CANOPY ARCHITECTURE, PHOTOSYNTHESIS AND YIELD OF COCOA TREES (*)

G. THOMAS, D. BALASIMHA (**)

Summary: Five different types of canopy architecture viz., unpruned single storey (T_1), unpruned double storey (T_2), minimum pruning to give cone shape (T_3), severe pruning (T_4) and flat spreading canopy (T_5) were maintained in cocoa. Due to pruning, the canopy area and number of branches were significantly reduced. A significantly low light interception efficiency with correspondingly high PAR was noted in pruned treatments. Due to this effect, stomatal conductance and transpiration rate increased in T_4 and T_5, with a reduction in water use efficiency. Net photosynthetic rate did not show any significant treatment effect. Current photoassimilates were translocated and the stored stem starch was mobilized to sustain the sink demand exerted by intense flushing observed in the pruned treatments. The maximum yield was obtained in T_1 and T_2. The low yields in T_3, T_4 and T_5 treatments can be attributed to the following reasons : (i) the reduction in canopy area and number of branches, (ii) carbohydrate exhaustion for flushing and subsequent carbohydrate stress at the time of flowering and pod load, (iii) high transpiration rate. It is concluded that cocoa requires a comparatively big and spreading canopy for better yield. Whenever pruning is found necessary, it should be restricted to maintenance pruning towards optimum leaf area index and removal of excessively shaded bottom or interior branches.

INTRODUCTION

For optimum productivity a comparatively big canopy with spreading nature seems to be ideal for cocoa. Maximum leaf area should be maintained with pruning practices to avoid self shading of leaves. Martin and Prasad (1983) reported a pruning experiment with three types viz., discretionary pruning where 2-3 basal chupons were allowed to grow, strict pruning and no pruning. Discretionary pruning showed higher yield which might have helped in maintaining optimum leaf area index. In Ghana a pruning experiment showed that during early years the pruned trees yielded slightly more than the unpruned trees, but after ten years from planting, the unpruned trees started to yield more (Bonaparte, 1966). In another trial (Ampofo, 1986) on five-year old trees pruning showed non-significant negative effect. These can be explained on the basis of light profile in different systems with the detailed physiological studies which however, have not been done so far. In order to understand and elucidate optimum canopy shape and structure of cocoa, physiological and biochemical responses, yield and light interception efficiency of mature cocoa trees at different sizes of canopy were studied.

MATERIALS AND METHODS

The Regional Station of the Central Plantation Crops Research Institute is located at Vittal (12.25 °N and 75.42 °E) in Karnataka, above 91 m mean sea level. The soil is typically lateritic in nature. The nutrient status of the soil is as follows : pH 5.3-5.6, organic carbon 0.70-1.1 %, total nitrogen 0.05-0.09 %, available P_2O_5 (Bray and Kurtz, no. 1 solution) 3.8-7.1 ppm, and available K_2O 35-85 ppm. The mean annual rainfall for the years (1988-1990) ranged from 3,678 mm to 3,977 mm distributed over a period of one hundred and five days. Usually a long dry period prevails from December to April. Temperature ranges between 32-33 °C maximum and 22-23 °C minimum.

The cocoa (*Theobroma cacao* Linn. cv. Forastero Accn. Landas 351) plants were used in the present

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(*) CPCRI Contribution No. 795.

(**) To whom correspondence should be addressed : Central Plantation Crops Research Institute, Regional Station, Vittal-574 243, Karnataka, India.

study. Planting was done in 1983 at a spacing of 2.7 × 5.4 m under the shade of eighteen year old arecanut palms (*Areca catechu* Linn.) at 2.7 × 2.7 m in spacing. The annual fertilizer dosage was 100 g N, 40 g P_2O_5 and 140 g K_2O per tree. The plants were irrigated at ten days intervals during dry periods. Four replicates per treatment were laid out each having five trees in a row. Five treatments were imposed during September, 1988. The canopies were maintained as follows: unpruned single storey (T_1), unpruned double storey (T_2), minimal pruning to give cone shaped canopy (T_3), severely pruned with 2-3 main branches at first jorquette (T_4) and pruned flat spreading canopy (T_5). The average canopy areas are given in table I. Measurements were taken for physiological parameters during November 1988 (S_1), April 1989 (S_2) and September 1989 (S_3) representing the onset of flowering, peak pod load and harvest respectively. Growth measurements were recorded and yield data for three years (1989, 1990 and 1991) were collected.

Four trees in each treatment were used for photosynthetic and biochemical measurements. Photosynthetic parameters were measured using a portable photosynthesis system LI-6200 as described earlier (Balasimha *et al.*, 1991). Six observations were taken for each tree from the outer canopy enclosing up to 30 cm² leaf area in a 1 l leaf chamber. The sampling was done between 10:00-12:00 h. Water use efficiency was calculated as ratio of P_N/E. Quantum flux distribution of light above and below the cocoa canopy were noted to obtain the light interception efficiency.

Phloem leaching was estimated according to the method proposed by King and Zeivaent (1974) using 20 mM EDTA solution with some modifications. Insoluble PVP (20 mg) was added to the samples after leaching for six hours in a humid chamber. The filtered solution was used for estimating total soluble sugars by phenol-sulphuric acid method (Dubois *et al.*, 1956). Chlorophylls and carotenoids were determined in 85 % acetone extracts according to Lichtenthaler and Wellburn (1983).

Dried tissue (0.1 g) was extracted in 80 % hot aqueous alcohol for soluble sugars, clarified to remove phenolics and estimated (Dubois *et al.*, 1956). The residue obtained after the alcohol extraction was estimated by the perchloric acid digestion method of Clegg (1956).

RESULTS AND DISCUSSION

The mean growth characters of cocoa due to the five treatments are given in table I. The canopy area of T_2 was significantly higher followed by T_1 and T_3. Treatments T_1 and T_2 also had significantly higher number of branches.

The PAR showed significantly higher values in T_3, T_4 and T_5 with reduced light interception implicating the percolation of more light through the canopy (table II). The lowest light interception efficiency and highest PAR was noted in T_4. In response to the increased quantum flux, the leaves of T_4 and T_5 treatments started to show light adaptation by increasing the SLW (table I). The differences in P_N of different treatments were not significant though higher levels were recorded in T_4 and T_5 (table III). Enhanced P_N associated with high SLW was thus observed as reported in apple (Barden, 1977). Transpiration rate increased with a reduction in WUE with the exposure of canopy (table III). A positive correlation ($R^2 = 0.20$, $P = 0.01$) was also noted between E and P_N (figure 1). The g_s was enhanced in T_4 and T_5 (table III).

TABLE I

Mean growth characters of cocoa trees

Valeur moyenne des caractères de croissance des cacaoyers

Treatment	Canopy area (m^2)	No. of branches	Stem girth (cm)	SLW (mg/cm^2)
T_1	21.52 b	43.8 b	37.91 b	6.53 a
T_2	26.78 a	53.6 a	43.53 a	5.94 b
T_3	18.60 b	25.7 c	37.87 b	6.41 a
T_4	12.71 c	18.4 d	35.93 b	6.83 a
T_5	13.30 c	23.4 c	36.41 c	6.91 a
LSD (P = 0.01)	3.16	4.8	2.27	0.55
CV (%)	16.58	14.2	5.80	10.32

Abbreviations:

Chl a : Chlorophyll a ;
Chl b : Chlorophyll b ;
E : Transpiration rate ;
g_s : Stomatal conductance ;
PAR : Photosynthetically active radiations ;
P_N : Net photosynthetic rate ;
PVP : Polyvinyl pyrrolidone ;
RH : Relative humidity ;
SLW : Specific leaf dry weight ;
T_{leaf} : Leaf temperature ;
VPD : Vapour pressure deficit ;
WVPD : Water vapour pressure deficit ;
WUE : Water use efficiency (= P_N/E).

TABLE II

PAR, light interception, T_{leaf} and VPD in treatments

Radiations actives de photosynthèse, interception de la lumière, température des feuilles et déficit en pression de vapeur dans les différents traitements

	PAR ($\mu mol\ m^{-2}s^{-1}$)	Light interception (%)	T_{leaf} (°C)	VPD (kpa)
Treatment				
T_1	536.17 c	96.79 a	34.36	2.59
T_2	681.67 c	96.85 a	35.80	2.98
T_3	864.71 b	80.85 b	34.48	2.53
T_4	1 007.22 a	74.96 b	36.25	2.97
T_5	893.00 b	88.96 a	35.14	2.73
LSD	277.77 *	8.27 **	1.47 NS	0.49 NS
Season				
S_1	764.02	85.14	34.58	2.92
S_2	848.86	96.15	35.89	3.22
S_3	776.86	91.13	35.15	2.13
LSD	215.16 NS	6.40 NS	1.14 NS	0.37 **
CV (%)	42.31	11.48	5.10	21.55

Significant at P = 0.05 (*) or P = 0.01 (**); NS = Not significant.

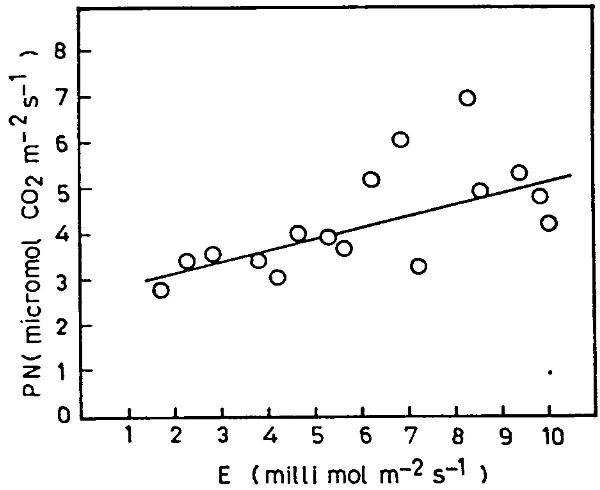

Fig. 1. — Relationship between net photosynthetic rate and transpiration rate. Linear regression, y = 0.2275 × + 2.8360, R^2 = 0.20 (P = 0.01)

Relation entre le taux net de photosynthèse et le taux de transpiration. Régression linéaire, y = 0,2275 × + 2,8360, R^2 = 0,20 (P = 0,01)

TABLE III

P_N and related characters in cocoa leaves

Taux net de photosynthèse et caractères qui lui sont associés dans les feuilles du cacaoyer

	P_N ($\mu mol\ m^{-2}s^{-1}$)	E ($mmol\ m^{-2}s^{-1}$)	g_s ($cm\ s^{-1}$)	Intercellular CO_2 (ppm)	WUE (P_N/E)
Treatment					
T_1	3.58	3.97 a	0.48	263.9	0.90
T_2	3.34	4.23 a	0.51	256.6	0.79
T_3	3.68	3.61 b	0.54	266.5	1.02
T_4	4.38	5.25 a	0.59	265.3	0.83
T_5	4.32	5.40 a	0.69	263.4	0.80
LSD	0.88 NS	1.36 *	0.19 NS	10.5 NS	0.25 NS
Season					
S_1	3.69	3.83	0.40	255.9	0.96
S_2	3.91	4.29	0.40	251.4	0.91
S_3	3.97	5.35	0.89	282.0	0.74
LSD	0.68 NS	1.05 *	0.15 **	8.1 **	0.19 **
CV (%)	27.88	36.88	42.78	4.8	32.32

Significant at P = 0.05 (*) or P = 0.01 (**); NS = Not significant.

Stomata of intact leaves generally open in response to increased PAR (Burrows and Milthorpe, 1976). Cumulative effect of PAR and leaf temperature (table II) would have enhanced g_s and E in T_4 and T_5. A strong positive correlation (R^2 = 0.57, P = 0.01) was observed between E and g_s (figure 2, p. 106). Balasimha and Rajagopal (1988) and Raja Harun and Hardwick (1988) demonstrated stronger effect of RH and WVPD respectively on stomatal action in cocoa. Since the VPD did not change significantly between the treatments, PAR perhaps played an important role in stomatal changes of pruned treatments (table II).

A ratio of 0.80-0.88 of intercellular CO_2 : ambient CO_2 was recorded, which is characteristic of any C_3 species. There was also no significant differences in intercellular CO_2 concentration (table III) as reported earlier for cocoa (Balasimha *et al.*, 1991). The

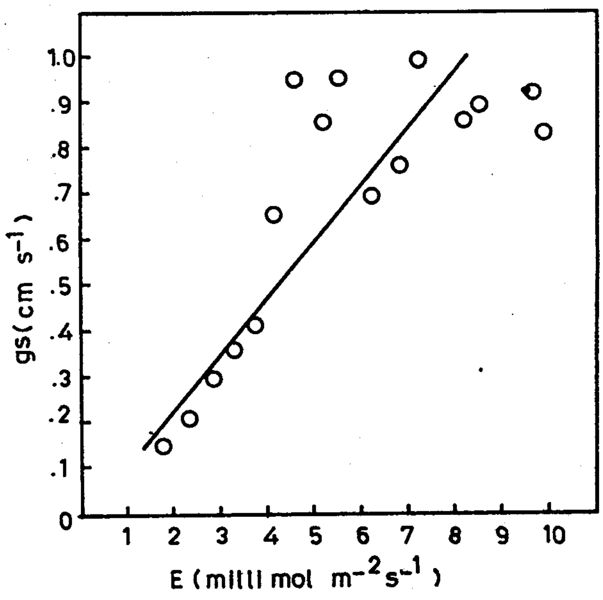

Fig. 2. — Relationship between stomatal conductance and transpiration rate. Linear regression, y = 0.1314 × − 0.0295, R^2 = 0.57 (P = 0.01)

Relation entre la conductance stomatale et le taux de transpiration. Régression linéaire, y = 0,1314 × − 0,0295, R^2 = 0,57 (P = 0,001)

pigment concentrations remained unchanged during sun adaptations (table IV).

During the sun exposure of T_4 and T_5 treated trees more photoassimilate had to partition towards thickening of leaves. When considering high metabolic investment involved in the allocation of more starch and nitrogen for thickening, marginal increases of P_N observed is insignificant. This was also accompanied by increased E which might reduce yields due to low WUE. Increased PAR associated with pruning could not substantially improve photosynthetic efficiency due to the inability of cocoa leaves to utilize higher light intensities.

The changes in sugar, starch and starch/sugar ratio of leaf and stem of sugar leaching from leaf phloem are shown in tables V and VI. Leaf sugar content was significantly high in S_1 season followed by significant reduction during S_2. Due to the heavy translocation of current photoassimilate from the leaves of pruned treatments towards flushing, the starch/sugar ratio was significantly reduced. Leaf starch content did not show significant differences between treatments. The carbohydrate requirement for developing flushes may exceed that available from current photosynthesis (Machado and Hardwick, 1988). A similar deficit can be expected at the time of pod filling (S_2) also. Any photosynthetic carbohydrate deficit is therefore balanced by import of stored carbohydrate from stem and root (Bird and Hardwick, 1982).

TABLE IV

Pigment contents in cocoa leaves

Teneur en pigments des feuilles du cacaoyer

	Chl a (mg g^{-1} FW)	Chl b (mg g^{-1} FW)	Chl a/b ratio	Carotenoids (mg g^{-1} FW)
Treatment				
T_1	1.70	0.64	2.65	0.35
T_2	1.79	0.67	2.67	0.39
T_3	1.60	0.62	2.58	0.34
T_4	1.71	0.63	2.71	0.38
T_5	1.69	0.62	2.73	0.36
LSD	0.22 NS	0.09 NS	0.35 NS	0.04 NS
Season				
S_1	1.89	0.61	3.09	0.43
S_2	1.68	0.63	2.66	0.37
S_3	1.52	0.67	2.27	0.31
LSD	0.17 **	0.07 NS	0.27 **	0.03 **
CV (%)	16.13	18.28	16.59	15.04

Significant at P = 0.05 (*) or P = 0.01 (**); NS = Not significant.

TABLE V

Carbohydrate and phloem leaching in cocoa leaves

Glucide et écoulement du phloème dans les feuilles du cacaoyer

	Soluble sugar (mg g^{-1} DW)	Starch (mg g^{-1} DW)	Starch/ Sugar ratio	Phloem leaching (µg/cm^{-2})
Treatment				
T_1	28.73 b	87.29	3.04	0.24
T_2	28.13 b	85.29	3.03	0.28
T_3	31.97 b	88.79	2.77	0.28
T_4	36.57 a	90.71	2.48	0.27
T_5	37.01 a	90.42	2.44	0.24
LSD	4.57 **	6.15 NS	0.61 NS	0.07 NS
Season				
S_1	30.11	69.57	2.31	0.14
S_2	27.32	65.35	2.39	0.15
S_3	40.02	130.57	3.25	0.51
LSD	3.54 **	4.76 **	0.47 **	0.06 **
CV (%)	17.10	8.44	24.33	36.19

Significant at P = 0.05 (*) or P = 0.01 (**); NS = Not significant.

Stem is the major repository of starch reserve (Balasimha, 1991). Mobilization of stored stem starch for flushing and pod load was observed in the present study (table VI). Due to excessive flushing in T_4 and T_5, starch content was depleted which also reduced the starch/sugar ratio. Due to the pod load at the S_2 season, stem sugar content of all the treatments was increased. During S_3, stem showed low sugar level and highest starch content when compared to earlier seasons. During this period there was neither pod load nor leaf flushing and the plants were restoring the depleted reserves. This is corroborated by a significant increase in phloem leaching from leaves during S_3 (table V).

From the foregoing results it is clear that the three consequences of pruning, viz., increased transmittance of light, flushing and reduction of canopy area had adverse effect on the productivity of cocoa. The yield of cocoa pods were higher in T_1 and T_2 during the three years of the experiment (table VII). A positive correlation of yield to number of branches and canopy area was noticed (table VIII). Yield was also positively correlated with stem sugar. Thus, from this study it is clear that the total canopy P_N i.e., P_N x leaf area is more important determinant of yield rather than leaf P_N. Cocoa requires a large canopy with optimum leaf area index of 7-9 (Balasimha, 1991) and pruning should be restricted only for maintenance of canopy shape, removal of bottom and interior non-bearing branches. This is very essential as highly shaded leaves do not show P_N but are maintained at the cost of other exposed leaves.

TABLE VI

Carbohydrates from cocoa stem tissues

Glucides des tissus du tronc du cacaoyer

	Soluble sugars (mg g^{-1} DW)	Starch (mg g^{-1} DW)	Starch/Sugar ratio
Treatment			
T_1	25.15 a	132.15 a	5.25 a
T_2	23.77 a	117.89 b	4.95 a
T_3	20.06 b	106.35 c	5.30 a
T_4	23.81 a	104.36 c	4.38 b
T_5	28.04 a	100.18 c	3.57 a
LSD	4.84 *	9.83 **	0.91 **
Season			
S_1	14.73	69.90	4.74
S_2	35.37	60.85	1.71
S_3	22.21	205.81	9.26
LSD	3.75 **	7.61 **	0.70 **
CV (%)	24.33	10.64	20.13

Significant at P = 0.05 (*) or P = 0.01 (**).

TABLE VII

Yield of cocoa in relation to canopy architecture

Rendement des cacaoyers en fonction de l'architecture de la frondaison

Treatment	Yield (no. of pods/tree)			
	1989	1990	1991	Average 1989-1991
T_1	40.2(8.72) *	61.8(13.41)	69.8(15.14)	57.3
T_2	30.5(7.78)	61.6(15.71)	78.4(19.99)	56.8
T_3	22.3(6.53)	53.3(15.61)	45.9(13.45)	40.5
T_4	15.4(5.47)	33.5(11.89)	38.2(13.56)	29.0
T_5	19.9(6.42)	24.5(7.91)	26.1(8.43)	23.5
SE	10.1	4.2	3.4	5.1

* Values in parantheses represent fresh weight of pods (kg/tree).

Valeurs entre parenthèses : poids des cabosses fraîches en kg/arbre.

TABLE VIII

Correlation matrix of growth characters, P_N, carbohydrates and yield of cocoa trees

Matrice de corrélation des caractères de croissance, du taux net d'assimilation, des glucides et du rendement des cacaoyers

Parameter	No. of branches	Yield	SLW	P_N	Stem sugar	Leaf sugar	Stem starch	Leaf starch
Canopy area	0.7919 **	0.6959 **	0.5891 **	− 0.1270	0.2540	− 0.2676	0.4276	0.0122
No. of branches		0.6491 **	− 0.6972 **	− 0.3164	0.2397	− 0.3695	0.6881 **	− 0.1606
Yield			− 0.3584	− 0.4357	0.5368 *	− 0.0451	0.4117	0.0501
SLW				0.3947	0.1707	0.4706 *	− 0.5022 *	0.2332
P_N					− 0.1327	0.2385	− 0.1345	0.1519
Stem sugar						0.0824	0.2684	0.0270
Leaf sugar							− 0.2791	0.2162
Stem starch								− 0.2638

Significant at P = 0.05 (*) or P = 0.01 (**).

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REFERENCES

AMPOFO (S. T.). — Spacing/cultivar/pruning experiment. Cocoa Research Institute, Ghana, Report for the period 1982/83-1984/85, Cocoa Research Institute (Tafo), 1986, p. 26-29.

BALASIMHA (D.). — A whole plant structure function model for cocoa. *Journal of Plantation Crops* (Kasaragod), vol. 18 (suppl.), 1991, p. 65-71.

BALASIMHA (D.), RAJAGOPAL (V.). — Stomatal response of cocoa (*Theobroma cacao*) to climatic factors. *Indian Journal of Agricultural Science* (New Delhi), vol. 58, 1988, p. 213-216.

BALASIMHA (D.), DANIEL (E. V.), BHAT (R. G.). — Influence of environmental factors on photosynthesis in cocoa trees. *Agricultural and Forest Meteorology* (Amsterdam), vol. 55, 1991, p. 15-21.

BARDEN (J. A.). — Apple tree growth, net photosynthesis, dark respiration and specific leaf weight as affected by continuous and intermittant shade. *Journal of American Society Horticultural Science* (Alexandria), vol. 103, 1977, p. 391-394.

BIRD (K. J.), HARDWICK (K.). — Carbohydrate balance during flush development in cocoa seedlings. *Proceedings 8th International Cocoa Research Conference*, Cartagena, Colombia, Oct. 18-23, 1981, Cocoa Producers Alliance (Lagos, Nigeria), 1982, p. 259-264.

BONAPARTE (E. E. N. A.). — Pruning studies on Amazon and Amelonado cocoa in Ghana. *Tropical Agriculture* (Trinidad), vol. 43, 1966, p. 25-34.

BURROWS (F. J.), MILTHORPE (F. L.). — Stomatal conductance in the control of gas exchange. *In :* Water Deficits and Plant Growth, ed. KOZLOWSKI, T. T., Academic Press (New York), vol. 4, 1976, p. 103-152.

CLEGG (K. M.). — The application of the anthrone reagent to the estimation of starch in cereals. *Journal of Science of Food and Agriculture* (Oxford), vol. 7, 1956, p. 40-44.

DUBOIS (M.), GILLES (A.), HAMILTON (J. K.), REBERS (P. A.), SMITH (F.). — Colorimetric method for the determination of sugars and related substances. *Analytical Chemistry* (Washington), vol. 28, 1956, p. 350-356.

KING (R. W.), ZEIVAENT (J. A. D.). — Enhancement of phloem exudate from cut petiole by chelating agents. *Plant Physiology* (Bethesda), vol. 53, 1974, p. 96-103.

LICHTENTHALER (H. K.), WELLBURN (A. K.). — Determination of total carotenoids and chlorophyll a and b of leaf extracts in different solvents. *Biochemical Society Transactions* (Colchester), vol. 603, 1983, p. 561-592.

MACHADO (R. C. R.), HARDWICK (K.). — Does carbohydrate availability control flush growth in cocoa. *Proceedings 10th International Cocoa Research Conference*, Santo Domingo, May 17-23, 1987, Cocoa Producers Alliance (Lagos, Nigeria), 1988, p. 151-157.

MARTIN (M. P. L. D.), PRASAD (G.). — Effects of pruning on Amelonado cocoa in Fiji. *Fiji Agricultural Journal* (Suva), vol. 45, 1983, p. 7-12.

RAJA HARUN (R. M.), HARDWICK (K.). — The effect of different temperatures and water vapour pressure deficits on photosynthesis and transpiration of cocoa leaves. *Proceedings 10th International Cocoa Research Conference*, Santo Domingo, May 17-23, 1987, Cocoa Producers Alliance (Lagos, Nigeria), 1988, p. 211-214.

THOMAS (G.), BALASIMHA (D.). — **Architecture de la frondaison, photosynthèse et rendement des cacaoyers.** *Café Cacao Thé* (Paris), vol. XXXVI, n° 2, avril-juin 1992, p. 103-108, 2 fig., 8 tabl., 15 réf.

Cinq types différents de frondaison, soit : un seul étage non taillé (T1), deux étages non taillés (T2), taille minimale pour donner la forme d'un cône (T3), taille sévère (T4), frondaison se développant horizontalement (T5), ont été réalisés chez le cacaoyer. Par suite de la taille, la surface de la frondaison et le nombre de branches sont significativement réduits. Une efficacité de l'interception de la lumière significativement faible avec, pour conséquence, des radiations photosynthétiquement actives (PAR) élevées sont notées dans les traitements dans lesquels les arbres sont taillés. A cause de cet effet, la conductance stomatale et le taux de transpiration croissent dans les traitements T4 et T5 avec une réduction de l'efficacité de l'utilisation de l'eau. Aucun traitement n'a d'effet significatif sur le taux net d'assimilation. Les assimilats de photosynthèse courants sont transférés et l'amidon stocké dans la tige est utilisé pour faire face à la demande exercée par la production intense des pousses chez les arbres taillés. Les rendements maximaux sont obtenus pour les traitements T1 et T2. Les faibles rendements observés pour les traitements T3, T4 et T5 peuvent être attribués aux raisons suivantes : (I) la réduction de la surface de la frondaison et du nombre de branches, (II) l'augmentation des besoins en glucides pour les nouvelles pousses et, en conséquence, le manque de glucides aux époques de la floraison et de la charge en cabosses, (III) le taux de transpiration élevé. Cette étude permet de conclure que le cacaoyer a besoin d'une frondaison assez grande et pouvant se développer pour avoir le meilleur rendement. Lorsque la taille est estimée nécessaire, elle devrait être limitée à une taille d'entretien assurant un indice de surface foliaire optimal et à l'élimination de la base de la frondaison trop ombragée ou aux branches internes de la frondaison.

THOMAS (G.), BALASIMHA (D.). — **Arquitectura de la frondosidad, fotosíntesis y rendimiento de los cacaos.** *Café Cacao Thé* (Paris), vol. XXXVI, n° 2, avril-juin 1992, p. 103-108, 2 fig., 8 tabl., 15 réf.

Con objeto de analizar la arquitectura de la frondosidad se realizaron cinco tipos diferentes de frondosidad del cacao : un solo nivel sin podar (T1), dos niveles sin podar (T2), poda mínima para darle la forma de un cono (T3), poda severa (T4) y frondosidad de desarrollo horizontal (T5). Como consecuencia de la poda se redujo notablemente la superficie de frondosidad y el número de ramas. En los tratamientos de poda se observó una eficacia de la intercepción de la luz bastante reducida, provocando asi elevadas radiaciones fotosintéticamente activas (PAR). A causa de este efecto, se observó un aumento de la conductancia estomática y del índice de transpiración en los tratamientos T4 y T5, así como una reducción de la eficacia de utilización del agua. Ninguno de los tratamientos tuvo efectos significativos sobre el coeficiente neto de asimilación. Los asimilados de fotosíntesis corrientes son transferidos y el almidón almacenado en el tallo es utilizado para satisfacer la demanda provocada por la intensa producción de brotes en los árboles podados. Los rendimientos máximos se obtuvieron con los tratamientos T1 y T2. Los rendimientos bajos observados en los tratamientos T3, T4 y T5 pueden atribuirse a las siguientes razones : (I) a la reducción de la superficie de la frondosidad y del número de ramas, (II) al aumento de glúcidos requeridos por los nuevos brotes y, por consiguiente, a la falta de glúcidos durante las épocas de floración y de formación de las mazorcas, (III) al elevado indice de transpiración. Este estudio permite concluir que, para ofrecer el mejor rendimiento, el cacao necesita una frondosidad bastante densa que pueda desarrollarse. Si la poda fuese necesaria, deberia limitarse a una poda de cuidado que permita obtener un óptimo índice de superficie foliar, a la eliminación de la base de la frondosidad demasiado sombreada o a las ramas internas de la frondosidad.