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Standardization of fertilizer requirement through fertigation for coconut under Krishna Godavari zone of Andhra Pradesh

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ABSTRACT

An experiment on fertigation in coconut was conducted from 2007 to 2014 to standardize the fertilizer application through drip irrigation and to work out the economics. The experiment was laid out in twenty year old existing coconut garden *cv*. East Coast Tall in RBD comprising of six treatment combinations with four replications. With respect to mean nut yield, maximum yield of 92.7 nuts/palm was also recorded with 100% RDF through fertigation (T_5) and it was on par with 75% RDF through fertigation (90.6 nuts/palm) (T_4). Perusal of data on copra content revealed that, the highest copra content of 131.8 g/nut was recorded with 100% RDF through fertigation and was on par with the other fertigation treatment except T_2 and control which was superior over control. The highest oil content was also recorded with 100% RDF through fertigation (64 %) and it was on par with 75% of RDF through fertigation (T_4) and 100% of RDF as soil application (T_6). From the study, it can be inferred that, application of 75 % RDF *i.e.*, 375 g N, 240 g P_2O_5 and 1875 g K_2O per palm per year through drip irrigation in eight splits from October to May resulted in higher nut yield per plam with the highest output-input ratio (2.69) when compared to control (1.79).

Key words: *Cocos nucifera*, nut yield, copra content, economics.

INTRODUCTION

Water and nutrients are the critical factors in irrigated agriculture and are the major inputs contributing to the higher productivity of crops. The method of fertilizer application and irrigation affects the efficiency of these inputs. The input use efficiency is currently very low in India leading to low crop productivity, degradation of soil health and increased environmental pollution apart from wastage of substantial quantity of these costly and scarce inputs. The water use efficiency as well as fertilizer use efficiency can be greatly improved through the adoption of drip irrigation system and fertigation respectively.

Fertigation is considered as the most advanced and efficient method of fertilizer application which ensures application of fertilizers directly to the root zone of the crop throughout the cropping period along with irrigation. Fertigation optimizes the use of water and fertilizer enabling to harness higher crop yields and ensure a healthy soil and environment. In fertigation method, it was shown that nutrient use efficiency could be as high as 90 per cent compared to 40-60 per cent in conventional methods and the amount of nutrients lost through leaching could be as low as 10 per cent when compared to 50 per cent in the traditional system (Solaimalai *et al*., 11). The studies on fertigation revealed significant fertilizer savings of 20-60 per cent and 8-41 per cent increase in yields of horticultural and vegetable crops (Singh *et al*., 10). With expanding area under drip irrigation in India, fertigation has great scope in fertilizer saving and increased fertilizer use efficiency and crop yield.

Coconut (*Cocos nucifera* L.) is one of the important plantation crops and grown in an area of 1.15 lakh hectares with a production of 1377 million nuts and annually productivity of 11957 nuts/ha during 2016-17 (CDB statistics, 3). Majority of the coconut gardens in East and West Godavari districts (KG Zone) of Andhra Pradesh are flood irrigated where in huge loss of water with poor water use efficiency apart from rapid weed growth and higher level of soil borne diseases like Ganoderma wilt are the major constraints. In this situation, fertigation is an efficient method of fertilizer application through drip system of irrigation which not only minimizes the cost of inputs (fertilizer and labour) but also increases fertilizer use efficiency. The area under micro irrigation has been steadily increasing over the years in different coconut growing states including Andhra Pradesh as the State and Central Governments are providing financial support for establishing drip irrigation. However, so far no standardized fertigation schedules were available for coconut cv. East Coast Tall which occupies major area (>80%) in Andhra Pradesh.

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Therefore, the present investigation was undertaken with the objective to standardize the fertilizer requirement through drip irrigation for coconut under East Godavari conditions of Andhra Pradesh and to work out the economic viability of fertigation system.

MATERIALS AND METHODS

The study was carried out during 2007-08 to 2013-14 at Horticulture Research Station, Ambajipeta, East Godavari district of Andhra Pradesh. The Research Station receives an annual rainfall of 1154 mm and mean temperature ranged from minimum of 26.9°C to maximum of 41.2°C. The average relative humidity varied between 64.2 and 86.5%. The soils are coastal alluvial type with impeded drainage and low in available nitrogen (278 kg N ha^{-1}), medium in available phosphorous (35 kg P_2O_5 ha^{-1}) and potassium (206 kg K_2O ha^{-1}). The experiment was laid out in RBD with six treatments and four replications. Application of 25 (T_2), 50 (T3), 75 (T_4) and 100 per cent of recommended NPK through drip irrigation (T_5) was compared with the soil application of 100 per cent recommended NPK (T_6) and the control (T_1) *i.e* without fertilizer application. The recommended fertilizer dose of 500:320:1500 g NPK $palm^{-1}year^{-1}$was adopted for fertigation as well as soil application.

Fertigation was done using fertigation tank connected to pipe line of drip irrigation system. Fertilizers were dissolved in water and added to the fertigation tank after filtering the solution and applied to coconut through drip irrigation system in eight equal splits in a year at monthly interval excluding peak rainfall months of June, July, August and September. For soil application of 100 per cent recommended NPK (RDF), the fertilizers of urea, single super phosphate (SSP) and muriate of potash (MOP) were applied in two equal splits during May-June and September- October. For the purpose of fertigation, urea, di-ammonium phosphate (DAP) and muriate of potash were used as sources of nitrogen, phosphorus and potassium respectively. The experiment was laid in 20 years old coconut *cv*. East Coast Tall planted at a spacing of 8.0 m × 8.0 m (156 palms ha^{-1}). The drip irrigation was given at 66 per cent of pan evaporation (E_o) and the quantity of water given was calculated based on 10 years average of mean monthly evaporation. The 1.8 m radius of coconut basin was taken as the effective root zone for calculating the water requirement (Kushwah *et al*., 7).

The drip irrigation system consisted of pumping of water from bore well and delivery after passing through water filter, main pipeline, sub pipeline, laterals and drippers. At the base of each palm, four drippers were placed one meter away from the bole at equidistance with the help of 4 mm LDPE micro tubes. The daily duration of drip irrigation was fixed based on the quantity of water to be given at 66 per cent E_o and discharge rate of 4 litres per hour per dripper. The water was allowed to drip up to 30 cm depth by putting the drippers in the conduit pipe. Mulching was provided to coconut basins using coconut leaves. The observation on the number of total leaves on crown, number of spadices per palm and female flowers per bunch were recorded. Soil samples were drawn from the basins of coconut at 0-30 cm depth for analyzing nutrient status (NPK) of soil. Similarly, the coconut leaf samples were collected from index leaf (14^{th} leaf) and analyzed for N, P and K content by adopting standard procedure (Jackson ,5).The fruits were harvested periodically at maturity from July to June and pooled to get nut yield per palm per year. Copra content per nut was estimated from random sample of ten fruits per treatment drawn at each harvest, followed by dehusking, separation of the kernel from shell, drying in the shade and averaging over harvests. The economics of fertigation was worked out considering the cost of inputs and market price of nuts (Rs. 8/- per coconut) prevailed during 2013-14. The data was analyzed statistically as per the procedure (Gomez and Gomez , 4).

RESULTS AND DISCUSSION

The growth and yield attributing characters of coconut are shown in Table 1. Fertigation had a significant influence on the number of leaves on the crown, number of spadices per palm and number of female flowers per bunch. The pooled data on biometric observations was revealed that the highest number of leaves on crown (35.2) and number of spadices per palm (13.0) were recorded in 100% RDF through fertigation (T_5). Similarly, the mean number of female flowers per spadix (23.6) was the highest in T_5 and it was statistically on par with T_4 (23.1) and T_3 (21.9). On an average, a healthy coconut palm normally produces one leaf and a subtending bunch in its axil per month that necessitates continuous supply of nutrients throughout the year (Khan,1993).The regular supply of nutrients coupled with optimum moisture in fertigation assisted for producing higher number of leaves on crown, number of spadices per palm and number of female flowers per spadix. Similar results were also reported by (Basavaraju *et al*., 1), wherein application of 100 per cent NPK through drip recorded significantly higher number of functional leaves, number of bunches and number of female

Table 1. Yield attributing characters of coconut as influenced by fertigation treatments (Pooled data 2007-14).

Treatments	Total no. of leaves on crown	Mean no. of spadices/ palm/ Year	Mean no. female flowers /bunch
T_1-Control	29.8	9.6	15.1
T_2 -25% RDF through fertigation	30.8	11.9	17.5
T_3-50% RDF through fertigation	33.3	12.0	21.9
T_4-75% RDF through fertigation	35.1	12.6	23.1
T_5-100% RDF through fertigation	35.2	13.0	23.6
S Em $\pm$	0.37	0.27	0.69
T_6-100% RDF as soil application	30.7	10.8	18.1
CD (P=0.05)	1.15	0.83	2.10

flowers at Horticultural Research Station,Ariskere. The superiority of the growth and yield attributing characters in palms receiving 75% NPK through drip irrigation was also reported at Kahikuchi in "Asom Green Tall" variety of coconut (Nath *et al*., 9) .

In the present investigation, we observed the influence of fertigation on nut yields of coconut from the first year of experimentation. Throughout the experimentation period, 100 % RDF through drip recorded the highest nut yield per palm with pooled nut yield of 92.7 nuts/palm/year (Table 2) and it was statistically at par with 75% RDF through drip (90.6 nuts/palm/year. During the 3rd year, 100% RDF through fertigation recorded maximum yield (87.8 nuts/palm/year) was on par with 75% RDF fertigation (86.4 nuts/palm/year) and 50% RDF fertigation (76.8 nuts/palm/year). The higher nut yield with 75 or 100 per cent of recommended NPK through fertigation over the conventional method of soil application of 100 per cent recommended NPK was mainly attributed to production of more number of female flowers and increased availability and uptake of nutrients. Continuous supply of nutrients through equal split doses might be helpful for perpetual emergence of one leaf and one inflorescence in a palm on monthly basis. The studies conducted at ICAR-Central Plantation Crops Research Institute, Kasaragod indicated the possibility of 50 per cent saving of chemical fertilizer through fertigation in coconut. Application of 50 and 75 per cent of fertilizer application through fertigation recorded significantly higher nut yield compared to soil application of 100 per cent fertilizer and was on par with 100 per cent fertilizer application through fertigation. The higher yield of coconut even in 50 per cent of recommended NPK through fertigation was attributed to increased availability of soil NPK, higher annual leaf production and higher photosynthetic activity and more number of female flower production (Subramanian *et al*., 12). A fertilizer saving of 50 per cent due to fertigation has also been reported from coastal Tamil Nadu and Konkan region of Maharashtra (Maheswarappa and Rajkumar, 8).

Significant differences were observed among different treatments for nut characters. The highest nut weight (1099.9 g) was recorded with 100% RDF of NPK through drip and it was on par with 100% of RDF as soil application (1060.2g) and 75% of RDF through drip (1022.8g). Dehusked nut weight (470.7 g) was the highest in 100% RDF through drip and

Table 2. Nut yield of coconut as influenced by different fertigation treatments.

Treatments	Nut Yield (Pre-treatment 2006-07)	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	Pooled Nut yield (2007-2014)
T_1-Control	52.0	53.5	55.6	56.4	62.5	63.5	66.0	67.5	60.7
T_2-25% RDF through fertigation	51.8	63.5	66.2	72.4	76.5	77.5	80.4	81.8	74.0
T_3-50% RDF through fertigation	74.0	75.6	76.8	78.5	79.3	80.0	80.9	82.0	79.1
T_4-75% RDF through fertigation	55.4	83.4	84.9	86.4	93.3	94.3	95.6	96.4	90.6
T_5-100% RDF through fertigation	68.5	85.6	86.5	87.8	95.2	95.7	98.8	99.5	92.7
T_6-100% RDF as soil application	58.4	66.8	69.0	72.7	82.4	83.1	85.2	86.1	77.9
CD (P=0.05)	7.77	10.11	9.37	9.84	11.53	11.98	12.25	3.54	2.30

it was on par with 75% RDF through drip (451.3g). The highest copra content (131.9 g) was recorded in 100% RDF through drip and it was on par with other treatments except for control. Oil content was highest in 100% RDF through drip (64 %) and it was on par with 75% of RDF through drip (63 %) (Table 3).

The soil NPK status after six years of fertigation was significantly higher with the application of 100 per cent NPK through drip irrigation (364.5, 38.0, 306.5 NPK kg/ha) and soil application (362.6, 36.5, 295.6 NPK kg/ha) and 75 per cent NPK through drip irrigation (348.6, 37.6, 274.5 NPK kg/ha) compared to all other treatments (Table 4). Similarly, the data regarding NPK content in leaf presented in Table 5 revealed that there was no significant differences for phosphorus and potassium in all the treatments. However significant differences among the treatments were noticed for leaf nitrogen content. The leaf nitrogen content was significantly highest in 100% RDF through fertigation (1.98 %) followed by 75% RDF through fertigation (1.93%) whereas the lowest leaf N content (1.42 %) was recorded in control. Increase in NPK was observed after receiving different fertilizer doses through drip irrigation. Application of fertilizers in split doses through drip irrigation minimizes leaching losses of nitrogen and potassium and fixation of phosphorus in the soil. Hence, the nutrient availability in the soil may be maintained at higher level in fertigation compared to soil application of fertilizers. Higher

Table 3. Yield attributes of coconut as influenced by fertigation.

Treatments	Fruit Weight (g/nut)	Husked fruit weight (g/nut)	Husk weight (g/nut)	Copra weight (g/nut)	Oil content (%)
T_1-Control	896.9	360.8	514.2	82.6	57.0
T_2 -25% RDF through fertigation	1032.1	377.9	601.8	108.0	59.0
T_3-50% RDF through fertigation	889.3	371.2	541.5	126.4	60.0
T_4-75% RDF through fertigation	1022.8	451.3	583.4	127.5	63.0
T_5-100% RDF through fertigation	1099.8	470.7	633.1	131.8	64.0
T_6-100% RDF as soil application	1060.2	450.24	610.08	125.14	62.00
CD (P=0.05)	90.96	39.91	67.78	29.20	3.93

Table 4. Soil fertility parameters as influenced by fertigation treatments (2014).

Treatments	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
T_1-Control	264.5	27.4	226.5
T_2 -25% RDF through fertigation	274.8	29.5	244.4
T_3-50% RDF through fertigation	329.2	32.5	264.5
T_4-75% RDF through fertigation	348.6	37.6	274.5
T_5-100% RDF through fertigation	364.5	38.0	306.5
T_6-100% RDF as soil application	362.6	36.5	295.6
CD (P=0.05)	70.84	7.26	54.75

Table 5. Leaf nutrient status as influenced by fertigation treatments (2014).

Treatments	Nitrogen (%)	Phosphorus (%)	Potassium (%)
T_1-Control	1.42	0.11	1.10
T_2 -25% RDF through fertigation	1.76	0.12	1.14
T_3-50% RDF through fertigation	1.89	0.15	1.20
T_4-75% RDF through fertigation	1.93	0.17	1.37
T_5-100% RDF through fertigation	1.98	0.18	1.39
T_6-100% RDF as soil application	1.82	0.16	1.30
CD (P=0.05)	0.36	N.S	N.S

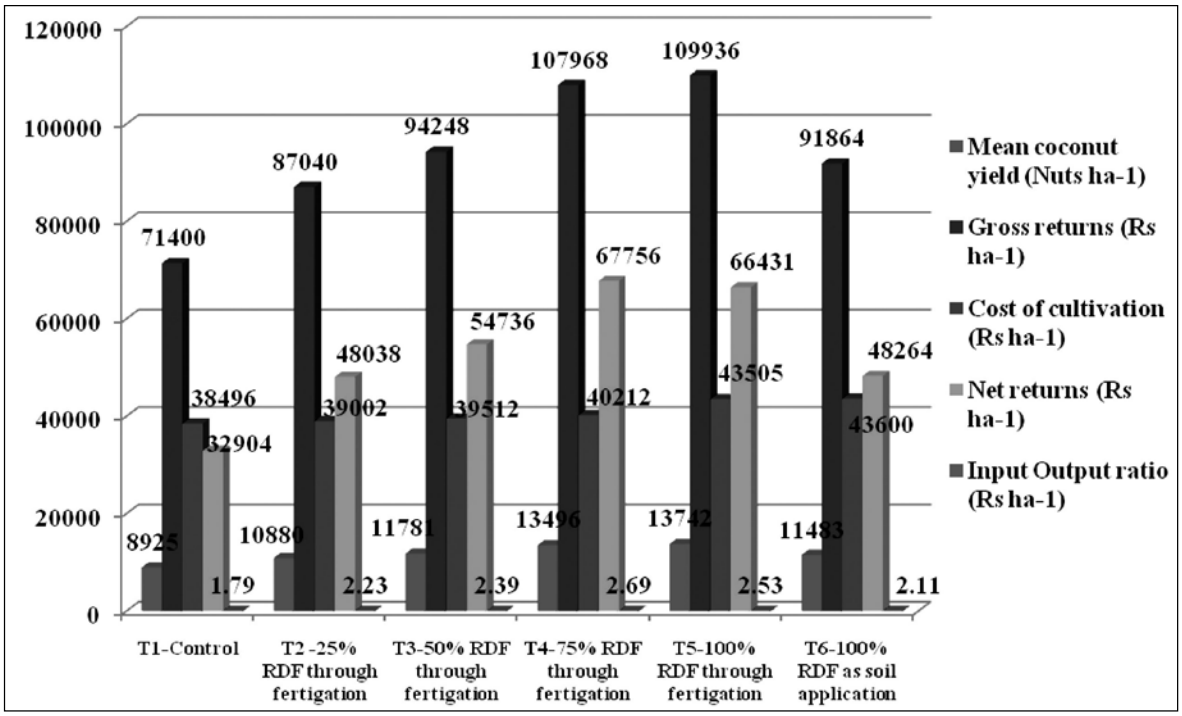

Fig. 1. Economics of fertigation in coconut (2013-14).

nutrient availability in fertigation favors increased nutrient uptake resulting in higher nutrient content in leaves. Similar results of higher soil NPK with fertigation were reported in coconut (Subramanian *et al*., 12 and Basavaraju *et al*., 1) and in arecanut (Bhat *et al.,* 2) .

The economics of fertigation was worked out based on the mean nut yield of six years and market prices prevailed during 2013-14 (Fig 1).The net returns (Rs. 67,756/-) were significantly higher with the application of 75 per cent NPK through drip irrigation compared to other treatments. The input-output ratio was also higher with the application of 75 per cent NPK through drip fertigation (2.69) compared to control treatment (1.79) with net returns of Rs. 32,904/-. The results are in consonance (Basavaraju et al., 1) where in the application of 75 per cent NPK through drip irrigation recorded net returns and benefit-cost ratio on par with 100 per cent NPK through drip irrigation and higher than 100 per cent NPK through soil application.

Thus from the study, it can be concluded that, application of 75 % RDF (375 g N, 240 g P_20_5 and 1875 g K_2O per palm per year) is recommended through fertigation in eight splits from October to May for higher nut yield with highest input - output ratio (2.69) against control (1.79) for East Coast Tall in Krishna Godavari Zone of Andhra Pradesh.

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