

Influence of drip irrigation on nut characters and yield of coconut (*Cocos nucifera*) in laterite soil

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ABSTRACT

A field experiment was conducted with 'Chowghat Orange Dwarf' ('COD') × 'West Coast Tall' (WCT) and 'West Coast Tall' coconut (*Cocos nucifera* L.) cultivars under laterite soil condition, to study the influence of drip irrigation on nut yield and nut characters during 1993–1999 at Kasaragod, Kerala. The treatments consisted of 3 levels of drip irrigation [33, 66 and 100% of open pan evaporation (E_o) daily] along with basin irrigation (100% of E_o) and rainfed control. Drip irrigation at 66% of E_o (27 litres water/palm/day during December–January and 32 litres of water/ palm per day during February–May) resulted in water saving and the nut yield was on a par with 100% through drip and 100 % of E_o through basin irrigation. Rainfed control and 33% of E_o through drip treatments recorded significantly lower nut yield in both the cultivars. The nut characters like nut weight, copra thickness, and copra content were superior under irrigated treatments compared to rainfed control.

Key words : Coconut, WCT, 'COD' × 'WCT', Drip irrigation, Nut characters, Yield, Copra content

Coconut is a high value commercial crop, grown in 93 countries with a total area coverage of 11.85 million ha. India, Indonesia, Philippines and Sri Lanka are the major global players, which together contribute 78% of the world production. In India, its is being grown on an area of 1.89 million ha and producing 12,821 million nuts with the productivity of 6,776 nuts/ha. Among coconut-growing states, Andhra Pradesh stands in the forefront with the productivity of 10,857 nuts/ha, while in Kerala productivity is as low as 6,144 nuts/ha mainly because of the fact that it is being grown as rain dependent crop and prevalence of root (wilt) disease. Though Kerala falls under heavy rainfall zone, the variability of rainfall coupled with inadequate irrigation resources and poor water management results in mild to severe stress on coconut palms between December and May, resulting in lower productivity. The importance of irrigating coconut for sustained yield has been emphasized (Varadan and Madhava Chandran, 1991; Dhanapal *et al.*, 2000). Among the irrigation systems, drip irrigation is gaining importance 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).

Keeping in view these facts, a field investigation was initiated at the Central Plantation Crops Research Institute,

Kasaragod, in laterite soil during 1993 with the objectives to study the drip irrigation requirement and its influence on nut characters and yield of 'Chowghat Orange Dwarf' × 'West Coast Tall' coconut hybrid and West Coast Tall variety.

MATERIALS AND METHODS

The experiment was conducted during 1993–99 at Central Plantation Crops Research Institute (CPCRI), Kasaragod, Kerala (India), which is situated at 12° 30' N and 75° 00' E at an elevation of 10.7 m above mean sea-level. The average rainfall received in the area is 3,400 mm, out of which, 86% is received during the 4 monsoon months (June–September) and the period from December to middle May remains rainless. The maximum temperature ranges between 28.8°C and 33.1°C and minimum temperature varies between 19.4°C and 24.4°C, with the maximum open pan evaporation during March–May (5.0 to 5.3 mm). The soil of the experimental field was classified as laterite soil with gravely-clay texture containing on an average 56% gravels.

Two separate trials with 'Chowghat Orange Dwarf' × 'West Coast Tall' coconut hybrid and 'West Coast Tall' coconut variety were conducted in randomized complete block design with 4 replications and 3 palms/ treatment. The treatments comprised: T₁, drip irrigation at 33% E_o

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(open pan evaporation) daily; T₂, drip irrigation at 66% E₀ daily; T₃, drip irrigation at 100% E₀ daily; T₄, basin irrigation at 100% E₀ applied once in 4 days through hose pipe, and T₅, rainfed control

Under drip irrigation, the quantity of water applied was based on mean monthly open pan evaporation (20 years average) during December–January and February–May. The mean monthly open pan evaporation values during December–January was 4.2 mm and February–May was 5.0 mm. The quantity of water applied in each treatment during different months, was as follows: Under treatment T₁, quantity of water during Dec-Jan months was 14 litres/ palm, and during Feb-May months, it was 16 litres/ palm. Under T₂ treatment it was 27 litres/ palm during Dec-Jan months and during Feb-May months, it was 32 litres/ palm. In treatment T₃ it was 42 litres/ palm during Dec-Jan months and during Feb-May months it was 50 litres/palm. Under basin method of irrigation (T₄) it was 168 litres/palm once in 4 days during Dec-Jan months and during Feb-May months it was 200 litres/ palm once in 4 days.

The drip irrigation system consisted of an overhead water tank and the outlet was connected with water filter along with main pipeline. From the main pipeline, the laterals [16 mm Low Density Poly Ethylene (LDPE) pipes] of convenient length were laid with end cap. At the base of the each palm 4 emitters were placed 1m away from the bole at equidistance with the help of 4 mm LDPE micro-tubes. The water from the emitters was allowed to drip at the rate of 2 litres/hr up to the 30 cm depth by putting the emitters in 30 cm³ pits with the help of conduit pipe. The coconut plams were planted during 1976 (17 years old) with the spacing of 7.5 m × 7.5 m. The adult plams were supplied with 500 : 320 : 1,200 g NPK per palm per year in the form of urea, Mussoorie rock phosphate, and muriate of potash applied in 2 splits, 1/3rd during April-May and 2/3rds during September-October. The drip irrigation treatments were imposed as per treatments from 1993 onwards during non-rain periods of December to May.

Nut yield from each palm was recorded separately during each harvest every year. Nut characters were studied from representative samples during 3 seasons of 1998 and 1999 and average was worked out. 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.

RESULTS AND DISCUSSION

Nut yield of hybrid

The pre-experimental data on nut yield was non-signifi-

cant among the treatments and the average yield ranged from 32 to 37 nuts per palm per year. Pooled data on nut yield for 6 years (1993–99) differed significantly among irrigation treatments and rainfed control (Table 1). Drip irrigation at 33% of E₀ recorded significantly lower nut yield compared to other irrigation treatments and was on par with rainfed control. Nut yield recorded at 66% and 100% of E₀ through drip or basin irrigation was statistically on par with each other.

Nut yield of variety

The pre-experimental data on nut yield was non significant among the treatments and the average yield ranged from 25 to 32 nuts per palm per year. Pooled data on nut yield for 6 years (1993–99) revealed that there was significant difference among irrigation treatments and rainfed control (Table 1). Among the irrigation treatments, drip irrigation @ 33% of E₀ recorded significantly lower nut yield (68.2 nuts/palm/year) compared to other irrigation treatments but recorded significantly higher yield compared with rainfed control (52.6 nuts/palm/year). Nut yield recorded with T₂, T₃ and T₄ treatments were statistically on par with each other.

This clearly indicated that drip irrigation at 33% of E₀ failed to produce significant increased in yield, may be due to the fact that the water applied could not meet the water requirement of the palm as indicated by lower stomatal conductance, transpiration rate and net photosynthesis. However, at higher levels of irrigation, there was increase in photosynthesis, transpiration rate and stomatal conductance which resulted in higher nut yield. Rajagopal *et al.* (1989) also reported greater stomatal resistance and epicuticular wax content and reduced transpiration rate, leaf water potential and reproductive dry matter under severely moisture stressed palms compared to well-watered palms. Increase in nut yield was mainly attributed to production of more number of leaves and better uptake of nutrients under these treatments (CPCRI, 2001). Coconut palm in general produces 1 inflorescence/bunch in each leaf axil and thus higher leaf production will directly contribute towards increased nut yield. This clearly indicated that irrigation at 66% of E₀ might be sufficient to produce maximum yield in laterite soil. Under rainfed condition, the hybrid palms suffer more as evident from lower physiological parameters like stomatal conductance, transpiration rate and photosynthesis. Under littoral sandy soil condition also, Dhanapal *et al.*, (2000) reported higher nut yield at 66% of E₀. It was also reported that yield of nuts for drip method at 30 and 45 litres/day/palm was on par with basin irrigation at 600 litres/palm/week (Varadan and Madhava Chandran, 1991) besides stabilized yield with minimum fluctuation under adequate irrigation (Jose

Table 1. Nut yield and nut characters of COD × WCT and WCT coconut as influenced by irrigation in laterite soil

Treatment	Nut yield (pre-experimental (1991–93))		Nut yield (average of 1993–99)		Nut weight (g/nut)		Copra content (g/nut)		Copra thickness (cm)	
	COD×WCT	WCT	COD×WCT	WCT	COD × WCT	WCT	COD × WCT	WCT	COD × WCT	WCT
	T ₁ , Drip irrigation at 33% of E ₀ daily	32.6	28.2	72.8	68.2	635	589	199	186	1.24
T ₂ , Drip irrigation at 66% of E ₀ daily	31.7	30.1	113.6	96.5	592	560	197	178	1.31	1.38
T ₃ , Drip irrigation at 100% of E ₀ daily	33.4	24.9	119.7	89.8	638	576	203	189	1.29	1.32
T ₄ , Basin irrigation at 100% of E ₀ once in 4 days	36.3	31.6	116.0	98.2	646	562	195	179	1.26	1.35
T ₅ , Rainfed control	37.3	30.8	58.6	52.6	467	467	155	148	1.04	1.19
CD (P=0.05)	NS	NS	16.8	9.5	NS	NS	21.3	26.1	0.07	0.08

COD, 'Chowghat Orange Dwarf'; WCT, 'West Coast Tall'

Mathew *et al.*, 1996). The main reason for 34% water saving in the 66% of E₀ through drip treatment compared to 100% of E₀ through drip or basin irrigation, was due to the fact that the water was applied at reduced quantity and thus the deep percolation loss was avoided. Though more water applied under 100% E₀ 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.

Nut characters

The nut characters in both the cultivars like nut weight (dehusked) did not differ significantly among the treatments (Table 1), but rainfed treatment recorded lower nut weight. Copra content and copra thickness were significantly higher in irrigated treatments compared to rainfed control. This clearly indicates that water plays an important role in copra production. Increase in copra content and copra thickness will have a direct influence on copra outturn from a palm.

From this study, it can be concluded that, under northern Kerala condition irrigating coconut palms with 27 litre of water during December-January and 32 litres of water during February-May is optimum to obtain higher nut yield and copra yield in 'Chowghat Orange Dwarf × 'West Coast Tall' and 'West Coast Tall' cultivars of coco-

nut in laterite soil.

REFERENCES

- CPCRI, 2001. *Annual Report for 2000*. Central Plantation Crops Research Institute, Kasaragod, India, pp. 103–109.
- Dhanapal R., Maheswarappa, H.P., Subramanian, P., Sairam, C.V. and Gopalsundaram, P. 2000. Micro irrigation technique for coconut in littoral sandy soil. (In) *Recent Advances in Plantation Crops Research*, pp. 181–185. Muraleedharan, K. and Raj Kumar (Eds.). UPASI Tea Research Foundation, Tea Research Institute, Valparai, Tamil Nadu, Allied Pub. Pvt. Ltd, New Delhi, India.
- Jose Mathew, Pillai, G.R., Santhakumari, G and Kuruvilla, Varughese. 1996. Irrigation management on yield stabilization and annual productivity of coconut. *Journal of Tropical Agriculture* 34 : 33–35.
- Rajagopal, V., Ramadasan, A., Kasturi Bai, K.V. and Balasimha, D. 1989. Influence of irrigation on leaf water relations and dry matter production in coconut palms. *Irrigation Science* 10 (1) : 73–81.
- Varadan, K.M. and Madhava Chandran, K. 1991. Irrigation requirement of coconut under drip method. (In) *Coconut Breeding and Management*, pp. 281–282. Silas, E.G., Aravindakshan, M. and Jose, A.I. (Eds). Kerala Agricultural University, Trichur, India.
- Vidhana Arachchi, L.P. 1998. Preliminary requirements to design a suitable drip irrigation system for coconut (*Cocos nucifera* L.) in gravelly soils. *Agricultural Water Management* 38 : 169–180.