SELECTION IN CASSAVA SEEDLINGS[1]

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ABSTRACT - The interrelationships among important cassava (*Manihot esculenta* Crantz) traits were evaluated at the seedling and clonal stages. The objective was, to find out a selection criterion which could effectively identify superior F_1 segregates that could maintain superior clonal performance. Fresh root weight of seedlings and clones was positively correlated with stem plus leaf weight and harvest index. Strong competitors were high root yielders at both stages of propagation. Selection for fresh root yield at the seedling phase was not an effective mechanism for the identification of genotypes which could maintain high fresh root yield at the clonal stage. Under the conditions this study was conducted, none of the measured traits was considered to be efficient for the selection of superior seedlings which could reproduce superior clones. Further detailed studies are needed giving priority to problems of interplant competition in genotypic mixtures and to the differential effects of the environment on seedlings and clones, since they must be grown in different years.

Index terms: *Manihot esculenta* Crantz, intergenotypic competition, efficiency of selection, heterogeneous populations.

SELEÇÃO EM PLÂNTULAS DE MANDIOCA

RESUMO - As interrelações existentes entre alguns caracteres agronômicos importantes da mandioca (*Manihot esculenta* Crantz) foram avaliadas durante as fases de plântulas e de propagação vegetativa. O propósito foi o de identificar uma característica agronômica que sirva como critério de seleção para identificar plantas F_1 superiores, capazes de manter superioridade clonal durante a fase de propagação vegetativa. A produção de raízes frescas das plântulas e clones correlacionou-se positivamente com a produção da parte aérea e o índice de colheita. Os genótipos com maior capacidade de competição apresentaram maior produtividade de raízes em ambos os estágios de propagação. A produção de raízes das plântulas não apresentou correlação significativa com nenhuma característica agronômica dos clones. A seleção para produtividade de raízes durante a fase de plântulas não foi considerada um mecanismo eficiente para a identificação de genótipos que mantenham alta produtividade durante a fase de propagação vegetativa. Sob as condições do presente trabalho, nenhum caráter estudado foi considerado eficiente para a identificação de plântulas superiores. Estudos adicionais, mais detalhados, são necessários, com prioridade para os problemas de competição intergenotípica em misturas genotípicas e para os efeitos diferenciais do ambiente sobre as plântulas e clones, uma vez que eles devem ser cultivados em anos diferentes.

Termos para indexação: *Manihot esculenta* Crantz, competição intergenotípica, eficiência de seleção, populações heterogêneas.

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is a monoecious species, but it has a distinct protogeny since both male and female flowers are born in the same inflorescence and the female opens one to two weeks earlier than the male flowers. This flowering mechanism prevents self pollination in the same inflorescence, but not in the same plant particularly for the genotypes that flower profusely. For practical means however, cassava can be considered an alogamous species.

Although a cultivar is heterozygote at most loci, it is composed of homogeneous genotypes, since the normal type of propagation is vegetative by means of stem cuttings. Therefore, hybridization of selected cultivars must be made for the creation of source populations with enough genetic variability. Due to the heterozygous state of most loci, segregation occurs at the F_1 generation.

Efficiency of selection at the F_1 generation is an extremely important aspect for the success of a cassava breeding program. The production of a large number of hybrid seeds is easily accomplished, but the identification of the superior genotypes may become very difficult and depends primarily on the mechanism used to identify the trait under selection. At the International Institute of Tropical Agriculture (IITA), seedlings are first exposed to Cassava Mosaic

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Disease (CMD) and Cassava Bacterial Blight (CBB) and only the survivors are subsequently evaluated for fresh root yield (Hahn et al. 1979). Based on the reaction to these diseases more than 95% of the original seedlings can be discarded at the F_1 generation (Hahn et al. 1973). However, in environments where major diseases and pests can not be used as a preliminary selection criterion, efficient selection for root yield among thousands of F_1 genotypes may be a limiting step of a breeding program.

Cassava plants originated from true seeds are somewhat different than plants propagated from stem cuttings, particularly for root characteristics (Kawano 1980). If selection for fresh root yield and other traits is to be efficient at the seedling stage, the genotype selected as superior must repeat its performance at subsequent cycles of vegetative propagation.

It has been reported that selection for total plant weight and harvest index at the seedling stage is efficient, since the correlation between these traits in seedling versus clonal stage was positive and significant (Kawano et al. 1978). Results shown at the annual report of the Centro Nacional de Pesquisa de Mandioca e Fruticultura (CNPMF) (National Research Center for Cassava and Fruit Crops) of the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), indicated positive correlations between seedling root yield and clone root yield and between seedling harvest index and clone harvest index (Relatório Técnico Anual . . . 1980). However, Batista & Bulow (1971) found very low correlations between seedling root yield and clone root yield. This results were obtained under high seedling density and suggest that selection for root yield at the seedling stage is not efficient.

The objectives of this paper are to report the relationships found among important cassava traits at the seedling, clonal and between these two stages, and to identify which trait could be used as an efficient selection criterion for fresh root yield at the seedling stage.

MATERIALS AND METHODS

The experiments were conducted at the CNPMF in Cruz das Almas, Bahia, Brazil.

In 1980, a total of 2,660 true cassava seeds from 133 different families were planted directly in the field without irrigation. Each family was an F_1 progeny from a different cross and consisted of 20 true seeds planted at 0.30 m intervals in rows 6 m long spaced 0.80 m apart. One year after planting, 139 F_1 plants from 56 families were harvested and measurements were taken on fresh root weight and stem plus leaf weight. Each selected plant was cloned and each clone planted in rows of five cuttings. Rows and plants were spaced 1 m apart.

In July of 1982, 120 clones were harvested and data were taken in the three central plants for fresh root yield, stem and leaf fresh weight.

Harvest index, defined as the ratio between fresh root weight and total plant fresh weight was calculated for the seedling and clonal stages.

Simple phenotypic correlation coefficients were calculated among all traits measured.

RESULTS AND DISCUSSION

The amplitude of fresh root weight was 4.100 kg/plant and the average was 1.211 kg/plant for the genotypes originated from true seeds. The average stem plus leaf weight was 1.014 kg/plant and the amplitude was 3.000 kg/plant (Table 1). The variability of fresh root weight, as expressed by the standard error and the coefficient of variation, was much similar to that of stem plus leaf weight (Table 1).

Fresh root weight showed a positive and significant correlation with harvest index and stem plus leaf weight, however the highest coefficient was for the correlation with stem plus leaf weight (Table 2). These results suggest that seedlings which have the capacity to produce more vegetative weight also produce more fresh root weight. This may reflect the fact that in genotypic mixtures strong competitors tend to produce higher root

TABLE 1. Performance of 120 cassava genotypes originated from true seeds. CNPMF, 1981.

Parameters	Root weight (kg/plant)	Stem plus leaf weight (kg/plant)
Average	1.211	1.014
Minimum	0.100	0.200
Maximum	4.200	3.200
Standard error	0.800	0.650
C.V. (%)	66.1	64.1

yields at the expense of poor competitors (Kawano & Thung 1982). Their conclusions, however, seem to be true only at high seedling density (Kawano et al. 1978), which was not the case in this experiment since only 456 seeds germinated from 2,660 planted.

The correlation between harvest index and stem plus leaf weight was negative, but not significant (Table 2).

The average fresh root weight of the same 120 genotypes propagated vegetatively was 1.118 kg/plant and the amplitude was 2.925 kg/plant (Table 3). These values were smaller than when these genotypes originated from true seeds. This may come about because of the increased interplant competition since each plant was spaced 1 m apart and the stands were complete for most families. Average and amplitude of stem plus leaf weight were 0.792 and 1.867 kg/plant, respectively (Table 3). These values were also smaller than the values of the seedlings and the reason may also be the increased interplant competition. Variability of fresh root and stem plus leaf weight of the clonal families were smaller as expressed by lower coefficients of variation and standard errors (Table 3).

Fresh root yield showed positive and significant correlations with stem and leaf weight and harvest index (Table 4). The highest coefficient was for the correlation with stem weight. These results suggest that families which produce heavier stem and leaf weights also produce larger root yields. The correlation of fresh root weight with harvest index was positive but yielded a coefficient of moderate magnitude (r = 0.446**). Stem weight was positively correlated with leaf weight and both of these traits were negatively correlated with harvest index (Table 4). These correlations were much similar to those found among traits of the seedlings and they indicate that, at each stage, strong competitors are high root yielders.

The coefficients of correlation calculated between traits of genotypes originated from true seeds and the same genotypes propagated vegetatively are presented in Table 5. Fresh root yield of seedlings was not significantly correlated with any trait measured on the clones. Meanwhile seedling harvest index was significantly correlated with all traits of the clones. Seedling harvest index showed a positive correlation with clone fresh root yield and clone harvest index and a negative correlation with clone stem and leaf yield. It must be emphasized, however, that all coefficients were of low magnitude and should be considered with caution. These results suggest that selection for root weight at the seedling stage is not an effective mechanism for the identification of genotypes

TABLE 2. Simple phenotypic correlation coefficients among traits of 120 cassava genotypes originated from true seeds. CNPMF, 1981.

	Root weight	Stem plus leaf weight
Stem plus Leaf weight	0.691**	
Harvest index	0.399**	- 0.279 NS

** Significant at 1% probability level;
NS = not significant;
N = 120.

TABLE 3. Performance of 120 cassava genotypes propagated from stem cuttings. CNPMF, 1982.

Parameters	Root weight (kg/plant)	Stem plus leaf weight (kg/plant)
Average	1.118	0.792
Minimum	0.125	0.200
Maximum	3.050	2.067
Standard error	0.616	0.431
C.V. (%)	55.1	54.4

TABLE 4. Simple phenotypic correlation coefficients among traits of 120 cassava genotypes propagated from stem cuttings. CNPMF, 1982.

	Root weight	Stem weight	Leaf weight
Stem weight	0.632**		
Leaf weight	0.571**	0.755**	
Harvest index	0.446**	-0,262 NS	- 0.294 NS

** Significant at 1% probability level;
NS = not significant;
N = 120

TABLE 5. Simple phenotypic correlation coefficients between traits of cassava genotypes originated from true seeds (TS) and these same genotypes propagated from stem cuttings (SC). CNPMF, 1982.

	Root weight (TS)	Stem plus leaf weight (TS)	Harvest index (TS)
Root weight (SC)	0.105 NS	- 0.057 NS	0.183 *
Stem plus leaf weight (SC)	0.009 NS	0.153 NS	- 0.196 *
Harvest index (SC)	0.092 NS	- 0.263 **	0.437 **

**, * Significant at 1 and 5% probability level, respectively; NS = not significant; N = 120

which will have superior root yield at the clonal stage.

According to Kawano et al. (1978), selection for harvest index at the seedling stage will effectively identify superior genotypes for fresh root yield at the clonal stage. Although the correlation between seedling harvest index and clone root yield was positive and significant (Table 5), the magnitude of the coefficient was too low to merit consideration (r = 0.183*).

From our results it can not be concluded what the most effective selection criterion might be for the identification of superior segregants which will perform similarly at the clonal stage. Since the number of studies in this area are relatively few, it is suggested that further investigations should be conducted giving special attention to intergenotypic competition and to the problems that the year effect may cause on the correlations.

CONCLUSIONS

1. Variability for fresh root yield of cassava seedlings originated from crosses between different cultivars was sufficiently high to permit efficient selection. This variability was maintained among clones propagated from seedlings.

2. Fresh root weight of seedlings and clones was found to be positively and significantly correlated with stem plus leaf weight and harvest index. However, the strongest correlation was between root weight and stem plus leaf weight, indicating that strong competitors are high root yielders at both stages of propagation.

3. Fresh root weight of seedlings was not correlated with any trait measured on the clones. On the other hand, harvest index of seedlings was significantly correlated with all clonal traits, but the coefficients were of low magnitude.

4. Selection for fresh root weight at the seedling stage was not an efficient mechanism for the identification of genotypes which can maintain similar performance at the clonal stage.

5. Under the conditions the study was carried out, none of the traits measured was considered efficient to select out the best genotypes at the seedling stage. Further studies are needed and special attention should be given to the effects of intergenotypic competition and to the problems that the year effect may cause on the correlations.

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