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Integrated nutrient management in COD x WCT hybrid coconut under alluvial clay-loam soil of Assam

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Abstract

A field experiment was conducted in alluvial clay-loam soil at the Horticultural Research Station, Kahikuchi of Assam Agricultural University under All India Co-ordinated Research Project on Palms from 2003 to 2007 to study the effect of integrated nutrient management treatments on COD x WCT hybrid coconut taking 27 treatment combinations with three levels each of N (0, 500, 1000 g/palm/year, where 50% N was substituted by vermicompost on N equal nutrient basis), P_2O_5 (0, 250, 500 g/palm/year) and K_2O (0, 1000, 2000 g/palm/year). The results revealed significant influence of the integrated nutrient treatments on number of functional leaves in the crown, number of female flowers, nut setting, nut yield per palm per year and copra content per nut. The highest values for all these characters were obtained under higher level of K application. However, the highest average nut yield of 111nuts/palm/year and benefit cost ratio of 2.02 were recorded in the treatment $N_1P_2K_2$ (500 g N wherein 50% N substituted by vermicompost, 500 g P_2O_5 and 2000 g K_2O/palm/year), while the lowest nut yield (44 nuts/palm/year) and benefit cost ratio of 0.20 were recorded in the treatment $N_0P_0K_0$ and $N_2P_2K_0$, respectively. The integrated nutrient treatments also improved the soil pH, organic carbon content, available N, P and K content of the soil and the leaf NPK contents of the palms under study.

Keywords: Hybrid coconut, integrated nutrient management, nut yield, vermicompost

Introduction

The concept of integrated plant nutrient management is gaining momentum in recent years and it is being realized worldwide that only chemical farming undermines the natural mechanisms operating in the ecosystem and often leads to soil degradation, pollution of groundwater and eutrophication of water bodies with nitrates, phosphates and pesticides (Upadhyay *et al*., 1998). However, application of chemicals alone is resulting in severe degradation of soil health and pollution of ground water. Application of chemical fertilizers by neglecting the organic sources resulting imbalance in soil nutrient status. A balanced supply of nutrients to plants through organic and inorganic sources ensures maximum yield, maintenance of soil fertility and productivity and proper ecological balance. Coconut (*Cocos nucifera* L.), widely known as 'Kalpvriksha' is an important perennial oil yielding crop of humid tropics. It has unique feature among the plantation crops in that it flowers and fruits through out the year. Therefore, its requirement of water and nutrients should be maintained during the entire period. It is estimated that on an average six to eight tonnes of dry coconut leaves are available from one hectare of well managed coconut garden. Vermicomposting is the method of composting the organic biomass by earthworms under favourable moisture and temperature conditions. Earthworms can mediate decomposition of lignin as well as poly phenol and thus accelerate the humification process. Central Plantation Crops Research Institute,

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Kasaragod, Kerala has identified a local strain of earthworm (*Eudrilus* sp.), similar to African night crawler, which is quite efficient in composting coconut leaves into granular vermicompost (Prabhu *et al.*, 1998). A considerable part of nutrient requirement of coconut palms can be met by converting these leaves into compost and recycling the same to the coconut garden. Thampan (1972) stated that any organic manure supplemented with required quantity equal to inorganic fertilizers is the best combination. However, information on the effect of integrated nutrient treatments on coconut in Assam region is not attempted. Hence, the present investigation was undertaken to study the effect of integrated nutrient management in COD x WCT hybrid coconut.

Materials and Methods

A field experiment was conducted in alluvial clay-loam soil at the Horticultural Research Station, Kahikuchi, Assam under All India Co-ordinated Research Project on Palms from 2003 to 2007 for studying the effect of integrated nutrient management on the performance of COD x WCT hybrid coconut in a 3^3 factorial confounded design with two replications under rainfed condition. The treatment comprised of 27 combinations of three levels each of N: 0, 500, 1000 g N/palm/year where 50% N was substituted by vermicompost on equal nutrient basis, P_2O_5: 0, 250, 500 g/palm/year and K_2O: 0, 1000, 2000 g/palm/year. The plot size was five palms per treatment. The soil of the experimental site has an acidic pH (4.8) with low to medium organic carbon (0.48-0.56 %), low in available nitrogen (235 kg/ha), medium in available phosphorus (28 kg/ha) and medium in potassium (164 kg/ha). The initial leaf nutrient contents (NPK) of palms under the experiment were also estimated by collecting composite leaf samples (14^{th} leaf), dried, ground and analyzed for nitrogen, phosphorus and potassium and found as 1.75% N, 0.11% P_2O_5 and 1.38% K_2O. Fertilizers were applied in the form of urea, single super phosphate and muriate of potash in two splits, one-half in first fortnight of April and the rest in first fortnight of September every year. Vermicompost from coconut leaves was prepared following the standard methods (Prabhu *et al*., 1998). The quantity of vermicompost calculated on N equivalent nutrient basis was applied. In general, the vermicompost from coconut leaves contain 1.5-1.9 per cent N, 0.1-0.2 per cent phosphorus and 0.2 -0.4 per cent potassium. Thus, for 250 g N, 13.1 kg vermicompost and for 500 g N 26.3 kg vermicompost/palm/year was applied. Observations on rate of leaf production, number of functional leaves per palm, number of inflorescences per palm, number of female flowers per palm, fruit set (%), nut yield and copra content per nut were recorded during January to December of the respective years of 2003 to 2007. The data were pooled for analysis. Soil samples collected from different depths were analysed for nutrient contents. Similarly 14^{th} leaf was analysed for available nitrogen (Subbiah and Asija, 1956), phosphorus and potassium contents by standard procedure (Jackson, 1967).

Results and Discussion

The results indicated significant differences due to main effect of N and K on number of functional leaves/palm, number of female flowers/palm and fruit setting (Table 1). The highest number of functional leaves (25.8), number of leaves produced (11.0), number of inflorescence (10.7), number of female flowers/palm (270.3) and fruit setting (29.0%) were recorded with K_2 level of potassium application.

The interaction effect showed (Table 2 & 3) that nut yield and copra content increased with the increased graded doses of nitrogen up to 500 g (50% N substituted by vermicompost) whereas, yield of nut/palm/year increased with the increasing level of phosphorus and potash *i.e*., highest level of P at 500 g and K at 2000 g/palm/year (Table 2). The NPK interaction on nut yield was significant and higher yield was obtained with $N_1P_2K_2$ level (110.5 nuts/palm). The copra content was also significantly higher (148 g/nut) with the level of 500g N/palm and with K_2 level of potassium application (146 g/nut) compared with other treatments (Table 3). The lowest content was observed in lower level of treatments. Economic analysis indicated higher net return (Rs. 64672/-) and B:C ratio (2.02) under $N_1P_2K_2$ level compared to other treatments (Table 4).

The increase in yield under higher level of potassium was due to more uptake and accumulation

Table 1. Growth and yield attributing characters of coconut (average of 5 years from 2003 to 2007) as affected by different levels of INM treatments and their interactions

Treatments	No. of functional leaves (Nos./palm)	Rate of leaf production (Nos./palm/year)	No. of inflorescence/ palm/year	No. of female flowers/ palm/year	Fruit set (%)
Nitrogen levels					
N_0	23.6	9.9	9.7	213.6	26.9
N_1	25.3	10.9	10.7	264.9	28.2
N_2	25.0	10.6	10.3	258.6	27.0
CD at 5%	1.71	NS	NS	1.21	1.04
Phosphorus Levels					
P_0	23.8	10.1	9.9	227.3	26.2
P_1	24.1	10.6	10.3	247.5	26.8
P_2	25.3	10.8	10.5	262.3	28.4
CD at 5%	NS	NS	NS	NS	NS
Potassium levels					
K_0	22.4	9.9	9.6	213.3	25.5
K_1	24.6	10.7	10.4	253.5	27.5
K_2	25.8	11.0	10.7	270.3	29.0
CD at 5%	1.71	NS	NS	1.21	1.04
CD for NP, NK, PK interaction	NS	NS	NS	NS	NS

Table 2. Nut yield (Nos./palm/year) as influenced by different levels of INM treatments and their interactions (average of 5 years: 2003 to 2007)

	N_0	N_1	N2	Mean	K_0	K_1	K_2
P_0	49.5	67.3	57.5	58.1	50.4	60.3	63.6
P_1	57.6	69.8	70.1	65.8	53.7	67.2	76.6
P_2	62.8	84.6	73.1	73.5	53.8	77.6	89.1
K_0	48.9	54.8	54.3	52.7			
K_1	58.5	77.1	69.4	68.3			
K_2	62.5	89.8	76.9	76.4			
Mean	**56.6**	**73.8**	**66.9**				

C.D. for N, K = 10.45, CD for NP, NK, PK interaction = NS

Table 3. Copra content (g/nut) as influenced by different levels of INM treatments and their interactions (average of 3 years of 2005 to 2007)

	N_0	N_1	N_2	Mean	K_0	K_1	K_2
P_0	120.3	134.6	138.0	130.9	119.4	133.8	139.6
P_1	132.4	151.5	138.4	140.7	132.0	140.1	151.3
P_2	133.0	158.0	140.2	143.7	133.7	147.0	147.2
K_0	115.1	141.9	125.4	127.4			
K_1	136.8	146.1	138.0	140.3			
K_2	133.8	156.1	148.2	146.0			
Mean	128.6	148.0	138.0				

CD for N, P & K = 3.12, CD for NP, NK, PK interaction = NS

of potassium in leaf tissues (Table 6), which in turn improved the photosynthetic efficiency (Cooper *et al.*, 1976), resulting in greater synthesis, translocation and accumulation of carbohydrates (Morad, 1974). This is reflected in growth parameters like number of functional leaves on crown, number of female flowers and fruit setting percentage. Further, organics might help to release the nutrients supply continuously and also help to improve the soil moisture holding capacity and other physical and chemical properties of the soil. The results obtained in the present study are in close proximity with the findings of Venkitaswamy and Hameed Khan (2002), Sahoo *et al*. (2004), Hanumanthappa *et al*. (2004) and Upadhyay *et al*. (2009) who observed higher nut yield through integrated application of organic manure and inorganic fertilizers. Bopaiah (1991) stated that addition of organics enriched the soil NPK content. Thus the overall combined effect might have helped to increase the nut yield.

Data in Table 5 revealed that the pH varied significantly due to main effect of N and P. The application of graded doses of nitrogen up to N_1 (500g N where 50% N substituted by vermicompost) increased the pH beyond which the soil pH decreased, while, that of phosphate increased it. The organic carbon (OC %) differed significantly due to main effect of N and K at 0-25 cm

Table 4. Mean yield of coconut (average of 5 years from 2003 to 2007) and their economics as influenced by different combination of N, P and K treatments

Treatments	Pre-experimental yield (from 1999 to 2002) of coconut (Nuts/palm/year)	Nut yield/ palm/year (Average of 5 years)	Cost of production (Rs./ha)	Gross Return (Rs./ha)	Net income (Rs./ha)	B:C ratio
$N_0P_0K_0$	44.0	43.5	18,936	38,062	19,126	1.01
$N_0P_0K_1$	47.3	51.0	19,745	44,625	24,879	1.26
$N_0P_0K_2$	51.6	54.1	21,419	47,337	25,918	1.21
$N_0P_1K_0$	46.1	50.5	19,380	44,187	24,807	1.28
$N_0P_1K_1$	58.0	60.5	21,175	52,937	31,762	1.50
$N_0P_1K_2$	60.6	61.8	22,345	54,075	31,730	1.42
$N_0P_2K_0$	47.1	52.6	20,547	46,025	25,478	1.24
$N_0P_2K_1$	57.7	64.1	22,707	56,087	33,380	1.47
$N_0P_2K_2$	67.5	71.7	24,130	62,737	38,608	1.60
$N_1P_0K_0$	46.4	55.9	26,297	48,912	22,615	0.86
$N_1P_0K_1$	66.3	70.7	27,992	61,862	33,870	1.21
$N_1P_0K_2$	68.3	75.3	29,546	65,887	36,342	1.23
$N_1P_1K_0$	49.8	50.8	27,104	44,450	17,346	0.64
$N_1P_1K_1$	74.0	74.9	28,494	65,537	37,043	1.30
$N_1P_1K_2$	80.4	83.6	28,686	73,150	44,464	1.55
$N_1P_2K_0$	46.6	57.7	30,052	50,487	20,435	0.68
$N_1P_2K_1$	72.4	85.6	30,950	74,900	43,949	1.42
$N_1P_2K_2$	102.6	110.5	32,016	96,687	64,672	2.02
$N_2P_0K_0$	44.8	51.9	34,660	45,412	10,752	0.31
$N_2P_0K_1$	53.6	59.2	35,972	51,800	15,927	0.44
$N_2P_0K_2$	60.2	61.4	37,570	53,725	16,155	0.43
$N_2P_1K_0$	56.0	59.8	35,595	52,325	16,729	0.47
$N_2P_1K_1$	60.0	66.1	37,075	57,837	20,762	0.56
$N_2P_1K_2$	81.6	84.3	38,219	73,762	35,542	0.93
$N_2P_2K_0$	46.3	51.2	36,129	44,800	8,671	0.24
$N_2P_2K_1$	81.6	83.0	37,243	72,625	35,381.	0.95
$N_2P_2K_2$	83.0	85.0	39,352	74,375	35,023	0.89
CD at 5%		15.05				0.42

Cost of commodities at the locality:

Urea: Rs. 10.0/kg, SSP = Rs. 11.0/kg, MOP = Rs. 16.0/kg, Vermicompost = Rs. 6.0/kg, sale price of coconut = Rs. 5.0/nut

depth. Organic carbon increased with increasing level of N-application in combination with vermicompost. The available nitrogen differed significantly due to main effect of N and K at 0-25 cm soil depth. However, it did not vary significantly at lower soil depth. Available P content in soil differed significantly due to main effect of P at 0-25 cm soil depth but at lower soil depth available P content did not vary considerably. The available soil K showed significant variation due to increased level of K application. Increasing level of K application improved the available K content in the soil at all depths. In general, soil analysis data showed sufficient levels of available N, P and K values due to the effect of integrated nutrient management in coconut. This in turn helped the palms in elevating the status of leaf NPK (Table 6) which ultimately influenced the reproductive behaviour of the palms under study, the reflection of which was well observed in the nut yield. The improvement in growth and yield can be attributed to the gradual improvement in the status of the rhizosphere of the palm basin due to application of integrated nutrient *i.e.*, 50% substitution of N-dose by vermicompost on equivalent nutrient basis in combination with different levels P and K as chemical fertilizer.

Table 5. Soil nutrient status as influenced by the INM treatments and their interactions

Treatments	pH	Organic carbon (%)			Available nitrogen (kg/ha)			Available phosphorus (kg/ha)			Available potassium (kg/ha)		
	0 -30 cm	0-25 cm	25-50 cm	50-100 cm	0-25 cm	25-50 cm	50-100 cm	0-25 cm	25-50 cm	50-100 cm	0-25 cm	25-50 cm	50-100 cm
Nitrogen levels													
N_0	4.90	0.61	0.48	0.31	175.0	171.2	85.1	44.2	33.6	28.2	374.2	357.9	246.2
N_1	5.12	0.78	0.51	0.36	294.6	219.0	88.0	54.5	41.2	31.0	501.6	374.1	264.5
N_2	4.84	0.79	0.58	0.39	328.2	224.0	92.1	59.8	45.0	36.8	438.6	325.0	225.8
CD at 5%	0.16	0.07	NS	NS	47.8	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus levels													
P_0	4.94	0.71	0.44	0.28	266.8	197.9	86.4	47.4	39.1	22.5	371.0	383.6	240.3
P_1	4.95	0.62	0.41	0.25	289.3	254.0	90.2	56.1	41.0	27.1	368.2	347.7	215.0
P_2	5.08	0.58	0.40	0.23	257.0	187.2	81.5	62.4	43.6	29.7	366.8	327.9	204.8
CD at 5%	0.16	NS	NS	NS	NS	NS	NS	29.8	NS	NS	NS	NS	NS
Potassium levels													
K_0	4.89	0.70	0.49	0.31	266.3	178.2	94.6	47.9	31.6	27.0	387.0	301.6	254.0
K_1	4.91	0.72	0.51	0.35	315.5	286.6	98.2	54.8	38.7	32.0	457.3	324.6	274.3
K_2	4.96	0.57	0.42	0.29	254.0	149.8	90.1	44.1	31.0	26.5	501.5	369.6	289.1
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	57.8	4.6	NS
CD for NP, NK, PK interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 6. Nutrient content in coconut leaf (frond 14) as influenced by the INM treatments and their interactions

Treatments	Nitrogen (%)	Phosphorous (%)	Potassium (%)
Nitrogen levels			
N_0	1.84	0.12	1.78
N_1	1.88	0.15	1.70
N_2	1.86	0.15	1.66
CD at 5%	NS	NS	NS
Phosphorous levels			
P_0	1.84	0.14	1.68
P_1	1.86	0.15	1.69
P_2	1.80	0.16	1.69
CD at 5%	NS	NS	NS
Potassium levels			
K_0	1.79	0.14	1.45
K_1	1.85	0.16	1.79
K_2	1.96	0.15	1.88
CD at 5%	0.12	NS	0.23
CD for NP, NK, PK interaction	NS	NS	NS

From the present study, it may be concluded that a combination of $N_1P_2K_2$ (500 g N wherein 50% N substituted by vermicompost: 500 g P_2O_5: 2000 g K_2O/palm/year) was found to be most effective for optimum production of nut yield/palm/year and maximum economic returns and improvement in soil fertility compared to other treatments. This integrated nutrient dose can be suggested for the successful production of hybrid coconut (COD x WCT) under Assam condition.

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