ESTIMATE OF GENOTYPIC VALUE: A PROPOSED METHOD

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SUMMARY

Genotypic differences in yield between breeding lines or cultivars may be estimated with the aid of functions of the regression of their individual yields, in different environments, on the mean yields of all the lines tested in the respective environments.

CONSIDERATIONS

The progress made in any breeding programme is dependent on the recognition of superior genotypes. Selection for disease- and insect-resistance, maturity, height, shape or colour of fruits etc. can be successfully done in a few nursery tests. However, the expression of some quantitative characters, and in particular that of yield, are strongly influenced by genotype × environment interaction effects. Therefore, selection for these characters has to be based on evaluations at many different environments. This can be obtained by conducting the tests at various sites and under different managements, e.g., crop rotation, fertilization, irrigation, seeding dates and rates, etc.

If these environments would comprise a representative sample of the population of environments for which the breeding programme is intended then the mean phenotypic performance of any line, averaged over these environments, should provide a reliable estimate of its genotypic value (COMSTOCK and MOLL, 1963). In practice such a representative sample of environments can hardly be achieved. It seems, however, feasible to conduct a series of tests under environmental conditions which include the range of conditions for which selection is being done.

PROPOSED METHOD

It is suggested to fit for each line a function of the regression of its individual yields, at the different environments, on the mean yields of all the tested lines at the respective environments. Data presented by FINLAY (1968) and our own investigations indicate that a good fit to a linear regression may be obtained either from the actual yield data or from their transformed values.

The regression functions for a breeding line $i$ and for an established cultivar $cv$, included in the trials as check, would be $\hat{Y}_{i} = a_{i} + b_{i}x$ and $\hat{Y}_{cv} = a_{cv} + b_{cv}x$, respectively. The value of $\hat{Y}_{i}$ at that level of $x$ for which $\hat{Y}_{cv}$ equals the average yield of this cultivar, under the conditions which the breeding programme is aiming at, may be regarded as an estimate of the genotypic value of line $i$ (Fig. 1).
Fig. 1. Regression functions of the yields (\( \hat{Y} \)) of an established cultivar (cv) and a breeding line (i), at different environments, on the mean yields of all tested lines and cultivars at each environment (×).

Encircled dot: estimated genotypic value of lin i.  
Dot: average yield of established cultivar under the conditions at which the breeding programme is aimed.

**EXAMPLE**

The above outlined method of estimating genotypic value can be illustrated by some data on wheat grain yields obtained in a series of trials in Israel (ZAR-SHALOM, 1970). In this case the following values for intercept (a), slope (b) and correlation factor (r) were obtained for the linear regression of an established cultivar and of two lines on trial means averaged over 7 lines and cultivars tested at each of 13 sites:

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>cv. F.A. 8193</td>
<td>-243</td>
<td>0.947</td>
<td>0.968</td>
</tr>
<tr>
<td>line Fan*</td>
<td>-735</td>
<td>1.245</td>
<td>0.940</td>
</tr>
<tr>
<td>line Mirjam 1*</td>
<td>182</td>
<td>0.997</td>
<td>0.972</td>
</tr>
</tbody>
</table>

The squares of the correlation coefficients indicate that about 90% of the variations in grain yield among trials could be attributed to linear regression on the trial means. The variation in yield among the trials was due mainly to differences in rain and soil fertility at the different sites. The array of the mean grain yields obtained at these sites includes the range of yields which are typical for the conditions for which the local wheat breeding programme has been established.

The average yield of the check cultivar F.A. 8193 in the principal local wheat-growing area is about 2000 kg/ha. According to the regression function of this cultivar, \( \hat{Y}_{F.A.8193} = 2000 \) if \( x = 2370 \). Therefore, the values of \( \hat{Y}_i \) when \( x = 2370 \) should be regarded as the estimates of genotypic value. These estimates were markedly different for the two lines (2215 and 2545 kg/ha for Fan and Mirjam 1, respectively) whereas their observed mean yields, averaged over all the series of trials, were almost similar (3790 and 3810 kg/ha, respectively).

* Bred by Dr Y. Ephrat, Volcani Center, Bet Dagan, Israel.