

Moisture depletion patterns in coconut plantation under rainfed and irrigated conditions

O. P. JOSHI, P. GOPALASUNDARAM and MOHD. YUSUF
*Central Plantation Crops Research Institute,
Kasaragod 670 124, Kerala*

ABSTRACT

Under rainfed conditions, the evapotranspiration was about 4mm/day during the first two days of receipt of rains. The values changed to 2.4mm/day and 2.1 mm/day, respectively, when calculated for the first week and first two weeks after rains. 0-70 cm layer had the maximum contribution to the water needs of coconut. Water loss from the interspaces was higher than from basins. Under irrigated conditions, the maximum evapotranspiration (6.6mm/day) and water loss from interspaces (5.6 mm/day) were recorded with 20 mm water at IW/CPE ratio of 1.00. Decreasing frequency gradually decreased the rates to 4.0mm and 2.3 mm/day at IW/CPE=0.75 and 0.50, respectively from 0-90 cm soil depth. It is concluded that irrigation with 20 mm of water at IW/CPE ratio=1.00 is adequate to meet the water needs of coconut for optimum growth. A higher quantity is not desirable as it leads to deep percolation losses.

Introduction

Evapotranspiration is one of the most important factors affecting the frequency of irrigation. It is the sum total of water lost by evaporation from soil and transpiration from plants. It is directly related to solar radiation, temperature, wind velocity, saturation deficit, level of soil moisture and plant cover. An increase in these factors causes an increase in evapotranspiration. Under identical climatic conditions, the rate of evapotranspiration depends on the availability of soil moisture. Therefore, studies were undertaken to determine soil moisture depletion under rainfed and irrigated conditions.

Materials and Methods

Soil moisture studies were carried out at the Central Plantation Crops Research Institute, Kasaragod during the summer seasons of 1984 and 1985 in an irrigation cum fertility experiment started in 1968. The treatments consisted of all combinations of three depths of irrigation water viz., 20 mm (q1), 40 mm (q2) and 60 mm (q3) of water per irrigation, three frequencies of irrigation viz. IW/CPE ratio of 1.00 (f1), 0.75 (f2) and 0.50 (f3) and three levels of fertilizers viz, 500 gN+330g P₂O₅+750g K₂O+170g MgO (m₁), 750g N+670g P₂O₅+1500g K₂O+170g MgO (m₂) and 1000g N+1000g P₂O₅+2250g K₂O+170g MgO (m₃) per palm

per year. The experiment was laid out in a 3³ factorial confounded design with two replications. There were four side treatments including a rainfed control. Soil moisture studies were conducted under different depths and frequencies of irrigation at the m₂ level of fertilizers.

The soil of the experimental field was sandy loam in texture, deep, highly permeable and non calcareous. The values of field capacity (FC) and permanent wilting point (PWD) were 10.0% and 5.2% (W/W), respectively and bulk density 1.4g/cc.

The soil moisture measurements were carried out by using a Troxler Neutron Probe, Model 3222. Access tubes were fixed at about 1 m distance from the bole in the basins and in the centre of the interspaces. Under rainfed condition, measurements were taken at an interval of 7 to 10 days whereas in irrigated treatments one day before and one day after each irrigation and also between two irrigations at suitable intervals. Perfo spray system was used for irrigation. The results are discussed under rainfed and irrigated conditions separately.

Results and Discussion

The rainfed treatment showed an increase in water content of the profile (0-130 cm) with the occurrence of rainfall. A drop in water content occurred with the cessation of rainfall obviously due to the poor WHC of the sandy loam soil that imbibe water quickly and releases most of it under the influence of gravity. A comparison of integrated water contents of basin and interspace revealed that the latter had higher water content in the profile as well as in different layers. This might be due to involvement of crop factors and receipt of more rain water in the interspaces because of less interception by the leaves.

In general, fluctuation of moisture was found to be more sharp in interspaces than in basins (Table-1). This might be because of the *in situ* enrichment of the basin soil with organic matter. The results indicated that the water content of the soil profile was higher as a result of NE monsoon (upto May) than the moisture at the time of first measurement (25th January, 1984) and the moisture balance remained positive till the end of SW monsoon (upto September, 1984). The highest integrated water content of the profile was recorded on 6th June, 1985 when positive balance was 80 mm and 86 mm for basins and interspaces, respectively. Moisture changes on 31st January, 1985 was negative and higher indicating higher evaporative demand of the climate. Interspaces recorded higher values indicating relatively higher exposure to radiation (Table-1).

The actual evapotranspiration (Et) for rainfed treatment was 4 mm/day during the first two days of receipt of rain. The Et values after one and two days of rain were 2.4 and 2.1 mm/day, respectively. This was because of the higher initial moisture content which decreased gradually in the absence of rains. The layer-wise Et data indicated that 0-70 cm layer had the maximum contribution (33 mm/day) to the water need of the coconut palm (Table-2).

Table 1: Rainfall and moisture changes in basins and interspaces.

Soil depth cm	25.1.84 to 4.4.84	4.4.84 to 26.5.84	26.6.84 to 18.9.84	18.9.84 to 31.11.85	25.1.84 to 31.11.85	25.1.84 to 2.3.85	21.1.84 to 6.6.85	27.2.84 to 15.2.85
RAINFALL								
	122.3	190.7	2352.7	598.7	3264.4	3264.4	4481.4	3261.6
<i>Moisture changes (mm) in basins</i>								
0-130	3.2	14.0	12.2	-33.8	-4.5	-7.3	79.6	2.8
0-90	1.1	9.9	12.2	-25.2	-1.6	-3.5	68.7	4.8
0-70	0.6	9.2	9.2	-20.2	-0.8	-1.8	59.9	5.3
0-30	2.0	4.4	4.0	- 8.3	+2.1	2.5	27.5	4.0
<i>Moisture changes (mm) in interspaces</i>								
0-130	1.1	12.1	13.5	-35.7	-9.0	-15.9	86.2	2.5
0-90	0.8	12.4	8.4	-27.6	-6.0	-10.4	71.2	3.7
0-70	1.3	11.0	6.2	-20.9	-2.3	-5.8	61.3	4.8
0-30	2.2	7.0	3.3	- 8.3	4.1	2.3	31.2	5.7

The water loss data from the interspaces (Table-3) revealed the same trend as that of Et from the basins. However, the water loss from the interspaces was higher than the Et from the basins. This might be due to the receipt of higher amount of water and more exposure of soil to solar radiation.

Table 2: Actual evapotranspiration (mm/day) by coconut.

Soil layers cm	1st week *10-17 March,84	2nd week 17-24 March,84	2 weeks 10-24 March,84	1st 2 days 10-11 March,84	Next 5 days 12-17 March,84
0-30	1.34	0.62	0.98	2.38	0.92
0-70	2.83	1.14	1.99	5.04	1.95
0-90	2.78	1.55	2.17	5.20	1.82
0-130	2.35	2.07	2.21	4.08	1.66

* Data on which profile was close to FC.

Table 3: Water losses (mm/day) from interspaces of coconut palm

Soil layers cm	1st week 10-17 March,84	2nd week 17-24 March,84	2 weeks 10-24 March,84	1st 2 days 10-11 March,84	Next 5 days 12-17 March,84
0-30	0.76	0.41	0.58	1.22	0.57
0-70	2.23	0.93	1.58	3.81	1.65
0-90	3.00	1.19	2.10	5.22	2.12
0-130	5.41	1.72	2.90	7.28	2.82

The evapotranspiration and water loss data for q1 (20 mm) and q2 (40 mm) with different frequencies are presented in Table 4. The data revealed that frequency of irrigation had great influence on Et as well as water loss from the interspaces. Within each quantity of water higher frequency recorded higher Et and water loss. A decrease in the frequency of irrigation gradually decreased the Et and water loss rates.

The maximum Et (6.6 mm/day) and water loss (5.6 mm/day) from interspaces were recorded under q1f1 (20 mm water IW/CPE=1.00) treatment from 0-90 cm soil layer. Decreasing the irrigation frequency to IW/CPE=0.75 and 0.50 gradually reduced the Et to 4.0 and 2.3 mm/day and water loss to 4.2 and 1.9 mm/day, respectively.

Table 4: Actual evapotranspiration (mm/day) from basis and interspacing coconut palm

Treatment	Soil depth (cm)	Basin	Interspaces
q1f1	0-30	3.2	3.7
	0-70	6.3	5.6
	0-90	6.6	5.6
	0-130	6.4	4.8
q1f2	0-30	2.7	3.0
	0-70	4.4	4.2
	0-90	4.0	4.2
	0-130	2.5	4.3
q1f3	0-30	1.3	1.8
	0-70	2.3	2.2
	0-90	2.3	1.9
	0-130	2.3	1.8
q2f1	0-30	2.0	1.8
	0-70	3.9	4.6
	0-90	4.2	5.7
	0-130	4.4	6.9
q2f2	0-30	2.2	1.5
	0-70	4.3	3.3
	0-90	4.5	3.9
	0-130	4.3	3.5
q2f3	0-30	1.1	0.9
	0-70	2.6	2.1
	0-90	3.0	2.5
	0-130	3.1	2.6

A comparison between 20 and 40 mm irrigation water at different frequencies indicated higher Et as well as water loss from the interspaces with 20 mm irrigation at IW/CPE=1.00. At IW/CPE ratios of 0.75 and 0.50 the trend was reversed and higher rates of Et and water loss were found under 40 mm of irrigation water.

uch a trend is expected because in well watered fields the Et rate is directly related to the moisture content in soils. Irrigation with 20 mm water at IW/CPE of 1.00 maintained higher moisture (Table-5) and unsequently the Et and water loss were higher. The same was the case with 40 mm water at IW/CPE ration 0.75 and .50.

Table 5: Soil moisture (%v/v) and integrated water content in basins one day after and one day before irrigation

Depth cm	After irrigation			Before irrigation			FC.
	q1f1 (7)	q2f1 (7)	q3f1 (2)	q1f1 (11)	q2f1 (8)	q3f1 (6)	
10	12.7	12.7	12.3	12.1	10.5	8.3	13
30	15.3	15.5	14.0	11.3	11.0	8.4	14
50	15.6	17.1	16.6	13.3	12.6	11.2	15
70	14.4	17.0	16.7	13.8	13.4	11.2	15
90	14.8	17.0	16.6	14.7	13.7	12.2	15
110	14.7	16.3	17.4	14.8	13.6	13.5	16
130	14.4	16.2	17.7	14.4	14.5	14.1	15
Integrated soil water content (mm)							
0-30	49.8	50.2	44.1	39.9	36.7	32.7	42
0-70	118.5	127.0	120.8	100.8	84.6	83.6	98
0-90	148.1	160.9	153.7	130.2	121.9	108.0	126
0-130	191.1	209.6	216.2	174.3	163.7	149.0	182

Figures in paranthesis are number of observations

Soil moisture and integrated water contents in the basins with 20, 40 and 60 mm irrigation water at the frequency of IW/CPE=1.00 one day after irrigation indicated that 20 mm irrigation water was just sufficient to recharge diferent layers to field capacity whereas 40 and 60 mm water raised the water content above the level of field capacity (Table-5). As the availability of water is 100% at FC level, excess water will go as deep percolation and therefore, irrigation higher than 20mm is not desirable under sandy loam conditions.

The moisture content before next irrigation indicated that 20 mm irrigation water maintained soil moisture almost near to FC. In the case of 40 and 60mm irrigation water, soil water content was less than the FC level in all the layers. The deficit was more with 60mm water. This was owing to wide intervals of irrigation i. e. 8 and 12 days, respectively, with 40 and 60 mm of water. Further, the results point out that application of higher quantities of irrigation water is not advantageous in the sandyloam soil.