

## GROWTH AND DRYMATTER PRODUCTION IN THE COMPONENT CROPS UNDER MONOCROPPING AND HIGH DENSITY MULTISPECIES CROPPING SYSTEMS\*

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### ABSTRACT

Growth and dry matter production of the crops grown under monocropping and coconut based high density multispecies cropping systems (HDMSCS) have been compared. Canopy growth and economic yield of intercrops under HDMSCS were considerably affected. The energy output/input based on NPK as active ingredients also was lower for the intercrops under HDMSCS system. Lower light intensity reaching the canopy of intercrops due to interception by coconut canopy appears to be the limiting factor for their growth and productivity. Shade loving species which require low light intensities are likely to perform better under HDMSCS system. Identification of such species of economic importance for trying in HDMSCS system is desirable.

### INTRODUCTION

Central Plantation Crops Research Institute, Kasaragod had developed new approaches in the planting systems like multi-storied cropping and mixed cropping (Nelliath, Bavappa and Nair, 1974) which indicate the possibilities of cultivating compatible combinations of other crops along with coconut. Nair et al (1975) explained the synergistic effects of crop combinations of coconut and cocoa on growth and productivity under mixed cropping. Creencia (1978) suggested that by multiple cropping the productivity of coconut can be increased. Bavappa (1975) reported that coconut utilizes only 30 to 40% of the total airspace available in the system and by the high density planting under coconut and arecanut plantations the yield of both the main crops as well as subsidiary crops could be increased (Bavappa et al

1986). Better utilization of environmental resources is the prime objective of these planting systems. In an intercropping system even if all other conditions are favourable for the growth of intercrops, light is the limiting factor since light penetration of a plant stand is reduced through interception and absorption by the taller canopy (Trenbath 1976). Biomass production of various crops in mixed system gives a rough indication of their compatibility (Okigbo 1979). The present study reports the growth and dry matter production of component crops under a coconut based HDMSCS *i.e.*, a closed system as compared to the open condition *i.e.*, as monocrop.

### MATERIALS AND METHODS

The data was collected from a coconut based HDMSC model established during

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1983 at CPCRI, Kasaragod with eighteen crop species planted with minimum crop competition between the species (Bavappa et al, 1986). A control plot without coconut was laid out with 13 species with the recommended spacing and cultural practices. Eventhough the original HDMSC experiment consisted of three fertilizer levels, for comparison purpose only the full dose of the recommended level of fertilizer for each species was taken into consideration. As the establishment of some of the crops like clove, nutmeg and pepper planted in the open as well as HDMSC system was very poor the comparison was made only between the established crops in both the systems. The crops selected were one annual-Tapioca, two biennials - Pineapple and banana and the perennials - Sapota, guava and subabul.

Canopy growth was estimated taking into consideration of the shape of the canopy, canopy surface, area as well as canopy volume (Jamaluddeen and Jacob, 1983). Total height of the plant, number of branches produced and girth of the stem were measured along with the measurements. The fresh weight and dry weight of the harvestable produce were determined. The energy output, input ratio on each crop was calculated based on NPK as active ingredients (Pimental, 1980).

Incident light was measured for one week during the summer month with the Steady State Porometer (Li 1600, Lambda Instruments, U.S.A.) from 7 A. M. to 6 P. M. at an interval of 3h.

The cultural practices recommended for each crop were adopted in both the systems.

## RESULTS

### Light profile

The incident light on each crop is given in Fig. 1. The PAR range from 10 to

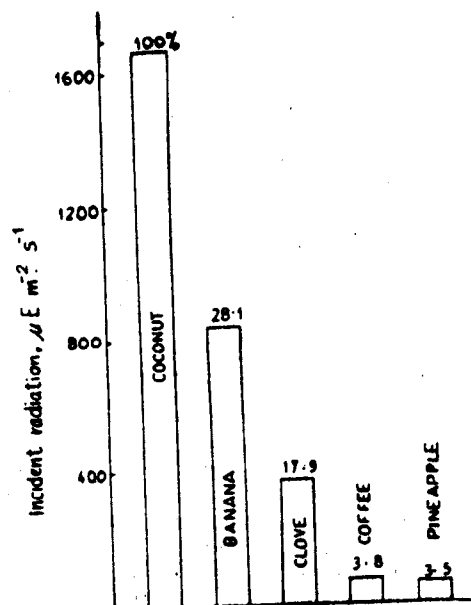


Fig. 1. Incident light on different crops

$15 \mu E m^{-2} s^{-1}$  from 7 A.M. with a peak at 12 noon when the PAR is about  $1800 \mu E m^{-2} s^{-1}$  in the open on a clear day. Below the coconut canopy the incident PAR is 40-50% less than in the open. At any time of the day the incident PAR received by the crops at the ground level is  $40-80 \mu E m^{-2} s^{-1}$  which is only 3.8% to 4.5% of the open. But the PAR input of the sunflecks is as high as 80% of the total PAR in the open.

### Canopy growth

Table I gives the per plant canopy area in the two cropping systems. Since the canopy growth do not show much variation among the plants under a particular system, the mean values are only given. The data show that there is a drastic reduction in the canopy growth under the HDMSCS. The growth of guava is found to be more affected (93%) followed by pineapple (76%) under the system as compared to the open system. The canopy growth of banana and sapota was comparatively less affected under HDMSCS.

The reduction was 27% and 35% respectively as compared to open conditions. Subabul showed lanky growth under the HDMSCS. The total height of the plant varied between 5 to 6 m and the girth of the stem ranged between 7 to 13 cm as compared to the open condition where the height was 2 to 3 m and the girth 14 to 22 cm.

Table I. *Canopy growth*

Crop	Canopy area HDMSCS	m <sup>2</sup> /plant OPEN
Banana	6.42	8.84
Pineapple	0.07	0.29
Guava	4.80	68.70
Sapota	5.00	7.70

#### Dry matter production

Only the economic yield is taken into consideration. Table II gives the fresh weight and dry weight of the harvestable produce as well as the energy output, input ratio.

From the table it is very clear that the fresh and dry weight of the fruits are affected under the HDMSCS. For instance fruit dry weight

is reduced by 28 and 25 respectively in banana and pineapple. Similar trend is exhibited by tapioca.

#### Energy ratio

Energy output, input ratio is low under the HDMSCS. Tapioca shows very low ratio which is 81% less than the open system. In the case of pineapple and banana it is only 39% and 31% respectively.

#### DISCUSSION

The effect of light on the growth and development of the crop plants are well known (Vince and Cockshull, 1981). Watson (1952) pointed out that the amount of light incident on the field is not the limiting factor for yield but the amount of light intercepted by a crop is the major discriminant. Earliness in flowering under the open condition also was reported in many crops (Evans, 1969). In the present study earliness in the flowering was noticed in the case of papaya (later removed) banana, pineapple and sapota in the open condition. This is corroborated by the data on light profile (Fig. 1).

The reduction in the growth under the system can be mainly attributed to the incident PAR on each crop. It was observed

Table II. *Dry matter production and energy output/input ratio*

Crop	Dry matter production				Output/input ratio*	
	Fresh Wt HDMSCS	Fresh Wt OPEN	Dry Wt HDMSCS	Dry Wt OPEN	HDMSCS	OPEN
	Kg/plant				No.	
Tapioca	0.96 ±0.117	2.82 ±198	0.22	0.65	0.084	0.25
Pineapple	1.4 ±0.081	1.9 ±0.15	0.18	0.24	0.086	0.116
Banana	9.42 ±0.094	13.0 ±1.08	1.60	2.2	0.018	0.026

\* Based on NPK as active ingredient

that the coconut canopy intercepts 50% of the light. The incident light on the banana was 28.1% and the pineapple receives only 3.5% of the total intercepted radiation. Since the adult gardens are characterized by large number of sunflecks, offer another possibility to the growth of intercrops by alternating with shady and bright light during the movement of the coconut leaf. Earlier observation revealed that the larger canopy tree crops influence the growth of under plants within one metre of its radius more than those at 2 metre radius and beyond. The incident PAR at 1 metre radius was lower ( $560 \mu \text{Em}^{-2} \text{S}^{-1}$ ) than at 2 metre radius ( $920 \mu \text{Em}^{-2} \text{S}^{-1}$ ). This may be because of the greater absorption of light by the taller canopy (Trenbath 1976).

It has been well established that the capacity of crop plants to adapt to shade is a major physiological limitation to productivity (Smith, 1981). Trenbath (1976) reported, in an intercropping system competition for various factors may be involved but there are also adaptive mechanisms of crops in response to competition for light, space and nutrients.

Although the yield potential could not be fully realized in tapioca, pineapple and banana under shaded conditions (HDMSCS) as much as that under open system, the reduced yield showed their adaptability to low light profiles. The partitioning of dry matter in tapioca was found to be more towards the tuber growth (1.13 kg) than for shoot growth (0.94 kg) when grown as a monocrop while the reverse trend occurred under HDMSCS i.e., tuber growth (0.22 kg) lower than shoot growth (1.46 kg). Tuber yield in yams also was found to be reduced when grown as intercrop (Okigbo 1979).

The extreme extension growth of stems and reduced branches of subabul, guava

and tapioca is another adaptive nature of these crops under shaded condition. It was noticed that when there was 2 to 3 branches for guava plant in the open system only a single branch was seen under HDMSCS. The thin spikeless leaves of pineapple with small fruits under HDMSCS as compared to the thick leaves with spikes and bigger fruits in the open condition show the modifications of plants to adapt in the less favourable environments. More than 40% of the pineapple fruits in the open weighed above 2 kg.

The energy output/input revealed higher ratios in the open condition. This may be because of the use of light to the fullest extent which is another form of energy whose input is less under HDMSCS.

Effective utilization of land, airspace and inputs with maximum returns are the advantages of HDMSCS. Eventhough the system gave an additional income from the increased coconut yield (Bavappa et al 1986) as well as from the yield of inter crops, effective utilization of all the inputs were not seen as compared to open condition. This is mainly because of the lower light intensity reaching the canopy of inter crops by interception by the coconut canopy. Therefore identification of suitable species such as shade loving ones which give a better yield when grown as intercrop as compared to the open is highly desirable.

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