PATTERN ANALYSIS OF GENOTYPE X ENVIRONMENT INTERACTIONS AND COMPARISONS WITH ALTERNATIVE ANALYSES

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Abstract

The occurrence of genotype-environment interactions is a problem affecting the interpretation of cultivar trials. Several analyses have been used to try to resolve the inconsistencies of cultivar performances which occur when these interactions are present.

An assessment of several techniques was carried out using three sets of data. Two sets of barley data came from one season's trials covering the barley growing areas of New Zealand. Ten wheat cultivars were tested in four locations in the lower North Island in two seasons.

The analyses which were examined were Analysis of variance, linear regression, Cluster Analysis and Principal Component Analysis. The parameters of Wricke, Hanson and Eberhart and Russell were also studied.

The Analysis of Variance revealed significant location, genotype and genotype-location interaction effects for the barley data. The wheat data had significant years, years x locations, genotype and genotype-year interactions effects.

There was a strong linear relationship between the genotype means and the environmental index for the Finlay-Wilkinson regression analysis. Following refinement of the error term $\beta_{i's}$ with significant differences from 1.0 could be seen for several Barley and Wheat genotypes. It was noted that a conflict existed between the aim of finding significant differences from 1.0 and the assumption of

independence of effects for the underlying model. It was suggested that an independent measure of environments be used.

The parameters of Wricke, Hanson and Eberhart & Russell were each related to different concepts of stability and the genotypes ranked accordingly. The three parameters gave reasonably consistent results for the rankings of the cultivars.

In the barley data the cultivars Goldmarker and Magnum had uniformly low rankings. The wheat cultivar Gamenya was generally found to rank highly. These were measures of variability over environments so a high ranking infers a low level of variability and vice versa.

A comparison of the different clustering strategies available was carried out and Wards Incremental Sums of Squares method was chosen as the major strategy. This was applied to each data set using both genotype-environment effects and means. A probabilistic cut off measure was used for truncation of the dendrogram.

The clusters formed could be related to the previous analyses and seemed to adequately summarise the different responses present.

A Principal Component Analysis was carried out and the number of components needed to account for 75% of the total variation were examined. For the barley data sets relatively large numbers of components were needed for this (five and six). This made interpretation and presentation of the genotypic performances difficult. For the wheat data two components

explained a satisfactory level of the total variation and the arrangement of the genotypes on these two axes agreed closely with the clustering results.

Varimax rotation did not aid greatly in the interpretation of the components.

It was felt that the roles of these different analyses were complementary in interpreting genotypic performances.

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Introduction

In order to assess the worth of a potential cultivar a Plant Breeder will carry out a series of trials which are designed to give an estimation of its relative performance. Ideally the trials should cover the range of environments, both sites and seasons, which will be experienced by the cultivar when grown commercially.

Decisions based on the results of these trial systems become confounded when genotype-environmental interactions are present. These interactions are seen as inconsistencies of relative genotypic performances over environments and mean that comparisons of genotype means are not a true indication of the situation.

The occurrence of genotype-environment interactions has been reported in many crops over a long period of time and has resulted in several different analyses being proposed to handle them (Hill, 1975). The adaptability of a genotype is a concept concerned with its responsiveness to environmental change. This is closely linked to genotype-environment interaction problems and some measure of adaptability has been the aim of some of these analyses.

The aim of a plant breeding program may be for specific adaptation to a particular environmental range or general adaptability to a wide range of environmental conditions. Some measure of adaptation will therefore be important.

Parameters designed for this purpose have involved analysis of variance techniques, partitioning into variance components and regression analysis. A more recent approach has been to describe the pattern of response of a genotype. This has involved the application of several multivariate analyses to trial data, using each test environment as a variable in the analysis.

This study has been designed to assess some of these methods in an attempt to identify the advantages and weaknesses of each. Of particular interest are the Pattern Analysis techniques since these are relatively untried in this field.

The data which has been used comes from regional trials for the evaluation of wheat and barley cultivars in New Zealand. Interpretation of these for the various stability and adaptability concepts has been carried out and related to the New Zealand situation.