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SYSTEM MANAGEMENT FOR SEQUENTIAL CROPPING OF SWEET POTATO– BANANA- SWEET POTATO IN COCONUT GARDENS OF COASTAL ECOSYSTEMS

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ABSTRACT

Coastal ecosystems in Kerala are dominated by coconut based cropping systems and it has cultural roots in our history. The present investigation entitled "System management for sequential cropping of sweet potato – banana - sweet potato in coconut gardens of coastal ecosystems" was conducted at the College of Agriculture, Padannakkad, Kasaragod during 2012-2016. The different nutrient doses tested for coconut were full dose, *i.e*., 500:320:1200 g NPK ha^{-1} year^{-1} (C_1), 2/3rd of the full dose (C_2), 1/3rd of the full dose (C_3) and organic basin management (C_4) and for sequential crops, full dose (100 %), *i.e*., 75 : 50 : 75 kg NPK ha^{-1} year^{-1} for sweet potato and 200 : 200 : 400 g plant^{-1} for banana (S1) and 75 % of full dose (S_2). Significant influence of nutrient doses of the main crop was evident on nut production and application of 2/3rd of the recommended dose resulted in the highest nut production during 1st, 2nd and 3rd year. Organic basin management significantly improved tuber yield in sweet potato during 1st and 3rd year. Application of full dose of nutrients increased tuber yield of sweet potato during 1st and 3rd year and bunch weight of banana during 2nd year. From the results it is concluded that integration of 2/3rd of the recommended dose of nutrients for coconut and 100 per cent for the sequential crops was necessary for maximizing total gross income in coconut based sweet potato – njalipoovan banana – sweet potato sequential cropping system.

KEYWORDS: Cropping Systems, Sequential Crops, Nutrient Management, Coconut

Coconut based cropping systems prevalent in coastal areas are poor in soil nutrient status, biological activity and other properties like poor water holding capacity, excessive infiltration, rapid leaching loss of nutrients. So adoption of suitable intercrops or sequential crops will favour the enrichment of soil resource base and soil properties through adequate supply of inputs like fertilizers, organic manures, plant protection chemicals etc.

Sustainable agriculture incorporates the idea of system approach. Compared to single units, efficient utilization of inputs are possible in systems. Coconut based systems are suitable to implement the sustainable approaches. So this will help to reduce the input use and a sustainable balance may be created between physico-chemical and biological properties of soil. In this context, an investigation entitled "System management for sequential cropping of sweet potato – banana - sweet potato in coconut gardens of coastal ecosystems" was conducted at the College of Agriculture, Padannakkad, Kasaragod during 2012- 2016 to develop a system based cost effective eco-friendly nutrient management practices in coconut based sequential intercropping systems of coastal ecosystems.

MATERIALS AND METHODS

The four year study was conducted in factorial RBD with three replications. Middle aged WCT coconut palms spaced at 7.6 m x 7.6 m were selected for the study. Sweet potato variety Kanhangad local, banana variety njalipoovan and sweet potato were raised as sequential crops during first, second and third year respectively. The treatments consisted of combinations of 4 levels of NPK for the main crop and two levels of NPK for component crops. The different nutrient doses tested for coconut were full dose, *i.e*., 500 : 320 : 1200 g NPK ha^{-1} year^{-1} (C1), 2/3rd of the full dose (C2), 1/3rd of the full dose (C3) and organic basin management(C4) and for sequential crops, full dose (100 %), *i.e*., 75 : 50 : 75 kg NPK ha^{-1} year^{-1}for sweet potato and 200 : 200 : 400 g plant^{-1} for banana (S1) and 75 % of full dose (S2). The experiment was carried out as part of EAP under the ongoing Kerala State Planning Board project. Four year data were collected and pooled analysis was carried out for coconut. For the sequential crops data were collected for a period of three years. Organic basin management (C4) for coconut consisted of green manuring *in situ* with the receipt of pre-monsoon showers, recycling of palm wastes after every harvest and application of FYM @ 50 kg + ash 5 kg + Azospirillum 25 g palm^{-1} year^{-1}.

Recommended doses of organic manures were also applied along with treatments before the application of chemical fertilizers. For basin management plots, ash (2.5 kg palm^{-1}) and cattle manure (25 kg palm^{-1}) were applied in May. Cowpea seeds (20 g palm^{-1}) were sown in the basins at the time of pre-monsoon showers for *in-situ* green manuring and incorporated 45 days after sowing. Azospirillum (12.5 g plant^{-1}) was also applied along with

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cowdung slurry in June. The same pattern was followed during North-East monsoon in September. After every coconut harvest, recycling of palm waste was done with the available bio wastes. Sprinkler method of irrigation was practiced for the sequential cropping system.

RESULTS AND DISCUSSION

Nutrient dose for the main crop significantly influenced the productivity of coconut and application of $2/3^{rd}$ of the recommended dose resulted in highest nut production during first, second and third year. During fourth year, $1/3^{rd}$ of the recommended dose was sufficient to significantly enhance nut production. Pooled analysis of the data also revealed the significance of $2/3^{rd}$ of the recommended dose in significantly increasing nut production and the per cent increase over organic basin management was 28.49 per cent (Table-1).

Table 1: Productivity of coconut as influenced by nutrient management and sequential cropping of sweet potato – banana – sweet potato

Treatments	First year	Second year	Third year	Fourth year	Pooled Mean
Factor A. Nutrient dose for the main crop (Coconut)					
C_1	89.83	99.33	96.00	105.17	97.58
C_2	91.83	110.66	116.83	94.00	103.33
C_3	62.33	75.33	101.50	113.83	88.25
C_4	68.00	66.00	85.16	102.50	80.42
SE	9.012	10.164	8.385	7.75	
CD (0.05)	19.329	21.799	17.985	16.63	
Factor B. Nutrient dose for the intercrop					
S_1	73.91	87.33	99.66	104.42	91.33
S_2	82.08	88.33	100.08	103.33	93.46
SE	6.373	7.187	5.93	5.48	
CD (0.05)	NS	NS	NS	NS	
Interaction effects (A x B)					
C_1 S_1	85.00	91.33	91.33	117.33	96.25
C_1 S_2	94.66	107.33	100.66	93.00	98.92
C_2 S_1	87.33	119.33	119.00	100.33	106.50
C_2 S_2	96.33	102.00	114.66	87.67	100.17
C_3 S_1	57.33	76.66	106.00	103.00	85.75
C_3 S_2	67.33	74.00	97.00	124.67	90.75
C_4 S_1	66.00	62.00	82.33	97.00	76.83
C_4 S_2	70.00	70.00	88.00	108.00	84.00
SE	12.745	14.374	11.86	10.96	
CD (0.05)	27.335	30.828	25.435	23.51	

Nutrient dose for the intercrop did not significantly influence the productivity of coconut throughout the four years of experimentation. Higher productivity was observed when the nutrient dose was reduced by 25 per cent, *i.e.*, application of 75 per cent of the recommended nutrient dose during 1^{st}, 2^{nd} and 3^{rd} year. A similar trend was observed with respect to pooled mean as well (Table 1).

Interaction effects indicated the superior performance of the treatment combination C_2 S_2 during first year, C_2 S_1 during 2^{nd} and 3^{rd} years and C_3 S_2 during 4^{th} year (Table 1).

It is concluded that integrated application of the $2/3^{rd}$ of the recommended dose of nutrients for coconut and 100 per cent for the sequential crops (sweet potato-first year; banana – second year; and sweet potato-third year) was beneficial for increasing nut yield in coconut which was 38.62 per cent higher compared to organic basin management of coconut combined with 100 per cent of the recommended dose for the sequential crops (Table 1).

Coconut, being an exhaustive crop depletes large quantities of plant nutrients to the tune of 20 to 174 kg N, 2.5 to 20.0 kg P_2O_5 and 35 to 49 kg K_2O ha^{-1} through nuts, fronds, trunk, bunch, spathe, etc (Ouverier and Ochs ; 1978). Consequently, it removes a considerable amount of nutrients from the soil within few years. The nutritional balance is essential to achieve high nut productivity. Hence nutrients supplied through inorganic fertilizers were

sufficient to meet the requirements of both the main and intercrop, which is resulted in an increase in the yield of coconut and sequential crops.

Significantly higher tuber yield in sweet potato was observed during 1st and 3rd year (7.67 t ha^{-1} and 13.5 t ha^{-1}) when organic basin management was practiced for coconut. Application of 100 per cent of the recommended dose of nutrients for coconut recorded lesser bunch yield of banana during second year whereas the other three treatments were on par (Table 2).

Table 2: Nutrient management and sequential cropping on biomass production of sequential crops (sweet potato – banana – sweet potato) in coconut gardens

Treatments	First year sweet potato (t ha^{-1})	Second year Njalipoovan (kg $bunch^{-1}$)		Third year sweet potato (t ha^{-1})
	Tuber	Pseudo stem	Bunch	Tuber
Factor A. Nutrient dose for the main crop (coconut)				
C_1	4.83	22.55	5.832	7.95
C_2	5.58	23.63	7.198	9.12
C_3	7.17	21.63	7.195	10.94
C_4	7.67	21.52	6.935	13.51
SE	0.95	1.808	0.416	1.57
CD (0.05)	2.04	NS	0.893	3.36
Factor B. Nutrient dose for the intercrop				
S_1	6.83	22.60	7.094	10.85
S_2	5.79	22.06	6.486	9.91
SE	0.68	1.278	0.294	1.11
CD (0.05)	NS	NS	NS	NS
Interaction effects (A x B)				
$C_1 S_1$	5.67	23.16	6.397	8.91
$C_1 S_2$	4.00	21.94	5.267	6.99
$C_2 S_1$	5.83	23.10	7.143	10.99
$C_2 S_2$	5.33	24.16	7.253	7.25
$C_3 S_1$	7.50	21.26	7.197	10.97
$C_3 S_2$	6.83	21.99	7.193	10.91
$C_4 S_1$	8.33	22.88	7.640	12.53
$C_4 S_2$	7.00	20.16	6.230	14.50
SE	1.35	2.557	0.5885	2.97
CD (0.05)	2.89	NS	1.262	6.38

Though not significant, application of 100 per cent of the recommended dose of nutrients increased tuber yield of sweet potato during 1st and 3rd year and pseudostem and bunch weight of banana during 2nd year (Table 2).

Interaction effects indicated the significantly superior performance of sweet potato during 1st year under organic basin management for coconut was integrated with 100 per cent of the recommended dose for the sequential crops (Table 2).

Organic management of coconut basin was beneficial for improving soil resource base in several ways for achieving higher productivity. Organic matter supplied by the manures to the soil keeps the plant nutrients bound on it and releases to the plant slowly, meeting the everlasting requirements. Similar results were reported by Krishnakumar et al. (2011), Maheswarappa et al. (2013) and CPCRI (2014).

During first year, the highest gross income and BCR of 2,77,227 and 2.46 were recorded when 2/3rd and 75 per cent of the recommended doses of nutrients were given to coconut and sweet potato (Table 3 and 4). The trend was similar during 2nd year (5,63,876 and 3.24) and there was significant difference (Table 3 and 4). However, during 3rd year, the highest gross income of

3,84,589 and BCR of 3.71 were recorded under organic basin management (Table 3 and 4). During 4th year, 1/3rd of the recommended dose registered higher gross income and BCR (Table 3 and 4). These results were supported by earlier research findings of Anilkumar et al. (2017a) in turmeric- banana- turmeric sequential cropping system and Anilkumar et al. (2017b) in ginger- banana- ginger system in coconut gardens.

The total gross income of 14,22,067 was recorded when coconut was given 2/3rd of the recommended dose (Table 5). Though not significant, 75 per cent of the recommended dose of nutrients for the sequential crops registered the highest gross income of 2,59,810 (Table 3) and BCR of 2.37 during 1st year (Table 4). The trend was almost similar with respect to BCR during 2nd year (Table 4). During 3rd and 4th year, 100 per cent of the recommended dose for the sequential crops gave higher gross income and BCR (Table 3 and 4). Analysis of the data over the four years indicated the superior performance of 100 per cent of the recommended dose of nutrients for the sequential crops (13,63,784) (Table 5). Among the different treatment combinations, C_2S_2 and C_4S_1 recorded the highest gross income and BCR respectively during 1st year (Table 3 and 4). During 2nd year, C_2S_2 registered significantly higher gross income and BCR (Table 3 and 4). However, during 3rd year, C_2S_1 and C_4S_2 recorded higher gross income and BCR respectively. C_3S_2 recorded higher gross income and BCR during 4th year (Table 3 and 4).

Present study reveals the importance of integrated nutrient management in coconut gardens. Integrated management involving 2/3rd of the recommended dose of nutrients for coconut and 100 per cent for the sequential crops was necessary for maximizing total gross income in coconut based sweet potato – njalipoovan banana – sweet potato sequential cropping system. The results reveal the importance of efficient use of nutrients in coconut gardens through enhanced productivity and profitability.

Table 3: Economic analysis (Income in □ ha^{-1}) of nutrient management and sequential cropping involving sweet potato – banana (njalipoovan) – sweet potato in coconut garden over four years

Treatments	First year			Second year			Third year			Fourth year
	Coconut	Sweet potato	Total	Coconut	Njalipoovan	Total	Coconut	Sweet potato	Total	Coconut
Factor A. Nutrient dose for the main crop (Coconut)										
C_1	189263	72500	261763	209278	272008	481286	207522	119250	326772	221568
C_2	193477	83750	277227	233155	330720	563876	246147	136775	382922	198042
C_3	131325	107500	238825	158714	330577	489291	213843	164100	377943	239827
C_4	143264	115000	258264	139050	319407	458458	181889	202700	384589	215950
SE	18986.94	14295.11	26232.87	21412.82	17875.88	17875.88	15209.88	23499.27	23752.91	16332.14
CD (0.05)	40723.00	30660.00	NS	45926.00	38340.00	38340.00	32622.00	50401.00	50945.00	35029.00
Factor B. Nutrient dose for the intercrop										
S_1	155729	102500	258229	183996	326245	510241	212614	162712	375326	219988
S_2	172935	86875	259810	186103	300111	486214	212087	148700	360787	217705
SE	13425.56	10108.22	18549.14	15141.34	12640.40	13055.36	10754	16616.55	16796.05	11548.45
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction effects (A x B)										
C_1 S_1	179080	85000	264080	192423	296280	488703	202957	133600	336557	247201
C_1 S_2	199446	60000	259446	226133	247736	473869	212087	104900	316987	195935
C_2 S_1	183996	87500	271496	251415	328357	579772	250712	164850	415562	211385
C_2 S_2	202957	80000	282957	214896	333083	547979	241583	108700	350283	184698
C_3 S_1	120791	112500	233291	161523	330648	492172	223323	164500	387823	217003
C_3 S_2	141859	102500	244359	155905	330505	486411	204362	163700	368062	262651
C_4 S_1	139050	125000	264050	130623	349694	480317	173462	187900	361362	204362
C_4 S_2	147478	105000	252478	147478	289120	436598	190316	217500	407816	227537
SE	26851.44	20216.49	37098.97	30283.11	25280.56	26111.30	21510.15	33233.52	33591.67	23097
CD (0.05)	57590.71	43360.14	NS	64950.91	54221.49	56003.26	46134.76	71278.92	72047.07	49538.30

Table 4: Economic analysis (BCR) of nutrient management and sequential cropping involving sweet potato – banana (njalipoovan) – sweet potato in coconut garden over four years

Treatments	First year			Second year			Third year			Fourth year
	Coconut	Sweet potato	Total	Coconut	Njalipoovan	Total	Coconut	Sweet potato	Total	Coconut
Factor A. Nutrient dose for the main crop (Coconut)										
C_1	2.46	1.80	2.23	2.72	2.67	2.69	2.69	2.96	2.79	2.88
C_2	2.67	2.08	2.46	3.22	3.26	3.24	3.40	3.39	3.40	2.73
C_3	1.93	2.67	2.21	2.34	3.26	2.89	3.15	4.08	3.49	3.53
C_4	2.26	2.85	2.49	2.20	3.13	2.78	2.87	5.04	3.71	3.41
SE	0.27	0.35	0.24	0.30	0.17	0.11	0.22	0.58	0.21	0.24
CD (0.05)	0.57	0.76	NS	0.65	0.36	0.23	0.47	1.25	0.46	0.52
Factor B. Nutrient dose for the intercrop										
S_1	2.21	2.51	2.33	2.60	3.04	2.87	3.03	3.99	3.39	3.14
S_2	2.45	2.19	2.37	2.63	3.13	2.92	3.02	3.74	3.30	3.14
SE	0.19	0.25	0.17	0.21	0.12	0.08	0.16	0.41	0.15	0.17
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction effects (A x B)										
C_1 S_1	2.32	2.08	2.24	2.50	2.76	2.65	2.63	3.27	2.86	3.21
C_1 S_2	2.59	1.51	2.22	2.94	2.58	2.74	2.75	2.64	2.71	2.54
C_2 S_1	2.54	2.14	2.40	3.47	3.06	3.23	3.46	4.04	3.67	2.92
C_2 S_2	2.80	2.01	2.52	2.96	3.47	3.25	3.33	2.73	3.12	2.55
C_3 S_1	1.78	2.76	2.14	2.38	3.08	2.81	3.29	4.03	3.57	3.20
C_3 S_2	2.09	2.58	2.27	2.29	3.45	2.97	3.01	4.12	3.42	3.87
C_4 S_1	2.19	3.06	2.54	2.06	3.25	2.81	2.74	4.60	3.47	3.23
C_4 S_2	2.33	2.64	2.45	2.33	3.01	2.74	3.00	5.48	3.96	3.59
SE	0.38	0.50	0.33	0.43	0.24	0.15	0.31	0.83	0.30	0.34
CD (0.05)	0.81	1.07	NS	0.91	0.51	0.33	0.67	1.77	0.65	0.74

Table 5: Economic analysis of nutrient management and sequential cropping involving sweet potato – banana (njalipoovan) – sweet potato in coconut garden over four years

Treatments	Total gross income (Rs. ha^{-1})
Factor A. Nutrient dose for the main crop (Coconut)	
C_1	1291389
C_2	1422067
C_3	1345886
C_4	1317261
Factor B. Nutrient dose for the intercrop	
S_1	1363784
S_2	1324516
Interaction effects (A x B)	
C_1 S_1	1336541
C_1 S_2	1246237
C_2 S_1	1478215
C_2 S_2	1365917
C_3 S_1	1330289
C_3 S_2	1361483
C_4 S_1	1310091
C_4 S_2	1324429

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