

Genotype x environment interaction and screening saline tolerant genotypes in okra [*Abelmoschus esculentus* (L.) Moench.]

K. RAMYA AND N. SENTHILKUMAR

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SUMMARY

Thirty five okra genotypes were evaluated in three different environments for their stability. G x E interaction was significant for days to first flowering, number of fruits per plant, plant height and single plant yield. The genotypes viz., Pusa A4, Parbhani Kranti, Varsha Uphar, Punjab Padmini, Hissar Unnat, PB 266, CO 1, Harbhajan, Arka Abhay and AOL-03-01 were found to have significantly higher regression coefficients along with desirable mean value for the trait pod yield per plant. These genotypes said to be average responsive and suitable for all the environments.

Key words : Stability analysis, Regression coefficient, Okra, Saline tolerance okra

Okra [*Abelmoschus esculentus* (L.) Moench.] is an annual vegetable crop grown throughout the tropics and warmer parts of temperate regions. It is an important vegetable crop for nutritional as well as economic point of view. Okra is special valued for its tender and delicious fruits all over the country. So there is a need to develop varieties with high yield potential and stable performance over wide range of environments. Genotype x environment interaction are important in developing stable genotypes which interact less with the environments. If stability of performance is a genetic characteristic, then preliminary evaluation could be planned to identify the stable genotypes. For developing stable varieties, some stability parameters for which Finlay and Wilkinson (1963), Eberhart and Russel (1966), Perkins and Jinks (1968) and Freeman and Perkins (1971) have given some models. The present study was, therefore, conducted to identify stable okra genotypes for further use in breeding programme.

MATERIALS AND METHODS

The material consisted of 35 genotypes viz., OKH 666, NOH 303, Arka Anamika, S51, Lakshmi, Ankur 40, DOV 1, Hisar Unnat, Varsha Uphar, Arya 351, PB 7, Pusa A4, Indol 03-01, Arka Abhay, Dov 2, MBORH 93, AOL 03-01, OKH 333, Kamini, Parbhani Kranti, Bakra, DSU 1, P7, MBORH 311, DSN 1, PB 266, Pusa Sawani, Pusa Makhmali, CO 1, MDU 1, Punjab Padmini, Gujarat

Bhindi 1, Harbhajan, Selection 2 and EMS 8 were studied to assess the stability performance under three different locations (Location I – soil with EC of 0.65 dSm⁻¹, location II – soil with EC of 2.65 dSm⁻¹, location III – soil with EC of 3.25 dSm⁻¹). The experiment was carried out in a randomized block design with three replication of spacing 30 x 45 cm during the year 2008. Recommended cultural practices were followed to raise the crop. Five competitive plants from each genotype in each replication were selected at random to record the data. Observations were recorded for 10 characters viz., days to first flowering, number of nodes to first pod, days to first pod harvest, number of branches per plant, number of pods per plant, single pod weight, length of edible pod, girth of edible pod, plant height and pod yield per plant. Statistical constants of mean for all the characters, regression coefficient (bi) and deviation from regression (S²di) for the characters where G x E interaction was significant, were estimated following the method proposed by Eberhart and Russell (1966).

RESULTS AND DISCUSSION

The analysis of variance revealed that highly significant differences existed among the genotypes (G) for all the traits except number of branches per plant and fruit girth. Further, the significant mean square due to (environment + genotype) x environment [E + (G x E)] for the trait number of fruits per plant, plant height and single plant yield depicted the existence of genotype x environment interaction. The linear contribution of the environmental effects on the performance of genotype was reflected by highly significant mean square due to environment (linear). The mean square due to G x E interaction (linear) was also important for days to first flowering, number of fruits per plant, plant height and

Correspondence to:

K. RAMYA, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, ANNAMALAINAGAR (T.N.) INDIA

Authors' affiliations:

N. SENTHILKUMAR, Department of Agricultural Botany, Faculty of Agriculture, Annamalai University, ANNAMALAINAGAR (T.N.) INDIA

single plant yield. Indicating that a considerable proportion of genotypes x environment interaction was contributed by the linear component. Therefore, prediction for most of the genotypes appear to be feasible for these characters. Highly significant mean square was observed due to pooled deviation for the character plant height and pod yield per plant revealing the importance of non linear component accounting for total genotype x environment interaction for these characters (Table 1). Therefore, genotypes differed considerably with respect to stability for these characters. Similar study were also made by Poshya and Vashi (1997).

The mean performance of a genotype along with two parameters *viz.*, regression coefficient (bi) and deviation from regression (S^2di) considered simultaneously to represent a measure of adaptability of the genotype. A genotype with desirable mean, deviation from regression line ($S^2d = 0$) not significantly deviating from zero and unit regression coefficient ($b = 1$) (not significantly deviating from 1) is said to be average responsive and suitable for all the environments (Table 2). The genotypes namely Parbhani Kranti, MDU 1, P 7, AOL-03-01, Pusa A4, Ankur 40, Varsha Aphar, Punjab Padmini, OKH 666 and Gujarat Bhindi 1 were found to be stable and suitable for all the environments for days to first flowering. The genotypes namely Lakshmi, Pusa Sawani, PB 266, Ankur 40, DOV 2, Harbhajan, AOL-03-01, DOV 1, OKH 333 and Selection 2 were stable for number of nodes to first pod and for days to first pod harvest, the genotypes namely EMS8, Kamini, Parbhani Kranti, Pusa Makhmali, PB7, Punjab Padmini, MBORH 93, Arka Abhay and OKH 333 were stable. The genotypes namely Panjab Padmini, Kamini, Hissar Unnat, Arya 351, PB 266, MDU 1, Varsha Uphar, OKH 666, Parbhani Kranti and EMS 8 were considered as stable genotypes for the trait number of

branches per plant and for the trait number of pods per plant, the genotypes *viz.*, Varsha Uphar, Pusa A4, AOL-03-01, Parbhani Kranti, Punjab Padmini, PB 266, Hissar Unnat, CO 1, Harbhajan and Ankur 40 were considered as stable. The genotypes *viz.*, Punjab Padmini, Arka Anamika, Pusa A4, Selection 2, Parbhani Kranti, Arka Abhay, Hissar Unnat, CO 1, MBORH 311 and Harbhajan were found to be stable for single pod weight and also the stable genotypes for the trait length of edible pod was Punjab Padmini, MBORH 93, Parbhani Kranti, CO 1, Arka Abhay, Varsha Uphar, Hissar Unnat, Bakra, Arka Anamika and DSU 1. The genotypes namely, OKH 333, CO 1, Punjab Padmini, Parbhani Kranti, MBORH 93, Varsha Uphar, Kamini, Pusa A4, PB 266 and DOV 2 were stable and suitable for all the environments for girth of edible pod and for the trait plant height, the genotypes namely, MBORH 311, MDU 1, DSN 1, P7, DOV 1, Pusa Sawani, PB 266, Arka Abhay, Hissar Unnat and Arka Anamika were stable. The genotype namely Pusa A4 (441.50 g), Parbhani Kranti (411.33 g), Varsha Uphar (379.67 g), Punjab Padmini (375.83 g), Hissar Unnat (315.08 g), PB 266 (305.00 g), CO 1 (294.00 g), Harbhajan (276.85 g), Arka Abhay (264.92 g) and AOL-03-01 (263.83 g) were considered as the best adapted genotypes for all the environments for pod yield per plant (Table 2).

A genotype with desirable mean, deviation not significantly deviating from zero and significant unit regression coefficient value ($b > 1$) is said to be highly responsive suitable for favourable environments (Table 3). For days to first flowering, the genotypes namely PB 7, Indo1-03-01, OKH 333, DSU-1, Pusa Sawani, Harbhajan, Selection 2 and EMS 8 had significant mean value with non significant S^2di value and significant regression coefficient value ($b > 1$). Arka Anamika, Indol-03-01, Bakra, DSU 1, DSN 1 and Gujarat Bhindi 1 for

Table 1 : Analysis of variance for stability analysis of 35 okra genotypes for various characters

Source	df	Mean sum of square									
		Days to first flowering	No. of nodes to first pod	Days to first pod harvest	No. of branches per plant	No. of fruits per plant	Average fruit yield (g)	Fruit length (cm)	Fruit girth (cm)	Plant height (cm)	Single plant yield (g)
Replication with in environment	3	0.38	0.004	0.005	0.01	0.63	0.03	0.17	0.009	0.97	2.11
Genotypes (G)	34	50.63**	2.30**	2.57**	0.51	50.91**	12.42**	16.26**	0.12	1707.59**	17045.9**
E + (G * E)	70	2.61	0.13	0.09	0.06	3.01**	0.42	0.34	0.03	36.76**	422.38**
Environment (linear)	1	166.41*	4.38	1.49	0.35	96.66**	2.37	4.36*	0.06	846.63**	12477**
G * E (linear)	34	2.43**	0.09	0.12	0.08	2.57**	0.55	0.41	0.02	31.75**	342.20**
Pooled deviation	35	0.95	0.03	0.35	0.03	0.03	0.23	0.15	0.04	18.49**	156.01**
Pooled error	102	0.75	0.003	0.03	0.02	0.28	0.12	0.09	0.02	4.06	17.98
Total	209	18.59	0.84	18.72	0.91	0.22	4.38	5.56	0.43	582.32	5838.11

* and ** indicate significant of values at P=0.05 and 0.01, respectively

number of nodes to first pod and Arka Anamika, Lakshmi, Ankur 40, Hissar Unnat, PB 7, Indol-03-01, Bakra, DSU 1, P 7, DSN 1 and Gujarat Bhindi 1 for days to first pod harvest and for number of branches per plant, Lakshmi, Ankur 40, PB 7, MBORH 93, AOL-03-01, DSU 1, Pusa Sawani, Pusa Makhmali, Gujarat Bhindi 1, Harbhajan and Selection 2 also performed similarly. The genotypes Arya 351, PB 7, Indol-03-01, OKH 333, DSU 1, Pusa Sawani, Pusa Makhmali, Gujarat Bhindi 1, Selection 2 and EMS 8 were suitable for favourable environment for the trait number of pods per plant and Lakshmi, DOV 1, Arya 351, PB 7, Pusa A4, Indol-03-01, OKH 333, Pusa Makhmali, Punjab Padmini and Gujarat Bhindi 1 for single pod weight and for length of edible pod, Lakshmi, Ankur 40, PB 7, Indol-03-01, OKH 333, MBORH 311, Pusa Makhmali, MDU 1, Gujarat Bhibdi 1, Harbhajan and EMS 8 were suitable for favourable or high input environment. The genotypes namely NOH 303, DOV 1, Hissar Unnat, PB 7, Arka Abhay, AOL-03-01, Bakra, DSN 1, Pusa Sawani, Gujarat Bhindi 1, Harbhajan, Selection 2 and EMS 8 were suited for high input/favourable environment for the trait girth of edible pod and for plant height, Arya 351, PB 7, Indol-03-01, OKH 333, DSU 1, Pusa Makhmali, Harbhajan and EMS 8 and the genotypes Arka Anamika (282.09 g), PB 7 (313.83 g), OKH 333 (192.50 g), DSU 1 (140.71 g), Pusa Sawani (177.83 g), Pusa Makhmali (224.17 g), Selection 2 (280.83 g) and EMS 8 (215.20 g) for pod yield per plant also recorded similarly (Table 3).

A genotype with desirable mean, non-significant S^2_{di} value and significant b value ($b < 1$) is said to be low responsive and suitable for unfavourable environments (Table 4). The genotypes NOH 303, DOV 2 and Kamini had significant mean value with non significant S^2_{di} value and significant regression coefficient value ($b < 1$). These genotypes were suitable for unfavourable or poor environments. The genotypes namely, NOH 303, S51, DOV 1, MDU 1 and Punjab Padmini for days to first pod harvest and for number of branches per plant, S 51, DOV 1,

Table 4 : Low responsive genotypes significant for unfavourable environments

Sr. No.	Days to first flowering	Number of nodes to first pod	Days to first pod harvest	Number of branches per plant	Number of pods per plant	Single pod weight (g)	Length of edible pod (cm)	Girth of edible pod (cm)	Plant height (cm)	Pod yield (g)
1.	NOH 303 (45.88)		NOH 303 (6.98)	S 51 (2.73)		OKH 666 (13.11)	DOV 2 (11.68)	Arka Anamika (5.78)		
2.	DOV 2 (40.75)		S 51 (0.19)	DOV 1 (2.25)		Arka Anamika (18.00)	AOL-03-01 (15.25)	S 51 (4.93)		
3.	Kamini (40.33)		DOV 1 (0.77)	Arka Abhay (2.97)		PB 266 (14.88)		Lakshmi (5.33)		
4.			MDU 1 (8.57)	DOV 2 (2.55)				Ankur 40 (4.96)		
5.			Punjab Padmini (7.17)	Bakra (2.62)				Indol-03-01 (5.92)		
6.				DSU 1 (3.27)				DOV 2 (5.27)		
7.				CO 1 (2.37)						

Parenthesis value = General mean value of three location

Arka abhay, DOV 2, Bakra, DSU 1 and Pusa Makhmali were also recorded similarly. For single pod weight the genotypes viz., OKH 666, Arka Anamika and PB 266 were suited for unfavourable environments. The genotypes DOV 2 and AOL-03-01 were found to be suited for low input environment for the trait length of edible pod. For girth of edible pod the genotypes viz., Arka Anamika, S51, Lakshmi, Ankur 40, Indol-03-01 and DOV 2 were suited for unfavourable or poor environments (Table 4). Similar studies were also made by Ariyo (1989)

and Ariyo and Ayo-Vaughan (2000).

Thus, it could be concluded that the better genotypes for stability were Parbhani Kranti, Hisar Unnat, Punjab Padmini, Varsha Uphar, Pusa A4, Arka Abhay, PB 266 and CO 1 on the basis of pod yield and its component traits. These genotypes may be recommended for commercial cultivation or used as parent in the crossing programme aimed at breeding a high yielding variety with general adaptability. These genotypes are also suggested to cultivate coastal areas where soil is salinity.

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