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Drip-fertigation for coconut

Drought: Effects, mechanisms and mitigation strategies in coconut

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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 Chairman's desk

Dear Readers,

The first fortnight of November witnessed the convergence of the world leaders at Glasgow for Climate Change Conference. The leaders emphasized on enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change. It is very crucial for the agriculture sector to adopt a cost efficient system of agricultural production which has minimum environmental impacts. The selection of the best cropping system and the associated farming practices determine the impact of the production system on environment. Coconut farming and coconut agro-ecosystem has been scientifically proven to be one of the country's largest agricultural systems that could substantially preserve carbon dioxide through sequestration.

Coconut is a crop that can promote carbon sinks in the biosphere since it promotes intercropping and mixed cropping. Carbon sequestration is achieved by removing carbon dioxide from the atmosphere and storing the same in the biosphere. Studies on the carbon sequestration potential of coconut orchards have proved that the orchard substantially contributed towards improving the above and below ground carbon stock. The coconut palm has high gross primary productivity and net primary productivity; it diverts most of its photosynthetic product to leaves, fruits, peduncle and fine roots which are all perishable in nature and gets added to soil organic matter after decay and decomposition.

Coconut as a mono crop sequesters significant amount of carbon, which increases considerably with intercropping, mixed cropping and multi tier cropping. Added to this is the enrichment of the soil with the decayed biomass which brings about improvement in the soil structure and texture thereby leading to prevention of soil erosion and sustainable agriculture. Coconut is thus an ideal crop to mitigate the issues of climate change. Also being a perennial, the crop has a multiplier effect. In traditional coconut growing regions in India, planting a coconut palm was done during moments of happiness and prosperity which was considered a good omen. Our culture is rich with many practices which have been followed for generations; the science behind it is realized by mankind much later.

Let us cherish our culture and take better care of our coconut plantations thereby enriching Mother earth and paving the way for mankind to survive the impacts of climate change. Let us also empower our coconut farmers and entrepreneurs for adoption and promotion of enviornment friendly and self sustainable coconut based Integrated Farming Systems.

Rajbir Singh IFS

Chairman

India's agriculture has grown progressive, rudimentary practices descending into oblivion

Shobha Karandlaje,
Minister of State for Agriculture & Farmers' Welfare, Government of India

India's agriculture is in an epoch-making era under the PM Sri Narendra Modi Ji. It is the phase where farmers are reaping the utmost benefit of numerous welfare measures and schemes without any hindrances. The incumbent government, since it assumed power, has unleashed revolutionary efforts to transform the country's agriculture, from being a dependent to an AtmaNirbhar. And, to realise it, budgetary allocations have been tremendously improved over the last seven years, from Rs 21,933.50 crores in 2013-2014 to Rs 1,23, 017.57 crores in 2021-22, annually.

Farmers' welfare has been the focal point of this government. Its agriculture policies have centered around the farmers enabling them to avail themselves without any hiccup and hurdle. To exemplify, for the first time in the history of India, farmers are receiving monetary assistance directly into their bank accounts under PM Kisan Samman Nidhi. Damaged crops are compensated with PM FasalBimaYojana, fertility of soils has been improved through Soil Health Cards, debts have been abolished by equipping them with Kisan Credit Card and many others. Of the set targets of 16 lakh crore, 0ver 14 lakh crore loans have already been disbursed via KCCs.

The MSPs for crops have been raised systemically to be commensurate with the input costs. And, the most effective strive has been the DBT in MSPs (Minimum Support Price) that got rid of the middle man and helped benefit the intended beneficiaries. A record number of procurements have been made through MSPs, and the same has been offered to other crops to induce crops diversification and opt high yielding crops.

The pandemic has not inhibited the government from extending monetary assistance, while the PM has explicitly stated in his pubic rallies how over 1.5 lakh crores were transferred even amidst the COVID pandemic.

The Ministry of Agriculture and Farmers' welfare is working vigorously to set up 10,000 Farmer Producer Organisations (FPOs) across the nation to facilitate the farmers to become entrepreneurs.

To reduce India's dependence on the import of edible oil, cultivation of edible oils are promoted in the states that are favorable and more areas are brought under the cultivation of oil palm, with special emphasis in the North-Eastern region, under National Mission on Oilseeds and Oil Palm (NMOOP). To this effect, a first-ever summit was organised in Assam to underscore the potential of the north-eastern states in substituting the nation's reliance on edible oil. Oil palm areas are expanded and processing units are established.

The Ministry, in its latest decision, has initiated a step to spur production, fertility of soils and diversify crops, and to effectuate, free of cost hybrid seeds mini seeds kit is being distributed to over 8 crores farmers, in 343 targeted districts of 15 adaptable states. The thrust of PM Sri Narendra Modi Ji to make India's agriculture self-

reliant is being ascertained in the truest spirit.

These are not merely on paper but tangible on the ground, and I have endless real-life accounts to share on how farmers across the length and breadth of the nation are benefitted from farmers' centric policies of the Modi government. The decision-making mechanisms have been decentralized while the space once reserved for the officials is opened to the farmers. Coconut Development Board now allowing a farmer to be its Chairman is a validation of it.

The notion of Indian farmers being impoverished and in tatters with bulls and plough are no more the case. Farming has become progressive with the application of modern technologies and sophisticated support systems. Seeds with distinct features to endure climate change and combat malnutrition in India, developed by ICAR, was dedicated to the nation by the PM Sri Narendra Modi Ji. These 35 varieties of climate-resilient seeds will also help counter malnutrition.

MoUs with the private players was signed to make the farmers take an informed decision about the cultivation of precise crops and in a specified time, resulting in higher yield. The farmers will be provided logistics and procurement support, enabling them to choose the just market for a better price.

Over 1000 Mandis have been assimilated into e-NAM (National Agriculture Market) in 18 states and 3 union territories, mitigating the volatility in the markets, and giving access to a unified market. Further, Kisal Rail has shrunk inaccessibility, expanded the market and is delivering agri-produce fresh from the farms to the customers, in the shortest time possible.

Agriculture is imbued with contemporary technologies and the rudimentary practices are descending into oblivion. Professionals are stepping in to farming with expertise, energy and eagerness and making value addition to crops; exploring international markets. Advanced mechanisation such as artificial intelligence, drones, robots remote sensing and GIS technology will be employed under the digital agriculture mission that has been set in for 2021-25. Database of 5.5 crore farmers have been created, their land records linked and exercise to generate a unique farmer's ID kicked off.

Organic farming has been popularised, and those who have left a mark in agriculture are recognised and accorded top civilian awards. The government has bestowed several female farmers with India's top awards who have refashioned farming and galvanised others with their sustainable techniques.

Prominence has been given to all crops that can supplement sustainable farmings and traditional farming methods are countenanced. One district one product is an ambitious scheme to identity at least one agri-product with export potential from each district of the country, to make it available in the international market. To our wonder, Nagaland's Raja Mircha is sold in London, Jackfruits from Tripura are exported to Germany and London, Red Rice of Assam is available in the US whereas Jamun from Kanpur, UP are for grabs in the UK, a novel exercise in the history of the country's agriculture.

In my state review meetings, held with respective states, to smoothen the coordination amongst the numerous departments of the centre and states, have categorically stated to form a separate cell to cater for the export demand of agri-products. The government's bitter decision has born fruitful results, and the exemplification of this was witnessed in J&K. In the last visit, there, I had the chance to converse with the local farmers and apprise myself of the prospects of the region's agriculture. The region produces world-famous saffron, and its cherries are making their way to foreign markets. The government is offering every possible help to the farmers of J&K in doubling their income and for this Kesar Park is being made operational. With this, saffron which was sold once for one lakh is now being sold at two and a half lakh rupees per kg.

India has taken to global forum to bring to fruition its predetermined goal to double the income of farmers and has got its resolution of observing the year 2023 as the 'International Years of Millets,' ratified by the United Nation. This nutrient-rich crop, once termed as a poor man crop, is carving a space in the global market. The peculiarity of this crop is that it has a little water precondition and can be grown in semi-arid land.

The list can go on to affirm our resolve of an AtmaNirbharKrishi and welfare of our Annadatas and corroborate Modi hain to Mumkinhain.

Source: PTI

Board's farm in Andhra Pradesh - marches ahead

Babu Varkey,
Senior Field Officer, DSP Farm, Coconut Development Board, Vegiwada, Andhra Pradesh

Coconut Development Board under the Ministry of Agriculture and Farmers Welfare, Government of India established in 1981 for the integrated development of coconut production and utilization in the country focuses on productivity improvement and product diversification. Facilitating production of quality planting materials of coconut is one of the major focus areas of the Board for enhancing the productivity, thereby the production thereby catering to the needs of the processing industry.

The Board implements several programmes facilitating seedling production by Individuals, Cooperative Societies, NGOs, KVKs and other Government/ Quasi Government organizations. Apart from these, CDB has been establishing 'Demonstration cum Seed Production Farms (DSP Farms)' on its own in various parts of the country with the main aim of seedling production and also to have demonstration value in terms of scientific coconut

DSP Farm of the Board in Vegiwada established in 1994 in an area of 71.80 ha. is ensuring availability of quality planting materials and demonstrate scientific coconut technologies for the farming community. The Farm is situated about 25 km away from Eluru town and 85 km away from Vijayawada

Table 1: Coconut Plantation in DSP Farm, Vegiwada

SL NO	Block	Variety	Palm population	Mother palm
1	A	East Coast Tall	255	191
2	A1	East Coast Tall	151	113
3	F	West Coast Tall	646	424
4	H	West Coast Tall	212	123
5	G	Tiptur Tall	379	221
6	I	Benaulim Tall	235	114
7	J	East Coast Tall	123	54
8	K	East Coast Tall	100	63
9	L	Philippines Ordinary	266	53
Total (a)			2367	1356
10	B	GangaBondam	140	52
11	B1	Ganga Bondam	346	138
12	C1	Ganga Bondam	86	25
13	C	Chowghat Orange Dwarf	254	227
14	D	Chowghat Green Dwarf	154	49
15	E1	Chowghat Green Dwarf	121	26
16	E	Malayan Yellow Dwarf	356	193
17	Border	MIX	43	0
Total(b)			710	1500
18	C	Naturally Cross Dwarf	25	0
Grand Total (a+b+c)			**3892**	**2066**

cultivation with different cropping system models.

Andhra Pradesh is one of the potential States for coconut cultivation. Coconut is cultivated in a total area of 1.14 lakh ha with a production of 12763.50 lakh nuts in the State and ranks 4th in the country in area as well as production.

With the objective of ensuring availability of quality planting materials in the State and to demonstrate scientific coconut technologies for the farming community, the Coconut Development Board took over the possession of 71.80 ha land

from the Government of Andhra Pradesh at Vegiwada, Pedavegi Mandal, West Godavari district in the year 1994-95 for establishing a DSP Farm. The Farm is situated about 25 km away from Eluru town and 85 km away from Vijayawada. The average minimum temperature in this Farm is 15^{0}C and the average maximum temperature is 50^{0}C. The soil type in this Farm is red loamy soil with compact/ ferruginous sand stones. The average annual rainfall in this Farm is 700 to 1100 mm per year

A). Coconut plantation:

The cultivable area of the farm is 40 ha only and the rest are rocky patches. With a view to select mother palms, plantations have been developed in 28.72 ha with 3892 coconut palms of different cultivars viz., 2367 tall variety (East Coast tall, West Coast Tall, Tiptur Tall, Benaulim tall and Philippines Ordinary), 1500 dwarf (Gangabondam, Chowghat Orange Dwarf, Chowghat Green Dwarf and Malayan Yellow Dwarf) planted in different blocks. One block is also planted with 32 naturally cross dwarf palms. Among these, 3593 palms are currently in bearing stage. For adding demonstration value different planting systems are adopted in the Farm viz., Square system of planting at a spacing of 7.5m x 7.5 m and 8m x 8m, single hedge system at a spacing of 6m x 9m and double hedge system at a spacing of 6m x 6m

x 9m. The plantation details are furnished in table 1.

Cocoa is the main intercrop in coconut plantations in the farm and 4822 cocoa plants are planted in six blocks. In addition to cocoa, Guava (18), Amla (28), Custard Apple (55), are also maintained as intercrops. In the rocky areas 110 no. of Cashew plants were also planted and being maintained.

B). Water Management

The main source of irrigation is bore wells and there are currently six bore wells in the Farm. Drip irrigation system is followed in the Farm and the coconut palms are applied with 32 to 80 litre per palm per day depending on the season.

For soil moisture conservation and effective control of weeds the Farm is adopting mulching with fallen coconut leaves in the coconut basins during summer and cover cropping in coconut basin with green manure seeds @ 100 g per basin.

C).Nutrient Management

Five vermicompost tanks with a capacity to produce 35 tonnes vermicompost are also maintained in the Farm. Vermicompost produced with coconut palm wastes and local earthworm, Eudrilus sp., are applied to the coconut palms.

D). Pest and Disease Management

Red palm weevil, rhinocerous beetle and eriophyid mite are the regular pests and Ganoderma wilt disease is observed in the farm and timely management measures are being taken as per scientific recommendations of ICAR-CPCRI, HRS, Ambajipeta, Dr. YSR Horticultural University and other reputed institutes.

In addition, the incidence of rugose spiralling whitefly was identified in the DSP Farm, Vegiwada during December 2018. For management of the pest, yellow sticky traps (size of 1 m x 1 m) @ 15 / acre smeared with castor oil at three days interval are placed on coconut tree trunks at 5 feet height. Entomopathogenic fungus Isaria fumosorosea @ 5ml/L of water mixed with detergent/ Khadi soap @ 5g/L is also sprayed in the crown which has helped in managing the pest population. Clipping of chrysopid predator, Pseudomallada astur on lower surface of leaflets of coconut @ 3000 eggs / acre is also being carried out.

E. Coconut production:

In general the farm is following the harvesting schedule of five harvests in a year. The Farm is producing on an average 2.75 lakh coconuts per annum. A total of 8.83 lakh nuts were harvested during the last 3 years. From the harvest details from the year 2018-19 to 2020-2021, it is observed that the highest production was recorded in West Coast Tall and Gangabondam among tall and dwarf varieties, respectively. As regard to the productivity, Tiptur Tall among tall varieties and Chowghat Green Dwarf among dwarf varieties recorded the highest productivity.

F. Coconut seednut/ seedling production:

From the coconut plantation mother palms with required parameters are selected for seednut/ seedling production. Out of the total 3892 palms, 1356 palms of different Tall varieties and 710 palms of Dwarf varieties have been selected as mother palms. After each harvest, the seednuts are selected from the nuts harvested from the identified mother palms and sown in the nursery, after providing suitable variety wise dormancy period, as per the targets allocated for each year.

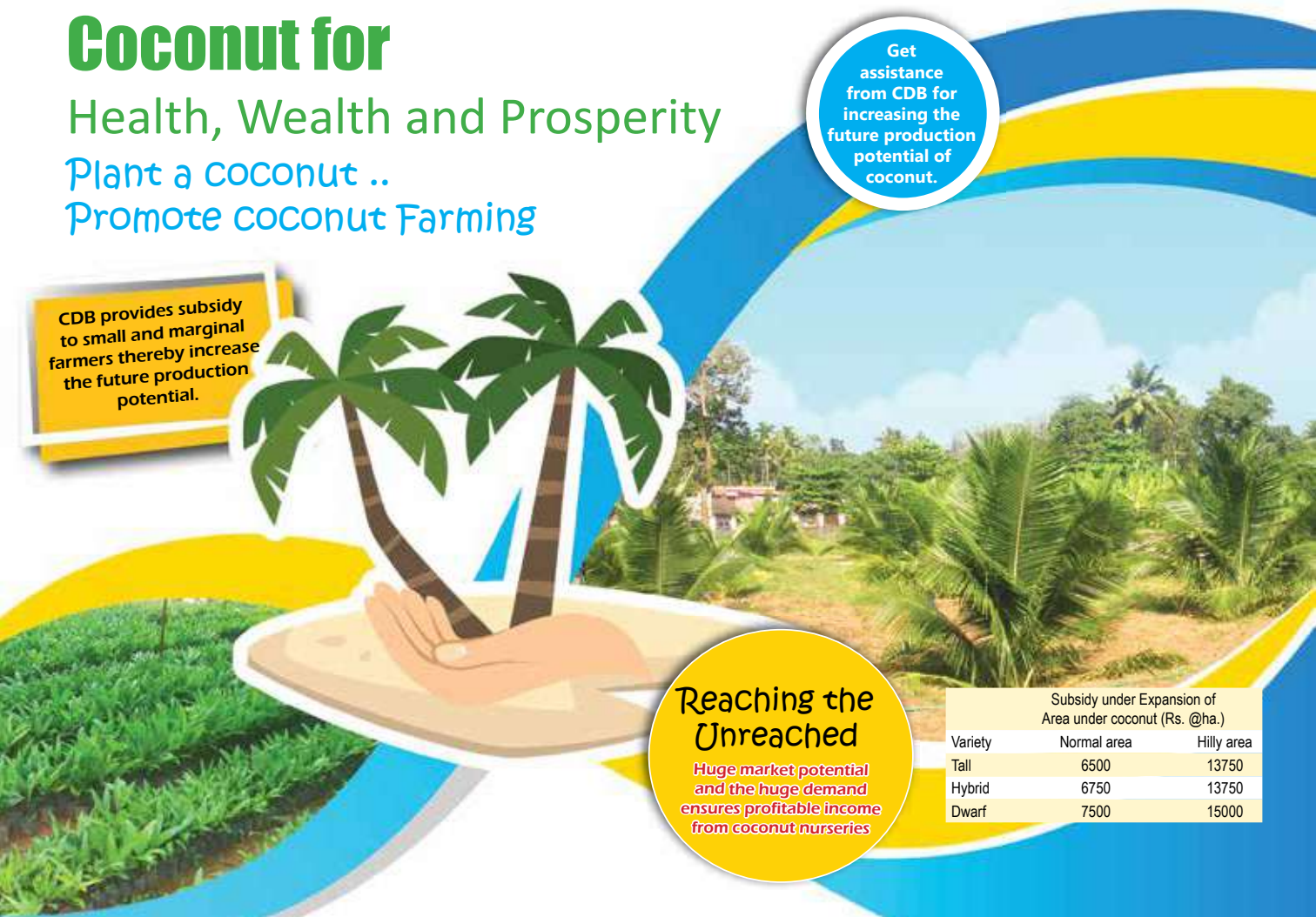
During the last three years 4.50 lakh seednuts were sown in the nursery at the DSP Farm, Vegiwada for production of seedlings. A total of 2.46 lakh coconut seedlings were produced during the period

in the Farm and made available for sale to the farmers.

Horizontal system of sowing of coconut seednuts in the nursery is adopted in order to ensure maximum germination. The nursery beds are provided with proper irrigation at weekly intervals with higher frequencies during peak summer and winter periods. Adequate mulching of the beds with dried coconut leaves during summer season and vertical mulching with red gram plants in the borders of nursery beds in winter season are practiced.

A total revenue of Rs. 181.51 lakh was realized in the DSP Farm, Vegiwada during the past 3 years from the coconut plantation including intercrops (Rs. 35.08 lakh) and from the coconut nursery (Rs. 146.43 lakh).

Those farmers require seedlings may contact the DSP Farm during working hours at Ph.: 08812-212539, 8331869886 or e-mail: f-vegiwada@coconutboard.gov.in.



Drip-fertigation for coconut

Neenu,S., Thamban, C., Subramanian, P.
ICAR-CPCRI, Kasaragod

During summer months coconut plantations are often subject to severe moisture stress especially in the absence of timely irrigation. Soil moisture stress frequently limits the growth and nut yield of the palms. The most common method of irrigation adopted in coconut plantation are flooding, basin irrigation, sprinkler or perfo-sprays and drip irrigation. Among them drip irrigation is one of the most efficient methods of micro irrigation in which water is applied directly to the root zone of plants and the usage of water can be controlled as per the requirement of the plant. It is suitable to all types of soils varying from porous or less porous to the very porous soils.

Drip irrigation is suitable for the undulated topography where any other type of irrigation will lead to wastage of water and energy. In this method water can be applied on surface or subsurface of the soil and compared to surface irrigation (25-30% efficiency) this system has an overall application efficiency of around 90%.

Components of Drip Irrigation in the field

▶ *Pump*

Drip irrigation is a form of pressurized irrigation wherein the water reaches the base of the plant through pipes at high pressure from the water source. Therefore, the first requirement in a drip irrigation system is a pump which allows water to flow into the pipes at high pressure and a water tank installed at a sufficient height. The pump in the drip irrigation system should be selected based on the water required for irrigation, the pressure required for the drip irrigation to work efficiently and the depth of the well from which water is pumping. The most popular pump available in the market today is the centrifugal pump. When the water source is a very deep bore well, a submersible or underwater pump should be used to pump the water. A jet pump can be used to pump water from deep wells.

When designing a drip irrigation system for homestead gardens with 20 to 30 palms, water can

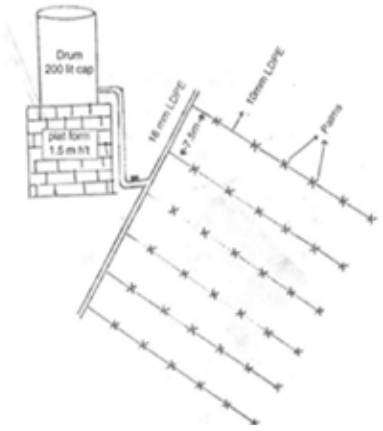


Fig. 1: A model layout plan of drip irrigation for coconut plantation (0.2 ha)

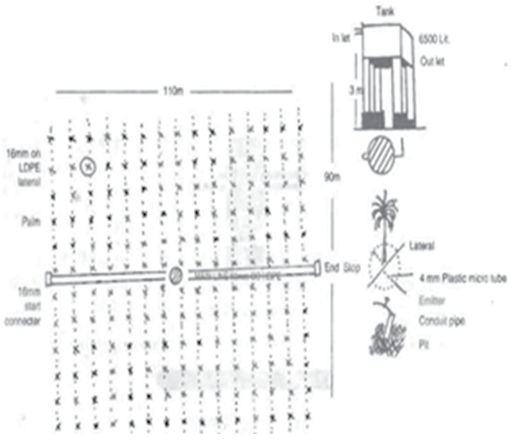


Fig. 2: A model layout plan of drip irrigation for coconut plantation (Area 1 ha)

be used from the overhead tank attached to the household. Based on the number of palms in the garden we can decide the tank size. A tank size of 1 x 1 x 1 m will hold 1000 litres of water. Depending on the area, the water requirement of palms varies. For crops like coconut, normally 3-4 drippers are given per palm. Either PVC or HDPE pipes can he used for the main lines. It is better to bury the main pipes at a depth of 1.5 to 2 feet below the soil surface so that, the intercultural operations like ploughing, fertilizer application etc. can be done without any interruption during rainy season. If the pipes are buried in soil, the life of the pipes will be longer. PVC pipes ranging from 2 to 4 inche size can be conveniently used or HDPE pipes of 2 - 3 inches can be used. These pipes run along the rows of the palm in the garden. Care should be taken to attach the valves as required when deploying the main line. It is also necessary to give the valve at the opening when taking branches or sub lines from the pump. The sub line is to carry water from the main line to the lateral. The number of sub lines depends on the area and shape of the farm. Sub lines are not required in small farms. Laterals can be deployed on the main line itself. Laterals are pipes to supply water from the main line or sub-line to the drippers. The size of the laterals varies from 11-16 mm depending upon the pressure requirement. Avoid the use of recycled laterals as its life span may not last for more than one year. It is recommended to use original/branded pipes as laterals which may last for 7 to 10 years. These laterals also can be buried in the soil at 20 cm depth when in use and can be coiled and tied on the trunk of the palms during off-season.

The dripper is the last component of drip irrigation system which brings down the high pressure of water to atmospheric pressure and supplies it to the plant at the required rate. The pressure of the water decreases due to the friction caused by the water passing through the dripper. Four main types of drippers available in the market are; dripper that changes the flow rate according to pressure, dripper that will not change the flow rate according to pressure, dripper similar to a tap and microtubes. The microtubes are much less likely to clog than the other three drippers and are cheaper than other drippers.

▶ *Emitter or Micro tube Placement in the Coconut basin*

Coconut basins are generally made in a radius of 1.8 to 2 m from the centre of the bole all round the palm. Studies on the coconut root spread indicates that, 0.75 to 1.25 m away from the bole is the active absorption zone and hence it is recommended to place the emitter micro tubes in the centre of that area (about 1m away from the bole). To avoid evaporative loss, it is recommended to allow the water to drip at 30 cm depth. This can be done by making a pit of 30 cm3 and a conduit pipe of 40 cm is placed diagonally in which the water is allowed to drip at 30 cm depth (Fig. 3, 4 & 5). The pit should be filled with locally available mulch preferably coir pith to avoid evaporation loss.

▶ *Water Spread*

In drip/trickle irrigation, the soil water distribution for different soil is an important factor to be taken into consideration before initiation of irrigation, as

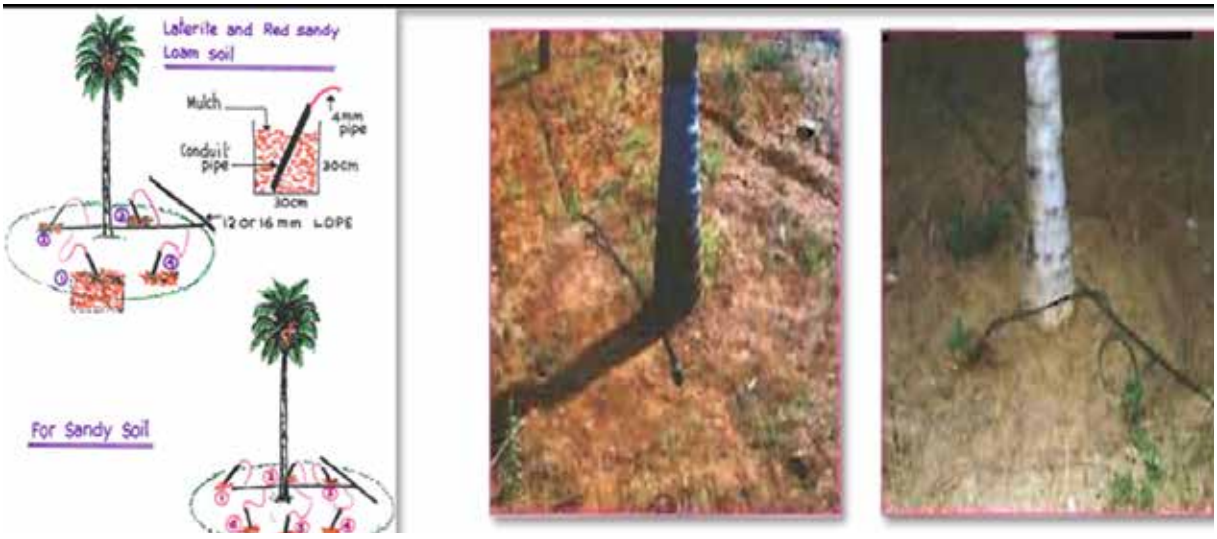


Fig. 3, 4 & 5

the volume of roots wetted has a direct relationship with the quantity of water supplied and the nutrient uptake. Soil water distribution is determined by the soil properties and the amount of water added and withdrawn from the soil surface. A minimum of 20 to 30 percent of the active root zone should be wetted to absorb the water required by the palms. Results of the experiment conducted at CPCRI has shown (water spread from a single point source) that minimum four emitters are required for the laterite and red sandy loam soil, whereas for the sandy soil, six emitters are required to wet adequate volume in active root zone. The rate of water application should be 2-3 litres per hour per emitter (Fig. 6)

Fig. 6

▶ *Quantity of water*

Based on a study conducted at ICAR- CPCRI under Kerala condition, 32-40 liters (66 % of open pan evaporation) of water/palm/day can be applied through drip irrigation based on the open pan evaporation. 34 per cent of water can be saved in drip irrigation (Subramanian et al., 2018) compared to basin irrigation @ 200 litres/palm once in four days. Irrigation should be started in December when the soil moisture depletes to 50% of available soil moisture (ASM).

Potential Advantages of Drip Irrigation System

Through drip irrigation, more area can be brought under irrigation as 30- 40% of water can be saved in drip irrigation over other methods of irrigation. Slow and frequent watering eliminate wide fluctuations in moisture content and results in better growth and yield. This is a better and efficient means for application of fertilizer and other chemicals. There would be only limited weed growth as there is partial soil wetting compared to other methods of irrigation and reduced energy requirements in terms of electricity and human labour. Drip irrigation system is very much suited to poor soils where conventional methods of irrigation lead to deep percolation (eg. sandy soil) and low infiltration (heavy soils).

Cost of Drip System

The cost of Drip system including installation would be around Rs. 450 and 500 per palm (exclusive of pump) which works out to Rs. 80000 to 90000/- approximately/ha of coconut garden with four emitters per palm.

Fig. 7: Fertilizer Tank

Fertigation

Fertigation is an efficient method of fertilizer application through irrigation. Water soluble fertilizers in the right quantity at the right time is applied along with drip irrigation, which ensures that nutrients reach the root zone realizing efficient use of the given fertilizer. Only less quantity fertilizer is required rather than the conventional method. Fertigation increases the efficiency of applied fertilizer. Water-soluble fertilizers such as urea, di-ammonium phosphate (DAP) and potassium chloride can be combined to provide through drip irrigation / trickle irrigation. Liquid fertilizers that dissolve very quickly can also be used, but it is slightly costly,

Depending on the age of the coconut palm and the soil conditions, farmers apply the required fertilizers twice a year at the basins of the coconut palm by conventional method. A portion of the fertilizer thus applied is lost by evaporation and leaching in the soil. The purpose of fertigation is to apply the fertilizer in small quantities during several times along with the drip irrigation so as to minimize the loss of nutrients. It does not cause any additional cost to the farmer in terms of labour charges and can also save the use of excess fertilizer.

Practices of Fertigation

To capitalize on fertigation benefits, special care should be taken in selecting fertilizers and injection equipments and maintenance of the system.

Fertilizer Injection Method

Fertilizer injectors are designed for a specific pressure and flow range. There should be suitable anti-siphoning valves or non-return valves to prevent the back flow or siphoning of water and fertilizer solution into fertilizer tank. The modern fertigation equipments are designed to regulate fertilizer quantity applied, fertigation duration, ratio of different proportions of fertilizers, starting and ending time etc. There are the following three methods of injection

▶ *1. Pressure Differential (By-pass) tank*

The fertilizer solution is poured into an airtight tank and a portion of the irrigation water is allowed to pass through the tank. Pressure differential tank system is working based on the principle of pressure differential created by a valve, pressure regulation, elbows or pipe friction in the main line (Fig.7). The pressure difference forces the water to enter through a by-pass pipe into the pressure tank that contains the fertilizer and to pumped out again by carrying varying amount of dissolved fertilizers. The application of nutrients is quantitative; therefore it is adapted for perennial crops like citrus, fruit trees and/or crops grown in heavy soil. The cost is around Rs. 8000/- for 120 litre capacity tank.

▶ *2.Vacuum Injection (Venturi)*

In this method, a venturi device (Fig.8) is used for reducing pressure (vacuum) that sucks the fertilizer solution info the line. It is very simple to operate as there is no moving parts, easy to install and maintain, suitable for very low injection rates and both proportional and quantitative fertilization. A plastic hose from both sides of a valve in the main line of the irrigation system is submerged into the fertilizer solution mixed in a bucket placed below and the valve is then slowly closed. In doing so, the water passes through the main pipe and also partly through the vent. When it reaches the narrow part of the vent, the speed of the water increases and the pressure decreases accordingly. The resulting low pressure pulls the solution out of the bucket. This valve can be controlled and the rate of fertilizer application can be adjusted.

▶ *3.Pump Injection*

Pumps are used for injecting the fertilizer solution from the supply tank into the line (Fig.9). Injection energy is provided by electric/ hydraulic motors (diaphragm and piston). The centrifugal pump used for conventional irrigation can also be used for this

Fig. 8: Fertigation with Venturi

Fig. 9: Fertigation with Injection pump

purpose. One of its disadvantages is that its flow rate decreases with the pressure of the water in the main irrigation pipe. This drawback can be avoided by using a positive displacement pump. These pumps are capable of pumping a certain amount of solution regardless of the external pressure. It has advantages like very accurate, proportional fertigation, no pressure loss in the line and easily adapted for automation.

Fertilizer Solubility

An essential pre-requisite for the solid fertilizers used in fertigation is its absolute dissolution in the irrigation water. Examples of highly soluble fertilizers appropriate for the fertigation are ammonium nitrate, potassium chloride, potassium nitrate, urea, ammonium monophosphate and potassium monophosphate. The solubility of fertilizers also depends on temperature. Di ammonium phosphate has good solubility which is mainly used for supplying phosphorous and nitrogen.

Nitrogen Fertigation

For nitrogen fertigation, urea is a well suited fertilizer for injection in micro irrigation system. It is extremely soluble and dissolves in non-ionic form, hence it does not react with other materials in the water. Fertilizer urea does not cause precipitation problems in the drip system. The nitrogenous fertilizers suitable for drip fertigation are urea, ammonium nitrate, ammonium sulphate, calcium ammonium sulphate, calcium ammonium nitrate etc.

Phosphorus Fertigation

Normally phosphorus application through irrigation water may cause precipitation of phosphate salts in the system. Among the phosphatic fertilizers phosphoric acid and mono ammonium phosphate are found to be more suitable for fertigation.

Potassium Fertigation

Potassium fertilizers are soluble in irrigation water and hence application of K fertilizer does not cause any precipitation of salts. Among the common potassium fertilizers, potassium nitrate, potassium chloride, potassium sulphate and mono potassium phosphate are used in drip fertigation.

Micro nutrients Fertigation

Micronutrients like iron, manganese, zinc, copper, boron and molybdenum are able to supply through drip fertigation to correct micronutrient deficiency in coconut.

Fertigation time and frequency

The fertilizers can be applied six or more times in an year in equal splits depending on the rainfall period. However, fertilizers should not be applied during periods of heavy rainfall. Findings of CPCRI indicated that 50% of the recommended dose of fertilizer (NPK) when applied through drip fertigation is sufficient to produce an yield equivalent to 100% of the recommended dose of fertilizer (NPK) applied through conventional method.

The fertilizers were applied through a by-pass tank to the palms. Fertilizers viz., urea @ 91g, phosphoric acid @33 ml and muriate of potash@170 g per palm per application and when DAP is used, it is recommended to provide Urea@70g , DAP @60g and muriate of potash@170g for single dose per palm. Six doses are to be applied to the palms from December to May at monthly intervals for Kerala conditions. For Phosphorus application, commercial phosphoric acid can also be used.

Facts about Fertigation

The success of fertigation often depends on the efficiency of the irrigation system. The complete advantages of fertigation become evident only if correct irrigation design is employed to meet the plant requirement for water and nutrients. Although the PVC, HDPE or LLDP pipes in the drip irrigation system do not react with the fertilizer chemicals, the metal components in the pipes may do so. Therefore it is better to avoid metal components in fertigation which are likely to undergo chemical reaction. The fertilizer materials are corrosive in nature and hence the component parts of the irrigation system that come in contact with the fertilizer solutions should be made up of stainless steel/ plastic /non-corrosive materials. The concentration of total nutrients in the mainline should not exceed 5g/litre. Care should be taken to mix fertilizers in sufficient quantity of water. If fertilizers are not dissolved fully prior to injection in to the system, it may result in application of varying concentration and create blockage in the system. Wherever necessary suitable anti-siphoning valves should be installed to prevent backflow or siphoning of water, fertilizer or chemical solution into fertilizer tank or irrigation supply.

Fertigation System Hygiene

Fertigation results in high concentration of nutrients in irrigation system and this may lead to the growth of bacteria, algae and slime in the system. These should be removed regularly by injecting chlorine or acid through the system. During the time of fertilizer injection, chlorine addition should be avoided. Care should be taken to ensure that the system should always be flushed of nutrients before completion of irrigation. During the fertigation period it is important to check pH effects over time in the root zone, soil temperature effect on nutrient availability, corrosion and blockage of outlets and reaction with salts in the soil and water.

Though fertigation is possible by drip, sprinkler and other irrigation methods, for plantation crops like coconut, arecanut etc. fertigation is most suitable and economical through drip irrigation as these crops are widely spaced. Fertigation adopted through sprinkler irrigation causes more water and nutrient loss. ■

Drought: Effects, mechanisms and mitigation strategies in coconut

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Abstract

Coconut (Cocos nucifera L.) is an important palm that plays a significant economic role in most of the South Asian countries including India. It is mostly grown in coastal areas and hilly terrain which is highly vulnerable to climate change. The coconut palm generally grows well in areas receiving an annual rainfall of 1300 to 2500 mm or more. A prolonged dry season lasting for up to four months may adversely affect the palms. This constraint occurs recently in various coconut growing countries. This erratic behaviour of monsoon has made the sustainability of coconut production dangerous. The drought stress not only causes decline in productivity and also could be the reason for mortality of palms in extreme cases.Drought management practices such as cultivation of drought tolerant genotypes, soil moisture conservation measures and crop management measures have to be adopted efficiently in order to have better social, economic and environmental sustainability under the pressure of climate change.

Introduction

Global food security is being vulnerable on account of the rapid increase in population and drastic changes in the climate. Drought is one of the most important limiting factors for crop productivity and ultimately the food security in the wake of changing climate. The reduced precipitation and changed rainfall patterns are causing the frequent onset of droughts around the world. Severe droughts cause considerable decline in crop yields through negative impacts on plant growth, physiology and reproduction. Average global combined temperature of land and ocean surface has increased by 0.85°C between 1880 and 2012 (IPCC, 2014). An average increase of at least 0.2°C per decade is projected from now onwards. The rising concentration of the greenhouse gasses is becoming a major cause of the global warming. Over the past 250 years a 30 and 150% rise in the concentration of the CO2 and methane has been observed (*Lal, 2004; Friedlingstein et al., 2010*). These stresses limit the plant growth and productivity rather than any other environmental factor.

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Plants are subjected to the drought conditions when either the water supply to the root is limited or the loss of water through transpiration is very high (*Anjum et al., 2011*). The severity of the damage caused by the drought is generally unpredictable as it is driven by various factors including, the rainfall patterns, moisture holding capacity of the soil, and water loss through evapotranspiration. Drought interferes with growth, nutrient and water relations, photosynthesis, assimilate partitioning and ultimately causes asignificant reduction in crop yields (*Farooq et al., 2009b; Praba et al., 2009*). The plant response to drought stress generally varies from species to species depending on plant growth stage and other environmental factors.

Coconut, Cocos nucifera Linnaeus, (family Arecaceae) is a pantropical plant. The coconut plantations are usually located in the lowlands just above sea level. The trees are tall, reaching up to 30 m in height, with a slender trunk. As every part of the coconut palm is of some use, the coconut palm has been described as 'one of Nature's greatest gifts to man' (Burkill, 1966).The weather conditions for optimum growth and development of coconut are well distributed rainfall of 130 and 230 cm, mean annual temperature of 27ºC, abundant sunlight ranging from 250 to 350 Wm-2 with at least 120 hours per month of sun shine period. The coconut palm experiences moisture stress when exposed to irradiation above 265Wm-2, temperature of 33ºC and vapour pressure deficit of 26 m bar.

Coconut is mainly grown as a rainfed crop and the productivity is 50% more when cultivated under well irrigated areas. Coconut is a perennial crop with long duration of inflorescence primordia initiation to nut maturity (about 44 months duration). Pre fertilization period is about 32 months and post fertilization period are around 12 months. Hence drought occurred in any of these critical stages of the inflorescence development stages affects the nut yield. The effects of drought could be observed in next three years. In worst affected situations, it takes four years to recover. Drought at early stages affects the growth and lead to seedling mortality. Depending on the soil type and the critical level of soil moisture, the water stress on coconut varies. In sandy loam soil water deficit of 110 mm is a critical level at which coconut suffer most as indicated by the stomatal closure. In general, palms suffered more in red sandy loam than in laterite soil as indicated by the stomatal resistance and leaf water potential components.

The recurrent droughts in the main coconut growing areas, experienced in recent decades, have led to heavy yield losses and sometimes in severely affected areas, the death of adult coconut palms.

Effect of drought on coconut palm

Drought stress in plants is characterized by reduced leaf water potential and turgor pressure, stomatal closure, decreased cell growth and enlargement (Farooq et al., 2009). Drought stress reduces the plant growth by influencing various physiological as well as biochemical functions such as photosynthesis, chlorophyll synthesis, nutrient metabolism, iron uptake and translocation, respiration and carbohydrates metabolism (Jaleel et al., 2008 and Farooq et al., 2009)

Drought slows down the activity of the growing point of stem. Leaf production is reduced and causes early aging and collapse. Palms without a minimum of about twenty leaves lack the vitality to produce nuts. Droughts arrest spikelet formation in the inflorescence bud, resulting in loss of female flowers. Heavy button shedding and immature nut fall is observed. Weight of fruit, husk and endosperm is reduced. When soils dry up for prolonged periods, outer cells in the absorbing region of roots develop thickened walls through which water cannot enter.

The typical symptoms of drought affected coconut palm is bending and breaking of dry leaves, poor spathe development and bunches with one or two nuts. Activity of roots and transpirational ratesalso show marked variations.

Drought Mechanisms in coconut palm

The tolerant palms extract more soil moisture from the entire soil profile but they conserve water in the tissues by reducing the transpiration rate through effective control of stomata. The root: shoot ratio in seedlings was higher in tolerant cultivars than in susceptible ones.

The increase in leaflet thickness is one of the mechanisms and it is mainly due to increase in parenchyma cell size. It is also associated with lowered stomatal frequency, an indication of adaptation to drought stress. Xeromorphic characteristics such as increased leaf thickness and thick cuticle are observed in some coconut varieties. Increase in thickness of leaflet causes decrease in the ratio of the external surface to its volume. Increased

parenchyma cell size indicates less intercellular space/unit area. This may help in reducing the water conductance towards epidermis thus reducing the transpirational rates and maintaining high water potentials. Stomatal frequency and stomatal index play a major role in plant water relations. Variations was observed among talls, dwarfs and hybrids with regard to stomatal characteristics. The tolerant palms have thick leaflet, thick cuticle on both sides, larger parenchyma, hypodermal and water cells compared to less tolerant ones. Coconut cultivar having thick cuticle are able to maintain higher leaf water potentials. Drought tolerant types also have more scalariform thickening on xylem tracheids in vascular bundles and large sub-stomatal cavities. Size of the epidermal cell (upper and lower) and guard cell are related to the drought tolerance characteristic of a cultivar. Hence collective effect of all these traits contributes for adaptation to drought stress.

Coconut palm responds to drought stress in terms of stomatal regulation and epicuticular wax content to maintain leaf water potentials. The leaf to air temperature difference influence the stomatal conductance and water relations during day time and thereby predominantly determine the variations in photosynthetic efficiency of coconut in irrigated and rainfed conditions. About 3-4 fold increase in epicuticular wax (ECW) during dry season was observed in some coconut hybrids. The physiological age of palms and leaves influence the formation of wax on leaf surface. Coconut palms accumulate organic solutes such as sugars and amino acids during stress period. Accumulation of these solutes was found to be more in the tolerant types than in the susceptible types during stress period. Hence osmotic adjustment plays an important role in the drought tolerance mechanism in coconut. Under drought stress conditions, where high evaporative demand in the atmosphere prevails, genotypes exhibit differential adaptability through stomatal regulation. In general, dwarf coconut types exhibit higher transpiration loss of water than tall and hybrids. Upregulation of scavenging enzymes to maintain cell membrane integrity is another important mechanism thereby enabling cells to tolerate stress. Drought stress was found to increase the activities of some of the stress sensitive enzymes namely peroxidase, polyphenol oxidase, superoxide dismutase, acid phosphatase and L-aspartate: 2- oxoglutarate amino transferase in adult stress tolerant coconut palms while activities of Malic dehydrogenase (MDH) and nitrate reductase (NR) were found to be decreasing. Drought tolerant coconut varieties are capable with a biochemical mechanism to prevent the adverse effects of drought by appropriate regulation of enzyme activities. Drought tolerant cultivar had higher stability of membranes. Stress tolerant coconut cultivars characterized by higher activities of the protective enzymes like SOD, catalase and peroxidase and lower level of lipid peroxidation and higher membrane integrity.

Cell size and number, sub-stomatal cavity size, stomatal frequency, epicuticular wax content and thickness, leaf thickness, stomatal resistance, water potential components, cell membrane stability, water use efficiency and activity levels of scavenging enzymes are the essential anatomical and physiological traits for assessing moisture stress in palms.

Mitigation strategies

Recovery after a severe drought is a slow process. In coconut palms, normal root absorption does not commence with the onset of first rains. FiInitially, growing points of roots have to be reactivated. This is followed by root elongation and formation of a new absorbing region. With the resumption of water supply, shoot activity begins and new leaves and inflorescences are formed. In extreme cases up to about two years may be necessary for a full recovery after a prolonged drought.

The development of drought tolerant coconut varieties has been recognized in the mid-1990s as an important and urgent area of research. With worsening climatic conditions, the need for drought tolerant varieties has become critical. Several attempts were taken to develop drought tolerant coconut cultivars through inter and intra varietal hybridization worldwide. New drought tolerant hybrid coconut varieties showing stable and higher yield under changing climatic condition and that could be produced by crossing selected drought tolerant tall parent with dwarf parents need to be developed. . However, improvement of quantitative traits such as drought tolerance or yield in a cross-pollinated crop cannot be achieved through simple selection. To gather favorable alleles responsible for those quantitative traits, genotypic recurrent selection techniques that combine several generations of selections followed by recombination are required. *Rajagopal et al. (1990)* standardised the techniques on screening coconut varieties for drought tolerance using epicuticular wax, stomatal frequency and leaf water potential. The West Coast Tall (WCT) and

Federated Malaya States (FMS), which are tolerant to water stress, had thick leaflets, thick cuticle on both surfaces and larger parenchyma, hypodermal and water cells compared to less-tolerant ones (COD × WCT, GBGD and MYD). Tall palms and tall hybrids showed relatively high stomatal resistance resulting in effective conservation of water in the tissues, whereas the dwarfs were sensitive to stress with a tendency to lose more water. Few genotypes tolerant to drought were reported viz., West Coast Tall (WCT) × WCT, Federated Malay States (FMS) and Java Giant. Apart from WCT and FMS, PHOT, WCTxCOD, LCT, LCTxGBGD and LCTxCOD also reported as drought tolerant genotypes/hybrids (Rajagopal et al., 2000).

Soil moisture conservation measures like mulching around palms by spreading vegetable material, e.g. coconut fronds, husks, lopping of trees and shrubs can be undertaken. Mulching should be carried out regularly so that soil is not exposed. It protects soil from direct solar radiation and wind effects reduce water loss and controls weed growth. Burying husks in trenches in the proximity of palms would be of help. Husks can absorb and retain water about six times its weight. Increase infiltration of water into the soil by terracing, contour drains and/or contour bunds. Build bunds across folds on the ground of undulating land to form mini tanks. They retain water flowing from, the higher land which can be used for at least a part of the dry season. This technique could be used on more clayey and lateric soils. Irrigation of seedlings during dry seasons results in rapid establishment and vigorous growth. Mulching with green leaf manures like Glyricidia or with other suitable green manure crops and organic manure crops should be followed either alone or in combination.

Crop management measures include removal of senescent (drying) leaves to reduce transpiration loss and planting drought tolerant cultivars/hybrids can be done. Water management includes drip irrigation, mulching the irrigated area, avoiding flooding, recycling of water from backyard and application of lifesaving irrigation once in 15 days may reduce the impact of drought.

Conclusion

Drought is a multidimensional factor of stress affecting the plants at various levels from cell to organ and to whole plant. Drought induces various biochemical and physiological responses in plants, and it is one of the most adverse environmental factors of plant growth and production.

Coconut palm is influenced both by atmospheric and soil droughts, as the palms are mainly cultivated on the coastal sandy, red sandy loam and laterite soils.As coconut is perennial in nature, the impact of drought stress will be having long-standing ill effects, consequently, which may adversely affect the economy of coconut sector. Hence research on identification of drought stress tolerant, high yielding coconut genotypes and adoption of other mitigation measures for soil moisture conservation have to be further strengthened. These strategies should be effectively transferred to the farmers to minimize socio-economic losses of the coconut sector.

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Ragi - The nutrimillet in coconut gardens

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The local millets are going global as United Nations (UN) declared 2023 as International Year of Millets. The UN resolution put forward by India will increase the awareness on the cultural and historical positioning, nutritional benefits, hardy nature to thrive climate change and could add these small crops in the bigger value chain, including export. The gain from opportunities thus created, have to reach the small and marginal farmers who are toiling and nurturing genetic diversity of millet crops.

Millets are the small seeded grasses belonging to the family, Poaceae/Graminae. There are two major millets (sorghum and bajra) and six minor millets (finger millet, foxtail millet, little millet, proso millet, kodo millet and barnyard millet). Recently few more minor millets have been added to this group viz., tef, fonio, quinoa and brown top millet (IIMR, 2020). Among them, jowar (sorghum), bajra (pearl millet) and ragi (finger millet) are the major millets currently growing in India. Due to the richness in nutrient content, millets are commonly known as 'nutri-cereals or nutri-millets'. Finger millet or ragi was one of the major diet component in southern states, which were later replaced by rice. Of late, there is a revival in the consumption and cultivation. Major millets familiar to Kerala are Pearl millet (Bajra/ Kambam), finger millet (Ragi/ Muththaari/ Panjappullu), little millet (Chama), foxtail millet (thina), barnyard millet (kuthira valley), kodo millet (varagu) and proso millet (panivarku). They are hardy and withstand adverse climatic condition, with short duration of the crop in general (3.5 to 4 months).

Ragi or Finger Millet- small grain for rich diet

Ragi *(Eleusine coracana)* is a cereal crop cultivated and consumed in several countries like India, Srilanka and East Africa. The history of common man's food and diet is incomplete without millets. Mentions of millets are there in Korean Peninsula (3500-2000 BC) and in India, Yajurveda mentions priyangava (foxtail millet), aanava (barnyard millet) and syamaka (black finger millet) pointing to the historical connections

with culture. Food was mainly locally produced and consumed wholesome in earlier periods of civilizations, but gradually has undergone rapid and drastic changes in eating habits, food forms, diet components, fast and packed foods etc. Ragi or fingermillet is also valued for its properties and high nutrient contents as published by several researchers globally.

Ragi is known for its excellent storage properties and the character of improving the quality on storage. It is said that finger millet or ragi could be stored up to 50 years, hence it is highly valued during famine situations. Millets are tough crops, environment friendly in terms of resource use, sustainable, rich nutrition cheap and offers food security. Ragi is rich in Calcium and 100 g ragi contains 344mg calcium, critical for bones and teeth, and boon for people allergic to diary products. Finger millet is a very popular weaning food to infants showing its easily digestible nature. Ragi varieties are available in various colours- yellow, white, red, brown, tan, but mostly red coloured is preferred.

Ragi is a rich source of starch (59.5-61.2%), pendosans (6.2 -7.2%), cellulose (1.4 -1.8%) and lignins (0.04-0.6%), phosphorus (283mg), iron (3.9mg), trace elements and vitamins. Dietary fibre content is much higher (11.5%) than in commonly used cereals. Supplementing finger millet diets with greens and pulses improve nutrition levels, protein digestibility and nitrogen retention in children. Finger millet also have health benefits due to its antioxidant properties and is beneficial in lowering glucose and cholesterol. Millets have wound healing property, nephro protective and anti cataractogenesis properties and improves heomoglobin status. Fermented ragi drinks are also used as natural probiotic treatment for diarrhea.

Palakkad and Malappuram are the leading districts in Kerala in millet cultivation. Only ragi is cultivated in Kerala. Cultivation of ragi in the interspaces of coconut was successfully demonstrated and practiced under the Farmer FIRST Program (FFP) of ICAR-CPCRI, Regional Station Kayamakulam which resulted in good yield and profit. This farmer participatory effort in 80 acres of 19 wards of Pathiyoor panchayath (FFP location), Alappuzha district, proved the success and scope of millet cultivation in sandy loam soils.

Intercrop in coconut gardens

Finger millets can be cultivated during June - September or as summer crop utilizing residual moistre from December- January to March -April. 2 kg seed is required per acre and slightly less if transplanted. At Pathiyoor, the sowing season was found to be best during December. Initially direct sowing and transplanting methods were demonstrated. Transplanting of seedlings was found to be superior than direct sowing of finger millet seeds. Transplanted crops do not lodge in windy or rainy days. For nursery preparation for planting in one acre area, 200 square meter nursery plot is required. Ants were the major problem and seeds were completely damaged in some plots. The nursery area should be tilled finely and mixed with 100 kg organic manures and beds may be well prepared. Seeds sown need to be covered with thin layer of soil and three week old seedlings can be transplanted to the main fields. Seedlings may be

planted with spacing of 25 cm between lines and 15 cm between plants. The recommended nutrition for one acre is 2 tonne organic manure, 20 kg urea, 45 kg rajphos and 15 kg muriate of potash as basal dose and after 21 days 20 kg urea need to be given as top dressing. Nutrients may be applied based on soil test results for judicious application. Timely weeding and irrigation on the day of transplanting and on weekly basis ensures good growth and high yield.

Cultivation of Ragi in coconut gardens at Pathiyoor, Kayamkulam

Harvesting can be done when the panicles turn brownish, either earheads alone or the plant can be cut from the base. The harvested millet plants/ earheads should be heaped and covered with the straw or jute bags and then dried in sun for 2 to 3 days and threshed. The produce is cleaned, winnowed and packed for sale or for the use of the farm family. At pathiyoor 300-400 kg were realized in well managed plots and 100-250 kg under average management as intercrop in coconut gardens.

Drying Ragi

Potential for coconut - millet products

Millet and coconut are combination crops in coconut based cropping system and also a good diet combination providing health and immunity. Presently millets are marketed mainly as grains after threshing and drying. Since it is grown as an inter crop in coconut garden, both coconut and millets can be used for preparation of diversified value added products. Millets are rich in minerals especially calcium, iron and zinc which are recorded to be very less in coconut meat. On the other hand, coconut is blessed with the goodness of healthy fat, dietary fibre, vitamins and amino acids. Fibre content in millets generally ranges from 2 to 10 percent. Healthy fat present in coconut especially lauric acid can aid in boosting immunity. Though coconut kernel or meat has 9-10 percent dietary fibre, quantity of consumption of coconut would be less. In this case, combining coconut and millet would definitely increase the fibre content. Besides, the healthy fat present in coconut which is lacking in millet, can be fortified in the integrated products. Coconut meat can be incorporated in two forms, as fresh gratings or desiccated coconut and as coconut milk residue/ defatted coconut meal. Characterization of coconut milk residue (CMR) revealed that the soluble, insoluble and total dietary fibre content in CMR is 2.7 per cent, 28.4 per cent and 31.1 per cent, respectively, which was more than that present in fruits such as orange, peach and pear (Ng et al., 2010; Gunathilake et al., 2009). There is a nutritious and simple preparation of ragi popular in Karnataka which known as 'mudde'. In Kerala, there are many ethnic foods prepared out of millet especially from ragi such as kanji (porridge), avalose podi (powders), puttu, kurukk, murukku, ilayada, uppumaavu, etc. Newer products like cake and chappathi prepared with millet are also available in the market.

Grated coconuts are an inevitable ingredient in the preparation of ragi puttu (steamed ragi powder).

Similarly, several ragi and coconut milk based preparations are popular in areas like Lakshadweep. Currently, coconut and millets based cookies and biscuits have started a boom in the market. In fact, ICAR- Indian Institute of Millet Research, situated at Hyderabad has published the recipe of sorghum based coconut cookies, and coconut laddu in combination with finger millet and pearl millet. ICAR-CPCRI also attempted to develop an extruded product by optimizing the levels of ingredients, and extrusion conditions. The optimized extruded snack consists of 41% rice flour, 25% corn flour, 19% foxtail millet and 15% coconut milk residue with a temperature of 117°C and 273 rpm screw speed. Further studies are in the pipeline. One of the technology licensees of ICAR-CPCRI (Ms. Pavithra) is marketing coconut and millet based cookies under the brand name 'Bommi & Co' in Coimbatore district of Tamil Nadu. There is a huge potential for coconut and millet based products both in Indian and international markets. New generation products like ragi cakes, ragi chocolate pudding, ragi halwa, ragi laddu, germinated ragi powder, nutrient mixes with ragi etc can be found in the market.

Millets are non acid forming food and easy to digest. It is considered to be one of the least allergic and most digestible grains available and is a warming grain as it helps to heat the body in cold or rainy season. Combination of millet and coconut meat can lead to better health and immunity. Constant efforts should be made to educate people about the nutritive value and health benefits of millet and coconut based food products. Coconut and finger millet was traditionally cultivated and was part of daily diet of common people. Reviving these traditional crops combinations with HYV varieties, dwarf varieties, hybrids under scientific management could be offering resilience against climate change risks. Balanced nutrition acquires critical position in national development through enhancing health, well being and immunity of all age groups. Millets are cheap and highly nutritious option for future and ethnic foods which are becoming popular choices in diets and food tourism not only as food items but also as better nutrition choices. The potential for coconut millet combinations in cropping systems and diet needs to be supported through appropriate policy support, upgrading value chain intervention and purposeful interventions from research and extension with social participation. ■

Orange Coconut Panna Cotta

Ingredients

Coconut milk - 1½ cup
Fresh Cream – ½ cup
Sugar- ¼ cup
China grass powder-2 tea spoon
Hot water- 4 table spoon

For preparation of orange layer

Orange juice- 2 cup
Sugar- 2½ tablespoon
China grass powder-2 tea spoon
Hot water- 4 table spoon

Mix hot water with china grass . Stir until the china grass dissolves completely. Heat orange juice in a pan. Add sugar to the solution and remove from the fire once the sugar completely dissolves. Half fill four glasses with the solution and keep in refrigerator for 40 minutes to set.

In the meantime, take china grass in a bowl, mix with hot water and stir thoroughly until it melts well. Heat coconut milk and cream in a saucepan, add sugar and mix well until it completely dissolves. Remove from fire and mix well. Pour this solution as top layer of the orange mix which was kept in refrigerator. Cover the same and keep in refrigerator for another 40 minutes. Panna Cotta is ready.

India has doubled its horticulture production through adoption of best practices- Shri Tomar

It is indeed a matter of pride that India has doubled its horticulture production and has marched from scarcity to abundance in the last few years, said Shri. Narendra Singh Tomar, Honourable, Union Minister for Agriculture & Farmers Welfare. He added that by adopting best practices and by sharing it with the world, we have not only improved in the production of fruits and vegetables but also have become the torch bearers for a sustainable and better future. He was addressing the National conference, organized by Ministry of Agriculture and Farmers Welfare in collaboration with FAO to celebrate "International Year of Fruits and Vegetables 2021" declared by the UN in collaboration with the Food and Agriculture Organization of the United Nations on 29th October 2021.

Shri Tomar said that India is the second largest producer of horticulture crops and produces around 12 percentage of the global fruit- vegetable production. To globally promote popular exotic and important indigenous fruit crops in the country, the Ministry has identified 10 globally popular exotic fruit crops of commercial importance and 10 important indigenous fruit crops with high nutritional and nutraceutical properties. The State Horticulture Departments are also given targets for the year 2021-22 regarding area expansion for these crops. During the current year, 8951 hectares area for exotic fruits and 7154 hectares area for indigenous fruits will be brought under cultivation.

Shri Tomar said that programmes have been started for cluster development based on the global significance of horticultural crops. The government has initiated an Agri infra fund for one Lakh crore rupees for financing the development of infrastructure in the villages and areas nearby the fields, supply chain services, e- marketing platforms, storage houses, pack houses, grading units, packing units, cold chain, primary processing centers and collection points for related logistic facilities.

Shri Tomar said that our active role in public-private participation has helped in improving the post harvest infrastructure as we are working with new emerging players and agriculture start ups. He stated, that "PM Shri Narendra Modi has said that in 21st century India needs post-harvest food processing revolution and value addition amid increased agricultural production. Today we should focus on processing in every sector of agriculture, each food, each vegetables, fruits, pisciculture and all. Farmers should get modern storage facilities near their village".

Shri Sanjay Agarwal, Secretary, Department of Agriculture & Farmers Welfare, Government of India said that horticulture has become the growth engine of Indian Agriculture. He further stated that "International Year of Fruits and Vegetables", is an attempt of the UN to raise awareness on the importance of fruits and vegetables and the conference is aiming to pay attention to the national and international level. It is the need of the hour to act together to achieve the goal.

Shri Tomio Shichiri, FAO Representative in India addressed the gathering. Shri Garth Atkinson, International Expert made a presentation on "Global shift in Horticulture Supply Chain". Shri Rajbir Singh, Joint Secretary (MIDH), presented an overview of the horticulture sector in the country. Dr. A.K.Singh, Deputy Director General, Indian Council for Agricultural Research was present during the occasion.

The Conference was attended by senior officers of the Ministry of Agriculture and Farmers Welfare, Government of India, senior officers of Embassy of Israel, Embassy of the Netherlands, Green Innovation Centre, GIZ, officers from National Horticulture Board, Coconut Development Board, ICAR Institutes and all State Horticulture Missions. Operational guidelines for the Horticulture Cluster Development Programme and QR code of the guidelines were also released during the ocassion.

CDB observed Vigilance Awareness Week – 2021

In accordance with the direction given by the Central Vigilance Commission, Coconut Development Board observed the Vigilance Awareness Week 2021 from 26th October to 1st November 2021 on the theme "Independent India @75: Self Reliance with Integrity"". Along with the Head Office of the Board, all unit offices including Regional Offices, State Centers and Demonstration cum Seed Production Farms of the Board observed Vigilance Awareness Week in order to promote the policy of Zero tolerance against corruption.

The Vigilance Awareness Week commenced with administration of Integrity Pledge on 26th October 2021 by Shri. Rajeev Bhushan Prasad, Chief Coconut Development Officer in charge, Coconut Development Board. As part of observance of Vigilance awareness week, posters and banners were displayed in the office for creating awareness to both the officers and other stakeholders and visitors. Activities were initiated for the improvement of internal processes and to carry out systemic improvements to improve the delivery of public services as directed by CVC. The importance of maintaining integrity in all aspects of life and its relevance for the progress of the country was stressed upon during the meetings.

A valedictory session was organized on 1st

November 2021. A talk by Shri. Arin Chandra Bose, Retired DSP, CBI was organized in hybrid mode on the Role of Vigilance and the various activities under Preventive Vigilance on 10th November 2021. He briefed on the roles of various agencies in combating corruption in the country.

Block Level Seminar

CDB State Centre Thane in association with KVK, Lanja, Ratnagiri organized a Block Level Seminar on 27th October 2021 at KVK, Lanja, Ratnagiri. Dr. Amiya Debnath, Deputy Director, CDB inaugurated the programme. Dr.Sandeep S. Patil, SMS, Extension, Prof. Sudeshkumar S Chavan, SMS, Plant Protection, Prof. Mahesh Mahale, SMS, Agronomy were present and spoke on Boards Schemes, Scientific Coconut farming & Integrated Nutrient Management Technique, intercrops in Coconut garden and Pest and Disease Management of coconut in Maharashtra. More than 50 farmers participated in the seminar.

Mezhukkattil's coconut oil bags India's first BIS tag - IS 542:2018 certification

The Aluva-based Mezhukkattil Mills has received India's first BIS certification in the cooking oil segment for its coconut oil as per IS 542: 2018 which identifies the level of purity of coconut oil with specification for critical chemical requirements and provides strict measures to prevent adulteration and pesticide residues in the oil.

BIS is committed to consumer safety and takes all measures to bring manufacturers under the certification fold. Many of the coconut oil producing companies are following FSSAI certification which is reported to be inadequate to curb adulteration in edible oils.

Having received the BIS certification, the company plans to enter the market with its brand MM Original initially in Kerala. The Kerala market for coconut oil is estimated at 20,000 tonnes per month and the company targets a sale of 120 tonnes for quality-conscious consumers.

Kerala has over 600 coconut oil making units and is one of the largest consumers of edible coconut oil, but the quality of the commodity is a matter of concern in the state.

India International Trade Fair 2021

Sushri Shobha Karandlaje, Hon'ble Minister of State for Agriculture & Farmers' Welfare, Government of India visiting Board's stall in IITF 2021.

Dr. Y.R. Meena, Additional Commisssioner, Extension in Board's stall

CDB MDIC New Delhi participated in 40th India International Trade Fair 2021 held at Pragati Maidan, New Delhi from 14th to 27th November 2021 on the theme Atmanirbhar Bharath. Board displayed various informative posters on Boards schemes and on the goodness of coconut, publications of the Board, coconut value added products and coconut based handicraft products.

Conservation and utilization of agro-biodiversity: Project to promote 'Bedakam Coconut

Conservation and utilization of agro-biodiversity is essential for the sustainable development of agriculture sector. Utilisation of superior coconut genetic resources available in farmers' gardens is the most important short term strategy to enhance seedling production to meet the demand for quality coconut seedlings. Decentralised coconut nurseries can be established and managed by Farmer Producer Organisations to produce coconut seedlings by utilising mother palms of locally adapted coconut varieties available in farmers' gardens and seedlings can be made available locally with the active participation of coconut farmers.

An innovative project to conserve and popularise 'Bedakam Coconut', a superior local ecotype of coconut has been initiated as part of the decentralised planning by the local self governments with the technical support of ICAR-Central Plantation Crops Research Institute, Kasaragod. 'Bedakam coconut' is a local ecotype of coconut which is tall and yield satisfactorily even under rainfed situations and water scarce areas. Farmers from various parts of Kasaragod district used to collect seed nuts of this variety from selected coconut gardens in Bedadka gramapanchayat in Kasaragod district. Under low input use conditions also it gives comparatively good yield. Dr. K. Samsudeen along with a team of scientists of ICAR-CPCRI Kasaragod has been collecting data on the characteristics and performance of this local coconut ecotype. This ecotype adapted to non-intensive agriculture is a suitable variety for cultivation under agroecology system and also for mitigating climate change challenges.

Based on the suggestions of scientists from CPCRI Kasaragod, Bedadka gramapanchayat has formulated a scheme to promote 'Bedakam Coconut' the local ecotype of coconut as part of the broader objective of conservation and utilization of agro-biodiversity under the decentralised planning programme for the year 2021-22. It has been proposed as a combined project involving Kasaragod district panchayat, Karadka block panchayat and Bedadka grama panchayat with equal budget support. Agricultural Officer, Bedadka Krishibhavan is the implementing officer for the project.

The major components of the scheme include facilitating formation of a society of farmers cultivating 'Bedakam coconut', facilitate, registration of 'Bedakam coconut' as a farmer variety under Protection of Plant Varieties and Farmers rights Authority (PPV&FRA), identification and documentation of mother palms of the 'Bedakam coconut' in farmers gardens, collection of seednuts and raising nursery in selected locations in the grama panchayat and making available quality seedlings of the variety to distribute to farmers. Initially it is proposed to collect 10000 seeednuts. ICAR-CPCRI will be organising capacity development programmes for the selected members of the Farmer Producer Organisation and Karshika Karma Sena (the skilled labour collective functioning under the Bedadka Krishibhavan).

A meeting was conducted on 17th November 2021 at Bedadka as part of the formation of Farmers' Society for the promotion of Bedakam Coconut. Dr. Ravi Bhat, Head Division of Crop Production, ICAR-CPCRI inaugurated the meeting. In his inaugural address Dr Ravi Bhat emphasised the

need to conserve and utilise the superior genetic resources of coconut available in farmers' gardens for the sustainable development of coconut sector.

Dr. Thamban. C, Principal Scientist, CPCRI Kasaragod presented the outline of activities envisaged under the project to promote Bedakam Coconut and the capacity development programmes to be conducted to benefit the labour collective and FPO representatives for managing the nurseries.

Advocate C. Ramachandran, Member, District Planning Committee while addressing the gathering highlighted the role of local self governments and activities to be taken up by the farmers' society for implementing the scheme.

The meeting was chaired by Sri Madhavan, Vice -president of Bedadka grama panchayat. Sri N.M. Praveen, Agricultural Officer, Krishibhavan, Bedadka Sri. K. Muralidharan, President of the farmers' society and Sri K. Balakrishnan, Secretary of the farmers' society also spoke during the

occasion. As part of the meeting, a field visit was conducted to selected coconut gardens of farmers cultivating Bedakam Coconut ecotype. Smt. Letha Gopi, Chairperson, Development Standing Committee proposed vote of thanks. ■

Report prepared by : Dr. C. Thamban and Dr. K Samsudeen, ICAR-CPCRI, Kasaragod

Retirement

Shri Khokan Debnath, Deputy Director, Development retired from the services of Coconut Development Board on 31st October 2021. He has served the Board for around 36 years.

Health, Beauty & Wellness 2021

Coconut Development Board, Kochi participated in Health, Beauty & Wellness 2021 virtual Expo held from 21st to 23rd October 2021 at Kochi. M/s Tejaswini CPC, M/s Nata Nutrico, M/s Anvi Coconut Products and M/s. Sooryashobha Industries displayed their products virtually along with CDB in the Expo.

Akshaya takes leaves and turns into art; enters Record Books

Kunnamangalam (Kozhikode): A girl who carved names of all prime ministers of India on jackfruit leaves has been included in the India Book of records. Akshaya, daughter of Padanilam native Chandran and Sobhana, obtained the record.

Akshaya won the record by carving the names of 15 prime ministers from Jawaharlal Nehru to Narendra Modi on 15 jackfruit leaves within a single day. She received the medal and the certificate. The 22-year-old is passionate about drawing in a very young age and later turned to leaf art during lockdown.

First, she carved faces of actors Mohanlal, Mammootty, Vijay, Fahadh Faasil, Suriya and Lena on jackfruit leaves. Then she started carving on coconut fronds. Nivin Pauly's face was first created on a coconut frond and then she made Kamal Haasan, Vijay, Unni Mukundan, Asif Ali, Prithviraj and other stars.

Akshya a said that she could be the first girl in Kerala to create figures on coconut frond. She also shares the pictures of the art through her Instagram. Kamal Haasan's daughter Shruti Haasan had shared his figure carved on coconut frond through Instagram story, Akshaya said.

Working as lab technician at National Hospital in Kozhikode, Akshaya engages in art during leisure time. She also gets support from her parents and sister Anulaya. Her next target is to obtain Asia Book of Records.

Source: www.mathrubhumi.com

Regional Awareness Campaign on Advances in Coconut Cultivation

The first regional awareness campaign on advances in coconut cultivation sponsored by Coconut Development Board, Kochi was organized by KVK-Lakshadweep, ICAR-CMFRI and Thanal-Charitable Organization on 6th September, 2021 at the campus of Thanal, Kavaratti with the technical guidance of CPCRI, Kasaragod. The awareness campaign was attended by 50 farmers from Kavaratti island.

The campaign was inaugurated by Mr. T. Abdul Kader, Chairperson, Lakshadweep (Dweep) Panchayat. The objective of the programme was to deliver the importance of emerging technologies in coconut cultivation for enhancing production and

productivity in coconut in the islands. Panchayat office bearers attended the programme and spoke during the occassion. The oldest coconut climbers and best farmers from Kavarati were felicitated in the meeting.

Coconut climbers Welfare Society, first of its kind in Lakshadweep was introduced after its formal registration to the community gathered for the awareness campaign formed by Thanal and KVK-Lakshadweep. Mr. T. Abdul Kader told that the coconut climbing machines are one of the key innovations in the island to be scaled up. Mr.Moulana, Chief, Thanal spoke during the occasion about the importance of coconut cultivation in Lakshadweep and also about the declining interest of youth in the island in agriculture and allied sectors. He informed that Thanal will work with KVK to reverse the situation to attract and retain youth in agriculture. KVK-Lakshadweep and ICAR-CMFRI took the initiative for organizing this programme with the funding from Coconut Development Board.

Dr. P. N. Ananth, Senior Scientist and Head spoke on the latest technologies, use of organic fertilizer, use of modern irrigation methods and use of ICAR-NBAIR organic products in controlling white fly in coconut palms. Dr. Abdul Gafoor, SMS of KVK coordinated the programme. A series of awareness campaigns will be organized in the other islands also.

Agriculture Fair

Coconut Development Board, DSP Farm, Chhattisgarh participated in Agriculture Fair held on 24th November 2021 at Jagdalpur, Bastar. Board displayed various value added coconut products, publications and informative posters.

Shri Bhupesh Baghel, Chief Minister of Chhattisgarh inaugurated the programme and visited Board's stall and interacted with the officers of the Board. Shri Ishwar Chandra, Farm Manager received the Minister in the CDB stall.

FoCT training programmes conducted through Unit Offices of CDB.

CDB RO, Chennai in association with ICAR-KVKs of Tenkasi and Tiruppur Dist of Tamil Nadu from 25th to 30th October 2021.

CDB, RO, Guwahati in association with KVK Nalbari conducted Friends of Coconut Tree (FoCT) Skill Development Training programme at KVK campus, Nalbari, Assam from 25th to 30th October 2021. 20 trainees attended the training.

CDB, SC, Thane conducted Friends of Coconut Tree (FoCT) training programme from 25th to 30th October 2021 at Regional Coconut Research Station, Bhatye, Maharashtra

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, 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

Spear leaf damage

Inflorescence damage

M anisopliae infected grub

Mass multiplication of M anisopliae

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 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.

Adults weevils

Crown entry

Toppling of palm

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 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.

Slug caterpillar infested field

Mature caterpillars on palm leaflet

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 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. This disease is 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. 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

Colony of rugose spiralling whitefly

Encarsiaguadeloupae

Sooty mould scavenging beetle

Leaf rot disease in juvenile palm

Basal stem rot disease

Bracket fungus

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.

Abnormal nut fall

Unusual and incessant rainfall during the past few months induced severe setbacks in the nutrient uptake by palms mainly due to leaching away of nutrients. Water logging and improper root respiration is noticed in most gardens as well. Furthermore, abnormal nut fall was also observed in many coconut gardens in Kerala caused by a complex of nut pests and diseases in this rainy phase. This period also coincides the lean phase of nut setting in palm bunches. Nut pests include coconut eriophyid mite (Aceria guerreronis) and the coreid bug (Paradasynus rostratus) and fungal pathogens (Phytophthora palmivora and Lasiodiplodia theobromae). Mites feeding on meristematic tissues would invariably incite and aggravate fungal infections. A holistic management strategy is therefore recommended to tackle this issue

Management

• Dig out drainage channels in water logged areas and scrap off the alluvium deposited in palm basin after cessation of rainfall to promote aeration.

• Nutrient supplementation based on immediate soil analysis.

• Crown cleaning and prophylactic leaf axil filling with neem cake admixed with sand

• Spray neem oil 2% (20 ml per litre) on bunches after pollination to check mite and coreid bug incidence and 1% Bordeaux mixture to reduce fungal infections.

Market Review – October 2021

Domestic Price

Coconut Oil

During October 2021, the price of coconut oil opened at Rs. 17000 per quintal at Kochi and Alappuzha markets and Rs. 17700 per quintal at Kozhikode market. The price closed with a net loss of Rs. 100 at Kochi and Alappuzha markets and Rs. 400 per quintal at Kozhikode market.

The price of coconut oil closed at Rs. 16900 per quintal at Kochi and Alappuzha markets and Rs. 17300 per quintal at Kozhikode market.

During the month, the price of coconut oil at Kangayam market opened at Rs. 14467 per quintal and closed at Rs. 14267 per quintal with a net loss of Rs. 200 per quintal.

Weekly price of coconut oil at major markets Rs/Quintal)				
	Kochi	Alappuzha	Kozhikode	Kangayam
01.10.2021	NR	NR	17700	14467
04.10.2021	17000	17000	17700	14400
11.10.2021	16800	16800	17500	14333
18.10.2021	16900	16900	17500	14533
25.10.2021	16900	16900	17300	14333
30.10.2021	16900	16900	17300	14267

Milling copra

During the month, the price of milling copra opened at Rs.10300 per quintal at Kochi and Rs.10250 per quintal at Alappuzha market and Rs. 10600 per quintal at Kozhikode market.

The prices of milling copra closed at Rs. 10200 per quintal at Kochi and Alappuzha markets and Rs. 10450 per quintal at Kozhikode market with a net loss of Rs.100 at Kochi and Rs.50 at Alappuzha market and Rs. 150 per quintal at Kozhikode market.

During the month the price of milling copra at Kangayam market opened at Rs. 9900 per quintal and expressed a downward trend and closed at Rs.9700 per quintal.

Weekly price of Milling Copra at major markets (Rs/Quintal)				
	Kochi	Alappuzha (Rasi Copra)	Kozhikode	Kan-gayam
01.10.2021	NR	NR	10600	9900
04.10.2021	10300	10250	10600	9800
11.10.2021	10100	10100	10400	9700
18.10.2021	10200	10200	10500	9800
25.10.2021	10200	10200	10450	9800
30.10.2021	10200	10200	10450	9700

Edible copra

During the month the price of Rajpur copra at Kozhikode market opened at Rs. 18900 and closed at Rs. 18800 per quintal with a net loss of Rs.100 per quintal.

Weekly price of edible copra at Kozhikode market (Rs/Quintal)	
01.10.2021	18900
04.10.2021	19400
11.10.2021	19500
18.10.2021	20500
25.10.2021	20600
30.10.2021	18800

Ball copra

The price of ball copra at Tiptur market opened at Rs. 16300 per quintal closed at Rs. 16700 per quintal with a net gain of Rs.400 per quintal.

Weekly price of Ball copra at major markets in Karnataka (Rs/Quintal) (Sorce: Krishimarata vahini)	
01.10.2021	16300
04.10.2021	16100
11.10.2021	16300
18.10.2021	16500
25.10.2021	16700
30.10.2021	NR

**NR-Not reported*

Dry coconut

At Kozhikode market, the price of dry coconut opened at Rs.15250 per quintal and and closed at Rs.15550 per quintal with a net gain of Rs.300 per quintal.

Weekly price of Dry Coconut at Kozhikode market (Rs/Quintal)	
01.10.2021	15250
04.10.2021	15250
11.10.2021	15250
18.10.2021	15550
25.10.2021	15550
30.10.2021	15550

Coconut

At Nedumangad market in Kerala, the price of coconut opened and closed at Rs. 16000 per thousand nuts during the month.

At Pollachi market in Tamilnadu, the price of coconut opened Rs. 28500 per tonne and closed at Rs.29000 per ton during the month.

At Bangalore market in Karnataka, the price of coconut opened at Rs. 22500 per thousand nuts and the prices continued at the same level throughout the month.

Weekly price of coconut at major markets			
	Nedumangad (Rs./1000 coconuts) (Source: Epaper,Kerala Kaumudi)	Pollachi (Rs./ MT) (Source: Star market bulletin)	Bangalore Grade-1 coconut, (Rs./ 1000 coconuts) (Source: Krishimarata vahini)
01.10.2021	16000	28500	22500
04.10.2021	16000	28500	22500
11.10.2021	16000	28500	22500
18.10.2021	16000	29000	22500
25.10.2021	16000	29000	22500
30.10.2021	16000	29000	22500

International price

Coconut

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

The price of coconut oil quoted at different international/ domestic markets are given below.

Weekly price of dehusked coconut with water				
Date	Domestic Price (US$/MT)			
	Philippines	Indonesia	Srilanka	India*
02.10.2021	182	221	250	383
09.10.2021	189	211	246	383
16.10.2021	190	227	244	390
23.10.2021	204	233	275	390
30.10.2021	NR	240	291	390
				*Pollachi market

Coconut Oil

International price as well as domestic price of coconut oil in Indonesia and Srilanka expressed an upward trend.

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/ Indonesia (CIF Europe)	Philip-pines	Indo-nesia	Sri lanka	India*
02.10.2021	1627	NR	1383	2840	1944
09.10.2021	1680	NR	1477	2947	1908
16.10.2021	1800	NR	1510	2947	1953
23.10.2021	2106	NR	1543	2728	1926
30.10.2021	NR	NR	1563	3098	1918
					*Kangayam

Copra

The price of copra at Philippines, Indonesia and Srilanka expressed an upward trend and India expressed a downward trend during the month. The price of copra quoted at different domestic markets in Philippines, Indonesia, and India are given below.

Weekly International price of copra in major copra producing countries				
Date	Domestic Price (US$/MT)			
	Philippines	Indonesia	Srilanka	India* * Kangayam
02.10.2021	854	866	1445	1331
09.10.2021	908	893	1448	1290
16.10.2021	943	904	1411	1317
23.10.2021	1014	962	1438	1304
30.10.2021	NR	959	1511	1304
				* Kangayam

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