Drip-fertigation for coconut

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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

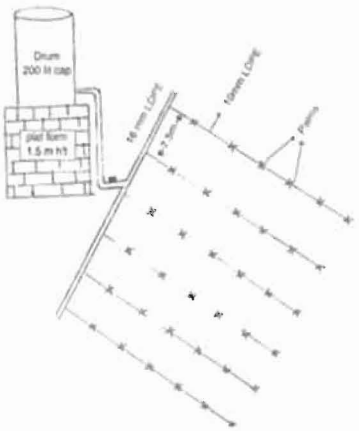

Fig. 1: A model layout plan of drip irrigation for coconut plantation (0.2 ha)

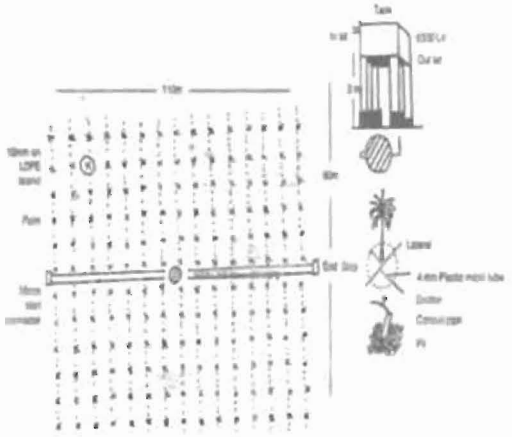

Fig. 2: A model layout plan of drip irrigation for coconut plantation (Area 1 ha)

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

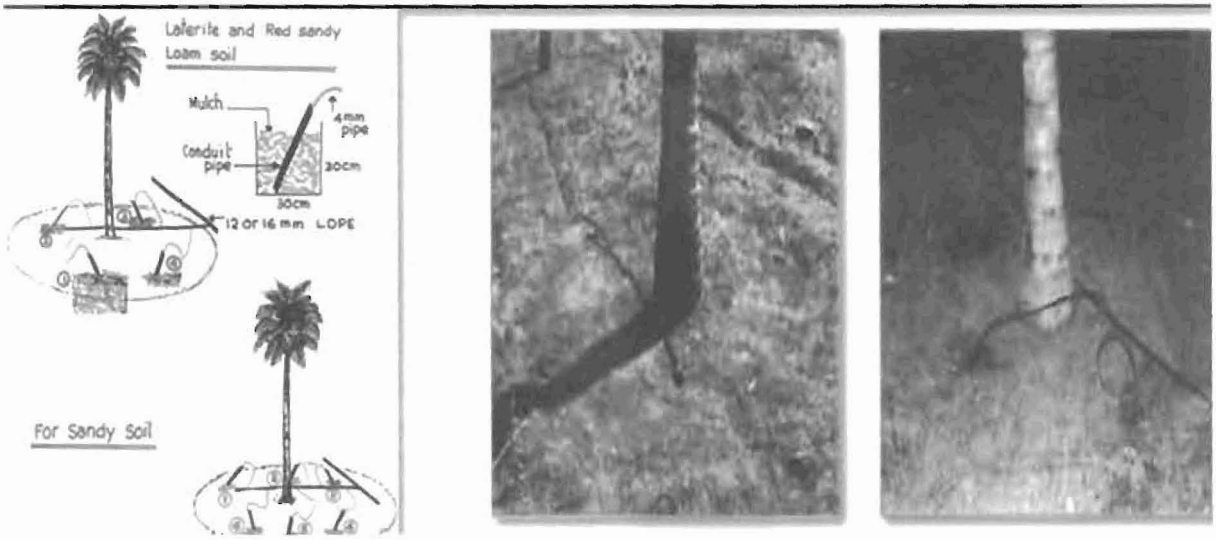

Fig. 3, 4 & 5

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)

▶ *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).

Fig. 6

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.

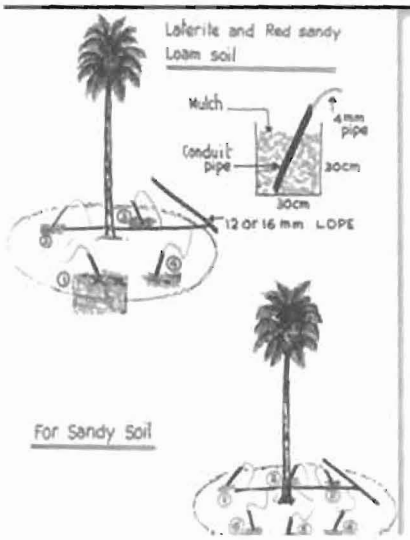

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Fig. 7: Fertilizer Tank

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. ■