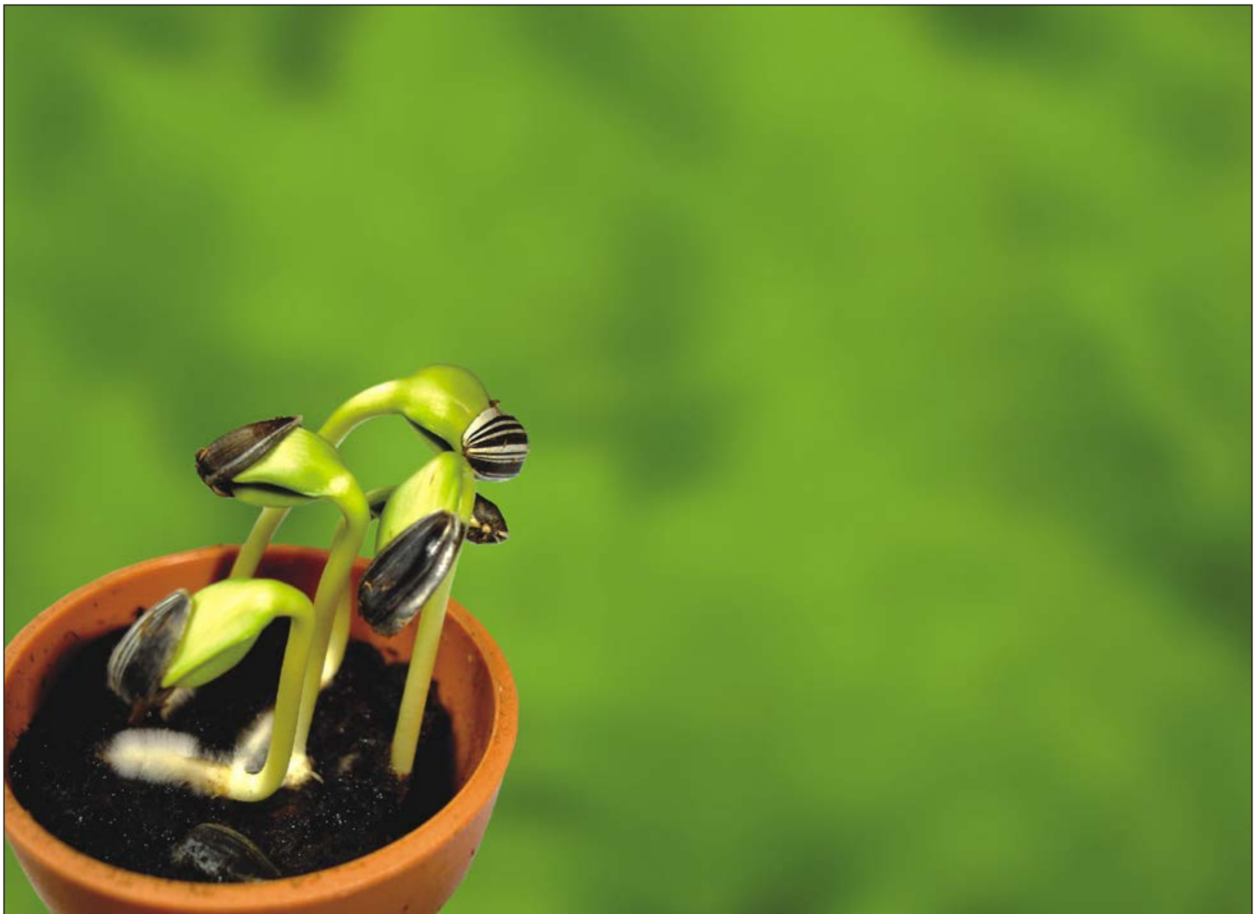

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# Stability Properties of Certain Oats (*Avena sativa* L.) Genotypes for Major Grain Yielding Characteristics

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## ABSTRACT

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 grain yield and its components in 10 genetically diverse genotypes using randomized block design. There was considerable variation in grain yield within and across environments. Stability analysis for grain yield was conducted to check the response to genotype×environment 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 non-linear response. Out of ten genotypes, only two oats lines i.e., Sabzaar and SKO-208 showed non-significant deviation from regression and their regression coefficient values were close to unity classified were desirable for grain yield across the environments. The cultivar, "SKO-208" with respective regression coefficient value of 1.011, the smallest deviations from regressions ($S^2di$) value and the highest grain 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:** *Avena sativa* L., grain yield, genotype environment interactions, Oat, stability

## INTRODUCTION

Oats (*Avena sativa*) is one of the important forage Cereals in temperate areas and economically is ranked as one of the eight important crops in the world. Besides, there are very limited studies about oat especially in Jammu and Kashmir. Therefore, regarding to the importance of oat as multi-purpose crop, the research on this crop to develop or introduce new superior genotypes or varieties would be of value. Oat grain has always been an important form of livestock feed. However, the amount of oats used for human consumption has increased progressively, owing its dietary benefits. Infact, the health effects of oat rely mainly on the total dietry fibre and beta glucan content (Kerckhoffs *et al*., 2003). Oat protein is nearly equivalent in quality to soy protein which has been shown by the World Health Organization to be equal to meat, milk and egg protein. The protein content of the hull-less oat kernel (groat) ranges from 12-24%, the highest among cereals (Lasztity, 1999). 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 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.

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, temperature and day length vary over the years and locations. There 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. 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). By growing genotypes in different environments, the highest yielding and most stable genotypes can be identified (Lu'quez *et al.*, 2002). Genotypes tested in different locations often have significant fluctuation in yield due to the response of genotypes to environmental factors such as soil fertility or the presence of disease pathogens (Kang, 2004). GEI results from a change in the relative rank of genotype performance or a change in the magnitude of differences between genotypes performance from one environment to another. Thus, GEI affects breeding progress because it complicates the demonstration of superiority of any genotype across environments and thus, the selection of superior genotypes (Ebdon and Gauch, 2002). Another undesirable effect of GEI includes low correlation between phenotypic and genotypic values, thereby reducing progress from selection. This leads to bias in the estimation of heritability and in the prediction of genetic advance (Alghamdi, 2004). Therefore, the magnitude and nature of GEI determine the features of a selection and testing program. Many researchers use the terms 'stability' and 'adaptability' to refer to consistent high performance of genotypes across diverse sets of environments (Ramagosa and Fox, 1993; Lin and Binns 1994) described two types of stable genotypes; those showing a stable average yield across environments and those with high yield in specific environments but poor yield in non-target environments (genotypes with specific adaptability). However, information on stability of oat for grain yield in the Jammu and Kashmir is limited. Therefore, we were interested to evaluate the stability for grain yield and yield components of oats and to identify genotypes having high stability across locations or specific location adaptability. The objective of this study was to identify genotypes with high stability for grain yield in variable environments.

## MATERIALS AND METHODS

The basic material for the present study consisted of ten 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 selected from the germplasm collection maintained at Division of Plant Breeding and Genetics, SKUAST-K, Shalimar were evaluated at three locations viz., Experimental Farm of the Division of Plant Breeding and Genetics, SKUAST-K, Shalimar, Mountain Research Centre for Field Crops, Khudwani Anantnag and FOA, Wadura. During rabi 2010-2011 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 4 quantitative characters viz., spikelets panicle$^{-1}$, 1000 seed weight (g), seed length breadth ratio and grain yield plant$^{-1}$ (g).

**Statistical analysis:** The method of Eberhart and Russell (1966) was used in this study to characterize genotypic stability. The following linear regression model was used:

$$Yij = \mu + biI\,j + \delta ij + \varepsilon ij$$

where, Yij is the mean of the genotypes ith at the location j; μ is the general mean of genotype i; bi is the regression coefficient of the ith genotype at the location index which measures the response of this genotype to varying location; Ij is the environmental index which is defined as the mean deviation of all cultivars at a given location from the overall mean; δij is the deviation from regression of the ith cultivar the jth location; εij is the mean of experimental error.

## RESULTS AND DISCUSSION

The stability analysis (Table 1) indicated the presence of significant G×E interaction for all the characters under study. 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 i.e., the environments created by locations were justified and had linear effects (Nehvi *et al*., 2007). By partitioning G×E interaction into linear and nonlinear (pooled deviation) components, differences between environments (environment linear) were highly significant which indicated the genetic control of genotypic response to environments (Zubair and Ghafoor, 2001). The G×E interactions, were however of non-linear type, because G×E (linear) was significant against pooled deviation, reflecting lack of genetic differences among genotypes for their response to varying environments.

The partioning of mean squares (environments+genotype×environments) (Table 1) 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

Table 1: Analysis of variance for stability for grain yield and its attributing traits in Oats

| | | Mean square | | | |
|---|---|---|---|---|---|
| Source of variation | df | Spikelets panicle$^{-1}$ | 1000 seed weight (g) | Seed length breadth ratio | Seed yield plant$^{-1}$ (g) |
| Genotype (G) | 9 | 82.611** | 28.250** | 0.461** | 0.324** |
| Environment (E) | 2 | 189.269** | 0.722** | 0.004** | 1.422** |
| G×E | 18 | 99.863** | 1.536** | 0.019** | 0.163** |
| Pooled error | 54 | 0.897 | 0.038 | 0.007 | 0.006 |
| Environment+(G×E) | 20 | 108.803** | 1.455** | 0.017** | 0.289** |
| E (linear) | 1 | 378.538** | 1.445** | 0.009** | 2.845** |
| G×E (linear) | 9 | 117.083** | 2.918** | 0.035** | 0.308** |
| Pooled deviation | 10 | 74.378** | 0.140** | 0.002** | 0.016* |

**Significant at 1%, *Significant at 5%, NS: Non-significant (linear) component against pooled deviation for grain 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 non-linear (un-predictable) components significantly contributed to genotype×environment interactions 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.* (2002), Rasul *et al.* (2006) and Akcura and Ceri (2011).

The stability parameters for all cultivars are given in Table 2. Eberhart and Russell (1966) emphasized the need of considering both linear (bi) and non-linear ($S^2$di) 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 $S^2$di = 0. In this study values for the regression coefficient (bi) ranged from 0.444 (SKO-210) to 1.293 (SKO-209) spike lets panicle$^{-1}$, 0.385 (SKO-205) to 1.385 (SKO-209) for 1000 seed weight (g), 0.091(SKO-204) to 1.822 (SKO-209) for seed length breadth ratio and 0.075 (SKO-210) to 1.637 (SKO-209) for grain yield plant$^{-1}$ (g).

The regression coefficient of genotypes viz., SKO-208 and Sabzaar for grain 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 grain yield over all the locations. The cultivars SKO-207, SKO-209 and SKO-213 gave below average performance besides deviation from regression was significant hence the performance of these cultivars seems to be unpredictable. The cultivars SKO-204, SKO-205, SKO-210 and SKO-211 that had regression coefficients of less than unity and below average grain yield, indicating that it offer a greater resistance to environmental change and a specially adapted to poor environments. SKO-212 had high deviations from regression indicating sensitivity to environmental changes. This cultivar cannot be recommended

Table 2: Stability parameters for grain yield and its attributing traits in Oats

| | Spike lets panicle$^{-1}$ | | | 1000 seed weight (g) | | | Seed length breadth ratio | | | Grain yield plant$^{-1}$ (g) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotype | Mean | bi | $S^2$ di | Mean | bi | $S^2$ di | Mean | bi | $S^2$ di | Mean | bi | $S^2$ di |
| SKO-204 | 45.222 | 0.481* | 0.078 | 35.188 | 0.841* | 0.034 | 2..267 | 0.091* | 0.077 | 2.977 | 0.095* | 0.024 |
| SKO-205 | 54.888 | 0.621* | 0.086 | 35.577 | 0.385* | 0.017 | 2.637 | 0.199* | 0.054 | 2.844 | 0.124* | 0.081 |
| SABZAAR | 49.000 | 1.002 | 0.001 | 31.466 | 1.006 | 0.007 | 3.466 | 1.008 | 0.002 | 2.533 | 1.031 | 0.073 |
| SKO-207 | 54.444 | 1.012 | 0.156* | 31.855 | 1.211 | 0.148* | 2.525 | 1.915 | 0.171* | 3.522 | 1.434 | 0.307* |
| SKO-208 | 58.777 | 1.003 | 0.001** | 39.644 | 1.021 | 0.034 | 2.756 | 1.017 | 0.002 | 3.111 | 1.011 | 0.003 |
| SKO-209 | 54.333 | 1.293 | 0.105* | 30.377 | 1.385 | 0.518* | 2.861 | 1.822 | 0.601* | 2.988 | 1.637 | 0.404* |
| SKO-210 | 58.222 | 0.444* | 0.067 | 33.611 | 0.976* | 0.045 | 2.165 | 0.565* | 0.078 | 3.288 | 0.075* | 0.027 |
| SKO-211 | 51.666 | 0.543* | 0.054 | 35.355 | 0.873* | 0.056 | 2.501 | 0.584* | 0.066 | 3.355 | 0.094* | 0.025 |
| SKO-212 | 63.555 | 1.099 | 0.466* | 29.777 | 1.086 | 0.102* | 2.545 | 1.065 | 0.197* | 2.533 | 1.083 | 0.871* |
| SKO-213 | 50.444 | 1.065 | 0.321* | 31.900 | 1.091 | 0.136* | 2.125 | 1.013 | 0.185* | 3.166 | 1.086 | 0.423* |
| Population | | 54..055 | | 33.475 | | | 2.585 | | | 3.032 | | |
| Mean±SE | | 6.098 | | 0.264 | | | 0.035 | | | 0.092 | | |

bi: Regression coefficient, $S^2$di deviation from regression (Eberhart and Russell,1966), **significant at 1%, *significant at 5%, NS: Non-significant due to their overall poor performance. Accordingly, "SKO-208" was the most stable cultivar for grain yield, since its regression coefficient was almost equal to the unity and it had the lowest deviation from regression.

## CONCLUSION

SKO-208 and SABZAAR was the most stable cultivars for grain yield and its contributing traits over all the locations. Hence, these cultivars may be recommended for cultivation in different environments.

## REFERENCES

Akcura, M. and S. Ceri, 2011. Evaluation of drought tolerance indices for selection of Turkish oat (*Avena sativa* L.) landraces under various environmental conditions. Zemdirbyste-Agriculture, 98: 157-166.

Alghamdi, S.S., 2004. Yield stability of some soybean genotypes across diverse environments. Pak. J. Biol. Sci., 7: 2109-2114.

Arshad, M., A. Bakhsh, A.M. Haqqani and M. Bashir, 2003. Genotype-environment interaction for grain yield in chicpea (*Cicer arietinum* L.). Pak. J. Bot., 35: 181-186.

Ashraf, M., A.S. Qureshi, A. Ghafoor and N.A. Khan, 2001. Genotype-environment interaction in wheat. J. Biological Sci., 1: 356-357.

Bull, J.K., M. Cooper, I.H. Delacy, K.E. Basford and D.R. Woodruff, 1992. Utility of repeated checks for hierarchical classification of data from plant breeding trials. Field Crop Res., 30: 79-95.

Ebdon, J.S. and H.G. Gauch, 2002. Additive main effect and multiplicative interaction analysis of national turfgrass performance trials: I. Interpretation of genotype-environment interaction. Crop Sci., 42: 489-496.

Eberhart, S.A. and W.A. Russell, 1966. Stability parameters for comparing varieties. Crop Sci., 6: 36-40.

Kang, M.S., 2004. Breeding: Genotype-by-Environment Interaction. In: Encyclopedia of Plant and Crop Science, Goodman, R.M. (Ed.). Marcel-Dekker, New York, USA., pp: 218-221.

Kerckhoffs, D.A., G. Hornstra and R.P. Mensink, 2003. Cholesterol-lowering effect of beta-glucan from oat bran in mildly hypercholesterolemic subjects may decrease when beta-glucan is incorporated into bread and cookies. Am. J. Clin. Nutr., 78: 221-227.

Lasztity, R., 1999. General characterization of the chemical composition of cereal grains. The Structure of the Cereal Grain in Cereal Chemistry, Akademiai Kiado, Budapest, Hungary, pp: 13-24.

Lin, C.S. and M.R. Binns, 1994. Concepts and methods for analysis regional trial data for cultivar and location selection. Plant Breed. Rev., 11: 271-297.

Lu'quez, J.E., L.A.N. Aguirrezabal, M.E. Aguero and V.R. Pereyra, 2002. Stability and adaptability of cultivars in non-balanced yield trials. Comparison of methods for selecting 'high oleic' sunflower hybrids for grain yield and quality. J. Agron. Crop Sci., 188: 225-234.

Nehvi, F.A., S.A. Wani, A. Hussain, M.I. Maqhdoomi, B.A. Allai, W. Yousuf, F.A. Bahar and Z.A. Dar, 2007. Stability analysis for yield and yield related traits in fodder oats (*Avena sativa* L.). Asian J. Plant Sci., 6: 628-632.

Qari, M.S., N.U.I. Khan and M.A. Bajwa, 1990. Comparison of wheat cultivars for stability in yield performance. Pak. J. Agric. Res., 11: 73-77.

Ramagosa, I. and P.N. Fox, 1993. Genotype-Environment Interaction and Adaptation. In: Plant Breeding: Principles and Prospects, Hayward, M.D., N.O. Bosenmark and I. Ramagosa (Eds.). Chapman and Hall, London, pp: 373-390.

Rasul, I., M. Zulkiffal, J. Anwar, S.B. Khan, M. Hussain and R. Din, 2006. Grain yield stability of wheat genotypes under different environment in Punjab. J. Agric. Soc. Sci., 2: 222-224.

Wani, S.A., J. Nasreen, Z.A. Dar, G. Zafra and F.A. Nehvi, 2002. Stability analysis in relation to green fodder yield in oats (*Avena sativa* L.). SKUAST. J. Res., 74: 148-151.

Zubair, M. and A. Ghafoor, 2001. Genotype environment interaction in mungbean. Pak. J. Bot., 33: 187-190.