Journal of Plantation Crops 20 (Supplement) : 19-24

RESOURCES USE IN ARECANUT BASED HIGH DENSITY MULTISPECIES CROPPING SYSTEM*

K.B. ABDUL KHADER, D. BALASIMHA and N.T. BHAT

Central Plantation Crops Research Institute, Regional Station, Vittal 574 243, Karnataka

ABSTRACT

The productivity of arecanut and six intercrops (coffee, cocoa, clove, pepper, banana and pineapple) in the high density multispecies cropping system showed enhanced returns per unit area. Of the six intercrops tried, five showed shade adaptability. The annual/biennial crops used the airspace and light in the initial years and these crops were gradually removed from the system as canopy of other perennial species developed. The leaf area index of the component crop species was maximum at heights of 2 to 5 meter. On evaluation of soil nutrient status it was observed that there was build up of NPK and there was scope for nutrient recycling.

INTRODUCTION

The crop production depends on the use of resources - light, water and nutrients. There is considerably higher potential for increasing the resources used in perennial based cropping systems (Bavappa and Jacob, 1982). Multiple cropping in arecanut gardens has received attention in the past (Sannamarappa and Muralidharan, 1982). Two high density multispecies cropping models in arecanut and coconut have been laid out in 1983 and preliminary results were reported (Bavappa *et al.*, 1986). The basic objective in high density cropping system is to increase crop productivity per unit land area and efficient resource use. Arecanut transmits up to 40% of light through its canopy when planted with a recommended spacing of 2.7 x 2.7 m and the air spaces under this can be utilized for cultivating suitable crop species. The pattern of light profile within an arecanut canopy and some physiological changes in the intercrop species have been studied earlier (Balasimha, 1989). The results of an experiment on the arecanut based high density multispecies cropping system are presented here.

MATERIALS AND METHODS

The experiment was laid out in 1983 at the CPCRI Regional Station, Vittal (12.25°N, 75.42°S), with six different intercrops viz., cocoa, coffee, clove, pepper, pineapple and banana in one hectare of 17-year old irrigated arecanut plantation. The detailed layout is presented in an earlier paper (Bavappa *et al.*, 1986). The plants were irrigated during dry months through sprinklers of 30 mm water at IW/CPE of 1.0, and the crops were fertilized at recommended levels for each crop. The pre-experimental soil characteristics are given in Table I.

Banana was gradually removed from the system after the third year of planting and pineapple and coffee were removed after the fourth year.

The canopy shape of individual crops was assumed to be in a certain geometric shape and canopy area calculated with suitable formulae. Plant growth char-

Table I. Pre-experimental nutrient levels in the arecanut garden (1983)

Soil depth (cm)	pH	Organic C %	P_2O_5 (ppm)	K_2O (ppm)
Arecanut basin				
0-25	6.7	1.05	60	190
25-50	6.5	0.60	38	158
50-75	6.3	0.45	15	132
Interspace				
0-25	5.7	0.93	20	154
25-50	5.7	0.47	16	126
50-75	5.6	0.42	4	117

* Contribution No. 767, C.P.C.R.I. Kasaragod

acters and biomass estimations were recorded during September every year (Bavappa *et al.*, 1986). The photosynthetically active radiation (PAR) was measured at various heights in different canopies using quantum radio meter during 1984, 1985 and 1988. The stratified leaf area index was also computed from the primary data on destructive samples of the intercrop species and data for 1988 are presented. The nutrient added annually as fertilizers, recycling, rainfall etc. was estimated in 1988. Composite soil samples from 0-25, 25-50 and 50-75 cm depths from basin of crops and interspaces in 1988 i.e., after 5 years of starting the experiment were collected. The estimation of P, K, organic carbon and soil pH was made by methods described by Jackson (1960). Calcium was estimated by using atomic absorption spectrophotometer (Model 2380, Perkin-Elmer).

RESULTS AND DISCUSSION

The data on the biomass and leaf characteristics after 5 years of study are presented in Table II. The dry matter partitioning and harvest index in banana and pineapple showed higher harvest index in banana (0.45) as compared to pineapple (0.26).

The yield of arecanut was monitored since 1983-84 after starting the experiment and the year-wise yield of arecanut, pineapple, banana, coffee, cocoa and pepper are presented in Table III. The response to package was observed from the second year of the treatment. The yield increase appeared to be

Table II. Leaf area and leaf area index of arecanut and intercrops

Crop	Plant population (No./ha)	Total standing Biomass (t/ha^{-1})	Leaf area/plant (m^2)	LAI ($plant^{-1}$)	LAI (ha^{-1})
Arecanut	1300	24.44	17.91	1.97	2.33
Pepper	1300	3.49	24.05	21.86	3.13
Banana	390	2.68	8.71	0.68	0.34
Cocoa	210	3.10	109.93	6.86	2.30
Clove	180	0.61	7.82	1.94	0.14
Coffee	780	0.60	3.93	1.99	0.31

Table III. Yield of different crops (in kg/ha)

Sl. No.	Crops	Year 1984	1985	1986	1987	1988	Remarks
1.	Arecanut (Chali)	1582	2490	4130	3507	3832	
2.	Banana (Fruit)	—	2650	2146	1421.5	390.5	Removed in 1986
3.	Pineapple (Fruit)	—	1263	419	244	427	
4.	Pepper (Dry pepper)	—	—	45	319.5	1418	
5.	Cocoa (Pods)	—	—	71	941	1084	
6.	Coffee (Dry beans)	—	—	10	30.5	68	Removed in 1988
7.	Clove	—	—	—	—	—	

by and large due to the cropping system adopted and the organic matter recycling. As compared to the pre-experimental nutrient levels there was a significant nutrient build up in the arecanut basins especially in the case of P_2O_5 and K_2O. This increase in soil fertility had reflected in increase in yield of arecanut.

Banana was found to be a successful intercrop in the initial years and was removed gradually as it was interfering with the growth of other component crops due to excess shade. The highest yield of 2650 kg of banana was obtained during the second year. Pineapple was removed as it was uneconomical. Among all the inter and mixed crops pepper was found to be one of the highly profitable intercrops in the system. The maximum yield was obtained during 5th year of planting (1418 kg/ha). Though pepper is prone to diseases in arecanut garden, by systematic and regular plant protection measures coupled with approved package of cultural practices as well as gap fillings it could be considered as one of the most successful intercrops.

In the case of cocoa, there was a steady increase in yield since the commencement of bearing. During the 5th year, the yield obtained was 1084 kg. Coffee was removed from the system due to unsatisfactory performance at the lower altitude. Clove had started flowering during the 6th year of planting.

The overall results of the high density cropping system revealed that in arecanut garden there is a better scope for increasing the income per unit area. Another interesting feature is that none of the crops tried affected the yield of arecanut adversely.

Approximately 55-90% of photosynthetically active radiation (PAR) was intercepted by arecanut canopy depending on the season and time of the day (Fig.1). The rest is transmitted and available for the intercrops occupying different heights of the air space. The stratified sampling done during 1988 gave a precise distribution of the LAI at different heights and the levels of transmitted light (Fig. 2).

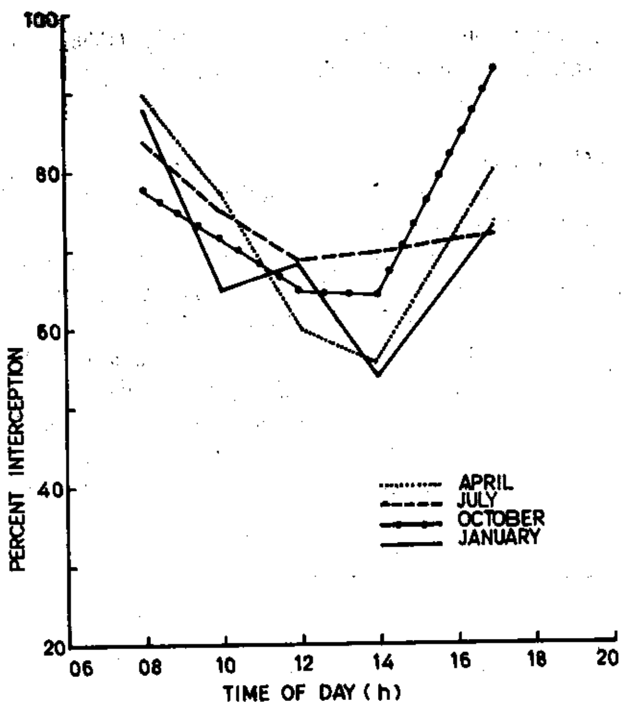

Fig. 1 : Interception of light by arecanut canopy (Mean of 1984 and 1985)

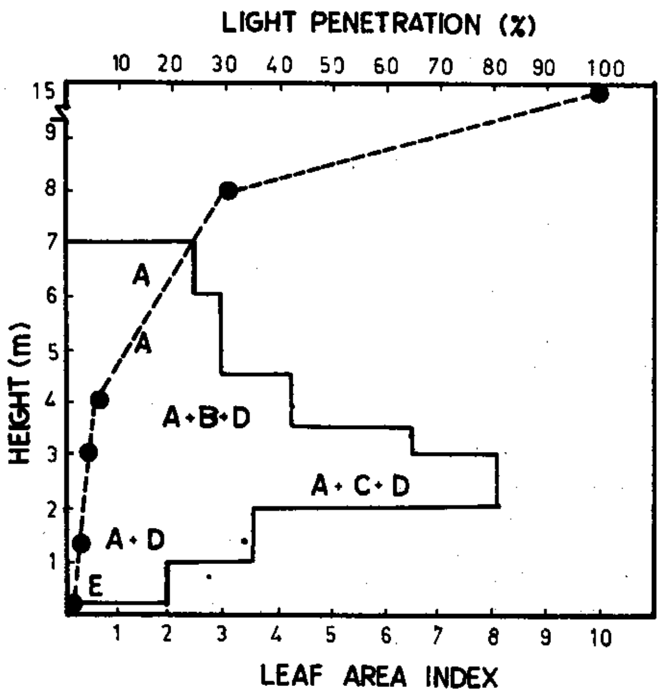

Fig. 2 : Leaf area index and light penetration in the arecanut HDMSCS (1988). Leaf areas represented are of pepper (A), banana (B), cocoa (C), clove (D) and coffee (E)

The component species of a high density cropping system may be complementary in temporal and spatial sense, by exploiting different soil depths and airspace (Trenbath, 1974). The differences in the temporal arrangement viz., the two short duration crops (banana and pineapple) provides for enhanced biomass production during the early years. These have been gradually removed after third year when the canopy of other perennial species have developed substantially to occupy the airspace. The LAI and light profiles at different heights clearly indicate the relative competition for light among the component species. The crop species with leaf areas at higher strata is at an advantage to harness light energy. When such canopies become large enough to intercept most of PAR, the component species at lower levels are at a disadvantage and have to be subsequently removed from the system. The success of any intercrop species also depends on its ability to adopt to shade. Five of the species selected in the present study showed some degree of physiological adaptation (Balasimha, 1989).

The soil nutrient factors were examined in soil layers of monocrop and HDMCS and the data are presented in Table IV. In the HDMCS, the ranges of nutrients were organic C 0.34 - 1.20%, P_2O_5 19 - 1852 ppm, K_2O 108 - 421 ppm and Ca 83 - 193 ppm as compared to organic C 0.57 - 1.95%, P_2O_5 8 - 81 ppm, K_2O 81 - 234 ppm and Ca 215 - 323 ppm in arecanut monocrop during 1988 (Table IV).

There was greater scope for internal recycling of plant nutrients with increased production of crop residues which can be efficiently utilised for moisture conservation and supply of organic matter (Table V).

Due to the favourable pedo-ecological conditions in the soil, the microbial load was high (Bavappa

Table IV. Soil characteristics in HDMSCS and monocrop of arecanut (1988)

Crop	Soil depth (cm)	Soil characters				
		pH	Org C(%)	P_2O_5 (ppm)	K_2O (ppm)	Ca (ppm)
High Density Cropping System						
Arecanut + Pepper	0-25	4.6	1.20	1852	421	191
	25-50	4.3	0.66	152	260	125
	50-75	4.7	0.42	48	221	148
Clove	0-25	4.9	1.02	1700	425	193
	25-50	4.7	0.74	339	289	180
	50-75	4.6	0.34	56	226	174
Coffee	0-25	5.1	1.09	532	108	156
	25-50	5.2	0.73	93	131	178
	50-75	5.5	0.54	24	147	162
Cocoa	0-25	4.5	0.90	498	382	98
	25-50	4.2	0.66	57	241	83
	50-75	5.2	0.37	19	189	131
Interspace of arecanut	0-25	5.3	0.80	127	101	152
	25-50	5.3	0.56	14	189	133
	50-75	5.3	0.34	9	166	305
Arecanut monocrop						
Arecanut	0-25	5.9	1.45	81	234	323
	25-50	6.0	0.87	16	81	239
	50-75	5.9	0.57	8	84	215
Interspace of arecanut	0-25	5.7	0.92	11	46	176
	25-50	5.7	0.67	8	55	192
	50-75	5.9	0.37	6	45	174

Table V. Nutrient budget in the HDMSC system during 1988 (kg/ha)

Components	N	P_2O_5	K_2O
Nutrients added by fertilizers	234	104	330
Nutrients added by organic recycling	101	20	105
Nutrients added by microbial biomass	135	16	—
Total nutrients added	470	140	435
Total nutrients removed	120	20	134

et al., 1986) which finally adds to the nutrient pool. Thus, there was better scope to increase crop productivity, biomass production and nutrient recycling in a high density multispecies cropping system.

ACKNOWLEDGEMENT

We thank Dr. M.K. Nair, Director, Central Plantation Crops Research Institute, Kasaragod, for providing facilities and his keen interest in the project.

REFERENCES

BALASIMHA, D. 1989. Light penetration patterns through arecanut canopy and leaf physiological characteristics of intercrops. *J. Plantn. Crops* **16** (Suppl) : 61-67.

BAVAPPA, K.V.A. and JACOB, V.J. 1982. High intensity multispecies cropping. *World Crops* **34** : 47-50.

BAVAPPA, K.V.A., KAILASAM, C., KHAER, K.B.A., BIDDAPPA, CC., KHAN, H.H., KASTURI BAI, K.V., RAMADASAN, A., SUNDARARAJU, P., BOPAIAH, B.M., THOMAS, G.V., MISRA, K.P., BALASIMHA, D., BHAT, N.T. and SHAMA BHAT, K. 1986. Coconut and arecanut based high density multispecies cropping systems. *J. Plantn. Crops* **14** : 74-87.

JACKSON, M.L. 1960. Soil Chemical Analysis, Prentice Hall, New Delhi.

SANNAMARAPPA, M. and MURALIDHARAN, A. 1982. Multiple Cropping. *In The Arecanut Palm* (ed. Bavappa, K.V.A., Nair, M.K., Premkumar, T) pp. 133-149, CPCRI, Kasaragod.

TRENBATH, B.R., 1974. Biomass production in mixture, *Adv.* Agronomy, **26** : 177-210.