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ESTIMATION OF ADAPTABILITY FOR PHYSIOLOGICAL CHARACTERS IN OATS (*AVENA SATIVA* L.)

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SUMMARY

Aim of present investigation was to assess genotype environment interaction and determine stable oat (*Avena sativa* L.) cultivar in central Uttar Pradesh under diverse environment for seed yield and its components in 25 genetically diverse genotypes using randomized block design with three replications during winter season of 2016 -17 and 2017-18 at Students Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U. P.) during rabi 2016-17 to 2017-18. There was considerable variation in seed yield within and across environments. Stability analysis for seed yield was calculated to know 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. The genotypes were found common in majority of characters namely, CSOFSC12-2, CSOFSC11-5, ANDO1, OS344, OS1, SKO105, CSAOFSC14-6, JHO03-91 and JHO851. Considering all the characters and all the models of stability under study none of the test genotypes were found stable for all the traits however, six genotypes namely,CSOFSC12-2, CSOFSC11-5, CSOFSC11-4, ANDO1,JHO03-91 OS344, OS1 SKO105, CSAOFSC14-6,JHO2007-1 and JHO851 were found stable for maximum characters under all dates of sowing in present study. These genotypes would be useful for commercial exploitation or can be exploited as elite gene pool in future breeding programme.

Key words : Oats, genotypes, environment, stability

Oat (*Avena sativa* L.) is used throughout the world for human food and animal feed, and it is frequently grown as a dual-purpose crop (grain harvest after grazing or forage cutting). It is one of the important forage Cereals in temperate areas and economically is ranked as one of the eight important crops in the world. Hence, 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 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 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 (Kant *et al.*, 2014). The phenotypic performance of a genotype may not be the same under diverse agro climatic conditions. This variation is due to GxE 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 GxE interactions. 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. 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. Another undesirable effect of GEI includes low correlation between phenotypic and genotypic values, thereby reducing progress from selection. Many researchers use the terms ‘stability’ and ‘adaptability’ to refer to consistent high performance of genotypes across diverse sets of environments. 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 yieldin variable environments.

MATERIALS AND METHODS

The basic material for the present study consisted of ten diverse genotypes of oats (*Avena sativa* L.) viz., CSOFSC12-2, CSOFSC11-5, Kent (C), CSOFSC11-4, CSOFSC11-1, CSOFSC12-1, UPO212, ANDO1, JHO03-91, CSAOSC12-1, ANDO2 (C), OS403, OS344, OS1, SKO105, NDO25, JHO2007-2, CSAOSC14-6, SKO101, JHO2007-2, JHO03-93, NDO612, OS6, JHO851and JHO99-2 were tested in a randomized completely block design with three replications during winter season of 2016 -17 and 2017-18 at Students Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during rabi 2016-17 to 2017-18 for the study of stability parameters of breeding values and the observations were recorded on randomly selected 5 plants from each replication of the three experiments under study for days to 50% flowering, days to maturity, numbers reproductive tillers per plant, plant height (cm), biological yield per plant (g), dry weight per plant (g), test weight (g), harvest index (%) and seed yield per plant (g).

Statistical Analysis : The method of Finley and Wilkinson, 1961 was used in this study to characterize genotypic stability. The following linear regression model was used

RESULTS AND DISCUSSION

For genotype to be economically successful, it must perform well across a range of environments in which the genotype has to be cultivated. Because the GXE has masking effect on the phenotype several breeders attempt to calculate the magnitude of interaction variance attributable to GxE interactions so that the precise estimate of genotypic variance could be obtained. Analysis of variance showed that all the genotypes had significant genetic variability for all traits in separately six ($E_{1\text{-}6}$) environments, indicating that performance of genotypes varied from environment to environment therefore, selection for stable genotypes may be effective. Combined analysis of variance revealed that all the genotypes had significant genetic variability for all traits in three environments, it is imperative to select the suitable genotype as per environmental conditions. Analysis of pooled data revealed that all the genotypes had significant genetic variability for all traits in three environments as interaction between genotype x environment was found significant for all the characters. It reflected significant variability among the genotypes under study. General analysis of pooled data over environments indicated significant differences among the test genotypes for the all traits, indicating available spectrum of variation in used genotypes. Analysis of variance based on pooled estimates (Table-1) showed that all the genotypes had significant genetic variability for all traits, exhibiting scope for selection of stable genotype under diverse environment.

Considering the stability parameters as described in the way of Finely and Wilkinson, The performance of genotypes for stability behavior is

TABLE 1

Analysis of stability parameters for yield and its components of oat as per Finley and Wilkinson, 1963

Source of Variation	D.F.	DF	DM	NRTPP	PH (cm)	BYPP (g)	DWPP (g)	TW	HI (%)	SYPP (g)
Genotypes	24	248.47**	569.72**	231.04**	3323.22	101.46	33.51**	37.53**	846.72**	9.13**
Environment	5	6291.53**	17738.55**	706.66**	30315.33	504.93	244.97**	5.13**	532.20**	54.90**
G x E	120	3.58**	1.20**	3.58**	23.59	0.35**	0.26**	0.02**	7.07**	0.06**
Regression	24	9.65**	4.45**	11.07**	90.36**	0.84**	0.27**	0.08**	13.50**	0.12**
Deviation from regression	96	2.06**	0.39**	1.71**	6.89**	0.23**	0.26**	0.11**	5.4**	0.04**
Residual	269	9.65	4.45	11.07	90.36	0.84	0.27	0.08	13.50	0.12

*, **Significant at P=0.01 and 0.05.

TABLE 2
Estimates of stability parameters for seed yield and its component traits in oat as per Finley and Wilkinson (1963)

S. No.	Genotypes	DF		DM		NRTPP		PH (cm)		BYPP (g)		DWPP (g)		TW		HI		SYPP (g)	
		Mean	bi	Mean	bi	Mean	bi	Mean	Bi	Mean	bi	Mean	bi	Mean	bi	Mean	bi	Mean	bi
1.	CSAOFSC12-2	87.06	0.88*	113.23	0.82*	12.06	0.87*	124.50	0.66*	11.39	0.92*	8.80	0.92*	4.64	0.97*	29.07	1.07*	3.851	0.93*
2.	CSAOFSC11-5	88.41	0.96*	115.87	1.00*	13.78	1.15*	132.39	1.07*	11.30	0.91*	8.83	1.06*	3.30	0.79*	30.23	1.44*	3.458	0.77*
3.	Kent	85.53	0.90*	111.08	1.19*	12.43	1.05*	119.22	0.53*	10.72	0.88*	7.99	0.80*	4.15	0.60*	31.13	1.40*	3.315	0.65*
4.	CSAOFSC11-4	89.21	0.92*	114.72	0.98*	14.03	1.89*	129.39	1.04*	11.76	1.12*	9.11	0.91*	3.82	1.76*	27.44	1.83*	3.256	1.17*
5.	CSAOFSC11-1	87.72	1.10*	114.52	1.10*	12.94	1.29*	130.22	1.04*	11.34	1.07*	8.98	1.04*	3.78	0.92*	28.69	1.57*	3.229	0.93*
6.	CSAOFSC12-1	89.41	0.89*	115.12	0.96*	12.00	1.75*	126.33	1.00*	11.94	1.02*	9.34	1.02*	4.39	1.20*	27.16	1.01*	3.268	0.98*
7.	UPO212	86.29	1.20*	114.88	1.08*	10.76	0.57*	128.33	1.11*	12.66	1.35*	9.17	1.07*	3.55	1.13*	26.98	0.52*	3.391	1.06*
8.	ANDO1	90.13	1.29*	117.01	1.01*	12.89	0.31*	122.00	0.68*	11.63	0.92*	8.71	0.94*	4.19	1.03*	29.84	0.95*	3.442	0.84*
9.	JHo03-91	88.07	1.10*	114.92	1.06*	11.83	0.39*	118.78	0.76*	12.47	0.87*	9.02	0.73*	4.73	1.43*	28.34	-0.06	3.497	0.84*
10.	CSAOSC12-1	88.06	0.88*	116.07	0.92*	12.03	0.25*	121.39	0.53*	12.40	1.39*	9.41	1.39*	3.75	1.05*	29.78	0.31	3.662	1.10*
11.	ANDO2	86.61	1.06*	116.15	0.97*	9.67	0.60*	131.94	1.44*	11.94	0.98*	8.39	0.96*	3.83	-0.09	30.87	0.92*	3.656	0.57*
12.	OS403	88.03	0.98*	117.64	0.96*	12.19	1.34*	123.89	0.92*	11.64	0.79*	8.62	0.87*	3.37	0.49*	30.75	0.65*	3.620	1.0*1
13.	OS344	88.01	1.04*	115.38	1.08*	13.33	1.05*	119.94	0.58*	11.13	0.96*	8.25	0.97*	3.85	0.73*	31.37	0.86*	3.506	0.91*
14.	OS1	89.58	1.26*	114.71	0.97*	12.06	1.41*	120.89	0.69*	11.51	1.22*	8.51	1.10*	3.22	0.23*	31.16	0.62*	3.573	0.98*
15.	SKO105	86.38	1.00*	111.78	0.93*	10.61	-0.19	123.83	1.20*	10.84	0.84*	8.27	0.84*	3.49	0.71*	31.38	1.10*	3.389	0.99*
16.	NDO25	89.68	1.41*	114.44	1.06*	9.41	0.87*	131.67	1.28*	11.21	0.86*	8.21	0.81*	3.76	1.24*	33.05	1.84*	3.722	1.21*
17.	JHO2007-2	87.34	0.98*	112.80	0.95*	11.78	1.41*	124.83	1.20*	12.25	1.45*	9.44	1.33*	3.84	0.78*	30.02	-0.05	3.634	1.03*
18.	CSAOSC14-6	86.97	0.99*	109.97	0.81*	9.89	1.25*	119.72	1.12*	10.46	0.78*	8.03	1.17*	4.60	0.45*	31.78	0.80*	3.336	0.89*
19.	SKO101	87.70	0.96*	114.26	1.05*	13.83	1.89*	127.28	1.10*	10.81	0.55*	8.20	0.81*	4.46	0.77*	33.00	1.68*	3.563	1.06*
20.	JHO2007-1	89.28	0.78*	114.06	1.02	11.44	0.82*	122.72	0.96*	10.99	1.14*	8.08	0.91*	5.08	1.09*	35.61	2.93*	4.073	1.76*
21.	JHO03-93	87.36	0.98*	112.23	1.12*	13.28	-0.01	127.00	1.22*	11.06	1.14*	8.93	1.28*	4.15	0.51*	27.61	1.02*	3.051	1.02*
22.	NDO612	87.68	1.03*	113.91	0.93*	13.00	0.26*	121.17	1.09*	11.43	1.02*	7.92	0.92*	4.30	3.15*	36.68	2.25*	4.190	1.41*
23.	OS6	85.01	0.34*	110.17	0.98*	11.11	2.06*	133.94	1.42*	11.12	0.89*	8.13	1.05*	4.65	1.07*	32.67	1.02*	3.647	1.05*
24.	JHO851	88.73	0.93*	111.96	0.97*	12.33	0.89*	129.39	0.97*	10.98	0.97*	8.14	1.05*	4.59	1.73*	31.50	0.78*	3.463	0.95*
25.	JHO99-2	88.32	0.94*	113.54	0.90*	12.50	1.83*	133.11	1.40*	11.31	0.95*	8.93	1.08*	3.46	1.27*	29.10	0.37*	3.272	0.79*
	Population mean	87.82		114.02		12.05		125.76		11.45		8.62		4.04		30.61		3.35	
	SE(mean)	0.63		0.27		0.57		1.15		0.21		0.22		0.05		1.02		0.09	
	SE(b)		0.09		0.02		0.24		0.07		0.10		0.16		0.22		0.50		0.13

presented in Tables 2 and 3**.** The genotypes were similar in their stability performance for seed yield and others contributing characters as per Finley and Wilkinson, model due to their similar regression coefficient values (bi) near to 1.00 and higher mean values as compared to population mean values. The genotypes were found common in majority of characters namely; CSAOFSC12-2, CSAOFSC11-5, ANDO1, OS344, OS1, SKO105, CSAOFSC14-6, JHO03-91 and JHO851. A critical examination of these genotypes showed that these were constituted through combination of different genotypes of diverse origin using multiple parents which produce non-sensitiveness in diver's environments. They may also produce greater buffering capacity over a wide range of environment. The genotypes showing positive response in favourable environments might be due to their sensitivity to favourable agronomical operation or lower buffering ability in changing environments.

The stability analysis technique portioned the genotype x environment interaction components of variance of each genotype into two parts. Therefore, each genotype will be characterized by three parameters namely, mean of the genotype over all environments (x) and linear regression coefficient in relation to environmental index (bi). Since the average slope of environmental index is one, regression coefficient for each genotypes maybe one (unity) or greater or lower than unity. Hence, genotype with regression value of unity is considered as to have an average adoptability in all sowing conditions (environments).

According to Finely and Wilkinson model ,the regression coefficient and mean values of genotypes namely, CSAOFSC12-2, CSAOFSC11-5, CSAOFSC11-5, ANDO1, JHO03-91 OS344, OS1 SKO105, CSAOFSC14-6, and JHO851showed higher than population mean values and near to unity of regression can be considered as stable under all the sowing conditions. Negative the values of regression coefficient (bi<1.0) genotypes those have showed its stability for late sown condition such a condition when mean values is higher than population mean values while other genotypes may be suited for early or normal and timely sown conditions and along with the various character including seed yield. As per individual analysis for stability parameters was also worked out in present study. The details of the various models are discussed as below.

TABLE 3
Comparative evaluation of stable Oat genotypes based on various Finley & Wilkinson

S. No.	Genotypes	Finley & Wilkinson
1.	CSAOPSC-12-2	DF, NRTPP, DWPP, TW and SYPP
2.	CSAOFSC-11-5	SVPP
3.	Kent	-
4.	CSAOFSC-11-4	DM
5.	CSAOFSC-11-1	-
6.	CSAOFSC-12-1	DF, DM and BYPP
7.	UPO-212	-
8.	ANDO1	BYPP, DWPP and SYPP
9.	JHO03-91	BYPP, DWPP
10.	CSAOFSC-12-1	
11.	ANDO2	DM and BYPP
12.	OS403	DM, BYPP
13.	OS344	HI and SYPP
14.	OSL	DM and SYPP
15.	SKO105	DM, SL, SDWPP and SYPP
16.	NDO25	-
17.	JHO2007-2	DF and DM
18.	CSAOFSC-14-6	DF, DWPP, HI and SYPP
19.	SKO101	TW
20.	JHO2007-1	-
21.	JHO03-93	DF and SVPP
22.	NDO612	-
23.	OS-6	-
24.	JHO851	DM, NRTPP, LL, PH, HI and SYPP
25.	JHO99-2	DM and NRTPP

According to Finely and Wilkinson model the regression coefficient and mean values of genotypes namely, CSAOFSC12-2, CSAOFSC11-5, CSAOFSC11-5, ANDO1,JHO03-91 OS344, OS1 SKO105, CSAOFSC14-6, and JHO851 showed higher than population mean values and near to unity and can be considered as stable for all kind of sowing conditions. Negative the values of regression coefficient (bi) genotypes those have showed its stability for late sown condition whiles other genotypes may be suited for normal, timely sown conditions. Rest of the genotypes may be suitable for other dates of sowing, these may considered as stable for all the sown conditions and would be suitable seed yield and its attributes in present study. Similar results earlier were also reported by Yadav *et al.*, (2010), Mehraj *et al.*, (2017), Zeki *et al.*, (2018) and Singh *et al.* (2019).

Genotypes namely, CSOFSC12-2, CSOFSC11-5, ANDO1, OS344, OS1, SKO105, CSAOFSC14-6, JHO03-91 and JHO851 were common in stable performance for seed yield, and individual genotypes namely, CSOFSC12-2 also showed their suitability for days to flowering, number of reproductive tillers per plant, test weight, CSOFSC11-5 for number of nodes per plant; ANDO1 for biological yield per plant, dry weight per plant; OS344 for harvest index; OS1 for days to maturity, SKO105 for days to maturity; CSAOFSC14-6 for days to flowering, dry weight per plant and harvest index; JHO03-99 for days to flowering, and JHO851 was suitable for days to maturity, number of reproductive tillers per plant, plant height and harvest index as per Finely and Wilkinson model.

Genotype namely, CSOFSC12-2 also showed their suitability for dry weight per plant and test weight; CSOFSC11-5 for days to flowering; ANDO1 for biological yield per plant and dry weight per plant; SKO105 for days to maturity; CSAOFSC14-6 for days to flowering and dry weight per plant; JHO03-99 for days to flowering and JHO851 was suitable for days to maturity, plant height and harvest index. Considering all the characters and the model of stability under study none of the test genotypes were found stable for all the traits however, six genotypes namely, CSOFSC12-2, CSOFSC11-5, CSOFSC11-4, ANDO1, JHO03-91 OS344, OS1 SKO105, CSAOFSC14-6, JHO2007-1 and JHO851 were found stable for maximum characters under all dates of sowing in present study.

CONCLUSION

CSOFSC12-2, CSOFSC11-5, ANDO1, OS344, OS1, SKO105, CSAOFSC14-6, JHO03-91 and JHO851 were the most stable cultivars for seed yield and its contributing traits under all environments. Hence, these cultivars may be recommended for cultivation in different environments.

REFERENCES

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

Finley, K. W. and G. N. Wilkinson, 1963 : *Analysis of adaption in a plant breeding programme*. *Aust. J. Agric. Res*. **14** : 742-754.

Kant, S., R. A. S. Lamba, R.K. Arya and I.S. Panwar, 2014 : Effect of terminal heat stress on stability of yield and quality parameters in bread wheat in south-west Haryana. *J. Wheat Res.*, **6** : 64-73.

Mehraj, U., I. Abidi, A. Ahmad and Z. Mushtaq, 2017 : Stability analysis for physiological traits, grain yield and its attributing parameters in oats (*Avena sativa* L.) in the Kashmir valley. *Elect. J. Pl. Breed.*, **8** : 59.

Yadav, A. K., M. S. Narwal and R. K. Arya, 2010 : Stability studies for seedling traits with supra-optimal temperature exposure at seedling stage in pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *Forage Res.* **32** : 65-70.

Zeki, M., A. Hasan., O. D. Erbas and Köse, 2018 : Grain yield, quality traits and grain yield stability of local oat cultivars. *J. Soil Sci. and Pl. Nutr*., **18** : 269-281.