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Stability Analysis for Fruit Yield and its Component Traits in Indian Bottle Gourd (*Lagenaria siceraria* (Mol.) Standl.) Varieties

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Stability of 18 bottle gourd (*Lagenaria siceraria* (Mol.) Standl.) varieties was studied for fruit yield and yield contributing traits during *Rabi*-summer seasons of 2011-12, 2012-13 and 2013-14. Pooled analysis of variance revealed highly significant differences among the varieties for all the traits except for leaf width, ovary length and fruit weight suggesting enough genetic variability among the genotypes for all these traits. Similarly the mean squares for environments were also significant for all the traits except peduncle length and fruit length indicting that the environments under study are diverse enough. Further, genotype × environment (G × E) interactions were also significant for all the traits suggesting that the traits responded to the environments differently. The environments (linear) also differed significantly for all the traits except leaf width and peduncle length which indicates that the environments selected for testing of genotypes were quite varied in their effect on the performance of genotypes. Considering all the stability parameters, the varieties, Narendra Rashmi and IIHR-19-1 proved to be most stable genotypes exhibiting significantly higher mean fruit yield/ha. For the yield contributing traits viz., fruit number, Narendra Dharidhar, KBGR-12, Pusa Samrudhi and Kalyanpur Long were stable over environments and for fruit weight Kashi Ganga, Punjab Komal and Pant Lauki-3 were stable with highest mean values, unit regression and least deviation which can be exploited for these yield contributing traits in the bottle gourd improvement programs.

Key Words: G×E Interaction, Bottle Gourd, Regression Coefficient, Stability Analysis, Stable Genotype, Vegetable Improvement

Introduction

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] commonly known as *Lauki* or *Ghiya* in India is one of the most important member of the family *Cucurbitaceae* and believed to be originated in Africa (Whitaker, 1971). It is commercially grown in all the states of India in both rainy and summer seasons. The immature fruits contain good amount of vitamins and have good medicinal values. In any breeding programme it is necessary to screen and identify phenotypically stable genotype for yield which could perform more or less uniformly under different environmental conditions. It is an established fact that yield is a complex character and largely depends upon its component characters, with an interaction with the environment, resulting into the ultimate product *i.e.* yield. So for breeding a stable variety, it is necessary to get the information on the extent of genotype × environment (GE) interaction for yield and its component characters.

To meet the objective of developing varieties with high yield potential, a wide collection of germplasm must be available so that the evaluation for desirable traits for yield can be exercised and a breeding program for an ideal plant type concept can be made accordingly. A phenotype is the product of interplay of genotype and its environment. A specific genotype does not exhibit the same phenotype under the changing environments and different genotypes respond differently to a specific environment. This variation arising from the lack of correspondence between the genetic and non-genetic effects is known as G × E interaction which is generally considered impediment in plant breeding as it baffles the breeder in judging the real potential of a genotype when grown in different environments. Several workers considered G×E interactions as linear function of environment and proposed regression of yield of a genotype on the mean yield of all genotypes in each environment to evaluate stability of performance

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of genotype (Eberhart and Russell, 1966; Finlay and Wilkinson, 1963; Perkins and Jinks, 1968). The main objective of a breeding programme is to develop varieties that perform well over a broad spectrum of environments. The information about phenotypic stability is useful for the selection of crop varieties as well as for breeding programmes. In bottle gourd, very few studies are available so far on these aspects by Parmar (2000) and Shaikh *et al*. (2012). Hence, the objective of the present study was to explore the effect of G × E on fruit yield and its attributing traits and identifying stable varieties in bottle gourd.

Material and Methods

The experimental material for the present study comprised of 18 bottle gourd reference varieties viz., ABG-1, NDBG-619, NDBG-132, Pusa Sandesh, IIHR-19-1, Pusa Santhusti, Pusa Naveen, Kalyanpur Long, Pant Lauki-3, Narendra Jyothi, Narendra Dharidhar, Arka Bahar, Narendra Rashmi, Punjab Komal, Punjab Long, Pusa Samrudhi, Kashi Ganga and KBGR-12 maintained at the Division of Vegetable Crops under PPV&FRA's DUS project. These 18 bottle gourd varieties were grown in randomized block design (RBD) with three replications at the Vegetable Farm, ICAR-Indian Institute of Horticultural Research, Bengaluru during *Rabi*-summer seasons of 2011-12, 2012-13 and 2013-14. All the recommended cultural and agronomic practices including pest control measures were adopted to raise good crop. To ascertain the comparative behaviour of different genotypes under different environments, observations were recorded on five randomly selected plants from each replication for 15 quantitative parameters such as vine length (m), branch number/vine, node number for first female flower appearance, days taken for first female flower appearance, stem intermodal length (cm), petiole length (cm), leaf length (cm), leaf width (cm), ovary length (cm), peduncle length (cm), fruit length (cm), fruit width (cm), fruit number/vine, fruit weight (g), fruit yield/vine (kg). In all the experiments, plot means (mean of five plants) were used for environment-wise analysis of variance and pooled analysis of variance for the estimation of G×E interaction effects and stability analysis as suggested by Eberhart and Russell (1966).

Results and Discussion

The pooled analysis of variance for different traits revealed highly significant differences among the varieties for most of the traits viz., vine length, branch number/vine, node number for first female flower appearance, days taken for first female flower appearance, stem intermodal length, petiole length, leaf length, peduncle length, fruit length, fruit width, fruit number/vine and fruit yield/vine suggesting enough genetic variability among the genotypes for all these traits. Similar significant differences among the genotypes for all the traits except for days to first picking and fruit weight in bottle gourd were reported by Shaikh *et al* (2012). Thakur *et al*. (1994) also reported significant differences for all the yield and yield contributing traits in bitter gourd. The variances associated with genetic effects were smaller than the variances associated with environmental effects for most of the characters viz., vine length, branch number/vine, node number for first female flower appearance, days taken for first female flower appearance, petiole length, leaf length, leaf width, ovary length, fruit number/vine, fruit weight, fruit yield/vine. This shows that under the present environmental conditions for determination of such characters, the genotypes need to be evaluated in multi-locational trials. Furthermore, the larger variances associated with genetic effects than the variances associated with genotype × environment for most of the traits under the study namely, vine length, node number for first female flower appearance, days taken for first female flower appearance, stem intermodal length, petiole length, leaf length, peduncle length, fruit length, fruit width, fruit number/vine, fruit weight, fruit yield/vine indicates a greater influence and stability of genetic factors relative to the variability associated with the interaction of genotype × environment for these characters in bottle gourd (Shaikh *et al.,* 2012). Similarly the mean squares for environments were also significant for all the traits except peduncle length and fruit length indicating that the environments under study are diverse enough. Further, G × E interactions were also significant for all the traits suggesting that the traits responded to the environments differently. The environments (linear) also differed significantly for all the traits except leaf width and peduncle length which indicates that the environments selected for testing of genotypes were quite varied in their effect on the performance of genotypes. Similar results were earlier reported for yield and yield contributing traits in ridge gourd by Varalakshmi and Subba Reddy (1998).

The G × E linear component was significant for branch number, node for fist female flower appearance, stem intermodal length and leaf length suggesting that

the variation in performance of different genotypes is due to the regression of genotypes on environments and hence the performance is predictable in nature (Krishnaprasad and Singh, 1992; Varalakshmi and Subba Reddy, 1998; Agasimani *et al.*, 2008; Shaikh *et al*., 2012; Vasanthkumar *et al.*, 2012). However, the mean square due for pooled deviation is significant for all the traits except for leaf length suggesting that variation in performance of genotypes is entirely unpredictable.

When stability parameters were studied for 18 bottle gourd reference varieties, it was found that none was ideal variety with stability over environments for all the 15 characters. However, fruit yield/vine is the main trait responsible for overall performance of a variety across environments and in the present study; two varieties, Narendra Rashmi and IIHR-19-1 which recorded significantly higher mean values over population mean (6.89 kg), unit regression coefficient and non-significant deviation from regression were stable over wider environments (Table 1). Similar findings have also been reported by Prasad *et al.* (1987) and Parmar (2000).

The long vine varieties, Pusa Sandesh and Narendra Jyothi were found to be stable for vine length with unit regression and least deviation, similarly NDBG-132 and Kalyanpur Long were stable for branch number (Table 1). The early varieites, Punjab Komal, Pant Lauki-3, Arka Bahar, Pusa Samrudhi, and Pusa Naveen were found stable over different environments for various earliness traits. For node number for first female flower appearance, Punjab Komal and Pant Lauki-3 were stable; Arka Bahar, Pusa Samrudhi, Pusa Naveen for days taken for first female flower appearance; Narendra Rashmi for stem intermodal length and Kalyanpur Long for petiole length were found to have stability over environments having lowest mean value (in the desirable direction) with unit regression and non-significant deviation from regression. Among the other leaf parameters, for leaf length, five varieties viz., Narendra Rashmi, NDBG-619, Pusa Santushti, Pusa Samrudhi and Narendra Jyothi and for leaf width four varieties viz., Arka Bahar, Kalyanpur Long, Punjab Long and Pusa Santushti were stable (Table 1). Several varieties were stable for various fruit traits which are directly correlated with yield; for ovary length, as many as eight varieties, Narendra Jyothi, Pusa Naveen, Punjab Long, Kalyanpur Long, ABG-1, Pant Lauki-3, Narendra Dharidhar and Kashi Ganga were stable with highest mean, unit regression and least deviation (Table 1). For peduncle length, Pusa Sandesh, NDBG-619, Punjab Long had lowest mean (desirable) with unit regression and non significant deviation from regression. IIHR-19-1, KBGR-12, NDBG-619, Pusa Naveen, and Punjab Long were stable for fruit length whereas Narendra Dharidhar, Kalyanpur Long, IIHR-19-1, NDBG-619, Punjab Komal, Narendra Jyothi and Pant Lauki-3 were stable for fruit width. For the yield contributing traits viz., fruit number, Narendra Dharidhar, KBGR-12, Pusa Sanrudhi and Kalyanpur Long were stable over environments and for fruit weight Kashi Ganga, Punjab Komal and Pant Lauki-3 were stable with highest mean values, unit regression and least deviation (Table 1) (Shaikh *et al*., 2012).

Among the varieties studied, the stable and adaptable varieties with high mean performance for fruit yield per vine identified for wider environment and specific (favourable) environment are presented in Table 2. Narendra Rashmi with highest fruit yield/vine followed by IIHR-19-1 would be stable over environments owing to the non-significant deviation from regression value associated with unit regression and high mean performance. Four other varieties viz., Arka Bahar, Pant Lauki-3, KBGR-12 and Narendra Dharidhar had above unit estimates of regression coefficient leading to below average stability hence found to be well adapted to better environment (Shaikh *et al*., 2012). However, Punjab Komal was adaptable to poor environments owing to its negative regression coefficient and least deviation.

Overall, variety, Kalyanpur Long showed stable performance for as many as six traits such as branch number, petiole length, leaf width, ovary length, frit width and fruit number; Narendra Jyothi was stable for four traits viz., vine length, leaf length, ovary length and fruit width. Three other genotypes were stable for more than one important yield contributing trait viz., Punjab Komal for node number, for first female flower appearance, fruit width and fruit weight; Pusa Samrudhi for days taken for first female flower appearance, leaf length and fruit number and KBGR-12 for fruit length, fruit width and fruit number which showed higher mean values than population mean in desirable direction, regression coefficient less than unity and non-significant deviation from regression. These varieties can be cultivated for specific trait(s) of choice under a wide range of agro-climatic conditions or can be used as parents in the hybridization programs in bottle gourd.

Table 1. Mean performance of the stable varieties along with stability parameters for different yield and yield contributing traits in bottle gourd

S.No.	Trait	Stable variety	Mean	bi	S^2di
1	Vine length (m)	Pusa Sandesh	5.01	0.83	-0.01
		Narendra Jyothi	4.95	1.62	0.05
2	Branch number/vine	NDBG-132	18.49	1.05	0.93
		Kalyanpur Long	14.41	1.12	1.85
3	Node number for first female flower appearance	Pant Lauki-3	6.03	0.65	0.23
		Punjab Komal	5.70	1.70	-0.06
4	Days taken for first female flower appearance	Pusa Naveen	40.11	0.99	-4.05
		Arka Bahar	39.34	0.73	0.32
		Pusa Samrudhi	39.85	0.63	6.05
5	Stem intermodal length (cm)	Narendra Rashmi	14.26	0.55	-0.30
6	Petiole length (cm)	Kalyanpur Long	13.14	1.05	-0.44
7	Leaf length (cm)	NDBG-619	18.58	1.16	-0.46
		Pusa Santhusti	18.57	1.04	-0.09
		Narendra Jyothi	17.51	1.83	-0.18
		Narendra Rashmi	19.78	1.97	-0.12
		Pusa Samrudhi	18.32	0.29	-0.11
8	Leaf width (cm)	Pusa Santhusti	22.58	1.09	-1.62
		Kalyanpur Long	23.08	1.16	-0.51
		Arka Bahar	23.56	0.10	8.65
		Punjab Long	22.97	1.13	1.48
9	Ovary length (cm)	ABG-1	4.56	1.15	0.09
		Pusa Naveen	4.66	1.01	-0.02
		Kalyanpur Long	4.59	0.87	-0.07
		Pant Lauki-3	4.54	1.12	0.02
		Narendra Jyothi	4.73	0.97	-0.06
		Narendra Dharidhar	4.42	1.12	0.06
		Punjab Long	4.65	1.17	0.19
		Kashi Ganga	4.32	0.82	0.08
10	Peduncle length (cm)	NDBG-619	9.26	-0.19	0.41
		Pusa Sandesh	8.71	-0.39	-0.15
		Punjab Long	9.87	2.22	0.55
11	Fruit length (cm)	NDBG-619	35.60	1.42	3.56
		IIHR-19-1	45.29	2.18	2.56
		Pusa Naveen	35.52	1.09	0.88
		Punjab Long	34.07	0.60	-1.08
		KBGR-12	37.29	2.82	4.41
12	Fruit width (cm)	NDBG-619	7.08	1.14	-0.09
		IIHR-19-1	6.95	0.08	0.13
		Kalyanpur Long	6.90	0.87	0.46
		Pant Lauki-3	7.50	1.40	0.31
		Narendra Jyothi	7.29	0.61	-0.10
		Narendra Dharidhar	6.54	0.82	0.01
		Punjab Komal	7.25	1.13	-0.01
13	Fruit number/ vine	Kalyanpur Long	5.87	0.79	-0.09
		Narendra Dharidhar	6.27	0.58	0.03
		Pusa Samrudhi	5.93	2.03	0.40
		KBGR-12	6.08	0.94	-0.06
14	Fruit weight (g)	Pant Lauki-3	1.25	1.94	0.02
		Punjab Komal	1.25	1.38	0.03
		Kashi Ganga	1.48	0.90	0.02
15	Fruit yield/ vine (kg)	IIHR-19-1	8.60	0.94	1.43
		Narendra Rashmi	9.37	0.73	1.05

Table 2. Ideal bottle gourd varieties identified for fruit yield per vine in different environmental conditions

Environment	Varieties identified
Wider environment	Narendra Rashmi and IIHR-19-1
Better environment	Arka Bahar, Pant lauki-3, KBGR-12 and Narendra Dharidhar
Poor environment	Punjab Komal

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