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Drip Irrigation Requirement of Coconut in *Maidan* Tract of Karnataka

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ABSTRACT

The experiment on drip irrigation was conducted at Agricultural Research Station, Arsikere, Karnataka during 2000-05 in a 25 year-old coconut garden of local cultivar-Tiptur Tall. The quantity of water given through drip system was based on the 10 years average of mean monthly evaporation. Irrigation either through drip or basin system significantly increased the nut yield of coconut over rainfed control. Drip irrigation at 100 per cent Eo recorded significantly higher nut yield compared to drip irrigation @ 33 per cent Eo and 66 per cent Eo and was on par with basin irrigation at IW/CPE equal to 1.0 at 3 cm depth The rainfed control recorded significantly lower nut yield compared to treatments of providing drip or basin irrigation. The increase in nut yield in irrigation treatments over rainfed control was due to more number of functional leaves, production of more number of flowering bunches and female flowers. The leaf nutrient status was also increased with irrigation. The net returns and B : C ratio were highest with drip irrigation at 100 per cent Eo followed by basin irrigation and drip irrigation at 66 per cent Eo. Hence, drip irrigation at 100 per cent Eo is found suitable for coconut in the *maidan* tract of Karnataka. The water to be applied during summer months (February-May) is 65-75 litres/palm/day while for winter and rainy months (June-January) is 40-50 litres/palm/day.

COCONUT requires a well distributed rainfall of 1500-2000 mm per annum for normal growth and development. However, the rainfall received in the *maidan* tract of Karnataka ranges from 600-800 mm distributed mainly during May to October. Hence, coconut crop needs to be irrigated during non-rainy periods for sustained yields (Abeywardena, 1971 and Varadan and Madhava Chandran, 1991). The water requirement of coconut is location specific and varies with the climate, soil, cultivar and system of irrigation. Among different irrigation methods, drip irrigation is gaining popularity among the coconut growers in the recent past as it maintains the soil moisture availability and air balance in the root zone of coconut near field capacity throughout the dry season and saves irrigation water (Vidhana Arachchi, 1998). Drip irrigation wets only a limited portion of the potential soil root volume, which would be adequate for most plants perform well, along with minimum evaporation loss of water (Dorota and Forrest, 1996). The water requirement through drip system may vary from region to region depending on the climate and soil. In the dry regions of Tamil Nadu, the transpiration from coconut leaves was reported to be 90 litres per palm per day (Mohandas *et al.* 1989). In the dry zone of Sri Lanka, coconut requires 25 to 30 litres of water per day through drip method (Mahindapala, 1987). Similarly, in the dry regions of Tamil Nadu, the water requirement for coconut palm through drip irrigation ranged from 55 litres per day in December to 115 litres per day in June (Kulandaivelu, 1990). Keeping view the above facts in mind, a field trial was conducted at Agricultural Research Station, Arsikere to elucidate information on the drip irrigation requirement of coconut in the *maidan* tract of Karnataka.

MATERIAL AND METHODS

The experiment on drip irrigation was conducted during 2000-05 in a 25 years-old coconut garden of local cultivar-Tiptur Tall at Agricultural Research Station, Arsikere which is located at 76° 15' E longitude and 13° 15' N latitude with an altitude of 808 m MSL. The annual average rainfall received at the Research Station is 654.8 mm in 46 rainy days distributed mainly during May to October. There are two peaks in rainfall distribution, one in May-June and the other during September-October. The mean minimum temperature is 10.3°C during December and the maximum temperature is 34.6°C during March.

The soil is clay loam with low in available N (182.5 kg/ha), medium in available P (12.5 kg/ha) and high in available K (280 kg/ha). The experiment consisting of 5 treatments was laid out in Randomized Block Design with four replications as detailed below:

T_1: No irrigation (Rainfed control)

T_2: Drip irrigation at 33 per cent Eo

T_3: Drip irrigation at 66 per cent Eo

T_4: Drip irrigation at 100 per cent Eo

T_5: Basin irrigation at IW/CPE=1 at 3.0 cm depth

The quantity of water given through drip system was calculated based on the 10 years average of mean monthly evaporation (Table I). The 1.8 m radius of coconut basin was taken as the effective root zone for calculating the water requirement for each treatment (Kushwah *et al.*, 1973; Maheswarappa *et al.*, 2000). The pan evaporation (Eo) was highest during the month of April (7.37 mm/day) and requires 75 litres/day/palm under 100 per cent Eo level, while the pan evaporation was lowest during December (4.39 mm/day) and requires 45 litres/day/palm.

The drip irrigation system consisted of pumping of water from bore well and delivers water through water filter, main pipeline, sub pipeline, laterals and drippers. At the base of each palm drippers were placed one metre away from the bole at equidistance with the help of 4 mm LDPE micro tubes. The daily duration of drip irrigation was same during the month in all the drip irrigation treatments but the number of drippers placed near the palm varied. The number of drippers was six for drip irrigation at 100 per cent Eo, while the number of drippers was reduced to four and

TABLE I

Mean monthly evaporation (Eo) and water applied to coconut through drip system

Month	Evaporation (mm/day)	Quantity of water applied / palm / day (litres) through drip irrigation at			No. of hours drip system was run
		100% Eo	66% Eo	33% Eo	
January	4.77	48.33	32.00	16.00	2.00
February	6.39	65.01	42.90	21.50	2.45
March	7.35	75.00	50.00	25.00	3.00
April	7.37	75.00	50.00	25.00	3.00
May	6.65	67.70	44.65	22.30	2.50
June	5.16	52.50	34.65	17.30	2.10
July	4.06	41.30	27.30	13.60	1.45
August	4.10	41.70	27.50	13.76	1.50
September	4.72	48.02	31.70	15.85	2.00
October	4.85	49.34	32.57	16.28	2.05
November	4.84	49.24	32.50	16.25	2.05
December	4.39	44.66	29.48	14.74	1.55
Mean	**5.39**	**54.83**	**36.19**	**18.09**	**2.15**

two respectively for drip irrigation at 66 and 33 per cent Eo. The water from the drippers was allowed to drip at the rate of 4 litres per hour up to the 30 cm depth by putting the drippers in 30 × 30 cm × 30 cm pits with the help of conduit pipe. For basin irrigation, 306 litres of water was applied in basins of 1.8 m radius whenever the cumulative pan evaporation reached 30 mm.

The coconut palms were planted during 1975 with a spacing of 10 × 10 m. The adult palms were supplied with 500: 320: 1200 g NPK per palm per year in the form of urea, single super phosphate and muriate of potash applied in two splits, 1/3rd during April- May and 2/3rd during September-October. The number of functional leaves and annual production of bunches and female flowers per palm were recorded during 2002-03 to 2004-05. Coconut leaf samples were collected from the index leaf (14th leaf) during 2005 and analyzed for N, P and K content by adopting standard procedures (Jackson, 1973). The nut yield from each palm was recorded separately during each harvest every year. Nut setting per cent was computed from the data on number of female flowers produced per palm and the nut yield per palm. The data recorded on various characters were subjected to Fisher's method of analysis of variance and interpretation of data was done as per the procedure given by Gomez and Gomez (1984).

Results and Discussion

Irrigation treatments significantly increased the number of functional leaves on the crown, number of flowering bunches, number of female flowers and nut setting per cent in coconut over rainfed control (Table II). Drip irrigation at 100 per cent Eo recorded significantly higher number of functional leaves on the crown compared to rainfed control and drip irrigation at 33 per cent Eo and 66 per cent Eo and was on par with basin irrigation at IW/CPE equal to 1.0. The number of bunches per palm was on par in different irrigation treatments and significantly higher than rainfed control. The number of female flowers produced per palm under drip irrigation at 100 per cent Eo was on par with basin irrigation at IW/CPE equal to 1.0 and significantly higher than rainfed control and drip irrigation at 33 and 66 per cent Eo. Similar results of increased leaf and female flower production under irrigated condition was also reported by Abeyawardena (1979), Venkitaswamy *et al.* (1997), Dhanapal *et al.* (2000) and Dhanapal *et al.* (2004). The nut setting per cent in drip irrigation at 100 per cent Eo was significantly higher than rainfed control but was on par with other irrigation treatments.

The leaf analysis for the major nutrients indicated that N, P and K contents were found to be statistically higher in the irrigated treatments compared to rainfed control (Table III). This indicates that water is the key factor which affects nutrient uptake from the soil. Higher uptake of N, P and K by coconut under irrigated conditions compared to rainfed control was also reported by Dhanapal *et al.* (2000) in littoral sandy soil and by Dhanapal *et al.* (2004) in laterite soil. Roots intercept more nutrient ions when grown in moist soil than in dry soil because of extensive root growth under adequate moisture conditions. Higher uptake of nutrients under adequate soil moisture condition was due to the increased solubility and better availability of the nutrients. The lower nutrient uptake under rainfed condition may be due to the fact that cells of the absorption zone of coconut become inactive by suberization and dehydration during dry weather affecting the nutrient and water absorption processes (Vidhana Arachchi, 1996).

The mean data on nut yield over five years from 2000-01 to 2004-05 showed that irrigation either through drip or basin method significantly increased the nut yield of coconut over rainfed control (Table IV). Drip irrigation at 100 per cent Eo recorded significantly higher nut yield (97.98 nuts/palm/year) compared to drip irrigation at 33 per cent Eo (78.17 nuts/palm/year) and at 66 per cent Eo (86.91 nuts/palm/year) and was on par with basin irrigation at IW/CPE equal to 1.0 at 3 cm depth (93.20 nuts/palm/year). The rainfed control recorded significantly lower nut yield (51.58 nuts/palm/year) compared to treatments that were provided with drip or basin irrigation. Rajagopal *et al.* (1989) observed increased stomatal conductance, photosynthetic rate and transpiration rate at higher levels of irrigation resulted in higher nut yield. On the contrary, greater stomatal resistance and epicuticular wax content and reduced transpiration rate, leaf water potential and reproductive

TABLE II

Effect of drip irrigation on yield attributes in coconut (Pooled over 3 years : 2002-03 to 2004-05)

Treatments	No. of functional leaves / palm	No. of bunches / palm	No. of female flowers / palm	Not setting (%)
No irrigation (Rainfed control)	23.8	9.2	151.3	29.8
Drip irrigation @ 33% Eo	28.1	10.3	182.1	37.9
Drip irrigation @ 66 % Eo	30.5	11.3	210.4	37.8
Drip irrigation @ 100% Eo	31.9	11.9	**232.9**	**39.6**
Basin irrigation @ IW/CPE=1	31.3	11.5	231.5	37.7
S. Em ±	0.30	0.17	3.8	1.5
CD (P=0.05)	0.92	0.53	11.8	4.7

TABLE III

Effect of drip irrigation on leaf nutrient status of coconut

Treatments	Leaf nutrient content (%)		
	N	P	K
No irrigation (Rainfed control)	1.36	0.105	1.16
Drip irrigation @ 33% Eo	1.57	0.118	1.27
Drip irrigation @ 66 % Eo	1.73	0.125	1.36
Drip irrigation @ 100% Eo	1.75	0.133	1.35
Basin irrigation @ IW/CPE=1	1.80	0.128	1.38
S. Em ±	0.03	0.004	0.03
CD (P=0.05)	0.08	0.012	0.10

TABLE IV

Effect of drip irrigation on nut yield of coconut during 2000-01 to 2004-05

Treatments	No. of nuts / palm / year						No. of nuts / ha
	2000-01	2001-02	2002-03	2003-04	2004-05	Mean (5 yrs)	
No irrigation (Rainfed control)	57.78	65.88	51.40	52.40	30.43	51.58	5158
Drip irrigation @ 33% Eo	94.38	91.73	86.10	79.80	38.85	78.17	7817
Drip irrigation @ 66 % Eo	99.43	98.80	94.30	94.40	47.60	86.91	8691
Drip irrigation @ 100% Eo	104.88	106.03	116.45	113.63	48.93	97.98	9798
Basin irrigation @ IW/CPE=1	100.40	103.30	107.00	108.20	47.08	93.20	9320
S. Em ±	5.52	5.92	2.38	4.39	2.54	2.38	215
CD (P=0.05)	17.00	18.24	7.32	13.54	7.84	7.33	662

TABLE V

Economics of drip irrigation system irrigation system in coconut (Based on the mean data of 5 years)

Treatments	Gross Returns (Rs. / ha)	Cost of Production (Rs. / ha)	Net Returns (Rs. / ha)	B : C Ratio
No irrigation (Rainfed control)	25790	11335	14455	2.27
Drip irrigation @ 33% Eo	39085	15645	23440	2.50
Drip irrigation @ 66 % Eo	43455	15745	27710	2.76
Drip irrigation @ 100% Eo	48990	15845	33145	3.09
Basin irrigation @ IW/CPE=1	46600	17095	29505	2.72
S. Em ±	1075	NA	1075	0.07
CD (P=0.05)	3312	–	3312	0.22

NA : Not analysed

dry matter was observed under severely moisture stressed palms compared to well watered palms. The increase in nut yield in irrigation treatments over rainfed control was mainly attributed to more number of functional leaves, production of more number of flowering bunches and female flowers and better uptake of nutrients.

The economics of different irrigation treatments was worked out, statistically analysed and presented in Table V. The net returns and B : C ratio were significantly highest with drip irrigation at 100 per cent Eo (Rs. 33145/ha and 3.09) followed by basin irrigation (Rs. 29505/ha) and 2.72) and drip irrigation at 66 per cent Eo (Rs. 27710/ha and 2.76). Similarly, Dhanapal *et al.* (2000) and Dhanapal *et al.* (2004) reported higher net income and B : C ratio in drip irrigated coconut garden compared to basin irrigation and rainfed gardens. Thus it can be inferred that drip irrigation at 100 per cent Eo is suitable for coconut in the *maidan* tract of Karnataka. The water to be applied during summer months (February-May) is 65-75 litres per palm per day while for winter and rainy months (June-January) is 40-50 litres / palm / day.

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