

## NUTRIENT MANAGEMENT IN ARECANUT

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Arecanut (*Areca catechu* L.) or betelnut is a tropical palm and the dry kernel is used for masticatory purpose in India and West Asia. India leads the world in production followed by Sri Lanka and Bangladesh. In India, arecanut is predominantly cultivated in traditional states like Karnataka, Kerala and Assam and its cultivation is spreading to non-traditional areas in Karnataka and Tamil Nadu. Arecanut is cultivated in about 4.2 lakh ha with a production of 5.2 lakh tonnes. But, the productivity remained stagnant during the last two decades (1188-1268 kg ha<sup>-1</sup>), which is often ascribed to the absence of adequate information on soil fertility and plant nutrition.

### Constraints in arecanut cultivation

Being a perennial crop, it is important to understand the constraints in arecanut cultivation and to adopt suitable strategies to overcome the constraints. Arecanut is predominantly grown in gravelly laterite soil of red clay type with inherent constraints like high rainfall, undulating topography, presence of kaolinite clay mineral, leaching of K<sup>+</sup> and Ca<sup>2+</sup>, P fixation and high zinc fixing capacity. It can also be grown in fertile clay loam soils with special care and microsite improvement. Clay soils pose a problem to monocot palm due to water stagnation, poor soil aeration and drainage. Sticky clay, sandy, brackish and calcareous soils are not suitable. Heavy rainfall and high relative humidity are the major climatic constraints for arecanut cultivation in humid tropics. Heavy rainfall leads to leaching of potassium and calcium and high relative

humidity is congenial for development of pests and diseases. Higher trunk biomass (70% of the total biomass), low nutrient use efficiency and susceptibility to water stagnation and water stress are the main crop constraints for higher yield levels in palms.

### Importance of soil testing

Nutrient balance in soil-plant system is important for sustaining the yield and soil fertility in perennial systems. Nutrient management strategies need to be planned for arecanut taking in to account the soil fertility, leaf nutrient status and yield level. It is advisable to consider nutrient deficiency/toxicity before the development of visual symptoms with the help of plant and soil analysis. Otherwise it may be too late to reverse the situation effectively by the time visual symptoms appear on palms. Soil testing is important to avoid deficit or excess presence of nutrients in soil. Excess soil fertility status is more dangerous than deficiency. Due to antagonistic nutrient interactions in soil, plant nutrient uptake will be affected. Soil sampling should be done at 50-60 cm distance from the trunk/stem of arecanut palm on two sides up to a depth of 30 or 45 cm. Auger or spade can be used for soil sampling. This should be done at least in 3-4 palm basins covering entire garden and all the samples should be mixed thoroughly and a representative sample of ½ kg should be given for soil testing.

Soil testing facilities are available at the soil testing laboratories of the state Agricultural Departments situated in each district head

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quarters. If soil test values of phosphorus and potassium are below 30 kg P<sub>2</sub>O<sub>5</sub> and 300 kg K<sub>2</sub>O per ha in arecanut basins, P and K are reaching deficit level and yields might reduce if nutrients are not applied sufficiently at this stage. Leaf sampling is required if problem of nutritional disorders due to deficiency or toxicity are noticed in few palms in the entire garden. Leaf samples should be collected from middle of the 4<sup>th</sup> leaf on either side.

### Precision agricultural practices

Optimization of nutrient norms becomes imperative due to wide spread adoption of organic farming practices, depletion of soil K, increased cost of production and nutrient imbalances

**Table1: Optimum leaf nutrient limits for arecanut**

Nutrient	Optimum concentration	Optimum range
Macronutrient (%)		
N	2.70	2.45-2.95
P	0.23	0.19-0.27
K	1.12	0.90-1.34
Ca	0.61	0.50-0.72
Mg	0.20	0.14-0.26
Micronutrient(mg kg <sup>-1</sup> )		
Na	63	45-80
Fe	146	100-190
Mn	56.5	15-95
Cu	2.6	1.4-4.0
Zn	45.8	26-65
B	39.5	25-55
Al	432	297-567

causing disorders/diseases for sustaining yield and soil health in arecanut growing regions. The most realistic strategy would be to maintain plant nutrient levels at or very close to the optimal levels, although the optimum nutritional ranges may be used as guidelines.

### Leaf nutrient limits for arecanut

Optimum leaf nutrient concentration, range and nutrient ratios are established for arecanut (Bhat and Sujatha, 2013). Optimum foliar concentrations for N, P, K, Ca and Mg were established as 2.70, 0.23, 1.12, 0.61 and 0.20%, respectively using leaf composition data from 12 year old best managed arecanut plantation. Optimum micronutrient concentrations (mg kg<sup>-1</sup>) were estimated at 146 for Fe, 56.5 for Mn, 2.6 for Cu, 45.8 for Zn, 39.5 for B, 432 for Al and 63 for Na.

### Soil nutrient limits for laterite soils for judicious use of inputs

Optimum soil nutrient limits are vital for diagnosing nutrient constraints, judicious use of fertilizers and reducing environmental pollution. The study revealed that optimum nutrient values were higher for laterite soils in arecanut tract than generalized guidelines for interpretation of soil analysis data. Arecanut tolerates higher micronutrient concentrations in soil but not in leaf.

### Quantity of nutrient application

In laterite soils, application of 100 g N (220g Urea), 40 g P<sub>2</sub>O<sub>5</sub> (200 g Rock Phosphate) and 140 g K<sub>2</sub>O (235 g Muriate of Potash) is recommended every year, if chali or kernel yield is around 2 kg per palm per year. If Diammonium

phosphate (DAP) is applied as source of phosphorus, which contains both nitrogen (18%N) and phosphorus (46% P<sub>2</sub>O<sub>5</sub>), 182 g urea, 87 g DAP and 230 g MOP is the fertilizer requirement for each palm per year. The quantity will vary with changes in soil fertility level and

period of December-May is ideal. The organic manures should be applied during September-October in basins around the base of each palm.

### Method of nutrient application

In the first year of planting 1/3rd of the

**Table 2 : Nutrient limits for laterite soils with arecanut as test crop**

Nutrient	Optimum concentration		Optimum range		Generalized guidelines
	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm
P	15	6	7-24	1-11	8-15
K	192	173	122-262	69-278	100-150
Ca	925	620	697-1152	483-757	801-1600
Mg	179	114	138-220	32-197	101-200
Fe	37	18.8	24-49	6-34	2.1-4.0
Mn	88	60	59-116	23-96	1.0-2.0
Cu	26	7	17-35	1.5-12.6	0.2-0.5
Zn	5.5	1.9	3.5-7.4	1-3	0.5-1.0
B	1.37	1.6	0.70-2.00	0.3-2.9	0.5-1.0
Al	1.38	4.48	1.22-1.55	2.27-6.69	-

(Bhat *et al.* 2012)

expected yield of arecanut. In addition, 12 kg each of green leaf and compost per palm can be applied if soil organic carbon levels are below 2%.

### Time of nutrient application

Fertilizers and organic manures should be applied when the soil has sufficient moisture. In unirrigated crop, fertilizers can be applied during May-June and September-October. When the crop is irrigated the pre-monsoon application can be advanced to February-March. As far as possible, fertilizer application during nut formation

recommended dose of fertilizer should be given. In the second year, 2/3rd of the recommended dose and from third year onwards, full dose of fertilizer should be given. Basin opening is important for application of manures and fertilizers wherever the soil hardens after monsoon season. The fertilizers should be applied in the basin at 40-50 cm distance around the trunk. The basins of the palms should be forked for incorporation of manures and fertilizers with the soil. Soil aeration is most important for production of fine roots, which are required for uptake of

nutrients and water. Roots contact only 1% of soil volume and only fine roots of less than 1 mm thickness will take water and nutrients. Majority of the fine/feeder roots of arecanut are concentrated within 30 cm depth and 60 cm distance from the trunk.

with kernel or *chali* yield more than 2.5 kg per palm per year. Lime application is needed only if soil pH is below 5. Due to low buffering capacity of laterite soils and leaching of Ca in heavy rainfall areas, lime needs to be applied every year. If arecanut is irrigated during post monsoon,

**Table 3 : Fertilizer recommendation for arecanut (g per palm per year)**

Nutrient/Fertilizer	First year of planting	Second year	From third year onwards
Nitrogen	33	66	100
Phosphorous	13	26	40
Potash	46	92	140
a) Rock phosphate as source of phosphorus			
Urea	72	144	220
Rock phosphate	65	130	200
Muriate of Potash	77	154	230
b) Single super phosphate as source of phosphorus			
Urea	72	144	220
Single super phosphate	83	167	250
Muriate of Potash	77	154	230
c) Diammonium phosphate as source of phosphorus			
Urea	61	121	182
Diammonium phosphate	29	58	87
Muriate of potash	77	154	230

In laterite soil region, where arecanut is predominantly grown and the soil is rich in soil organic carbon and micronutrients, it is advisable to apply organic manures once in 2 or 3 years. In arecanut plantation with above 2% soil organic carbon levels, urea application can be skipped if organic manure application is the preference of farmers every year. It is important to note that organic manure application alone cannot meet K demand of arecanut as organic manures contain very less K except *gliricidia* and arecanut husk. Double dose of fertilizers especially N and K can be applied for high yielding arecanut palms

irrigation water supplies Ca and Mg which is sufficient to maintain pH in arecanut basins. Soil fertility status in clay soil region of arecanut is above optimum. It is advisable to regulate NPK fertilizer application. There is no need to apply lime/gypsum, Magnesium sulphate or micronutrient mixtures separately as organic manures and irrigation water supply sufficient calcium, magnesium and micronutrients.

**Nutrient uptake in arecanut**

Nutrient uptake pattern in arecanut suggests higher removal and uptake of N and K and regular

**Table 4 : Nutrient uptake in arecanut**

Nutrient	Nutrient exported through 1000 kg kernel	Total uptake at yield level of 3.58 kernel kg/palm	
		Per palm	Per ha
N	20 kg	352 g	458 kg
P	2 kg	36 g	46 kg
K	16 kg	303 g	394 kg
Ca	3 kg	122 g	159 kg
Mg	1.2 kg	30 g	39 kg
Cu	74 g	883 mg	1.5 kg
Zn	1275 g	645 mg	840 g
Fe	10 g	15.13 g	20 kg
Mn	52 g	1586 mg	2 kg
B	56 g	698 mg	907 g

application of N and K either through organic or inorganic source is most important to sustain yields and soil fertility.

### Organic matter recycling

On an average, 5.0 to 8.5 tonnes of leaf wastes are available from one ha of areca garden per year. Direct application of these wastes in the garden will take long time for decomposition and will not meet the nutrient demand of the crop immediately. Hence, these materials can be composted using earthworms effectively and used as organic manure in areca gardens (Chowdappa *et al.*, 1999). About 80% recovery of vermicompost from these wastes is expected. This can be effectively used as organic source of nutrients for areca palms or to intercrops.

### Preparation of vermicompost

Areca wastes are chopped into small pieces of 10 cm and heaped. The heap is sprinkled with water daily and kept for two weeks. Then the chopped material is arranged in beds of one meter width and convenient length. Cement tanks or trenches can be used for this purpose. A layer of 10-15 cm waste material is

alternated with 2 cm layer of cow dung over which earthworms are released at the rate of 1000 numbers per square meter.

The two species of earthworms *Eudrilus eugeniae* and *Eisenia foetida* can be used for composting the arecanut leaf wastes. The wastes are converted into fine granular, odourless vermicompost within 60 days. During this period, the earthworm population is doubled. Vermicompost is rich in N, P, Ca, Mg and micronutrients. About 4 kg of vermicompost per palm per year meets the N and P nutrient demand

### Nutrient composition of vermicompost

Nutrient	Concentration
N%	1.38-2.64
P%	0.35-0.6
K%	0.9-0.98
Ca%	1.6-1.9
Mg %	0.45-0.66
Fe (mg kg <sup>-1</sup> )	2561-4412
Mn (mg kg <sup>-1</sup> )	240-502
Zn (mg kg <sup>-1</sup> )	351-396
Cu (mg kg <sup>-1</sup> )	70-120

of arecanut. Potassium needs to be added through other sources like MOP, arecanut husk or *gliricidia*.

### Impact of vermicompost application on arecanut

Arecanut kernel yields with vermicompost application alone are 85% of the yields obtained in the inorganic source. Exhaustion of soil K and reduction in leaf K concentration in arecanut is noticed with VC application (Sujatha and Bhat, 2013). All the wastes from arecanut when recycled as vermicompost with average nutrient composition of 2% N: 0.4% P: 0.9% K can supply substantial quantity of nutrients. Vermicompost has potential to reduce the dependence on imported N and P fertilizers and to some extent K fertilizers. Further environmental hazards due to unscientific dumping or burning of the recyclable wastes can be avoided. If farmers

attempt vermicomposting *in situ*, the net benefit from organic waste recycling would increase considerably. In the likely scenario of steep increase in fertilizer prices, vermicompost becomes a viable alternative to inorganic fertilizers.

Recycling of arecanut wastes as vermicompost with K supplementation not only safeguards the soil health and environment but also improves the productivity and profitability. Organic K sources are rare and not easily available. If organic farming is the preference, further studies are required on organic nutrition with the use of locally available *gliricidia* (2.3% K) and arecanut husk (1% K) as potential K sources. Vermicompost produced from arecanut wastes can be used for successful cultivation of intercrops or can be taken up as business venture also. The profit from vermicompost production is given below.

**Table 5 : Estimated cost of vermicompost production from organic wastes available in one hectare of arecanut per year**

No. of Shed Leaves	:	7
Weight of dried whole leaf	:	600g
Leaf waste available per palm per year	:	4.2 kg
Total leaf waste available per ha per year	:	5430 kg
<b>A</b>		
(1) Labour cost (536.4 man hrs)		
For collection of wastes, cutting, watering and drying	:	Rs. 4,694.00
(2) Cost of earthworms (5.46 kg)	:	Rs. 2,730.00
<b>Total A</b>	:	<b>Rs. 7,424.00</b>
<b>B</b>		
Recovery of vermicompost	:	4791.15 kg
(1) Value of vermicompost @ Rs. 5.00/kg	:	Rs. 23,955.00
(2) Value of earthworms multiplied (13.1 kg) @ Rs. 10/kg	:	Rs. 6,552.00
<b>Total B</b>	:	<b>Rs. 30,507.00</b>
<b>Net Profit (B-A)</b>	:	<b>Rs. 23,083</b>

## **Nutritional disorders**

Common nutritional disorders in arecanut are crown choking, crown bending, oblique nodes and nut spitting (Bhat and Sujatha, 2014). These problems develop in areas with excess soil fertility and water stagnation and in paddy converted areas. Crown choking can be identified at initial stages with appearance of dark green leaves with erect nature and reduced leaf size. Zinc deficiency is mainly responsible for development of disorders. Excess availability of nitrogen, phosphorus and other nutrients hinder uptake of zinc and cause disorders. In soils with low Zn content, soil application of zinc sulphate @ 10 g per palm can be applied at initial stages of disorders. In case of severe reduction in leaf size and crown choking, spraying of 0.5 % zinc sulphate (5 g per litre of water) mainly on fresh foliage can be done so that new leaves will emerge normally. Combined deficiency of zinc and calcium causes crown bending. Nut splitting is due to less potassium and application of potassium is required to correct nut splitting as both husk and kernel require high potassium.

## **Drip fertigation**

The application of nutrients through drip irrigation water is called as drip-fertigation. The advantages of adopting drip-fertigation are reduced labour charges on fertilizer application, weeding and irrigation and diesel charges due to less operational hours (Bhat and Sujatha, 2006). This technology can be profitably adopted in arecanut, which can save fertilizer up to 50% in pre-bearing stage and 25% in bearing stage. Drip fertigation improves root growth pattern in terms of root weight and fine root production which are the main roots absorbing nutrient and water (Bhat and Sujatha, 2008). Drip fertigation reduces cost

of cultivation on inputs and labour by Rs.34,000/ha with higher net return per rupee investment.

## **Criteria for applying fertilizers through drip**

The fertilizers used should avoid corrosion of the system. The fertilizers should be soluble in water. The fertilizer should not react with salts or other chemicals in irrigation water leading to clogging of the emitters.

## **Fertigation methods**

The fertilizers can be injected into the system by different methods. Important techniques are fertilizer tank method or vacuum injection (venturi) technique. The fertilizer tank can be used when area is large. When area is small, venturi technique can be followed.

## **Sources of nutrients**

Liquid fertilizers, which are easily soluble in water, are costly. Easily available fertilizers like Urea, Diammonium phosphate (DAP) and Potassium chloride (MOP) are water soluble and cost effective sources of NPK.

## **Application time and frequency**

Fertilizers should be applied during post-monsoon season from December to May. The fertilizers can be applied preferably once in 10 or 20 days, but can be applied once in 30 days also. Application of fertilizers should be avoided during monsoon season. Total quantity of fertilizer to be given is to be split into 6 or 9 or 18 parts and each part will be applied once in 30 or 20 or 10 days respectively.

For pre-bearing palms 50% of recommended fertilizer is sufficient when supplied through drip irrigation. For bearing palms 75% of the recommended fertilizer dose is

sufficient (Bhat et al., 2007). Recommended nutrient dose to be given through fertigation is 75:30:105 g N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O per palm per year. Quantity of fertilizer required to supply recommended dose per palm per year is 136 g Urea, 65 g DAP and 175 g MOP.

### ADVISORY TO FARMERS

- \* Soil testing may be done before planting and at least once in 3 years after planting.
- \* Do not take soil samples in the interspaces.
- \* Nutrient application during post monsoon season is more effective and advisable as growth rate of palm is more after monsoon season.
- \* Avoid application of only urea or organic manures, which supply only nitrogen.
- \* Potassium and zinc deficiency is increasingly noticed in laterite soils in arecanut belt.
- \* Potassium is very important for arecanut and thus its application through MOP or other sources like arecanut husk, coconut coir pith, gliricidia is essential.
- \* Soil application of zinc sulphate @ 10 g per palm may be applied once in 3 years as disorders are increasingly noticed in entire arecanut belt.

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