Full Length Research Paper

Parametric stability analyses for green forge yielding traits in oats (Avena sativa L.)

Mushtaq Ahmad*, Gul Zaffar, Z. A. Dar, Noorul Saleem and Mehfuza Habib

Division of Genetics and Pant Breeding, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir Shalimar campus, Srinagar -191 121, India.

Received 28 August, 2013: Accepted 20 February, 2014

The objectives of this research were to assess genotype environment interaction and determine stable oat (Avena sativa L.) cultivar in Kashmir division over three locations for fodder yield and its components in 10 genetically diverse genotypes using randomized block design. There was considerable variation in forage yield within and across environments. Stability analysis for forage yield was conducted to check the response to Genotype × Environment (G × E) interactions. The mean squares due to G × E (linear) were significant depicting genetic differences among genotypes for linear response to varying environments. Mean squares due to pooled deviations were highly significant, reflecting considerable differences among genotypes for nonlinear response. Out of 10 genotypes, only 4 oats lines, that is, Sabzaar, SKO-211, SKO-212 and SKO-213 showed non-significant deviation from regression and their regression coefficient values were close to unity classified were desirable for forage and dry matter yield across the environments. The cultivar, “SKO-212” with respective regression coefficient value of 1.001, the smallest deviations from regressions (S²di) value and the highest green forage yield could be considered the most widely adapted cultivar. The other test cultivars were sensitive to production-limiting factors, their wider adaptability, stability and general performance to the fluctuating growing conditions within and across environments being lowered.

Key words: Genotype × Environment (G × E) interaction, stability analysis, forage yield, oats.

INTRODUCTION

Oats occupies a prominent place among rabi fodders in India. It provides a high tonnage of nutritious green fodders. In India, oats have a wider adaptability, particularly in western and north western regions of the country because of its excellent growing habitat’s, quick re-growth and better nutritional value. As per national estimate, by 2015 and 2025 A.D., 60 corers animals will need 1097 and 1170 million tonnes of green fodder, respectively. Deficiency of green fodder will be about 64.9% and for dry fodders it may go up to 24.9% in 2025 A.D. (Government of India, Planning Commission, 2001). The yielding ability of a variety is the result of its interaction with the prevailing environment. Environmental factors such as soil characteristics and types, moisture, sowing time, fertility and temperature and day length vary over the years and locations. There

*Corresponding author. E-mail: sahilmushtaqdar@rediffmail.com. Author(s) agree that this article remain permanently open access under the terms of the Creative Commons Attribution License 4.0 International License
is strong influence of environmental factors during various stages of crop growth (Bull et al., 1992), thus genotypes differ widely in their response to environments. The development of cultivars or varieties, which can be adapted to a wide range of diversified environments, is the ultimate goal of plant breeders in crop improvement program. The adaptability of a variety over diverse environments is usually tested by the degree of its interaction with different environments under which it is planted. A variety or genotype is considered to be more adaptive or stable one if it has a high mean yield but low degree of fluctuations in yielding ability when grown over diverse environments (Arshad et al., 2003). The phenotypic performance of a genotype may not be the same under diverse agro-climatic conditions. This variation is due to Genotype × Environment (G × E) interactions, which reduces the stability of a genotype under different environments (Ashraf et al., 2001). Many models have been developed to measure the stability of various parameters and partitioning of variation due to G × E interactions. The most widely used model (Eberhart and Russell, 1966) was followed to interpret the stability statistics in different crops.

Many research workers are of the view that average high yield should not be the only criteria for genotype superiority unless its superiority in performance is confirmed over different types of environmental conditions (Qari et al., 1990). Therefore, in the present investigation an attempt has been made to evaluate oat genotypes for forage yield and its component characters under different environments to identify genotypes with suitable performance in variable environments.

### MATERIALS AND METHODS

The basic material for the present study consisted of 10 diverse genotypes of Oats (Avena sativa L.) viz: SKO-204, SKO-205, SABZAAR, SKO-207, SKO-208, SKO-209, SKO-210, SKO-211, SKO-212, and SKO-213 collected from National Bureau of Plant Genetic Resource (NBPGR) New Delhi and Sabzaar (Released variety) (Table 1) were evaluated at three locations viz., Experimental Farm of the Division of Plant Breeding and Genetics, SKUAST-K, Shalimar district Srinagar, Mountain Research Centre for Field Crops, Khudwani district Anantnag and FOA, Wadura district Baramula (Jammu and Kashmir, India) during rabi 2010 to 2011 in a randomized block design with three replications at each location and each treatment was sown in 2 rows each of 4 m length. Row to row and plant to plant spacing was maintained at 30 and 10 cm. The observations were recorded on 5 quantitative characters viz. number of leaves plant\(^{-1}\), number of tillers metre\(^{-1}\) row, leaf stem ratio, green fodder yield plant\(^{-1}\) (g), and dry matter yield plant\(^{-1}\) (g). Data were subjected to stability analysis according to Eberhart and Russel (1966).

### RESULTS AND DISCUSSION

The analysis of variance (ANOVA) for stability analysis (Table 2) indicated the presence of Genotype (G), Environment (E), G × E (Interaction), Environment + (Genotype × Environment), Environment (Linear) and Genotype × Environment (Linear) significant for all the characters under study.

The partitioning of mean squares (environments + genotype × environments) (Table 2) showed that environments (linear) differed significantly and were quite diverse with respect to their effects on the performance of genotypes for forage yield and majority of yield components. Further, higher magnitude of mean squares due to environments (linear) as compared to genotype × environments (linear) exhibited that linear response of environments accounted for major part of total variation for most of the characters studied. The significance of mean squares due to genotype × environment (linear) component against pooled deviation for green fodder yield suggested that the genotypes were diverse for their regression response to change with the environmental fluctuations. Similarly, the significant mean squares due to pooled deviation observed for all the characters under study suggested that the deviation from linear regression also contributed substantially to words the difference in stability of genotypes. Thus, both linear (predictable) and nonlinear (un-predictable) components significantly contributed to genotype × environment interactions.

### Table 1. Genotypes used in the study with their accession number.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Genotype</th>
<th>EC number/Place of collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>SKO-204</td>
<td>EC-529089</td>
</tr>
<tr>
<td>2.</td>
<td>SKO-205</td>
<td>EC-529090</td>
</tr>
<tr>
<td>3.</td>
<td>SKO-207</td>
<td>EC-529092</td>
</tr>
<tr>
<td>4.</td>
<td>SKO-208</td>
<td>EC-529093</td>
</tr>
<tr>
<td>5.</td>
<td>SKO-209</td>
<td>EC-529094</td>
</tr>
<tr>
<td>6.</td>
<td>SKO-210</td>
<td>EC-529095</td>
</tr>
<tr>
<td>7.</td>
<td>SKO-211</td>
<td>EC-529096</td>
</tr>
<tr>
<td>8.</td>
<td>SKO-212</td>
<td>EC-529097</td>
</tr>
<tr>
<td>9.</td>
<td>SKO-213</td>
<td>EC-529098</td>
</tr>
<tr>
<td>10.</td>
<td>Sabzaar</td>
<td>Released variety (SKUAST-Kashmir)</td>
</tr>
</tbody>
</table>

Ahmad et al. 1009
observed for all the characters. This suggested that predictable as well as un-predictable components were involved in differential response of stability. Similar results were reported by (Wani et al. (1999), Rasul et al. (2006) and Akcura and Ceri (2011). Higher magnitude of mean squares due to environments indicates considerable difference between environments for all the characters suggesting large difference between environments along with greater part of genotypic response to environments (bi) and nonlinear (S^2di) components of genotype-environment interactions in judging the stability of a genotype. A wide adaptability genotype was defined as one with bi = 1 and high stability as one with S^2di = 0. In this study, values for the regression coefficient (bi) ranged from -3.491 (SKO-210) to 1.773 (SKO-204) for number of tillers m^-1, -9.615 (SKO-205) to 16.538 (SKO-208) no of leaves plant^-1, 0.272 (SKO-209) to 2.199 (SKO-208) for leaf stem ratio, -1.012 (SKO-207) to 4.372 (SKO-204), -0.001 (SKO-205) to 0.029 (SKO-2013) for dry matter yield.

The regression coefficient of genotypes viz., Sabzaar, SKO-2012, SKO-2011 and SKO-2013 for green fodder yield was non-significant and almost approaching unity (bi = 1) and it had the lowest and non-significant deviation from regression and was most suitable for green forage yield over all the locations. Genotypes SKO-207, SKO-208, SKO-209 and SKO-2010 gave below average performance besides deviation from regression were significant hence the performance of these cultivars seems to be unpredictable. Accordingly, “SKO-2012” was the most stable cultivar for green forage yield, since its regression coefficient was almost equal to the unity and it had the lowest deviation from regression.

### Conclusion

The cultivar “SKO-2012” was the most stable cultivar for green forage yield over all the locations. Hence, this cultivar is recommended for cultivation in different environmental conditions. The cultivar “SKO-2013” had regression coefficient significantly greater than 1.0 would be recommending for cultivation under favorable conditions only. “SKO-204” had regression coefficient significantly less than 1.0 low in green forage yield; this cultivar is, therefore, insensitive to environmental changes and adapted only to poor environments. The performance of cultivar “SKO-209” was poor; it produced below average green forage yield. This cultivar had high deviations from regression indicating sensitivity to environmental changes.

This cultivar cannot be recommended due to its overall poor performance. Genotypes Sabzaar,

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>df</th>
<th>Number of tillers m^-1</th>
<th>No of leaves plant^-1</th>
<th>Leaf stem ratio</th>
<th>Green fodder yield plant^-1 (g)</th>
<th>Dry matter yield plant^-1 (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genotype (G)</td>
<td>9</td>
<td>219.935**</td>
<td>41.022**</td>
<td>33.916**</td>
<td>11.706**</td>
<td>0.468**</td>
</tr>
<tr>
<td>Environment (E)</td>
<td>2</td>
<td>56.207*</td>
<td>30.048**</td>
<td>272.657**</td>
<td>1.110*</td>
<td>0.044*</td>
</tr>
<tr>
<td>G × E (Interaction)</td>
<td>18</td>
<td>54.483**</td>
<td>21.233**</td>
<td>14.724**</td>
<td>210.647**</td>
<td>0.095*</td>
</tr>
<tr>
<td>Pooled error</td>
<td>54</td>
<td>1.016</td>
<td>0.081</td>
<td>0.0736</td>
<td>0.015</td>
<td>0.006</td>
</tr>
<tr>
<td>Environment + (G × E)</td>
<td>20</td>
<td>54.655**</td>
<td>51.114**</td>
<td>40.517**</td>
<td>0.694*</td>
<td>0.027*</td>
</tr>
<tr>
<td>E (Linear)</td>
<td>1</td>
<td>112.414**</td>
<td>20.096**</td>
<td>545.314**</td>
<td>112.220**</td>
<td>0.988**</td>
</tr>
<tr>
<td>G × E (Linear)</td>
<td>9</td>
<td>95.240**</td>
<td>71.773**</td>
<td>26.865**</td>
<td>1.024*</td>
<td>0.040*</td>
</tr>
<tr>
<td>Pooled deviation</td>
<td>10</td>
<td>12.353**</td>
<td>0.623**</td>
<td>2.325**</td>
<td>0.244**</td>
<td>0.009**</td>
</tr>
</tbody>
</table>

**., * significance at 1 and 5% level respectively.
Table 3. Stability parameters for forage yield and its attributing traits in oats.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Genotype</th>
<th>Number of tillers m⁻¹</th>
<th>No of leaves plant⁻¹</th>
<th>Leaf stem ratio</th>
<th>Green fodder yield plant⁻¹ (g)</th>
<th>Dry matter yield plant⁻¹ (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>bi</td>
<td>S²di</td>
<td>Mean</td>
<td>bi</td>
</tr>
<tr>
<td>1</td>
<td>SKO-204</td>
<td>69.000</td>
<td>1.773</td>
<td>14.203**</td>
<td>4.444</td>
<td>3.077</td>
</tr>
<tr>
<td>2</td>
<td>SKO-205</td>
<td>68.444</td>
<td>0.216</td>
<td>15.314**</td>
<td>4.444</td>
<td>-9.615</td>
</tr>
<tr>
<td>3</td>
<td>SABZAAR</td>
<td>86.222</td>
<td>1.010</td>
<td>100.001</td>
<td>4.666</td>
<td>1.030</td>
</tr>
<tr>
<td>4</td>
<td>SKO-207</td>
<td>86.666</td>
<td>1.522</td>
<td>11.058**</td>
<td>6.000</td>
<td>2.308</td>
</tr>
<tr>
<td>5</td>
<td>SKO-208</td>
<td>73.666</td>
<td>-1.381</td>
<td>4.332*</td>
<td>5.555</td>
<td>16.538</td>
</tr>
<tr>
<td>6</td>
<td>SKO-209</td>
<td>64.777</td>
<td>-2.826</td>
<td>11.853**</td>
<td>4.555</td>
<td>-6.538</td>
</tr>
<tr>
<td>7</td>
<td>SKO-210</td>
<td>65.000</td>
<td>-3.491</td>
<td>19.433**</td>
<td>4.222</td>
<td>-0.769</td>
</tr>
<tr>
<td>8</td>
<td>SKO-211</td>
<td>72.555</td>
<td>1.051</td>
<td>0.034</td>
<td>4.777</td>
<td>1.098</td>
</tr>
<tr>
<td>9</td>
<td>SKO-212</td>
<td>83.555</td>
<td>1.042</td>
<td>0.102</td>
<td>5.333</td>
<td>1.049</td>
</tr>
<tr>
<td>10</td>
<td>SKO-213</td>
<td>80.777</td>
<td>1.057</td>
<td>0.083</td>
<td>4.444</td>
<td>1.023</td>
</tr>
<tr>
<td>Population mean</td>
<td>75.066</td>
<td>4.844</td>
<td>24.756</td>
<td>13.146</td>
<td>2.629</td>
<td></td>
</tr>
<tr>
<td>SE ±</td>
<td>2.485</td>
<td>0.558</td>
<td>1.078</td>
<td>0.349</td>
<td>0.699</td>
<td></td>
</tr>
</tbody>
</table>

Bi, Regression coefficient; S²di, deviation from regression (Eberhart and Russell, 1966).

SKO-2011 and SKO-2013 showing better performance under unfavorable environmental conditions are best candidates for evaluating this performance under marginal environments through participatory varietal selection programmes.

Conflict of Interest

The author(s) have not declared any conflict of interests.

REFERENCES


Ahmad et al. 1011
