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Integrated Nutrient Management in East Coast Tall Coconut

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A field experiment was conducted during 2006-2009, on 29 years old East Coast Tall (ECT) coconut palms at Coconut Research Station, Veppankulam to explore the possibility of nitrogen substitution through organic manure. It was aimed to substitute 50 per cent of recommended nitrogen through organic manure. There were five treatments *viz.,* T_1 - Absolute control, T_2 - Recommended NPK (560:320:1200 g/palm/year), T_3 - 100% N as Composted Coir Pith (CCP) + balance PK as fertilizer, T_4 - 50 % N as CCP + balance NPK as fertilizer and T_5 - Neem cake (10 kg) + ash (20 kg), bonemeal (2kg). The experimental results proved that 50 % nitrogen substitution through organic manure (CCP) and remaining 50 % nitrogen through fertilizers (T_4) recorded comparable mean annual nut yield (111 and 117 nuts / palm / year, respectively, in 2008 and 2009) and other yield contributing parameters viz., no. of functional leaves, no. of bunches and no. of female flowers, with 100% NPK through fertilizers (T_2). However, the soil fertility viz., soil available NPK and index leaf NPK content were significantly higher due to chemical fertilizers at their recommended level. Hence, in coconut nutrition, 50 per cent nitrogen can be substituted through organics (CCP) and this may pave the way for gradual replacement of chemical fertilizer in coconut garden in the long run by way of waste recycling.

Key words: Integrated Nutrient Management, composted coil paith, coconut yield, economics.

Adequate fertilization is vital to enhance the productivity and quality of coconut. Most coconut soils throughout the country are highly weathered and low in fertility. Soil fertility management is important in coconut plantations, since coconut is a perennial palm with a continuous productive life. Continuous use of fertilizers with total negligence of organic manure often leads to decline in nut yield and deterioration of soil health. Organic manures are thus indispensable in the fertilizer schedule of coconut for sustained production and preserving soil health. Neither organic manure nor fertilizer alone can satisfy the nutrient requirement of an exhaustive crop like coconut. Only a judicious use of organic manure and fertilizer will solve the twin problem of soil health and sustainable production. About 1% of coconut plots receive inorganic fertilizers and around 50% of the plots receive meaer quantity of organic manure in the form of farmyard manure and green leaf manures (Mathew, 1976). In India, huge quantities of organic wastes are being generated annually. Coconut produces 11.2 mt of organic biomass which includes husk, dried leaves, coir dust etc, (Bidappa *et al*., 1996). If part of this waste is recycled atleast 50 per cent of coconut nutrition can be supplemented by the organic manure generated in coconut gardens. This may pave way for the safe disposal of organic wastes and prevent deterioration of soil health in coconut based cropping system. Coir pith, a lignocellulosic material, has wide C: N ratio from 112:1 (Nagarajan *et al*., 1985) to 58: 1 (Ravichandran, 1988) and composting will reduce the C: N to the tune of 20: 1 to 15: 1. The present investigation deals with substitution of 50 % nitrogen for coconut through organic manure by way of waste recycling.

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Materials and Methods

A field experiment was initiated during 2006 at Coconut Research Station, Veppankulam to study the scope for nitrogen substitution in coconut through organic manure (coconut waste recycling) with following treatements *viz.,* T_1 - Absolute control, T_2 - Recommended NPK (560:320:1200 g/palm/ year), T_3 - 100% N as Composted Coir Pith (CCP) + balance PK as fertilizer, T_4 - 50 % N as CCP + balance NPK as fertilizer and T_5 - Neem cake (10 kg) + ash (20 kg), bonemeal (2kg).. The age of the palm is 36 years. There were five treatments and the experiment was conducted in randomized block design, replicated four times with six palms per treatment. The experimental site was located at 20 m above MSL, with an average mean annual rainfall of 1,125 mm. The experimental soil was sandy loam in texture with a pH 7.01, EC 0.13 dSm^{-1} and organic carbon content 0.23 per cent. The available NPK content of the experimental soil was low in N and P and medium in K *viz.,* 112, 10.5, 203 kg ha^{-1} respectively. The palms were supplied with 50 %

nitrogen through composted coir pith and remaining 50 % nitrogen, phosphorus, potassium through fertilizers. The composted coir pith was applied to substitute 50 % nitrogen, on equal nutrient basis, out of total recommendation of 560 g N/palm/year. The composted coir pith had a NPK content of 1.02: 0.60: 1.06 per cent and C: N ratio of 24:1. P and K were applied @ 320 and 1200 g / palm/ year respectively excluding the quantum supplied by the composted coir pith applied to substitute 50 % nitrogen. All the treatements, except absolute control (T_1), received the recommended organic manure *viz.,* 50 kg FYM/palm/year. The annual nut yield, copra yield and growth parameters were recorded and analyzed statistically. The total return and B:C ratio were worked out. The soil NPK availability and index leaf NPK content were estimated at the end of each year and analyzed statistically.

Results and Discussions

Effect of treatments on growth and yield attributes of coconut

Functional leaves production

Application of recommended NPK consistently produced the maximum number of functional leaves per palm. It recorded an increase from 21.2 to 30.7 (2006-'07) 26.5 to 33.1 leaves (2007-08) and 24.2 to 34.1 (2008-09) / palm (Table 1). With respect to treatments, the application of recommended NPK (560:320:1200 g/palm/year) recorded the highest number of functional leaves (30.7 for 2006-'07, 33.1 for 2007-'08 and 34.1 for 2008-'09) and it was followed by the treatment receiving 50% N as CCP + 50% N, balance P and K as fertilizers (30.3 for 2006-'07, 31.1 for 2007-'08 and 32.5 for 2008-'09).

Table 1. Effect of INM on yield attributes of East Coast Tall (ECT) coconut

Treatment	No. of functional leaves/palm			No. of bunches /palm			No. of female flowers/ spathe		
	2006-07	2007-08	2008-09	2006-07	2007-08	2008-09	2006-07	2007-08	08-09
T_1 - Control	21.2	28.8	24.2	11.3	12.9	11.0	23.1	24.3	21.0
T_2 - NPK (560: 320: 1200g/ palm / year)	30.7	33.1	34.1	12.6	14.3	14.0	35.3	36.8	37.2
T_3- 100% N as CCP + balance PK as fertilizer	22.7	30.7	30.5	11.6	13.8	13.0	28.3	29.1	30.5
T_4– 50% N as CCP + balance NPK as fertilizer	30.3	31.1	32.5	12.3	13.5	13.5	32.4	34.1	35.1
T_5 – 10 kg Neem cake + 2 kg bone meal +20 kg wood ash	24.2	26.5	28.0	11.2	11.8	12.1	26.1	28.5	29.7
SEd	1.5	1.4	1.5	0.5	0.1	1.0	1.4	1.2	1.5
CD (p=0.05)	3.2	2.9	3.0	NS	NS	NS	3.1	2.8	3.0

However, these two treatments were comparable with each other. The 100% N as CCP (T_3) and various combination of organics ie., T_5 (Neem cake, bone meal and wood ash) produced relatively lesser number of leaves / palm. Nitrogen is indispensable as a constituent of amino-acids, proteins and nucleic acids. Shortage of nitrogen makes itself felt throughout the coconut's physiology and provokes a substantial yield decline (Manciot *et al.,* 1980). Number of bunches per palm varied between 11.2 and 12.3 in 2006-07, 11.8 and 14.3 in 2007-08 and 11 and 14 in 2008-09. The different treatments failed to exert a significant influence on bunches production by the palm.

Female flowers production

The number of female flowers produced by the application of recommended NPK (T_2) ranged from 23.1 to 35.3 (2006-'07) and 24.3 to 36.8 (2007-'08) / inflorescence (Table 1). As in the case of functional leaf production, the highest (35.3 for 2006-'07 and 36.8 for 2007-'08) female flower production was registered by the application of recommended NPK in combination with 50 kg of FYM /palm/year. However, it was at par with treatment that received 50% N as CCP, remaining 50% N and P,K as fertilizers which registered a female flower production of 32.4 (2006-'07) and 34.1 (2007-'08) / inflorescence. The other two treatments viz., 100%

Table 2. Effect of INM on soil fertility and index leaf nutrient content

Treatment	Available NPK (kg ha^{-1})									Index leaf NPK content (%)								
	2006-07			2007-08			2008-09			2006-07			2007-08			2008-09		
	N	P	K	N	PK				NPKN	P	K	N	P	K	N	P	K	
T_1 - Control	110	10.1	198	102	8.8	191	96	7.2	176	1.80	0.19	1.21	1.70	0.11	0.96	1.60	0.10	0.86
T_2 - NPK (560: 320:1200 g/palm / year)	130	15.8	236	146	17.1	242	152	18.6	248	2.20	0.24	1.42	2.25	0.26	1.46	2.26	0.28	1.48
T_3- 100% N as CCP + balance PK as fertilizer	121	12.1	211	127	13.1	217	135	13.5	222	2.12	0.19	1.28	2.15	0.21	1.32	2.15	0.22	1.36
T_4– 50% N as CCP + balance NPK as fertilizer	131	13.5	222	137	14.2	228	144	15.2	236	2.10	0.21	1.38	2.15	0.23	0.38	2.22	0.25	0.41
T_5 –10 kg Neemcake+2 kg bone meal +20 kg wood ash	116	11.2	205	121	11.8	211	126	12.4	220	1.91	0.21	1.40	1.94	0.28	1.34	1.96	0.29	1.33
SEd	3	0.3	5	3	04	6	3	0.7	6	0.06	0.03	0.08	0.06	0.02	0.09	0.07	0.04	0.10
CD (p=0.05)	6	0.6	10	8	0.7	11	1	0.8	12	0.12	NS	NS	0.13	NS	NS	0.14	NS	NS

N as CCP (T_3) and various organic combinations (T_5) registered comparable number of female flowers and they were at par. The absolute control (T_1) registered the lowest female flower production.

Soil fertility

Nitrogen substitution through organic manure positively enhanced the soil available nitrogen besides, the phosphorus and potassium (Table 2). However, the highest available NPK was recorded under the treatment T_2, which received the recommended NPK, which was significantly superior over other treatments (130, 146 and 176 kg ha^{-1} in 2007, 2008 and 2009, respectively). There was a significant reduction in soil available NPK over the years under absolute control. It is obvious that the total omission of external inputs either organics or inorganics lead to rapid depletion of soil fertility and results in soil degradation. Hameed Khan (2004) brought that fertilizer application and INM practices are must for increasing and sustaining the productivity of coconut garden.

Index leaf nutrient content

As observed in soil fertility, the index leaf NPK content was significantly altered due to different treatments. The highest leaf NPK (2.20, 0.24, 1.42 & 2.25, 0.26, 1.46%, respectively for 2007 & 2008) was observed due to adoption of recommended package for coconut (T_2). This was superior over other treatments. The immediate release and its subsequent absorption by the palms resulted in higher NPK in leaf under the NPK treatment (Sahoo *et al*., 2004). The 50 % nitrogen substitution through organics registered the next best values. The absolute control recorded the lowest NPK content of leaf tissues.

Table 3. Effect of INM on nut yield of ECT coconut

Treatment	5 years average (2001-2006)	2006-07	2007-08	2008-09	Mean (2006-09)
T_1 – Absolute control	69	63	68	60	66
T_2 – Rec NPK (560: 320: 200g/ palm)	108	114	120	126	117
T_3 – 100% N as CCP + balance PK as fertilizer	88	86	111	115	99
T_4 – 50% N as CCP + balance NPK as fertilizer	95	105	116	119	111
T_5 –10 kg Neem cake + 2 kg bone meal + 20 kg wood ash	80	84	101	111	93
SEd	6	4	5	5	-
CD (p=0.05)	12	10	10	10	-

Nut yield

Different treatments registered a significant influence on nut yield of coconut. Application of recommended NPK (T_2) registered the highest nuts / palm / year which showed an increase from 108 (2000-'06) to 120 (2007-'08) / palm / year and it was at par with treatment receiving 50% N as CCP and remaining 50% N as fertilizer (T_4). The nut yield under T_4 was in the range of 95 (2001-06) to 116 (2007-08) / palm / year (Table 2). The nut yield recorded under the treatment receiving 100% N as CCP (T_3) was comparable with combination of organics (T_5). Analysis of mean nut yield (2006-07, 2007-08 and 2008-09) showed that application of recommended NPK (T_2) recorded the highest number of nuts (117) / palm / year which was followed by 50 per cent N as CCP and remaining 50 % N and P,K as fertilizer with 111 nuts / palm / year (T_4). Treatment receiving 100% N as CCP (T_3) and various organic input combinations (T_5) recorded 99 and 93 nuts / palm / year respectively. Hameed Khan *et al*. (1990) reported that doubling the recommended dose in the first year followed by the recommended dose viz., 500, 320, 1200 N, P_2O_5, and K_2O respectively/palm/year helped in early enhancement of nut yield.

Table 4. Effect of INM on coconut yield and economics

Treatment	Copra yield mean palm/year(kg $palm^{-1}$)			B:C		
	2006-07	2007-08	2008-09	2006-07	2007-08	2008-09
T_1 - Absolute control	8.2	8.5	8.0	2.05	2.09	2.10
T_2- NPK 560:320:1200g/palm/year)	14.3	15.6	17.3	2.13	2.17	2.21
T_3 -100% N as CCP + balance PK as fertilizer	10.8	13.9	15.0	1.82	2.00	2.01
T_4 - 50% N as CCP + balance NPK as fertilizer	13.2	14.7	16.4	2.04	2.03	2.15
T_5 -10 kg Neem cake + 2 kg bone meal +20 kg wood ash	10.7	11.2	12.8	1.03	1.60	1.72
SEd	0.2	0.3	0.4	-	-	-
CD (p=0.05)	0.5	0.6	1.0	-	-	-

Comparing the mean nut yield with pretreatment yield, all the treatments recorded higher number of nuts / palm with exception of absolute control (T_1), which recorded 66 nuts / palm / year. The reason for stagnation in nut yield here might be due to poor nutrient supply in the complete negligence of nutrients. The enhanced nut yield registered in other treatments even within three years might be due to staggered and continuous supply of nutrients from the decomposing organics coupled with enhanced use efficiency of inorganics. Thus, integrated nutrient management lays emphasis on improving and maintaining soil fertility for sustained productivity (Hameed Khan *et al.,* 2000). The coconut based cropping system offers excellent scope for INM practices in view of biomass generated in the system (Bidappa *et al*., 1996).

Copra yield

The different treatments registered a significant influence on the copra yield of coconut. The highest copra yield of 14.3 kg / palm / year was recorded by the application of recommended NPK (T_2), which was comparable with treatment receiving 50 per cent N as CCP, remaining 50 per cent N and entire P, K as fertilizers (13.2 kg / palm / year) in 2006-07 (Table 3). Increase in copra production by the application of composted coir pith was earlier reported by Venkitaswamy (2003) and Ghosh and Bando padhyay *et al* (2009). The trend of observation was similar in 2007-08 and 2008- 09 as well.

Economics

Application of recommended NPK (T_2) recorded the highest benefit cost ratio of 2.13 (2006-07) and this was followed by treatment receiving 50% N as CCP and remaining 50% N and entire P, K as fertilizers (T_4) with a B:C of 2.04. Comparing the B: C of other treatments with absolute control, the B: C obtained for T_3 (1.82) and T_5 (1.03) were lower than control. The trend of observation was similar in 2007-08, 2008-09 as well. The cost of inputs viz., composted coir pith, neem cake, bone meal and wood ash were the contributing factors for higher cost of cultivation under the treatment T_5, which eventually reduced the B: C.

Conclusion

The application of recommended NPK (T_2) and the treatment receiving 50 per cent nitrogen substitution through composted coir pith (CCP) and remaining 50 per cent N and entire P, K as fertlizers (T_4) recorded the comparable nut yield. However, the highest soil available NPK and index leaf NPK content were registered under recommended package. ie., (560:320:1200g NPK/palm/year with TYM 50 kg/palm/year. Considering the quantum of organic manure added, the latter (T_4) effective in sustaining the nut yield and soil fertility in long run and higher economic return. Besides, the availability of organic manure is dwendling and economic feasibility of converting them into manure in coconut garden is a costly affair and hence, out of total recommendation, 50 per cent nitrogen may be supplied through organics and remaining 50 per cent N through fertilizers.

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