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Stability Analysis for Yield and Yield Related Traits in Fodder Oats (*Avena sativa* L.)

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Abstract: Stability analysis was carried in twenty genotypes of fodder oats under four random environmental conditions of Kashmir valley. Observations were recorded on 10 maturity, morphological, quality, yield and yield related traits. Significant variation among genotypes was observed for all the traits indicating presence of high level of variability Significant GXE interaction was observed for all the traits. Partitioning of GXE interaction revealed that both the components were highly significant in all the characters with predominance of the Linear component, thereby, suggesting that the performance of genotypes across environments could be predicted with greater precission. Eleven genotypes showed average stability for green fodder yield of which nine genotypes (EC-3517, EC-35134, EC-13178, EC-1085898, EC-96848, EC-9865, EC-131532, Sabzaar and Kent) were well adopted and two genotypes (EC-54837 and EC-99170) were poorly adopted to all environments. Genotypes EC-35117, EC-35134, EC-13178, EC-1085898, EC-97248, EC-131532, Sabzaar and Kent were found to be stable and well adopted to all environments for most of the yield and yield related traits. These genotypes would be useful for commercial exploitation or can be exploited as elite gene pool in future breeding programme.

Key words: GXE interaction, stability, morphological, maturity, yield, oats (*Avena sativa* L.)

INTRODUCTION

The State of Jammu and Kashmir, the Kashmir valley in particular is ideally suited for fodder oat cultivation because of its temperate climate. However, availability of good and sufficient quantity of fodder for stall feeding during the winter months has been a problem in the Kashmir valley. In order to diversify the varietals profile of oats in Kashmir valley it is necessary to identify and evolve more number of genotypes having high potential of fodder yield and quality through application of sound and pragmatic breeding programme. The GXE interactions are of major consequences to the breeders in the process of evolution of new varieties. The breeders aim at evolving strains which may give the maximum mean economic yield over environments and show consistent performance. A variety or genotype is considered to be moreadaptive 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) Significant advances have been made in the measurement of contribution of the genotypes over environments by using the regression techniques. Stability model proposed by Eberhart and Russel (1966) is a powerful tool which enables to measure the phenotypic stability related to performance of genotypes. Ebarhart and Russel (1966) recommended growing of varieties in adequate number of environments covering a full range of possible environmental conditions so that useful information is available regarding stability. Mean value, regression slope of the genotype and deviation from the regression is considered while assessing the performance of a genotype in a given environment. Taking into view the above considerations the present investigation was carried out over a set of 4 diverse environments to characterize the nature of GXE interaction and to estimate the stability parameters for identification of stable genotypes across environments.

MATERIALS AND METHODS

Material for the present study comprised of twenty oats genotypes of both indigenous and exotic origin viz., Oats-16, EC-3230, EC-35117, EC-35134, EC-35151, EC-35189. EC-35753, EC-13178, EC-1085898, EC-96848, EC-9865, EC-35765, EC-54837, EC-97248, EC-86444, EC-99170, EC-131532, OS-6, Sabzaar andent. The genotypes were grown in randomized block design with three replications at 4 random environments representing the distinct locations of Kashmir valley of India viz., Shalimar (E1), Malangpora (E2), Khudwani (E3) and Wadoora (E4). Each genotype was planted in 12 rows of 5 m length spaced 25 cm apart in 2001-02. Observations were recorded on ten randomly selected and tagged

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competitive plants from each experimental plot in each replication for plant height and leaf stem ratio, whereas, for rest of the traits excepting number of tillers/m^2, the data was recorded on whole plot basis. Observations were recorded on forage characters (days to 50% flowering, plant height, leaf stem ratio, green fodder yield q ha^{-1}, dry fodder yield q ha^{-1}), seed characters (days to maturity, seed yield q ha^{-1}, 1000 seed weight) and quality characters (protein content). The data was subjected to analysis of variance for single as well as pooled over environments and stability analysis (Eberhart and Russel 1966). Pham and Kang (1988) indicated that genotype × environment interactions minimize the usefulness of genotypes by confounding their yield performance. Backer and Leon (1988) also indicated that assessment of Stability across many locations and years could increase both repeatability and heritability of important traits.

RESULTS AND DISCUSSION

For a cultivar to be commercially successful, it must perform well across a range of environments in which the cultivar has to be grown. Since the genotype environment interaction has masking effect on the phenotype some breeders attempt to estimate the magnitude of interaction variance attributable to GXE4 4 interaction so that the precise estimate of genotypic variance could be obtained. Analysis of variance revealed that all the genotypes possessed highly significant genetic variability for all the traits). Mean square due to environments were significant for all the traits revealing influence of environment on their expression. The mean square due to environment + cultivar × environment were significant for all the characters revealing variable response of genotypes for all the traits in the changing environment. The GXE interaction component was also significant for all the traits revealing that these traits were not stable over the environments. Pham and Kang (1988) indicated that genotype × environment interactions minimize the usefulness of genotypes by confounding their yield performance. Backer and Leon (1988) also indicated that assessment of stability across many locations and years could increase both repeatability and heritability of important traits. Further component analysis of environment + genotype environment mean square revealed that differences between the environments existed and they had considerable influence on all the traits. The major portion of these variations could be attributed to linear regression. Significance of linear component implied that the behavior of the genotypes for all the traits was predictable over environments and this had resulted from the linear function of the environmental component. Significance of non linear component for all the traits revealed that the behavior of deviation from regression existed among genotypes for all the traits (Table 1) When genotype × environment is due to variation in predictable environment factors, Oat breeders have the alternatives of either developing specific varieties for different environments (location, soil types, winter type, spring type etc.) or broadly adapted cultivars that can perform well under variable conditions. However, when genotype × environment interaction results from variation in unpredictable environmental factors, such as year to year variation in rainfall distribution, the breeders needs to develop stable genotypes that can performs reasonably well under a range of conditions. Similar results have been reported (Akcura *et al*., 2005; Wani *et al*., 2002).

Identification of stable genotypes having adoptability over a wide range of agro-climatic conditions is of major significance in crop Improvement. Comstock and Moll (1963) suggested that selection would not be

Table 1: Analysis of variance for morphological, maturity, quality and yield related traits in fodder oats

Source	df	Days to 50% flowering	Plant height (cm)	No. of tillers (m^{-2})	Leaf stem ratio	Days to maturity	Green fodder yield (q ha^{-1})	Dry fodder yield (q ha^{-1})	Protein content (%)	1000 seed weight (g)	Seed yield (q ha^{-1})
Genotypes	19	11.72**	101.72**	102224.17**	0.00129**	48.10**	15848.32**	1062.24**	5.25**	37.69**	29.12**
Environment +(GXE)	60	2.71**	7.69**	2284.62**	0.00018**	2.30**	1258.48**	80.14**	0.50*	0.64*	4.88**
Environment	3	45.03**	66.31**	12832.69**	0.00082**	6.60**	8963.16**	465.03**	1.17**	1.13*	33.80**
Genotype × environment	57	0.49*	4.61*	1729.46**	0.00015*	2.07**	852.97**	59.88**	0.47*	0.62*	3.36***
Environment (linear)	1	135.10**	198.95**	38498.08**	0.00245**	19.80**	26889.48**	1395.11**	3.52**	3.39**	101.42**
Genotype × environment (linear)	19	0.87**	8.22**	3860.10**	0.00026**	4.10**	1948.45**	128.20**	0.86**	1.10**	6.48**
Pooled deviation (Linear)	40	0.28**	2.66**	630.93**	0.00009**	1.00**	289.97**	24.43**	0.26**	0.36**	1.71**
Pooled error	152	0.09	0.34	37.03	0.00001	0.18	32.43	2.00	0.03	0.01	0.21

*, **: Significant at $p = 0.05$ and 0.01, respectively. ***Very highly significant at 0.001

effective due to presence of significant GXE interaction, therefore breeders should give emphasis on stable performance of a line over a wide range environments. According to Ebarhart and Russel (1966) a stable genotype was defined as one which showed high mean yield, regression coefficient b around unity and deviation from regression S^2di nearer to zero. The non significant linear b and non Linear S^2di components indicated average stability with high precision across environmental changes. Where as, significant b and non-significant S^2di components suggest above average stability for favorable environments. The significant/non-significant and S^2di component indicates that behavior of genotypes is highly unpredictable and they are not suitable for changed environments. Estimates of stability parameters for 20 different genotypes for ten traits revealed significant mean square deviations from regression S^2di with respect to Days to 50% flowering in 7 genotypes; for plant height in 8 genotypes; for number of tillers/m^2 in 10 genotypes; for days to maturity in 6 genotypes; for green fodder yield q ha^{-1}) in 8 genotypes; for dry fodder yield (q ha^{-1}) in 6 genotypes; for protein content in 11 genotypes; for 1000 seed weight in 12 genotypes and for seed yield (q ha^{-1}) in 7 genotypes. Contrarily the mean square deviation from regression was non-significant in all the genotypes for leaf stem ratio (Table 2 and 3). The genotypes showing non-significant mean square deviation from regression (pooled deviation) indicated that non-linear component (heterogeneity from regression) was equal to zero, hence the performance of these genotypes for a given environment could be predictable. Accordingly a genotype whose performance could be predictable (i.e., S^2di = 0) was classified to be stable.

The Linear regression (bi) deviated from unity for days to 50% flowering in 15 genotypes; for plant height in 5 genotypes; for number of tillers/m^2 in 6 genotypes; for leaf stem ratio in 2 genotypes; for days to maturity in 3 genotypes; for green fodder yield (q ha^{-1}) in 5 genotypes; for dry fodder yield (q ha^{-1}) in 5 genotypes; for protein content in 3 genotypes; for 1000 seed weight in 3 genotypes and for seed yield (q ha^{-1}) in 6 genotypes. Hence they could be considered as more responsive. However, considering their mean value, deviation from regression (S^2di) and desirability of the traits, the genotypes showing above average stability for favorable environment were identified in Oats-16, EC-35134, EC-35151, EC-35189, EC-13178, EC-96848 and EC-35765 for days to flowering; Sabzar for leaf stem ratio; EC-131532 for protein content and EC-13178 and EC-96848 for seed yield (q ha^{-1}). However, for plant height, number of tillers m^{-2}, days to maturity, green fodder yield (q ha^{-1}), dry fodder yield (q ha^{-1}) and 1000 seed weight, no genotype was identified to exhibit above average stability for favorable environments.

The genotypes not deviating significantly from unit regression for a particular trait revealed that they were average in stability with high prediction across environments and as such were either poorly or well adopted to all the environments depending upon the

Table 2: Stability parameters for morphological and maturity related traits in fodder oats

	Days to 50 % flowering			Plant height (cm)			No. of tillers (m^{-2})			Leaf stem ratio			Days to maturity		
Genotypes	X	bi	S^2di	X	bi	S^2di	X	bi	S^2di	X	bi	S^2di	X	bi	S^2di
Oats-16	168.8	1.3*	-0.05	118.5	0.50	3.20*	350.4	4.05**	764.7*	0.25	-0.14	0.00	206.5	2.20	-0.10
EC-3230	169.5	0.7	0.01	119.5	0.42	-0.99	416.5	2.39*	324.5*	0.24	2.05	0.00	203.5	2.67	3.10*
EC-35117	169.8	0.2	0.13	130.7	0.43	2.19*	941.9	0.12	138.0*	0.24	1.85	0.00	205.7	3.47*	1.20*
EC-35134	169.3	1.6**	0.06	130.6	0.04	-0.95	655.5	0.18	37.8	0.26	0.93	0.00	208.8	0.41	0.10
EC-35151	167.8	1.3*	-0.05	121.0	1.39	2.69*	402.1	2.39*	1417.4*	0.23	1.90	0.00	204.7	6.86*	2.10*
EC-35189	168.8	1.4**	-0.10	119.0	2.31*	3.66*	345.4	2.85*	3074.9*	0.28	1.90	0.00	208.6	3.58*	1.20*
EC-35753	170.8	1.0*	0.29*	129.7	-0.19	-0.17	732.7	-0.02	43.2	0.27	0.74	0.00	211.8	1.55	-0.20
EC-13178	168.6	0.7*	-0.01	131.6	0.82	-0.04	757.5	-0.34	206.7*	0.27	0.68	0.00	207.4	-0.42	0.04
EC-1085898	170.4	0.5	0.21	130.5	0.36	0.36	658.1	-0.08	43.7	0.22	1.46	0.00	210.0	0.48	6.00*
EC-96848	168.3	0.9*	-0.09	130.5	1.59*	1.73	678.0	1.08	2599.5*	0.26	1.48	0.00	207.2	-0.51	0.01
EC-9865	172.5	0.9*	0.15	128.4	0.92	0.22	641.6	-0.02	-15.9	0.28	1.27	0.00	215.0	1.18	0.10
EC-35765	169.2	1.0*	-0.01	121.2	3.09*	13.20*	446.3	-0.53	977.1*	0.23	-0.60	0.00	208.0	-2.42	-0.10
EC-54837	172.8	1.0*	0.29*	127.3	2.51*	11.00*	572.5	0.08	-37.5	0.23	-0.17	0.00	212.8	-0.00	1.20*
EC-97248	172.4	1.3*	0.21	129.0	0.62	-0.22	579.0	-0.07	36.9	0.28	2.01	0.00	213.5	0.95	0.00
EC-86444	171.5	1.0*	0.35*	118.0	0.39	0.11	334.9	3.95**	1667.0*	0.26	1.28	0.00	213.5	-0.84	-0.20
EC-99170	172.5	0.7	0.01	119.5	2.11*	6.25*	409.7	1.82*	82.9	0.24	0.50	0.00	214.4	1.79	0.20
EC-131532	172.4	1.3*	0.71*	1126.8	1.25	-0.29	616.3	0.14	-7.7	0.26	-3.84	0.00	212.5	-0.51	0.01
OS-6	171.0	0.3	0.41*	128.4	0.05	0.21	591.4	0.95	307.1*	0.24	3.04*	0.00	212.5	-0.40	0.05
Sabzaar	172.5	0.9*	0.32*	130.5	0.09	0.20	633.6	0.45	-46.6	0.27	2.41*		213.5	-0.17	0.30
Kent	168.6	1.2*	0.37*	129.1	0.34	-0.02	591.2	0.57	46.7	0.26	1.21		209.7	0.38	0.06
Pop mean	170.4			126.0			567.7			-0.02			210.0		
SE (m)±	0.30			0.94			14.50			0.005			0.57		
SE (b)±	0.20			0.51			0.57			0.84			1.01		

*Significant, ** Highly significant

Table 3: Stability parameters for quality and yield related traits in fodder oats

	Green fodder yield (q ha^{-1})			Dry fodder yield (q ha^{-1})			Protein content (%)			1000 seed weight (g)			Seed yield (q ha^{-1})		
Genotypes	X	bi	S^2di	X	bi	S^2di	X	bi	S^2di	X	bi	S^2di	X	bi	S^2di
Oats-16	281.3	3.39*	445.59*	68.1	3.70*	73.23*	7.6	-4.26	1.06*	45.1	-2.53	0.83*	14.6	0.74	5.09*
EC-3230	277.6	2.58*	637.64*	67.3	2.51*	18.13*	6.9	-0.05	-0.01	42.8	4.87*	0.75*	11.9	0.85	-0.18
EC-35117	485.8	0.40	-29.01	118.6	0.22	-1.85	8.6	2.42	-0.03	37.1	2.72	1.49*	14.8	0.85	-0.18
EC-35134	425.4	0.42	-28.74	109.2	0.36	-0.23	7.1	1.09	0.68*	45.3	0.89	0.43*	17.3	0.44	0.80*
EC-35151	295.2	2.81*	1821.09*	72.2	2.54*	161.45*	7.7	1.07	-0.01	39.4	-0.28	-0.01	11.5	-0.86	0.21
EC-35189	286.7	3.57*	284.74*	71.2	4.73*	42.40*	9.5	0.00	0.30*	41.4	0.14	-0.00	12.7	0.77	0.00
EC-35753	451.9	0.14	74.80*	112.7	0.04	2.55	9.3	1.68	0.00	36.7	1.54	0.23*	18.3	3.64*	8.99*
EC-13178	458.4	0.50	-24.06	112.8	0.29	-1.73	8.7	-2.40	-0.01	46.1	-4.10	0.02	15.6	2.35*	0.44
EC-1085898	415.3	0.19	15.78	98.1	0.27	-0.587	6.8	-1.58	0.59*	45.1	3.18	1.14*	21.4	0.88	8.71*
EC-96848	430.8	0.49	-23.63	102.8	0.85	2.57	6.4	-0.72	0.05	41.7	3.20	0.01	17.7	1.82*	0.12
EC-9865	411.2	0.05	39.82	98.0	0.17	0.99	6.6	2.05	0.01	42.1	4.35*	0.27*	13.7	1.88*	-0.17
EC-35765	351.5	0.95	657.70*	84.9	1.05	99.35*	8.9	3.66*	0.10*	43.1	1.-60	0.75*	12.4	1.23	0.32
EC-54837	366.4	0.36	-3.29	88.3	0.23	-0.23	9.4	2.38	0.03	43.6	-0.66	-0.01	11.02	-0.78	0.13
EC-97248	394.9	-0.04	-9.15	100.5	-0.07	3.73	10.0	0.32	0.56*	47.3	-1.14	0.28*	13.53	0.51	0.36
EC-86444	285.0	2.31*	566.33*	77.3	1.71*	28.22*	9.1	2.54	0.49*	42.8	6.48*	0.15*	11.12	-0.72	1.27*
EC-99170	316.3	1.07	-5.85	73.4	0.79	3.14	8.7	-0.45	0.19*	45.6	0.04	-0.01	12.96	0.58	0.28
EC-131532	395.9	0.38	-5.46	95.6	-0.05	-1.76	9.7	4.31*	0.06	45.4	0.41	0.01	13.5	1.11	3.33*
OS-6	380.6	0.20	669.53*	97.4	0.11	0.64	7.0	2.51	0.02	46.2	-0.11	-0.00	13.6	1.78	-0.11
Sabzaar	405.4	0.15	0.07	104.6	0.20	-2.07	7.8	1.06	0.10*	46.3	-0.96	0.14*	16.4	1.58	-0.08
Kent	395.8	0.00	-11.79	101.7	0.31	-3.11	8.8	4.34*	0.32*	46.7	0.43	0.32*	13.9	2.30*	0.71*
Pop mean	374.2			92.7			8.2			43.5			14.9		
SE (m)±	9.83			2.85			0.29			0.34			0.755		
SE (b)±	0.46			0.59			1.21			1.46			0.58		

* Significant

mean performance. However, the non-significant Linear regression coefficient (bi) was valid only for genotypes with non-significant deviation from regression (S^2di). Genotypes that showed average stability and were well adopted to all the environments included EC-3232 for days to 5% flowering; EC-35117 for days to 50% flowering, green fodder yield, dry fodder yield and protein content; EC-35134 for plant height, number of tillers m^{-2}, leaf stem ratio, days to maturity, green fodder yield and dry fodder yield; EC-35189 for leaf stem ratio; EC-35753 for leaf stem ratio, dry fodder yield and protein content; EC-13178 for plant height, leaf stem ratio, green fodder yield and dry fodder yield; EC-1085898 for days to 50% flowering, plant height, green and fodder yield; EC-9865 for plant height, leaf stem ratio, green fodder and dry fodder yield; EC-54837 for number of tillers m^{-2} and protein content; EC-97248 for plant height, leaf stem ratio and green fodder yield; EC-99170 for 1000 seed weight; EC-13152 for plant height, number of tillers m^{-2}, green fodder yield and 1000 seed weight.

None of the genotype was well adopted for all the traits to all the environments. However, EC-35117, EC-35134,EC-13178, EC-10858898, EC-97248, EC-131532, Sabzaarand Kent exhibited stability and were well adopted to all the environments for most of the yield and yield related traits. Akcura *et al*. (2005) also reported wide adoptability of oat genotypes across locations. Gupta and Singh (1997) also reported stable performance of several genotypes in respect of various yield and quality traits. Dubey *et al*. (1995) identified genotypes that were best suited to poor environments, normal and high input conditions.

CONCLUSIONS

The cultivars EC35117, EC-35134, EC-13178, EC-1085898, EC-97248, EC-131532, Sabzaar and Kent were found to be stable and well adopted to all environments of Kashmir valley of India. These genotypes recorded non-significant mean square deviation from regression for yield. Hence, these cultivar may be recommended for cultivation for all the

REFERENCES

Akcura, M., S. Ceri, S. Taner, Y. Kaya, E. Ozer and R. Ayranci, 2005. Grain yield stability of winter oat (*Avena sativa* L.) cultivars in the central anatolian region of Turkey. J. Cent. Eur. Agric., 6: 203-210.

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.

Becker, H.B. and J. Leon, 1988. Stability analysis in plant breeding. Plant Breed., 101: 1-23.

Comstock, R.E. and R.H. Moll, 1963. Genotype-environment interaction. In: Symposia on statistical genetics and plant breeding. NAS-NRC. Publ., 982 :164-196.

Dubey, R.K., R.S. Shukla and G.S. Tkakur, 1995. Phenotypic stability of fodder yield in Oats. Adv. Plant Sci., 8: 301-307.

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

Gupta, S.P. and L.N. Singh, 1997. Genotype × Environment interaction study in forage oats (*Avena sativa* L.). Environ. Ecol., 15: 26-30.

Pham, H.N. and M.S. Kang, 1988. Interrelationships among respectability of several stability statistics estimated from international maize trials. Crop Sci., 28: 925-928.

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.