

# IRRIGATION REQUIREMENT OF COCONUT AND RESPONSE TO LEVELS OF FERTILISER UNDER IRRIGATED CONDITION DURING THE EARLY BEARING STAGE

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## ABSTRACT

An investigation to determine the irrigation requirement of coconut and the optimum fertiliser dose under irrigated condition was carried out at CPCRI, Kasaragod. The growth characters and yield performance of palms in the early bearing stage showed that depth of irrigation water had negligible effect. Irrigating at  $\frac{\text{irrigation water}}{\text{cumulative potential evaporation}}$  ratio of 0.50 gave significantly lower increase in growth and yield; while the differential response to irrigation at the ratios 1.00 and 0.75 was of low magnitude. Significant increase in growth and yield were manifested up to the  $m_2$  level of fertiliser. The response to fertiliser application alone was higher than that to irrigation alone under local conditions.

Based on the performance during the early bearing stage, the irrigation requirement of coconut was found to be 660 to 680 mm per dry season, irrigating at  $\frac{IW}{CPE}$  ratio 0.75. The West Coast Tall palms receiving summer irrigation responded favourably to split application of 750 g N + 670 g  $P_2O_5$  + 1500 g  $K_2O$  + 170 g MgO/palm/year.

## INTRODUCTION

Coconut is a rainfed crop of the humid tropics. In areas with long dry spell, the soil moisture is one of the major limiting factors on growth and yield of palms. Vijayalakshmi and Marar (1959) and Marar (1963) reported that irrigation during the dry season increased yields of coconut by 20 to 25 nuts/palm/year. Venkitesan (1973) found that irrigation during hot summer months improved female flower production and arrested button shedding, resulting in increased yield. Irrigation with 200 l of water, applied within a radius of 1.5 m around the base of palms once in two weeks, revived the palms in deep sandy soil (Padmanabhan,

1973). Nelliath (1968) reported that applying 45 l of water in planting pits, once in 4 days during the first three years, resulted in the vigorous growth of young palms and was superior to watering with 22.5 l every 2 days or 90 l every 8 days. Singh *et al.* (1971) established that (1) the water use efficiency of crops is raised by fertilisers, (2) the response to fertilisers is generally high under irrigated condition and (3) the response to frequent irrigations is generally enhanced by increase in levels of fertiliser application.

The main objective of the present study is to determine the irrigation requirement of coconut in relation to the ratio of irrigation water to cumulative potential evaporation. It was also envisaged to assess the nutritional requirement of coconut under irrigated condition.

#### MATERIAL AND METHODS

The experiment was laid out at the Central Plantation Crops Research Institute, Kasaragod in Field 1, Block B. The soil is deep sandy loam with the following characteristics:

Sand	80.29%	Available N 100 ppm
Silt	1.40%	Available P <sub>2</sub> O <sub>5</sub> 24 ppm
Clay	17.00%	Exchangeable K <sub>2</sub> O 10 ppm
Field capacity	10.0%	pH 5.5-5.6
Wilting point	5.2%	
Bulk density	1.34 g cm <sup>-3</sup>	

Depth to water table during dry months ranged from 8.5 to 10.5 m and during rainy season from 1.5 to 2.0 m. The mean monthly rainfall and evaporation are given in Table 1.

The treatments consisted of all possible combinations of three depths of irrigation water (q) viz. 20, 40 and 60 mm, three  $\frac{\text{irrigation water}}{\text{cumulative potential evaporation}}$  ( $\frac{IW}{CPE}$ ) ratios (f) viz. 1.00, 0.75

**Table 1.** Mean monthly rainfall and evaporation at CPCRI, Kasaragod (20 year average).

Months	Rainfall (mm)	No. of rainy days	Evaporation/day (mm)
January	0.8	0.1	4.5
February	0.0	0.0	4.8
March	5.4	1.1	5.1
April	39.4	1.9	5.2
May	222.8	8.1	5.0
June	894.2	19.5	3.6
July	1115.4	29.4	2.3
August	671.2	21.4	2.6
September	330.5	11.8	3.5
October	173.8	9.3	3.6
November	79.6	4.3	4.1
December	21.7	1.8	4.1
Total	3554.9	108.7	—

and 0.50 and three fertiliser mixtures(m) viz. 500-330-750-170, 750-670-1500-170 and 1000-1000-2250-170 g/palm/year of N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and MgO, respectively. Irrigation was done during the dry months i.e. from December to May. Fertilisers were applied in two equal splits in August and February. A factorial confounded design with two replications was adopted. Four additional treatments, viz. q<sub>3</sub>f<sub>1</sub>m<sub>0</sub>, q<sub>3</sub>f<sub>2</sub>m<sub>0</sub>, q<sub>3</sub>f<sub>3</sub>m<sub>0</sub> and q<sub>0</sub>f<sub>0</sub>m<sub>2</sub> under each replication were also included.

One year old seedlings of the West Coast Tall (WCT) variety were planted in 1968. The seedlings were pot watered during the summer months till 1973, with 20, 40 and 60 l of water (in lieu of q<sub>1</sub>, q<sub>2</sub> and q<sub>3</sub>) and the young palms were fertilised at one-third and two-third the full dose during the first and second year, respectively.

Observations on the growth characters viz. total production of leaves, number of functional leaves, length of petiole, length of leaf-let bearing portion (lamina), number of leaflets and length and width of leaflets were recorded every year. Date of first flower-

ing, number of female flowers produced and yield of nuts were also recorded.

The moisture determinations (gravimetric) were carried out once a month from soil samples drawn from each treatment, before the subsequent irrigation was given, to estimate the soil moisture depletion.

The actual quantity of irrigation water utilised under various treatments is given in Table 2.

**Table 2.** *Total depth of irrigation water utilised per season*

IW : CPE ratios						
1.0		0.75		0.50		
Depth per irrigation	No. of irrigations	Depth of water (mm)	No. of irrigations	Depth of water (mm)	No. of irrigations	Depth of water (mm)
$q_1$ (20 mm)	46.5	930	34	680	23.0	460
$q_2$ (40 mm)	23.0	920	17	680	11.0	440
$q_3$ (60 mm)	15.0	900	11	660	7.5	450

## RESULTS AND DISCUSSION

### Growth characters

Mean values and summary of analysis of data on the vegetative characters are presented in Table 3.

**Leaf production:** Frequency of irrigation alone had significant effect on the total number of leaves produced. Palms receiving irrigation at  $\frac{IW}{CPE}$  ratio 1.0 produced 4 to 5 leaves more than those receiving irrigation at the other two ratios. The difference in leaf production did not attain the level of significance among other irrigation treatments. Higher levels of fertiliser also resulted in the production of more leaves than the lowest level. None of the interactions was significant. Observations in the side treatments, showed that the mean number of leaves produced by palms receiving irrigation without fertiliser, was only 89 compared to 98 leaves produced by non-irrigated palms receiving fertiliser.

**Table 3.** Effect of depth and frequency of irrigation and fertiliser levels on growth characters of WCT coconut palms, June, 1977

Treatment	Total production of leaves till 1977	Leaves on crown in 1977	Petiole length (cm)	Lamina length (cm)	Number of leaflets	Breadth of leaflets (cm) 1975	Length of leaflets (cm) 1975
q <sub>1</sub>	98	30.6	133.2	391	227	6.1	113
q <sub>2</sub>	100	31.5	134.0	397	232	6.2	116
q <sub>3</sub>	102	31.3	136.4	401	232	6.2	116
SE	1	0.4	1.3	4	3	0.1	2
f <sub>1</sub>	103	31.9	138.0	396	226	6.3	116
f <sub>2</sub>	98	30.7	133.1	396	232	6.2	116
f <sub>3</sub>	98	30.9	132.5	397	233	6.0	115
SE	1	0.4	1.3	4	3	0.1	2
CD	4	—	3.9	—	—	—	—
m <sub>1</sub>	97	31.1	135.7	389	232	6.2	116
m <sub>2</sub>	101	31.0	31.0	405	229	6.0	118
m <sub>3</sub>	101	31.4	134.0	397	231	6.3	113
SE	1	0.4	1.3	4	3	0.1	2
q <sub>3</sub> f <sub>1</sub> m <sub>0</sub>	91	29.5	137.6	394	224	5.8	138
q <sub>3</sub> f <sub>2</sub> m <sub>0</sub>	90	28.6	144.4	398	232	6.1	110
q <sub>3</sub> f <sub>3</sub> m <sub>0</sub>	89	28.0	142.1	407	227	6.1	122
q <sub>0</sub> f <sub>0</sub> m <sub>2</sub>	98	30.0	137.9	398	219	6.4	126

**Functional leaves:** None of the main effects and interactions showed any significant difference on the number of functional leaves on the crown. The mean number of functional leaves on the crown of the experimental palms was either 31 or 32.

**Petiole length:** Main effects of the depths of irrigation water and levels of fertiliser were not significant. But the petiole of palms receiving irrigation at  $\frac{IW}{CPE}$  ratio 1.0 was significantly longer than that of palms receiving irrigation at the ratios 0.75 and 0.5.

**Length of lamina:** Neither the depth of irrigation nor the frequency of irrigation had any effect on this character. The palms receiving the fertiliser level  $m_2$  recorded significantly longer leaflet bearing portion (404 cm) than palms fertilised at  $m_1$  level. The interactions were not significant.

**Number of leaflets:** None of the main effects nor the interactions manifested significant differences on the number of leaflets per leaf. The number of leaflets per leaf of palms receiving the side treatment fertiliser application without irrigation was 219 which was 5 to 13 leaflets less than that of palms receiving irrigation alone.

The longer lamina observed at  $m_2$  level of fertiliser application had, therefore, accommodated the same number of leaflets as in the other treatments. The wider spaced leaflets would permit more sunlight to percolate and thus reduce the mutual shading of leaves.

**Breadth of leaflets:** The mean breadth of leaflet was 6 cm and was not affected by the irrigation or fertiliser treatments. The interactions were also not significant. The palms in the side treatment receiving fertiliser without irrigation had broader leaflets (6.4 cm) than those receiving irrigation alone (5.8 to 6.1 cm).

**Length of leaflet:** Though the main effects of the treatments failed to show any difference on the character, the interaction  $q \times m$  had significant influence on the length of leaflets (Table 4). Treatment  $q_1 \times m_2$  recorded the longest leaflets

**Table 4.** *Length of leaflet  $q \times m$  interaction (cm)*

	$m_1$	$m_2$	$m_3$
$q_1$	108	122	108
$q_2$	120	118	112
$q_3$	119	113	118

(122.32 cm). Since there was no difference in number of leaflets, the longer leaflets under the above treatment should result in greater leaf area.

### Yield

Data on the number of palms that yielded during 1975 and the total female flower production, setting percentage and yield up to June 1977 and the mean yield in 1977 are given in Table 5.

**Number of bearing palms:** Only few palms came to bearing in 1974 i.e. the sixth year after planting. In 1975, 50% yielding palms were recorded in irrigation treatments  $q_2$  and  $f_1$ . Fertiliser levels had significant effect on the number of yielding palms. While 50% palms had come to bearing in both  $m_2$  and  $m_3$  treatments, only 28% palms had reached the yielding stage in  $m_1$  treatment. By 1976 (eighth year) most of the experimental palms had come to bearing.

The palms under the side treatment, fertiliser alone or irrigation alone recorded only 13% yielding palms in 1975.

**Female flower production upto 1977:** Details of cumulative production of female flowers/palm are given in Table 5, and Fig. 1. Depth of irrigation water had no significant effect on the number of flowers produced. The  $\frac{IW}{CPE}$  ratios 1.00 and 0.75 were found superior and produced 120 and 78 female flowers more than those produced in the treatment  $\frac{IW}{CPE} = 0.50$ . The palms receiving the fertiliser treatments  $m_3$  and  $m_2$  produced 420 and 412 female flowers, respectively, compared to only 280 female

Table 5. Effect of depth and frequency of irrigation and fertilisers on yield attributes of WCT coconut palms

Treatment	No. of bearing palms/plot (1975)*	Total production of female flowers/palm till 1977	Setting percentage till 1977	Total production of nuts/palm till 1977	Mean yield of nuts palm in 1977
q1	1.3	355	29.4	106	51
q2	2.0	378	28.0	106	51
q3	1.9	379	26.6	102	47
SE	0.3	23	1.0	8	2
f <sub>1</sub>	2.2	424	29.0	123	56
f <sub>2</sub>	1.7	382	28.0	107	50
f <sub>3</sub>	1.3	305	27.0	83	43
SE	0.3	24	1.0	8	2
CD	—	67	—	22	7
m <sub>1</sub>	1.1	280	28.7	81	43
m <sub>2</sub>	2.0	412	29.6	115	52
m <sub>3</sub>	2.3	420	27.6	117	53
SE	0.2	24	1.0	8	2
CD	0.8	67	—	22	7
q <sub>3</sub> f <sub>1</sub> m <sub>0</sub>	0.1	68	30.6	21	12
q <sub>3</sub> f <sub>2</sub> m <sub>0</sub>	0.1	83	26.6	22	9
q <sub>3</sub> f <sub>3</sub> m <sub>0</sub>	0.1	59	34.1	20	7
q <sub>0</sub> f <sub>0</sub> m <sub>2</sub>	0.1	99	28.7	28	14

\*Plot size: 4 palms

flowers produced by the palms receiving the lowest level of fertilisers.

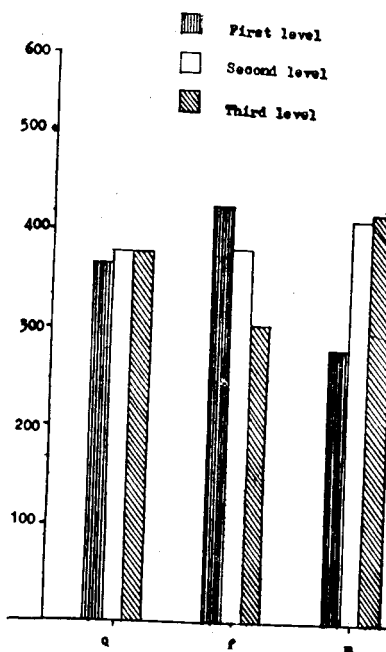


Fig. 1. Effect of treatments on female flower production/palm (1974-77)

The palms receiving fertilisers at  $m_2$  level without irrigation recorded only 99 female flowers, while the female flower production ranged between 60 and 83 in palms receiving irrigation alone. Lowest number of female flowers, produced by palms receiving any combination of irrigation and fertiliser treatments was 280.

**Setting percentage:** The percentage set of female flower ranged between 27 and 29 in different treatments and did not manifest any significant difference due to the main effect of the treatments or their interactions.

**Total yield upto June, 1977:** Cumulative yield of nuts/palm is given in Table 5 and Fig 2. Response to different depths of irrigation water was not significant. Significant difference in the cumulative yield of nuts was effected by the  $\frac{IW}{CPE}$  ratios.

Irrigation at  $\frac{IW}{CPE}$  ratio 0.5 reduced the yield considerably compared to ratios 1.0 and 0.75 which were on a par. Fertiliser levels also had significant effect on yield. Fertiliser application at  $m_2$

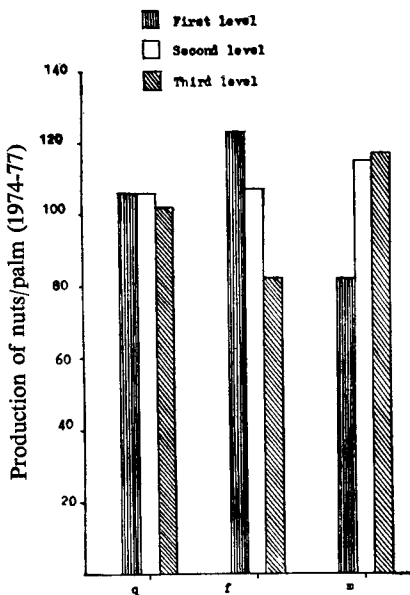


Fig. 2. Effect of treatments on total production of nuts/palm (1974-77)

and  $m_3$  levels resulted in the production of 114 and 117 nuts compared to 81 nuts/palm in  $m_1$  treatment. Side treatments showed that fertiliser alone was more efficient than irrigation alone, the cumulative yield of nuts being 40% more.

**Mean yield of nuts/palm/year (1977):** Mean yield of nuts/palm was not significantly affected by the depth of irrigation water (Table 5 and Fig. 3). As in the case of cumulative nut production, the per palm annual yield also showed significant differences due to  $\frac{IW}{CPE}$  ratios and fertiliser levels. Highest mean yield of 56 nuts/palm was observed in the treatment  $\frac{IW}{CPE}$  ratio 1.0 which was on a par with the treatment  $\frac{IW}{CPE}$  ratio 0.75, mean yield being 50 nuts/palm. Higher levels of fertilisers viz.

$m_2$  and  $m_3$  yielded 52 and 53 nuts/palm/year which was significantly higher than the yield of 43 nuts/palm/year recorded at  $m_1$  level.

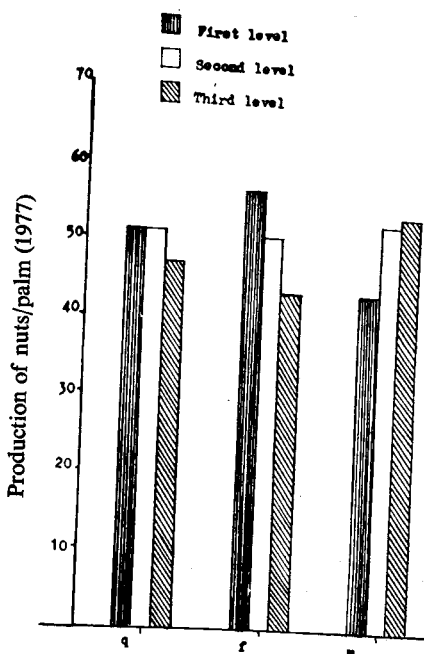


Fig. 3. Effect of treatments on yield of nuts/palm during 1977

Among the side treatments, fertiliser application without irrigation resulted in the mean yield of 14 nuts/palm/year compared to the mean yield of 12, 9 and 7 nuts/palm from those receiving 60 mm depth of irrigation water at  $\frac{IW}{CPE}$  ratios 1.0, 0.75 and 0.50, respectively, without fertilisers.

### Soil moisture status

Mean soil moisture content in the plots receiving different irrigation treatments, determined before the subsequent irrigation, is given in Table 6.

The soil moisture content at all depths decreased with decrease in the  $\frac{IW}{CPE}$  ratio. Appreciable reduction in the soil moisture

**Table 6.** *Mean soil moisture status before irrigation*

Irrigation treatment	Mean soil moisture content (% wt.)		
	0-25 cm	25-50 cm	50-100 cm
q <sub>0</sub> f <sub>0</sub>	3.3	5.6	6.5
q <sub>1</sub> f <sub>1</sub>	9.0	8.9	10.3
q <sub>1</sub> f <sub>2</sub>	8.8	7.4	7.9
q <sub>1</sub> f <sub>3</sub>	4.5	6.1	6.3
q <sub>2</sub> f <sub>1</sub>	7.4	7.3	8.3
q <sub>2</sub> f <sub>2</sub>	6.1	7.4	7.2
q <sub>2</sub> f <sub>3</sub>	4.5	6.9	6.7
q <sub>3</sub> f <sub>1</sub>	7.4	8.0	8.9
q <sub>3</sub> f <sub>2</sub>	6.2	6.2	8.2
q <sub>3</sub> f <sub>3</sub>	5.0	6.9	6.1

occurred even in the  $\frac{IW}{CPE}$  ratio of 0.75. The soil moisture in plots receiving irrigation at the  $\frac{IW}{CPE}$  ratio of 0.5 reached low values nearing the wilting point. The highest soil moisture content was observed in the plot receiving treatment q<sub>1</sub>f<sub>1</sub>.

Performance of palms during the early bearing stage indicated that the depth of irrigation water had negligible effect on the growth characters and yield. The  $\frac{IW}{CPE}$  ratio had a marked effect on both growth and yield. The young palms in the treatment in which depth of irrigation water equaled the cumulative potential evaporation (f<sub>1</sub>) gave the best response in vegetative growth, early bearing, female flower production and yield. Response of palms receiving the treatment f<sub>2</sub> was on a par with treatment f<sub>1</sub> although the values were slightly lower. Depth of irrigation water equal to half the CPE gave significantly reduced response in growth and yield.

The female flower production in f<sub>3</sub> treatment was only 72% that of palms in f<sub>1</sub> treatment and the cumulative yield of nuts of palms in f<sub>1</sub> treatment was 50% more than that of palms in f<sub>3</sub> treatment. The quantity of irrigation water at f<sub>2</sub> frequency per season amounted to 660 to 680 mm compared to 900 to 930 mm under f<sub>1</sub> treatment, irrespective of the depth of irrigation water per

irrigation. Since the reduction in yield of nuts is marginal and 25% saving in the quantity of water consumed could be effected the  $\frac{IW}{CPE}$  ratio 0.75 would be economical.

Fertiliser levels had marked effect on the growth characters; but the differential response was more marked in the yield components. The palms receiving  $m_2$  level of fertilisers produced 47% more female flowers and 23% more nuts than those receiving fertilisers at  $m_1$  level. The response of young palms to  $m_2$  and  $m_3$  levels of fertiliser was on a par. The data on both growth characters and yielding habits showed positive response only upto the  $m_2$  level of fertiliser application.

The cumulative yield of palms receiving  $m_2$  level of fertilisers with irrigation was 114.5 nuts compared to 28.4 nuts recorded on the palms receiving the same dose of fertilisers but without irrigation. Also, the mean cumulative yield of nuts in the side treatment  $q_3f_1m_0$  was only 20.8 nuts. It is obvious that the efficiency of both inputs viz. irrigation and fertilisers gets considerably enhanced when combined. The present recommended dose of fertilisers for rainfed coconut is nearly the same as  $m_1$  level in the experiment. Under irrigated conditions, the  $m_2$  level of fertilisers is about the optimum.

It is, therefore, concluded that under west coast conditions, the irrigation requirement of coconut palms in the early bearing stage during the dry months is around 680 mm, to be applied at  $\frac{IW}{CPE}$  ratio of 0.75 and the application of 750 g N+670 g  $P_2O_5$ +1500 g  $K_2O$ +170 g MgO/palm/year, in two splits to WCT palms under irrigated conditions is beneficial.

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