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STUDIES ON GENETIC VARIABILITY AND TRAIT INTER-RELATIONSHIP IN BOTTLE GOURD (*Lagenaria siceraria* (Mol.) Standl)

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ABSTRACT : A field investigation was carried out at Horticulture Farm of Institute of Agriculture, Sriniketan to evaluate the twenty seven genotypes of bottle gourd in randomized block design with three replications. Sowing was done in late *kharif* season of 2013 at a spacing of 50 cm between hills. Observations were recorded for 8 quantitative characters viz., node number of first female flower, sex ratio, days to first harvest, number of fruits per plant, fruit weight, fruit length, fruit girth and fruit yield per plant. The analysis of variance showed highly significant differences for all the characters studied indicating considerable variability among the genotypes. The highest GCV (34.84%) and PCV (35.14%) were observed for sex ratio. The differences between GCV and PCV were high for fruit number per plant indicating environmental influences. High heritability associates with high estimates of genetic advance in per cent of mean were noted for node number of first female flower, sex ratio, fruit length, fruit girth, number of fruits per plant and fruit yield per plant. It indicated the presence of additive gene effect and selection for these traits would be effective. Fruit yield/plant was positively and significantly correlated (at genotypic and phenotypic level) with fruit length and fruits number/plant. Negative associations of fruit yield/plant were noted with node number of first female flower, sex ratio and days to first harvest. Path analysis revealed that days to first harvest (2.783) and fruit girth (1.356) had very high positive direct effect on fruit yield/plant.

Keywords : *Bottle gourd, variability, heritability, genetic advance, correlation, path co-efficient.*

Bottle gourd (*Lagenaria siceraria* L.) is an important vegetable grown for its tender fruits both on homestead gardens and Farms. Bottle gourd is gaining popularity as a health food because of its easy digestibility, diuretic and cardiatonic effects (Rahaman *et al.,* 13). Bottle gourd is a cross pollinated crop with large amount of variation for many economically important traits. India is one of the centres of diversity of bottle gourd endowed with a variety of diverse germplasm (De-Candole, 5). Evaluation of a collection of bottle gourd from different parts of India revealed genetic diversity for various qualitative (Mathew *et al.,* 11) and quantitative characters (Singh *et al.,* 15). Collection and evaluation of bottle gourd genotypes from different parts of India will be helpful for identifying superior genotypes) for a specific region. Until now no systematic work have been reported on bottle gourd under Red and Laterite zone of West Bengal. Again, the earliness and yield potentiality of this crop can be improved through an effective breeding program. Studies on variability along with heritability and genetic advance helps in predicting inheritance pattern of various characters. Correlation and path co-efficient studies between yield and its components and their relative contributions to yield will be of great value in planning sound breeding program. Therefore, the present investigation was undertaken with a view to work out phenotypic and genotypic coefficients of variation, heritability, genetic gain, association of important genetic traits and path analysis between components of yield in the twenty seven genotypes of bottle gourd, so as to make effective selection for improvement of this crop.

MATERIALS AND METHODS

The experiment was conducted at the Horticulture Farm of Institute of Agriculture, Sriniketan, Visva-Bharati. The 27 genotypes of bottle gourd were sown in randomized block design with three replications. The crop was grown in channel and bed system (0.5m x 2.5m). The plant to plant spacing was given 50cm. Sowing of pre-soaked seeds was done on 14th September, 2013. Standard package of practices was adopted to raise a good crop. Observations were recorded for 8 characters *viz.,* node number of first female flower, sex ratio, days to fruit harvest, number of fruits per plant, fruit weight, fruit length, fruit girth and yield per plant. The data were analyzed to estimate genotypic and phenotypic co-efficient of variation (Burton *et al,* 4), heritability in broad sense (Burton and Devane, 3) and genetic advance (Allard, 1), correlation

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co-efficient (Johnson *et al.,* 8) and path coefficients (Dewey and Lu, 6). The data were analyzed using Statistical Package for Agricultural Research (SPAR-1) developed at Indian Agricultural Statistical Research institute, New Delhi.

RESULTS AND DISCUSSION

The mean sums of squares due to genotypes were highly significant for all the characters subjected to analysis of variance (Table 1). This indicated the presence of considerable amount of variation among the genotypes to carry out further genetic analysis. Similar results were also reported by Pandit *et al.* (12). The highest coefficient of variation (17.99%) was recorded for number of fruits/plant. Therefore, it is possibility of selection of genotype having more number of fruits plant from available germplasm. Among the genotypes, the range of variation was observed from 7.80 to 14.87 with mean value of 10.98±0.98 for node number of flowers per plant, 4.73 to 14.87 with mean value of 7.64±0.28 for sex ratio, 61.33 to 96.27 days with mean value of 77.71±2.99 for days to first harvest, 2.10 to 5.30 with mean value of 3.35±0.49 for number of fruits per plant, 547.33 g to 980.00 g with mean value of 775.80±76.80 for fruit weight, 15.93 cm to 40.77 cm with mean value of 28.74±2.57 for fruit length, 22.20 cm to 39.77 cm with mean value of 27.68±1.60 for fruit girth and 2.00 kg to 4.00 kg with mean value of 2.74±0.22 for fruit yield per plant. In order to obtain a clear understanding of the pattern of variations, the phenotypic variances have been partitioned into genotypic and environmental variance. Considerable genotypic variances were found in sex ratio followed by fruit length and fruit number per plant. Greater value of PCV than that of GCV for fruits number per plant indicated considerable environmental influences in inheritance of this character. High heritability associated with high estimates of genetic advance in percent of mean (GAPM) was noticed for sex ratio, fruit length, fruit girth, number of fruits per plant and fruit yield per plant. It indicated the presence of additive gene effect and selection for these traits would be effective. The present findings are supported by Kumar *et al.* (9) and Yadav *et al.* (17).

Table 1: Estimates of genetic parameters of 8 characters in 27 bottle gourd genotypes.

Traits	NNFFF	SR	DFH	NFP	FW	FL	FG	FYP
MSG	13.10**	21.34**	201.50**	2.21*	29746.25**	153.47**	126.01**	1.00**
CV (%)	10.96	4.53	4.72	17.99	12.12	11.38	6.80	9.79
Mean	10.98	7.64	77.71	3.35	775.80	28.74	27.68	2.74
Range	7.80 - 14.87	4.73 - 14.87	61.33- 96.27	2.10 - 5.30	547.33 - 980.00	15.93 - 40.77	22.20 - 39.77	2.00 - 4.00
SE(±)	0.98	0.28	2.99	0.49	76.80	2.57	1.60	0.22
GCV	17.95	34.84	10.19	23.44	10.76	24.99	22.21	20.41
PCV	21.03	35.14	11.23	29.55	16.21	27.46	23.22	22.64
h^2b	72.85	98.34	82.34	62.91	44.06	82.83	91.43	81.29
GAPM	31.55	71.18	19.04	38.29	14.71	46.85	43.74	37.91

Here, * & ** indicates 5% and 1% level of significance, MSG = Mean sum of squares due to genotypes, CV = Co-efficient of Variation, SE = Standard Error, GCV = Genotypic coefficient of variation, PCV = Phenotypic coefficient of variation, h^2b = Heritability, GAPM= Genetic Advance in percent of mean; NNFFF- Node Number of First Female Flower, SR- Sex Ratio, DFH- Days to First Harvest, NFP- Number of Fruits per Plant, FW- Fruit Weight (g), FL- Fruit Length (cm), FG- Fruit Girth (cm), FYP- Fruit Yield per Plant (Kg).

High genotypic and phenotypic coefficients of variation (>20%) were recorded for sex ratio, fruit length, fruit girth, fruits number/plant and fruit yield/plant. High heritability (>60%) coupled with high genetic advance over mean (>20%) was observed for node number of first female flower, sex ratio, fruit length, fruit girth, fruits number/plant and fruit yield/plant. The individual bottle gourd genotypes which showed desirable mean values in characters like sex ratio, fruit length and number of fruits per plant should be selected, because these characters with high genotypic coefficients of variation, high heritability and high genetic gain are controlled by additive gene action and hence direct selection is effective. Days to first fruit harvest and fruit weight registered low genotypic coefficient of variation, moderate heritability and low genetic gain which indicated the preponderance of non additive gene action and influence of environment.

Correlation indicated the mutual relationship among various plant characters and determines the component characters on which selection can be based for genetic improvement of yield. In present study, the nature of genotypic correlations was similar to the phenotypic correlations. However, values of

genotypic correlation were higher than the phenotypic correlation that indicates a less influence of environmental factors. Correlation coefficients at genotypic and phenotypic levels were worked out among different characters keeping fruit yield/plant as dependable variable (Table 2). Fruit yield/plant was positively and significantly correlated (at genotypic and phenotypic level) with fruit length and fruits number/plant. Similar associations of the characters were observed by Badade *et al.* (2) and Gayen and Hossain (7). However, node number of first female flower, sex ratio and days to first harvest had negative association at genotypic and phenotypic level with fruit yield/plant. Fruit yield/plant was also negatively correlated with fruit girth but only at genotypic level. Sarvesh and Singh (14) reported negative correlation of yield per plant with the node number of first female flower and days to first harvest in bottle gourd. Association of component characters revealed positive and significant genotypic and phenotypic correlations of node number of first female flower with sex ratio, days to first harvest, fruit girth and fruit weight (only at genotypic level); sex ratio with days to first harvest and fruit weight; days to first harvest with fruit weight; fruit length with fruits number/plant at only genotypic level; fruit girth with fruit weight (only at genotypic level). Manna and Paul (10) gave high priority to fruit length, fruit weight and number of fruits per plant for improvement of tomato.

The genotypic correlations were portioned into direct and indirect effects through path coefficient analysis to know the relative importance of 8 characters (Table 3). Path analysis revealed that days to first harvest (2.783) and fruit girth (1.356) had very high positive direct effect on fruit yield/plant, followed by node number of first female flower (0.769) and fruits number/plant (0.396). However, fruit length (-1.728) and fruit girth (-1.645) had negative and very high direct effects on fruit yield/plant. The characters showing high negative direct effects can be selected via other traits. The present findings were in agreement with Umamaheswarappa *et al.* (16) and Gayen and Hossain (7). Node number of first female flower had negative and significant association with fruit yield/plant but its direct effect was noted high positive (0.769). This character showed very high positive indirect effect via days to first harvest (1.799) and high positive effect via fruit length (0.916) and fruit weight (0.544). Sex ratio had negative and significant correlation with fruit yield/plant but its direct effect (-0.115) was low. It had very high to moderate positive indirect effect via days to first harvest (1.659), node number of first female flower (0.403), fruits number/plant (0.490) and fruit girth (0.288). Days to first harvest had negative and significant association with fruit yield/plant. However, it possessed very high positive direct effect (2.783) on fruit yield per plant. This character showed high positive indirect effect *via* node number of first female flower (0.497) and fruits number/plant (0.815). Fruits number/plant was positively and significantly correlated with fruit yield/plant but it possessed very high negative direct effect (-1.728). This character had very high positive indirect effect via fruit weight (1.482). Fruit weight had

Table 2 : Genotypic (G) and Phenotypic (P) correlation coefficients among different characters of bottle gourd.

Characters		SR	DFH	NFP	FW	FL	FG	FYP
NNFFF	**G**	0.524**	0.646**	-0.530**	0.678**	-0.608**	0.401**	-0.438**
	P	0.455**	0.545**	-0.373**	0.574**	-0.360**	0.115	-0.297**
SR	**G**		0.596**	-0.284*	0.475**	-0.630**	0.212	-0.528**
	P		0.540**	-0.253*	0.454**	-0.491**	0.161	-0.458**
DFH	**G**			-0.471**	0.507**	-0.578**	-0.059	-0.581**
	P			-0.378**	0.451**	-0.411**	-0.086	-0.476**
NFP	**G**				-0.901**	0.268*	0.107	0.305**
	P				-0.748**	0.186	0.038	0.270*
FW	**G**					-0.406**	0.306**	-0.281*
	P					-0.297**	0.158	-0.215
FL	**G**						-0.380**	0.815**
	P						-0.257*	0.765*
FG	**G**							0.197
	P							0.190

* & ** indicates 5% and 1% level of significance**;** NNFFF- Node Number of First Female Flower, SR- Sex Ratio, DFH- Days to First Harvest, NFP- Number of Fruits per Plant, FW- Fruit Weight (g), FL- Fruit Length (cm), FG- Fruit Girth (cm), FYP- Fruit Yield per Plant (Kg).

Table 3 : Genotypic path coefficient of different characters with fruit yield/plant of bottle gourd.

Characters	NNFFF	SR	DFH	NFP	FW	FL	FG	Correlation with fruit yield/plant (Kg)
NNFFF	0.769	-0.060	1.799	0.916	-1.115	-0.241	0.544	-0.438** -0.297**
SR	0.403	**-0.115**	1.659	0.490	-0.782	-0.249	0.288	-0.528** -0.458**
DFH	0.497	-0.069	**2.783**	0.815	-0.834	-0.229	-0.080	-0.581** -0.476**
NFP	-0.408	0.033	-1.312	**-1.728**	1.482	0.106	0.146	0.305** 0.270*
FW	0.522	-0.055	1.412	1.557	**-1.645**	-0.161	0.415	-0.281* -0.215
FL	-0.467	0.073	-1.608	-0.463	0.668	**0.396**	-0.516	0.815** 0.765*
FG	0.308	-0.024	-0.164	-0.185	-0.504	-0.151	**1.356**	0.197 0.190

Residual effect =0.166; Diagonal values (Bold) indicate direct effect; * & ** indicates 5% and 1% level of significance; NNFFF- Node Number of First Female Flower, SR- Sex Ratio, DFH- Days to First Harvest, NFP- Number of Fruits per Plant, FW- Fruit Weight (g), FL- Fruit Length (cm), FG- Fruit Girth (cm).

very high negative direct effect (-1.645) on fruit yield/plant that was confirmed by negative correlation between this character and fruit yield/plant. Its positive indirect effects were recorded very high *via* days to first harvest (1.412) and fruits number/plant (1.557), and high via node number of first female flower (0.522) and fruit weight (0.415). Fruit length possessed high positive direct effect (0.396) on fruit yield/plant. It also contributed towards fruit yield/plant possessing high positive indirect effects via fruit weight (0.668). Positive and higher magnitude of direct and indirect association of this character with fruit yield/plant resulted into positive and significant correlation. Fruit girth had very high positive direct effect (1.356) and high indirect effect via node number of first female flower (0.308) towards fruit yield/plant. Lower magnitude of positive indirect effects and higher magnitude of negative indirect effects cancelled the positive effects leading to non-significant correlation. The residual effect (0.166) indicated that the eight characters included in this study explained higher percentage of variation in yield of this population.

CONCLUSION

In present study, bottle gourd genotypes that showed desirable mean values with high genotypic coefficients of variation, high heritability and high genetic gain in traits like sex ratio, fruit length and number of fruits per plant should be selected, where direct selection assumed to be effective. Fruit yield/plant was also positively and significantly correlated (at genotypic and phenotypic level) with fruit length and fruits number/plant. Traits like days to first harvest and fruit weight should be given due consideration for bottle gourd improvement work as revealed from path analysis study.

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