PERFORMANCE IN ASSOCIATION OF CULTIVARS OF CASSAVA (*Manihot esculenta* Grantz) AND COWPEA (*Vigna unguiculata* Walp.) OF DIFFERENT GROWTH HABITS

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ABSTRACT

Studies related to the improvement of crops growing in association with special emphasis on cassava and grain legumes are reviewed. With the objective of determining the effect of growth habit of the components species of the cassava-cowpea association, an experiment in randomized blocks was set up on typic distropept with four repetitions and 24 treatments: (for growth habits of cassava and monoculture of cowpeas) X (four growth habits of cowpea and monoculture of cassava). Two crops of cowpeas planted 0 and 253 days after planting cassava were harvested before the cassava reached maturity. With non-climbing cowpea types cassava was planted in double rows while climbing cowpeas were planted with cassava in a 1m x 1m arrangement. Agronomic, morphologic and microclimatic parameters were measured.

Only in the second cowpea cycle was there a significant interaction between cassava and cowpea growth habits. Height of the cassava and the percentage of photosynthetically active light which in intercepted influenced yield of cowpea planted 220 days after cassava planting. However, these interactions were often not the most important determinants of yields of the components. The results are discussed in terms of general and specific compatibility of the growth habit under consideration. Phenotypic characteristics related to such compatibility are postulated.

Associated plantings of different crops species is a predominant agricultural practice in both the paleo and neotropics (Francis, Flor, and Temple, 1976). While selection of genotypes suitable for this practice has been carried on by local farmers for centuries it is only in the past years that it has received the attention of professional breeders (Willey, 1979; Ruthenberg, 1977). From crop competition studies, Harper (1963) concluded that the performance of the associated crops cannot be deduced from the performance of the individual species in monoculture. Willey (1979), stated that the objective of the selection for crop mixtures should be simply to find genotypes which maximize complementary reciprocal effects. Unquestionably, a genotype which will eventually be used in association with another species should be evaluated under those conditions at some stage in the selection process.

The association of cowpeas and cassava appears to offer a means of exploiting to the fullest most resources of the humid tropical environment,both species are relatively tolerant to adverse soil conditions and show reasonable disease and insect resistance under these conditions. The combination of a tall long-season crop (cassava) with a shorter, quicker growing crop (cowpea) should be the ideal combination

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(Sanchez, 1976) for exploiting the light resources of such an environment as well as minimizing interspecific competition.

The objetive of the present study was to determine if cassava and cowpea cultivars of different growth habits interacted differently when grown in association. It was hoped a combination of cassava and cowpea plant type could be found which maximized the resources available.

Materials and Methods

A randomized complete block experiment with four repetitions was planted september 15, 1981 in the experimental farm of CATIE (Centro Agronómico Tropical de Investigación y Enseñanza) on a soil classified as a Typic Dystropept, mixed, fine isohyperthermic (Aguirre, 1971) at 600m above sea level with an annual precipitation about 1600mm. Treatments consisted of four different cultivars of cassava and cowpeas, each of differente growth habits, in all possible combinations as well as in monoculture, for a total of 24 treatments. Cassava cultivars were differentiated on the basis of height to first ramification and leaf area (Table 1). Growth habits of the cowpea cultivars corresponded to types 7,6,3 and 2 of the catalogue published by the International Institute of Tropical Agriculture (1974) where they are identified as climbing, prostrate, semierect, and erect, respectively.

The cassava-cowpea system consisted of a single cassava crop and two cowpea crops. The first cowpea crop was planted simultaneously with the cassava except for the climbing types which were used only as a second crop. The second cowpea crop was planted 253 days after the cassava planting when the leaf area index was beginning to decline. Crop arrangement, plot size, and cultivars representing each plant type of cowpea are presented in Fig.1. Cowpeas of the climbing habit were associated with cassava planted at 1m x 1m, while other growth habits were planted in the 2.5 m space between double rows of cassava separated by 0.83 m. In both arrangements, planted populations of cassava were 10,000 plants per hectare. For climbing, prostrate and semierect cowpeas, plant population were 80,000 pl/ha in association and 133,333 pl/ha in monoculture. For erect cowpeas, plant population in association and monoculture were 160,160 and 266,666 pl/ha respectively.

Soil analysis of the experimental area indicated: pH 5.a, O.M. 77.77, Exch Ca, Mg, K, and Al: 4.0, 1.0, 0.4, and 0.3 me/100 ml respectively, available P_2O_5 (modified Olsen) - 14.2 ug/ml for which 0.5 T/ha agricultural limestone, 20 kg/ha,N, 44 kg/ha P_2O_5 and 42 kg/ha K_2O were recommended.

Premature branching of cassava due to insect attack was prevented by the application of Methamidophos at 0.5 kg/ha. A mixture of Benomyl and Carbaryl at 0.5 g a.i/l and 1g a.i/l, respectively, was applied to cowpeas for control of leaf diseases and Diabrotica spp. Cassava was pruned at 90 days to eliminate lateral shoots.

Dry matter in stems, leaves, and petioles as well as leaf area index was determined on a two plant sample of cassava at three dates previous to harvest when a 16 plant area was harvested for dry matter and yield. Cassava was harvested 440 days after planting. Height and with of plant canopy for both cowpeas and cassava were determined at monthly intervals. Percent of photosynthetically active radiation (PAR) not intercepted by cassava was measured 176, 186, 237, 308, 369 and 382 days after planting with a LICRO LI-190SB sensor above the canopy and a LI-191SB line quantum sensor at ground level, utilizing a transect of 6 m for the plots with cassava planted in double rows and of 2 m for the plots with cassava at the 1.0 m x 1.0 m spacing.

Cassava roots were dried for 72 hours at 70°C. Both cowpea and cassava yields were corrected for stand by an analysis of covariance. (Steel and Torrie, 1980).

Results and Discussion

Effect of Cowpea on Cassava Yields.

Yields of cassava for the different treatment combinations are shown in Fig.2. Two distinct patterns are apparent. In the 'CMC 84' and 'Col 1684' cultivars, cowpea plant types reduced cassava yield in this order: erect-prostrate-semierect-climbing. This effect might be explained by the fact that the latter two cowpea types offered less competition, due to later planting of the climbing type and high disease incidence in the second planting of the climbing type and high disease incidence in the second planting of the semierect type. In the other two cassava cultivars ('Creole' and 'Valencia'), no such trends were observed although the factors affecting cowpea development (planting date and disease incidence) were the same.

Statistical analysis further clarified these trends although F tests for main effects of cowpea type and cassava type as well as for interaction were not statistically significant. However, one degree of freedom tests for certain components of the interaction showed significance at the 5% level and are illustrated in Figure 3. Thus, it can be seen that the cowpea plant types affected the two groups of cassava cultivars in a significantly different manner. The reason for the two trends in cassava response to cowpea plant types is not inmediately apparent as the cassava cultivars presenting a similar response are of dissimilar growth habits (Table 1). More detailed analysis of yield components of the cassava cultivars will be necessary to explain the trends observed.

Photosynthetically active radiation (PAR) not intercepted by the cassava canopy at 6 dates are shown in Figure 4. In general non-intercepted radiation increased for the second sampling date (186 DAP), when it had an average value of 41.3%. At the third sampling date (237 DAP), non-intercepted PAR began to decline and maintained this trend until the last date on which measurements were taken (382 DAP) when it was 19.1%. As a second cowpea planting was made 253 days after planting, it is these latter three determinations (made at 308, 369, and 382 DAP when the non-intercepted PAR was 27.3, 25.1, and 19.1% of the PAR respectively), which determine the light available to the second cowpea crop. From Figure 4, it can also be noted that 'Valencia' variety intercepted the smallest amount of light during this period, with a mean 32.4% non-intercepted PAR for the last three dates. The 'Creole' cultivar only transmitted 18.1% of the PAR while the 'CMC 84' and 'Col 1684' cultivars failed to intercept moderate (24 and 21% respectively) amounts of the radiation.

The effect of these differences on cowpea yield in the second crop can be seen most clearly in Table 2, where yield appears to be directly proportional to amount of light not intercepted by the cassava cultivars. Yields for the semierect plant type are not included as this cultivars was heavily attacked by anthracnose and failed to yield.

From the better performance of the 'CMC 84' and 'Col 1684' cultivars when with the climbing cowpea, which was only planted 253 days after the cassava, it can be concluded that these varieties were adversely affected by competition by cowpea in the period soon after planting. These effects were strongest with the prostrate and erect cowpeas, which would be expected to produce the greatest competition, the former due to its greater vigor and the latter due to the higher population. Poor competing ability of the semierect cowpea is reflected in the low yields of cowpeas and relatively high yields of cassava obtained by this combination with all cassava cultivars.

The greater light penetration allowed by the 'Valencia' cultivar, permiting higher cowpea yields in the second planting, is offset by the relatively lower yield potential of this cultivar, as well as by the fact that the highest yields of cowpea were produced by the prostrate types, in which yields of the first planting were much higher than in second planting. Thus, total yields of prostrate cowpeas with 'Col 1684' and 'Criolla' varieties was higher than with the 'Valencia' cultivar despite the significantly higher yield with the latter cultivar in the second planting. All the cassava cultivars outyielded the 'Valencia' cultivar when associated with the prostrate cowpeas although this difference never attained statistical significance.

Final choice of the best combination of cassava and cowpea cultivars would have to depend on local preferences and market conditions. In areas such as northern Brazil where cowpea is important in the diet, a farmer would realily sacrifice 2000 Kg/ha of cassava for an additional 1000 Kg/ha of cowpeas. However, in the case of the 'CMC 84' and 'Col 1684' cultivars, subtitution of climbing for prostrate cowpea would entail a 5000 Kg/ha gain in cowpea yield. It should be noted however, that the 'CMC 84' and 'Col 1684' cultivars are bitter, requiring processing to produce a saleable product, which woulf thus reduce then return.

With 'Creole' and 'Valencia' cultivars, the only ones acceptable in areas such as Central America where bitter cassavas are not used, the substitution of prostrate for climbing cowpea would be more readily made involving, as it does, only a small decrease, and in the case of the 'Creole', a slight increase, in cassava yield cowpea yield would increase by some 500 Kg/ha. Because of the higher yield of 'Creole' cultivar and the that the prostrate cowpea yielded much better in the first planting with this cultivar than with 'Valencia', one would conclude that this cultivar would be preferred despite the higher yield of the second crop cowpea with the 'Valencia' cultivar.

The performance in association of cowpea and cassava cultivars of different plant type depended not only upon competitive ability but also on yield capacity of the different components. The higher yield capacity of the postrate cowpea and of the 'Creole' cassava cultivar appears to be as important as the low light interception of the 'Valencia' cultivar especially as the smaller leaf area associated with lower light interception might also be responsible for lower yields of cassava. In fact, it would seem that the combination of two aggressive plant types was more productive than the association of less aggressive, complementary plant types which should have offered less mutual competition.

The authors thank Dr. Julio Henao, of the estatistics unit of CATIE, for help in the statistical analysis and Mr. Gregorio Fuentes for his assistance in the field measurements. Thanks are also due to Dr. Jonathan Woolley, formerly of CATIE, presently cropping systems agronomist at CIAT, for his help in designing the experiment.

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Table 1. Characterization of growth habits of the four cassava cultivars used in the study.

Cassava Cultivar	Origin	Height from soil surface to first ramification (m) (2)	Canopy height (m) (2)	Canopy width (m) (2)
Valencia	Costa Rica	2.0 ± 0.4 (1)	2.8 ± 0.4 (1)	1.3 ± 0.4 (1)
Criolla	Honduras	1.4 ± 0.5	2.1 ± 0.3	1.6 ± 0.2
CMC 84	CIAT (3)	1.8 ± 0.3	2.6 ± 0.3	1.5 ± 0.3
COL 1684	Colombia	0.4 ± 0.2	1.3 ± 0.3	1.5 ± 0.3

(1) Mean $\pm$ s.d

(2) Measurement taken 288 days after planting

(3) International Center of Tropical Agriculture (CIAT)

Table 2. Non-Intercepted photosynthetically Active Radiation (PAR) and yields of second crop of three different cowpea plant types as affected by four cassava cultivars of different plant types.

Cassava Cultivars	COWPEA YIELDS (Kg/ha) Climbing	Triling	Erect	Mean of 3 plant types	Non-intercepted PAR (%) 1
'Valencia'	1098 a	532 b	320 b	647	32.4
'Creole'	296 b	77 c	130 b	168	18.1
'Col. 1684'	709 b	340 b	135 b	394	24.0
'CMC 84'	470 b	183 b	136 b	263	21.0

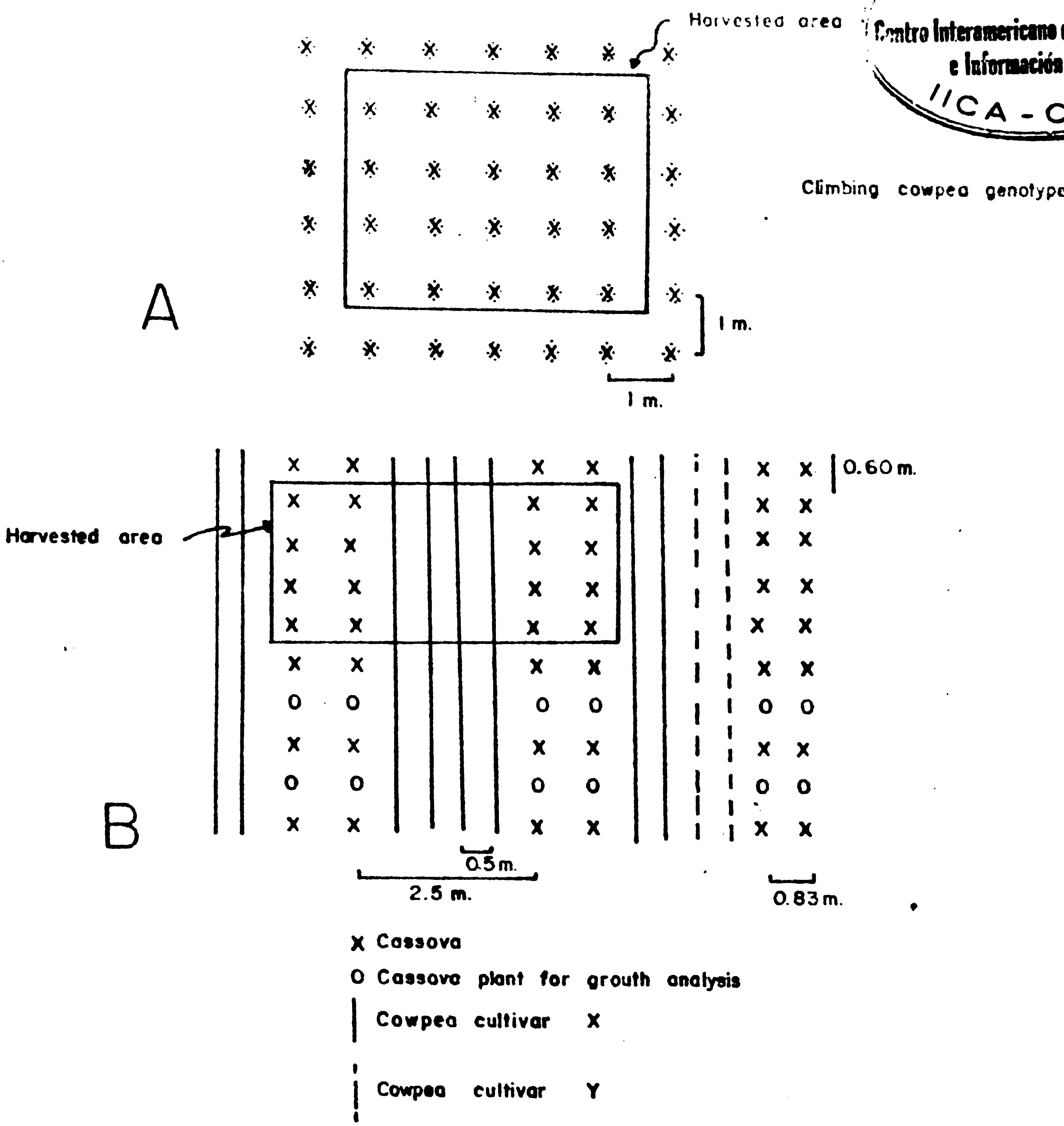
Values followed by same letter do not differ significantly by L.S.D. at 5% level.

1 Mean of last three sampling dates.

Table 3. Cassava and cowpea yields resulting from combinations of different cultivars.

Cassava Cultivar	Cowpea Cultivar	Yield of Cassava (kg/ha)	Yield of Cowpea (kg/ha) Ist cycle	2nd cycle	Total yield
CMC 84	Erect	9778 ab	660	136	796 bfg
	Prostrate	11734 ab	1125	184	1309 abfg
	Semierect	13714 ab	167	0	167 fg
	Climbing	16386 ab	0	388	388 dfg
COL 1684	Erect	10631 ab	379	136	515 defg
	Prostrate	11095 ab	1705	340	2045 a
	Semierect	12327 ab	152	0	152 fg
	Climbing	17552 a	0	794	794 cg
CREOLE	Erect	14386 ab	526	130	656 bfg
	Prostrate	13584 ab	1519	77	1596 abfg
	Semierect	14749 ab	131	0	131 f
	Climbing	9987 ab	0	377	377 dfg
VALENCIA	Erect	11141 ab	877	320	1197 abfg
	Prostrate	10184 b	960	524	1484 abcfg
	Semierect	11890 ab	208	0	208 fg
	Climbing	11477 ab	0	993	993 befg

Values followed by the same letter do no differ significantly at $p = 0.05$.



Growth Habit	Classification (IITA, 1974)	Cultivar	Origin
Climbing	7	'Negro Tenabo'	México
Prostrate	6	'TVU 1190'	Nigeria
Semierect	3	'Centa 105'	El Salvador
Erect	2	'Selec. 288'	U.S.A.

Fig. 1. Crop arrangement, plot, size, and classification of cowpea cultivars.
A. Crop arrangement for cassava associated with climbing cowpea cul...
B. Crop arrangment for cassava associated with erect, semierect, and prostrate cowpea cultivar.

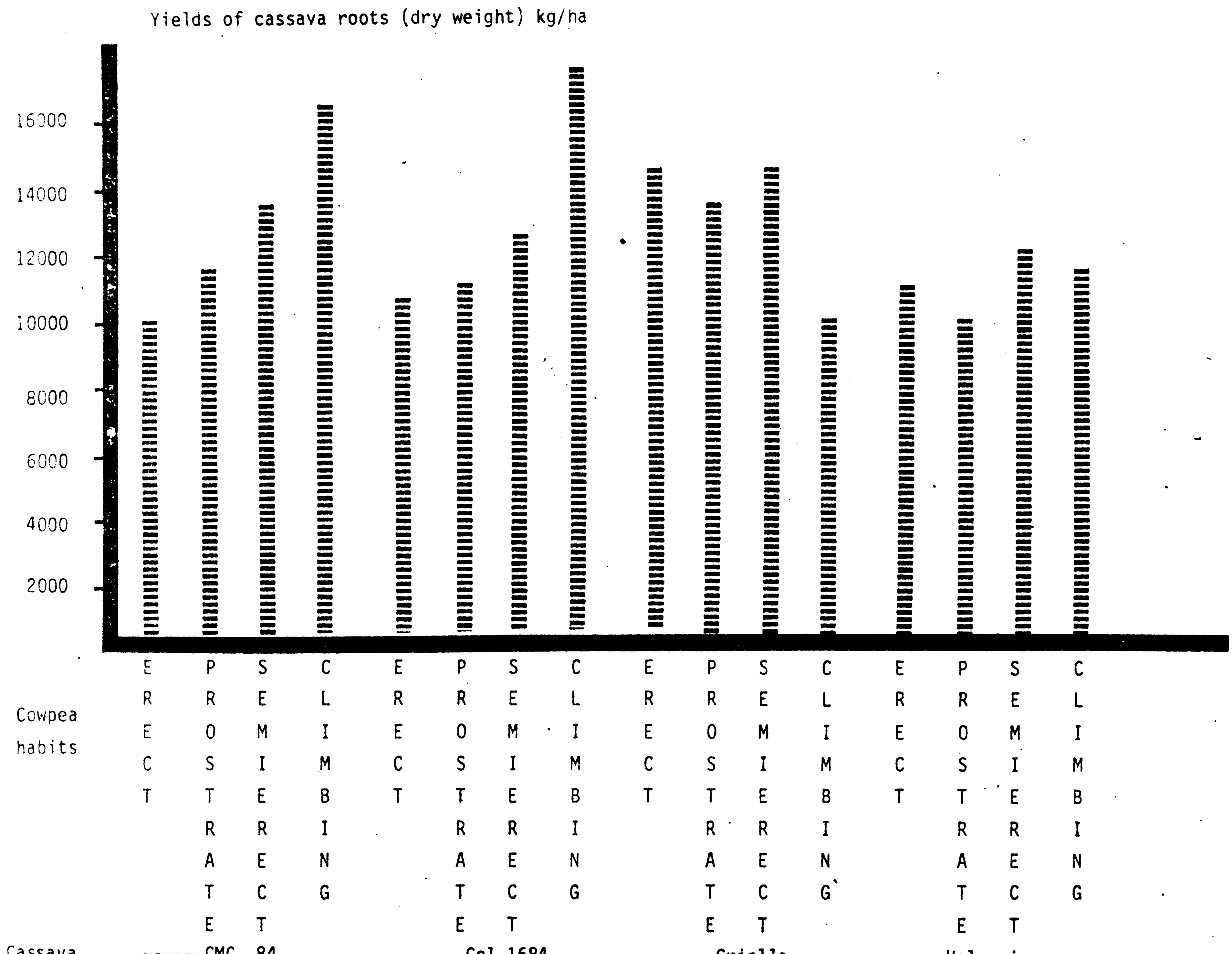


Fig. 2. Yields of cassava cultivars associated with cowpea cultivars of different growth habits.

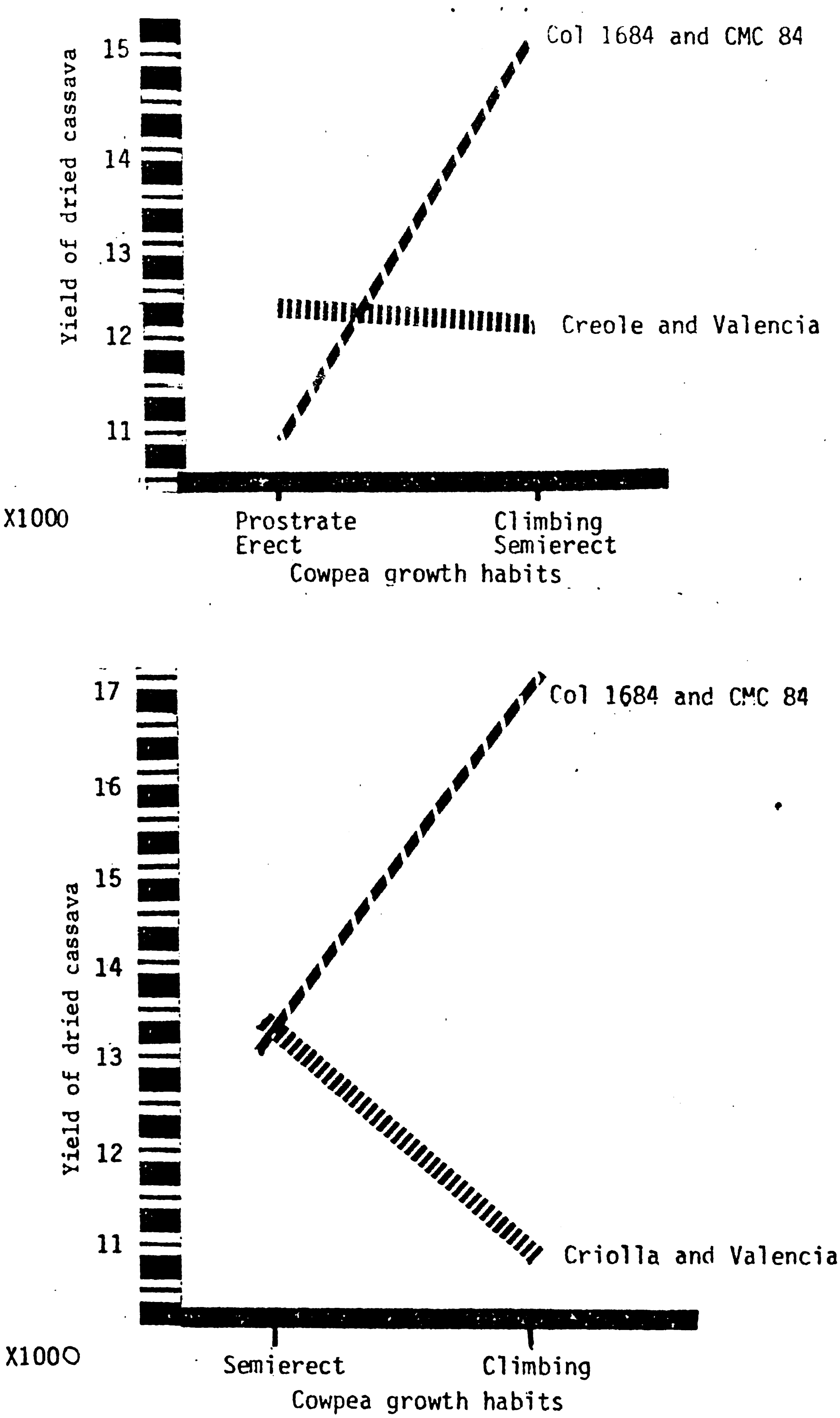
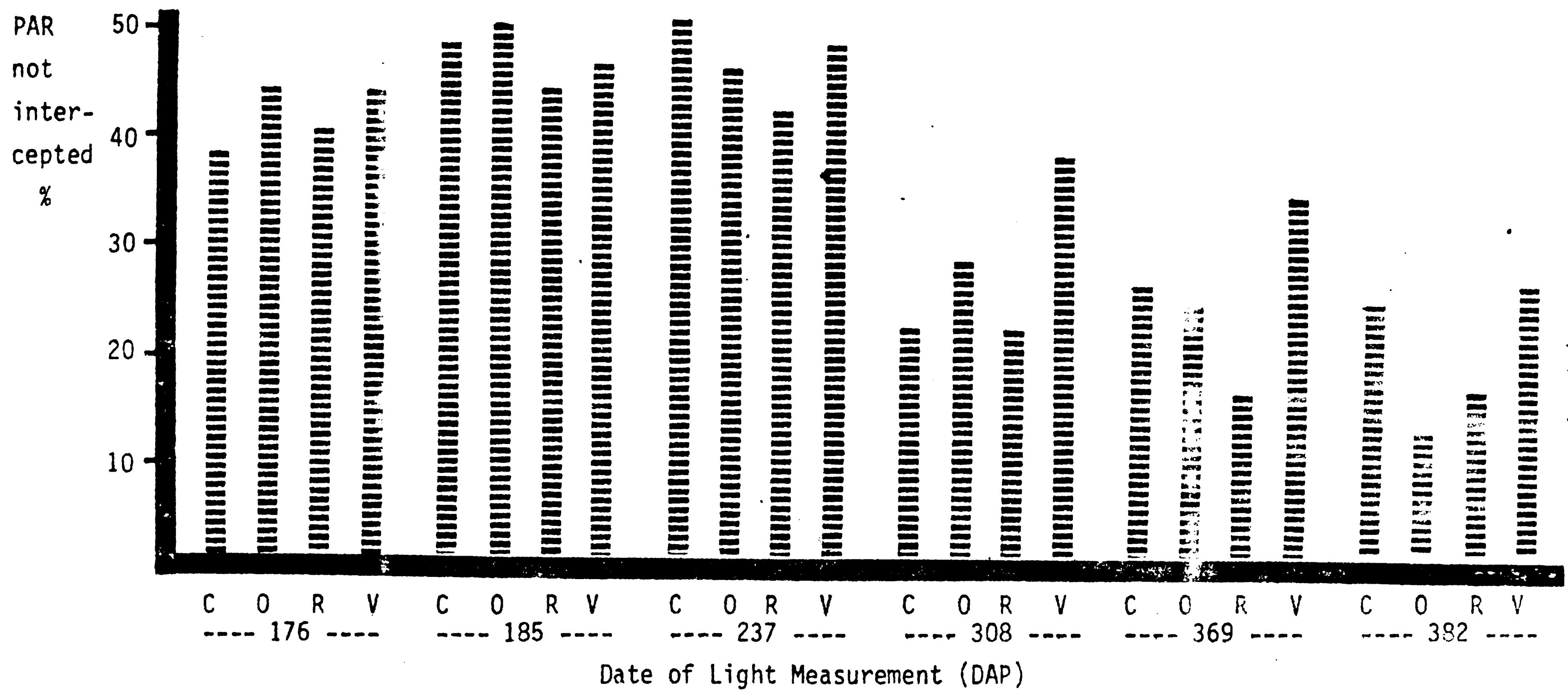


Fig. 3. Mean yields of two groups of cassava cultivars as affected by association with cowpeas of different growth habits.



Abbreviations for Cassava Cultivars:

C - CMC 84
O - Colombia 1684
R - Creole
V - Valencia

Fig. 4. Photosynthetically active radiation not intercepted by four cassava cultivars at six dates after planting.

FITO No. 2033-81
19 de junio de 1984