Recent Advances in Plantation Crops Research, 2000, pp.181-185.

MICROIRRIGATION TECHNIQUE FOR COCONUT IN LITTORAL SANDY SOIL

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An experiment on drip irrigation was initiated in littoral sandy soil at the Central Plantation Crops Research Institute (CPCRI), Kasaragod in the year 1986 and later modified in 1993. Drip irrigation equal to 66 per cent of open pan evaporation (Eo) proved to be the best method of irrigation with a water saving of 34 per cent compared to 100 per cent of Eo of basin and drip method. The nut yield with 66 per cent of Eo was on par with 100 per cent and 133 per cent of Eo through drip and 100 per cent of Eo through basin irrigation. The 66 per cent Eo under drip irrigation system included six drippers per palm operating at a discharge rate of two litres per hour per dripper and the quantity of water was 2.7 liters palm^{-1} day^{-1} during March to May under northern Kerala conditions. The labour saving in drip irrigation could be as high as 80 man days per ha compared to conventional basin irrigation system. Irrigation along with mulching resulted in significantly higher yields. Leaf nutrient status was better in the irrigated treatments compared to the rainfed control. The benefit-cost ratio for drip irrigation was higher (2.02) compared to basin irrigation (1.68) and rainfed control (1.07).

INTRODUCTION

India ranks first in coconut production (13908 million nuts) from an area (1.796 million hectare) which ranks third in the world. Kerala contributes 47 per cent of the total production. However, the yields realised are far below the potential yields of coconut palm. One of the main reasons for the low productivity is that coconut is grown as a rain dependent crop in Kerala. Though, the state falls under the heavy rainfall zone, the palm invariably suffers from mild to severe stress between the months of December and May. In northern Kerala, most of the rainfall is received during a period of four to five months whereas in southern Kerala, it lasts for eight to nine months. Hence, there is good response to irrigation during the non rainy period, especially under northern Kerala conditions.

The littoral sandy soil which occurs along the 600 km coastal length of Kerala, is the second largest soil type where coconut is predominantly grown. These coastal sandy soils are poor in fertility and water holding capacity. In addition, these soils get heated up quickly and the heat remains during the full day time affecting

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water and nutrient uptake. Coconut palms which are grown in these soils, experience stress during summer which makes the palms to yield much below their potential. So it is imperative to provide irrigation during the non rainy season.

As the sandy soils contain mainly sand particles (99.1%), their infiltration rate is very high and hence the system of irrigation must be chosen very carefully. An ideal irrigation system will be the one in which water is supplied at the same rate at which it is absorbed by the palms and drip irrigation fits well to these conditions.

The efficacy of irrigation can be increased by mulching the irrigated area and its favourable effect on soil temperature regulation (Varadan and Rao, 1983), soil moisture conservation and soil temperature reduction (Maheswarappa *et al.*, 1998) have been established.

Keeping the above in view, a field trial was started in the littoral sandy soils of CPCRI, Kasaragod. The study was aimed to identify a suitable method of irrigation for coconut, quantity of water requirement under littoral sandy soil, elucidate the effect of mulching on nut yield and to work out the economics of different systems of irrigation.

MATERIALS AND METHODS

The experiment was conducted at CPCRI, Kasaragod during the non rainy seasons of 1993 to 1998, in a coconut garden planted in 1972 with West Coast Tall variety. In a normal year there will be rainfall for about five months from June to October and one or two summer showers. The relative humidity will be around 50-80 per cent and the minimum temperature will be around 20°C and the maximum around 34°C.

The experiment was of split plot design involving irrigation treatments in the main plot viz., T_1: drip irrigation at the rate of 66 per cent Eo (open pan evaporation), T2 : drip irrigation at the rate of 100 per cent Eo, T_3: drip irrigation at the rate of 133 per cent Eo, T_4: basin irrigation at the rate of 100 per cent of Eo applied once in four days through hose pipe, and T_5 : rainfed control. The subplot treatments included were: M0: no mulch and M_1: mulching with coconut leaves (fifteen coconut leaves were used to cover the 1.8 m radius of the basin area). Under drip irrigation, the quantity of water applied was based on monthly mean of the open pan evaporation (twenty years average was taken into account) from December to May. For each drip irrigated palm six emitters were placed at 0.75 m away from the bole with equal distance between the emitters.

The soil of the experimental field was classified as littoral sand (Quartzipsamments) with a mechanical composition of 95.8 per cent coarse sand, 3.3 per cent fine sand, 0.2 per cent silt and 0.7 per cent clay. The field capacity of the soil was 4.2 per cent and wilting point was 0.44 per cent with a bulk density of 1.66 g cc^{-1}

The nut yield per palm was recorded regularly and annual leaf production per palm was also recorded during 1996-97 and 1997-98. Leaf samples were collected from the index leaf (14th leaf) during 1996-97 and analysed for N, P and K content by adopting standard procedures.

Economic analysis was done on the basis of cash flow using a discount rate of 15 per cent. The input and output values were based on 1996-97 market prices which prevailed in north Kerala and the cost of investment in drip system (including pump and tank) was calculated taking into consideration the 50 per cent subsidy given by the government.

RESULTS AND DISCUSSION

The annual leaf production ranged from eight to 11 in both the years of observation (Table 1). The irrigated treatments irrespective of the method and quantity of water applied, produced similar results which varied significantly from unirrigated control. When there was adequate supply of water and nutrients there was positive

Table 1. Annual leaf production and leaf nutrient status of coconut as influenced by irrigation and mulching in littoral sandy soil

Treatments	Annual leaf production $palm^{-1}$		Leaf nutrient content (per cent)		
	1996-97	1997-98	N	P	K
Main Plot					
T1: 66 % of Eo through drip	11.0	11.2	1.78	0.10	1.56
T2: 100% of Eo through drip	11.1	11.2	1.79	0.11	1.52
T3: 133 % of Eo through drip	10.6	11.1	1.77	0.11	1.64
T4: 100 % of Eo (Basin irrigation)	11.1	11.1	1.78	0.10	1.61
T5: Rain fed	8.0	7.5	1.41	0.11	1.11
C.D. P = 0.05:	0.80	0.98	0.35	NS	0.23
Sub Plot					
M0 : No Mulch	10.2	10.5	1.76	0.10	1.45
M1 : Mulch	10.5	10.3	1.78	0.11	1.47
C.D. P = 0.05:	NS	NS	NS	NS	NS

response in growth characters which resulted in higher leaf production. Coconut palm in general produces one inflorescence/bunch of nuts in each leaf axil and thus higher leaf production will directly contribute towards increased nut yield.

Analysis of leaf indicated that N and K contents were influenced by the irrigation treatments, but P content was unaffected. (Table 1). N and K contents were significantly higher in the irrigated treatments compared to rainfed control. Roots intercept more nutrient ions when grown in soil with adequate moisture than in dry soil because root growth is more extensive. Mass flow of soil water to supply the transpiration stream, transports most of the nitrates to the roots (Tisdale *et al.* 1985). Higher uptake of N under adequate levels of irrigation was also noticed by Sharda and Gupta (1975). Higher uptake of K under adequate soil moisture condition was due to the increased solubility and better availability of the nutrient.

Pooled data on nut yield for four years (1994-98) showed that there was no difference among drip irrigation treatments and between drip and basin irrigation (Table 2). Nut yield under all irrigated treatments were on a par with each

Table 2. Influence of irrigation and mulching and their interaction on coconut nut yield (pooled data for three years)

Irrigation treatment	Nut Yield palm-1 Year-1		
	No Mulch	Mulch	Mean
T1: 66% of Eo through drip	57.5	74.8	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: Rain fed	30.1	23.7	26.8
Mean	53.3	61.4	-

C.D. (P=0.05) for main plots = 12.6; C.D. (P=0.05) for sub plots = 3.8; C.D. for sub plot at the same level of main plot=12.3; C.D. for main plot at the same or different levels of subplot=19.7

other but were significantly superior to that of rainfed control (26.8 nuts palm^{-1} year^{-1}). The highest nut yield (72 nuts palm^{-1} year^{-1}) was observed in the drip irrigated treatment where water was applied at 100 per cent of Eo which was 169 per cent more than that of the rainfed control, but was only nine per cent more than that of the drip treatment with 66 per cent of Eo. This indicated that there was good response for irrigation in littoral sandy soil. The soil being porous and poor in organic matter, the response for the quantity of water applied was less conspicuous, and thus the treatment where 66 per cent of Eo applied through drip could produce the same effect as that of 100 and 133 per cent Eo through drip and 100 per cent of Eo through hose irrigation in coconut basin. It was also reported that yield of nuts for drip method at 30 and 45 litres day^{-1} palm^{-1} was on par with basin irrigation at 600 litre palm^{-1} week^{-1} (Varadan and Madhava Chandran, 1991) besides stabilised yield with minimum fluctuation under adequate irrigation (Jose Mathew *et al.* 1996). The main reasons for 34 per cent water saving in the 66 per cent 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 per cent 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. Venkitaswamy *et al.*, (1997) reported that nut yield under drip irrigation at 100 per cent of Eo was on par with basin irrigation at IW/CPE ratio of 1.0.

The sub plot treatments did not bring about any marked difference in annual leaf production. However, application of dried coconut leaves as mulch resulted in a significant improvement in yield and the mulched treatment produced eight nuts more palm^{-1} year^{-1} than the 'no mulch' treatment (Table 2). It is a proven fact that mulching influences soil moisture and soil temperature to the greater extent.

The data on the interaction (Table 2) revealed that there was no yield improvement with mulching in unirrigated treatment indicating that unless there was enough moisture in the soil, the effect of mulch was negligible on nut production. The yield increase over control in the irrigated treatments under 'no mulch' was only 76 to 121 per cent while in the mulched treatments the difference was 167 to 230 per cent. This was mainly attributable to the increase in the availability of soil moisture and reduction in the soil temperature under irrigation with mulch treatments (Varadan and Rao, 1983 and Maheswarappa *et al.*, 1998). However, mulching did not produce a significant impact under basin irrigation. This may be because sandy soils with low water holding capacity and high infiltration and percolation rates could not retain all the hose applied irrigation water with in the root zone of the coconut palms. Generally the surface applied mulch will be effective only to a shallow depth. As the capillary movement of water was also less in the sandy soil, evaporation control per se for the basin irrigation by mulching would not have come into the picture.

Water requirement of coconut under littoral sandy soil for the non rainy season period (Dec. - May) was 5821, 8820 and 11730 litres of water per palm in 66, 100 and 133 per cent of Eo treatments. Since the treatment 66 per cent Eo was adequate to get higher yields , and no response was recorded for higher irrigation levels, irrigation with 66 per cent Eo under drip system with six drippers per palm operating at a discharge of two litres per hour per emitter may be recommended. The quantity of water of applied at the above level will be 27 litre palm^{-1} day^{-1} during December to February and 35 litres palm-1 day-1 during March to May under northern Kerala conditions.

The cash flow analysis indicated that the benefit:cost ratio (BCR) in the drip irrigated coconut garden was 2.02 as compared to 1.68

under basin irrigation and 1.07 in rainfed gardens (Table 3). In addition, the pay back period for this investment on the drip irrigation system was only two years. This analysis thus confirms the economic viability of investing in drip systems for coconut gardens. Under the present socioeconomic conditions in which labour is not only costly but also scarce, it is always advisable to adopt less labour intensive technologies. Adoption of drip irrigation system is one among them through which about 80 man days of labour per hectare (worth about Rs. 8000/ha) could be saved compared to the conventional basin irrigation system.

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Table 3. Economic analysis ofinvestment in drip irrigation for one hectare coconut garden

Years	Cost (Rs.)	Return (Rs.)	Discounted* margin (Rs.)
		Drip irrigation	
1	47,260	51,975	4,100
2	22,260	51,975	22,469
3-20	4,00,680	9,35,550	1,37,688
BCR		2.02	
Pay back		2 years	
		Basin irrigation	
1	29,060	48,825	17,187
2	29,060	48,825	14,945
3-20	5,23,080	8,78,850	91,584
BCR		1.68	
Pay back			
		Rainfed	
1	19,710	21,262	1,350
2	19,710	21,262	1,174
3-20	3,54,780	3,82,725	7,194
BCR		1.07	
Pay back		-	

* a discount rate of 15 per cent was considered to calculate the discount margin

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