STATISTICAL MODELS TO DESCRIBE G x E INTERACTION FOR SEED YIELD AND OIL CONTENT IN BROWN SARSON (*Bressica rapa* L.) GENOTYPES

Asima Gazal, Z.A. Dar, M. Habib, A.B. Shikari and Gul Zaffar
Division of Plant Breeding and Genetics,
Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar (J&K)
Email: zahoorpbg@gmail.com.

ABSTRACT

Comparison of different statistical models to describe G x E interaction for seed yield/plant and oil content (%) in twelve brown sarson genotypes under random environmental conditions of Kashmir valley produced uniform information and ranked the genotypes without any major disagreement. Comparison for seed yield/plant (g) revealed significant G x E interaction and stability of SKBR-11 as confirmed by relationship of linear regression coefficient (bi) and non-linear deviation from regression (S^2di) of Eberhart and Russell model with linear response (s^2i), deviation from linear response (ëi) of Tai, stability variance (s^2i) of Shukla and Ecovalence value of Wricke. Whereas comparison for oil content (%), stability of only two genotypes, SKBR-11 and SKBR-7 was confirmed. Four stability models confirmed the stability of one genotype, SKBR-11 as stable variety under valley conditions.

Key words : *Statistical models, G x E interaction, oil cointent, yield, brown sarson.*

In Kashmir valley brown sarson is the only edible oilseed crop being cultivated during rabi season. This is the only crop of the rapeseed-mustard group which fits well in the oilseed – paddy rotation prevailing in the valley of Kashmir. The G x E interaction is of major consequence to the breeders in the process of evolution of new varieties. Besides the stability statistics developed by (1) many univariate parametric stability statistics were developed by (2, 3, 4). In order to diversify the varietal profile of brown sarson in the Kashmir valley, it is necessary to identify and evolve more number of genotypes possessing high yield potential and better quality.

The phenotype of an individual is determined by both the genotype and the environment, these two effects are not always additive which indicates that genotype x environment interactions (GEI) are present. The GEI result in inconsistent performances between the genotypes across environments. Significant GEI results from the changes in the magnitude of differences between genotypes in different environments or changes in the relative ranking of the genotypes (5, 6). (7) defined these two forms of GEI as qualitative (rank changes) and quantitative (absolute differences between genotypes). GEI makes it difficult to select the best performing and most stable genotypes and is an important consideration in plant breeding programs because it reduces the progress from selection in any one environment (8, 9).

When the varieties are grown at several locations for testing their performance, their relative ranking usually does not remain same; this causes difficulty in demonstrating the significant superiority of a variety. Comparison of different stability models shall provide comparative efficiency as well as agreement regarding ranking of genotypes for stability. With this objective present study was initiated to compare efficiency of different stability models for yield in brown sarson.

MATERIALS AND METHODS

Materials under study comprised of twelve diverse brown sarson genotypes. The material was grown in randomized block design with three replications and three environments representing the distinct location of Kashmir valley viz., Shalimar, Khudwani and Wadura during rabi 2011-2012. Each genotype was grown in a 3-row experimental plot of 3 metre length with inter and intra row spacing of 30 and 10 cm, respectively. The experimental fields were well prepared and all the recommended packages were adopted to raise a good crop. Observations were recorded on seed yield/plant (g) and oil content (%). Besides the stability statistics developed by (1) many univariate parametric stability statistics were developed by (2, 3, 4) were compared for their relative performance.

RESULTS AND DISCUSSION

(2) proposed the use of the G x E interaction for each genotype, squared and summed across all environments, as a stability measure and termed it Ecovalence (Wi). Ecovalence is the contribution of the genotype to the total genotype x environment interaction sums of squares. If small ecovalence values are desired, this may be called an agronomic concept of stability, for it describes properties desirable in crop production. Variety with the least ecovalence was considered to be more stable and the varieties with a high ecovalence have a poor stability. Ecovalence was highly correlated with other stability statistics such as deviation from regression (S^2di) of (1) model, deviation from linear regression (λ**i**) of [3] model and stability variance (σ^2i) of (4) model.

The genotypic stability model proposed by (3) measured the linear responses of genotypes to environmental effects (αi) and the deviation from linear responses (λi). This method was similar to the method of (1) in that both analyses attempted to determine the linear response of a genotype to environment effects. A perfectly stable variety will be characterized by the linear response of a genotype to environmental effects (λi) equal to -1 and deviation from the linear response (σ^2i) equal to 1. The perfectly stable genotype may not exist and the breeders may be satisfied with genotypes having linear responses (σ^2i) equal to zero and deviation from the linear response (λi) equal to 1 (equivalent to bi =1 and S^2di = 0 in (1).

(4) uses a covariate to remove the linear effect from the G x E interactions. The remainder of the interaction could be assigned (σ^2i) and the significance of each component could be tested. The stability variance approach of (4) calls a genotype stable if its stability variance (σ^2i) is equal to within environmental variance (σ^2i) which means that (σ^2i = 0). The stability variance (σ^2i) is taken as the sum of two components viz, within environmental variance ($\sigma^2$0) and between environmental variance (σ^2i). A zero regression will be obtained if there is no linear relationship between genotypic and environmental mean, yet the stability variance σ^2i may be greater than $\sigma^2$0. It has been suggested that stability variance (σ^2i) be used in preference to Ecovalance (Wi). (4) definition of stability is different from that of (3) in that its definition of stability coincides with the (3) definition of “average” stability (αi = 0; λi= 1 in (3) notations).

(1) model has been extensively used as stability measure. Stable genotype was defined as the one, which showed high mean yield, regression coefficient ‘b’ around unity and deviation from regression σ^2di nearer to zero. The non-significant linear (b) and non-linear (σ^2di) components indicated average

Table-1: Relative performance of different stability models for seed yield/plant (g) in brown sarson.

Genotype	Eberhart and Russell (1966)			Tai (1971)		Shukla(1972) σ^2i	Wricke (1962) Ecovalence
	Mean	b_i	S^2d_i	λ_i	α_i		
SKBR-4	5.67	3.700*	73.232*	23.922	2.865	244.50**	663.82
SKBR-7	6.14	0.794	3.416	1.985	-0.220	4.44	15.66
SKBR-11	6.67	0.853	2.579	1.810	-0.160	3.48	13.07
SKBR-16	5.48	2.548*	61.458*	51.540	1.640	182.52**	496.47
SKBR-20	6.55	0.943	0.558	1.801	-1.022	26.99**	76.55
SKBR-22	6.36	0.832	0.237	0.930	-0.813	16.06**	47.03
SKBR-24	5.40	-0.079	3.731	2.170	-1.142	33.85**	95.07
SKBR-26	4.35	1.713*	28.223*	9.834	0.755	35.05**	98.29
SKBR-27	4.83	2.510*	18.130*	6.675	1.598	73.33	201.66
SKBR-28	5.10	-0.052	-1.764	0.450	-1.114	28.29**	80.06
KS-101	4.28	0.113	0.649	1.203	-0.940	21.84**	62.63

Table-2 : Relative performance of different stability models for oil content (%) in brown sarson.

Genotype	Eberhart and Russell (1966)			Tai (1971)		Shukla (1972) $\sigma^2 i$	Wricke (1962) Ecovalence
	Mean	b_i	S^2d_i	λ_i	α_i		
SKBR-4	40.09	0.742	5.096	26.180	-0.258	3.95**	10.93
SKBR-7	41.40	0.854	-0.182	0.101	-0.148	-0.04	0.66
SKBR-11	41.63	0.779	0.003	1.105	-0.222	0.14	0.14
SKBR-16	40.24	3.647*	8.996*	45.452	2.651	19.87*	53.93
SKBR-20	39.67	2.235*	0.449	3.221	1.237	0.63	1.97
SKBR-22	40.92	0.513	0.127	2.626	0.324	0.39	1.87
SKBR-24	38.67	1.822*	-0.171	0.154	0.883	1.38**	4.01
SKBR-26	37.47	1.822*	0.361	2.784	-0.488	0.76**	2.33
SKBR-27	38.04	-0.720	1.271	7.281	-0.723	6.55**	17.95
SKBR-28	39.70	0.580	0.285	2.409	-0.420	1.41**	4.09
KS-101	37.91	1.112	3.337*	17.489	0.112	2.55**	7.14

stability with high precision across environmental changes, whereas, the significant 'b' and non-significant 'σ^2di' component suggested above average stability for favourable environments. The significant/non-significant 'b' and significant 'σ^2di' component indicated that behaviour of genotypes was highly un-predicted and they were not suitable for changed environments. The linear regression (bi) deviated from unity for seed yield/plant in SKBR-4, SKBR-7 SKBR-16 and SKBR-26 and for oil content in SKBR-16, SKBR-20, SKBR-22 and SKBR-24. However, considering their mean value deviation from regression (σ^2di) and desirability of the traits, no genotypes showed above average stability for favourable environment. 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 poorly or well developed to all the environments depending upon the mean performance. However, non significant linear regression coefficient (bi) was valid only for genotypes with non significant deviation from regression (σ^2di). Genotypes that showed average stability and were well adapted to all the environments included SKBR-7, SKBR-11 and SKBR-20.

Comparison of statistical models for seed yield/ plant (g) (Table-1) in the present investigation revealed stability of SKBR-11 as confirmed by relationship of linear regression coefficient (bi) and non-linear deviation from regression (S^2di) of (1) model with linear response (σ^2i), deviation from linear response (λi) of (3), stability variance (σ^2i) of (4) and Ecovalence value of (2).

The genotype had high mean performance in comparison to overall population mean, thus suggesting that genotype is well adapted to all environments. However, genotypes SKBR-7, SKBR-11, SBS-1, SKBR-22 and KS-101, were identified as stable genotypes while comparing stability parameters of Eberhart and Russell, Tai and Wricke, stability variance of Shukla's stability model conformed the stability of only one genotype SKBR-11 having stability variance (σ^2i) within the limits of environmental variance ($\sigma^2$0). All the four stability revealed similar results in identifying genotypes SKBR-4, SKBR-16, SKBR-24, SKBR-26 and SKBR-27 more unstable. Only SKBR-20, SKBR-22 could not generate agreement among the four stability models with respect to their instability as they were identified as stable in (1). Hence the instability of the genotypes was almost similar.

Four stability models confirmed the stability of two genotypes, SKBR-11 and SKBR-7 for oil content (Table-2) as was evident from the relationship of linear regression coefficient and deviation from regression of (1) with stability parameters of (2, 3, 4) identified as stable genotype which revealed no relationship with the other stability models for these genotypes. Similarly, SKBR-11 was identified as stable genotypes ignoring the Tai's stability model (3) revealing no relationship of

Tai's model (3) with other stability models for these genotypes

CONCLUSION

The comparative efficiency of different stability models produced uniform information and ranked the genotypes without any major disagreement. Similar results have been reported by (10). Regression stability model of (1) showed major agreement with (2, 3) stability model. However, (4) stability model revealed agreement with other stability models in the case SKBR-7 and SKBR-11 for seed yield/plant and SKBR-11 for oil content. (11) reported a significant positive relationship of si with bi and ei with S^2di, and s^2i and S^2i in maize, wheat and sorghum. SKBR-11 was identified as stable variety for seed yield/plant (g) and oil content (%) under valley conditions.

REFERENCES

1. Eberhart, S.A. and Russell, W.A. (1966). Stability parameters for comparing varieties. *Crop Science, 6 :* 36-40.
2. Wrickle, G. (1962). Uber eine methode zur erfassung der okologischen strevbreite in feldversuchan *Z. Pflanzenuecht 47 :* 92-96 [c.f. G x E interaction, its measurement and significance in Plant breeding. Communication centre, *Punjab Agricultural University* Ludhiana., 101pp.].
3. Tai G.C.C. (1971). Genotypic stability analysis and its application to potato regional traits. *Crop Science, 11:* 184-190.
4. Shukla, G.K. (1972). Some statistical aspects of partitioning genotype environmental components of variability. *Heredity, 29*: 237-245.
5. Falconer, D.S. 1952. The problem of environment and selection. *Am. Nat., 86:* 293-298.
6. Fernandez, G.C.J. (1991). Analysis of genotype x environment interaction by stability estimates. *Hort Science, 26(8):* 947-950.
7. Peto, R. (1982). Statistical aspects of cancer trials. In: Treatment of Cancer, Eds. E.E Halnan, pp. 867-871. Chapman and Hall, London.
8. Hill, J. (1975). Genotype-environment – a challenge for plant breeding. *J. Agric. Sci., 85:* 477-493.
9. Yau, S.K. (1995). Regression and AMMI analyses of genotype x environment interactions: An empirical comparison. *Agron. J., 87:* 121-126.
10. Peltonen-Sainio P., Moore K and Pehu E. (1993). Phenotypic stability of oat measured with different stability analysis. *Agricultural Sciences, 121(1):* 13-19.
11. Guilan Yue., Perng S.K., Walter T.L., Wassom C.E. and Liang G.H. (1990). Stability analysis of yield in maize, wheat and sorghum and its implications in breeding programmes. *Plant Breeding, 104 :* 72-80.