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Genetic variability studies for improvement in bottle gourd under hot arid agro-climate

D. K. Samadia
Central Institute for Arid Horticulture, Bikaner 334 006

Abstract

Variability studies in bottle gourd indicated that a good amount of genetic variation is present in the evaluated germplasm. Characters like number of fruits/plant, fruit yield/plant, fruit weight and number of seeds/fruit exhibited high estimates of GCV. High estimates of heritability accompanied with high genetic gains observed for number of fruits/plant, fruit yield/plant, fruit weight and fruit length indicated additive type of gene action, hence possibilities for effective improvement by selection for these traits. The characters association studies revealed that number of fruits/plant has strong correlation with yield/plant. On the basis of fruit quality, shape and marketable yield, the line AHLs-11, AHLS-12, AHLS-24 and AHLS Round-1 were found to be the most potential for exploitation under arid agro-climate.

Key word: *Genetic variability, Lagenaria siceraria, bottle gourd, arid environment.*

Introduction

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] is a potential cucurbitaceous vegetable of arid and semi-arid region of north-western India. This is because of easiness in its cultivation, short duration and good market demand throughout the year. The region specific varieties from favourable agro-climate are not performed well under extremes of high temperature and abiotic stresses of arid environment. In absence of suitable long fruited genotypes, the framers of arid areas are compelled to use seeds of open pollinated varieties or hybrids of this cross pollinated crop as available in the market and resulted in to poor quality marketable fruits and low yield potential due to environmental susceptibility. However, on the basis of preliminary work the long fruited varieties such as Pusa Naveen and PSPL were recommended for the cultivation (Samadia, 2002). Very limited systematic studies were done under the conditions of abiotic stresses and therefore, the present investigations were undertaken to understand the nature and magnitude of variability in the evaluated germplasm in order to identify the desirables lines based on *per se* performance and to select promising donors for various characters which could be used in hybridization programme to obtain useful recombinants and to create additional variability.

Materials and Methods

The study was conducted under hot arid agro-climatic conditions at Central Institute for Arid Horticulture (CIAH), Bikaner (28° N latitude and 73° 18' E longitude and altitude of 235 m above mean sea level). The agro-climate of location of study is characterized by low and erratic rainfall (150 - 350 mm restricted during July September) in a few spells, extremes of temperature (-4° C in winter to 48° C in summer), high solar radiation, high wind speed (12-16 km/hr) with several dusty days and also the summer season is for prolong duration. Beside, the sandy soil is with poor fertility and water holding capacity. Twenty germplasm (18 land races collected from tribal area of Rajasthan and Gujarat and two lines) were assessed in randomized block design over the seasons both during rainy and summer from 2004 to 2007. The experimental material was grown in channels of 10 m length spaced at 2.5 m apart accommodating to 20 plants of each germplasm with three replications. The observations were recorded on five plants selected per replication for each germplasm on 25 quantitative and quality characters. To categorize the germplasm, important characters of plant, fruit, quality and seed were also recorded. The important characters are days to appearance of first male flower (DFMF) days after sowing (DAS), days to appearance of first female flower, DAS (DFFF), node to first fruit set (NFF), days to first harvest, DAS (DFH), fruit length, cm (FL), fruit diameter, cm (FD) and marketable fruit weight, kg (FW), number of fruits/plants (NF/P), fruit yield/plant, kg (FY/P), vine length, m (VL), leaf length, cm (LL), leaf width, cm (LW), mature fruit length, cm (MFL) and number of seeds/fruit (NSF). The data were compiled and analyzed adopting standard statistical procedures using computer based INDOSTAT packages.

Results and Discussion

In the present study the analysis of variance revealed significant genotypic difference for all the characters exhibiting greater diversity in the experimental material (Table-1 & 2). The data on plant growth, flowering and fruiting behaviour and fruit yield are presented in Table-1 and 2 for performance studies. The period taken for appearance of first male and female flower ranged from 38.46 - 50.26 and 43.83 - 55.26, respectively. The first

marketable fruit harvest ranged from 61.46 to 71.77 days from sowing. Among the evaluated lines, the earliest harvest (< 65 days) was in AHLS Round-1 (61.46) followed in order by AHLS-12, AHLS-14, AHLS-15, AHLS-16, AHLS-17 and AHLS-23. The number of marketable fruits/plant ranged from 1.95 - 7.54. The line AHLS Round-1, AHLS-22, AHLS-23 and AHLS-24 recorded higher number of fruits (6.0) per plant exhibiting better yield potential under arid conditions. The marketable fruit yield/plant ranged form 1.174 - 4.270 kg with a population mean of 2.544 kg. The line AHLS Round-1, AHLS Long-1, AHLS-12, AHLS-21 and AHLS-22 recorded higher yield (> 3.0 kg) compared to the lowest yield in AHLS-15 (1.18 kg). On the basis of quality, shape and marketable characters of fruit the line AHLS-11, AHLS-12, AHLS-24 and AHLS Round-1 were found to be the most potential. The landraces/genotypes exhibited diversity and thus provide great potentiality for improvement in fruit quality and yield characters. The genotypes giving more number of fruits at lower nodes along with very early fruit set and harvest should result in higher and early yields. The selected genotypes should also tolerate high temperature and stresses of arid environment during later stage of crop growth and fruit yield on secondary and tertiary branching (Samadia, 2002; Samadia, 2005).

The absolute variability in different characters cannot be the criteria for deciding the character showing the highest degree of variability. In the present study, the estimates of genotypic and phenotypic coefficient of variation (GCV and PCV) indicated an ample scope for crop improvement (Table-2) because the estimates of PCV in general were higher than GCV for all the characters. The GCV ranging from 4.82 (days to first harvest) to 45.13 per cent (number of fruits/plant) gives a picture of the extent of genetic variability in the population. These estimates were considerably high (> 30 %) for characters such as number of fruits/plant, fruit yield/plant, fruit weight, mature fruit length and number of seeds/fruit and moderate for characters such as tender fruit length and diameter and leaf size and length. A close correspondence between PCV and GCV value in respect of all the characters indicate that environment has very little influence on the expression of the characters. In such situation, selections on the basis of the phenotypic characters alone will have equal probability of success.

However, with the help of GCV alone, it is not possible to determine the amount of variation that is heritable. Heritable variation can be determined with greater degree of accuracy when heritability (h^2, broad sense) is taken into consideration along with genetic advance (GA). Hence, both heritability and genetic advance were determined to get a clear picture of the scope of improvement in various characters through selection. Very high heritability estimate values were observed for all the characters. The genetic advance in the present study ranged from 9.85 to 92.93 % of mean (genetic gain). Thus the investigation revealed that economic characters like number of fruits/plant could be improved by 3.54 units at 5 % selection intensity (SI) which would be 92.93% higher to the mean. High heritability values accompanied with high genetic gain were observed for number of fruits/plant, fruit yield/plant, fruit weight, fruit length, mature fruit length and number of seeds/fruit and were moderate for fruit diameter. This indicates additive type of gene action. Simple selection, therefore, could be effective for the improvement of these traits. High heritability estimates along with low genetic gain in respect of days to first harvest, days to appearance of first male and female flower were probably due to non-additive type of gene action. Thus, direct selection for these characters will be less effective (Panes and Sukhatme, 1957). The present findings with regards to genetic variability are in agreement with those of Abusaleha and Dutta (1990a) in cucumber and of Narayana *et al.* (1996) in bottle gourd. It is clear from data of Table-2 that the characters like number of fruits/plant, fruit yield/plant, mature fruit length and number of seeds/fruit possessing high estimates of GCV, heritability and genetic gain and thus could be used for effectively selection. Johnson *et al.* (1955) suggested that characters with high heritability coupled with high genetic gain would respond to selection better than those with high heritability and low genetic gain. The high variability and heritability along with high genetic advance as percentage of mean expressed by the above mentioned traits indicate that the genotypes could be tested in multi-location trials and selected as donors for these characters or can be used as parents in hybridization programme.

In general, the magnitude of genotypic correlation coefficient were slightly higher than their corresponding phenotypic correlation coefficient for the important characters (Table-3) indicating, there by, a strong inherent association between the traits under study. The results are in agreement with the findings of Dahiya *et al.* (2000) in round melon and Abusaleha and Dutta (1990b) in ridge gourd. Yield is a dependent character and is highly influenced by the environment and therefore, information of its association with its main components is beneficial in formulating breeding strategy for crop improvement. The positive and significant association of number of fruits/plant (0.682) with yield indicates that effective improvement through this character could be achieved in bottle gourd. Fruit length and diameter exhibited positive but non-significant association with yield/plant. Days taken for first harvesting, an indication for earliness or late maturing has positive and significant association with days to appearance of first male and female flower clearly depicted mutual association of these characters. Negative and significant association of fruit weight and length with number of fruits/plant clearly indicates that smaller sized fruits results in more number of fruits/plant. Thus, it is suggested that for higher yield in bottle gourd selection should be based on number of fruits/plant.

Table 1: Flowering and fruit yield characters in bottle gourd germplasm under arid agro-climate

Genotype	Days to first male flower (DAS)	Days to first female flower (DAS)	Node number to first fruit set	Days to first harvest (DAS)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (kg)	Number of fruits/plant	Fruit yield /plant (kg)	Vine length (m)
AHLS 11	41.36	51.36	15.40	65.06	37.10	7.35	0.83	3.53	2.95	3.11
AHLS 12	46.43	49.43	20.40	63.50	51.73	6.71	1.44	3.13	3.59	3.14
AHLS 13	47.43	53.30	19.50	66.33	42.96	7.35	1.22	2.26	2.78	3.31
AHLS 14	38.46	43.83	21.76	62.26	51.73	6.06	0.74	3.84	2.86	3.12
AHLS 15	44.63	48.80	19.36	61.76	33.23	5.14	0.51	2.31	1.18	3.16
AHLS 16	45.56	50.36	18.50	62.36	41.03	7.35	1.08	2.11	2.31	2.46
AHLS 17	45.30	51.33	19.56	63.20	32.16	6.45	0.72	2.29	1.66	2.79
AHLS 18	44.60	52.86	18.20	65.33	31.30	5.42	0.41	2.81	1.17	3.15
AHLS 19	47.26	53.43	18.33	65.90	50.50	9.38	0.92	1.94	1.80	2.82
AHLS 20	41.90	52.30	19.76	62.80	39.13	5.73	0.56	2.83	1.60	2.94
AHLS 21	43.73	52.26	20.40	71.03	51.36	5.77	0.75	4.17	3.17	2.53
AHLS 22	49.26	53.23	18.43	68.80	24.80	7.05	0.51	6.56	3.34	2.64
AHLS 23	50.26	54.33	16.36	69.13	25.30	7.37	0.45	6.23	2.83	3.15
AHLS 24	38.63	48.30	16.13	62.96	21.70	7.47	0.40	6.44	2.59	2.58
AHLS 25	44.60	51.76	18.50	65.33	52.43	5.73	0.89	3.24	2.91	2.77
AHLS 26	43.30	52.16	21.53	64.60	34.03	7.48	0.72	4.06	2.94	2.75
AHLS 27	47.40	53.40	20.76	70.40	22.23	5.78	0.42	2.94	1.24	2.83
AHLS 28	46.16	55.26	20.36	71.76	43.26	6.14	0.57	2.41	1.38	2.63
AHLS Long-1	45.30	49.43	18.40	65.30	38.86	5.71	0.75	5.56	4.22	3.25
AHLS Round-1	38.70	47.06	16.50	61.46	18.00	10.70	0.56	7.54	4.27	2.45
CD 5%	0.72	1.01	0.85	1.22	1.59	0.22	0.06	0.14	0.23	0.17

Table 2: Genetic variability component for various characters in bottle gourd

Characters	Range		Mean	CV (%)	GCV (%)	PCV (%)	h^2 (broad sense)	Genetic Advance (GA)	GA as percentage of mean (5 %SI)
	Minimum	Maximum							
DFMF	38.46	50.26	44.52	0.98	7.49	7.51	88.43	6.85	15.39
DFFF	43.83	55.26	51.21	1.19	5.32	5.37	98.35	5.57	10.87
NFF	15.40	21.76	18.91	2.73	9.32	9.45	97.22	3.58	18.93
DFH	61.46	71.77	65.47	1.13	4.82	4.87	98.19	6.45	9.85
FL	18.00	52.43	37.14	2.81	29.82	29.86	99.75	22.79	61.35
FD	5.15	10.71	6.81	1.99	20.01	20.04	99.67	2.80	41.14
FW	0.401	1.224	0.712	5.42	34.69	34.83	99.19	0.51	71.17
NF/P	1.95	7.54	3.81	2.29	45.13	45.15	99.91	3.54	92.93
FY/P	1.174	4.270	2.544	5.59	37.78	37.92	99.28	1.97	77.55
VL	2.45	3.31	2.88	3.73	9.36	9.61	94.97	0.54	18.80
LL	14.35	25.81	20.84	0.71	15.14	15.15	99.93	6.50	31.19
LW	13.74	30.04	21.66	0.49	16.78	16.79	99.97	7.49	34.57
LS	210.13	775.69	461.42	0.87	29.67	29.68	99.97	282.03	61.12
FPL	8.44	19.28	13.15	0.56	23.13	23.14	99.95	6.26	47.64
MFL	26.14	91.04	54.48	2.79	32.24	32.28	99.75	36.14	66.34
NS/F	83.87	319.67	203.62	2.96	35.19	35.23	99.76	147.45	72.41
SL	1.396	1.793	1.615	3.28	7.77	8.01	94.37	0.25	15.58
SW	0.606	0.917	0.777	6.26	9.71	10.36	87.81	0.15	18.74
STW	14.55	23.87	18.13	1.01	15.66	15.67	99.86	5.84	32.24

Table 3: Genotypic and phenotypic correlation coefficient in bottle gourd

Characters		DFFF	NFF	DFH	FL	FD	FW	NF/P	FY/P	VL
DFMF	G	0.737	0.100	0.586	0.035	-0.148	0.143	-0.230	-0.187	0.217
	P	0.730**	0.097	0.582**	0.036	-0.150	0.142	-0.230	-0.186	0.207
DFFF	G	---	-0.013	0.738	-0.039	-0.101	-0.056	-0.277	-0.386	-0.029
	P		-0.014	0.729**	-0.037	-0.100	-0.057	-0.274	-0.383	-0.035
NFF	G		---	0.150	0.457	-0.460	0.185	-0.480	-0.246	0.079
	P			0.144	0.452*	-0.451*	0.183	-0.474*	-0.240	0.055
DFH	G			---	0.028	-0.208	-0.191	0.011	-0.123	-0.104
	P				0.029	-0.209	-0.189	0-011	-0.122	-0.103
FL	G				---	-0.267	0.697	-0.563	0.037	0.210
	P					-0.267	0.695**	-0.562**	0.038	0199
FD	G					---	0.166	0.390	0.403	-0.383
	P						0.164	0.389	0.402	-0.373
FW	G						---	-0.437	0.306	0.173
	P							-0.435*	0.311	0.165
NF/P	G							---	0.684	-0.245
	P								0.682*	-0.238
FY/P	G								---	-0.048
	P									-0.050
VL	G									---
	P									

*, ** Significant at 5% and 1% level, respectively.

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