Recycling of wastes in areca based cropping system

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Abstract

Continuous use of chemical fertilizers has deteriorated the soil health and made the use of organic matter essential to restore the soil health and productivity. The availability of organic matter is again a problem because of the increase in area under crop cultivation. Thus recycling of the available organic wastes from the existing gardens especially in perennial crops gets more importance. 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 applying them back 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 biomass through the waste materials from the cropping system was recorded as 9.73 t/ha/year from areca, cocoa and clove. When these materials were converted into compost using earthworms a recovery percentage of 82 was obtained. The soil was analysed for organic carbon, mineralisable nitrogen, phosphorus and potash. There was an increase in the organic carbon, 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. The yield of the crops was recorded and it was found that combination of chemical and organic sources of nutrients is the best for obtaining sustainable yield. Application of only organics did not show significant increase in the yield. All the recorded parameters showed improvement with 2/3rd of recommended chemical fertilizer and OMR. Thus in the present context 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.

Keywords: arecanut, cropping system, organic matter recycling, composting

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. Wider spacing and the rooting pattern of arecanut allows 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). 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). 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. Thus the study was conducted to assess the biomass availability and feasibility of applying them back into the system.

Materials and Methods

The experiment was initiated at Central Plantation Crops Research Institute, Regional 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 3,500 mm and a mean temperature ranging from 19ºC (minimum) to 36ºC (maximum). The soil of the experimental site was laterite with a pH of 5.25, 1.3% OC, 42 ppm N, 15.0 ppm P, 56.8 ppm K. The cropping system involved arecanut (base crop), cocoa, clove, banana, coffee and pepper (Figure 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 biomass produced from the system is recorded and it was converted into vermicompost using earthworms. The yield data of different crops were recorded. The soil was analysed for available nutrients under different crops.

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

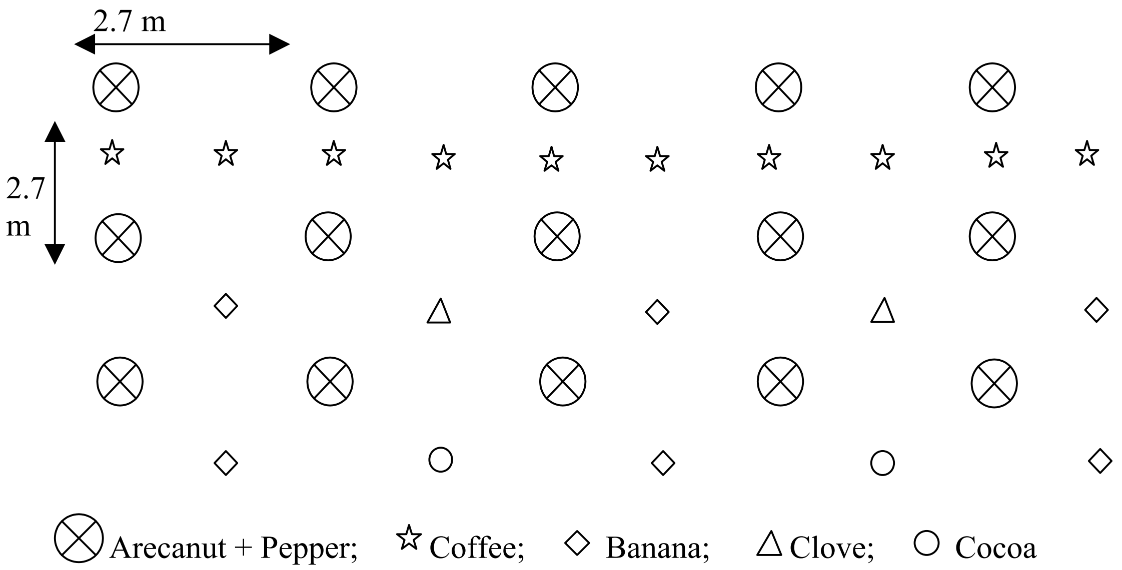

Figure1 Layout of the cropping system.

Results and Discussion

Biomass production and nutrient supply

The biomass produced in the system is presented in Figure 2. The system produced a total of 2455.68 kg of waste materials from arecanut, cocoa and clove. Since other crops were just planted the biomass from those crops were negligible. The total biomass was converted into compost by using earthworms. Finally about 2013.66 kg of vermicompost was produced with a conversion efficiency of 82%. This was applied to all the crops in the system @ 2 kg/plant. This two kg of vermicompost supplied 30 g N, 3 g P_2O_5 and 13 g K_2O/plant. The compost supplied almost 1/3rd requirement of arecanut, cocoa and pepper and full dose of coffee. Thus we can conclude that by recycling the wastes from the gardens, a part of the chemical fertilizer can be replaced, which will save money and improve the soil health. 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 P_2O_5 and 30.8 kg K_2O per ha annually (Jothimani, 1994).

Nutrient content in the soil

The analysis of soil for major nutrients and organic carbon indicated difference due to various treatments. The actual nutrients added to the system are presented in Table 3. The soil samples were collected separately from the basins of arecanut, cocoa and clove only as they were in bearing stage. The organic carbon content was higher with lower chemical fertilizer application and at lower depths in all the crops. This may be due to enhanced decomposition process with higher level of chemical fertilizer, 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 1,785 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. 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.

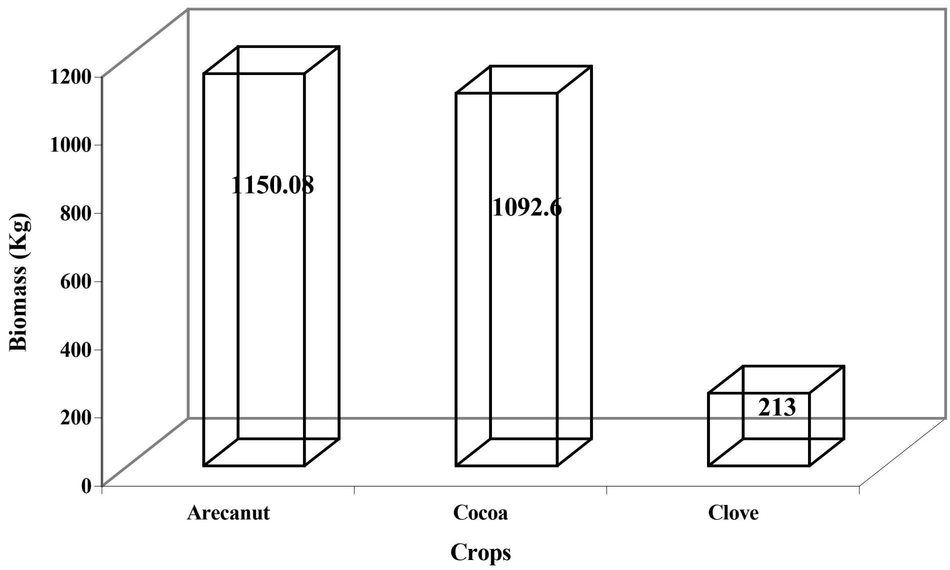

Figure 2 Available biomass from the system.

Yield of the crops

The yield data collected from the system is presented in Table 2. The coffee and pepper were just flowered and banana started yielding in the second year. There was no significant difference between different treatments. But there was an increasing trend with increase in fertilizer level. But the increase in yield after 2/3rd recommended level of fertilizer and organic matter recycling was not substantial. It was seen from Table 3. that the vermicompost has supplied more than 1/3rd of the nitrogen requirement of arecanut, pepper and cocoa. In an earlier high density experiment which included arecanut-pepper-banana-cocoa, it was found that application of 2/3rd of the recommended dose of fertilizer was sufficient for sustainable yield of the crops (Bhat Ravi, personnel communication).

Table 2 Yield of different crops in the system.

Treatment*	1999-2000				2000-2001			
	Arecanut	Cocoa	Clove	Banana	Arecanut	Cocoa	Clove	Banana
1	1.46	0.96	1.35	-	1.34	2.98	0.50	5.78
2	1.42	1.11	1.34	-	1.29	2.88	1.00	6.17
3	1.53	1.26	1.11	-	1.38	3.42	0.50	6.32
4	1.49	1.24	1.28	-	1.47	2.81	0.54	8.88

(1) Control (only organic matter recycling (OMR))
(2) 1/3rd of the recommended chemical fertilizer and OMR
(3) 2/3rd of the recommended chemical fertilizer and OMR
(4) Full chemical fertilizer and OMR.

Table 3 Nutrients added to the soil through inorganics and organic sources in a year in the system.

Treatments	Inorganics (kg/plot)			Organics (kg/plot)		
	N	P	K	N	P	K
Control + OMR	-	-	-	1.80	0.32	0.78
1/3rd of fertilizer dose + OMR	1.64	1.01	2.77	1.80	0.32	0.78
2/3rd of fertilizer dose + OMR	3.27	2.01	5.55	1.80	0.32	0.78
100% of fertilizer dose + OMR	4.91	3.02	8.32	1.80	0.32	0.78

Table 4 Organic carbon content in the soil as influenced by different treatments under different crops.

Treatments	Arecanut		Cocoa		Clove	
	0-30 cm	30-60 cm	0-30 cm	30-60 cm	0-30 cm	30-60 cm
Control + OMR	1.89	1.20	1.91	1.58	1.73	1.27
1/3rd of fertilizer dose + OMR	1.75	1.20	1.56	1.37	1.74	1.19
2/3rd of fertilizer dose + OMR	1.92	1.49	1.74	1.31	1.81	1.36
100% of fertilizer dose + OMR	1.62	1.50	1.53	1.25	1.75	1.25

Table 5 Mineralisable N, Phosphorus and potassium content in soil – Arecanut (2000).

Treatment	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
Control + OMR	95.67	88.67	58.19	7.98	118.00	81.25
1/3rd of fertilizer dose + OMR	99.17	99.16	62.16	9.31	144.92	127.38
2/3rd of fertilizer dose + OMR	100.70	107.60	74.92	20.71	168.90	133.33
100% of fertilizer dose + OMR	99.30	95.67	83.65	29.71	163.99	120.28

Table 6 Mineralisable N, phosphorus and potassium content in soil – Cocoa (2000).

Treatment	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
Control + OMR	98	84	15.29	1.60	82.14	64.43
1/3rd of fertilizer dose + OMR	70	77	20.90	5.29	129.84	90.03
2/3rd of fertilizer dose + OMR	42	56	27.27	9.41	143.12	94.79
100% of fertilizer dose + OMR	28	56	25.06	2.66	145.98	94.79

Table 7 Phosphorus and potassium content in soil – Clove (2000).

Treatment	Phosphorus (ppm)		Potassium (ppm)	
	0-30 cm	30-60 cm	0-30 cm	30-60 cm
Control + OMR	65.25	8.07	175.60	70.76
1/3rd of fertilizer dose + OMR	46.37	2.99	190.48	172.51
2/3rd of fertilizer dose + OMR	38.40	3.89	221.17	241.74
100% of fertilizer dose + OMR	30.29	4.02	221.84	237.61

Conclusions

In these days of scarce availability of organic sources, recycling of the wastes available wastes in the cropping system. Areca based cropping system can produce about 8.73 t/ha/annum of wastes, which can be profitably recycled. The wastes when converted into compost using earthworms can replace the chemical substantially. The recycling of wastes added the organic matter to the soil thereby increasing the organic carbon and available nutrient contents. The yield of the crops was not negatively affected by reducing the chemical fertilizer with the addition of composted wastes.

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