut plantations, palm residue recycling can be effectively practiced through vermicomposting and coir pith composting.

Coconut leaf vermicomposting

The fallen leaves and coconut fronds can be converted into nutrient rich vermicompost in tanks or in pits with the help of Eudrilus sp. of earthworms. The well withered coconut leaves should be kept for two weeks after sprinkling with cow dung slurry @ 1/10th of the weight of the leaves. Later earthworms can be introduced@ 1 kg per tonne of the waste. Moisture content need to be maintained sufficiently and shade should be provided to prevent direct

Fig. 1. Deficiency symptoms of major nutrients in coconut

Nitrogen Phosphorus Potassium Magnesium

sunlight. The compost will be ready by 2.5 to 3 months. Watering need to stopped one week before the collection of the compost.

Once the composting process starts, in order to prevent rhinoceros beetle from being attracted to the tanks for egg laying, the tank can be covered with nylon nets or shade net. Clerodendron leaves and metarhizium anizoplea can be put in the tanks as it will prevent the larval transformation to adult.

Coir pith composting

Coir pith is a waste product of coir processing industry, rich in lignin and cellulose. If not composted, they are dumped at the factory premises causing serious disposal problems. However, they can be converted into value added compost using the technology developed at ICAR-CPCRI. For this, 900 kg coir pith is properly mixed with 100kg poultry manure, lime and rock phosphate each @ 5 kg and is spread evenly in an area of 4 X 2 X 1-meter dimension. Water is sprinkled regularly to maintain the moisture. The heap is covered with dry grass to prevent the moisture loss. The heap needs to be turned once in 15 days to enhance the speed of decomposition and the colour changes from reddish brown to dark brown indicating the completion of composting process.

Application of major nutrients

Providing essential nutrients in the requisite amounts after the correction of soil reaction is essential for ensuring soil and palm health as well as to sustain the palm productivity. The major nutrients required for coconut production are nitrogen, phosphorus, potassium, calcium and sulphur.

Importance of maintaining balance of major nutrients in palm

Nitrogen

Nitrogen is a constituent of plant cells and chlorophyll. It is important for the rapid growth and development. It promotes the development of vegetative parts of the plants especially leaves and shoots. The deficiency of nitrogen is reflected in deficit leaf formation and restricted growth. But the effect of nitrogen in plant metabolism could be achieved only if phosphorus and potassium are provided. Leaf analysis is the best diagnostic method for predicting the nitrogen demand as well as possible nitrogen deficiency in the palm.

The deficiency of nitrogen predominates under dry climatic conditions when there is inhibition of nitrification, organic matter poor soils such as sandy soils as well as in waterlogged conditions. The deficiency of nitrogen is indicated as yellowing of the outer whorls of the leaves. In the leaflets, the midrib also turns yellow. Number of female flowers per inflorescence becomes lower and therein the rate of bunch production and the yield will be reduced. The annual requirement of nitrogen for adult coconut palms is 500g per palm. Soil test-based application of fertilisers, basin management with leguminous crops, application of organic manures and farmyard manure can supply requisite amounts of nitrogen to the palm.

Phosphorus

It is found in the leaves and seeds as well as in parts where vigorous cell division occurs. Application of phosphorus increase leaf production, collar girth and root density of coconut seedlings and lower the age of flowering. Under conditions of magnesium deficiency the movement of phosphorus within the plant is hampered and plant may experience the double deficiency of P and Mg according to de Silva (1973), even if the palm is supplied with available source of phosphorus.

The deficiency results in deficit root development and delayed ripening of the fruit. No characteristic visual symptom apart from slowing down of growth and shortening of fronds is observed. In young

Fig.2. Boron deficiency symptoms in coconut

palms there will be stunted appearance and rosette appearance. Khan *et al* (1990) found that skipping phosphorus application for 14 years did not show any adverse effect either on yield or leaf P levels, which suggest that utilization of built up reserves in soil is the most ideal and economical way of management of coconut groves. Green manure addition could also assist in the dissolution and availability of P to palms. It was suggested based on the studies that if the available P in the 0-90cm soil is less than 10 ppm, apply the full recommended dose of 320 g P and if it is between 10 and 20 ppm, maintenance dose of 160g P2O5 per year is recommended. If the available P is more than 20ppm, P application can be skipped for a few years and monitored through soil analysis.

Potassium

It is the nutrient required which is removed in the highest proportion from coconut. Potassium could improve all the nut characters like weight of whole nut, weight of husked nut and copra weight per nut. It increases the production of inflorescence and thereby the number of fruits and copra per nut. Potassium increases the resistance to drought and diseases and hastens maturity and increases fruit set and the number of harvested nuts. Plants take up potassium in the form of K+ ion and its absorption will be hindered by the higher concentration of calcium and magnesium and sodium. There exists nutrient antagonism between, K-Mg, K-Na and K-Ca.

Under conditions of deficiency, the first visible symptom is the appearance of rusty spots on either side of the midrib, which remains green, followed by yellowing of the lamina. The yellowing is more prominent towards the tip. Later the older leaves assume an orangish tinge and the younger leaves remain green and the rusty spots coalesce into numerous irregular brown blotches. Later the yellowing surface becomes necrotic. Overall growth of the palm is reduced and the trunk tapers and becomes slender.

Calcium

Calcium is the base nutrient ion associated with the imparting of turgidity and vigour to the leaves. It is essential for the developing tissues and cell wall development. Acidic soils contain low calcium and continuous crop removal can result in the deficiency of calcium. Calcium is an immobile element in plant and the deficiency symptoms first appear on the youngest leaves. Calcium deficiency in coconut palms are manifested as loss of vigor and turgidity in the youngest tissues, necrosis and death of the bud. Under conditions of calcium deficiency, spraying 0.5% calcium nitrate solution is recommended. Lime application@ 1 kg per palm two weeks prior to fertiliser application will supply calcium to the soil.

Magnesium

Magnesium is the central atom in the chlorophyll molecule in its porphyrin ring structure. It has a definite role in the pigment system and affects the photosynthetic capacity. It also enhances the production of female flowers and activates several enzyme systems in the plant. Magnesium deficient leaves have distinctly green leaf centres and bright lemon yellow to orange margins. Yellowing occurs principally in those parts of the leaf which are exposed to sunlight. In most of the cases, the shaded part remains green.

It is recommended to apply magnesium sulphate @ 500g per palm in areas prone to the deficiency of

Fig. 3. Soil sampling in coconut

the nutrients as well as in root (wilt) affected areas where foliar yellowing is a major issue of concern.

Owing to the antagonistic effect of NH4+ions on the magnesium absorption by the palms, nitrogen fertilisation depresses the foliar magnesium levels. Also, potash fertiliser application depresses the magnesium uptake by the palm. Application of higher levels of potassium fertiliser hence has a depressive effect on the uptake of magnesium from the soil. But addition of organic manure could improve the exchange capacity of the soil and thereby nutrient balance can be achieved to a certain extent.

Sulphur

Sulphur is a component of amino acids such as cystene, cystine and methionine. It also forms part of sulpho lipids in the cell membrane. Sulphur is also a constituent of coenzymes and plays a key role in the redox system in the plants. Sulphur is involved in oil synthesis, copra quality as well as chlorophyll synthesis. Young leaves have low concentration of sulphur, which is gradually increased up to middle aged leaves and beyond which the concentration is decreased.

Sulphur deficiency is seen in the younger leaves and the colour changes to yellowish to orangish yellow. Nut size becomes smaller and it becomes rubbery copra on drying of the kernel. Sulphur can be supplied to soil through the sulphates of potassium and magnesium.

Micronutrients required for coconut nutrition

Boron

Boron is an inevitable micronutrient for coconut and is associated with the activity of apical meristem. It improves the water relations and transport of sugars in plants, enhances tissue respiration, nitrogen metabolism and oxidation-reduction equilibria in cells.

Deficiency of boron causes irregular leaf expansion, distorted leaves and shortened internodal length. The deficiency reduces photosynthetic capacity and stomata conductance. Apart from the foliar symptoms, there will be nut splitting longitudinally, barren nuts, cracking in the shell and button shedding.

Deficiency of boron can be corrected by the application of borax@160g per palm in 4 splits along with organic manure @20 kg per palm.

Copper

It is another important micronutrient for coconut mainly associated with enzymes involved in oxidation reactions. Copper is taken up as Cu2+ ions. In soils with very high organic matter content there will be chelation of copper ions within the matrix and becomes unavailable to plants, imposing deficiency symptoms. The symptoms include bending of rachis of the young leaves followed by yellowing and drying of the leaf tip, with brown and yellow margins and the middle portion remains green. Under severe deficiency, new leaves become short and there will be a diminutive and pendulous appearance to the palm.

If the soil test values of copper is less than 1 ppm, application of copper sulphate@ 25g per palm to the

soil can correct the deficiency.

Zinc

Zinc is associated with enzymes involved in the conversion of starch to sugar, formation of auxins, growth regulation and elongation. It is also associated with the plant defence mechanism.

The deficiency of zinc causes abnormal growth of young leaves which becomes rough in the surface. There will be reduced female flower production. Zinc deficiency occurs if the soil content is less than 1 ppm. The deficiency can be corrected by the application of zinc sulphate@ 100g per palm.

Chlorine

Chlorine is another important micronutrient for coconut productivity. it is taken up as chloride ions. Chlorine is associated with osmoregulation, stomatal opening and closing as well the activity of photo system II in photosynthesis. It increases the thickness of kernel and copra weight. It spurs plant development by promoting collar girth and frond production rate. It enhances the better absorption of potassium, calcium and magnesium which hastens the growth and flowering in coconut.

The deficiency symptoms of chlorine include yellowing or orange mottling in the older leaves and drying up of the outer edges and tips, reduction in number and size of the leaves.

How the balanced fertiliser application can be effected in coconut

We now have seen the importance of balanced fertiliser application in coconut. All the essential nutrients are equally important irrespective of the quantity applied in the soil. Nutrient balance in coconut can be achieved by the systematic adoption of scientific cultivation practices, considering the soil and palm health aspects in a holistic manner. Soil test-based application of nutrients can ensure the application of nutrients in the right amounts in the optimum combination so as to ensure the optimum use of resources in an environment friendly manner.

How to do soil testing in a coconut garden

Soil sample collection from the basin of coconut palms for testing is to be taken at a distance of one meter from the trunk of the palm at a depth of 30 cm, from diagonally opposite points, which are later mixed together to form a composite sample. In order to estimate the general fertility of the field, samples in this manner can be taken in between four palms. The samples are dried in the shade and labelled properly for the laboratory estimation of major, secondary and micronutrients.

Based on the soil testing, if the soil is acidic in reaction as indicated by pH values less than 6.5, liming with agricultural lime or dolomite@ 1 kg per palm has to be applied two weeks prior to fertiliser application in coconut. However, it is necessary to ensure sufficient moisture in the soil before the application of liming material.

Fertiliser application to coconut can be done as per the following schedule. Under rainfed conditions, application of fertilisers can be done two times in a year: with the advent of South West monsoon in June July and with the advent of North East monsoon during September-October. Depending on the intensity of the rainfall, 1/3rd of the total recommended quantity can be applied in the first dose and the remaining 2/3rd can be applied as the second dose.

Table 1. Nutrient recommendation for coconut

Stage of the palm	Organic manure	Urea	Mussoriephos	Muriate of potash
	kg/palm	g/palm /year		
Kerala				
3 months after planting	5	100	160	200
1 year after planting	5	360	535	668
2 year after planting	10	720	1065	1300
3 year after planting onwards	25	1000	1600	2000
Tamil Nadu				
6 months after planting	10	-	-	-
1 year after planting	20	304	400	500
2 year after planting	30	608	800	1000
3 year after planting	40	911	1200	1500
4 year after planting	50	1215	1600	2000
Karnataka				
3 months after planting	20	109	200	225
1 year after planting	20	347	600	676
2 year after planting	20	716	1200	1350
3 year after planting onwards	50	1085	1600	2000

(Source: 1. Coconut Cultivation Practices. 2007.ICAR- Central Plantation Crops Research Institute, Kasaragod, Kerala. Eds. (Dhanapal, R., Thampan, C).Extension Publication No. 179.p.26. 2.http://www.agritech.tnau.ac.in/expert_system/coconut/coconut/coconut_mainfield.html)

3. Package of Practices Recommendations, University of Agricultural Sciences, Bangalore

Enriching soil fertility with leguminous crops

Because of the innate ability of the leguminous crops to tap atmospheric nitrogen in the root nodules, they can serve as live nitrogen suppliers to the plant. Sowing 100g cowpea seeds along with first dose of fertiliser and when one or two plants have started flowering, by 45th to 60th day of planting, they can be turned in to the field. This practice can provide 25-30kg biomass per basin along with supply of 150g nitrogen. This can enrich soil fertility. This sort of basin management with leguminous crops can also promote microbial activity favouring the nutrient mineralisation and its release for palm growth. Apart from cowpea, sun hemp, horse gram, mimosa and daincha can also be sown in the basin.

During the second dose of fertiliser application in September-October, magnesium sulphate@ 500 g per palm can be applied. This can alleviate the occurrence of magnesium deficiency symptoms and reduce the intensity of yellowing in coconut palms particularly in root (wilt) affected tracts.

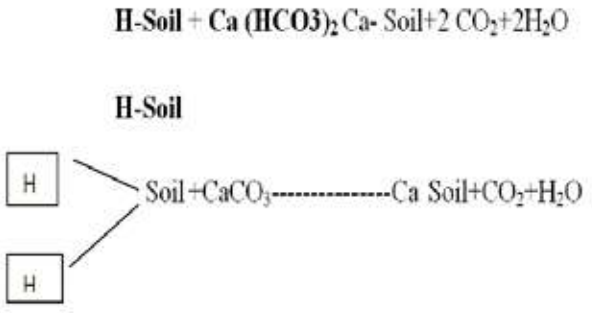
Under conditions of boron deficiency, borax@160g per palm in 4 splits can be applied along with organic manure.

Nutrient mixtures for juvenile palms and adult palms

Considering the soil nutrient status and the palm nutrient requirement, ICAR-Central Plantation Crop Research Institute, Regional Station, Kayamkulam has developed two nutrient mixtures viz., 'Kalpa Poshak' and 'Kalpa Vardhini' for juvenile and adult coconut palms, respectively. 'Kalpa Poshak' comprises the nutrients such as potassium, boron, sulphur, zinc copper whereas 'Kalpa Vardhini' contains potassium, magnesium, sulphur, boron and zinc in different concentrations. The dose recommended for 'Kalpa Poshak' is 40 g/ palm during first year after planting and 100 g/ palm for the second and third years of planting. The dose for 'Kalpa Vardhini' is 500g/palm/year. These mixtures are to be added 10 days after the normal dose of fertilizer application as per the schedule.

Irrigation

One of the critical resources in coconut production is the availability of water. Water is



the medium for absorption of plant nutrients. For all physiological process within the plant including photosynthesis water is essential. There is constant upward movement of water from soil solution through the roots of palms under transpiration pull. Sufficient water should be available in the root zone to maintain plant functions and productivity. Though the coconut growing regions in the coastal belt are endowed with high rainfall, the rainy period is confined to few months during the monsoon season. The palm experiences moisture stress and drought conditions for varying periods extending up to 5-6 months in a year which affects productivity. In the coconut growing region other than the coastal belt coconut has to be grown throughout the year by supplemental irrigation. When irrigation water is delivered through hose pipes, about 250 litres water is required to be applied every 4 days per palm. But when drip irrigation is followed, irrigation is scheduled to compensate the loss of water through evapo transpiration which amounts to 32-40 litres per day for adult palms, under Kerala conditions.

Conclusion

The perennial plantation crop of coconut is highly amenable to systematic and scientific management practices involving soil test based nutrient application, pest and disease management. In a nutshell, adoption of palm health measures systematically will ensure returns to the coconut farmer in tune with the management practices adopted. However, it requires the application of nutrients considering the availability in the soil as well as in the leaf. Correction of nutrient deficiencies as and when noticed in the soil or on the leaf should also be done periodically, for which soil and leaf analysis is inevitable. Hence balanced nutrition is an essential component for the sustainment of palm health and its productivity. ■

Coconut Water

Nature's miracle health drink

Chemistry, Health Benefits, Packaging, Storage and Technologies : A Review

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Coconut water is a natural, nutritious, health, and therapeutic drink from coconut palm trees. The main nutrients of coconut water are minerals, sugars, protein, fat, and other minor nitrogenous and phenolic compounds, vitamins, etc. Coconut water has a typical flavor of coconuts due to delta-lactone and has polyphenol oxidase, peroxidase, and some other enzymes. The composition of coconut water depends on many factors such as soil, nut maturity, variety, and climate. Coconut water is classified as tender coconut water (TCW) and mature coconut water (MCW). TCW has been mainly used as a natural drink while MCW is usually discarded. MCW showed much better in hypolipidemic action in cholesterol-fed rats than TCW according to studies in experimental rats and therefore may be carefully collected and bottled for use also as a health drink. The healing therapies of tender coconut water have been scientifically proven. Experimental studies involving humans and animals showed that TCW can be used to prevent oxidative stress, provide antioxidant activity, prevent lipid peroxidation activity, improve lipid profile, control blood pressure, improve cardio protective activity, provide anti-inflammatory effects, diarrhea therapy, to increase hemoglobin levels, anti-diabetic effects and anti-thrombotic activities and probably many more.

The water available from the coconut produced in the country is estimated at 0.6 million KL valued

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Table 1. The average composition of coconut and by-products and its availability (3a)

Whole coconut	Estimated By-products*			
Production of coconuts/year (average during 2010-2015)	Kernel (33% of nut)	Coconut water (18% of nut)	Husk (33% of nut)	Shell (16% of nut)
India 22,167 million	7315 million nuts equivalent	3990 million nuts equivalent	7315 million nuts	3547 million nuts equivalent
		3591 million nuts equivalent to 359100KL		
World 67,040 million	22123 million nuts equivalent	12067 million nuts equivalent	22123 million nuts equivalent	10726 million nuts equivalent
Tender coconuts (10% of total production**) available	132 million nuts	399 million nuts ** 99750KL	132 million nuts equivalent	64 million nuts equivalent
Current Value at Rs.20/nut(taking 250ml/nut)*	-	**798crores	-	-

*Of the total coconut production in the country, 52 percent is consumed in raw-form. About 95 percent of this is used for household uses and about 5 percent is used for small-scale industrial use like manufacturing of desiccated coconut, coconut cream, coconut milk powder, Nata-de-coco, etc. About 10 percent of the. tota1 coconut production in the country is consumed as tender coconut, it is a natural soft drink for quenching thirst. The remaining 38 percent is processed into copra, a major portion being milling copra. (consumption pattern of coconut – Shodhgangashodhganga.inflibnet.ac.in › bitstreamPDF)

**3990-399=3591million nuts x100/1000=3591million litres= 359100KL

at Rs.6000 crores/year (calculated at Rs.20/nut). Coconut water gets spoiled within 24 hr of storage at room temperature(27^{o}C) while at 10^{o}C stable for 2 weeks and at -20^{o}C to +2^{o}C, it could be stored in glass/plastic bottles(pearl pet bottles) for about 2-3months at the author's laboratory. The contents solidify into a transparent mass and could be easily reconstituted when brought to room temperature for experimental purposes). Available technologies may be used to add value to coconut water and also to provide health benefits to consumers. There is a demand to find a cheaper technology to make packaged coconut water by retaining the natural flavour and quality. Indian Specification for tender and mature coconut water is available.

Introduction

Cocos nucifera is a perennial plant, bearing fruit continuously for up to 60–70 years [(1)]. In India, coconut (*Cocos nucifera L.,*) is also called "KalpaVriksha" and is grown in 17 states and 3 union territories, mainly grown in the southern part of India. The productivity and production of coconut have been significantly increasing in India. Coconut plantation supports the livelihoods of more than 10 million people in India. It gives the national agrarian economy accompanied an annual contribution of Rs. 9000 crores to the GDP and foreign exchange earnings of about Rs. 1200 crores [(2)]. India stands at the third position in the world area and first in production with a share of 17 % and 31 % respectively [(3)].In India, coconut farming plays an important role especially in the economy of Kerala, Karnataka, Andhra Pradesh, and Tamil Nadu states and it generates a significant share in the agriculture income in India. Kerala has been called the "land of coconuts" and has a history of coconut cultivation. The coconut production in India during 2015-16 was 22167 million nuts from an area of 2.09 million hectares [(4)]. Coconut oil contributes around 6 % as national edible oil besides the crop contributes Rs. 7000 crores every year to the Gross Domestic Product (GDP) in India [(5)].

The global scenario of coconut, as per the statistics of 2015, coconut has been cultivated in more than 94 countries in the world in 11.988 million ha. The coconut production is at more than 67.04 billion nuts with a productivity of 5592 nuts ha-1 in the world. Coconut cultivation gives livelihood security to millions of people in the Pacific and Asian regions, which combines more than 89 % of the global coconut area and 85 % of copra production earning more than 1.08 billion US$ as export income. The production of coconut crop has increased almost two times from 1969 to 2015 over a period of five decades(6). Indonesia, Philippines, India and Sri Lanka are the four major coconut

Table 2. Coconut processing units assisted under CDB/TMOC* during 2002-2016)

Product	Units	Processing capacity (Million nuts/year)	Coconut water potential availability calculated at 250ml water per nut **	
			KL	Value @ Rs.100/L
Copra and coconut oil	105	1221.07	-	-
Desiccated coconut powder	103	1011.45	252863	2528.63 crores
Virgin coconut oil	54	216.56	54140	541.40 crores
Ball copra	47	20.94	5235	52.35 crores
Tender coconut water	25	138.6	34650	346.50 crores
Coconut chips and other products	11	3.09	773	7.73 crores
Coconut Milk & Milk Powder	03	16.50	4125	41.25 crores
		Total	351786	3517.86 crores

**Jnanadevan R., Coconut sector experiencing an all-time high price. Indian Coconut Journal February 2018, pages 8-11. ** Codex Alimentarius commission (3a).*

producing countries which amount to 78% of the global production[7,8]. The production of coconut in India and the World, and the estimated availability of coconut water for tender and mature types are provided in Tables 1 and 2. The data indicates that there is a huge availability of the raw material coconut water in the country. Table 1 shows the availability of coconut water and Table 2 shows the availability of mature coconut water that is wasted at present which can be preserved to be sold as a mature coconut water beverage.

The fruit is categorized into two stages of maturity i.e., tender coconut and mature coconut. Coconut water (CW) and coconut kernel (CK) are the edible portions of coconut. Tender coconut water is considered a refreshing and rehydrating drink as it contains sugars, vitamins, minerals, growth-promoting factors, proteins, and amino acids [9]. Tender coconut water is low in fat and low in calories (Tables 4 & 5). As coconut is a rich source of nutrients, it is likely to get contaminated with microbes. As

Table3. Varieties suitable for tender coconut water production

Type of cultivar	Name of Cultivar
Dwarf	COD, CGD, Gangabondam, MOD, Cameroon Dwarf, King Coconut
Tall	Benaulim, Fiji, Cochin china, Guam III, FMS, West African Tall, Tripura Tall, Sakhigopal Tall, Jamaican Tall, East coast Tall, Zanzibar, Andaman Giant
Hybrids	CODxWCT, LCTxCOD, Chandrasankara&Chandralaksha

Table 4. Proximate Composition of tender and mature coconut water of India and US

Component	Tender coconut water	Mature coconut water	USDA reported values of tender coconut water
Moisture (g/100 g)	96.7	95.7	95
Fat (g/100 g)	0.2	1.2	0.2
Total protein (mg/dl)	150	450	720
Total sugar (%)	4.8	3.1	2.61
Total reducing sugar (%)	4.0	2.0	-
Ash (g/100 g)	0.3	0.3	-
Carbohydrates%(by difference)	2.65	2.35	3.71
Potassium mg%	300	257	200
Calcium mg%	40	44	24
Magnesium mg%	16	14	24
Sodium mg%	31.4	31.9	
Iron mg%	4.2	4.0	
Zinc mg%	0.8	0.2	
Vitamin-C mg%	25	15	2.4
L-arginine mg%	30	150	-
Calorie calculated kcal/100g	13	22	19.5
Calorie kcal/100g calculated =(FatX9+Proteinx4+Carbohydratex4)			

Table 5. Proximate Composition of Indian grown tender and mature coconut kernel 12, 12a, 14a)

Composition	Coconut kernel (tender)	Coconut kernel (mature)
Moisture (g/100 g)	85.3	51.0
Fat (g/100 g) dry basis(wb)	5.33 (0.78)	26.71(13.09)
Protein g/100g db (wb)	0.90* (0.13)	2.41* (1.18)
Ash (g/100g) (wb)	9.3 (1.37)	4.3 (2.11)
Carbohydrates % (calculated by difference) wb	12.42	32.62
Potassium (mg/100 g)	97.5	122.1
Sodium (mg/100 g)	34.7	21.6
Calcium (mg/100 g)	21.5	18.1
Iron (mg/100 g)	6.3	7.9
Zinc (mg/100 g)	1.9	2.2
Calorie calculated kcal/100g	57.2	253

*na = not analysed, *Wynn T., (14a)*

Table 6. Water and kernel content at different stages of maturity of Indian coconut (12)

	Tender coconut 1	Tender coconut 2	Mature coconut
Water content g/nut	312±12	308±7	117±43
Kernel content g/nut	80±5	142±14	330±20

long as the CW is inside the fruit, it is considered to be the most sterile liquid. The shelf life of CW and CK is short. A small crack in the shell can cause spoilage. Therefore the shelf life of CW and CK has to be increased to preserve and in transporting to other parts of the country. The CW and CK contained phytonutrients like phenolics and tocopherols that provide health benefits.

Botanical name:*Cocos nucifera L.*

Some of the cultivars grown in India are Andaman Tall (AT); Andaman Ordinary Dwarf (AOD); Arasikere Tall(AT);Malaysian Orange Dwarf (MOD); Malaysian Yellow Dwarf (MYD); Chowghat Orange Dwarf (COD); Chowghat green dwarf (CGD); Cameroon dwarf; King coconut, Gangabondam, Benaulim, Fiji, Cochinchina, Guam III, FMS, West African Tall, Tripura Tall, Sakhigopal Tall, Jamaican Tall, East coast Tall, Zanzibar and others such as West African Tall (WAT), Malaysian Yellow Dwarf (MYD), Equatorial Guinea Green Dwarf (EGD), etc.,

Varieties suitable for tender coconut water production

It has been reported that dwarf cultivars of coconut such as dwarf COD, Chowghat green dwarf (CGD), Gangabondam, MOD, Cameroon dwarf, and King coconut are suitable for tender coconut water production[10,10a,8] (Table 3). Harvesting period for tender coconut water production is usually about 7 months period of maturity to have the maximum amount of water in the nut (8). The weight of tender coconut ranges from 850g to 2.8kg and coconut water ranges from 200 to 700ml with an average of 425ml for different varieties The tender coconut water comprises 95.5% water, 4% sugar, 0.1% fat, minerals such as calcium, phosphorus, iron, zinc, magnesium [8].

Proximate composition of coconut water

The proximate composition of tender coconut water has been reported by Yong et al., (US)[11], Prakruthi Appaiah et al., (India) [12,12a], Zulaikhah (Indonesia)[13]. The data provided by Yong et al.,[11] for US dwarf variety are water content, 206-565 and 393 g/nut; dry solids, 5.01-5.82 and 5-5.5g/100g energy value, 19 kcal/100g, protein, 0.12-0.72, and 0.52 g/100g; total lipid, 0.07-0.2 and 0.13 g/100g; ash, 0.39-0.87 and 0.47 g/100g; carbohydrates by difference, 3.71-4.76 and 4.41 g/100g; sugars, 2.61-5.23 and 3.42 g/100g; calcium, 24-27 and 32 mg/100g; magnesium, 6-25 and 9 mg/100g; iron, traces; sodium, 2-105 and 16 mg/100g; potassium 204-250 and 258 mg/100g; vitamin C as ascorbic acid, 2-7 and 7 mg/100g; vitamin B group (less than 1mg) traces for tender and mature coconut water respectively. Delta lactone is responsible for the typical flavour of coconut water; auxin and cytokines are growth hormones present in coconut water. The review also covers other minor components present in coconut water. The proximate composition of coconut water for Indian tender and mature coconut reported by Sandhya and Rajamohan[14] and Prakruthi Appaiah *et al.*, [12,12a] are provided in Tables 4, 5, 6, 7 and 8. Table 4 shows the proximate composition of tender coconut water and the mature coconut water of India and the US. Table 5 shows the proximate composition of tender and mature coconut kernel. Table 6 shows the water and kernel content of coconut at different maturity stages. Table 7 shows the chemical characteristics of the Indian coconut at different maturity stages. Table 8 shows the chemical characteristics of coconut water

at different maturity stages on a nut basis. A typical proximate composition of tender coconut water reported by USDA provided by Sangamitra et al.,[15] which is also shown in Table 8 along with data for Indian grown tender coconut for comparison. The data indicates similarity in some of the parameters for the Indian and US tender coconuts. The amino acid composition of tender coconut water from dwarf viridis (wulung) variety from Indonesia is as follows.

Vitamin C (ascorbic acid)	32.5mg/L
Major amino acids include L-arginine	12.7mg/L
L-aspartic acid	115.6mg/L
L-glutamic acid	56.65mg/L
L-lysine	23.8mg/L
L-tyrosine	23.6mg/L
L-histidine+serine	47.3mg/L

According to Zulaikhah[13] which also provides data of other chemical characteristics.

The composition of coconut water depends on many factors such as soil, nut maturity, variety and climate (16,17). Coconut water waste is converted into valuable products in food industries. Coconut water waste is rich in growth hormones auxin and cytokines which are known to trigger plant growth (18) and contain nutrients such as sodium, potassium, iron, calcium, etc., (19).

Quality standards for coconut water

Quality standards for coconut water in India are provided in Table 9 [20,21]BIS, 2009 and 2010). Some local specifications are also available for other countries [22].The specification and major general composition such as moisture, total solids, fat, protein, carbohydrate, ash, minerals composition (potassium and sodium), vitamin C, amino acid such as L-arginine content, pH, acidity as citric acid may be used to authenticate the quality and potability. Table 9 shows the draft BIS specification for Indian grown tender and mature coconut water.

The health benefits (healing therapies) of coconut water are given in Table 10 and the literature of research carried out in India is provided in Table 11. Many reviews are available on the subject and hence only a few are cited. Priya and Ramaswamy [14b], Yong *et al*., 2009[11] and Zulaikhah [13] reviewed chemical aspects, biological properties, and health benefits of coconut water from coconuts grown in India, the US dwarf and Indonesian dwarf viridis wulung varieties.

Studies on health improvement in experimental animals and humans

Darilyn *et al.*,[23] studied the short term intravenous use of coconut water in humans and report the successful use of coconut water as a short-term intravenous hydration fluid for a Solomon Island patient. Bhagya et al., [24] investigated whether tender coconut water (TCW) mitigates oxidative stress in a fructose-fed diet and treated with TCW (4 mL/100 g of body weight) for 3 subsequent weeks. TCW significantly lowered the systolic blood pressure and reduced serum triglycerides and free fatty acids. The overall results suggested that TCW treatment could prevent and reverse high blood pressure induced by high fructose diet probably by inhibition of lipid peroxidation, upregulation of antioxidant status and improved insulin sensitivity. Loki and Rajamohan,[25] studied the hepato-protective and antioxidant effects of tender coconut water (TCW) in carbon tetrachloride (CCl4)-intoxicated female rats. Decreased activities of antioxidant enzymes in CCl4-intoxicated rats and their reversal of antioxidant enzyme activities in TCW treated rats, shows the effectiveness of TCW in combating CCl4-induced oxidative stress. The hepato- protective effect of TCW is also evidenced by the histopathological studies of the liver, which did not show any fatty infiltration or necrosis, as observed in CCl4-intoxicated rats. Nair and Rajamohan [26] in their study evaluated the effect of coconut water on nicotine-induced reproductive dysfunction in the experimental male rat model system. Male Sprague Dawley rats were treated with tender and mature coconut water intragastrically and nicotine subcutaneously for 5days. The findings indicated that the coconut water supplementation improves epididymal spermatogenic cell density ($p \leq 0.05$), sperm motility, and morphology which were altered by nicotine. Coconut water also shows a significant increase ($p \leq 0.05$) in testosterone levels in nicotine treated rats. Coconut water ameliorates the reproductive toxicity caused by nicotine due to the presence of nutrients L-arginine, ascorbic acid, minerals like calcium, and magnesium. The study may also corroborate the use of coconut water in Folk medicine to reduce the toxic effects of nicotine and alcohol in reproductive function in men. Preetha et al.,[27] studied the comparative effects of mature coconut water *(Cocos nucifera L.,* Arecaceae) and glibenclamide in alloxan-induced diabetic rats. Treatment with a lyophilized form of mature coconut

Table 7. Chemical characteristics of Indian coconut (from Mysore) water and kernel at different maturity stages (12)

Type	Moisture %wb	Fat* %	Ash** %	Total solids %wb	Total sugars %wb	Acidity % as citric acid wb	pH
TCW1	97	0.2	0.3	3.4	4.2	0.4	4.5
TCW2	96	0.4	0.4	3.7	3.9	0.3	5.1
MCW	96	1.2	1.2	4.3	4.6	0.4	5.2
TCK1	85	37.0	9.3	15.0	-na-	-na-	-na-
TCK2	78	50.0	6.6	22.0	-na-	-na-	-na-
MCK	51	55.0	4.3	49.0	-na-	-na-	-na-

-na- = not analysed. *expressed on a dry basis; **expressed on a dry fat-free basis

water and glibenclamide in diabetic rats reduced the blood glucose and glycated hemoglobin along with improvement in plasma insulin level, showed altered levels of blood urea, serum creatinine, albumin, albumin/globulin ratio indicating that mature coconut water has a comparable effect to that of a well-known antidiabetic drug glibenclamide. Sandhya and Rajamohan [28] carried out a study to determine the effect of coconut water feeding in cholesterol-fed rats. Administration of coconut water counteracts the increase in total cholesterol, VLDL + LDL cholesterol, and triglycerides, while high-density lipoprotein cholesterol was higher, histopathological studies of liver and aorta revealed much less fatty accumulation, increased plasma L-arginine content, urinary nitrite level, and nitric oxide synthase activity indicated that both tender and mature coconut water have beneficial effects. Table 10 shows the healing therapies of tender coconut water. Table 11 shows the studies carried out on the health benefits of coconut water.

Side effects of drinking coconut water

Coconut water is a natural drink for all ages. Coconut water might decrease blood pressure. Taking coconut water along with medications for high blood pressure might cause the blood pressure to go too low. Hence people having hypertension may consume this carefully in appropriate quantities in consultation with the cardiologist(Tables10 & 11).

Processing of coconut water for stability improvement

Coconut water *(Cocos nucifera L.)* is an ancient tropical natural beverage from immature coconuts and it need careful collection and bottling to sell as a commercial product. Coconut water which is removed from the nut and is ready to drink is very sensitive to biological and chemical injuries. Thermal treatment, chemical additives, micro- and ultrafiltration have been studied and have been used in the industry. Preserving taste, aroma, and colour are still a problem in the industry.

Storage at low temperatures (10°C and below), heat treatment, additives treatment, concentrate preparation and spray drying techniques are being used to improve the storage life of coconut water. According to Chowdhury *et al*.,[29], the CW heated at 100 °C for 10 min can be stored for 6 months at ambient temperature. The untreated CK got spoiled within 24hr at room temperature with bad smell and further spoilage with bacterial and mold growth with successive days of storage. The treated CK could be stored for a long time (7 months) without any spoilage. The stability of CW and CK were less than 24hr at room temperature (27 °C) as indicated by its smell and taste as reported by Prakruthi et al., [12]. The acidity of CW (as citric acid) increased with maturity from 0.36 to 1.84 % (TCW1), 0.35 to 1.84 % (TCW2), and 0.49 to 1.7 % (MCW) indicating the increase in the sourness of CW due to spoilage caused by microbial activity. The stability of CW could be increased to more than 24hr and up to 48 hr by heating CW at two different temperatures separately i.e., 80 and 95°C. After the heat treatment, though there was an increase in the acidity the CW was fresh in smell and taste. The authors have found the freshly opened tender coconut water kept in glass/pet bottles at -20°C to +2°C for experimental purposes showed fresh coconut smell and no sourness for 2-3 months. A technology-based on concentrate preparation has been developed at CSIR-CFTRI, Mysuru which can be purchased through CDB Kochi [3,3b]. A healthy food based on tender coconut water concentrate (tender coconut solids) has been developed with good sensory properties which may provide health benefits of tender coconut water[30,31]. Many other research institutes such as the DRDO-Defence Food Research Laboratory, Mysuru and some universities have also prepared/preserved tender coconut water with chemical additive treatments/ different processing methods such as spray drying and some products are available commercially[3b]. The Coconut Development Board has commissioned about 25 production units for the preservation of tender coconut water(Table 2). Due to the presence of many






Table 8. Chemical characteristics of Indian coconut (from Mysore) water at different maturity stages (data expressed on nut basis (12)

Type	Water g/ nut	Fat g/nut	Total solids g/nut	Total sugars g/nut	Ash g/ nut	pH	TPC mg/nut water
TCW1	312	0.624	10.8	13.1	1.0	4.5	4.4
TCW2	308	1.232	11.4	12.0	1.2	5.1	5.5
MCW	117	1.404	5.0	5.4	1.4	5.2	4.6

health beneficial components like minerals, sugars, enzymes, fat, phenolics, tocopherols, growth-promoting factors, cytokines etc., CW and CK can serve as a nutritive food at any stages of its maturity and can be used in the preparation of functional food supplements [30,31]. Both tender and mature coconut water hence may be used as a health beverage by carefully collecting and storing in appropriate containers at low temperatures or through additives treatment or through concentrate preparation/spray drying technique.

Jeyalekshmi *et al.,* [17] studied the characteristics of coconut water at eight successive stages of maturity for titratable acidity, pH, total solids content, total and reducing sugar content, total nitrogen content and non-protein, the composition of fats and fatty acids as well as the content of ash and mineral constituents which changed during ripening which impaired the water quality. Campos, *et al.,* [32] have studied the chemical composition of green coconut water. Both polyphenol oxidase and peroxidase were observed to be present and active in green coconut water. These enzymes showed optimum activity at pH 6.0 and 5.5 and at temperatures of 25°C and 35°C, respectively. Among the chemical and physical treatments investigated, heating at 90°C for 550sec and the addition of ascorbic acid were, individually, the most efficient for enzyme inactivation. The addition of ascorbic acid did not affect sensory properties, however, heat treatment at 90°C for longer than 100 sec decreased flavour quality. Combinations of heat treatment with potassium metabisulfite, ascorbic acid, or both additives did not affect flavour quality. Reddy, et al., [33] developed a filtration system for sterile green coconut water in a two-stage laboratory-scale constant pressure filtration system with a pre-filtration unit by ordinary filter paper (Whatman No. 4) for removal of suspended particles, and a micro-filtration unit by cellulose nitrate membrane (0.2lm pore opening) for removal of microorganisms. Coconut water concentrate can be produced using the spray evaporation technique[34]. Fresh coconut water obtained from freshly opened shells under hygienic conditions, the suspended solids and oils were removed by centrifugation before concentration, whereas minerals were removed from the centrifuged coconut water by passing it through the ionic resin packed column to get a sweet taste. The concentrate had a shelf life of 6 months to 24 months depending on the degree of concentration. Ten liters of coconut water would yield about 800g of concentrate. The concentrate can also be frozen

Table 9. Indian specification for tender and mature coconut water (20,21,22)

Parameter	Tender coconut water BIS (2009)	Mature coconut water
BIS (2010)		
Total solids g/100ml	4.71	3.9 - 5.5
Total sugar g/100ml	2.08	1.70 – 3.38
Reducing sugar g/100ml	0.08	0.23 – 1.30
pH	4.5	5.2
Ash content g/100ml	0.62	0.5 – 0.84

or preserved in cans and after dilution to the desired strength, it can be used in the production of carbonated or non-carbonated coconut beverages as a base as reported by Muralidharan and Jayashree [34]. Recently a German technology is available for the production of spray-dried tender coconut powder (Fig.1, e). Alexia, *et al.,* [35] reviewed the work on coconut water preservation and processing. Thermal treatment combined with chemical additives is already used by the industry but other technologies such as micro- and ultrafiltration are not yet available on an industrial scale. Whatever the process, taste, aroma and colour (linked to enzymatic activities) are still difficult to control. Sangamithra *et al.*, [15] reviewed the work on value-added products from coconut. Adingra *et al*., [36] carried out a comparative study between the physicochemical properties of the coconut water of Guinea Equatorial dwarf variety stored at 28°C and 10°C during two weeks indicated that coconut water storage at the cool temperature of 10°C preserved nutrients during two weeks. A recent study by Archana *et al*., reported during 2020 [37] showed membrane processing of tender coconut water as a clean, green, and energy-efficient method for cold sterilization. Sensorial quality of ultra-filtered TCW was found to be good after three months storage period with zero microbial counts. Other processing methods/technology providers are shown in Table 12, which shows the technologies available on tender coconut water preservation and packaging

Packaging of coconut water and its business:

Fresh tender coconut water in the nut is available for sale in India throughout the year (Fig 1 c). The nut has to be cut open and then water to be sipped using a straw. The fresh/stabilized coconut water packed in tetrapak/pet bottles/sachets is also available only in some parts of India the details of packaging technology available with the manufacturers (addresses provided in Table 12) (Fig 1 and 2). The coconut water packaging market stood at $ 9.2 million in 2017 in India and it will reach $ 25.4 million by 2023. Due to the stress and hectic lifestyle, there is a huge demand for coconut water to address the health concerns among consumers. There is a clear indication that the coconut market is exploding. Coconut water currently represents an annual turnover of US$ 2 billion with more than 200 brands are now marketing coconut water.

The major packaged coconut water producers in India are

1. Jain Agro Food Products Private Limited, Bangalore, Karnataka,
2. Pure Tropic, Tiruppur, Tamil Nadu,
3. Dabur India Limited, Ghaziabad, UP
4. Manpasand Beverages Ltd, Savli Vadodara, Gujarat
5. Lifetree Agro Foods Private Limited, Kerala
6. Nilgai Foods Private Limited, Mumbai
7. Habit Wellness Private Limited, Mumbai
8. Madhura Agro Process Private Limited, Coimbatore, Tamil Nadu
9. Agricoles Naturel Foods Pvt Ltd, Kuttoor, Kerala
10. Nature's First India Private Limited, Krishnagiri, Tamil Nadu

Trade/brand names for packaged coconut water:

Packaged tender coconut water is also known by the following brand names internationally: Agua de Coco, Asian Coconut Water, Coconut Drink, Coconut Fruit Water, Coconut H2O, Coconut Juice, Coconut Palm Water, Coconut Rehydration Solution, Cocos nucifera, Eau de Coco, Eau de Coco Verte, Eau de Jeune Coco, Eau de JeunesNoix de Coco, Eau de Noix de Coco, Eau de Noix de Coco d'Asie, Eau du Fruit du Cocotier, Fresh Young Coconut Water, Green Coconut Water, Kabuaro Water, Young Coconut Water.

It is commonly practiced that the coconut water present in the mature coconut used for the production of virgin coconut oil is being wasted and allowed to putrify/dry in open pits in some industries due to reasons not known. Many kiloliters of this water are going as waste in this way and maybe carefully collected and processed/ vacuum concentrated for use at a later stage for use as a health drink. (Table 12 Fig 2.).

Many research institutions and universities are contributing to the production of wide varieties and hybrids of coconut, cultivation technologies, value-added products, and by-product utilization at the national level, and these are provided below and

Table 10.Healing therapies of Tender coconut water(3)	
1	Feeding baby with intestinal disorders
2	Oral rehydration
3	Preventing body chillness
4	Preventing prickly heat, eliminating rash caused by chickenpox, measles, etc.
5	Killing the worms
6	A good drink in case of cholera
7	Diuretic
8	Treating kidney and urethral stones
9	Preventing urinary tract infection and urinary tract antiseptic
10	Intravenous injection in case of emergency
11	Detoxification in cases of toxins poisoning
12	A tonic for the elderly and the sick

technologies providers address shown in Table 12.

1. ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala

2. State Agriculture Universities

3. Coconut Development Board, Kochi, Kerala

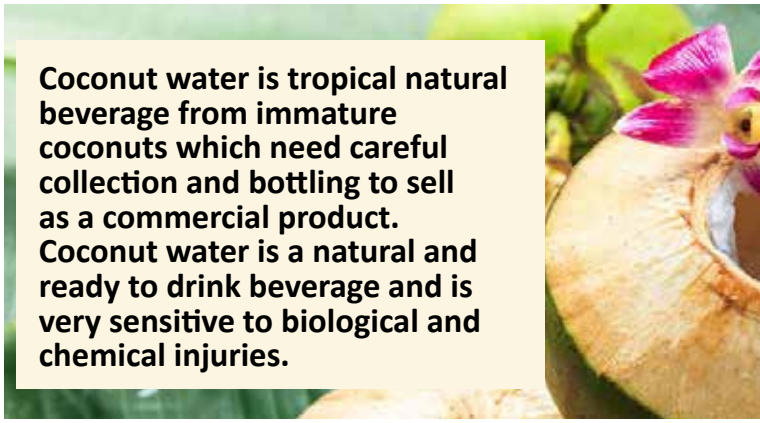
4. CSIR-Central Food Technological Research Institute, Mysuru, Karnataka

5. Regional Research Laboratories under CSIR, and others.

6. Indian Institute of Technology, Kharagpur

Conclusion

Coconut water is a natural, nutritious, health, and therapeutic drink from coconut palm trees. Coconut water is classified as tender coconut water (TCW) and mature coconut water (MCW). While the tender coconut water is available which forms only 10%, the mature coconut water forming 90% gets wasted due to its diverse uses in daily food preparation, coconut processing industries, marriage, and religious functions such as offering to god in temples, etc., However, the mature coconut water wasted in industries processing coconut and the industries producing virgin coconut oil may be collected and preserved for bottling/spray-dried powder production. TCW can be used in many healing therapies such as to prevent oxidative stress, provide antioxidant activity, prevent lipid peroxidation activity, improve lipid profile, control blood pressure, improve cardio-protective activity, provide anti-inflammatory effects, diarrhea therapy, to increase hemoglobin levels, anti-diabetic effects and anti-thrombotic activities and probably many more such as anticancer and antiviral effects. Therefore, the tender and mature coconut water need to be carefully collected, preserved, and bottled/ or spray-dried and packed for marketing later on as shelf-stable products using presently available technologies to add value to coconut water and also to provide health benefits to consumers. There is a demand to find a cheaper technology to make packaged coconut water by retaining the natural flavour and quality. Indian specification for tender and mature coconut water is available. The amount of coconut water (tender+mature) available from the present production is estimated at 0.6 million kilolitres valued at Rs.6000 crores/year. Although some attempts are being made to collect, process and pack tender and mature coconut water, its full potential to be realized to get value addition to the coconut growing farmers and the industry which in turn may meet the increasing demand of coconut water in the country and also provide health benefits to the consumers.■



Coconut water is tropical natural beverage from immature coconuts which need careful collection and bottling to sell as a commercial product. Coconut water is a natural and ready to drink beverage and is very sensitive to biological and chemical injuries.

Table 11. Studies on health benefits of Indian tender coconut water in experimental rats and humans

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Table 12. Technologies provider addresses

Web results on Technologies for Indian coconut water

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CDB enhances benefits under Kera Suraksha Insurance scheme

The 'Kera Suraksha Insurance Scheme' being implemented by Coconut Development Board for coconut tree climbers and Neera technicians had been modified with enhanced benefits from November 2020. Sum assured under the revised policy is five lakhs. This is an accident insurance policy which covers hospitalization charges upto one lakh rupees and is implemented through M/s Oriental Insurance Company Ltd. All the trainees under 'Friends of Coconut Tree' training programme and Neera technician training programme are covered free of cost under the policy during the first year and their entire first year premium shall be fully borne by the Board. The period of insurance is one year. On expiry, the same can be renewed for ensuring continued benefits under the scheme through payment of beneficiary share of premium of Rs 99/. Traditional coconut tree climbers aged between 18 to 65 years can also avail benefit under this scheme by payment of beneficiary share of premium Rs 99/- for a period of one year. Application form duly filled in, countersigned by Agriculture Officer/Panchayath President/CPF office bearers/CPC Directors along with a demand draft for Rs. 99/-, drawn in favour of COCONUT DEVELOPMENT BOARD, payable at Ernakulam, along with copy of age proof needs to be sent to Chairman, Coconut Development Board, SRV Road, Kera Bhavan, Kochi - 682011, Kerala. Beneficiaries share of premium can also be paid online. Application form, claim form and other details are available at Board's website, www.coconutboard.gov.in. For further details please visit the website www.coconutboard.gov.in or contact Statistics section, Coconut Development Board, Kochi. Phone: 0484-2377266 – Extn : 255.

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Fig. 1

Scorching of Cocoa Leaves in Coconut Gardens

C.Sudhalakshmi[1], B.Meena[2], S.Praneetha[3] and H.P.Maheswarappa[4]

Coconut Research Station, Aliyarnagar is conducting various experimental trials at its station spreading across fifty acres of land. Farming System trial is a perfect example of Cumbu Napier Hybrid and Desmanthus growing along with , Glyricidia, Agathi, Moringa. Trial on High Density Planting System with Coconut, Cocoa, Banana, Pineapple and Pepper undertaken in the station is a perfect scientific illustration of a cropping system effectively harnessing the plentiful natural resources available in the Trophosphere. Cocoa leaves almost competing with plantain leaves in its area, intercropped in the High Density Cropping System trial of Aliyarnagar centre were drying, drooping and wilting (Fig. 1). An analysis was made on the causes for the drying of cocoa leaves and the following observations were made.

1. Vascular streak die-back

Vascular streak dieback caused by the fungus *Ceratobasidium theobromae* is cited as the primary cause for scorching of cocoa plants. The disease is reportedly caused due to an air-borne fungal pathogen, which ejects spores into the air during night time. The spores penetrate the epidermal tissues, take their route deep into the stem where they remain for three to five months before expressing the symptoms.

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Fig. 2

Symptoms and Pathogenesis

First indication of the disease is chlorosis of a single leaf with scattered green tissues on the second or third flush (Fig. 2.). The youngest and oldest leaves remain intact whilst all the middle leaves fall off from the affected shoot. The disease progresses eventually through colonized xylem vessels to the stem causing a dieback leading to the death of the plant. Wet moisture regime favours basidiophore production and the disease is very common in high rainfall regions. On longitudinal splitting of the stem, a brown streaking of the wood is observed, which is the characteristic diagnostic symptom of the disease.

The pathogen has Rhizoctonia-like, binucleate hyphae with dolipore septa and hyphal constrictions adjacent to right angled branches when growing in infected xylem vessels. Hyphae can be observed asymptomatically colonizing xylem vessels several centimeters beyond the visible streaking. Basidia develop after evening rainfall and basidiospores are discharged after midnight but lose viability when exposed to morning sunshine. Basidiophores remain viable for about a week on attached branches, but only for a day or two on cut branches (Marelli et al., 2019). However, a factor of satisfaction in the cocoa plants of Aliyarnagar centre was that the longitudinal splitting of stems of the affected fields did not reveal any brown discoloration, oozing or mycelial growth. Hence scorching due to vascular streak die- back was ruled out. *(Adopted from Marelli et al., 2019)*

2. Cocoa Swollen Shoot Virus

Cocoa swollen shoot virus belonging to the family Caulimoviridae is yet another reason for marginal scorching. The virus infects cocoa plantations, pulling down the productivity during the first year and killing the entire plant within few years. Discoloration of leaves, necrosis of root, swelling of stem, red vein banding and die-back are the common symptoms of the disease. The disease is transmitted through mealy bugs and increased light intensity inhibits the development of the disease. The disease is very common in Africa especially under shaded conditions and as red vein banding is not witnessed in the cocoa plants of Aliyarnagar Centre, the possibility of viral infection in the affected cocoa plants has been excluded.

The most common abiotic factor attributing for marginal scorching is potassium deficiency. The deficiency expresses itself as irregular chlorosis spreading from the outer edge towards the leaf base. Necrotic lesions center within the yellow tissues of leaves and in extremities older leaves fall off and show terminal die-back. As the cocoa plants received Muriate of Potash @ 120 g per plant, the 1NNH4OAc- K content of the soil was 218 kg /ha, possibility of potassium deficiency was also overruled.

Agro Meteorology Record

Agro Meteorological Record gave the perfect answer for the reason behind marginal scorching and drying of cocoa leaves. Weather variables of the Meteorological Standard Weeks 31 and 32 recorded in the Agro Meteorological Observatory of Aliyarnagar Centre is furnished in Table 1 and Figure 3. Prominent peaks were observed in wind velocity which laid the foundation for the havoc.

Table 1. Weather variables of the Meteorological Standard Weeks 31 and 32.

Date	Max. Temp (^{o}C)	Min. Temp (^{o}C)	Rainfall (mm)	Wind Velocity (kmph)
Standard Week 31				
30.07.2020	32.0	24.0	3.4	2.2
31.07.2020	32.5	26.0	0.0	3.0

FIG. 4

Fig. 4

01.08.2020	33.5	27.0	0.0	4.8
02.08.2020	31.5	26.5	0.0	3.8
03.08.2020	35.0	25.5	5.0	3.5
04.08.2020	33.5	26.0	12.0	43.3
05.08.2020	30.5	25.0	13.3	52.9
Standard Week 32				
06.08.2020	30.5	27.5	0.0	3.8
07.08.2020	31.5	25.0	35.3	7.5
08.08.2020	31.0	26.5	0.0	5.5
09.08.2020	33.0	25.5	22.2	2.4
10.08.2020	32.5	24.5	0.0	1.5
11.08.2020	32.0	25.0	0.0	3.0
12.08.2020	32.5	24.5	2.3	4.4

High wind velocity experienced three days before the expression of symptoms at the centre was the cause of the mechanical injury in cocoa plants. As structural pruning was done by the end of July 2020, the heavy winds blown through the pruned branches resulted in non-dimensional damages as tearing of leaves, abrasion and damage of plant tissues through rubbing, together with breaking of branches. Winds also lifted the loose sand particles resulting in surface creep. As the pruned branches provided space for the winds to pass through physical knock down of the plants was prevented.

Remedy for the Malady

To protect the exposed ends from fungal infection, immediately the plants were sprayed with copper oxy chloride solution @ 3 g per litre of water (Fig.4.). Two days later, scorching and drying of the leaves ceased and the plants responded positively to the fungicidal spray. Black and infected pods were cleared off from the plants, broken twigs were removed carefully with secateur and the cut ends were smeared with slurry of copper oxy chloride solution. Copious irrigation was given to prevent water stress. Now, the dried leaves withered down, the plants started giving off new reddish flushes and regained completely from the mechanical injury (Fig. 5).

During the same period, high wind velocity left its foot prints on the cocoa plantations in farmers' holdings also. Several enquiries were received at the centre by the farmers pronouncing their fear about the fate of their cocoa plants, conceiving these symptoms as the manifestation of a deadly disease. Even some were prepared to clear off the cocoa plantations, fearing it may spread to coconut also. Having pinned out the exact cause of the issue the curative measures were extended to the farmers and all the succumbed cocoa plantations have started blooming.

Conclusion

Lesson taught by Nature is that a pest or a pathogen need not always be victimized for the maladies occurring in crops. Weather variables viz., temperature, relative humidity, wind velocity, dew point also contribute equally for any disorder in crop system. Whenever cocoa is intercropped in heavy-wind prone areas, wind breaks or shelter belts may be provided along the periphery of the coconut gardens to restrain the turbulence of winds and to save the plants from mechanical injuries. Scrupulous application of organic manures is imperative to stimulate root growth and provide better anchorage as a means of preventing uprooting of plants. Structural pruning is imperative to allow the breeze to pass through the branches. Balanced fertilization is imperative to impart tolerance to diverse stress factors. From the experience of Aliyarnagar Centre, marginal scorching and drying in cocoa plants is not always due to biotic factors but occasionally due to abiotic factors too.

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Rerirement

Shri. M.P Gangadharan Pillai retired from the services of Coconut Development Board on 31st October 2020 on superannuation. He has served the Board around for 30 years.

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139th Meeting of Coconut Development Board

The 139th meeting of Coconut Development Board was held on 27th October 2020 under the Chairmanship of Smt. G. Jayalakshmi IAS, Chairman, Coconut Development Board through Video Conferencing.

Members of the Board; Shri K.K. Ragesh, Member of Parliament (Rajya Sabha), Smt. Chinta Anuradha, Member of Parliament (Lok Sabha),Shri G.S. Basavaraj, Member of Parliament (Lok Sabha), Dr. B.N Srinivasa Murthy, Horticulture Commissioner, Dr. Anitha Karun, Director, CPCRI, Shri K.R. Uday Bhaskar, Principal Commissioner, Central Excise, Customs & Service Tax, Kochi, Shri Naba Kishore Tad, Deputy Director of Horticulture, Government of Odisha, Shri Kuldeep Singh Gangar, Secretary (Agriculture), Department of Agriculture, Government of Goa, Shri Om Prakash Mishra' Secretary (Agriculture), Department of Agriculture, Lakshadweep Administration , Dr. B. Ramakichenin @ Balagandh, Director, Directorate of Agriculture & Farmers Welfare, Govt. of Puducherry, Shri P. Reghunath Kerala, Shri K. Narayanan Master Kerala, Shri S.V. Muthuramalingam, Tamilnadu, Shri Guruswamy D, Karnataka and Shri R. Elango, Tamilnadu attended the meeting. Shri Saradindu Das, Chief Coconut Development Officer and Shri R. Madhu, Secretary, Coconut Development Board also attended the meeting.

CDB observed Vigilance Awareness Week

In accordance with the direction given by Central Vigilance Commission, Coconut Development Board observed Vigilance Awareness Week2020 from 27th October to 2nd November 2020 on the theme "Vigilant India, Prosperous India". Smt. G. Jayalakshmi IAS, Chairperson, Coconut Development Board administered the Integrity Pledge through video conferencing on 27th October 2020 and all the officials of the Headquarters, Regional Offices, State Centres, DSP Farms and other unit offices of the Board took the Integrity pledge. Chairperson, CDB sought the staff members to uphold integrity and stand to ensure zero tolerance against corruption. The necessity of organizing the event and awareness about the observance of Vigilance Awareness Week was also conveyed. As part of training and capacity building of the staff, a virtual lecture on the importance of Preventive Vigilance by Smt.Sandeepni Garg, Deputy Superintendent of Police of the Anti Corruption Branch of CBI, Kochi was arranged for all the staff members of the Board on 2nd November 2020 through video conferencing.

During the valedictory session Smt. G Jayalakshmi IAS, Chairperson, CDB emphasized on the development of standard operating procedures in concerned areas. Shri. Saradindu Das, Chief Coconut Development Officer, CDB, Kochi during his felicitation emphasized that all should lead from the front in maintaining high standards of integrity, transparency and good governance in all aspects of office activities. Shri.R. Madhu, Secretary also felicitated the gathering and shared his views and briefed the responsibility of the individual to be vigilant. Smt.Deepthi Nair S, Deputy Director & Vigilance Officer-in-Charge, CDB requested all the Officers and staff of CDB to maintain integrity and ensure code of ethics in official dealings.

Regional seminar on Coconut Cultivation Technology

Coconut Development Board, State Centre, Odisha organized one day Webinar on Cultivation Technology in Coconut on 11th November 2020 with 50 farmers of different CPS who were connected through video conferencing mode from five different locations .

Dr.Rajat Kumar Pal, Deputy Director, CDB welcomed the Chief Guests, Dr.S.C.Sahoo, Professor and Officer in Charge, AICRP on Palms, OUAT, Bhubaneswar & Dr. Gobind Ch. Acharya, Head, ICAR-CHES who were present in the programme as resource persons at CDB, State Centre, Odisha.

Members of M/s. Maa Jogamaya CPS, Pipli, M/s. Baba Grameshwar CPS, Chandanpur, M/s. Akhandalmani CPS, Kendrapara, M/s. Jai Hanuman CPS, Jagatsinghpur and M/s. Bindhyabasini CPS, Nimapara attended the webinar from various locations.

Dr. S.C. Sahoo, Professor and Officer-in-Charge, AICRP on Palms, OUAT, Bhubaneswar spoke on Care of young seedlings and Management of Rugose Spiraling Whitefly and Dr. Gobind Ch. Acharya, Head-CHES briefed on Suitable varieties of Coconut in Odisha condition.

Dr. Rajat Kumar Pal, Deputy Director, CDB interacted with the farmers on various schemes of CDB and clarified their queries. The regional level webinar programme helped the farmers in various aspects of coconut cultivation.

Regional level webinar

A regional level webinar was organised by CDB RO, Chennai on 3rd November 2020 for the coconut farmers of Kanyakumari, Tenkasi and Tuticorin districts. Around 25 coconut farmers from three districts attended the webinar through video conference along with officials of RO, Chennai and Farm Manager, DSP Farm, Dhali.

The webinar started with a welcome cum inaugural address by the Director i/c Smt. T. Bala Sudhahari. In her address, she briefed the importance of the webinar and requested the farmers to bring more area under coconut cultivation and also to explore the possibility of setting up coconut processing units for producing value added products from coconut.

In the technical session which followed, Professor and Head Dr. K. Ganesamoorty and Prof. Dr. K. Rajamanickam, TNAU, Coimbatore briefed on type of coconut varieties, seed selection, nursery management, coconut cultivation, pest and disease, integrated management practices and value addition on coconut etc.

Mr. Sasikumar C., Development Officer, CDB spoke on Boards schemes and its subsidy, coconut insurance, FOCT etc.and requested the farmers to set up small coconut nurseries so as to avail financial assistance from CDB. In the interaction session the technical team clarified farmers doubts in coconut cultivation, pest and disease management as well CDB schemes. The programme ended with a vote of thanks by Mr. A, Suresh, Technical officer (contract) CDB, RO, Chennai.

Official Language Inspection

Shri.Sunil Kumar, Director(OL), Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare along with two officials inspected the status of progressive use of Hindi in Coconut Development Board, Kochi on 11th November 2020. A meeting was held to review the Official Language activities implemented in the Board. Shri. Saradindu Das, CCDO, Shri.R. Madhu, Secretary and Smt.S.Beena, Assistant Director(OL) attended the meeting.

Cultivation Practices for Coconut - December

Collection and storage of seednuts

From the identified mother palms seed nuts should be carefully harvested and properly stored to prevent drying of nut water. Wherever the ground surface is hard, harvested bunch should be lowered to the ground using a rope.

Nursery management

Irrigation has to be provided to the seedlings in the nursery. Weeding has to be done wherever necessary. Mulching with coconut leaves or dried grass or live mulch by raising green manure crops can be done in the nursery. If termite infestation is noted in the nursery drenching with chlorpyriphos (2ml chlorpyriphos in one litre of water) should be done. Spraying of water on the lower surface of leaves of seedlings can be done against spiralling white fly attack. Remove five month old ungerminated seed nuts and dead sprouts from the nursery.

Fertilizer application

• For irrigated coconut palms one fourth of the recommended dose of chemical fertilizers can be given during December.

• Drip fertigation, wherever feasible, may be continued in coconut gardens as per the monthly schedule.

• Apply 100 g of Borax in coconut palm basin wherever Boron deficiency is observed.

• Apply 500 g Magnesium sulphate per palm in the basin wherever yellowing of coconut leaves is observed due to Magnesium deficiency.

▶ *Mulching and intercultivation*

• Mulching of palm basins can be undertaken if not done earlier. Fallen dried coconut leaves available in coconut gardens can be used for mulching.

• Level down the soil mounds piled up earlier in the coconut garden.

▶ *Shading*

• Shade has to be provided for the newly planted and young coconut seedlings.

▶ *Irrigation*

• Regular irrigation can be started in coconut gardens during December.

• Clean the irrigation channels if irrigation water is guided to the palm basin through channels.

• If basin irrigation method is adopted, provide irrigation once in four days @ 200 litres per palm.

• Drip irrigation is the ideal method of irrigation for coconut. The number of dripping points should be six for sandy soils and four for other soil types. Depending on the evaporation rate, quantity of water to be provided through drip irrigation system in different coconut growing tracts can be decided. In Kerala 30-35 litres and in Tamil Nadu and Karnataka 35-45 litres of water is sufficient per palm per day through drip irrigation system.

• Seedlings can be given irrigation either through drip or basin method. If drip method is adopted,

Spear leaf damage

Inflorescence damage

M anisopliae infected grub

Mass multiplication of M anisopliae

provide irrigation @ 10 litres of water per seedling per day. If other methods like basin method is adopted 60 litres per seedling once in four days is sufficient.

• Irrigation can be started to negate the effect of low temperature in the non-traditional areas like Bihar, Chattisgarh, Madhya Pradesh and North eastern states. Also ensure thick mulch in the palm basin to regulate the soil temperature in such areas.

▶ *Drainage*

• Provide adequate drainage in coconut gardens in localities having drainage problems.

Pest and disease management

The receding phase of North-East monsoon is one of the hallmarks of December month, wherein the weather slowly turns dry and at the same time become cool with the opening up of winter season. Cool and dry period triggers pest occurrence in the perennial system including coconut plantations.

Wetness coinciding monsoon showers could diminish pest incidence, whereas advent of winter (December) opens out pest prevalence as well as subdues disease causing pathogens, and therefore strict vigilance and sustained scouting should become more focussed for timely pest and disease diagnosis and management. Regarding common and perennial diseases such as leaf rot, stem bleeding and basal stem rot persists during this period for which adequate health restoration is the key for the palms to withstand the pressure incited by them and avoid further deterioration.

The cosmopolitan insect pests viz., rhinoceros beetle and red palm weevil, as well as incidences of slug caterpillar, rugose spiralling whitefly, coreid bug and rodents could emerge and take an upper hand during this period in endemic zones.

▶ *Rhinoceros beetle (Oryctes rhinoceros)*

In the post-flood fury, Kerala witnessed habitat destruction of breeding grounds of rhinoceros beetle (Oryctes rhinoceros) which could suppress the damage potential of the pest in adult palms. Being a ubiquitous cum cosmopolitan pest, incidence of rhinoceros beetle is invariably observed in all seasons and the juvenile palms are extensively damaged. Coconut seedlings planted during May-June should be customarily shielded from pest incursion during this period. More than 0.5% natural incidence of Oryctes rhinoceros nudivirus (OrNV) was recorded in Peninsular India and therefore the OrNV-insensitive Coconut Rhinoceros Beetle-Guam (CRB-G) strain is not prevalent in our country, as this strain is taking a great toll in South-East Asian region causing great concern among International community making extensive damage.

Management

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

• Routine palm scrutiny during morning hours along with brushing of teeth and hooking out the beetle from the infested site reduces the floating pest population.

• Shielding the spear leaf area of juvenile palms with fish net could effectively entangle alighting rhinoceros beetles and placement of perforated sachets containing 3 g chlorantraniliprole /fipronil on top most three leaf axils evade pest incursion.

• Dairy farmers could treat the manure pits with green muscardine fungus, Metarhizium anisopliae @ 5 x 1011 /m3 to induce epizootics on the developing

Adults weevils

Crown entry

Toppling of palm

grubs of rhinoceros beetle. Area-wide farmer-participatory approach in technology adoption could reduce the pest incidence very effectively and forms an eco-friendly approach in pest suppression.

• 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.

▶ *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.

Management

• 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.

• 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 reduced pest incidence than mono-cropping.

▶ *Slug caterpillars (Darna nararia)*

Emergence of slug caterpillar, Darna nararia is East Godavari district, Andhra Pradesh and Tumkur, Karnataka could happen as this period is quite conducive for the population build up especially on coconut palms planted along the river beds and brackish water zones. Several hundreds of caterpillars would congregate and feed from under surface of palm leaflets, causing glistening spots and in synergy with grey leaf blight disease complete scorching of leaflets could be observed. In severe cases, complete defoliation was realized and only midribs will be spared. High temperature and cool weather could be one of the triggering factors.

Management

• 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.

• 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.

▶ *Rugose Spiralling Whitefly (Aleurodicus rugioperculatus)*

This period could also witness the establishment of the invasive rugose spiralling whitefly (Aleurodicus rugioperculatus) in new areas as well as re-emergence in already reported areas. Presence of whitefly colonies on the under surface of palm leaflets and appearance of black coloured sooty mould deposits on the upper surface of palm leaflets are characteristic visual symptoms of pest attack. In severe cases, advancement in senescence and drying

Slug caterpillar infested field

Mature caterpillars on palm leaflet

of old leaflets was observed. Leaflets, petioles and nuts were also attacked by the whitefly pest and a wide array of host plants including banana, bird of paradise, Heliconia sp. were also reported.

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.

• No insecticide should be used as this causes resurgence of the pest and complete kill of the natural aphelinid parasitoid, Encarsia guadeloupae.

• Installation of yellow sticky traps and conservatory biological control using E. guadeloupae could reduce the pest incidence by 70% and enhance parasitism by 80%.

• 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.

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 to double income.

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 post-monsoon phase during the month of December. Affected leaves turn necrotic and are not detachable from the palm and remain intact. This disease could be initially observed as minute lesions which later enlarge, coalesce and cause extensive rotting affecting the photosynthetic efficiency of palms. The disease is endemic to root (wilt) affected regions of Southern Kerala

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.

Stem bleeding (Thielaviopsis (*Ceratocystis) paradoxa*)

This disease is mostly confined in the acid soils of Kerala and becomes quite explicit during the period. Conspicuous exudation of reddish-brown gummy fluid is visible on the trunk which turns black on drying. It could be observed initially as small bleeding patch along the longitudinal crack, which later coalesce and form extensive lesion. The tissues underneath show tremendous discoloration and decay subsequently. In advanced stage of infection, outer whorls of leaves turns yellow, dry and shed prematurely affecting the overall health of the palm. Invasion by scolytid beetles such as Diocalandra and Xyleborus would further weaken the stem.

Management

• Avoid burning of trash and palm residues near the trunk to avoid trunk/root injury

• Adequate irrigation and adoption of soil and water conservation measures is advised.

• Application of 5 kg of neem cake enriched with Trichoderma harzianum and soil test based nutrition.

• Application of paste of Trichoderma harzianum talc formulation on the bleeding patches on the trunk was also found effective in preventing the spread of

Colony of rugose spiralling whitefly

Encarsiaguadeloupae

Sooty mould scavenging beetle

Leaf rot disease in juvenile palm

Basal stem rot disease

Bracket fungus

stem bleeding.

Basal stem rot disease (*Ganoderma spp.*)

It is a destructive disease observed in all coconut growing regions and found very severe in soils with higher pH and moisture stress condition. The pathogen invades the root system during early stages of infection that are not visibly noticed. Very severe in areas of Thanjavur, Tamil Nadu parts of East Godavari, Andhra Pradesh and Arsikara, Karanataka. The outer whorl of leaves turn yellowish, then gradually become brown and droop from their point of attachment and hang vertically downwards to form a skirt around the trunk apex.

In course of time, the apex of the trunk shows tapering with the advancement of the disease, and bleeding symptoms may appear on the bole region. At the base of the stem a characteristic reddish brown discoloration develops, accompanied by the exudation of a brown viscous gummy substance. These brownish patches may extend up to one metre from ground level and at times bark pealing was also observed. Sometimes fruiting bodies (basidiocarp) of the pathogen develop from the affected trunk.

Management

- Avoid burning of trash and palm residues near the trunk to avoid trunk/root injury
- 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.
- Isolation of neighboring healthy palms, by digging isolation trenches (60 cm deep and 30 cm wide) around the affected palm (1.2 m away from the base of the trunk).
- 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.
- Root feeding of hexaconazole @ 2% (100 ml solution per palm) and soil drenching with 0.2 % hexaconazole or with 40 l of 1% Bordeaux mixture in the coconut basin are recommended

Hence, sustained monitoring and prophylactic treatments would suppress the damage potential of pest and disease and suitable health management strategies need to be adopted at the appropriate time.

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

Market Review – October 2020

Domestic Price

Coconut Oil

During the month of October 2020 the price of coconut oil opened at Rs. 18300 per quintal at Kochi and Alappuzha market and Rs. 19800 per quintal at Kozhikode market. The price of coconut oil at Kochi and Alappuzha market expressed an overall upward trend and Kozhikode market expressed a downward trend.

The price of coconut oil closed at Rs. 18500 per quintal at Kochi and Alappuzha market and Rs. 19500 per quintal at Kozhikode market with a net gain of Rs.200 at Kochi and Alappuzha and with a net loss of Rs.300 per quintal at Kozhikode market.

The prices of coconut oil at Kangayam market in Tamilnadu, which opened at Rs. 16667 per quintal, closed at Rs.17200 with a net gain of Rs. 533 per quintal.

Weekly price of coconut oil at major markets Rs/Quintal)				
	Kochi	Alappuzha	Kozhikode	Kangayam
03.10.2020	18300	18300	19800	16667
10.10.2020	18300	18300	19600	17000
17.10.2020	18400	18400	19500	17133
23.10.2020	18300	18300	19200	16867
31.10.2020	18500	18500	19500	17200

Milling copra

During the month, the price of milling copra opened at Rs.12400 per quintal at Kochi and Rs.12350 per quintal at Alappuzha market. The price of copra at these markets expressed an overall upward trend.

The prices closed at Rs.12600 per quintal at Kochi market and Rs.12450 per quintal at Alappuzha market with a net gain of Rs.200 and Rs.100 per quintal respectively. At Kozhikode market the prices opened at Rs. 12500 per quintal and closed at the same price.

At Kangayam market in Tamilnadu, the prices opened at Rs. 11000 per quintal and closed at the same price respectively.

Weekly price of Milling Copra at major markets (Rs/Quintal)				
	Kochi	Alappuzha (Rasi Copra)	Kozhikode	Kan-gayam
03.10.2020	12400	12350	12500	11000
10.10.2020	12400	12350	12400	11100
17.10.2020	12500	12350	12300	11200
23.10.2020	12400	12300	12200	10900
31.10.2020	12600	12450	12500	11100

Edible copra

The price of Rajpur copra at Kozhikode market which opened at Rs. 14000 per quintal expressed a mixed trend during the month and closed at Rs.15000 per quintal with a net gain of Rs.1000 per quintal.

Weekly price of edible copra at Kozhikode market (Rs/Quintal)	
03.10.2020	14000
10.10.2020	13800
17.10.2020	14100
23.10.2020	13800
31.10.2020	15000

Ball copra

The price of ball copra at Tiptur market opened and closed at the same price and it shows a mixed trend during the month.

Weekly price of Ball copra at major markets in Karnataka (Rs/Quintal)	
03.10.2020	11500
10.10.2020	11300
17.10.2020	11800
23.10.2020	11500
31.10.2020	NR

**NR-Not reported *NQ-Not quoted*

Dry coconut

At Kozhikode market, the price of dry coconut opened at Rs.13900 per quintal and expressed a downward trend during the month. The prices closed at Rs.12700 per quintal with a net loss of Rs.1200 per quintal during the month.

Weekly price of Dry Coconut at Kozhikode market (Rs/ Quintal)	
03.10.2020	13900
10.10.2020	13000
17.10.2020	12500
23.10.2020	12500
31.10.2020	12700

Coconut

At Nedumangad market in Kerala, the price of coconut opened at Rs.17000 per thousand nuts and closed at Rs. 19000 during the month with a net gain of Rs. 2000 per thousand nuts.

At Pollachi market in Tamil Nadu, the price of partially dehusked coconut opened and closed at the same price.

At Bangalore market in Karnataka, the price of coconut opened at Rs.11500 per thousand nuts and closed at Rs. 22500 during the month with a net gain of Rs. 11000 per thousand nuts.

No report was received from Mangalore market during the last four weeks of the month. During the first week of the month the prices reported was Rs. 28000 for 1000 nuts.

Weekly price of coconut at major markets (Rs /1000 coconuts)				
	Neduman-gad	Pollachi	Banglore	Mangalore (Grade -1)
03.10.2020	17000	16000	11500	28000
10.10.2020	17000	16000	NR	NR
17.10.2020	NR	16000	22500	NR
23.10.2020	15000	16000	22500	NR
31.10.2020	19000	16000	22500	NR

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*
03.10.2020	159	195	NQ	498
10.10.2020	159	183	NQ	498
17.10.2020	NQ	183	NQ	498
24.10.2020	NQ	190	NQ	491
31.10.2020	NQ	204	NQ	498
*Pollachi market				

Coconut Oil

International price as well as the domestic price of coconut oil in Philippines and Indonesia and India expressed an upward trend during the month.

The price of coconut oil quoted 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/Indone-sia (CIF Europe)	Philip-pines	Indo-nesia	Sri lanka	India*
03.10.2020	1055	980	970	2460	2244
10.10.2020	1068	990	973	2348	2289
17.10.2020	NQ	NQ	970	NQ	2307
24.10.2020	1160	NQ	982	NQ	2271
31.10.2020	1160	NQ	982	NQ	2316
* Kangayam					

Copra

The domestic price of copra in Indonesia and India expressed an overall upward trend.The price of copra quoted at different domestic markets are given below.

Weekly International price of copra in major copra producing countries				
Date	Domestic Price (US$/MT)			
	Philippines	Indonesia	Srilanka	India* * Kangayam
03.10.2020	634	600	1433	1481
10.10.2020	644	611	1384	1481
17.10.2020	NQ	639	NQ	1508
24.10.2020	NQ	647	NQ	1467
31.10.2020	NQ	689	NQ	1495

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Regional Offices

KARNATAKA
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