

SELECTION OF LOCATIONS FOR COMMON BEAN (*Phaseolus vulgaris* L.) GERMPLASM EVALUATION

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ABSTRACT

Environmental sampling for the evaluation of germplasm is an important factor for the success of cultivar recommendations for a commercial crop species. Based on grain yield data of the common bean, a definition of key locations for testing advanced lines obtained from a breeding program is presented. Through the evaluation of the statistical significance of the genotypes by locations interaction, it was possible to select a group of contrasting locations that better represent the environmental population for which the recommendation would be made. In our tests key locations for the evaluation of the "mulatinho" type common bean, were Irecê (BA), Aracaju (SE) and areas of Goiânia (GO) with high and average fertility soils.

INTRODUCTION

The evaluation of germplasm over a large number of environmental conditions (different locations, years, sowing dates, and soil fertility levels), although theoretically being an efficient way of recognizing the characteristics that favor the ecological adaptation of a population, has not always produced such a result. This occurs because a series of locations with similar effects over a set of genotypes may be used in the evaluations, instead of locations with peculiar and more contrasting environments. The limitation imposed by the large quantity of seeds necessary for the

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evaluation of a large number of environments is another factor that reduces the environmental range over which a particular set of genotypes may be tested.

Considering also that the consequences of the interaction of genotypes with environments represents an important problem for cultivar recommendation, it is convenient that the selection of locations for germplasm testing of a given crop be based not only on the edafoclimatic traits of such locations, but also on the aspects that relate to the interaction of genotypes with environments. The present paper proposes a technique for the definition of key locations for germplasm evaluation in the final stages of a breeding program. For such environments, a large number of trials and a careful experimental control should be assured. The technique is based on the estimation of the effects of the interaction of genotypes with locations, following a procedure similar to that of the ecological zoning proposed by Horner and Frey (1957).

MATERIAL AND METHODS

Grain yield data (Kg/ha) of the common bean (*Phaseolus vulgaris* L.), were taken from the preliminary yield trials of cream seeded types. They were organized and coordinated by the National Research Center for Rice and Beans (CNPAP), which belongs to the Brazilian Enterprise for Agricultural Research (EMBRAPA). Six selected experiments (Goiânia, GO/average soil fertility; Goiânia, GO/high soil fertility; Vilhena, RO; Rio Branco, AC; Irecê, BA and Aracaju, SE) were made in the agricultural year of 1985/86, with 76 treatments (experimental lines and cultivars), which were common to all locations.

Average treatment yields in each location were submitted to a joint variance analysis in order to detect significant genotype by environment (GE) interactions. Joint variance analysis for each pair of locations were performed as proposed by Horner and Frey (1957). For m locations, $m(m-1)/2$ analyses are made. The structure of the variance analysis is presented in Table I.

The genotypes by locations (GL) interaction variance was taken as a measure of ecological similarity among locations, and groups of locations that were ecologically similar were formed (Ecological Zoning). Based on the value obtained in the calculation of the F test for the GL interaction, a location was chosen within each group as representative of that ecological region. These were named "key locations" and were those places that had average mean squares for the GL interaction showing the highest statistical significance when they were analysed in comparison with locations of the other ecological regions (they had the highest degree of contrast with each other).

Table I - Joint variance analysis for each combination of locations taken two by two, considering n genotypes and r replications.

Sources of variation	DF	MS	F
Genotypes (G)	$n - 1$	Q_1	Q_1 / Q_3
Locations (L)	1	Q_2	Q_2 / Q_3
GL interaction	$n - 1$	Q_3	Q_3 / Q_4
Mean error ¹	$2(n - 1)(r - 1)$	Q_4	-

¹ Residual variance was estimated by the average of the residual mean squares of the individual analysis of each location divided by r .

DF: degrees of freedom; MS: mean squares; F: F test values.

RESULTS AND DISCUSSION

The results of the joint variance analysis, considering all locations, are presented in Table II. The differential effect of the environments over the different genotypes was evident (the GE interaction was statistically significant at the 1% probability level).

Table II - Joint analysis of variance of the average yields of 76 common bean genotypes in six environments (1985/86).

Sources of variation	DF	MS	F
Genotypes (G)	75	83,872.70	2.10*
Environments (E)	5	1,351,430.96	33.85*
GE interaction	375	39,921.72	2.67*
Mean error	450	14,934.23	-

* Values which are significant at the 1% probability level.

DF: degrees of freedom; MS: mean squares; F: F test values.

Estimates of the GL interaction mean squares as well as the F values are shown in Table III.

Table III - Estimates of the genotype by locations (GL) interaction mean squares (MS_{gx1}) and the respective F values obtained by the analysis of pairs of locations.

Location pair	MS_{gx1}	F
Aracaju/Vilhena	66,777.36	3.26*
RioBranco/Vilhena	33,061.22	1.16
Irecê/Vilhena	26,229.30	1.27
Goiânia-HF ¹ /Vilhena	46,145.89	1.94*
Goiânia-AF ¹ /Vilhena	33,869.38	1.64*
RioBranco/Aracaju	51,443.64	3.49*
Irecê/Aracaju	53,136.68	8.09*
Goiânia-HF/Aracaju	56,953.73	5.79*
Goiânia-AF/Aracaju	48,649.14	7.46*
Irecê/RioBranco	17,991.36	1.22
Goiânia-HF/RioBranco	41,157.20	2.28*
Goiânia-AF/RioBranco	25,046.93	1.70*
Goiânia-HF/Irecê	47,297.84	4.80*
Goiânia-AF/Irecê	33,334.86	5.09*
Goiânia-HF/Goiânia-AF	17,730.51	1.81*

¹HF: High soil fertility level; AF: Average soil fertility level.

* Values which are significant at the 1% probability level.

Only three of the 15 analyses did not show statistical significance at the 5% probability level for the GL interaction variances (Table III). These were from the following location pairs: Rio Branco/Vilhena, Irecê/Vilhena and Irecê/Rio Branco. Therefore, locations Rio Branco, Vilhena and Irecê are ecologically similar, or, they belong to the same ecological region. This is equivalent to say that in that year, only one of these locations would have been enough for the correct evaluation of that group of genotypes in that region. Based on the F value it was possible to choose Irecê as the most representative of the region. That location was more divergent from the locations that belong to ecological regions other than Rio Branco and Vilhena, since it presented larger F values on average. For that agricultural year it was possible to define four "ecological regions" with the following "key locations": Irecê, BA; Aracaju, SE; Goiânia, GO, high soil fertility level and Goiânia, GO, average soil fertility level.

Among the six experiments that were made that year, only four were necessary for the germplasm evaluation.

A problem that appears when the interaction of genotypes with environments is studied, is the instability of the results from one year to the next. For this reason "key locations" that are chosen in one year, may not be as representative in another (Duarte, 1988). This is due to the unpredictable environmental variation, which influences the interaction of genotypes with years and genotypes with locations and years (Allard and Bradshaw, 1964; Eberhart and Russell, 1966). Considering the importance of such components of the GE interaction (Santos, 1980; Duarte, 1988), such instability should be common. Therefore the researcher must establish a group of genotypes and keep it under test for a large number of years or planting seasons, in order to obtain a "key locations" definition that is consistent through years ("key locations" that are common to most years or planting seasons). Obviously, to define the "key locations" a much larger number of locations from the environmental population must be studied. In this way their value in representating such a population is guaranteed.

Once the "key locations" are defined, they should be used for a number of very well planned careful experiments, to compensate the frequent losses that occur due to the large residual variation.

RESUMO

A amostragem ambiental para a avaliação de germoplasma é determinante no sucesso da recomendação de cultivares de uma determinada espécie cultivada. Este trabalho propôs, com base em dados de rendimento de grãos em feijoeiro, a definição de locais "chave" para o teste dos materiais genéticos obtidos nas etapas finais dos programas de melhoramento. Por meio da avaliação da significância estatística da variação decorrente da interação de genótipos com locais, pode-se eleger de um conjunto de locais, aqueles mais contrastantes entre si e que melhor representariam a população de ambientes para a qual se faria a recomendação. No presente caso, os locais "chave" para avaliação de feijões mulatinhos foram Irecê (BA), Aracaju (SE), Goiânia/alta fertilidade e Goiânia/média fertilidade (GO).

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