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EFFECT OF GRADED NUTRIENT LEVELS ON MORPHOLOGICAL CHARACTERS OF ARECANUT (*ARECA CATECHU* L.) UNDER CONSERVATION AGRICULTURE WITH INTERCROPS

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ABSTRACT

The present study was undertaken to evaluate the effect of graded levels of nutrient application on the morphological traits of arecanut (*Areca catechu* L.) under a conservation agriculture system with intercrops. A field experiment was laid out in a randomized block design with four treatments replicated five times during the 2019–20 and 2020–21 cropping seasons at Balindi Research Farm, Bidhan Chandra Krishi Viswavidyalaya, West Bengal. Treatments included three graded levels of NPK with farmyard manure (FYM) and a control: T₁ (125:50:175 g NPK palm⁻¹ + 5 kg FYM), T₂ (100:40:140 g NPK palm⁻¹ + 5 kg FYM), T₃ (75:30:105 g NPK palm⁻¹ + 5 kg FYM) and T₄ (control). Morphological parameters such as plant height, number of leaves, and plant girth were significantly influenced by the nutrient levels. The highest values for all parameters were recorded under T₁ at 30 months after planting, with plant height (284.2 cm), number of leaves (28.84), and plant girth (39.51 cm), while the lowest values were recorded in the control. The findings demonstrate that higher and balanced nutrient application enhances vegetative growth, which is critical for the long-term productivity of arecanut under conservation agriculture practices.

Key words : Arecanut, Nutrient, Intercrops, Conservation agriculture, Height, Girth.

Introduction

Arecanut (*Areca catechu* L.), popularly known as ‘betelnut’ or ‘supari’, is one of the important plantation crops in humid tropics belonging to family Arecaceae (Rangaswami, 1977; Ramappa, 2013). The dried kernel is the most popular masticatory stimulant and has various medicinal properties (Amudhan *et al.*, 2012, Schoneman, 2010; Balanagouda *et al.*, 2021) in many parts of Asia and tropics of India. The palm is also cultivated in several other South Asian and South East Asian Countries such as Indonesia, Myanmar, China, Bangladesh, Thailand, Malaysia, Vietnam, Philippines, etc. (Homey and Manojkumar, 2014). India is the leading producer globally with Karnataka, Kerala, parts of Maharashtra, Assam and West Bengal are the traditional arecanut growing regions. It is a commercial crop with religious significance

and all parts of the palm are useful. About 16 million people are dependent on arecanut industry for their livelihood. Recent years have witnessed a steady increase in the crop’s area—from 0.505 million ha in 2017–18 to 0.731 million ha in 2019–20—highlighting its economic importance (DASD, 2020). Arecanut is primarily cultivated in laterite soils along the West coast of India, which are characterized by heavy rainfall, low nutrient use efficiency, low productivity and less income. The laterite soils are poor in nutrient retention capacity due to low cation exchange capacity (CEC) of 3–15 cmolc kg⁻¹ (Tandon and Ranganathan, 1988). These soils commonly exhibit nitrogen and potassium deficiencies (Badrinath *et al.*, 1998) and nutrient use efficiency in arecanut is low: 10–15% for nitrogen, 25–30% for phosphorus and 20–25% for potassium. Given the

perennial nature of the crop and its high nutrient demand, efficient nutrient management is critical. Hartemink (2005) emphasized that the nutrient content in perennial crop biomass often exceeds the nutrients removed via harvest. Hence, rationalizing fertilizer application to meet crop demands without overburdening the soil is essential. This study was conducted to determine the optimal fertilizer dose to enhance vegetative growth under a conservation agriculture system involving intercrops.

Materials and Methods

Field experiment was conducted for two consecutive years i.e., 2019-20 and 2020-21 at Balindi Research Farm, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal. The research station was located at 22°57' N 88°32' E, with an altitude of 9.75 m above the mean sea level. Topographic situation of the experimental site comes under the well-drained Gangetic new alluvial soil (order: Inceptisol) of West Bengal having clay type of soil. Topsoil texture was granular with an organic carbon content of 0.91%, pH level of 7.57, 227.8 kg of available nitrogen, 35.4 kg of available phosphorus, and an impressive 340.26 kg of available potassium per hectare (kg ha^{-1}). A perennial based cropping system was designed for the experiment and the cropping system considered was Arecanut - Carrot (*rabi*) - Mint (*pre-kharif*).

One year old arecanut plants were selected for the experiment. Seedlings (var. Mohit Nagar) were collected from ICAR-CPCRI, Research Center, Mohitnagar, Jalpaiguri, West Bengal. Pits were prepared and before planting, the bottom layer of the pits were filled up with a mixture of topsoil, FYM / compost in equal proportion single super phosphate (200 g) and carbofuran (10 g) up to half portion of the pit and planting was taken up in the center of the pit and properly staked. The remaining half portion (top layer) of the pit is filled up with bottom soil. This method of planting helps in better anchorage of roots and better roots spread and development. Planting was

done during first week of October at a spacing of 3m x 3m in the main field. Treatments included three graded levels of NPK with farmyard manure (FYM) and a control: T_1 (125:50:175 g NPK palm^{-1} + 5 kg FYM), T_2 (100:40:140 g NPK palm^{-1} + 5 kg FYM), T_3 (75:30:105 g NPK palm^{-1} + 5 kg FYM) and T_4 (control). Fertilizer doses were applied in accordance with the scheduled treatment in two split doses. One third of the fertilizer applied in May-June and two third along with the organics during September-October. For one year old plant 1/3rd of the recommended dose and for two-year-old plant 2/3rd recommended dose and for three year and above full dose of recommended fertilizer and organic amendments were applied for proper growth and development. Morphological characters like plant height (cm), number of leaves and plant girth (cm) of three tagged plants per replication was measured at 12, 24 and 30 months after planting.

Observations recorded in Arecanut

Plant height (cm)

The plant height of 3 tagged plants/ replication was measured from the ground level to the tip of the main shoot and their mean was expressed in cm.

Girth of the plant (cm)

Girth of 3 tagged plants/ replication was measured from the 5 cm above the ground level and average of the plant girth per plant was worked out and recorded.

Number of leaves per plant

Numbers of the leaves of 3 tagged plants/ replication were counted average of the leaves was recorded.

Results and Discussion

Plant height (cm)

Plant height was significantly influenced by the different fertilizer treatments (Table 1). Initially data was recorded from one year old plant during November'2019,

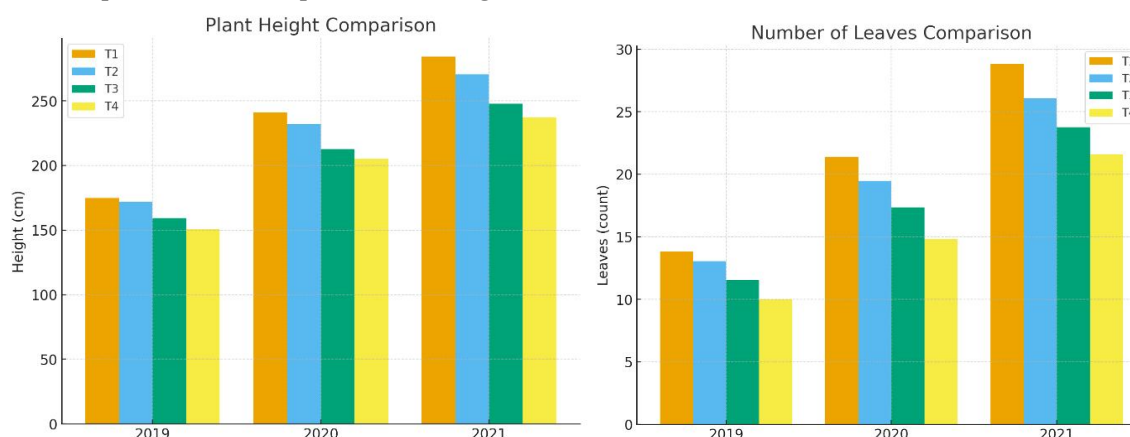
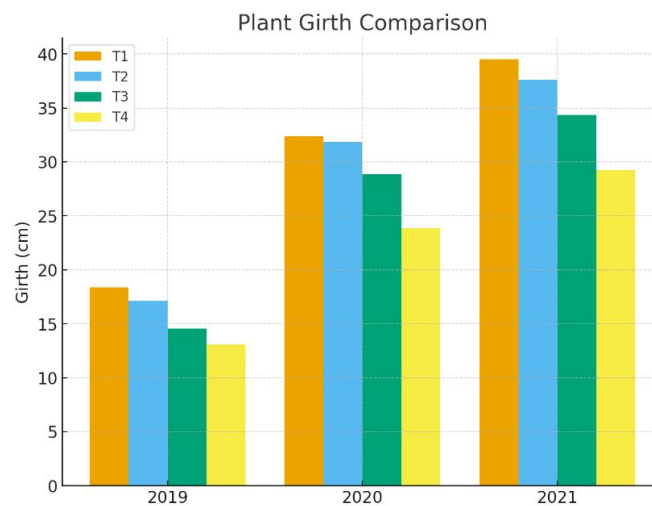


Fig. 1 : Effect of graded levels of nutrient application on plant height and number of leaves.

Table 1 : Effect of graded levels of nutrient application on growth of Arecanut.

Treatment	Plant height (cm)			Number of leaves			Plant girth (cm)		
	Nov 2019	Nov 2020	May 2021	Nov 2019	Nov 2020	May 2021	Nov 2019	Nov 2020	May 2021
T ₁	174.8	241	284.2	13.82	21.39	28.84	18.36	32.38	39.51
T ₂	171.8	231.84	270.8	13.06	19.47	26.102	17.14	31.85	37.65
T ₃	159.4	212.6	247.8	11.56	17.34	23.78	14.56	28.88	34.36
T ₄	150.8	205.32	237	9.99	14.82	21.62	13.06	23.84	29.26
S.Em (±)	1.64	1.76	1.57	0.34	0.91	0.50	0.41	0.68	0.45
C.D (0.05)	5.11	5.50	4.88	1.04	2.82	1.57	1.26	2.13	1.41

T₁: 125: 50: 175 NPK g palm⁻¹ + 5 kg FYM palm⁻¹; T₂: 100:40:140 NPK g palm⁻¹ + 5 kg FYM palm⁻¹; T₃: 75: 30: 105 NPK g palm⁻¹ + 5 kg FYM palm⁻¹; T₄: Control (No fertilizer) + 5 kg FYM palm⁻¹.

**Fig. 2 :** Effect of graded levels of nutrient application on Plant Girth.

the tallest palms (174.8 cm) was recorded in highest dose of fertilizer T₁ (125: 50: 175 NPK g palm⁻¹ + 5 kg FYM palm⁻¹) followed by 171.8 cm in T₂ (100:40:140 NPK g palm⁻¹ + 5 kg FYM palm⁻¹) and lowest in control (150.8 cm). After one year (November' 2020) also plant height was increased under T₁ (241.0 cm) followed by 231.84 cm in T₂ (100:40:140 NPK g palm⁻¹ + 5 kg FYM palm⁻¹). At 30 months, plant height peaked at 284.2 cm in T₁, showing the cumulative benefit of higher nutrient input, particularly N and K, in promoting cell elongation and internodal growth (Lingga and Marsono, 2013). The progressive height gain aligns with earlier findings (Manicot *et al.*, 1981) indicating that increased potash enhances vegetative elongation in palms.

Number of leaves

Marked variations were also observed with respect of number of leaves produced per plant among the different treatments (Table 1). T₁ (125: 50: 175 NPK g palm⁻¹ + 5 kg FYM palm⁻¹) consistently produced the highest number of leaves across all time points—13.82 at 12 months, 21.39 at 24 months, and 28.84 at 30 months.

The increase in leaf number may be attributed to adequate N and P supply, which support photosynthetic tissue formation and metabolic activity (Nambiar *et al.*, 1983). T₄ (control) consistently recorded the lowest leaf count (9.99–21.62). This supports the findings of Karna *et al.* (2022), who noted that leaf number and production rate are vital indicators of palm vigour and nutrient status.

Plant girth (cm)

Girth of palms also responded positively to nutrient application (Table 1). T₁ (125: 50: 175 NPK g palm⁻¹ + 5 kg FYM palm⁻¹) significantly increased palm girth from 18.36 cm (12 months) to 39.51 cm (30 months old). Lowest girth was recorded in control (29.26 cm). This is in agreement with Mathew and Ramadasan (1964), who reported that P and K play pivotal roles in stem thickening, partly by enhancing root uptake efficiency and cell division.

Fertilizer application is essential to compensate for nutrient deficiencies in the soil that cannot meet the complete nutritional demands of crops. Arecanut (*Areca catechu* L.), being a perennial and high biomass-producing palm, exhibits a substantial requirement for macronutrients to sustain optimal vegetative growth and reproductive output. Nitrogen (N), phosphorus (P) and potassium (K) are the primary macronutrients critical for plant physiological and metabolic functions. As reported by Lingga and Marsono (2013), nitrogen is integral for promoting vigorous vegetative growth, particularly influencing cell division and elongation in stems and foliage. Phosphorus, although required in smaller quantities, plays an indispensable role in root development, energy transfer, and reproductive success. Its indirect effect, as noted by Mathew and Ramadasan (1964), through enhanced uptake of potassium, may have contributed to the improved girth and leaf development observed in this study. Potassium's role in enzyme activation and translocation of photosynthates (Hartemink, 2005) likely contributed to improved biomass accumulation and stem



Planting of arecanut and layout of intercrops



Fertilizer application



Carrot as Intercrop



Basin management in arecanut



Mint as Intercrop

Plate 1 : Layout of the experiment.

thickening.

The increase in the number of leaves per palm under higher nutrient doses may also reflect better nutrient mobility and utilization, leading to enhanced canopy development. Karna *et al.* (2022) emphasized that the number of leaves is a direct indicator of a palm's photosynthetic potential and its overall productivity. Moreover, Smith (1964) and Manicot *et al.* (1981) reported similar trends where nitrogen and potassium application improved palm height and stem thickness, reinforcing the current findings.

Furthermore, the increasing trend in all vegetative traits with rising NPK levels underscores the synergistic interaction among nutrients in optimizing physiological processes. Arecanut, being a slow-growing, perennial crop with a high biomass and nutrient accumulation rate, has a long juvenile phase. Thus, nutrient management during early stages has a strong bearing on the long-term productivity and sustainability of the plantation. This was evident from the significant improvements in morphological parameters over the two-year period in this study. Thus, the judicious and sustained application

of nitrogen and potassium—through either organic amendments or inorganic fertilizers—is critical for maintaining high yield potential and ensuring long-term soil fertility and nutrient balance (Ravi and Sujatha).

Conclusion

Overall, results of the study provide a strong case for adopting an optimized NPK regimen with organic inputs, particularly at 125:50:175 g NPK palm⁻¹ + 5 kg FYM produced the most vigorous vegetative growth in terms of height, girth, and leaf production. These findings validate that balanced nutrient application ensures growth and early establishment of arecanut palms under conservation farming systems.

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