

INFLUENCE OF WASTE RECYCLING ON NUTRIENT STATUS OF THE SOIL IN HIGH DENSITY MULTISPECIES CROPPING SYSTEM

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ABSTRACT

A project was initiated at Central Plantation Crops Research Institute, Regional Station, Vittal, India during 1999 in an existing areca garden with the objective to assess the biomass availability and feasibility of recycling into the system. The main crop was arecanut and other crops in the system were cocoa, clove, coffee, banana and pepper. The areca was planted in 1965, cocoa and clove in 1983 and the other crops in 1999. There were four treatments *viz.*, control (only organic matter recycling (OMR)), 1/3rd of the recommended chemical fertilizer and OMR, 2/3rd of the recommended chemical fertilizer and OMR and full chemical fertilizer and OMR. The treatments were replicated five times. The wastes available from different crops were collected and they were converted into compost using earthworms. The total recyclable biomass through the waste materials from the cropping system was recorded as about 7.7 t/ha/year from areca, cocoa and clove. The materials were converted into compost using earthworms with 80 per cent recovery. The soil was analysed for organic carbon, mineralisable nitrogen, phosphorus and potash. There was an increase in the organic carbon, nitrogen, phosphorus and potassium content in the soil after the application of compost. The increase was to the extent of about 30%. Thus recycling of the wastes available garden has improved the nutrient content of the soil. Thus in the present day of scarce availability of organic materials from external sources, recycling of the available wastes from the existing gardens especially in arecanut based cropping systems would be an important practice for sustainable agriculture.

INTRODUCTION

Arecanut (*Areca catechu* L.) is an important commercial crop being grown in humid tropics of India. It is generally grown in laterite soils of acidic nature and low nutrient retention capacity. These soils are rich in secondary forms of iron, aluminium or both, poor in humus and either hard or subjected to hardening. The constraints in these soils for successful raising of crops are deficiency of phosphorus, nitrogen, potassium, sulphur, magnesium and calcium and aluminium toxicity. The high content of reactive iron and aluminium in these soils fixes the applied water-soluble phosphorus. By following proper nutrient management practices these soils can be made productive. One of the important practices to improve the fertility and productivity of these soils is application of more organics.

Wider spacing and the rooting pattern of arecanut allow growing of mixed crops in the garden. Pepper, banana, cocoa and few other crops were found economical in arecanut gardens (Muralidharan, 1980; Nair, 1982; Shama Bhat, 1988; Khader *et al.*, 1992). Further studies showed that more than one crop can be grown simultaneously which is found economical and the system is called as High Density Multi Species Cropping System (Bavappa *et al.*, 1986 and Bhat *et al.*, 1999). These

systems need lot of nutrients to be applied for better productivity. Use of chemical fertilizers, which played vital role in the green revolution of India in 1960's, was found to deteriorate the soil health in long run (Acharya *et al.*, 1988). This was attributed to reduced application of organic matter to the soil. Organic matter applied to soil was found to increase the nutrient status of the soil. One of the reasons for the reduced organic matter application, which can maintain the soil health is lack of availability of organic matter due to increase in area under crop cultivation. Thus it was felt that recycling of the wastes available from the existing garden would be a better proposition for organic matter application. The wastes from one hectare of arecanut plantation could meet 50% of N, 32% of P and 26% of K requirement of the crop by converting it into vermicompost (Chowdappa *et al.*, 1999). When compared to the sole crop of arecanut, the availability of wastes from the cropping system will be much higher. The available biomass could be recycled back into the system. The study was conducted to study the influence of recycling of the biomass on the soil nutrient status in the cropping system.

MATERIALS AND METHODS

The experiment was initiated at Central Plantation Crops Research Institute, Regional

Waste recycling in multispecies cropping system

Station, Vittal, India during 1999 in an existing areca garden. The place is situated at 91 m above MSL. The place is characterized by warm humid climate with a mean annual rainfall of 3500 mm and a mean temperature ranging from 19°C (minimum) to 36°C (maximum). The soil of the experimental site was laterite with a pH of 5.25, 1.3% organic carbon, 42 ppm N, 15.0 ppm P, 56.8 ppm K. The cropping system involved arecanut (base crop), cocoa, clove, banana, coffee and pepper (Fig. 1). Each treatment had 18 arecanut, 3 cocoa, 3 clove, 18 pepper, 6 banana and 12 coffee plants. The areca was planted in 1965, cocoa and clove in 1983 and other crops in 1999. The recommended dose of fertilizer for the crops is given in Table 1. There were four treatments replicated five times. The treatments included (i) control (only organic matter recycling (OMR)) (ii) 1/3rd of the recommended chemical fertilizer and OMR, (iii) 2/3rd of the recommended chemical fertilizer and OMR and (iv) full chemical fertilizer and OMR. The chemical fertilizers were applied in two splits - 2/3rd in September after opening the basin of the trees and 1/3rd in May with forking and mixing in the soil. The waste material collected from the garden from each treatment was separately converted into vermicompost and distributed among the crops during September in the same treatment. The yield data of different crops were recorded. The soil was analysed for available nutrients *viz.*, nitrogen, phosphorus and potassium following standard procedures. The soil samples were collected separately from the basins of arecanut, cocoa and clove only as they were in bearing stage before monsoon. The data presented are analysed after two years of starting of the experiment.

Table 1. Recommended fertilizer levels for different crops in the system

Crop	Nitrogen (g/tree)	Phosphorus (g/tree)	Potassium (g/tree)
Arecanut	100	40	140
Cocoa	100	40	140
Pepper	100	40	140
Clove	300	250	750
Banana	160	160	320
Coffee	30	20	30

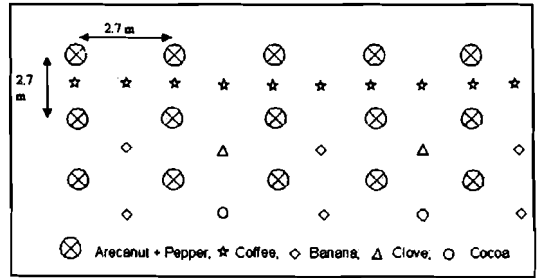


Fig. 1. Layout of the cropping system

RESULTS AND DISCUSSION

Nutrient supply

The total recyclable biomass obtained from the treatments varied from 6.9 to 7.7 t/ha. These wastes were converted into compost using earthworms with a conversion efficiency of about 80%. Each plant was given 1.5-2.0 kg of vermicompost. The nutrient content of the compost was found to be 1.71% N, 0.21% P and 0.43% K. The nutrient applied through vermicompost was equivalent to about 30, 7 and 5% of total nitrogen, phosphorus and potash requirement of the system. The high potash requirement of clove and the less recyclable biomass from clove is responsible for low potash replacement. The total quantity of nutrients supplied to the system is presented in Table 2. It was reported earlier that from one hectare of areca garden the waste recycling could meet 50% of N, 32% of P and 26% of K requirement of the crop by converting it into vermicompost (Chowdappa *et al.*, 1999). Utilization of wastes in other crops like coconut also has been reported where it is possible to plough back 20.7 kg N, 10.5 kg P₂O₅ and 30.8 kg K₂O per ha annually (Jothimani, 1994).

Soil nutrient status

A substantial increase in organic carbon content and available N, P and K content was noticed with recycling of wastes in the cropping system as compared to the initial values (Table 3, 4 and 5). The analysis of soil for major nutrients and organic carbon indicated difference due to various treatments. The organic carbon content was not significantly different among various treatments under arecanut and cocoa. But under clove the organic carbon content increased up to 2/3rd chemical fertilizer application and then decreased. This may be due to enhanced

decomposition process with higher level of chemical fertilizer application to clove, which reduced the organic carbon content in the soil. So when the quantity of compost is higher as compared to the chemical fertilizer, there was increase in organic carbon content. A similar result of increased organic carbon content in coconut-cocoa system has been observed where 818 to 1785 kg of cocoa litter fall can be recycled annually (Varghese *et al.*, 1978). The available N, P and K were more up to 2/3rd fertilizer application with organic matter recycling and further increase in

the chemical fertilizer did not increase the availability substantially except that of potassium under clove. The higher application of potassium resulted in higher available potassium. This may be due to the increased efficiency of the nutrient release even at lower levels of fertilizers in the presence of compost. Such an increased efficiency in the nutrient release in the arecanut basins due to incorporation of organic manures has been reported by Bopaiah and Bhat (1981). They attributed this increase to the proliferation of microbes in the rhizosphere of arecanut palms.

Table 2. Nutrients added to the system through organic and inorganic sources in different treatments

Treatments	Inorganic (kg/ha)			Organic (kg/ha)		
	N	P	K	N	P	K
Control + OMR	-	-	-	94.3	11.6	23.7
1/3 rd of fertilizer dose + OMR	105.5	64.5	177.1	93.7	11.5	23.5
2/3 rd of fertilizer dose + OMR	211.0	129.0	354.2	98.8	12.1	24.8
100% of fertilizer dose + OMR	316.5	193.5	531.3	105.3	12.9	26.5

Table 3. Organic carbon, mineralisable nitrogen, available phosphorus and potassium content in soil - Arecanut (2001)

Treatment	Organic carbon (%)		Mineralisable N (ppm)		Phosphorus (ppm)		Potassium (ppm)	
	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
	Control + OMR	2.00	1.39	87.79	75.41	36.90	6.86	110.25
1/3 rd of fertilizer dose + OMR	1.88	1.31	85.54	83.29	73.95	8.84	197.25	154.00
2/3 rd of fertilizer dose + OMR	1.92	1.33	83.29	68.66	33.03	6.77	159.50	114.25
100% of fertilizer dose + OMR	1.94	1.23	87.79	68.66	42.11	7.67	193.50	156.25
S.Em.±	0.09	0.10	4.13	2.44	9.20	1.32	24.79	12.54
C.D.(5%)	NS	NS	NS	7.52	28.35	NS	NS	38.64

Table 4. Organic carbon, mineralisable nitrogen, available phosphorus and potassium content in soil - Cocoa (2001)

Treatment	Organic carbon (%)		Mineralisable N (ppm)		Phosphorus (ppm)		Potassium (ppm)	
	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
	Control + OMR	1.59	1.07	69.79	58.53	15.77	3.58	94.50
1/3 rd of fertilizer dose + OMR	1.67	1.06	75.41	63.03	14.75	3.15	102.75	64.25
2/3 rd of fertilizer dose + OMR	1.59	1.14	73.16	49.53	19.36	2.40	102.75	75.25
100% of fertilizer dose + OMR	2.02	1.14	76.54	67.53	23.16	2.56	112.25	90.00
S.Em.±	0.15	0.11	2.89	3.94	1.89	0.72	10.43	12.14
C.D.(5%)	NS	NS	NS	12.14	5.82	NS	NS	NS

Table 5. Organic carbon, mineralisable nitrogen, available phosphorus and potassium content in soil - Clove (2001)

Treatment	Organic carbon (%)		Mineralisable N (ppm)		Phosphorus (ppm)		Potassium (ppm)	
	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
Control + OMR	1.65	1.07	77.66	58.53	31.50	3.69	91.25	89.50
1/3 rd of fertilizer dose + OMR	1.49	1.03	70.91	61.90	24.01	2.40	179.00	188.50
2/3 rd of fertilizer dose + OMR	1.82	1.12	78.79	67.54	28.29	3.31	197.50	295.00
100% of fertilizer dose + OMR	1.35	0.97	82.17	86.67	29.89	3.20	383.00	450.50
S.Em.±	0.07	0.09	3.99	10.30	4.99	1.18	29.97	28.13
C.D.(5%)	0.21	NS	NS	NS	NS	NS	92.35	86.68

CONCLUSIONS

In these days of scarce availability of organic sources, recycling of the wastes available in the cropping system holds a better option. Areca based cropping system can produce about 7.7 t/ha/annum of wastes, which can be profitably recycled. The wastes when converted into compost using earthworms can replace the chemical fertilizers substantially. The recycling of wastes added the organic matter to the soil thereby increasing the organic carbon and available nutrient contents.

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