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Numerical taxonomy of maize landraces: comparison between experimental designs

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ABSTRACT

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Seventy three maize (Zea mays L.) landraces from Northwestern Spain were grown according to two different experimental design. The first one (design A) was a randomized complete blocks design with two replications per trial at two locations for two years. The second design (design B) is simpler than the first one: the populations were grown at one location without replications for three years.

Numerical taxonomy of these landraces was made according to results of the field trials using the different experimental designs. Clustering, after principal components analysis on the basis of 11 quantitative traits, showed that the two maize landraces classifications are quite similar. For this reason when the number of populations is high, a simple design may be more efficient in numerical classification of maize landraces.

INTRODUCTION

In most maize breeding programs improvement is accompanied by a decrease in genetic diversity. This reduces the potential variability available to the breeder for selection, and more importantly, the commercial product has increased vulnerability and faces an increased risk of economic loss from new pathogens, insect pest or unusual environment stress (Duvick, 1986).

From this point of view the maize landraces preservation is necessity. The next step is to evaluate these base populations and

to know the phylogenetic and taxonomic relationships among them. This step is an essential prerequisite for an efficient and wise utilisation of genetic resources in breeding programs.

During the last years many classifications of landraces of maize have been carried out, most of them according to numerical taxonomy methods based on quantitative traits. However, the measures can often be biased by particular environmental conditions but these biases can be avoided growing the landraces in different environments using an experimental design like randomized complete blocks with replications in both space and time (Cochran and Cox, 1965). However, a high number of landraces evaluated in field trials arranged according to this design would mean a substantial human and material effort. In this case a simpler design could be more adequate.

In this paper we present a study of 73 landraces from Galicia (Northwestern Spain). Two different experimental designs were used. The first one (design A) was a randomized complete blocks design with two replications per trial and it was carried out at two locations for two years. The second design (design B) was simpler than the first one, the landraces were grown at one location without replications for three years.

Our main objective is to compare the differences in distribution of populations into clusters arising from numerical classifications based on the results of field trials carried out according to the two different experimental designs.

MATERIALS AND METHODS

The study reported here includes 73 landraces from Galicia (Northwestern Spain) maintained in the maize collection at the Misión Biológica de Galicia.

In 1984 and 1985 these populations were grown in two locations in Pontevedra (Spain) according to the design A. Plots consisted of two rows with 80 cm between rows and sown with 15 two-kernel hills per row, spaced 30 cm apart. One plant per hill was left after thinning leaving a plant population density of approximately 42000 plants/ha. With design A eight measures per landrace were obtained for each quantitative trait considered.

In 1985, 1986 and 1987 the 73 populations were also grown in Pontevedra using design B. The unit plot used had the same characteristics as the unit plot used in the design A. In this case three measures per population were obtained for each trait.

In all experimental plots data were taken on days to pollen shedding and silking, plant and ear height, length of the ear, kernel rows per ear, kernel characteristics (length, weight and texture) and finally, cob proportion and cob colour. These traits were measured or determined by the standard methods. Previous studies with these populations have shown that these quantitative characters have a considerable amount of genetic variance, and can be considered appropiated for numerical taxonomy purposes (Ron and Ordás, 1987; Ron, 1987).

Before clustering the landraces a principal components analysis was carried out in order to find uncorrelated composited variables. Only those standardized components which explained per-

centages of variability greater than 1% were taken into account in following clustering computations. Cluster analyses were done by the UPGMA method with euclidean distances as the measures of the dissimilarity among populations.

RESULTS AND DISCUSSION

In the principal components analysis of the results of field trials using design A, eight standardized components explained percentages of variability greater than 1% and accounted for 98,3% of the total variability. Figure 1 (A) Shows the dendrogram with classification of landraces into twelve groups after cluster analysis.

In the other case nine standardized components, which explain 98,7% of the total variability, were used for clustering. This analysis gives eleven groups as shown in the dendrogram in the Figure 1 (B).

Correlations between the cophenetic matrix of cluster analysis arising from design A and design B shows a coefficient value of 0.81, which can be considered relatively high. As far as the distribution of the populations into clusters is concerned, it is shown to be quite similar in both cases. Only 15 populations of 73 (those that are marked with * in the Figure 1) cannot be confidently placed within a particular group.

We must also take into account that when the number of landraces evaluated is high, it is very costly to carry out an experiment with replications in two locations during two years. Usually a complete design is used to evaluate low numbers of populations (Goodman, 1967; Camussi et al., 1983), but when the number of landraces is high, simpler designs may be used with six or less measures per trait and population (Alvarez and Lasa, 1987; Camussi, 1979; Goodman and Mc Bird, 1977; Goodman and Paterniani, 1969).

For these reasons the use of simple designs in maize landraces evaluation and numerical classification may be more efficient when the number of landraces involved is high.

RESUMEN

Se han clasificado, mediante métodos numéricos, 73 poblaciones de maíz del Noroeste de España utilizando para los ensayos de campo dos diseños experimentales. El primero (diseño A) es un diseño de bloques aleatorios con dos repeticiones realizado en dos localidades durante dos años. En el segundo (diseño B) las poblaciones se ensayaron en una localidad, sin repeticiones durante tres años.

Sobre la base de los resultados obtenidos en los ensayos de campo se llevó a cabo la clasificación taxonómica de las poblaciones. Para ello, se realizó un análisis de los componentes principales seguido por un análisis de grupos, empleando 11 caracteres cuantitativos.

La clasificación de las poblaciones cuando se utiliza el diseño experimental A es similar a la que se obtiene cuando se utiliza un diseño más sencillo como el B. Por ello en la evalua-

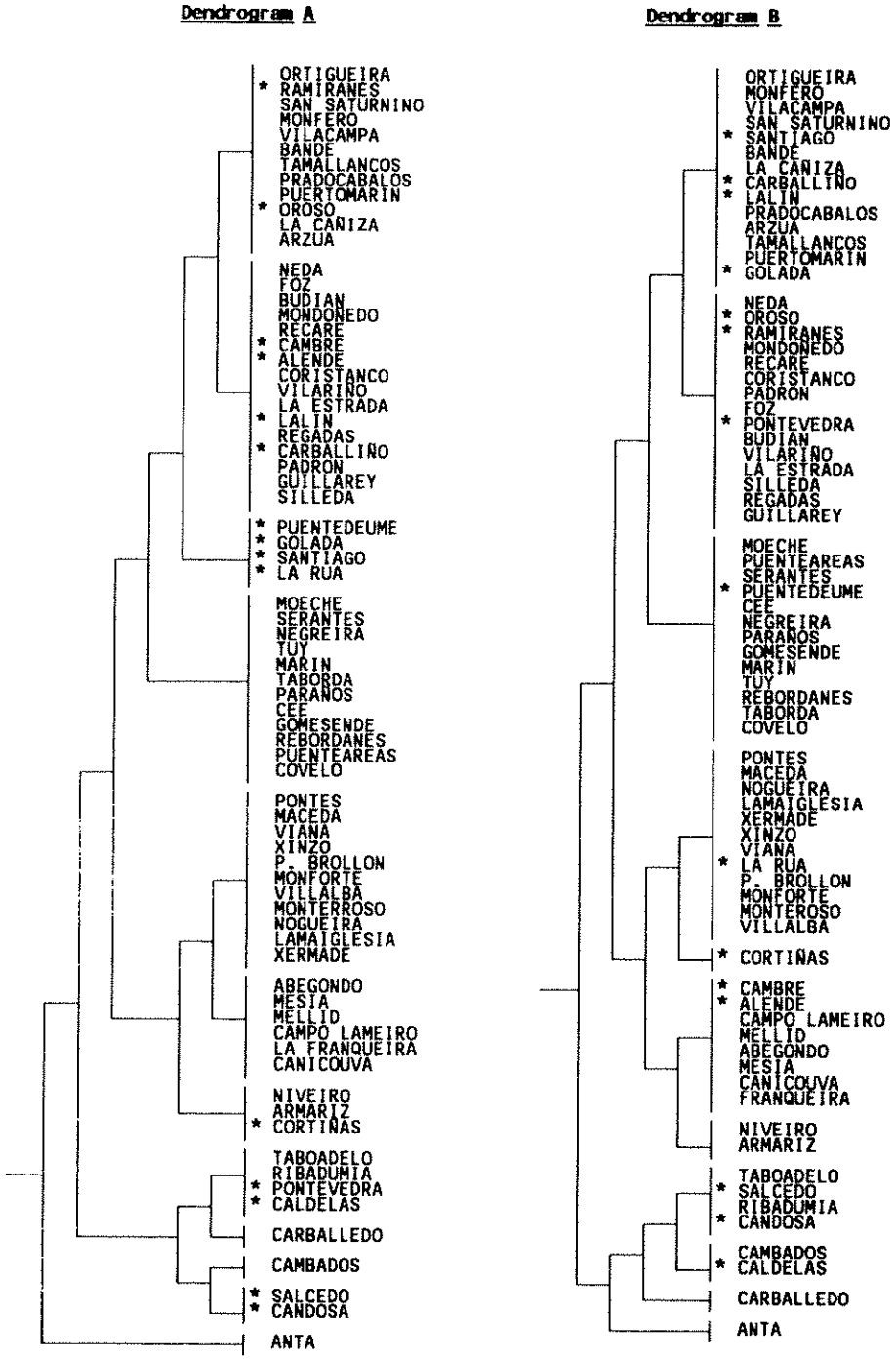

Figure 1. Dendrograms showing distribution of populations into clusters according to the two different (A and B) experimental designs employed.

ción de elevado número de poblaciones con finalidad taxonómica, puede resultar más adecuado y eficaz un diseño experimental sencillo.

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