Stability for seed yield in ajwain based on Gentoype Selection Index

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ABSTRACT

Ajwain is the second most important seed spice crop in Andhra Pradesh, India. It is grown as rainfed crop in vertisols. The crop is sown usually during July to September as a rainfed crop. There is a need for identifying suitable high yielding genotypes adaptable to rainfed vertisols. In view of this, fourteen genotypes were evaluated for the ir performance in rainfed vertisols for four years. The uniqueness of the rainfed environment which varies with year to year was taken as advantage and Additive Main Effect and Multiplicative Interaction (AMMI) analysis was used to understand the complex genotype x environment (GE) interactions. Further AMMI Stability Values and Genotype Selection Index (GSI) were worked out for the genotypes. Stability when assessed should be reliable. Genotype Selection Index (GSI) due to its nature of combining the estimated the stability measure and yield data, gave more useful information for selection and recommendation. The most desirable genotypes for selection of both stability and high grain yield were genotype 3 (LTa-26) followed by genotype 2 (LTa-25).

Key words: Adaptability, AMMI, PCA, Selection index, Stability.

INTRODUCTION

Ajwain is primarily grown as rainfed crop in vertisols. As of now very few varieties have been developed in this crop and there is immense scope for evolving genotypes suitable for rainfed situations. In rainfed situation, each season is unique therefore reliability of genotype performance across these environments is the key to identification of suitable genotypes under such conditions. A stable cultivar, with desired yield capacity is far desirable than a genotype that gives high yield only under certain environments but poorly adaptable. Stable performance and broad adaptation is most desirable in addition to high yielding potential of any variety under development. Although several methods are employed for GEI (Genotype x environment interaction) or phenotypic stability analysis, Additive Main Effect and Multiplicative Interaction (AMMI) model is desirable it facilitates simultaneous selection of varieties for yield and stability (Gauch, 1992). The model helps in establishing the relationship of genotypes, environment and their interaction (Gauch and Zobel, 1996).

The present study was therefore conducted to assess the nature and magnitude of G-E interaction, degree of correlation among some stability parameters of grain yield and to identify stable ajwain genotypes.

MATERIALS AND METHODS

Fourteen genotypes of Ajwain (Trachyspermum ammi (L.) Sprague ex Turrill) collected from Andhra Pradesh, India were evaluated for four consecutive years, (2005-2009) under rainfed conditions of Horticultural Research Station, Lam. Description of the four environments are given in Table 1. The experimental design was randomized completely block design (RCBD) with three replications. The recommended package of practices for the area was adopted. A row to row spacing of 60 cm and plant to plant spacing of 20 cm was adopted. Observations on number of primary branches, number of secondary branches, number of umbels per plant, number of umbellets per plant, number of days to fifty percent flowering, duration to maturity and grain yield were recorded.

Statistical analysis: The four year yield data was subjected to pooled analysis using Crop Stat 7.2. Adaptability and stability of the genotypes was estimated using the Crop Stat 7.2. G x E biplots were generated to evaluate the genotypes simultaneously for yield and stability. ASV (AMMI Stability Value) values were estimated for both genotypes and environments. Further, GSV (Genotype Stability Index) values were estimated for genotypes.

RESULTS AND DISCUSSION

Since the environments are the years, the perusal of meteorological data of the study period indicated that environments the parameters which varied included the rainy days, total rainfall and the minimum rainfall. The minimum rainfall was received in the environment III whereas maximum was received in environment I. Minimum number of rainy days were recorded in environment IV. The differences in weather parameters of the test environments
projected a scenario for better discrimination of the genotypes.

The result of the pooled analysis over environments and AMMI analysis of grain yield is given in Table 2. The source of variation in the combined analysis were highly significant \((P<0.01)\) genotype (G), environment (E) and G x E interaction. Out of the total variance, environment alone accounted for larger variation of 46.7\% followed by G x E interaction (GEI) (21.7\%) and genotype (20.4\%). This variability was primarily due to larger variation in rainfall, number of rainy days in each environment and high variation in mean sunshine hours among the environments. Further, the genotypes showed varied performance in response to the environments in which they were tested thus contributing larger variation in genotypes, and genotype and environment interaction. The mean yield across locations over four years revealed considerable changes in ranks among the genotypes, reflecting the presence of high G x E interactions (Baker, 1998). Pham and Kang (1988) viewed that as G x E interaction minimizes the usefulness of genotypes by confounding their yield performance, it is of great importance to study the adaptability and stability of the genotypes. Becker and Leon (1988) further indicated that estimation of stability could increase both reliability and heritability of important traits.

The larger variance component due to environment indicated that the test environments were reasonably different. The larger variance of genotypes and GEI indicated that the test varieties differed in their performance substantially over environments and there was a close association of performance of genotype to environments. The magnitude of the GE interaction was almost equivalent to that of genotypes (1.06 times), showing that there were varied differences in the genotypic response across environments. Overall, AMMI model contained 90.3\% of the treatment SS, while the residual contained 9.7\%. These results indicate that the AMMI model fit the data well and justifies the use of AMMI.

The mean squares of genotypes, environments and genotype x environments were all highly significant indicated that significant differences existed among genotypes, the environments (seasons in the present study) had exerted significant influence on the expression of genotypes. Significant G x E mean squares indicated that the expression of genotypic performance was non linear across the environment, in other words was unpredictable. Such observations are common in rainfed farming situations, with considerable year to year variations in the performance of the genotypes. This signifies the fact that the breeders need to develop stable varieties that can perform reasonably well under a range of conditions to avoid risk in the production systems. Especially in marginal environments, farmers opinion that yield stability is the most desired trait to overcome crop

<table>
<thead>
<tr>
<th>Environment</th>
<th>Details of the environments evaluated</th>
<th>Year</th>
<th>Date of sowing</th>
<th>Date of harvesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2005-06</td>
<td>10-08-06</td>
<td>03-03-06</td>
<td>231.9</td>
</tr>
<tr>
<td>II</td>
<td>2006-07</td>
<td>15-11-06</td>
<td>15-04-06</td>
<td>43.9</td>
</tr>
<tr>
<td>III</td>
<td>2007-08</td>
<td>17-11-07</td>
<td>25-04-08</td>
<td>21.0</td>
</tr>
<tr>
<td>IV</td>
<td>2008-09</td>
<td>18-11-09</td>
<td>28-04-09</td>
<td>67.2</td>
</tr>
</tbody>
</table>
Table 2: The combined analysis of variance and interaction principal components in AMMI for grain yield.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F-value</th>
<th>% in Variance</th>
<th>Total</th>
<th>% G X E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment (E)</td>
<td>3</td>
<td>7397320.00</td>
<td>2465770.0</td>
<td>145.13&quot;</td>
<td>46.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genotype (G)</td>
<td>13</td>
<td>3224500.00</td>
<td>248038.00</td>
<td>14.60&quot;</td>
<td>20.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G x E</td>
<td>39</td>
<td>3440200.00</td>
<td>88210.3</td>
<td>5.19&quot;</td>
<td>21.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPCA 1</td>
<td>15</td>
<td>2221662.2</td>
<td>148110.8</td>
<td>8.7&quot;</td>
<td>14.4</td>
<td>64.6</td>
<td></td>
</tr>
<tr>
<td>IPCA 2</td>
<td>13</td>
<td>1110686.7</td>
<td>85437.4</td>
<td>5.3&quot;</td>
<td>7.0</td>
<td>32.3</td>
<td></td>
</tr>
<tr>
<td>IPCA 3</td>
<td>11</td>
<td>107851.1</td>
<td>9804.6</td>
<td>0.6ns</td>
<td>0.7</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>104</td>
<td>1766980.00</td>
<td>16990.2</td>
<td></td>
<td></td>
<td>11.2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>167</td>
<td>15829000.00</td>
<td>94784.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** significant at p=0.01%, CV=19.3%, df=degrees of freedom, SS= Sum of squares, MS= Mean square

Failure. (Ceccarelli, 1994 and Piepho, 1998). Further, Romagosa and Fox (1993) indicated that while developing varieties for variable environments, testing of widely adapted genotypes covering representative samples of special and temporal variations would achieve the desired breeding outcome. Most of the GxE variation was explained by IPCA I scores.

**IPCA qualitative and quantitative interactions:** The genotype and environment scores for IPCA were both positive and negative values. (Table 3 and 4) representing a disproportionate genotype response (Yan and Hunt, 2001), thus forming the principle source of variation for any crossover interaction. Conversely, scores with the same sign or near zero represent a non-crossover G x E interaction or a proportionate genotype response. The IPCA scores of a genotype in the AMMI analysis were reported by Gauch and Zobel (1996) as indication of the stability of genotypes are across their testing environments (Yau, 1995).

**AMMI Stability Value (ASV):** The distance from zero in a two dimensional scattergram of IPCA1 (interaction principal component analysis axis 1) scores against IPCA2 scores is a fair indication of stability (Purchase, 1997; Adugna and Labuschagne, 2002). The genotypes with high ASV were most unstable and vice-versa. The ASV values indicated that the genotypes LTa-35, LTa-24 and LTa-22 were most stable across environments. And the genotypes, LTa-25, LTa-36 and LTa-29 performed superiorly in certain environments.

**G x E bi-plot analysis:** Biplot analysis and ordination techniques revealed high significant differences for IPCA1, IPCA2 and IPCA3. The noise estimated in the interaction pattern is only 9.2% indicating that the model used is fit for evaluating the genotypes (Gauch and Zobel, 1988; Gauch, 1992). The results of PCA of GEI are presented in Figure 1 and 2 as per Cooper and Delacy (1994). Biplot analysis revealed that the environments 2, 3 and 4 had the greatest effect in GE interaction. Biplot of IPCA1 and IPCA2 (Figure 1) covers 96.6 % of GE interaction. The position and perpendicular projection of genotypic points onto an environmental vector can be used to identify a genotype or genotypes having specific adaptation in that environment(s) (Yan et al., 2000). Genotype farther from the center of biplot show specific adaptation. Several genotypes had shown specific adaptations to specific environments.

The genotypes LTa-25 and LTa-26 though had high mean yields, were having adaptability to the environment 3. The genotypes LTa-36 and LTa-29 were better adapted to the environment 2. Genotypes toward the center of biplot have zero interaction, therefore have general adaptation with different mean grain yield. Genotypes 1 (LTa-24), 12 (LTa-35), and 9 (LTa-32) are located in this category. However, their mean yields are lower than the check variety Lam Selection-1. However, genotype 3 (LTa-26) and 2 (LTa-25) has highest mean yield and relatively stable over the four environments, presents a better selection option for the breeder.

The simultaneous overview of stability and yield helps quick and precise interpretation and selection of genotypes (Wade et al., 1999; Alagarswamy and Chandra, 1998; Farshadfar and Sutka, 2003). The environment vectors...
covered a wide range of the Euclidean space, indicating that the nine environments of study represented a wide range of environments (Table 2).

### Genotype Selection Index (GSI):

Usually, stability is not the primary selection criteria but the yield. The genotypes with yield superiority may not have desired level stability (Mohammadi et al., 2007). Hence, Genotype Selection Index as proposed by Kang (1991, 1993) are used here to interpret the data of the genotypes. de Oliveira (2014) used selection index to discriminate advantageous genotypes in Maize and expressed importance of selection index. ASV takes into account both IPCA1 and IPCA2 that justify most of the variation of GE interaction, therefore the rank of ASV and mean grain yield (R) are incorporated in a single selection index namely Genotype Selection Index (GSI). The least GSI is considered as the most stable with high grain yield.

### REFERENCES


