PHENOTYPIC VARIATION IN NATURAL POPULATIONS OF CAIAUÉ (*Elaeis oleifera* (H.B.K.) Cortés) IN THE BRAZILIAN AMAZON

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1. Introduction

The possibility of employing *Elaeis oleifera* germplasm as a source of genetic variability in breeding programs for oil palm (*Elaeis guineensis* Jacq) is an important strategy for the solution of problems presently hampering cultivation, such as better quality of oil, greater disease resistance and slower trunk growth (HARDON 1969, VALLEJO *et al.* 1975, MEUNIER 1975 and 1976, MEUNIER *et al* 1976).

Although the species is widely distributed throughout Brazil, little is known about its characteristics as well as the pattern of variation existing among materials collected in their matural conditions, factors of great importance in defining programs for exploring genetic resources of a species (OOI *et al* 1979 and 1981, RAJANAIDU 1983).

X The present work, based on data obtained from natural populations of E. *oleifera* in the Brazilian Amazon and compiled during a joint Empresa Brasileira de Pesquisa Agropecuária-EMBRAPA/ Institut de Recherche pour les Huile^s et Oléagineux - IRHO survey,^X analyses the characteristics considered most important for intra-and inter-specific genetic breeding programs. In spite of the great environmental heterogenety acting upon the populations and which must have an influence on some of the variables studied, the results revealead aspects of the pattern of variation that exists in this species.

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II. Materials and Methods

The data presented here were obtained during a survey undertaken for the collection of *E.oleifera* seeds that covered the majority of the area of occurrence of this species in the Brazilian Amazon.

The area surveyed was divided into 6 regions (Figure 1), with collections in 5 to 13 locations or populations per region and sampling 2 to 25 plants per location. Only plants presenting ripe bunches were sampled and the characteristics linked to habitat, population and to the vegetative and reproductive systems of the plant were registered.

1. Characteristics studied

Measurements were taken according to the methodology employed in studies on oil palm (CORLEY *et al*, sd). Information was collected on a total of 29 characteristics relating to vegetative and reproductive organs of the plant.

Only those characteristics relevant to breeding will be described in this study although some analyses were performed considering all the variables originally involved.

The following variables were studied:

x_1 length of foliar rachis - cm

x_2 weight of bunch - kg

x_3 percentage of normal fruits

x_4 percentage of parthenocarpic fruit

x_5 percentage of mesocarp in normal fruit

x_6 average weight of normal fruit - g

x_7 percentage of oil in dry mesocarp

x_8 percentage of oil unsaturation

2. Statistical Analysis

Considering the number of different plants sampled per population as well as the lack of standardization on the number of populations studied, a hierarchical analysis was applied as a model for variance analysis in order to determine the effect of plants in populations and the effect of populations within regions (KENDALL *et al* 1966, SEARLE 1971, SNEOECOR *et al* 1974, KEMPTHORNE 1979).

The total variation of each characteristic was determined by calculating the average, minimum and maximum value, standard deviation and coefficient of variation for each.

The average for each characteristic studied was compared with those obtained for each region.

3. Discriminant Analysis

The generalised distance method of mahalanobis was applied employing a total of 29 vegetative, reproductive and oil characteristics in order to synthetize the differences among regions in relation to the total of available characteristics (MAHALANOBIS 1948, RAO 1964, KENALL *et al* 1966, MEUNIER 1969 & RAJANAIDU *et al* 1979).

III. Results and Discussion

The total phenotypic variation for the 8 characteristics studied is shown in Table 1. The coefficient of variation (C.V.) varied between 8,1% and 109,37. The percentage of unsaturation presented the lowest value (8,1%) while the percentage of parthenocarpic fruits on the bunch (x_4) was the largest one. The coefficients of variation found are in general higher than those found for the species in the experimental plantations in Costa Rica (ESCOBAR 1980) and similar to the values found for natural populations of oil palm that occur in the Ivory Coast (MEUNIER 1969) and in Nigéria (RAJANAIDU *et al.* 1979).

The values found for the characteristics studied were consistently superior to those found for the species in natural populations in Honduras, Nicaraguá, Costa Rica, Panamá and Colômbia (RAJANAIDU *et al* 1983) as well as those found for material of various origins planted in experimental conditions in Costa Rica (ESCOBAR 1980).

This fact shows a more detailed description of the data presented earlier (OOI 1981) where characteristic of bunch and fruit of Brazilian *oleifera* material were compared with that of different origins (Colômbia, Suriname , Costa Rica, KLM).

The variance analysis (Table 2) indicates the existence of significant differences among regions for all the characteristics studied. Similar differences were fround among the populations, except for the characteristic percentage of oil in dry mesocarp (x7). When the averages are compared among regions (Table 5), it can be observed a striking difference between region 4 and the others for foliar rachis length (x_1) and bunch weight (x_2) being much lower than the average values found for other regions. The other characteristics studied (percentage of normal fruit (x_3), percentage of parthenocarpic fruit (x_4), percentage of mesocarp (x_5), percentage of oil in dry mesocarp (x_7) and percentage of oil unsaturation (x_8) do not presented very significant differences among the various regions (Figure 2 to 9). Figure 1 shows that region 4 (Manaus Caracaraí Highway) is geographically close to Surinam where the *E.oleifera* material studied presents characteristics that are distinct from those of material originating from Costa Rica, Honduras, Panamá, Nicaraguá and Colômbia. This lead to conclude that there is a strong relationship between the material from region 4 and Surinam.

The variance decomposition (Table 2) shows that the characteristic foliar rachis (x_1) has its greatest source of variation (60%) due to differences among the regions and is mainly influenced by the low average (263,6) presented by region 4 - Manaus Caracaraí, representing material with low vegetative development, and by the high average (472,7) presented by region 6 - Solimões river, indicating material with a great vegetative development. The other characteristics, with the exception of percentage of normal fruit (x_3) and the percentage of parthenocarpic fruit (x_3) for which the main variation is the due to intra population differences (the latter being not significant), present as the main component of variance the differences verified among plants of a same population.

The mahalonobis differences (D^2) computed among the regions, in function of 29 characteristic (vegetative, reproductive, oil content etc), indicate the existence of significant differences among all the regions studied (Table 4). Considering these values as a measurement of divergence between materials occurring in different regions, one can observe that Region 4 - Manaus/ Caracaraí is the most distant region (Figure 9). This information can be employed to guide breeding programs for this species, where region 4, for example, could be crossed with any other region. Regions 1 - Manaus, 2- Madeira river and 3- mid-Amazon river should not be crossed among each other, the same being true for the regions 5 - Negro river and 6 - Solimões river.

Electrophoresis of this material will eventually be performed in order to better define the pattern of genetic variation of this species in the Brazilian Amazon.

IV. Conclusions

Natural populations of *Elaeis oleifera* occurring in the Brazilian Amazon present a phenotypic variation thats permits to be ranked into at least two clearly defined groups: material from the region of Manaus-Caracaraí that is similar to material from Surinam, and material from the other regions , similar to that of other regions of Central and South America.

The characteristics studied presented values (averages, minimums and maximums) superior to those obtained for this species in other countries. For this reason, the germplasm of Brazilian E. *oleifera* has a greater potencial for success in breeding programs.

V. Acknowledgements

We would like to thank those who participated in the EMBRAPA/IRHO prospection for seed collection of *Elaeis oleifera* in the Brazilian Amazon in 1982, namely Drs. Lídio Coradin (CENARGEN-EMBRAPA), Abílio R. Pacheco (CNPSD-EMBRAPA), Emeleocípio B. Andrade (CPATU-EMBRAPA), Soi Chai Ooi (IICA-EMBRAPA), Jacques Meunier, Phillip Amblard and Bertrand Tailliez (IRHO), Antônio R. Carvalho (CEPEC-CEPLAC) and Mr. Glocimar Pereira da Silva (CENARGEN-EMBRAPA).

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TABLE 1 - Phenotypic characteristics observed on plants from natural populations of *Elaeis oleifera* (H.B.K.) Cortés) of the Brazilian Amazon, 1985.

CHARACTERÍSTICA	N*	Mean	Min	Max	σ	C.V. %
x_1 - Foliar rachis length - cm	299	393	188	647	93,78	23,86
x_2 - Bunch weight - kg	205	6,7	0,9	18,0	3,67	54,78
x_3 - Normal fruits (%)	171	59,42	11,2	90,5	15,74	26,50
x_4 - Parthenocarpic fruit (%)	157	9,52	0,0	45,7	10,39	109,37
x_5 - Mesorcarp (%)	176	46,0	14,6	62,3	6,51	14,15
x_6 - Average normal fruit weigth	187	7,87	3,45	14,66	2,30	29,22
x_7 - Oil (%) in dry mesocarp	171	42,84	16,10	57,20	6,52	15,23
x_8 - Unsaturation/oil (%)	171	70,11	59,98	77,66	5,69	8,12

N - number of observations.

TABLE 2 - Variance analysis of phenotypic characteristics observed on plants from natural populations of *Elaeis oleifera* (H.B.K.) Cortés of the Brazilian Amazon, 1985.

CHARACTERISTICS	Mean square			Variance components %		
	Plant	Population	Region	Plant	Population	Region
x_1 - Foliar rachis length - cm	2.340	15.460**	194.560**	20	20	60
x_2 - Bunch weight - kg	9,21	19,42*	28,86*	78,2	18,8	3,6
x_3 - Normal fruits(%)	66,6	634,4**	238,8**	30,8	69,2	-
x_4 - Parthenocarpic fruit (%)	40,0	247,5**	321,2**	41,3	56,5	2,1
x_5 - Mesocarp (%)	25,9	59,9**	164,2**	64,9	22,4	12,7
x_6 - Average normal fruit weigth	2,4	7,3**	19,9**	57,3	28,1	14,6
x_7 - Oil (5) in dry mesocarp	39,7	35,4	366,7**	69,9	-	30,1
x_8 - Unsaturation oil (%)	6,5	21,4**	39,3**	58,0	35,9	7,0

* significant at 5%

** significant at 1%.

TABLE 3 - Comparison between mean values among regions for phenotypic characteristics observed on natural populations of *Elaeis oleifera* (H.B.K.) Cortés of the Brazilian Amazon, 1985.

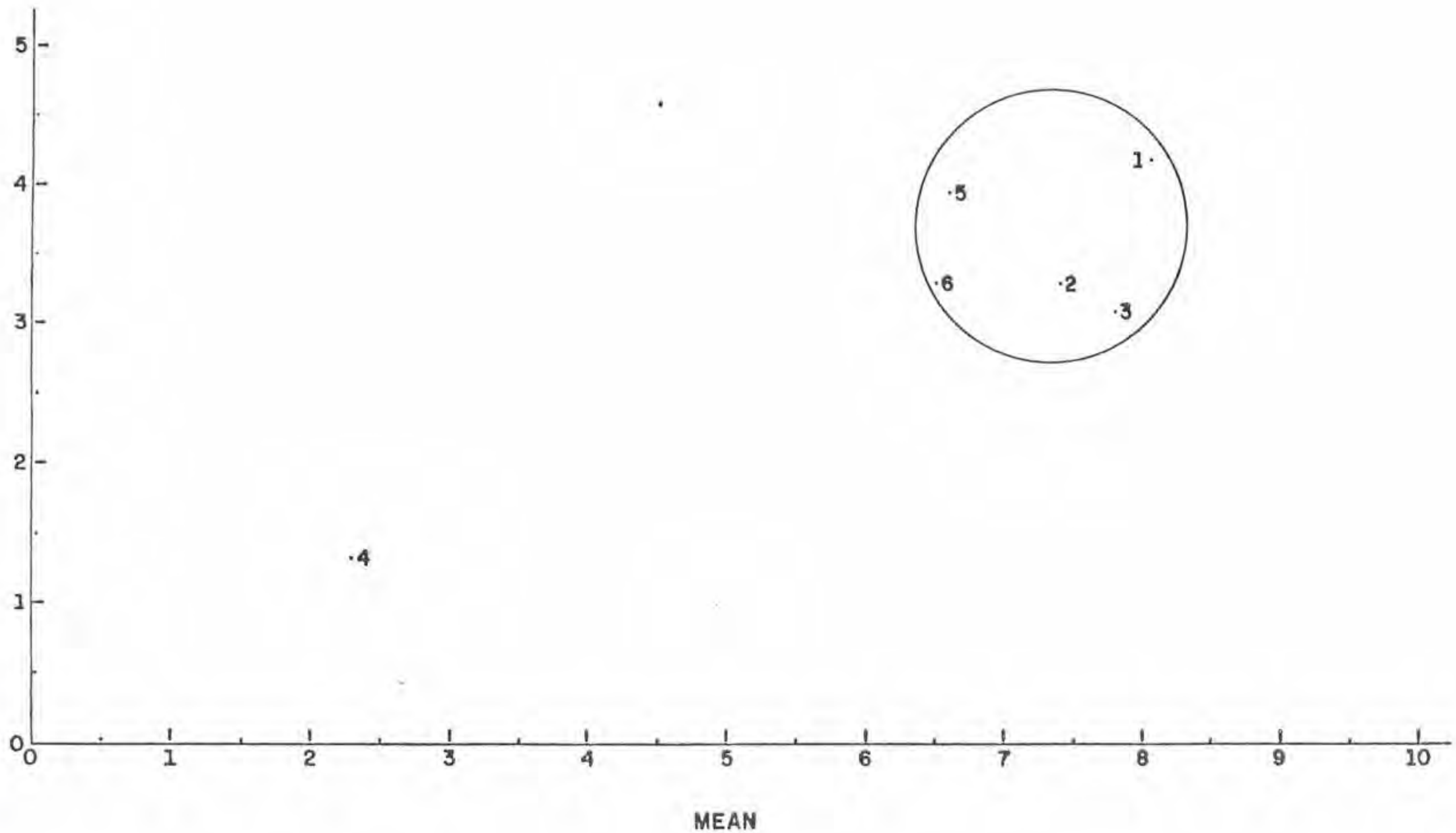
Region	Mean value							
	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
1 - Manaus	$406{,}7_{bc}$	$8{,}0_{b}$	$59{,}2_{ab}$	$15{,}6_{b}$	$44{,}1_{a}$	$5{,}8_{a}$	$39{,}8_{ab}$	$69{,}9_{abc}$
2 - Madeira river	$399{,}2_{bc}$	$7{,}4_{b}$	$55{,}4_{a}$	$7{,}1_{a}$	$48{,}4_{a}$	$8{,}4_{b}$	$44{,}4_{c}$	$71{,}7_{cd}$
3 - Mid-Amazon river	$421{,}9_{c}$	$7{,}8_{b}$	$67{,}0_{b}$	$10{,}8_{ab}$	$44{,}4_{a}$	$7{,}8_{b}$	$44{,}6_{c}$	$68{,}5_{a}$
4 - Manaus - Caracaraí	$263{,}6_{a}$	$2{,}3_{a}$	$61{,}8_{ab}$	$7{,}1_{a}$	$46{,}9_{a}$	$7{,}2_{ab}$	$42{,}2_{bc}$	$73{,}5_{d}$
5 - Negro river	$354{,}1_{b}$	$6{,}6_{b}$	$58{,}8_{ab}$	$8{,}6_{ab}$	$46{,}6_{a}$	$7{,}3_{ab}$	$46{,}2_{c}$	$69{,}4_{ab}$
6 - Solimões river	$472{,}7_{d}$	$6{,}5_{b}$	$55{,}2_{a}$	$8{,}1_{ab}$	$45{,}5_{a}$	$2{,}55_{b}$	$36{,}3_{a}$	$80{,}8_{bcd}$

Obs: The mean values followed by identic al letters do not differ significantly.

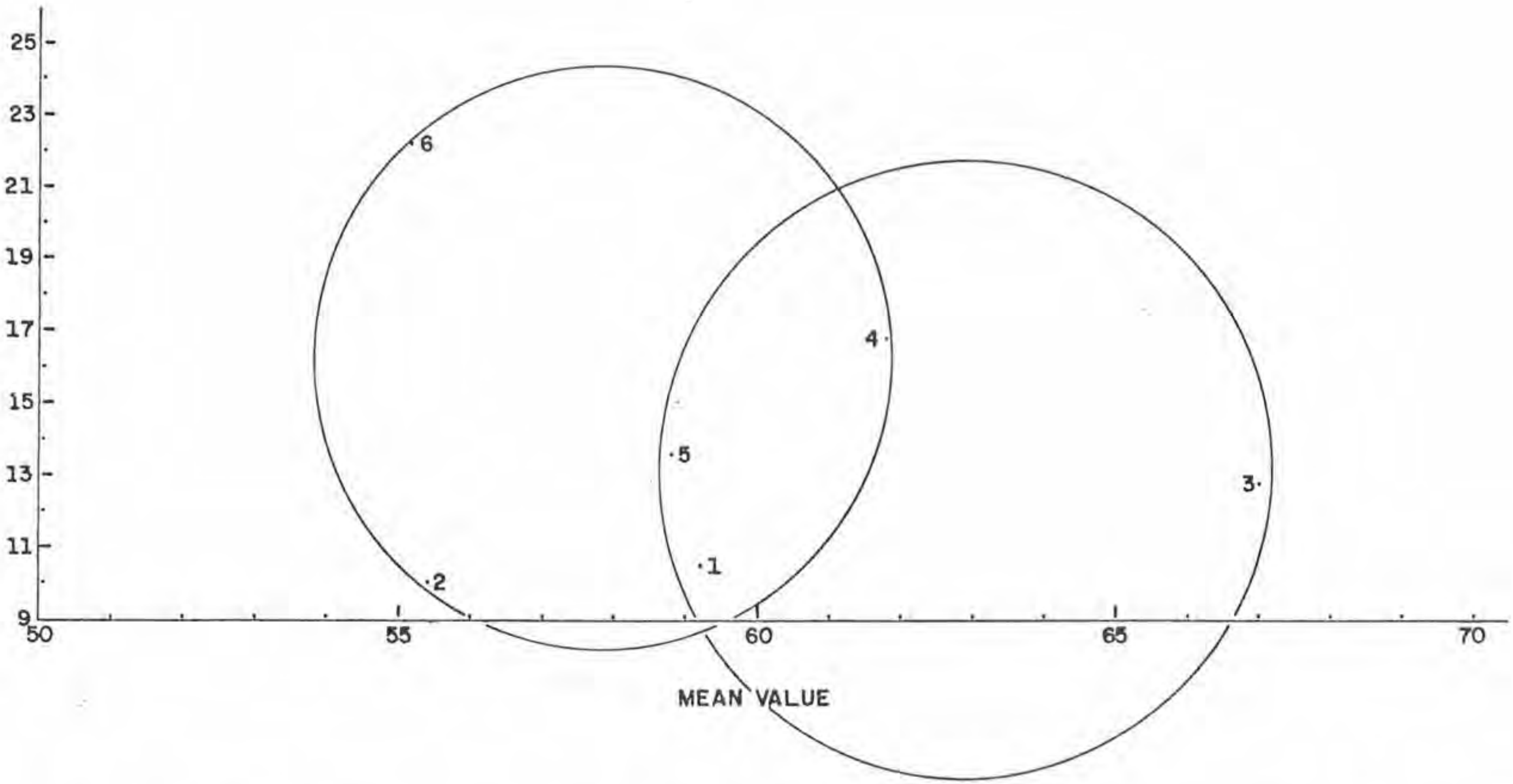
TABLE 4 - Significance study of Mahalanobis distances among regions

Regions	Regions 2	3	4	5	6
1 - Manaus	3,45**	3,04**	7,72**	4,03**	4,71**
2 - Madeira river		3,55**	8,56**	4,32**	5,13**
3 - Mid- Amazon river			8,48**	3,82**	5,20**
4 - Manaus - Caracaraí				8,01**	7,31**
5 - Negro river					4,62**
6 - Solimões river					-

**significant at 1%



IG. 3- BUNCH CHARACTERISTICS AMONG REGIONS (NUMBERS 1 TO 6) BUNCH WEIGTH (Kg)



4- BUNCH COMPOSITION CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6) FRUIT TO BUNCH (%)

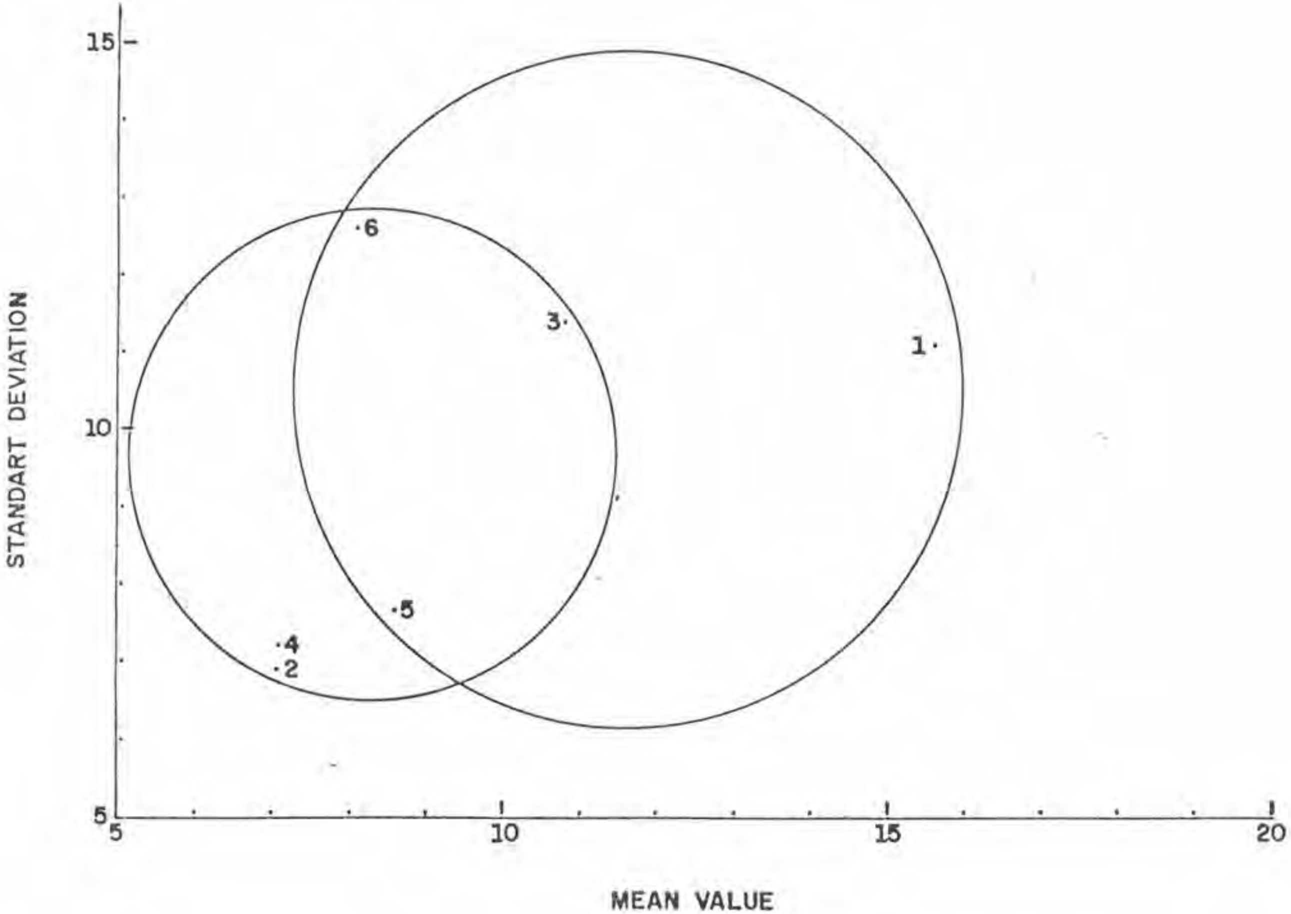
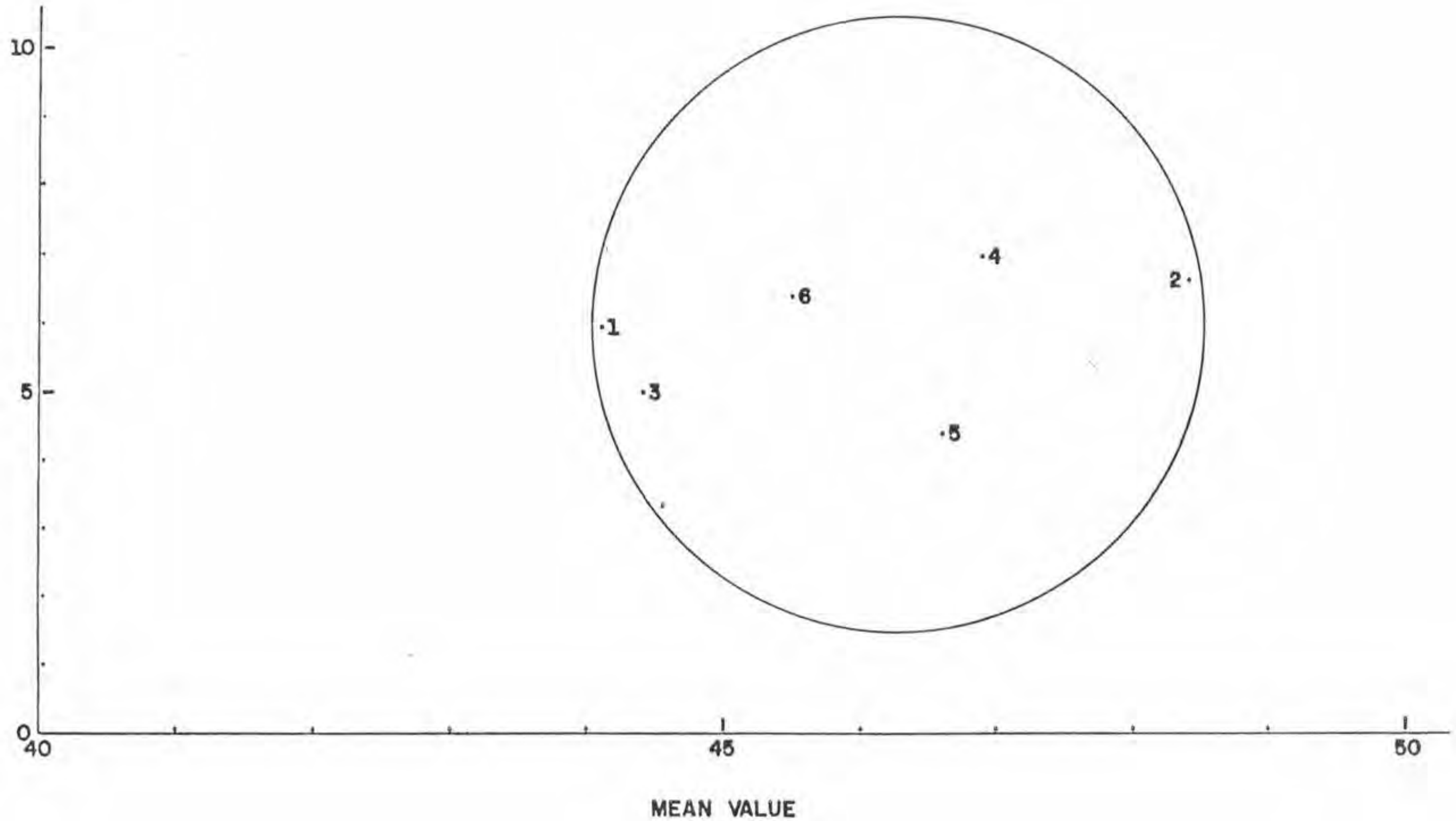


FIG. 5- BUNCH COMPOSITION CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6) PARTHENOCARPIC FRUIT TO BUNCH (%)



3. 6 - FRUIT QUALITY CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6) MESOCAPP/ FRUIT PERCENTAGE

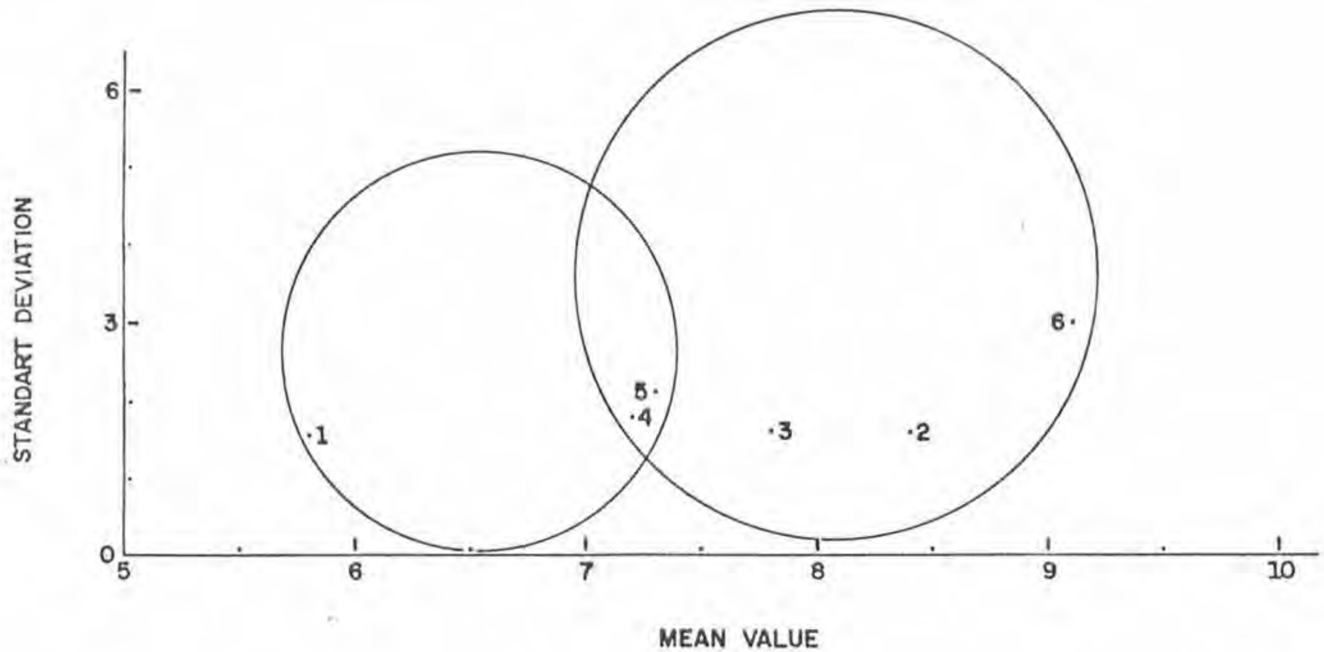


FIG. 7 - BUNCH COMPOSITION CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6)
MEAN NORMAL FRUIT WEIGHT (g)

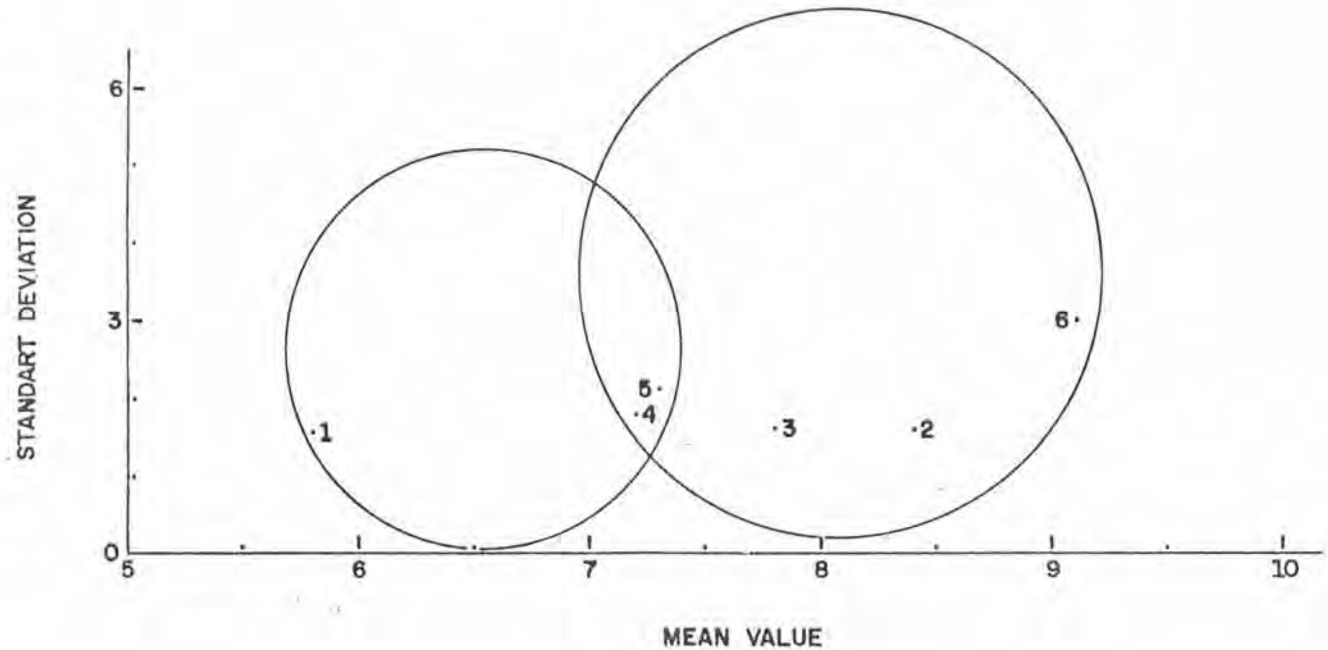


FIG. 7 - BUNCH COMPOSITION CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6)
MEAN NORMAL FRUIT WEIGHT (g)

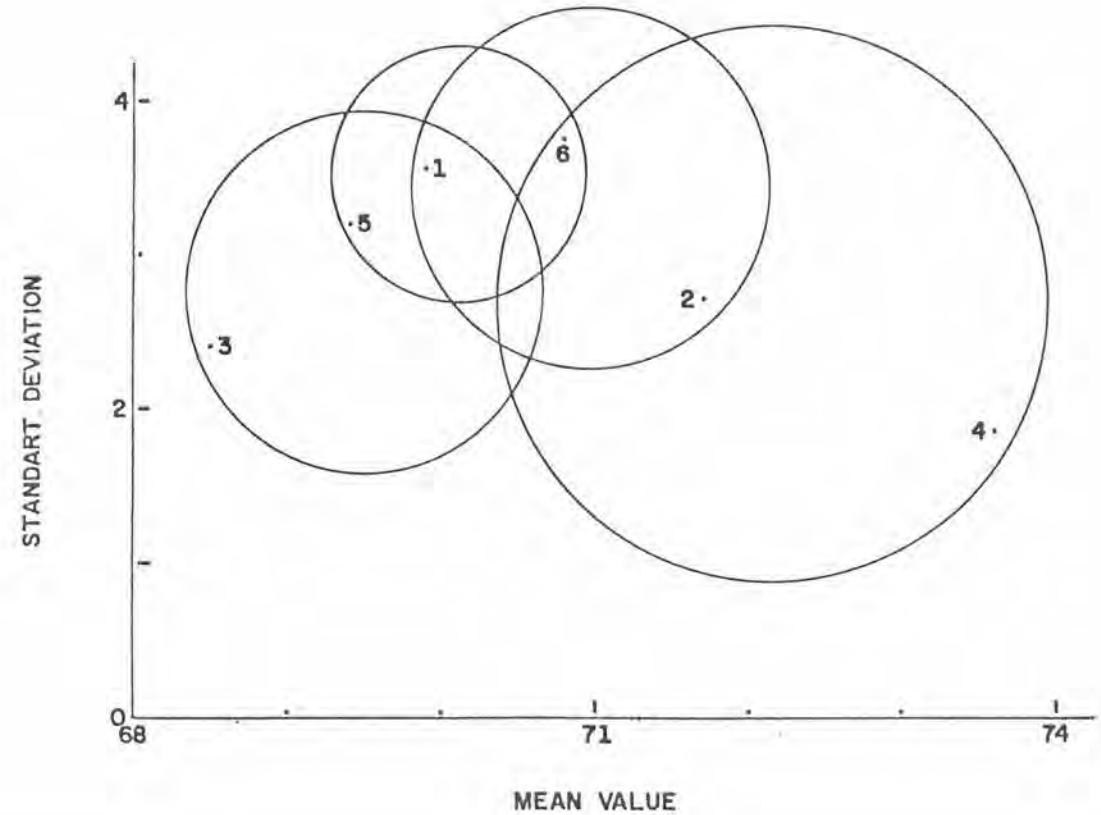


FIG. 9- OIL ANALYSIS CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6) OIL INSATURATION PERCENTAGE

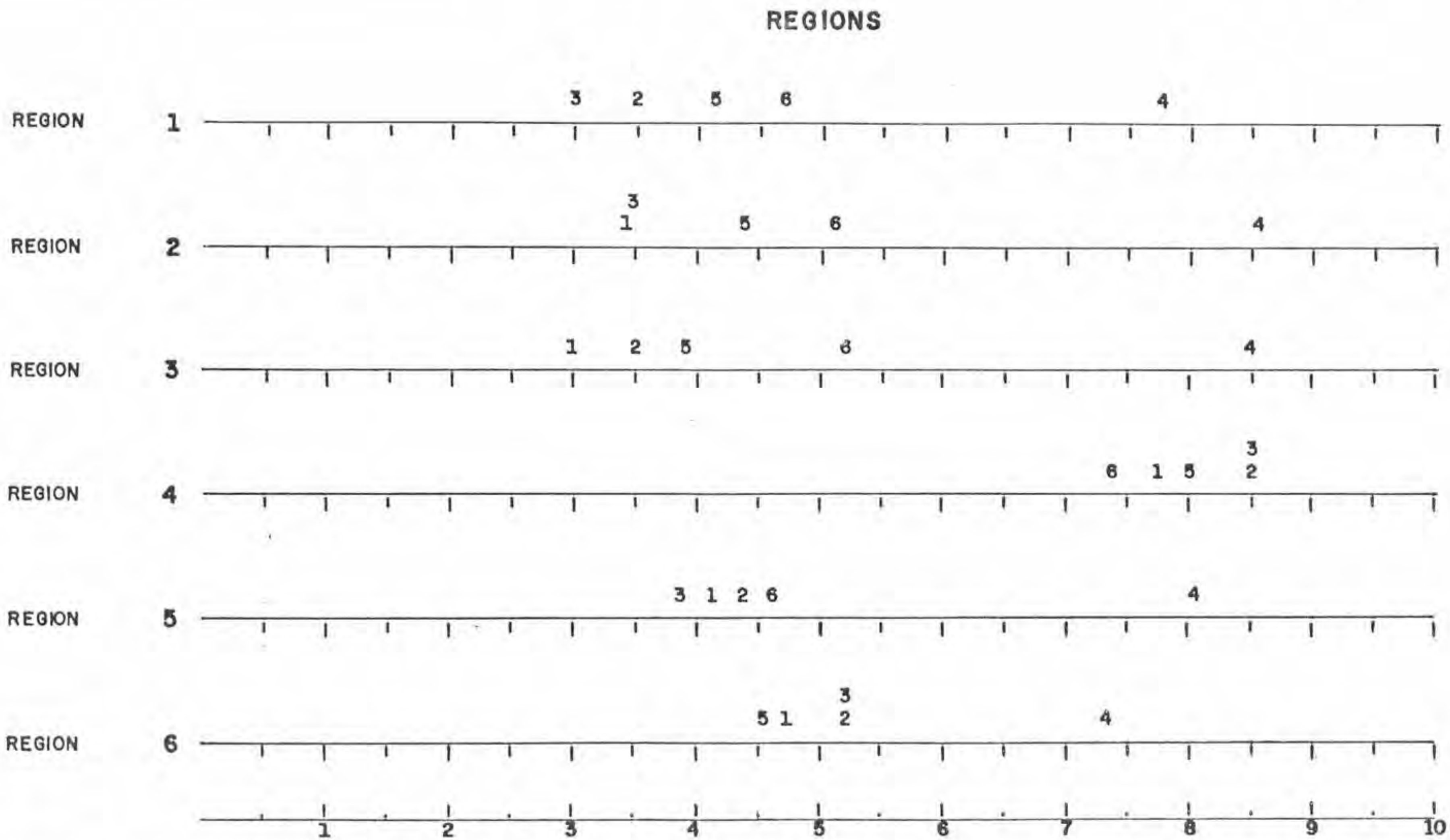


FIG. 10 - MAHALANOBIS'S DISTANCES AMONG REGIONS