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Microclimatic and photosynthetic characteristics in arecanut and cardamom mixed cropping system

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Abstract

The microclimatic and photosynthetic characteristics of arecanut (*Areca catechu*) and cardamom (*Elettaria cardamomum*) mixed cropping system were studied at Sirsi (Karnataka, India). Arecanut canopy received higher amount of light and also photosynthetically active radiation. Arecanut also recorded higher photosynthetic rate, transpiration rate, stomatal conductance, intercellular CO_2 concentration, carboxylation efficiency and water use efficiency at gas exchange level.

Key words: arecanut, *Areca catechu*, cardamom, *Elettaria cardamomum*, microclimate, mixed cropping, photosynthetic characteristics.

In mixed cropping systems plants compete for light, water, soil and space. Competition occurs when the immediate supply of a single necessary factor falls below the combined demands of the plants (Donald 1963). In multistoreyed cropping systems, the leaf canopy of the components of crop combinations occupy different vertical layers with the tallest component having foliage tolerant to strong light and high evaporative demand and the shorter component(s) having foliage requiring or tolerating shade and/or high humidity (Nair 1979). In mixed cropping systems, even if all other conditions are favourable for the growth of intercrops, light is a limiting factor since light penetration of a plant stand is reduced through interception and absorption by the taller canopy. In this situation, shade loving species which require low light intensities are likely to perform better (Kasturibai *et al.* 1991; Balasimha & Yadukumar 1993; Rethinam & Venugopal 1994). In arecanut (*Areca catechu* L.) plantations situated at higher elevations, especially in Uttara Kannada District in Karnataka (India), arecanut occupies the top most canopy and shade loving crops like cardamom (*Elettaria cardamomum* Maton) are grown under its shade. Arecanut has a fairly deep root system which can tap water and nutrients from deeper layers, whereas cardamom is a shallow rooted crop, which can absorb water and nutrients from top layers. The microclimate and photosynthetic characteristics in arecanut and cardamom mixed cropping system was studied at Sirsi (Uttara Kannada District, Karnataka) and the results are reported here.

The field experiment was undertaken at Sirsi and arecanut (Sirsi local) was planted at 2.7 m x 2.7 m spacing in both mono and mixed cropping systems. Cardamom (Cl-37, Malabar type) was introduced between rows of arecanut at a spacing of 2.7 m x 1.2 m. The experiment was laid out in a complete randomised block design with eight replications. The age of arecanut was 10 years and cardamom 3 years at the termination of the experiment. Physiological parameters namely, photosynthetic rate (A), transpiration rate (E), stomatal conductance (g_s), intercellular CO_2 concentration (C_i), and microclimatic parameters such as light interception (%), photosynthetically active radiation (PAR), relative humidity (%), leaf temperature and air temperature (°C) were measured by using leaf chamber analyzer (LCA-3) during March 1993–94 at 10–12 am on fully

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Table 1. Microclimatic variables in arecanut and cardamom mixed cropping system

Crop	Light interception (%)	PAR ($\mu molm^{-2}sec^{-1}$)	Relative humidity (%)	Air temperature (°C)	Leaf temperature (°C)
Arecanut	59.1	886.0	23.4	31.5	31.0
Cardamom	40.3	350.0	25.3	29.5	29.9
't' test	**	**	**	**	**

PAR = Photosynthetically active radiation
** = Significant at P<0.01

opened intact leaves of arecanut and cardamom. The ratios of A/E, A/C_i and A/g_s were also computed. The data were analysed by 't' test.

Microclimate

All the microclimatic parameters were significantly different in mixed cropping system of arecanut and cardamom. Arecanut received higher amount of light (59.06%) compared to cardamom (40.25%) due to arecanut crown forming the top most canopy and cardamom constituting the lower canopy in the cropping system. Similar results were observed with PAR also i.e., arecanut received 886.0 $\mu molm^{-2}sec^{-1}$, whereas cardamom received 350.0 $\mu molm^{-2}sec^{-1}$. Relative humidity was low under arecanut canopy (23.45%) compared to cardamom (25.30%). Air and leaf temperatures were higher in arecanut than cardamom due to higher light interception (Table 1).

Table 2. Photosynthetic characteristics in arecanut and cardamom mixed cropping system

Crop	Pn ($\mu molCO_2\ m^{-2}s^{-1}$)	Tr ($\mu molH_2O\ m^{-2}s^{-1}$)	SC ($molm^{-2}s^{-1}$)	Int. CO_2 (ppm)
Arecanut	4.2	4.8	0.20	286.0
Cardamom	4.1	4.0	0.24	316.0
't' test	NS	**	**	**

Pn = Photosynthetic rate; Tr = Transpiration rate; SC = Stomatal conductance; Int. CO_2 = Internal CO_2 concentration
NS = Non significant; ** = Significant at P<0.01

Physiological parameters

Transpiration rate, stomatal conductance and intercellular CO_2 concentration showed significant variations. Photosynthetic rate was higher in arecanut (4.2 $\mu molCO_2m^{-2}sec^{-1}$) compared to cardamom (4.1 $\mu molCO_2m^{-2}sec^{-1}$). Transpiration rate was also higher in arecanut (4.8 $\mu molH_2Om^{-2}sec^{-1}$) compared to cardamom (4.0 $\mu mol\ H_2Om^{-2}sec^{-1}$) due to higher light interception by the arecanut canopy (Table 2). Stomatal conductance was higher in cardamom (0.24 $molm^{-2}sec^{-1}$) than arecanut (0.20 $molm^{-2}sec^{-1}$). Intercellular CO_2 concentration was higher in cardamom (316.0 ppm) compared to arecanut (286.0 ppm). A/Ci which indicates carboxylation efficiency (Farquhar & Sharkey 1982) and A/E and A/g_s which indicate the intrinsic water use efficiency of crop plants were higher in arecanut (Table 3) which was due to higher light interception and intrinsic plant factors. The relation of 'A' and C_i has been reported to be linear in other crops (Farquhar & Sharkey 1982; Marco *et al.* 1988; Balasimha *et al.* 1991). Similar results were also observed in cashew (Balasimha & Yadukumar 1993).

Table 3. Mean values of A/E, A/g_s and A/C_i in arecanut and cardamom mixed cropping system

Crop	A/E	A/g_s	A/C_i
Arecanut	0.89	21.2	0.015
Cardamom	1.03	17.5	0.013
't' test	**	**	**

A = Assimilation rate; E = Transpiration rate; g_s = Stomatal conductance; C_i = Internal CO_2 concentration
** = Significant at P<0.01

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