

## BENEFITS OF DRIP FERTIGATION IN ARECANUT

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### INTRODUCTION

In the present-day context, agriculture is challenged to manage water and nutrients such that production benefits are maximized, while adverse environmental effects are minimized. The right combination of water and nutrients is a prerequisite for higher yields and good quality produce. Arecanut (*Areca catechu* L.), which belongs to family Palmae, is a tall growing, erect and important commercial plantation crop grown in humid tropics of India. It is cultivated in an area of 0.381 million hectares with a production of 0.483 million tones, but the productivity is low (1268 kg ha<sup>-1</sup>) as arecanut is very sensitive to both water logging and water stress. In the tropical belt where arecanut is grown, rainfall is more but the distribution is very poor. Precipitation is confined to six months from June to November with an average rainfall of 3700mm. Thus, insufficient water has been a major limiting factor in post monsoon season (December-May) due to high evaporative demand of arecanut and depleting ground water table. The arecanut palm produces maximum number of inflorescences during post monsoon season i.e., December to March. Thus, providing irrigation and nutrition during that period would contribute to higher yields and improved

resource use efficiency.

A vast majority of arecanut is predominantly grown in acidic laterite soils in India. Faster depletion of ground water, long post monsoon season, less application efficiency and poor moisture retention capacity of laterite soils limit the use of flood irrigation. The annual nutrient mining by the arecanut palm is 79 kg N, 28 kg P<sub>2</sub>O<sub>5</sub> and 79 kg K<sub>2</sub>O per hectare. The nutrient use efficiency of the crop is very low ranging from 10-15% for nitrogen, 25-30% for phosphorus and 20-25% for potassium. Further, root system is shallow and more than 70% of the roots are concentrated within the first 60 cm depth from the ground level and within a radius of 60 cm from the palm. Due to these problems, fertilizers should be applied in synchrony with crop demand in the root zone in smaller quantities during post-monsoon season. Drip fertigation has come in handy for this purpose. Fertigation enables the application of fertilizer uniformly and more efficiently. The method of fertilizer application is also important in improving the use efficiency of nutrients. Fertigation enables adequate supplies of water and nutrients with precise timing and uniform distribution to meet the

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crop nutrient demand. Further, fertigation ensures substantial saving in fertilizer usage and reduces leaching losses. Earlier studies in arecanut demonstrated a yield increase of 45% with drip irrigation over basin method. Another disadvantage with drip fertigation was improved nutrient movement of soil P and K in root zone.

### **ESTABLISHMENT OF DRIP FERTIGATION SYSTEM**

The drip fertigation system should consist of tank or water source, sand filter, ventury, screen filter and two pressure gauges. The crop was drip irrigated at 100% Epan during post-monsoon season and the fertilizer was applied from December to May. Three emitters of 8 L h<sup>-1</sup> discharge rate were placed 60 cm away from the base of the palm on three sides. The sources of fertilizers used were urea (46% N), diammonium phosphate (DAP, 18% N and 21% P) and muriate of potash (MOP, 50% K). The DAP was soaked in water and after softening mixed with urea and MOP just before application. A ventury was used to inject the fertilizer solution into the main line of drip system after allowing the solution to pass through screen filter. For larger areas a fertilizer tank may be a better option in place of ventury. Every year the fertilizer was applied in 21, 9 and 6 split doses at 10, 20 and 30 days frequency, respectively, from December to May. In case of 100% NPK soil application, fertilizers were applied in two splits, i.e. 1/3rd in May–June with the onset of monsoon and 2/3rd in September– October at the cessation of monsoon.

### **ROOT DISTRIBUTION**

Root growth and distribution: Root studies conducted at the initial stage and end of experiment indicated better root distribution pattern with drip fertigation particularly in terms of fine root biomass, which ultimately helps in better absorption of nutrients and water (Sujatha and Abdul Haris, 2000; Bhat and Sujatha, 2008). The weight density of both fine and thick roots was more along dripping plane than along non dripping plane at 0-50 cm soil depth irrespective of fertigation treatments necessitating the change of dripping points to avoid root concentration. This long term study also indicated that soil moisture availability and root distribution indicated that the root distribution was strongly influenced by the irrigation method. Interestingly, though organic manures were not applied during the experimental period, significant enrichment in organic carbon status due to fertigation over no fertilizer application was noticed. The organic carbon content was significantly higher with frequent application of fertilizers i.e., at 10 days (1.96%) and 20 days (1.93 %) compared to 30 days interval (1.83 %).

### **OPTIMIZATION OF FERTIGATION DOSE AND FREQUENCY**

During pre-bearing stage of arecanut, it was observed that all fertilizer levels were good and 50% of the standardized fertilizer dose was found sufficient for pre-bearing arecanut palms through ferti-drip irrigation saving considerable fertilizer dose (Sujatha et al., 2000).

During bearing stage of arecanut, pooled analysis of 4-year yield data indicated that fertigation of 75% NPK at 10 days registered maximum yield ( $4017 \text{ kg ha}^{-1}$ ) followed by fertigation of 75% NPK at 20 days frequency ( $3924 \text{ kg ha}^{-1}$ ) and fertigation of 100% NPK at 20 days frequency ( $3579 \text{ kg ha}^{-1}$ ). The kernel yield increased significantly up to 75%NPK fertigation and reduced with 100%NPK. The yield increased by 21% and 19% in 75% NPK fertigation over 25% and 50%, respectively. Fertigation at 10 and 20 days frequency was found significantly superior to 30 days interval. Overall the study suggests that 25% of recommended NPK can be saved (Bhat et al., 2007a).

The stabilized average productivity recorded in drip fertigation experiment was  $3593 \text{ kg ha}^{-1}$ , while the national and state productivity are  $1268$  and  $1335 \text{ kg ha}^{-1}$ , respectively. Thus, the yield gap was very huge both at national level (183%) and state level (169%). This reveals the importance of fertigation technology in increasing the productivity and arresting the horizontal expansion of area under arecanut which has increased rapidly by 57% (0.1 million ha) during last ten years. The 11-year study indicated that adoption of fertigation not only increases productivity, but also ensures higher efficiency of the two most critical inputs i.e., water and nutrients in crop production in view of increasing scarcity of water and cultivated land and escalating fertilizer prices.

## SOIL FERTILITY

**Nutrient mobility:** The movement of available P and K in soil was beyond 30 cm depth and distance

from dripping point. Nutrient distribution pattern showed that both 50 % and 100 % NPK levels maintained more or less same available phosphorus and potassium concentration in arecanut rhizosphere (Bhat et al., 2007b). This study gives scope for reducing the fertilizer dose if applied through drip irrigation on long term basis.

**Soil pH and organic carbon :** The soil pH increased to 6.0 at the end of experiment in 2006 compared to the pre-experimental soil pH of 5.6 in 1996. In 0- 25-cm depth interval, the soil organic carbon (SOC) increased significantly from 1.06% in 1999 to 1.84% in 2006, and in 25- 50-cm depth interval, it increased from 0.68 to 1.13% (Bhat and Sujatha, 2009).

**Available soil P and K :** Temporal variation in available P and K content in arecanut root zone was significant due to drip fertigation. At 0- 25-cm depth interval, increase in fertigation dose from 50% to 100% NPK did not result in significant increase of Bray's P content, which remained at par ranging from  $5.24$  to  $5.32 \text{ mg kg}^{-1}$ . Fertigation every 30 days resulted in significantly higher available P ( $5.32 \text{ mg kg}^{-1}$ ) than fertigation every 10 days ( $4.49 \text{ mg kg}^{-1}$ ), while it was at par with fertigation every 20 days ( $5.09 \text{ mg kg}^{-1}$ ). The K availability at 0- 25-cm depth interval was significantly lower at 25% NPK level ( $114 \text{ mg kg}^{-1}$ ) than at 75% ( $139 \text{ mg kg}^{-1}$ ) and 100% ( $137 \text{ mg kg}^{-1}$ ). With respect to fertigation frequency, the 30-day interval resulted in higher available K of  $139 \text{ mg kg}^{-1}$  than 20 ( $128 \text{ mg kg}^{-1}$ ) and 10-day intervals ( $120 \text{ mg kg}^{-1}$ ). Availability of P and K at 25- 50-cm depth interval followed similar

trend as that of 0- 25-cm depth interval. Nutrient distribution pattern showed that both 75% and 100% NPK levels maintained more or less same available phosphorus and potassium concentration in arecanut rhizosphere. The study indicates that 75% of recommended NPK applied at 10 days interval will result in higher nutrient partitioning to economic parts in arecanut (Bhat and Sujatha, 2009).

**Nutrient uptake by arecanut :** The total N uptake ( $\text{g palm}^{-1} \text{ year}^{-1}$ ) by leaves, nuts and husk varied between 143 in 0% NPK to 198 in 75% NPK fertigation. Similarly, the total P uptake ( $\text{g palm}^{-1} \text{ year}^{-1}$ ) ranged between 15 for the 0% NPK to 25 for the 75% NPK treatment. The total K uptake ( $\text{g palm}^{-1} \text{ year}^{-1}$ ) was 62 for the 75% NPK treatment followed by 56 for the 25%, 56 for the 50%, 54 for the 100% and 46 for the 0% NPK treatments. The nutrient uptake pattern and marginal availability of soil P and K highlight the importance of drip fertigation during post monsoon season to improve and sustain the yield of arecanut in a laterite soil (Bhat and Sujatha, 2009).

### **ECONOMICS OF DRIP FERTIGATION IN ARECANUT**

During pre-bearing stage, annual maintenance cost in pre bearing stage of arecanut could be reduced considerably through saving in labour and fertilizer input to the tune of Rs. 14,450/ha over normal practice of basin application of fertilizers and irrigation. During bearing stage, the cost of cultivation in conventional method of arecanut cultivation was Rs. 60,242 per ha per year,

while with fertigation it reduced to Rs. 26,377 (Table 1). Mean data of four years (Table 2) indicated that fertigation of 75% NPK at 10 days interval was highly profitable with highest net return per rupee investment of 4.57 followed by 75% NPK fertigation at 20 days interval (4.44). With adoption of ferti-drip irrigation the advantages accrued were reduced labour charges (146%) on fertilizer application, weeding and irrigation and diesel charges due to less operational hours.

In order to ensure sustained productivity of arecanut and to break alternate bearing habit, the nutrients immobilized in trunk and roots and nutrient partitioning to economic parts should also be considered besides nutrient fixation and losses due to several factors and to lessen the environment pollution.

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**Table 1. Estimated cost of cultivation for arecanut (Rs ha-1)**

Particulars	(Rs./ha)
<b>Fertigation method</b>	
1. Establishment cost during pre-bearing stage(5 years)	1,02,400
2. Cost of drip system with bore	1,00,000
3. Total establishment cost including drip system	2,02,400
4. Annuity value for establishment cost	10,617
5. Annual fixed cost of drip irrigation system	13,500
6. Labour charges for annual maintenance	15,260
7. Input charges for annual maintenance (75% NPK)	11,117
8. Total annual maintenance cost (75% NPK)	26,377
<b>Conventional method</b>	
1. Establishment cost during pre-bearing stage	3,16,568
2. Annuity value for establishment cost	32,923
3. Labour charges for annual maintenance	33,300
4. Input charges for annual maintenance (100% NPK)	26,942
5. Total annual maintenance cost (100% NPK)	60,242
<b>Saving in fertigation (75% NPK) over conventional method</b>	
1. Labour charges	18,040
2. Input charges	15,825
3. Total saving in annual maintenance charges	33,865
<b>Input</b>	<b>Price per unit</b>
Seedling	Rs. 10 /each
Urea	Rs. 4.80 /kg
DAP	Rs. 10.00 /kg
MOP	Rs. 4.52 /kg
FYM	Rs. 700 /tonne
Copper Sulphate	Rs. 60 /kg
Lime	Rs. 8.0/kg
Labour charges (per manday)	Rs. 80.00
Chali (Dry kernel)	Rs. 70.00/kg

Source: Bhat et al. (2006)

**Table 2. Effect of ferti-drip irrigation on yield and net return per rupee investment in arecanut**

Fertilizer dose (% of Rec. NPK)	Fertigation frequency (days)	Mean Chail Yield (Kg/ha)	Cost of production (Rs ha <sup>-1</sup> )	Net return per rupee investment (Rs Re <sup>-1</sup> )		
				Rs.45/kg Chail	Rs.70/kg Chail	Rs.90/kg Chail
25%	10	3125	48882	1.88	3.48	4.75
	20	2954	48882	1.72	3.23	4.44
	30	3172	48882	1.92	3.54	4.84
50%	10	3308	49688	2.00	3.66	4.99
	20	3071	49688	1.78	3.33	4.56
	30	2983	49688	1.70	3.20	4.40
75%	10	4017	50494	2.58	4.57	6.16
	20	3924	50494	2.50	4.44	5.99
	30	3222	50494	1.87	3.47	4.74
100%	10	3272	51319	1.87	3.46	4.74
	20	3579	51319	2.14	3.88	5.28
	30	2428	51319	1.13	2.31	3.26
Control 1 (Absolute)		2008	48077	0.88	1.92	2.76
Control 2 (100% NPK soil application)		3561	52519	2.05	3.74	5.10

Source: Bhat et al. (2006)

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