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ECOCLIMATE OF A COCONUT PLUS CACAO CROP COMBINATION ON THE WEST COAST OF INDIA

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ABSTRACT

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Daily variations in temperature, vapour pressure, relative humidity and evaporation were measured at 0, 100, and 200 cm above ground level, inside plantations of unirrigated and irrigated monocrops of coconut, inside a combination crop of irrigated coconut + cacao, and in the open area during November—May in two consecutive seasons. The crop combination offered a sort of buffering effect against drastic diurnal variation in its ecoclimate. Differences between the average daily values of maximum and minimum temperature and relative humidity were considerably less in the ecoclimate of the crop combination. Evaporation from the ecoclimate of the crop combination was only about 30% of that from the open area.

INTRODUCTION

The modified ecoclimate within a crop combination is likely to influence the environment of crop communities and modify the rates of various biological processes regulating the growth and productivity of crops. Information on the ecoclimate variations in mixed plantings of coconut and cacao is therefore of importance in the management of and crop protection practices for this promising crop combination. Preliminary studies (Balakrishnan et al., 1976) have shown that during the dry period (December—May), the evaporation from the open surface (observatory) was about twice the corresponding value for the ecoclimate of cacao during the early stage of its growth as a mixed crop with coconut. Further studies on the ecoclimate of a coconut + cacao crop combination in comparison with that of pure palm stands are described in this paper.

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MATERIALS AND METHODS

The observations were recorded at the research farm of the Central Plantation Crops Research Institute (CPCRI), Kasaragod, on the west coast of India. Average monthly meteorological data from the agrometeorological observatory of the Institute are given in Table I.

TABLE I

Mean*[1] climatic parameters at CPCRI, Kasaragod*[2], India

Month	Rainfall		Air temperature (°C)		Relative humidity (%)	Sunshine (h/day)	Evaporation (USWB pan; mm/day)
	quantity (mm)	no. of rainy days	max.	min.			
January	0.8	0.1	31.8	20.3	85	9.2	4.5
February	—	—	32.1	21.3	87	9.8	4.8
March	3.1	1.0	32.5	23.3	88	9.5	5.1
April	43.6	2.1	33.3	25.1	82	9.2	5.2
May	281.9	9.3	32.3	25.0	84	7.5	5.0
June	965.9	20.2	29.7	23.4	92	3.9	3.6
July	1098.2	28.9	28.5	22.8	94	2.7	2.3
August	644.0	22.8	28.5	22.8	95	3.7	2.6
September	319.8	11.9	29.2	22.7	94	5.8	3.5
October	193.6	10.1	30.4	22.7	92	6.9	3.6
November	76.5	4.3	32.0	22.0	87	8.2	4.1
December	19.3	1.6	32.3	20.9	83	8.3	4.1

*[1] Average for 20 years 1956—75.
*[2] Kasaragod: 10.7 m above MSL; 12°30′N and 75°E.

Observation sites

(1) Open area: an area free of and away from crops.

(2) Unirrigated coconut: 30-year-old Tall variety coconut palms, from the centre of a field of pure palm stand. Palms were spaced 7.5 x 7.5 m apart.

(3) Irrigated coconut: same as (2). The field was sprinkler-irrigated during November—May (dry months) at the rate of 2.8 cm at weekly intervals.

(4) Coconut + cacao: in a field as in (3), cacao was planted as a mixed crop in 1972 at 3.0 x 3.0 m spacing in a double-hedge system in the interspaces of coconut. Canopies of cacao plants were restricted (by pruning) to a height of about 2.5 m.

Observations

Details of observations are given in Table II.

The observations were recorded at 1.0 m distance from the trunks of coco-

TABLE II

Details of observations

Sample No.	Parameter	Periodicity and time of measurement	Measuring site	Method
1	Evaporation	Daily, at 14h30*[1]	0, 100 and 200 cm above ground level	Cup evaporimeter (Balakrishnan et al. 1976)
2	Relative humidity	Daily, at 8h00 and 14h30*[1]	0, 100 and 200 cm above ground level	Assman's psychrometer
3	Vapour pressure	Daily, at 8h00 and 14h30*[1]	0, 100 and 200 cm above ground level	Assman's psychrometer
4	Air temperature	Daily, at 8h00 and 14h30*[1]	0, 100 and 200 cm above ground level	Met. thermometer*[2]
5	Maximum and minimum temperature	Daily, once*[1]	100 cm above ground level	Max.—Min. thermometer*[2]

*[1] Five days in a week excluding rainy and irrigation days.
*[2] The thermometers affixed to their frames were attached to wooden stands at appropriate measuring sites and were exposed directly to the open.

nut palms in pure palm stands (sites 2 and 3). In the coconut + cacao plot, the measurements were made at two sites: 30 cm from the base of plants and in the centre of four cacao plants. All measuring sites were replicated twice. The observations were made during two dry seasons (November—May) in 1974—75 and 1975—76.

RESULTS AND DISCUSSION

Replicated values for each site were averaged and monthly means and standard deviations calculated. Vapour pressure and temperature were almost constant during the two years, so they were averaged. In order to have a single value for each parameter at each site, the values at different heights of each site were also averaged. The variations in temperature under different cropping systems, expressed as "deviations from the open area values", are presented in Fig.1.

Table III summarises the vapour pressure variations. The patterns of variation in evaporation and relative humidity are indicated for both seasons in Figs.2 and 3.

There was practically no difference in vapour pressure at different sites. Maximum day temperature, as was expected, was always highest in the open

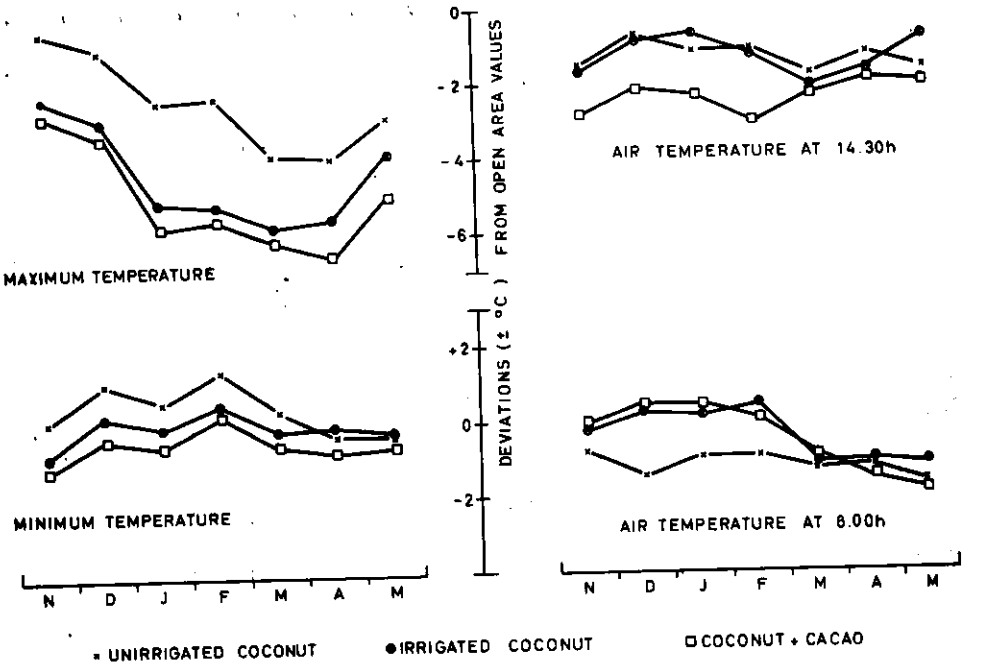

Fig.1. Temperature variations in the ecoclimates of different cropping systems expressed as "deviations from open area values".

TABLE III
Mean vapour pressure during different months

Month	Vapour pressure (mm Hg) in ecoclimates			
	*1	*2	*3	*4
8h00:				
November	19.2	18.4	18.8	19.1
December	15.3	15.0	15.4	15.3
January	15.4	15.3	15.3	15.5
February	18.5	18.3	18.8	19.0
March	21.6	21.6	21.8	21.8
April	22.3	22.0	22.0	21.9
May	22.5	22.4	22.5	22.7
14h30:				
November	19.0	19.1	19.6	20.0
December	16.3	16.9	16.7	17.1
January	17.1	17.4	16.9	17.4
February	19.6	20.1	19.9	21.5
March	22.4	22.6	22.4	22.7
April	23.2	23.5	23.4	23.6
May	23.0	23.2	23.3	23.7

*1 Open area.
*2 Unirrigated coconut.
*3 Irrigated coconut.
*4 Coconut + cacao combination.

area and lowest inside the crop mix. However, the minimum temperature was almost the same in all the sites (Fig.1). Thus the average differences between the maximum and minimum temperature in the ecoclimates of unirrigated coconut, irrigated coconut, and the crop combination were 2.6, 4.0 and 5.2°C less than that of the open area respectively.

Daily variations in the relative humidity (Fig.3) were also much less in the ecoclimate of the crop mix compared with that of the pure palm stand (unirrigated) or open area. In the afternoons, particularly during November—January, when the relative humidity of the open area was low, the ecoclimate of the crop mix was much more humid. However, the most striking difference noticed was the variations in evaporation from different ecoclimates (Fig.2). Values of evaporation (mm per day) from different sites expressed as percentages of evaporation from the open area are given in Table IV. The evaporation from the ecoclimate of the crop combination was only about 30% of that from the open area, whereas it was about 60% under irrigated coconut.

Table V shows the average variation in air temperature during 1975—76 in the morning and afternoon at 1.0 m and 2.0 m heights above the ground level for each site, expressed as deviations from the corresponding values at ground

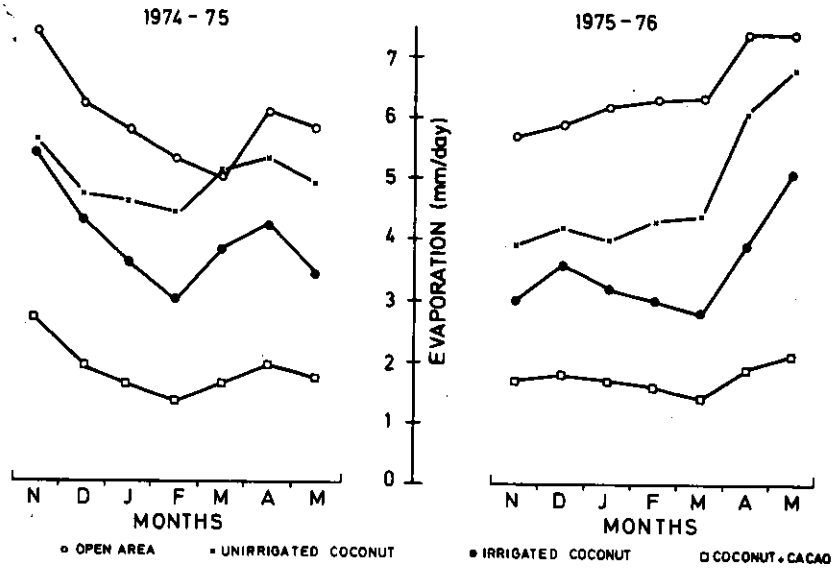

Fig. 2. Evaporation from the ecoclimates of different cropping systems.

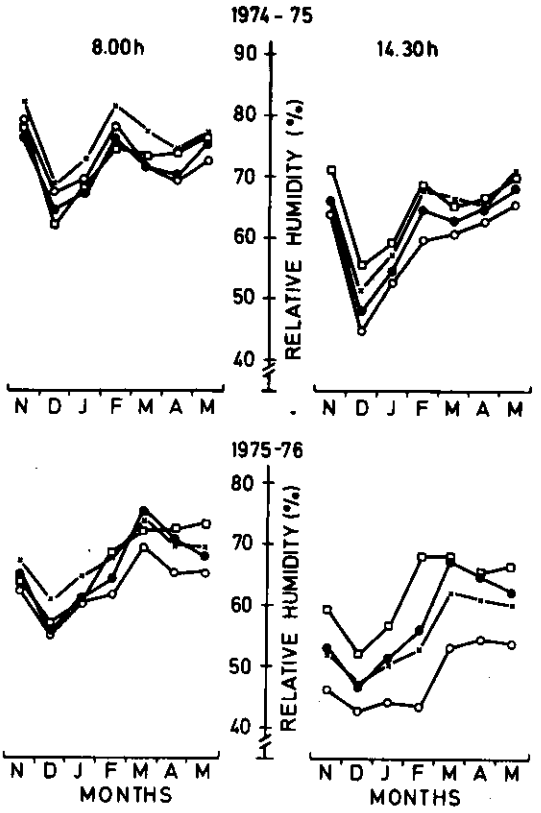

Fig. 3. Variation of relative humidity in the ecoclimates of different cropping systems (for legend, see Fig. 2).

TABLE IV

Evaporation from different ecoclimates expressed as percentages of evaporation from open area

Month	Ecoclimates of			
	*1	*2	*3	*4
1974—75:				
November	100 (7.4)*5	75.7	66.2	36.5
December	100 (6.2)	75.8	69.4	30.6
January	100 (5.8)	79.3	62.1	27.6
February	100 (5.3)	83.0	56.6	24.5
March	100 (5.0)	102.0	76.0	32.0
April	100 (6.1)	86.9	68.8	30.6
May	100 (5.8)	84.5	58.6	29.3
Mean	100	80.9	65.4	30.1
1975—76:				
November	100 (5.7)	68.4	52.6	29.8
December	100 (5.9)	71.2	61.0	30.5
January	100 (6.2)	64.5	51.6	27.4
February	100 (6.3)	68.3	47.6	25.4
March	100 (6.3)	69.8	44.4	22.2
April	100 (6.3)	82.4	52.7	25.7
May	100 (7.4)	91.9	68.9	28.4
Mean	100	73.8	54.1	27.0

*1 Open area.
*2 Unirrigated coconut.
*3 Irrigated coconut.
*4 Coconut + cacao combination.
*5 Figures in parentheses are the mean monthly values of evaporation (mm/day) for the open area.

level. In the afternoon, when air temperature in the open area and under unirrigated coconuts at both heights was about 2—3°C less than at ground surface, there was practically no such variation under the crop combination. On the other hand, in the morning, when temperature was lower, the air temperature in the crop mix was slightly higher than at its floor. Evaporation, vapour pressure, and relative humidity did not, however, vary markedly with height from the soil.

Considering the values from the open undisturbed area as the normal climatic parameters, the variations brought about by the cropping systems (unirrigated coconut, irrigated coconut, and coconut + cacao crop mix) are expressed quantitatively in this study. Coconut, being a tall unbranched tree, is likely to alter the climate near the plantation floor only to a limited extent, particularly when grown unirrigated. Irrigation causes some variation in the ecoclimate, particularly in temperature and evaporation. A monocrop of

TABLE V

Average air temperature variations, November 1975 to May 1976 at two heights expressed as deviations from the corresponding values at ground level

Height above ground (cm)	Deviations (±°C)				
	*1	*2	*3	*4	*5
8h00:					
100	−0.4	−0.1	+0.3	+0.5	+0.5
200	−0.8	0	+0.2	+0.7	+1.0
14h30:					
100	−2.1	−1.3	−0.8	+0.2	−0.1
200	−2.8	−1.9	−1.3	+0.3	+0.3

*1 Open area.
*2 Unirrigated coconut.
*3 Irrigated coconut.
*4 Coconut + cacao, at 30 cm from base of cacao.
*5 Coconut + cacao, at the centre of four cacaos.

coconut permits better movement of air within the plantation and is thus more open to the outside environment. But the crop combination of coconut and cacao presents a relatively less ventilated system and it creates greater aerodynamic roughness. In a previous study, Nair and Balakrishnan (1976) have found that a pure palm stand of coconut shades only about 50% of the plantation floor, whereas about 87% shading is effected by a coconut + cacao (double-hedge) system. This reduces the evaporation from the area and makes the environment within the crop mix cooler. The crop combination acts as a buffer against drastic changes in the ecoclimate. This has considerable effect on the various biological processes occurring in the environment (including soil) of the crop community, and on the multiplication of plant parasites.

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