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Variability studies in F_3 populations of bottle gourd (*Lagenaria siceraria* (Molina) Standl.) for yield and yield contributing traits

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Abstract
Genotypic coefficient of variation and phenotypic coefficient of variation, heritability and genetic advance were undertaken for sixteen characters of five crosses of bottle gourd in F_3 generation. High genotypic and phenotypic coefficient of variation and high heritability estimates associated with high values of genetic advance as a percent mean were observed for fruit yield per plant in all the five crosses, average fruit weight in Pusa Sandesh × Arka Bahar and Pusa Naveen × Pusa Santhusti, number of fruits per vine in Pusa Sandesh × Arka Bahar, Pusa Naveen × Pusa Santhusti and Pusa Naveen × Local Round, number of seeds per fruit in Pusa Naveen × Pusa Santhusti which indicated additive gene action for these characters, which could be improved by simple selection method.

Keywords: Bottle gourd, genotypic coefficient of variation, phenotypic coefficient of variation, heritability, genetic advance

Introduction
Bottle gourd (*Lagenaria siceraria* (Molina) Standl.) is an annual monoecious species belongs to the family Cucurbitaceae with Chromosome number 2n = 22. Bottle gourd is one of the cultivated tropical and subtropical vine and it is commonly known as calabash gourd, white flowered gourd, lauki, Ghia etc., The term *Lagenaria siceraria* is derived from two Latin words *lagena* which means bottle and *sicera* means drinking utensil. Bottle gourd is originated in Africa with a long history of cultivation in Asia and other warmer regions of the world. Secondary centre of origin of bottle gourd is India with a very good repository of diverse germplasm.

The main prerequisite for launching a breeding programme is the extent of genetic variability and genetic divergence in breeding material. Wide differences between morphological traits such as size, colour, resistant to pests and diseases and yield are of immense importance to the breeder since number of cultivars could be developed to suit various requirements.

As the area and production of bottle gourd are increasing fast but the crop still remains less explored on aspects of crop improvement by breeding methods. Thus, there is much need of cultivars with early fruiting, high yield, and high female to male ratio, medium sized fruits. Therefore, to introgressed these horticultural traits, the F_3 progenies were assessed for variability, heritability and genetic advance for the utilization in crop improvement.

Material and methods
The experiment was conducted at College of Horticulture, Dr. YSR Horticultural University, Venkataramannagudem, West Godavari District. Selected F_2 plants were selfed and generated F_3 progeny which were evaluated during *Kharif* 2021, at PG and Ph.D. Research Block, Department of vegetable science, College of Horticulture, Venkataramannagudem. The experimental site was well prepared, cultural practices include training, pruning, weeding, irrigation, fertilizer application and plant protection measures were followed for the healthy growth of crop. Observations were recorded on various yield parameters from all the plants of F_3 generation number of fruits per vine, fruit length (cm), fruit diameter (cm), average fruit weight (g), number of seeds per fruit, fruit yield per vine (kg), TSS (Brix) and Vitamin-C (mg/100g) GCV, PCV (Burton, 1952), Heritability analysis and Genetic Advance (Allard, 1960).

The mean, GCV, PCV, heritability, genetic advance as percent mean are given in table 1, table 2, table 3, table 4 and table 5.

In the present investigation, the magnitude of GCV and PCV were closer in all the five crosses of F_3 generation *viz*. Pusa Sandesh × Arka Bahar, Pusa Sandesh × Punjab Bahar, Pusa Naveen × Pusa Santhusti, Pusa Naveen × Local long, Pusa Naveen × Local round for majority of the characters. These results suggests that, greater contribution of genotype rather than environment to the variability present in different traits. Similar findings were observed by Rashid *et al.* (2020) [18], and Kandasamy *et al.* (2019) [9] in bottle gourd, Kannan and Rajamanickam (2019) [11, 12] and Gautham and Balamohan (2018) [6] in ridge gourd. The values of PCV were slightly higher than GCV which indicated the minor role of environment on the population in five crosses studied. These results were similar with the findings of Chandra Mouli *et al.* (2021) [1], Vaidya *et al.* (2020), Swayam Parvadas *et al.* (2018) in bottle gourd and Deepa *et al.* (2018) [2] in cucumber.

High estimates of GCV and PCV were observed in the traits *viz.*, number of fruits per vine, average fruit weight, fruit yield per plant in Pusa Sandesh × Arka Bahar, average fruit weight, fruit yield per plant, fruit length in Pusa Sandesh × Punjab Bahar, average fruit weight, number of seeds per fruit, fruit yield per plant in Pusa Naveen × Pusa Santhusti, fruit yield per plant in Pusa Naveen × Local Long, number of fruits per vine, fruit yield per plant in Pusa Naveen × Local Round. These results were indicating that there is a broad range of variability in the population and further selection in these traits play a major role. These results were in accordance with Chandra Mouli *et al.* (2021) [1], Vaidya *et al.* (2020), Swayam Parvadas *et al.* (2018), Thakur *et al.* (2017), Sharma and Sengupta (2013) and Singh *et al.* (2002) in bottle gourd, Gautham and Balamohan (2018) [6] and Kannan and Rajamanickam (2019) [11, 120] in ridge gourd.

Moderate estimates of GCV and PCV were observed in the traits *viz.*, fruit length, number of seeds per fruit in Pusa Sandesh × Arka Bahar, number of fruits per vine, fruit diameter in Pusa Sandesh × Punjab Bahar, number of fruits per vine in Pusa Naveen × Pusa Santhusti, number of fruits per vine, fruit length and average fruit weight in Pusa Naveen × Local Long, number of fruits per vine, fruit length, average fruit weight, number of seeds per fruit in Pusa Naveen × Local Round. It implies that moderate amount of variability is present in the population and further selection would be possible up to some extent. These results were in accordance with Mahilo *et al.* (2016), Janaranjani and Kanthaswamy (2015) [8, 10] in bottle gourd and Deepa *et al.* (2018) [2] in cucumber.

Low estimates of GCV and PCV was observed in the traits *viz.*, fruit length, fruit diameter, TSS and vitamin-C in Pusa Sandesh × Arka Bahar, number of seeds per fruit, TSS and vitamin-C in Pusa Sandesh × Punjab Bahar, fruit length, fruit diameter, TSS and vitamin-C in Pusa Naveen × Pusa Santhusti, Pusa Naveen × Local Long and Pusa Naveen × Local Round. These characters would have less scope for exploitation in further generations. Similar results were obtained from the findings of Similar findings in bottle gourd were observed by Samadiya (2011) in ridge gourd and Kanimozhi *et al.* (2015) [10] in wax gourd.

High heritability coupled with high genetic advance was observed in the traits *viz.*, fruit length, fruit diameter, average fruit weight, number of seeds per fruit, fruit yield per plant in all the five crosses *i.e.*, Pusa Sandesh × Arka Bahar, Pusa Sandesh × Punjab Bahar, Pusa Naveen × Pusa Santhusti, Pusa Naveen × Local Long and Pusa Naveen × Local Round. This indicates the presence of additive gene action in inheritance of these traits. So, there was ample scope for direct selection in these traits. These results were similar with the findings of Chandramouli *et al.* (2021) [1], Rashid *et al.* (2020) [18], Kandasamy *et al.* (2019) [9] in bottle gourd, Balmohan *et al.* (2018), Ramesh *et al.* (2018) [16] in ridge gourd and Janghel *et al.* (2018) in muskmelon.

Moderate to high heritability coupled with low genetic advance was observed in the traits *viz.*, TSS and vitamin-C in all the five crosses *i.e.*, Pusa Sandesh × Arka Bahar, Pusa Sandesh × Punjab Bahar, Pusa Naveen × Pusa Santhusti, Pusa Naveen × Local Long and Pusa Naveen × Local Round. The high value of heritability accompanied with low genetic advance as per cent of mean indicated the non-additive gene action in inheritance of these traits. High heritability was due to high environmental influence rather than the genotype. Direct selection for such traits may not be rewarding. Similar results were obtained from the findings of Ahmad *et al.* (2019), Deepa *et al.* (2018) [2] and Rani *et al.* (2017) [17] in bottle gourd.

Table 1: Mean, GCV, PCV, heritability and genetic advance in F_3 population of Pusa Sandesh × Arka Bahar.

Sl. No	Character	Mean	GCV (%)	PCV (%)	h^2	GA	GAM (%)
1	Number of fruits per vine	11.14	24.53	26.46	85.92	5.22	46.83
2	Fruit length (cm)	34.86	9.12	11.82	59.50	5.05	14.49
3	Fruit diameter (cm)	31.57	5.30	9.25	62.75	1.99	22.47
4	Average fruit weight (g)	1181.43	26.18	28.95	81.77	566.22	48.77
5	Number of seeds per fruit	325.71	15.25	20.33	56.24	76.71	23.55
6	Fruit yield per vine (kg)	16.69	30.24	39.73	57.92	7.91	47.40
7	Total soluble solids ($^{\circ}$B)	3.03	9.11	11.83	59.28	0.44	14.45
8	Vitamin-C (mg/100g)	8.29	4.57	5.52	68.43	0.65	7.79

Table 2: Mean, GCV, PCV, heritability and genetic advance in F_3 population of Pusa Sandesh × Punjab Bahar

Sl. No	Character	Mean	GCV (%)	PCV (%)	h^2	GA	GAM (%)
1	Number of fruits per vine	16.29	17.17	19.06	81.14	5.19	31.86
2	Fruit length (cm)	14.43	17.80	25.06	66.44	1.59	10.38
3	Fruit diameter (cm)	22.14	16.41	19.93	67.82	6.17	27.85
4	Average fruit weight (g)	1337.86	20.86	22.70	84.42	528.19	39.48
5	Number of seeds per fruit	298.14	7.11	9.15	75.41	12.63	4.27
6	Fruit yield per vine (kg)	19.60	21.12	31.16	45.97	5.78	19.50

7	Total soluble solids (°B)	3.08	13.14	14.61	80.88	0.75	24.33
8	Vitamin-C (mg/100g)	7.61	6.09	8.26	54.30	0.70	9.24

Table 3: Mean, GCV, PCV, heritability and genetic advance in F_3 population of Pusa Naveen × Pusa Santhusti.

Sl. No	Character	Mean	GCV (%)	PCV (%)	h^2	GA	GAM (%)
1	Number of fruits per vine	7.43	13.46	20.17	44.55	1.37	18.51
2	Fruit length (cm)	32.43	8.06	9.16	47.55	4.74	14.63
3	Fruit diameter (cm)	34.39	8.68	10.31	60.42	3.13	9.10
4	Average fruit weight (g)	1168.59	26.13	32.23	65.71	509.86	43.63
5	Number of seeds per fruit	298.57	22.46	25.98	74.70	119.38	39.98
6	Fruit yield per vine (kg)	9.15	44.19	47.50	86.55	7.75	34.70
7	Total soluble solids (°B)	3.09	8.30	11.15	55.47	0.39	12.74
8	Vitamin-C (mg/100g)	9.57	5.77	6.20	86.54	1.06	11.06

Table 4: Mean, GCV, PCV, heritability and genetic advance in F_3 population of Pusa Naveen × Local long.

Sl. No	Character	Mean	GCV (%)	PCV (%)	h^2	GA	GAM (%)
1	Number of fruits per vine	6.00	18.13	21.82	69.05	1.86	31.04
2	Fruit length (cm)	32.43	9.89	11.92	68.86	5.48	16.91
3	Fruit diameter (cm)	42.86	10.08	10.71	88.59	8.37	19.54
4	Average fruit weight (g)	1325.14	12.62	16.85	56.05	257.84	19.46
5	Number of seeds per fruit	292.86	9.73	14.42	45.52	35.59	13.52
6	Fruit yield per vine (kg)	8.87	18.63	25.56	63.08	2.48	27.95
7	Total soluble solids (°B)	2.85	10.45	13.00	64.61	0.49	17.30
8	Vitamin-C (mg/100g)	8.66	8.82	8.90	61.05	0.53	6.16

Table 5: Mean, GCV, PCV, heritability and genetic advance in F_3 population of Pusa Naveen × Local Round.

Sl. No	Character	Mean	GCV (%)	PCV (%)	h^2	GA	GAM (%)
1	Number of fruits per vine	9.00	23.11	25.20	87.13	3.93	33.67
2	Fruit length (cm)	18.00	16.72	21.00	63.43	4.94	27.44
3	Fruit diameter (cm)	43.74	6.13	6.92	40.57	1.80	4.11
4	Average fruit weight (g)	1427.29	11.72	16.77	68.87	241.00	16.89
5	Number of seeds per fruit	391.57	11.53	17.00	46.04	63.13	16.12
6	Fruit yield per vine (kg)	12.16	28.56	34.99	66.66	5.84	48.04
7	Total soluble solids (°B)	3.53	7.34	10.71	47.02	0.37	10.37
8	Vitamin-C (mg/100g)	8.17	7.47	8.54	76.53	1.11	13.53

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