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Exploring the Possibility of Organic Farming in Coconut

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Field experiments were conducted during 2008-2011 at Coconut Research Station, Veppankulam to evaluate the efficacy of organic nutrient mix for coconut developed by TNAU with 30 years old ECT and 38 years old hybrid coconut (WCT x COD) palms proved that the application of TNAU Cocomix irrespective of their splits was significant in enhancing the yield attributes and sustained the soil fertility due to continuous application over years. Among the treatments, application of cocomix once a month for the first year and subsequently once in three months recorded the highest nut yield of 130 and 156 nuts / palm / year in tall and hybrid coconut respectively (2008-09). The cocomix at various interval to both tall and hybrid coconut significantly increased the soil microbial load viz., bacteria, fungi and actinomycetes and improved the soil enzyme activity.

Key words: Coconut, organic nutrient mix, nut yield, soil fertility, soil microbes and enzymes

Coconut production becomes sustainable when the natural resource base is prudently used through the adoption of non-exploitation production technologies. It is now widely realized that intensive use of chemical fertilizers have negative environmental effects. The continued use of such inputs with total negligence of organic manure in the fertilizer schedule disturb the soil and often leads to deterioration of soil health (Thomas Mathew, 2008). In coconut, the harvested nuts, fronds and other parts used for various purposes remove nutrients and this leads to gradual depletion of nutrients (Somasiri, 1994). These problems could be avoided in coconut based copping system through *in-situ* organic recycling through composting. On farm organic recycling is an essential component for maintaining the soil fertility and crop productively in any cropping system. The continuous nutrient removal by the palm over the years causes depletion of soil nutrient resource and hence the palm productivity declines gradually. It has been estimated that approximately 11.2 million tonnes of waste is likely to be available from coconut for recycling (Biddappa *et al*. 1996). Recycling of these coconut waste will add 79.15, 76 and 49.45 thousand tonnes of N, P_2O_5 and K_2O respectively (Nair *et al*. 1996). The feasibility of organic farming is tried elsewhere under different intercropping / mixed cropping / multiple cropping systems.

The present investigation is contemplated mainly to protect the soil health and to explore the possibility of organic farming in coconut for economic productivity.

Materials and Methods

Field experiments were laid out at Coconut Research Station, Veppankulam during 2008-11 to evaluate the efficacy of organic nutrient mix developed by TNAU on coconut and to explore its possibility of organic farming. The experimental soil of tall coconut experiment is sandy loam in texture with a pH of 7.1, EC 0.14 and organic carbon 0.21 per cent. The soil NPK availability is 156,15.0,168 kg ha^{-1} respectively. The micronutrient content of the experimental soil *viz.,* iron 4.0, zinc 0.26, manganese 4.42 ppm, copper 0.22 and boron 4.01 ppm respectively. The soil microbial population *viz.,* bacteria, fungi and actimomyceetes were 12.0 $x10^6$ cfu/g, 14.0 $x10^4$ cfu/g and 9.5 $x10^2$ cfu/g dry soil respectively and soil enzymes activity *viz.,* urease, phosphatase and dehydrogenase were 60 µg NH4-N/g, 62 µg P-NPP/g and 18 µg TPF/g dry soil hr^{-1} respectively. While, hybrid coconut field experimental soil is sandy loam in texture with a pH of 7.0, EC 0.18 and organic carbon 0.24 per cent. The soil NPK availability is 148, 17.6,186 kg ha^{-1} respectively. The micronutrient content of the experimental soil *viz.,* iron 4.2, zinc 0.28, manganese 4.08 ppm, copper 0.26 and boron 4.12 ppm respectively. The soil microbial population *viz.,* bacteria, fungi and actimomyceetes were 30.1 $x10^6$ cfu/g, 15.5 $x10^4$ cfu/g and 10 $x10^2$ cfu/g dry soil respectively and soil enzymes activity *viz.,* urease, phosphatase and dehydrogenase were 58 µg NH4-N/g, 21 µg P-NPP/g and 15 µg TPF/g dry soil hr^{-1} respectively. The treatments consisted of organic sources of plant nutrients viz., T_1- 40 kg Composted Coir Pith (CCP) / Verimicompost (VC) +500 g Rock Phosphate (RP) +12.50 g each of Azospirillum (AZOS) and Phosphobacteria (PB) + 250g groundnut (GN) cake once in six months in two equal splits (Cocomix), T_2 – Cocomix once in a month for 1^{st} year and once in three months from 2^{nd} year onwards in equal splits, T_3- Cocomix once in two months for 1^{st} year and once in three months from 2^{nd} year onwards in equal splits, T_4 – Cocomix

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once in three months from 1st year onwards in four equal splits and T_5 – control – (recommended package) were imposed in 30 years old ECT palms. Likewise, double the quantities as applied for tall coconut as per the above schedule were imposed in 38 years old hybrid coconut (WCT x COD). The Cocomix was applied as per the treatments schedule to both ECT and Hybrid (WCT x COD) coconuts. The experiment is being carried out in Randomized block design and replicated thrice @ four palms / treatment. The data on yield and yield attributes of coconut, soil available NPK and soil microbial load and soil enzyme activity were recorded/ estimated, analyzed statistically and the results are discussed hereunder.

Results and Discussion

Effect of cocomix on yield attributes and nut yield of coconut (Table 1)

The yield and yield attributes of coconut were recorded for four years ie., 2007-2011. The data on yield and yield attributes of both tall and hybrid coconut over the years showed a perceptible variation in yield attributes due to application of TNAU cocomix irrespective of their splits, though there was a reduction of yield attributes and nut yield during the initial years. However, among the various splits tried, application of cocomix once a month (T_2) for the first year and subsequently once in three months in equal splits registered numerically the highest no. of functional leaves / palm /year, no. of buttons / bunch and nut yield and it was comparable with recommended package ie., (T5). Though, there was a decline in all the growth parameters and annual nut yield due to cocomix in the initial years of experimentation, later it picked up and became comparable with recommended package at the end of the fourth year are to repeated application. The trend observation was similar for both tall and hybrid coconut, though there were some numerical variation among the various treatments. Similar increase in nut yield due to 100 per cent N substitution through composted coir pith was earlier reported by Hanumanthappa *et al*. (2004) and 50 per cent N substitution by Mohandas (2012). This increase is mainly due to higher growth parameters like number of functional leaves, number of inflorescence and no. of female flowers/spathe in plots applied with various organic compositions (Marimuthu *et al*. 2001). Further organics might have helped to release the nutrients continuously and improve the soil physical, chemical and biological properties for better soil environment and subsequent nutrient absorption by the palms.

Table 1. Effect of organic cocomix on yield attributes and nut yield of coconut

Tall coconut																	
Treatment	No. of functional leaves / palm				No. of bunches /palm				No. of female flower/ bunch				Nut yield /palm /year				
	2008	2009	2010	2011	2008	2009	2010	2011	2008	2009	2010	2011	2008	2009	2010	2011	Mean
T_1	29.0	29.9	30.1	31.1	12.4	12.1	11.8	11.9	26.2	29.2	21.8	24.8	108	112	120	110	113
T_2	32.8	33.8	33.5	34.5	13.8	13.6	12.5	12.8	32.5	34.5	28.5	31.5	118	119	118	129	121
T_3	30.2	31.2	31.5	32.5	12.1	12.4	12.0	12.1	30.8	30.1	22.0	26.0	111	116	120	118	116
T_4	30.0	33.0	32.1	32.9	12.5	18.5	12.0	12.0	31.5	32.5	22.0	24.0	119	120	125	120	121
T_5	33.5	35.2	35.0	35.2	13.9	14.1	13.0	13.5	34.4	35.4	32.6	32.8	120	126	129	133	127
SEd	1.0	1.20	1.1	1.2	1.1	1.10	1.0	1.0	1.2	1.20	0.5	0.5	4	4	4	4	
CD (p=0.05)	2.0	2.40	2.2	2.2	NS	NS	NS	NS	2.4	2.30	0.1	0.1	8	9	8	8	
Hybrid coconut																	
T_1	28.5	28.5	30.0	31.6	11.5	11.5	11.5	11.6	30.0	30.0	30.5	31.5	136	132	138	142	137
T_2	34.0	34.0	34.5	33.5	13.1	13.1	13.1	13.8	35.1	34.1	35.4	35.2	148	156	150	165	155
T_3	30.0	30.0	31.2	32.2	12.9	12.9	12.9	12.4	31.5	31.5	30.1	31.1	142	140	152	168	151
T_4	32.1	32.1	32.1	31.1	12.5	12.5	12.5	12.6	33.2	33.2	32.5	32.5	144	150	148	148	148
T_5	34.1	35.1	35.0	34.5	13.2	13.8	14.0	14.2	35.6	35.6	35.0	36.0	158	160	156	169	161
SEd	1.3	1.3	1.2	1.2	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.3	4	4	5	4	
CD (p=0.05)	2.7	2.7	2.4	2.4	NS	NS	NS	NS	2.4	2.4	2.4	2.6	9	9	9	9	

Effect of cocomix on Soil fertility (Table 2)

The soil samples of both tall and hybrid coconut experiments for all the year of experimentation (2007-11) were analyzed for their OC, NPK content, soil microbial load and enzyme activity. The soil fertility status of both hybrid and ECT experimental fields indicated that the soil is medium in organic carbon, low in available nitrogen, medium in available phosphorus and available potassium irrespective of application of cocomix at various splits. The soil organic carbon (OC) level was not significant with respect to treatments however there was a considerable built-up over NPK. The variation among soil available NPK, both in hybrid and tall coconut experiment is not much, though it was statistically significant. Number of splits of application registered same level of soil available NPK. The trend cocomix was similar both in tall and hybrid experiments. Bopaiah (1991) also reported that addition of organics enriched the soil NPK availability.

Effect of cocomix on Soil microbial population (Table 3)

The effect of organic nutrient mix on soil microbial population was profound. In general, the TNAU cocomix significantly enhanced the soil microbial population. However, no marked variation was observed among the various treatments both in hybrid and ECT experiments, except that the recommended package for ECT coconut i.e., 560: 320: 1200 g NPK + 50 kg FYM / palm / year and hybrid coconut i.e., 1000: 250: 2000 g NPK + 50 kg FYM / palm /year recorded the lowest soil microbial load viz., bacteria, fungi and actinomycetes ie., 8.2 x 10_6 cfu/ g, 9.1 x 10_4 cfu/ g and 7.2 x 10_2 cfu / g dry soil

Table 2. Effect of cocomix on soil NPK availability

Treatment	Soil available nutrients (kg ha^{-1})															
	Tall experimental soil															
	2008				2009				2010				2011			
	OC (%)	N	P	K	OC (%)	N	P	K	OC (%)	N	P	K	OC (%)	N	P	K
T_1	0.24	140	15.0	160	0.26	160	18.8	161	0.25	158	20.5	165	0.26	152	21.5	160
T_2	0.28	175	20.6	178	0.32	165	20.1	168	0.30	168	21.2	172	0.32	171	23.2	181
T_3	0.25	160	18.5	170	0.28	170	20.0	176	0.25	175	21.0	170	0.24	163	20.0	172
T_4	0.30	148	17.0	165	0.30	178	21.5	178	0.30	176	21.1	168	0.28	164	20.6	160
T_5	0.25	181	22.8	182	0.26	180	21.2	175	0.20	181	21.5	178	0.22	178	24.8	186
SEd	0.11	4	0.4	4	0.02	5	0.4	4	0.01	5	0.4	4	0.01	4	0.4	9
CD (p=0.05)	NS	8	0.8	9	0.04	10	0.8	8	0.02	10	0.8	8	0.02	9	0.8	10
Hybrid expérimental soil																
T_1	0.24	148	23.7	180	0.20	162	19.2	160	0.25	158	20.5	165	0.28	148	21.0	160
T_2	0.25	181	23.1	170	0.36	179	24.0	168	0.30	168	21.2	172	0.36	178	25.6	189
T_3	0.27	164	17.2	166	0.25	172	21.8	172	0.25	175	21.0	170	0.32	170	22.1	170
T_4	0.31	151	25.5	169	0.30	178	23.6	175	0.30	176	21.1	168	0.24	170	21.8	168
T_5	0.30	185	21.6	171	0.20	188	24.7	179	0.20	181	21.5	178	0.23	182	25.8	188
SEd	0.15	5	0.5	4	0.20	4	0.4	4	0.01	5	0.4	4	0.01	4	0.5	5
CD (p=0.05)	NS	10	1.2	8	NS	8	0.8	8	0.02	10	0.8	8	0.02	8	1.0	10

in tall experimental field and 7.1 x 10_6 cfu/ g, 8.1 x 10_4 cfu/ g and 8.8 x 10_2 cfu / g dry soil in hybrid experimental field respectively. While, all other treatments involving cocomix at various splits registered comparable soil microbial population, which were appreciably higher over recommended package, though it was not statistically significant. Microbial biomass was high in the system where organic recycling is practiced (Hameed Khan and Upadhyay, 2002).

Table 3. Effect of cocomix on soil microbial population

Treatment	Soil microbial population											
	Tall experimental soil											
	Bacteria (x 10_6 cfu/ g dry soil)				Fungi (x 10_4 cfu/ g dry soil)				Actinomyceetes (x 10_2 cfu / g dry soil)			
	2008	2009	2010	2011	2008	2009	2010	2011	2008	2009	2010	2011
T_1	12.0	12.1	11.2	12.2	14.0	15.0	11.6	10.6	9.5	9.8	8.8	8.0
T_2	10.5	14.1	14.5	15.5	14.0	13.5	15.2	14.2	9.5	11.2	11.9	12.9
T_3	12.0	12.5	13.0	14.0	12.0	12.5	13.0	13.2	8.5	10.1	10.5	12.5
T_4	12.0	13.8	12.5	13.5	12.0	14.8	12.8	12.0	8.5	10.0	10.8	11.3
T_5	10.0	10.5	9.2	8.2	10.0	10.4	9.5	9.1	6.0	7.5	7.0	7.2
SEd	0.2	0.3	0.40	0.30	0.3	0.6	0.5	0.5	0.2	0.5	0.5	0.4
CD (p=0.05)	0.5	0.6	0.80	0.60	0.6	1.2	1.0	1.2	0.4	1.0	1.1	1.0
Hybrid expérimental soil												
T_1	30.2	13.5	10.0	9.0	15.6	11.2	11.1	10.1	10.1	10.5	9.0	9.5
T_2	30.1	11.5	11.5	12.2	15.1	18.2	15.5	15.1	10.8	13.2	10.2	11.2
T_3	21.8	12.1	11.8	11.0	12.8	16.1	14.2	14.6	8.6	11.5	11.2	10.2
T_4	20.0	10.5	11.0	10.0	12.2	17.5	13.5	13.4	8.1	11.2	12.0	10.0
T_5	9.8	10.1	8.1	7.1	10.2	11.0	8.1	8.5	6.2	8.8	9.1	8.8
SEd	0.3	0.6	0.4	0.3	0.4	0.6	0.5	0.4	0.2	0.5	0.4	0.3
CD (p=0.05)	0.6	1.1	0.8	0.6	0.8	1.2	1.0	0.8	0.4	1.0	0.8	0.6

Effect of cocomix on soil enzyme activities

The activity of soil enzyme viz., urease, phosphotase and dehydrogenace were estimated at the end of every year. The organic cocomix application at different splits appreciably increased the soil enzyme content over recommended NPK fertilizers. The cocomix at various splits are comparable with each other in respect of soil enzyme activity. Numerically, the highest soil enzyme activity viz., urease, phosphatase and dehydrogenace ie., 80 µg NH4-N/g, 36 µg P-NPP /g and 34 µg TPF /g

Table 4. Effect of Cocomix on soil enzyme activity (g $^{-1}$ dry soil hr^{-1})

Treatment	Soil enzyme activity											
	Tall experimental soil											
	Urease (µg NH4-N/g dry soil hr^{-1})				Phosphatase (µg P-NPP /g dry soil hr^{-1})				Dehydrogenase (µg TPF /g dry soil hr^{-1})			
	2008	2009	2010	2011	2008	2009	2010	2011	2008	2009	2010	2011
T_1	60	62	64	64	22	21	20	22	18	17	18	21
T_2	64	69	60	80	26	24	26	36	24	25	24	34
T_3	65	61	65	75	20	18	16	26	18	16	18	28
T_4	58	56	52	58	22	24	22	28	24	21	24	29
T_5	50	49	42	46	15	14	15	18	15	12	16	17
SEd	2	2.0	2.0	2	1	1	1	1	1	1	1	1
CD (p=0.05)	4	4.0	4.0	4	3	3	3	2	3	2	2	2
Hybrid expérimental soil												
T_1	58	54	52	58	21	22	20	24	17	16	18	22
T_2	67	68	66	76	28	26	22	28	26	24	26	36
T_3	62	63	60	70	22	23	20	21	21	21	22	32
T_4	63	65	64	74	20	21	19	23	23	25	20	30
T_5	48	46	45	48	16	17	16	18	16	17	16	21
SEd	2	2	2	2	1	1	1	1	1	1	1	1
CD (p=0.05)	5	5	5	5	3	3	3	3	3	3	3	3

dry soil hr^{-1} in tall experimental field and 66 µg NH4-N/g, 28 µg P-NPP /g and 36 µg TPF /g dry soil hr^{-1} in hybrid experimental field respectively were recorded due to the application of cocomix once a month for the first year and subsequently once in three months at equal splits. While, the lowest soil enzyme activity viz., urease, phosphatase and dehydrogenace ie., 42 µg NH4-N/g, 18 µg P-NPP /g and 17 µg TPF /g dry soil hr^{-1} in tall experimental field and 48 µg NH4-N/g, 18 µg P-NPP /g and 21 µg TPF /g dry soil hr^{-1} in hybrid experimental field respectively was associated with recommended NPK fertilizers at the end of experimentation (2011).

Effect of cocomix on index leaf nutrient content

The index leaf nutrient content (NPK), on the contrary were highest due to application of recommended NPK through fertilizers ie., 1.52, 0.29 and 1.46 per cent NPK in tall coconut and 1.56, 0.28 and 1.48 per cent NPK in hybrid coconut respectively. While, all other treatments receiving at cocomix at various splits registered lower NPK in their index leaf tissues. The quick release of nutrients by the fertilizers and better absorption might have resulted in better assimilation by the palms.

Table 5. Effect of cocomix on index leaf nutrient content (%)

Treatment	Index leaf nutrient content											
	Tall experimental soil											
	2008			2009			2010			2011		
	N	P	K	N	P	K	N	P	K	N	P	K
T_1	1.21	0.12	1.21	1.28	0.13	1.10	1.22	0.09	1.10	1.21	0.11	1.12
T_2	1.28	0.19	1.28	1.48	0.19	1.21	1.51	0.28	1.38	1.41	0.26	1.40
T_3	1.26	0.14	1.10	1.40	0.16	1.02	1.56	0.09	1.01	1.36	0.21	1.21
T_4	1.20	0.10	1.26	1.38	0.12	1.00	1.47	0.18	1.12	1.37	0.22	1.22
T_5	1.41	0.16	1.28	1.41	0.21	1.28	1.55	0.29	1.40	1.52	0.29	1.46
SEd	0.05	0.04	0.09	0.08	0.02	0.09	0.05	0.02	0.09	0.05	0.02	0.09
CD (p=0.05)	0.10	0.08	0.18	0.16	0.04	0.18	0.10	0.04	0.10	0.10	0.04	0.10
Hybrid expérimental soil												
T_1	1.22	0.14	1.11	1.22	0.14	1.12	1.11	0.10	1.00	1.01	0.18	1.06
T_2	1.31	0.21	1.26	1.51	0.21	1.22	1.52	0.19	1.41	1.42	0.22	1.41
T_3	1.28	0.20	1.14	1.42	0.19	1.01	1.50	0.18	1.31	1.40	0.18	1.21
T_4	1.21	0.18	1.28	1.36	0.16	1.11	1.49	0.20	1.00	1.39	0.20	1.10
T_5	1.34	0.21	1.31	1.55	0.22	1.25	1.56	0.22	1.44	1.56	0.28	1.48
SEd	0.06	0.05	0.10	1.09	0.03	0.10	0.06	0.02	0.08	0.06	0.02	0.08
CD (p=0.05)	0.12	0.10	0.20	0.18	0.06	0.20	0.11	0.04	0.16	0.11	0.04	0.16

Salient findings

Application of TNAU Cocomix continuously over four years was comparable to recommended NPK fertilizers in enhancing the yield attributes and nut yield of both tall and hybrid coconuts. Among the different split, application of cocomix the application at the rate of once a month for the first year and subsequently once in three months (4 equal splits) recorded the highest mean annual nut yield of 121 and 155 nuts / palm in tall and hybrid coconut respectively. However, no marked variation was observed with respect to nutrient availability in soil and index leaf tissue nutrient content due to application of cocomix at various intervals in equal splits. Though there was a decline in nut yield and soil nutrient status during the initial years of experimentation, the organic cocomix over the years became comparable to recommended package. However, the organic cocomix was superior over recommended package in enhancing the soil microbial population and enzyme activity.

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