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JUVENILE-MATURE CORRELATIONS IN HEART OF PALM PLANTS

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ABSTRACT

Juvenile-mature correlation coefficients relating some vegetative characters and yield of *Euterpe edulis* Mart. are presented as an aid for early and indirect selection in breeding work with this palm. Non-destructive measurements, such as plant girth, number of leaves, raquis and petiole length, showed high phenotypic correlation coefficients when paired with heart of palm weight, diameter and length. Age to age correlation coefficients between palm girth and number of leaves were also positive and statistically significant, from eighteen months until ten years after planting, with increasing correlation coefficients over time. Estimates of correlated gain obtained by selection on plant girth at different ages showed that expected gain starts to be worthwhile three years after planting, corresponding to over 73% of the gain expected when selection was delayed to the last stage. Expected gain for number of leaves starts increasing significantly four years after planting. As girth and number of leaves were correlated, it is advisable to select only for girth, as it showed a better relationship with yield components at harvest. Due to the rate of change of correlation over time and the expected gain obtained by the selection practiced, especially as regards palm girth, it is suggested that phenotypic selection of heart of palm plants could start as early as eighteen months, with a better probability of selecting superior genotypes three years after planting.

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INTRODUCTION

Recent studies have shown that the main characters that can be utilized for indirect selection of superior plants of the species *Euterpe edulis* Mart., commonly known as "palmito" or heart of palm plant, are plant girth or diameter at breast height and number of live leaves (Bovi *et al.*, 1991). Nonetheless, it would be of interest, for breeding work being carried out with this palm, to verify if these same traits could be used for early selection. Heart of palm plants are long-lived organisms, with a fairly long vegetative cycle (8 to 12 years to start flowering and harvest) and they are highly variable. As heart of palm breeding is aimed primarily at yield characteristics of individual plants, the rate of genetic improvement could be increased by early testing and selection, if genetic correlations of juvenile-mature traits were strong and positive, and if the characters had a high heritability.

Juvenile-mature correlation studies are very common in forest trees, which have an even greater generation span than *Euterpe* species. In reviewing the literature on this subject it was found that most of the juvenile-mature relationships, especially of growth traits, were based on estimates of phenotypic rather than genotypic correlations (Visser and De Vries, 1970; Corley *et al.*, 1971; Steinhoff, 1974; Kung, 1975; Mohrdiek, 1979; Nepveu and Birot, 1979; Waxler and Buijtenen, 1981; Ades and Burgess, 1982). These is quite understandable, as experiments especially designed to study genetic relationships are rare even in the most studied perennial species. Although predictions about genetic gains based on phenotypic correlations are accurate only when the associated environmental correlations are negligible (Franklin, 1977), sometimes they are the only data breeders have at hand for a given crop. Neither genetic correlations, nor heritability estimates have yet been reported for mature traits in heart of palm plants. Genetic studies on this palm are recent and well designed experiments are quite rare, and as yet provide only preliminary results. Meanwhile, it is expected that with continued data collection, a general pattern of the relative genetic control for the various characters under investigation with this palm may gradually become apparent. In this study, age to age correlation coefficients and expected gain obtained from selection at ten different ages are reported.

MATERIAL AND METHODS

In order to identify the relationships between easily measured characters and heart of palm yield components (weight, diameter and length of heart of palm or palmito), age to age correlation analyses were made for 170 plants growing at Ubatuba (23°06'S and 45°03'W), State of São Paulo, in a planting density equivalent to 6,600 plants per hectare. Climate data and soil type of the region were reported earlier by

Bovi *et al.* (1987a). Periodical measurements of plant girth and number of live leaves were made from 18 months until 10 years after planting. Girth at 10 cm was measured at 18 months and two years after planting. After three years the measurements were taken at 50 cm height, with the subsequent girth evaluation made at breast height (130 cm). The "palmito" was harvested 10 years after planting, when eleven different characters related to plant and palmito yield were measured. The evaluated characters were symbolized by: GIR - plant girth; NLE - number of live leaves; LRA - length of the fourth leaf raquis; LFI - length of the first (newest) leaf raquis; LPE - length of the outer petiole; CRO - length of the crown shaft, measured from the base of the outer petiole to the insertion of the newest leaf; CON - crown shaft condensation (LPE subtracted from CRO); HGI - heart of palm external girth, measured at the base of the outer petiole; HDI - heart of palm mean diameter; HLE - heart of palm length; and HWE - heart of palm weight.

The traits GIR and NLE can easily be measured from the ground. The number of leaves (NLE) starts to be difficult to count after the heart of palm plants are over 6 years old. The crown shafts at that stage begin to be interlaced with the others and, when the species is intercropped or cultivated under natural forest protection, the canopy of other trees interferes with the visibility of the entire crown shaft. Measurement of the characters LRA, LFI, LPE, CRO, CON and HGI, although non-destructive, is very difficult to be taken due to the palm height at harvest age (8 to 15 meters). The traits HDI, HLE and HWE correspond to heart of palm yield components and are, evidently, destructive. They were taken following the procedures given by Ferreira *et al.* (1976).

The correlation coefficients were estimated from the analyses of covariance involving the characters evaluated at harvest in order to identify the most easily measured among those correlated with yield.

Correlation analyses were made by Pearsons' method and the significance of the coefficients was tested by the "t" test, with a 5% probability level (Steel and Torrie, 1980).

Estimates of the expected correlated gain in the mature trait after selection on the juvenile trait were obtained by a modification of the formula proposed by Falconer (1964).

Falconer stated that the gain in the mature trait as a correlated response to selection in the juvenile trait ($G_{M/J}$) is:

$$G_{M/J} = i_j \cdot h_j \cdot h_m \cdot r_{Gjm} \cdot S_{Pm} \qquad (1)$$

where i_j is the selection differential for the juvenile trait; h_j is the square root of the heritability of the juvenile trait; h_m is the square root of the heritability of the mature trait; r_{Gjm} is the genotypic correlation between juvenile and mature traits; and S_{Pm} is the phenotypic standard deviation of the mature trait.

The genetic correlation between a juvenile and a mature trait is related to the phenotypic correlation as follows:

$$r_{Pjm} = h_j \, . \, h_m \, . \, r_{Gjm} + e_j \, . \, e_m \, . \, r_{ejm}$$

where $e = \sqrt{1 - h^2}$ and r_{ejm} is the environmental correlation between the juvenile and the mature trait.

It is usually assumed that $e_j . \, e_m \, . \, r_{ejm}$, the product of the environmental path coefficients from the juvenile to the mature phenotype, is so small as to be negligible (Franklin, 1977). When this assumption is correct equation (1) is simplified to:

$$G_{M/J} = i_j \, . \, r_{Pjm} \, . \, S_{Pm}$$

which is the formula used by Nanson (1968 and 1969), in a series of juvenile-mature correlations of forest trees.

In the present study the selection differential, expressed in standard deviation units, was assumed to be equal at all ages, because the growth curves for the same trait in other heart of palm populations have shown a regular trend, where the superior plants had greater values since the early stages of development (Bovi *et al.*, 1987a,b). Selection was theoretically applied to the studied population by choosing 21% of the superior palms in all ages, establishing as a criterion the selection of those plants with values 30% above the population mean in all stages. The selection differential was determined using a table presented by Singh and Chaudhary (1979) for finite populations.

Correlated genetic gain can be expressed in standard deviation units and in percentages, by dividing it by the mean of the population for the juvenile trait (X_J) and multiplying it by 100 (Vencovsky, 1977) as follows:

$$G_{M/J}(\%) = (G_{M/J} \, / \, X_J) \, . \, 100$$

The relative gain from early selection in relation to selection practiced 10 years after planting can also be utilized as a means for the comparison between earlier selection and selection done at later stages.

RESULTS AND DISCUSSION

Estimates of the correlation coefficients obtained between the eleven characters evaluated at harvest are presented in Table I. Correlation coefficients were positive and statistically significant for all paired comparisons at the 5% probability level. As reported earlier with other *E. edulis* populations (Bovi *et al.*, 1987a, 1991), palm girth and number of leaves were highly correlated with yield components (diameter, length and weight of heart of palm). Both traits were also correlated with other non-destructive characters of difficult measurement, such as crown shaft and petiole length. Palm girth and number of leaves showed an even better relationship with heart of palm yield components than those more directly related to the diameter and the length of the heart of palm itself. The trait with the weaker correlation coefficient (though it was statistically significant), was the length of the first leaf raquis. Correlation coefficients in the range of 0.333 and 0.422 were found for this trait.

Table I - Estimates of correlation coefficients between some vegetative traits and yield components of heart of palm plants (*Euterpe edulis*) at harvest (10 years after planting). Number of plants: 170. Ubatuba, São Paulo State, Brazil.

Characters:	NLE	LRA	LFI	LPE	CRO	CON	HGI	HDI	HLE	HWE
Plant girth (GIR)	0.869*	0.863*	0.385*	0.811*	0.902*	0.820*	0.879*	0.932*	0.867*	0.935*
Number of leaves (NLE)		0.803*	0.338*	0.674*	0.849*	0.847*	0.820*	0.860*	0.852*	0.863*
Fourth leaf raquis (LRA)			0.364*	0.815*	0.866*	0.758*	0.808*	0.875*	0.820*	0.827*
First leaf raquis (LFI)				0.334*	0.355*	0.327*	0.345*	0.358*	0.343*	0.422*
Petiole length (LPE)					0.886*	0.631*	0.689*	0.821*	0.779*	0.789*
Crown shaft length (CRO)						0.921*	0.776*	0.870*	0.896*	0.884*
Crown shaft condensation (CON)							0.713*	0.759*	0.830*	0.804*
Heart of palm external girth (HGI)								0.882*	0.810*	0.894*
Heat of palm diameter (HDI)									0.855*	0.936*
Heart of palm length (HLE)										0.906*
Heart of palm weight (HWE)										

* Significant at 5% probability level.

The results suggested that palm girth, or diameter, at breast height, and number of leaves could be used as indirect traits for selection of superior heart of palm yielding plants, as they show highly significant and positive correlation with yield components. In high density plantings, or when intercropped with other plants, the number of leaves is very difficult to count due to the interlaced crowns. Palm girth is the easiest character to measure in this situation and, due to its better relationship with palm yield, should be preferred for indirect evaluation of superior palms (Bovi *et al.*, 1991).

Juvenile mature correlation coefficients for palm girth and number of leaves are presented, respectively, in Tables II and III. Correlations coefficients for palm girth and yield components (diameter, length and weight of heart of palm) were all positive and statistically significant since the first evaluation (18 months after planting) with increasing values over time. A very sharp increase in correlation coefficients was found three years after planting. A similar trend, although with a lower magnitude, was obtained for number of leaves (Table III). When age to age correlated coefficients were calculated for number of leaves, the rate of increase of the correlation coefficients was higher only after 4 years after planting. These results are in accordance with other studies done with other species. In most forest trees juvenile-mature correlations have being used and, as a rule, correlation of growth performance at very young ages with performance at mature ages are very poor, but correlations improve progressively as the assessment time comes closer to the mature age (Wakeley, 1971; Zobel and Talbert, 1984). As Lambeth (1980) has pointed out, adjusting to a much different environment than that of the nursery and the presence of maternal effects, such as seed size, are some of the problems that might be involved. In most of the species studied a certain amount of time is required for the plant to demonstrate consistent performance.

Due to the close relationship existing between such non-destructive and easily measured traits as palm girth and number of leaves and yield components, heart of palm yield prediction seems to be possible, especially three years after planting.

Age to age correlation coefficients between palm girth and number of leaves are presented in Table IV. They show that palm girth is highly correlated with number of leaves at all ages, with the rate of correlation also increasing over time. The results indicate that early selection based on these two traits should be effective on heart of palm plants. As girth and number of leaves are well correlated, it is advisable to select only for girth, as it showed a better relationship with yield components at harvest.

The expected correlated gains in the mature trait after selection on the juvenile trait are presented in Table V for palm girth and in Table VI for number of leaves. The genetic gain in standard deviation units was small for selection practiced at 18 months, corresponding only to 4.46% when the mean of the trait is involved in the calculations, and 6.52% of the gain obtained when selection is practiced 10 years after planting. The gain in standard deviation units or in percentage increases markedly three years after planting. Selection practiced at that age would give a 15.61% of the total gain and 73.61% of the relative gain, when compared with the one obtained at 10 years. Nonetheless, culling of the poorest plants could start at 18 months.

Table II - Estimates of correlation coefficients between plant girth (GIR) measured at different times with other traits evaluated at harvest of heart of plant palms (*Euterpe edulis*). Ubatuba, São Paulo State, Brazil.

Palm girth (GIR):	GIR10	NLE	LRA	LFI	LPE	CRO	CON	HGI	HDI	HLE	HWE
GIR1 - 18 months	0.250*	0.157*	0.201*	0.100	0.112	0.146*	0.163*	0.208*	0.240*	0.159*	0.197*
GIR2 - 2 years	0.371*	0.214*	0.295*	0.170*	0.235*	0.263*	0.254*	0.273*	0.360*	0.257*	0.319*
GIR3 - 3 years	0.615*	0.466*	0.520*	0.297*	0.417*	0.441*	0.389*	0.518*	0.571*	0.466*	0.542*
GIR4 - 4 years	0.737*	0.592*	0.607*	0.385*	0.545*	0.545*	0.457*	0.676*	0.686*	0.572*	0.679*
GIR5 - 5 years	0.843*	0.686*	0.738*	0.430*	0.656*	0.661*	0.555*	0.750*	0.806*	0.669*	0.773*
GIR6 - 6 years	0.921*	0.770*	0.805*	0.430*	0.737*	0.756*	0.644*	0.816*	0.876*	0.746*	0.856*
GIR7 - 7 years	0.947*	0.809*	0.833*	0.433*	0.766*	0.799*	0.691*	0.843*	0.901*	0.783*	0.886*
GIR8 - 8 years	0.970*	0.824*	0.866*	0.379*	0.801*	0.853*	0.750*	0.859*	0.913*	0.819*	0.897*
GIR9 - 9 years	0.982*	0.860*	0.858*	0.392*	0.793*	0.872*	0.787*	0.881*	0.923*	0.846*	0.931*
GIR10 - 10 years											

* Significant at 5* probability level.

As three years old palms are not yet in competition, a closer spacing between plants could be used and thus larger breeding population could be handled until that stage. In larger populations additional gain could be made by increasing the selection intensity (Nanson, 1969). On the other hand, close spacing allows trails to be placed on more uniform sites, reducing experimental error.

After selection of superior plants at three years, care should be taken to increase insolation to accelerate flowering and frutification. Although plants in dense competition start flowering only after 8 to 12 years, palms in a large space and under less shading conditions can start flowering as soon as six years after planting. Thus, early selection together with some cultural practices could shorten the breeding cycle of this palm.

Table III - Estimates of correlation coefficients between number of leaves measured at different times and other traits evaluated at harvest of heart of palm plants (*Euterpe edulis*). Ubatuba, São Paulo State, Brazil.

Number leaves (NLE):	GIR10	NLE10	LRA	LFI	LPE	CRO	CON	HGI	HDI	HLE	HWE
NLE1 - 18 months	0.194*	0.158*	0.207*	0.029	0.207*	0.178*	0.121	0.136*	0.251*	0.157*	0.179*
NLE2 - 2 years	0.328*	0.274*	0.270*	0.083	0.196*	0.241*	0.243*	0.233*	0.305*	0.271*	0.282*
NLE3 - 3 years	0.383*	0.309*	0.322*	0.165*	0.221*	0.280*	0.273*	0.274*	0.355*	0.290*	0.334*
NLE4 - 4 years	0.504*	0.429*	0.407*	0.229*	0.328*	0.373*	0.354*	0.393*	0.489*	0.347*	0.423*
NLE5 - 5 years	0.656*	0.601*	0.654*	0.305*	0.517*	0.562*	0.502*	0.625*	0.663*	0.539*	0.587*
NLE6 - 6 years	0.717*	0.686*	0.679*	0.364*	0.586*	0.619*	0.543*	0.680*	0.728*	0.615*	0.666*
NLE7 - 7 years	0.853*	0.785*	0.831*	0.315*	0.744*	0.779*	0.675*	0.791*	0.851*	0.734*	0.776*
NLE8 - 8 years	0.857*	0.811*	0.835*	0.347*	0.745*	0.798*	0.704*	0.794*	0.861*	0.742*	0.789*
NLE9 - 9 years	0.878*	0.874*	0.853*	0.349*	0.702*	0.816*	0.772*	0.835*	0.861*	0.798*	0.832*
NLE10 - 10 years											

* Significant at 5% probability level.

Table IV - Estimates of correlation coefficients between plant girth (GIR) and number of leaves (NLE) of heart of palm plants (*Euterpe edulis*) during a ten year period. Ubatuba, São Paulo State, Brazil.

Characters	NLE1	NLE2	NLE3	NLE4	NLE5	NLE6	NLE7	NLE8	NLE9	NLE10
GIR1 - 18 months	0.533*	0.489*	0.524*	0.448*	0.365*	0.300*	0.269*	0.260*	0.238*	0.157*
GIR2 - 2 years	0.500*	0.574*	0.534*	0.491*	0.449*	0.341*	0.327*	0.343*	0.317*	0.214*
GIR3 - 3 years	0.479*	0.573*	0.633*	0.659*	0.626*	0.542*	0.613*	0.498*	0.568*	0.466*
GIR4 - 4 years	0.330*	0.409*	0.487*	0.632*	0.668*	0.625*	0.700*	0.549*	0.676*	0.592*
GIR5 - 5 years	0.310*	0.403*	0.487*	0.603*	0.721*	0.693*	0.780*	0.633*	0.755*	0.686*
GIR6 - 6 years	0.289*	0.390*	0.469*	0.578*	0.729*	0.740*	0.859*	0.675*	0.817*	0.770*
GIR7 - 7 years	0.270*	0.383*	0.461*	0.557*	0.734*	0.734*	0.864*	0.692*	0.841*	0.804*
GIR8 - 8 years	0.235*	0.359*	0.416*	0.536*	0.700*	0.722*	0.871*	0.705*	0.866*	0.824*
GIR9 - 9 years	0.213*	0.333*	0.405*	0.509*	0.677*	0.727*	0.861*	0.708*	0.877*	0.860*
GIR10 - 10 years	0.194*	0.328*	0.383*	0.504*	0.656*	0.717*	0.853*	0.716*	0.878*	0.869*

* Significant at 5% probability level.

Table V - Phenotypic correlation coefficients, standard deviation of the mature trait, mean of the trait in the original population, expected gain, percentage gain and relative gain obtained by selection on plant girth of heart of palm plants (*Euterpe edulis*). Ubatuba, São Paulo State, Brazil.

Plant girth	rp[1]	S_{pm}[2]	Mean[3]	Gain[4]	Gain[5]	Gain[6]
18 months	0.250	1.465	7.687	0.342	4.46	6.52
2 years	0.371	2.652	13.043	1.349	10.35	25.69
3 years	0.615	4.586	24.790	3.870	15.61	73.69
4 years	0.737	3.175	17.642	3.214	18.22	61.19
5 years	0.843	2.911	17.920	3.374	18.82	64.23
6 years	0.921	3.335	19.318	4.218	21.83	80.30
7 years	0.947	3.877	20.114	5.164	24.02	91.99
8 years	0.970	3.877	21.471	5.164	24.05	98.31
9 years	0.982	4.562	22.511	6.146	27.30	117.01
10 years	1.000	3.827	24.386	5.252	21.54	100.00

[1]Phenotypic correlation coefficient.

[2]Standard deviation of the mature trait.

[3]Mean of the trait in the original population.

[4]Gain in standard deviation units.

[5]Gain expressed in percentage.

[6]Relative gain, expressed in relation to the gain obtained if selection is practiced only at 10 years after planting.

When the number of leaves was considered, increased gain was obtained four years after planting, corresponding, at that age, to 56% of the gain achieved at 10 years.

As pointed out before, the expected gains were calculated based on phenotypic rather than genotypic correlations, assuming that environmental correlations are negligible. In fact, many studies give evidence that genotypic correlations between juvenile and mature traits are almost identical, if not superior to phenotypic counterparts between those traits, and could be replaced by them. Examples for that statement are providing by La Farge (1975), Steinhoff (1974), Squillace and Gansel (1974) and Borges *et al.* (1980).

Table VI - Phenotypic correlation coefficient, standard deviation of the mature trait, mean of the trait in the original population, expected gain, percentage gain and relative gain obtained by selection on number of leaves of heart of palm plants (*Euterpe edulis*). Ubatuba, São Paulo State, Brazil.

Number of leaves	r_p[1]	S_{pm}[2]	Mean[3]	Gain[4]	Gain[5]	Gain[6]
18 months	0.158	0.774	4.932	0.168	3.40	10.51
2 years	0.274	1.024	6.017	0.384	6.39	24.08
3 years	0.309	1.166	7.494	0.495	6.60	31.01
4 years	0.429	1.520	7.500	0.895	11.93	56.05
5 years	0.601	1.203	8.670	0.992	11.44	62.13
6 years	0.686	1.095	8.375	1.032	12.32	64.63
7 years	0.785	0.824	8.875	0.887	10.00	55.59
8 years	0.811	2.764	9.176	3.077	33.55	192.76
9 years	0.874	1.357	8.994	1.629	18.11	102.04
10 years	1.000	1.163	9.278	1.596	17.20	100.00

[1]Phenotypic correlation coefficient.
[2]Standard deviation of the mature trait.
[3]Mean of the trait in the original population.
[4]Gain in standard deviation units.
[5]Gain expressed in percentage.
[6]Relative gain, expressed in relation to the gain obtained if selection is practiced only at 10 years after planting.

Although the results showed here indicate that selection for number of leaves and palm girth, which is an indirect selection for heart of palm yield, could be practiced beginning 18 months after planting, with an increased probability of selection of superior genotypes three years after planting, the importance of juvenile-mature correlations and the reliability of prediction of later performance from early assessment has not yet been established for this palm. As heart of palm is essentially inner leaves in different stages of development (Ferreira *et al.*, 1976) it is assumed that superior genotypes at maturity had a regular rate of growth, as measured by number of leaves and the correlated trait plant girth, since an early age. Evidence that corroborates this assumption is presented by Bovi *et al.* (1987a). The authors report growth curves for hybrid plants in comparison with parental populations. The mean of the hybrid population was superior to that of the parents in all characters measured beginning with the first evaluation, taken at 17 months after planting.

In spite of the expected gains reported here it should be considered that the genetics of growth is complex and besides the additive component, the non-additive and the environment effects are also expressive (Zobel and Talbert, 1984). Also, it should be remembered that there is often a strong genotype x environment interaction for growth that restricts the expected gains when one population is destined for use over wide areas. Breeding techniques for heart of palm plants still rely on the selection of desired plants, testing these to determine the best genotypes and seed production by open pollination among the selected genotypes. As Zobel and Talbert (1984) had pointed out, because of segregation and recombination that takes place when sexual reproduction is used, it is expected that the progeny will not be exactly the same or as good as the parents, especially if there is a substantital nonadditive variance. How much of the total variance is composed by additive, nonadditive and environmental effects is yet to be determined for heart of palm plants. Nonetheless, with the advent of *in vitro* micropropagation of this palm (Guerra, 1989), the concept of predicting performance at a young age turns out to be very important, as superior phenotypes could be readily propagated and tested over a wide range of environments.

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RESUMO

Coeficientes de correlações obtidos entre caracteres relacionados ao desenvolvimento vegetativo obtidos em diferentes idades e a produção de palmito da espécie *Euterpe edulis* são apresentados visando auxiliar na identificação de caracteres que possam ser utilizados para seleção precoce e indireta de plantas superiores dessa palmeira com vistas ao melhoramento genético. Caracteres não destrutivos, tais como circunferência da planta, número de folhas, comprimento da raquis e do pecíolo foliar, mostraram coeficientes de correlação elevados quando pareados com a produção de palmito, avaliada pelo seu peso, diâmetro e comprimento. A circunferência da planta e o número de folhas mostraram-se também altamente correlacionadas entre si durante todas as fases de desenvolvimento, com magnitude aumentando gradativamente com o tempo. Estimativas do ganho correlacionado obtidas por seleção praticada no carácter circunferência da planta em diferentes idades, evidenciaram que o ganho esperado começa a ser satisfatório aos três anos após o plantio, correspondendo a mais de 73% do ganho esperado quando a seleção é delegada para a ocasião da colheita. Para o número de folhas, o ganho esperado aumentou significativamente após 4 anos do início do experimento. Visto que a circunferência

da planta e o número de folhas são caracteres correlacionados, é recomendável selecionar apenas para circunferência da planta, dada a presença de boa correlação fenotípica entre esse caracter e os componentes da produção. Devido à taxa crescente apresentada pelos coeficientes de correlação e às estimativas de ganho esperado por seleção praticada especialmente sobre o carácter circunferência da planta, sugere-se que a seleção precoce em palmiteiro possa ter início logo aos 18 meses após o plantio, com maior probabilidade de selecionar genótipos superiores dessas palmeiras após três anos de campo.

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