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Irrigation Management in Coconut Plantation

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A study was conducted at CPCRI on irrigation management in coconut. It was found that yield of coconut with drip irrigation @ 30 litres per palm per day during January to May was comparable to basin irrigation @ 600 litres per palm per week. There was 67 percent saving of water in drip irrigation. Drip irrigation demonstration for coconut with 50 litres per palm per day in various districts of Kerala by CWRDM during 1985-88 has shown that the yield of nuts improved significantly from 3rd year after start of the irrigation.

*(**Key words** : Irrigation management, Methods of irrigation, Stress management, Coconut)*

One of the critical resources in coconut production is the availability of water. Though the coconut growing regions in the coastal belt are endowed with high rainfall, the rainy period is confined to few months during the monsoon season. The palm experiences moisture stress and drought conditions for varying periods extending upto 6-7 months in an year. In the coconut growing region other than the coastal belt coconut has to be grown throughout the year by supplemental irrigation. The adverse effect of moisture stress on the productivity of coconut has been well established. Utilization of the available water in most effective manner by optimizing irrigation schedules and by adopting soil moisture conservation practices with water harvesting measures assume particular significance in coconut cultivation.

Unfavourable soil and climatic conditions create moisture stress from December to May and this necessitate coconut palms to be irrigated. Non-availability of water during summer months (Dec-May) is the most critical for coconut production especially in North Kerala. By drip irrigation, soil moisture is maintained near to field capacity and further water loss due to seepage and other losses is avoided.

Effect of moisture stress on coconut

1. Increases in the rate of frond shedding and slowing-up of frond production resulting in reduced leaf area and light interception.
2. Induces greater stomatal resistance, reduced transpiration rate and lower leaf water potential.
3. Affects the inflorescence production and further results in shedding of buttons and young nuts.
4. Nut size gets reduced resulting in low *copra* content.

Water requirement of young palms

The evapotranspiration rates of 5 year-old coconut palms (cv. West Coast Tall) grown in an oxisol on the West Coast of India increased from 2.9 mm day^{-1} in Dec. to 5.5 mm day^{-1} in April, and decreased to 2.3 mm day^{-1} in June following the onset of monsoon rain. Consumptive use of water by 6 year-old palms with a leaf area index of 2.4 during the observation period (Nov. 1986 to May 1987) was of the order of 3.3 mm day^{-1} and ranged from 2.7 to 4.1 mm day^{-1}. The crop coefficient values were 0.54, 0.73, 0.60 and 0.65 for Penman, Blaney-Criddle, radiation and US Class-A pan methods, respectively.

In West Coast of India, regular irrigation during Dec-May is essential for establishment and optimum growth. In other regions of the country, irrigation is generally given throughout the year as and when required. Nelliat (1968) reported that irrigation with 45 litres of water once in 4 days combined with application of 0.15 m^3 of red earth in planting pits prior to planting in littoral sandy soil resulted in quick and vigorous growth of young palms. Similar results were also reported from coconut research station, Nileswar, where 40 litres of water twice a week resulted in vigorous growth of seedlings. Pitcher irrigation in areas of water scarcity by burying the earth pots of 20 litre capacity at a distance 75 cm from the shoot on either side of the seedling and filling the pots periodically with water supplied sufficient moisture for establishment and vigorous growth of seedling. The total water requirement was 1591 and 1533 mm per year for maintaining 80 to 100 percent of available soil moisture and 60-100 percent of available soil moisture respectively. Mulching with coir dust reduced water requirement by about 40 to 55 percent.

Water requirement of adult palms

In coconut, initiation and differentiation of vegetative and reproductive primordia and enlargement of cells are very sensitive to moisture stress. The palm is mostly grown under rainfed condition by the vast majority of coconut growers particularly in the major coconut growing State of Kerala. Excess moisture during the monsoon period which varies from four to six months and moisture stress during summer is a common phenomenon in the West Coast of India. Saseendran and Jayakumar (1988) computed the mean yearly consumptive use of coconut to be 1,126 mm (37 1 $palm^{-1}$ day^{-1} for a basin area of 12 m^2). The yearly irrigation requirement was estimated to be 4,656 l $palm^{-1}$ spread over the non-monsoon months of December to May.

The mean annual water requirement of coconut plantations in Kerala was 1126 mm (37 litres per palm daily for a basin area of 12 m^2) and the mean annual irrigation requirement was 338 mm (4656 litres per palm for a basin area of 12 m^2), spread over the non-monsoon months of January- May and November and December, respectively (Saseendran and Jayakumar, 1988).

Soil and climate based irrigation schedule study for coconut in South Kerala, India indicated that requirements of water varied according to the type of soil. Yield became stable under adequate irrigation water supply, observed during different periods of the year. The annual irrigation and water requirements in this treatment, during the non-rainy period, were determined as 538 mm and 1093 mm, respectively. The consumptive use during this period was estimated as 272 mm with an irrigation : cumulative pan evaporation ratio of 1.02. Application of 40 litre water twice a week was found essential for establishment and early growth of coconut (cv. CRIC 60) in the dry zone of Sri Lanka (Liyanage and Mathes, 1989).

Response of coconut to irrigation

Irrigation and fertilizers brought about precocious flowering in T X GB coconut hybrids. Development and precocity of dwarf coconut palms production varied under different irrigation frequencies from 6 to 28 litres per plant per day. During the third year, an average yield of 118 fruits per plant was obtained and no significant differences were found among the treatments. More than 4 decades of research in Sri Lanka have indicated that coconut cv. CRIC65 is capable of producing a sustained higher yield than cv. CRIC60 in the absence of adverse soil water deficit (Peries, 1994). The cumulative yields of nuts and *copra* were 50% higher in CRIC65 than in CRIC 60 over a period of 32 years.

Financial analysis of irrigation investments in existing and new plantations of coconuts in mixed cropping system indicated that investment in irrigation was financially feasible.

Studies on the effect of mulches and irrigation on young coconut plants in coastal Karnataka indicated better growth under drip irrigation and coir pith mulch (Uthaiah *et al.*, 1989). Dwarf X West African Tall coconut hybrids planted in a dry climate with supplementary irrigation and NPK fertilizers gave *copra* yields of 4.1-4.3 t per ha per year in contrast to 3.4-3.6 t per ha per year recorded under low management input (Daniel *et al.*, 1991).

A seven-year trial with basin irrigation applied during dry periods at 82 gallons per palm weekly or fortnightly, or at 164 gallons per palm fortnightly indicated that total *copra* yield increased from 3488 to 5377 lb ha^{-1} due to weekly applications in drier years and from 5011 to 6311 lb ha^{-1} in wetter years (Abeywardena, 1979). In 3-year trials with 3 coconut cv. Malayan Dwarf Yellow, Malayan Dwarf Green and Malayan Dwarf Red (13 to 16 year-old palms), irrigation on alternate days was highly effective to enhance the yield compared to irrigation at fortnightly intervals.

Irrigation methods for coconut

Irrigation methods commonly adopted in coconut gardens are flooding, basin, sprinkler or perfo-spray and drip irrigation.

Flood irrigation

This kind of irrigation was in use prior to introduction of Microsystems of irrigations. However, this practice of irrigation is still in use in some of the coconut growing areas of Tamil Nadu, Andhra Pradesh and Karnataka. Most of the coconut growing soils of Kerala are not suitable for this type of irrigation. If there is no dearth for water, one can go for flooding but there are many problems associated with this type of irrigation.

Basin irrigation

In basin irrigation water is applied in the basins of 1.8 to 2.0 m, which is the active root zone of coconut. Irrigation channels are provided in between two rows and each basis is connected with the channel. In this method there will be some loss of water due to deep percolation, seepage and

evaporation. However, this loss is reduced when basins are irrigated through hose pipes (Dhanapal *et al.*, 1999), where only limited area of the coconut field is wetted. Application of 200 litre of water once in 4 days in the coconut basin in red sandy loam soil is sufficient to bring about significant yield increase in coconut.

Sprinkler or Perfo-irrigation

Sprinkler irrigation or perfo-sprays are most suited to inter or mixed cropping systems, where the entire surface requires wetting. Perfo-irrigation is a kind of sprinkler irrigation where small holes are formed throughout the pipe length through which water is forced out in small sprinkle.

Systematic studies based on the climatic approach on irrigation requirement of West Coast Tall (WCT) coconut palms were conducted at CPCRI Kasaragod during 1976-1985 in red sandy loam soil. The response to three depths of irrigation water (IW) viz., 20,40 and 60 mm at three frequencies based on IW/CPE ratio of 1.00, 0.75 and 0.50 were studied. Palms irrigated with 20 mm of water at IW/CPE ratio of 1.00 produced the highest cumulative yield of 918 nuts per palm followed by the same depth of irrigation at 0.75 IW/CPE ratio (872 nuts per palm). The mean yield of the palm under the above treatment viz., IW/CPE ratio of 1.00 and 0.75 with 20 mm IW were 123 and 121 nuts per palm per year, respectively (Anon., 1988).

Drip irrigation

Water is applied over a long period to meet the water requirement. To avoid wastage and to suit the infiltration rate water is applied at frequent intervals. Water is applied near or into the plants root zone.

Water spread

In trickle irrigation the water distribution for different soils is an important factor to be understood before initiation of irrigation as the volume of roots wetted has relationship with the quantities of water uptake. Soil water distribution is determined by the soil properties and by the way water is added and withdrawn from the profile.

A minimum of 15 to 20 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 at least four emitters are required for the laterite and red sandy loam soil, whereas for the sandy soil, six emitters are required. Water spread recorded in these soils is shown in Table 1.

Table 1. *Moisture distribution pattern in coconut basin under drip irrigation*

Soil Type	Water spread (cm)		% active root zone wetted *
	Horizontal	Vertical	
Laterite soil	60	100	28.8
Red sandy loam	61	115	31.0
Sandy soil	34	110	10.2

* For four emitters

Emitter/Microtube placement in the coconut basin

Studies on the coconut root absorption indicate that 0.75 m to 1.25 m away from the bole is the active absorption zone and hence it is recommended to place the emitter/microtubes in the centre of this zone (1 m away from bole).

Effect of drip irrigation for nut yield

Based on a study conducted at Kozhikode, it was concluded that yield of coconut with drip irrigation @ 30 litres palm^{-1} day^{-1} during January to May was comparable to basin irrigation @ 600 litres palm^{-1} week^{-1}. Thus, there was 67 percent saving of water in drip irrigation. Drip irrigation demonstration for coconut with 50 litres palm^{-1} day^{-1} in various districts of Kerala by CWRDM during 1985-88 has shown that the yield of nuts improved significantly from 3rd year after start of irrigation.

Significant response in nut yield has been reported due to drip irrigation in different soil types when compared to the yield in rainfed control palms. In the drip irrigated experiments with West Coast Tall palms, the palms under different levels of drip irrigation showed significantly higher yield than the rainfed palms. Among the irrigated treatments, higher level of irrigation (66% and 100% of Eo) recorded significantly more number of nuts (89.8 to 98.2 nuts per palm per year) compared to the lower level of irrigation (33% of Eo, yielding 52.6 nuts per palm per year) under drip. In the experiment with high yielding hybrid, COD x WCT, pooled data on nut yield for six years (1993-99) showed no significant difference among levels of drip irrigation at 66 and 100% of Eo and between the drip and basin irrigation. Drip irrigation at 33% of Eo failed to produce significant yield increase over rainfed control. The highest nut yield (119.7 nuts palm^{-1} year^{-1}) was however observed under the drip irrigated treatment at 100 percent of Eo, which and was on par with the treatment drip irrigation with 66 per cent of Eo (113.6 nuts) and the basin irrigation (116 nuts).

Table 2. *Influence of irrigation and mulching and their interaction on coconut nut yield (pooled data for four years) in littoral sandy soil*

Irrigation treatment	Nut yield/palm/year		
	No mulch	Mulch	Mean
T1: 66% of Eo through drip	57.5	78.4	66.2
T2: 100% of Eo through drip	65.6	78.4	72.0
T3: 133% of Eo through drip	53.2	66.6	59.9
T4: 100% of Eo (Basin irrigation)	59.9	63.4	61.6
T5: Rainfed	30.1	23.7	26.8
Mean	53.3	61.4	-

(Dhanapal *et al.*, 1998)

Coconut yield under drip irrigation with 30 and 45 litres per day per palm was at par with basin irrigation at 600 litre per palm per week. The main reasons for 34 percent water saving in the 66 percent of Eo through drip treatment were the reduction in the quantity of applied water and avoidance of loss due to deep percolation. Though more water was applied under 100 and 133 percent Eo under drip and basin irrigation, it did not contribute towards higher yield, probably because the excess water might have moved beyond the root zone and was not used by the palms. Venkiteswamy *et al.* (1997) reported that nut yield under drip irrigation at 100 percent of Eo was at par with basin irrigation at IW/CPE ratio of 1.0.

In drought prone gravelly soils of the Andigama series (Red Yellow Podzolic) in Madampe, Sri Lanka, irrigation through four drippers placed equidistant in the circumference of a circle of radius 100 cm around the base of the tree and discharging water at the rate of 30 litres h^{-1} for 2.5 h wetted a large volume of soil in the effective root zone (Arachchi, 1998).

A trial conducted to evaluate the economic viability of trickle irrigation on a full bearing coconut plantation in the south Saurashtra region of Gujarat, India indicated that it could save 45-50% water over surface irrigation without any significant reduction in yield (Kapadiyal *et al.*, 1998). With the water thus saved one hectare extra could be brought under irrigation thereby increasing the net income of the farmers.

The available soil moisture was higher by 22.2 to 28.8 percent in the drip irrigated basins under mulch compared to drip without mulch. In basin irrigation also, on fourth day after irrigation, the available soil moisture stored in the mulch treatment was 36.8 to 37.6 mm and it was 18.2 to 19.9 mm in the absence of mulch indicating higher level of moisture depletion. Similarly, there was reduction in the soil temperature under irrigated, mulched plots by 1.6 to1.7° C compared to non-mulched rainfed plots at 15 cm depth. Drip irrigation alongwith mulching will be a useful practice with regard to both soil moisture conservation and soil temperature regulation in case of littoral sandy soil (Maheswarappa *et al.*, 1998).

Pooled data on nut yield for four years showed that there was no difference among drip irrigation treatments in littoral sandy soil and between drip and basin irrigation (Table 2). Nut yield under all irrigated treatments were at par with each other but were significantly superior to that of rainfed control.

Based on a study conducted at Kozhikode, it was concluded that yield of coconut with drip irrigation @ 30 litres per palm per day during January to May was comparable to basin irrigation @ 600 litres per palm per week. Thus, there was 67 percent saving of water in drip irrigation. Drip irrigation demonstration for coconut with 50 litres per palm per day in various districts of Kerala by CWRDM during 1985-88 has shown that the yield of nuts improved significantly from 3rd year after start of the irrigation

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