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Genotype x Environment Interactions in Pigeonpeas (Cajanus cajan) Variety Trials — R. Abrams, J. Velez Fortuno, and J. Lopez Garcia

INTRODUCTION

Pigeonpea is one of the major grain crops cultivated in Puerto Rico. It is commercially cultivated mainly in the South, Southwestern, and Northwestern parts of the island. The variability of the environment in the island is a well known fact by the plant breeders; soil type and fertility level vary considerably throughout the island, temperature and rainfall pattern vary greatly from year to year as well as from one region to another.

Variety tests conducted for the purpose of comparing seed yields and other characters of selected material with standard varieties are of considerable importance in all crop improvement programs. These tests are usually grown over years and locations, thus, for an efficient varietal evaluation program it seemed desirable to obtain information on the importance of variety x environment interactions in varietal tests.

The purpose of this paper is to present estimates of variety x location, variety x years, and variety x location x years interactions and to consider their implications in selection.

MATERIALS AND METHODS

For estimating the interaction variances, data for 3 years at 2 locations involving 20 varieties of pigeonpeas were available. The varieties used, Kaki and Saragateado, have been grown commercially in Puerto Rico for canning and as fresh product. The other entries included in each test were 16 radiation-derived lines from Kaki, one introduction from Trinidad, P. I. 5690, and an all-season variety, Amarillo. Data for the years 1964, 1965, and 1966 were used.

The two test locations were Fortuna Substation, in the Southern region and Isabela Substation in the Northwestern region. A randomized block design with three replications was used for all experiments. The plots were two 40-foot rows with 8-foot spacing between rows. The seeds were planted in hills spaced 4-foot apart. Yield, flowering date, weight per 100 seeds, and plant height were recorded for each plot. Sufficient seed for each years' test was grown at the Isabela Substation the year prior its use.

RESULTS

The importance of the components as sources of variation is indicated by their relative magnitude and statistical significance. The variety component was significant at the 1% level for all characters studied. Considerable genotypic variance appears to be present among varieties, as shown by the magnitude of the variety component compared to that of the error component.

The variety x location source of varation, except for date of flowering, is non-significant and negative. Miller *et al* have suggested that since

the true parameters cannot be negative, these values must be intérpreted as being estimates of variance which are zero or small positive numbers. Such small variety x location interaction tends to indicate that there were no consistent and substantial locations effects on differential varietal response in these trials. The 20 varieties yielded similarly to each other at the 2 locations during the 3 years. The reaction of varieties to the environmental conditons during different years in any location generally were similar to those in the other location.

Considering the variety x years source of variation, except for plant height it is statistically significant. For plant height and seed weight, the variety x year interaction component has smaller values than for grain yield and date of flowering. This suggests that number of years should not be decreased when testing for these characters and most probably increased in order to minimise the magnitude of this interaction.

The second order interaction of variety x location x year is highly significant at the 1% level for all characters except yield, however, this source of variation was smaller than the varietal component for all characters. The significance of these tests suggests that some genotype x environment does occur. The magnitude of the interaction component is relatively smaller than that of the variance among lines, consequently, this interaction component may not be affecting the varietal evaluation very much.

DISCUSSION

The present data involves varietal experiments conducted for the purpose of comparing seed yield, date of flowering, plant height and seed weight of selected radiation-derived lines with standard varieties. In order to evaluate the efficiency of a breeding program, good estimates of genotype x year and genotype location are necessary.

The variety x location component in these studies has been small for all characters studied as compared to the variety component The magnitude of the variety x location component is very small, in fact negative and non-significant, except for date of flowering .This significance in date of flowering might be due more to differences in date of planting at the two locations during the years 1964 and 1965 rather than to the effect of locations *per se*. In the present studies the trials have been conducted only at two locations, such small variety x location component indicates that the 20 varieties behaved similarly relative to each other at the 2 locations during the years of testing. To substantiate this fact a rank correlation analysis was performed and a highly significant correlation of 0.70 between ranks was obtained. This suggests that little would be gained by increasing the number of testing areas or division of the island into testing areas as proposed by Horner and Frey for oats in Iowa. Nevertheless, it should be recognized that the data based on two locations may not provide the true picture of variety x location effects.

The overall magnitude of thc variety x year interaction in the present data was larger than the variety x location interaction and statistically significant. This indicates that varietal reaction between years was less

consistent than between locations. According to this data it seems advisiable to test varieties for more than two years. Optimum number of years for testing the four attributes studied should be determined with further experimentation.

The second order interaction in the present data, although statistically significant for all characters studied, are considerably smaller than the variety component and equal to or smaller than the variety x year interaction. This tend to indicate that part of the differential response to environment may be accounted for year effect.

Pigeonpea is a well adapted crop in Puerto Rico. It is grown under a great variety of climatic conditions, different soil types, and is very resistant to drought spells. Investigations by Samuels and Landrau showed that application of fertilizers to pigeonpeas had no effect on yields. The crop is a short day plant i.e., flowering is induced during exposures to short daylight. This fact could be a very important factor between locations for the characters studied, however if we consider that there is only a difference of one-half degree in latitude (18.O S — 18.5 N) between the Southern and Northern part of the island, the relative importance of this factor is minimised and consequently the flowering behaviour is very similar at both locations.

The results cited in this paper indicate that the data from one location for a period of three years or more should be sufficient to eliminate most of the low yielding entries from a varietal test. The time and expense involved in testing in additional locations may be justified in the final evaluation of the high yielding lines prior to release, but even in this case two or at most three locations should be sufficient.