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Research Paper

Effect of fertigation on the productivity of coconut (*Cocos nucifera*) in Brahmaputra valley region of Asom

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ABSTRACT

A field experiment was conducted during 2009–10 to 2012–13 to study the effect of fertigation on the productivity of coconut (*Cocos nucifera* L.) at the Horticultural Research Station, Kahikuchi, Asom. Application of 25, 50, 75 and 100% of recommended NPK through drip irrigation system was compared with the soil application of recommended NPK as well as control with no fertilizer application. Fertilizers were given through drip-irrigation system during October to April in 10 equal splits at 20-day intervals. Application of 75% NPK through drip irrigation resulted in significantly higher number of functional leaves, bunches/palm, number of female flowers and nut setting percentage compared to the control and the other fertigation treatments, except 100% NPK through drip irrigation. The mean nut and copra yield/palm over 4 years was significantly higher with the application of 75% NPK through drip irrigation than the control and the other fertigation treatments, but on a par with 100% NPK through drip irrigation. The net returns in 75% NPK through drip irrigation were also at par with the application of 100% NPK through drip irrigation, but application of 75% NPK through drip irrigation resulted in significantly highest benefit: cost ratio compared to all the other treatments. The study indicated the possibility of saving 25% of the recommended fertilizers by adopting fertigation which ensures higher productivity in coconut.

Key words: Coconut, Copra yield, Fertigation, Productivity, Net returns

Coconut is truly an important plantation crop which provides health, wealth, food and also livelihood to millions of people all over the world, and in Asom state it could go a long way in boosting the rural economy. During 2014–15, the state produced 237.49 million nuts in an area of 21.14 thousand ha, with productivity of 11,234 nuts per hectare and occupied 8th position in the production of coconut in the country (CDB, 2016). There is a lot of scope for increasing productivity of coconut with better management in the state and thus improving the rural economy. Fertigation is the application of water-soluble solid fertilizer or liquid fertilizer through drip-irrigation system. In this system, fertilizer solution is distributed evenly in irrigation. The use of fertigation is gaining popularity because of its efficiencies in nutrient management, time, labour and potentially a greater control over crop performance. One of the major factors to promote modern fertigation is the development of micro-irrigation system which includes drip, jet and sprinklers. This has facilitated more widespread adoption of fertigation, especially for perennial fruit crops. In this method, liquid fertilizer as well as water-soluble fertilizers are used and fertilizer-use efficiency is increased.

Fertigation is 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. In fertigation, nutrient-use efficiency could be as high as 90% compared to 40–60% in conventional methods. The amount of nutrient lost through leaching can be as low as 10% in fertigation, whereas it is 50% in the traditional system (Solaimalai *et al*., 2005). The studies on fertigation revealed significant fertilizer savings of 20–60% and 8–41% increase in yield of horticultural crops (Singh *et al*., 2010). Fertigation in coconut increased yield and profit under Kerala and Karnataka region (Subramanian *et al*., 2012; Basavaraju *et al*., 2014). With expanding area under drip irrigation in India, fertigation has great scope in fertilizer saving and increased yield. Therefore, a field trial on fertigation in coconut was carried out to find out the effect of fertigation

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on the productivity of coconut under Asom condition.

MATERIALS AND METHODS

The study was carried out during 2009–10 to 2012–13 at the Horticultural Research Station, Kahikuchi (26.3° N, 91.7° E, 64.0 m above mean sea-level), Guwahati, Asom, under All India Coordinated Research Project on Palms. The station enjoys a sub-tropical climate, with an annual rainfall of about 1,500 mm. The soil of the experimental site was alluvial clay-loam with *p*H 4.9, low in available nitrogen (236.0 kg/ha), medium in available phosphorus (23.0 kg/ha), medium in available potassium (278.0 kg/ha), with an organic carbon of 0.45 %.

The experiment was laid out in randomized block design (RBD) with 6 treatments and four replications. Treatments were: T_1, control (no fertilizer); T_2, 25% of recommended NPK (drip); T_3, 50% of recommended NPK (drip); T_4, 75% of recommended NPK (drip); T_5, 100% of recommended NPK (drip); T_6, 100% of recommended NPK (soil). The recommended fertilizer dose of 690 : 400 : 1,050 g NPK/palm/year was adopted for fertigation as well as soil application. Fertilizer was dissolved in water and added to the fertigation tank after filtering the solution and applied to coconut through drip-irrigation system in 10 splits in a year during dry months, i.e. from October to April at 20-day intervals. Soil application of 100% recommended NPK, the fertilizers were applied in 2 splits- half during April–May and half during September–October. Urea, diammonium phosphate and muriate of potash were used as sources of nitrogen, phosphorus and potassium respectively. The palms were 41-year-old 'Asom Green Tall' cultivar planted at spacing of 7.5 m × 7.5 m.

The drip irrigation was given at 66% of pan evaporation (E_0) 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.*, 1973). The E_0 was the highest during March (7.35 mm/day), while it was the lowest during November (4.37 mm/day) and the water requirement through drip irrigation at 66% E_0 level was 50 and 30 litres/day respectively. At the base of each palm 4 drippers were placed 1 m 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% E_0 and the discharge rate of 4 litres/h in a dripper. The water from dripper was allowed to drip up to 30 cm depth by putting the drippers in the conduit pipe. Mulching was provided to coconut basin using coconut leaves.

Observations on the number of functional leaves and annual production of bunches and female flowers/palm were recorded. Soil samples were drawn from the basins of coconut at 0–25 cm, 25–50 cm and 50–100 cm depths for analyzing nutrient status (NPK) of soil. Similarly, the coconut leaf samples were collected from index leaf (14th leaf) and analyzed for N, P and K content by adopting standard procedure (Jackson, 1973). The nuts were harvested periodically at maturity from July to June and pooled to get nut yield/palm/year. Copra yield/palm was computed based on the copra content in the nut in each treatment. The economics of fertigation was worked out considering the cost of inputs and market price of nut prevailed during 2012–13. The data were analyzed statistically as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Yield-attributing characters of coconut

Significant differences were observed for number of functional leaves, bunches/palm and number of female flowers owing to the fertigation treatments (Table 1). The highest values for all these characters were obtained under application of 75% NPK through drip irrigation, closely followed by 100% NPK through drip irrigation, while the

Table 1. Effect of fertigation treatments on number of functional leaves, number of bunches, number of female flowers and nut setting % in coconut (pooled data for 2009–10 to 2012–13)

Treatment	Number of functional leaves	Number of bunches	Number of female flowers	Nut setting (%)
T_1, Control (no fertilizer)	30.4	9.8	219.5	26.0
T_2, 25% of Rec. NPK (drip)	31.8	10.6	242.1	27.3
T_3, 50% of Rec. NPK (drip)	33.1	10.9	250.2	29.0
T_4, 75% of Rec. NPK (drip)	34.8	11.9	284.5	32.4
T_5, 100% of Rec. NPK (drip)	33.6	11.6	274.2	30.9
T_6, 100% of Rec. NPK (soil)	31.7	11.2	241.3	30.2
SEm ±	0.35	0.17	4.70	0.45
CD (P=0.05)	1.10	0.52	14.25	1.36

Rec., Recommended

lowest values for the above characters were observed in the control. The nut setting (%) was significantly higher with the application of 75% NPK through drip irrigation compared to the control and the other treatments. The regular supply of nutrients coupled with optimum moisture in fertigation favoured higher number of female flower production and increased nut setting. The studies conducted at coastal Tamil Nadu also highlighted the superiority of fertigation to conventional method of fertilizer application on the number of bunches and female flowers produced/palm. Application of 50% NPK through fertigation produced bunches and female flowers per palm comparable to 75% and 100% NPK through fertigation and 100% NPK through soil application (AICRP-Palms, 2011). Increasing level of N fertigation from 0 to 120 kg/ha resulted in gradual increase in most of the yield attributes in Indian mustard (Rathore *et al*., 2014).

Soil and leaf nutrient status in coconut

With regard to soil-nutrient status (NPK) after 4 years of fertigation (Table 2), it was found that significantly higher available N at different depth with application of 100% NPK through soil compared to other treatments and was on a par with 100% NPK through drip and 75% NPK through drip irrigation. In case of phosphorus, 100% NPK through drip resulted significantly higher values than the other treatments. However, at higher depth it was on a par with 75% NPK drip and 100% NPK soil application. Significantly higher K was found with 100% NPK through soil was on par with 100% NPK drip irrigation. At higher depth, K values were significantly higher over other treatments with application of 100% NPK through soil application. Similarly, the leaf NPK status was also significantly higher with the application of 100% NPK through drip irrigation compared to control and application of 25% NPK through drip irrigation (Table 3). The leaf N status in 100% NPK through soil application was significantly lower than 100% NPK 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 will be maintained at higher level in fertigation compared to soil application of fertilizers. Higher nutrient availability in fertigation favoured increased nutrient uptake, resulting in higher nutrient content in coconut leaves. Similar results of higher soil NPK with fertigation in coconut was reported in coastal sandy soils of Kerala (CPCRI, 2011). Improved availability of nutrients due to fertigation was also reported by Bhat *et al.* (2007) in arecanut and Behera *et al.* (2013) in stevia.

Table 3. Leaf-nutrient status in coconut as influenced by fertigation treatments (after 4 years: 2012–13)

Treatment	Leaf nutrient content (%)		
	N	P	K
T_1, Control (no fertilizer)	1.42	0.11	1.10
T_2, 25% of Rec. NPK (drip)	1.76	0.12	1.14
T_3, 50% of Rec. NPK (drip)	1.89	0.15	1.20
T_4, 75% of Rec. NPK (drip)	1.93	0.17	1.57
T_5, 100% of Rec. NPK (drip)	1.98	0.18	1.69
T_6, 100% of Rec. NPK (soil)	1.82	0.16	1.50
SEm±	0.046	0.006	0.06
CD (P=0.05)	0.14	0.017	0.19

Yield of coconut

The nut and copra yield of coconut/palm were significantly influenced by fertigation treatments during all the years of experimentation (Table 4). Pooled data on nut yield for 4 years revealed that application of 75% NPK through drip irrigation (T_4) resulted significantly the highest yield of nuts (88.1 nuts/palm/year), which was on par with application of 100% NPK through drip irrigation (82.2 nuts/palm/year), whereas significantly the lowest nut

Table 2. Effect of fertigation treatments on soil-nutrient status under coconut (after 4 years: 2012–13)

Treatment	Nitrogen (kg/ha)			Phosphorus (kg/ha)			Potassium (kg/ha)		
	0–25cm	25–50cm	50–100cm	0–25 cm	25–50cm	50–100cm	0–25 cm	25–50cm	50–100cm
T_1, Control (no fertilizer)	237	228	221	22.6	20.9	14.6	278	264	240
T_2: 25% of Rec. NPK (drip)	253	248	244	24.7	21.8	15.8	286	269	245
T_3, 50% of Rec. NPK (drip)	269	256	250	26.9	22.6	17.6	317	276	252
T_4, 75% of Rec. NPK (drip)	286	279	262	30.1	25.7	18.9	335	294	270
T_5, 100% of Rec. NPK (Drip)	315	303	266	32.4	26.3	19.3	357	318	294
T_6, 100% of Rec. NPK (soil)	319	311	281	28.8	24.6	19.0	373	349	324
Initial value	236			23.0			278		
SEm±	11.06	11.36	6.80	0.62	0.58	0.39	10.86	9.90	9.10
CD (P=0.05)	33.2	34.1	20.4	1.86	1.75	1.17	32.6	29.7	27.3

Rec., Recommended

Table 4. Effect of fertigation treatments on yield of coconut

Treatment	Pre-experimental yield	Annual nut yield (nuts/palm/year)					Increase (%) over pre-experimental yield	Copra yield (kg/palm)
		2009–10	2010–11	2011–12	2012–13	Pooled		
T_1, Control (no fertilizer)	51.0	51.6	54.0	58.0	55.0	54.7	7.3	8.02
T_2, 25% of Rec. NPK (drip)	53.8	55.8	57.2	71.0	69.5	63.4	17.8	10.21
T_3, 50% of Rec. NPK (drip)	55.0	58.6	62.0	78.6	76.4	68.9	25.3	10.98
T_4, 75% of Rec. NPK (drip)	56.2	69.4	78.2	104.0	100.6	88.1	56.8	14.24
T_5, 100% of Rec. NPK (drip)	55.6	65.8	77.2	95.4	90.3	82.2	47.8	12.96
T_6, 100% of Rec. NPK (soil)	53 .6	59.6	67.2	77.8	74.3	69.7	30.0	11.0
SEm±		1.47	1.99	3.11	3.09	2.75		0.51
CD (P=0.05)	NS	4.45	6.05	9.45	9.37	8.35	–	1.56

Rec., Recommended

Table 5. Economics of fertigation in coconut (mean data of 4 years from 2009–10 to 2012–13)

Treatment	Mean coconut yield (t/ha)	Gross returns (× 10^3₹/ha)	Cost of production/ha (× 10^3₹/ha)	Net returns (× 10^3₹/ha)	Benefit: cost ratio
T_1, Control (no fertilizer)	6.12	95.7	38.5	57.2	1.48
T_2, 25% of Rec. NPK (drip)	7.10	110.9	44.8	66.1	1.48
T_3, 50% of Rec. NPK (drip)	7.71	120.5	45.8	73.7	1.60
T_4, 75% of Rec. NPK (drip)	9.86	154.1	47.1	107.0	2.27
T_5, 100% of Rec. NPK (drip)	9.20	143.8	48.8	95.0	1.95
T_6, 100% of Rec. NPK (soil)	7.80	121.9	45.8	76.1	1.66
SEm±	0.29	4.7		4.1	0.07
CD (P=0.05)	0.89	14.2		12.4	0.19

Rec., Recommended

The cost and returns were calculated based on 2012–13 prices: Sale price of coconut, ₹15,630/tonne (1,563 nuts=1 tonne)

yield of 54.7 nuts/palm/year was obtained in the control (no fertilizer). The treatment T_4 (application of 75% NPK through drip) also resulted in highest increase in nut yield (56.8% over pre-experimental yield) and copra yield (14.24 kg/palm/year) compared to the other treatments. It was observed that application of 75% NPK through drip irrigation, produced nut and copra yield/palm on a par with the application of 100% NPK through drip irrigation indicating possibility of saving of 25% of recommended NPK by adopting fertigation. The higher nut yield with fertigation of 75% recommended NPK over other fertigation treatments was mainly attributed to increased availability of soil NPK, higher annual leaf production and higher photosynthetic activity and more number of female flower production (Subramanaian *et al*., 2012; Basavaraju *et al*., 2014). A fertilizer saving of 50% owing to fertigation has been also reported from coastal Tamil Nadu and Konkan region of Maharashtra (AICRP-Palms, 2011). Bhat *et al*. (2007) recorded higher arecanut yield under 75% of the recommended dose of fertilizer through drip irrigation.

Economics of fertigation

The economics of fertigation was worked out based on the mean nut yield of 4 years and market price that prevailed during 2012–13 (Table 5). The net returns were significantly higher with the application of 75% NPK through drip irrigation compared to the other treatments, except 100% NPK through drip irrigation. The benefit: cost ratio was also significantly higher with the application of 75% NPK through drip irrigation compared to all other treatments.

It can be concluded that a fertilizer saving of 25% was possible by adopting fertigation with 75% NPK through drip irrigation. The number of bunches and female flowers/palm, nut and copra yield/palm and monetary returns in 75% NPK through drip irrigation was comparable to fertigation of 100% NPK through drip irrigation.

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