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To study the genetic variability, heritability and genetic advance for agronomic traits of Bottle gourd [*Lagenaria siceraria* (Mol.) Standl]

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Abstract
Thirty diverse genotypes of Bottle gourd were carried out in Randomized Block Design with three replications during *summer season* of 2018 at Main Experiment Station, Department of Vegetable Science at the Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.). The analysis of variance revealed highly significant differences among the genotypes for all twelve characters under studies. The estimates of coefficients of variation relieved that magnitude of phenotypic coefficients of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the characters. High estimates of phenotypic as well as genotypic coefficients of variation were observed in case of number of fruits per plant followed by fruits yield per plant, while moderate variation was noted in case of node number to first pistillate flowers, average fruit weight, vine length, node number to first staminate flowers, fruit circumference (cm), number of primary branches per plant, fruit length and lowest days to first pistilate flower anthesis, days of first fruit harvest and days to first staminate flower anthesis. High estimates of heritability (>75%) were recorded for fruit yield/plant, average fruit weight, number of fruit/plants, node number to first pistillate flower, node number to first staminate flowers, vine length (m). The highest value of genetic advance in per cent of mean (>20%) was shown by number of fruits per plant, fruit yield/plant kg, node number to first pistillate flower, average fruit wt /fruit (Kg), vine length (m), node number to first staminate flowers and fruit circumference (cm). High heritability combined with high genetic advance suggests that additive gene action governs these traits, and that these traits can be increased through simple selection.

Keywords: Bottle gourd, GCV, PCV, heritability, genetic advance, variability

Introduction
Bottle gourd [*Lagenaria siceraria* (Mol.) Standl] belongs to the family Cucurbitaceae having chromosome number 2n = 2x = 22, originated in southern Africa. Bottle gourd or white flowered gourd is commonly known as Lauki, it is one of the important cucurbitaceous vegetable crops cultivated in India. The names "lagenaria" and "siceraria" are derived from Latin words "lagena" means bottle and "sicera" means drinking utensil (Deepti, 2013) [4].

It is an economically important crop cultivated worldwide for vegetable purpose. Numerous health benefits are reported in bottle gourd including its anticancerous, cardio protective, diuretic, aphrodisiac, general tonic, antidote to certain poisons and scorpion stings, alternative purgative and cooling effects (Badmanaban and Patel, 2010) [1].

It can also be used to cure pain, ulcers and fever and is used for pectoral cough, asthma and other bronchial disorders using prepared syrup from the tender fruits (Upaganlawar and Balaraman, 2010). Bottle gourds are known to lower cholesterol, triglyceride, low density lipoproteins, pain and inflammation (Ghule *et al*., 2006) [8], free radicals and oxidation (Deshpande *et al*. 2008; Kubde *et al*., 2010) [5, 13].

Bottle gourd is monoecious, annual vine with soft pubescence. The leaves are cordate – ovate to reniform – ovate, 15-30 cm across, not lobed. The flowers are white, solitary, showy and open at night. The flowers have five petals. The staminate flowers are on long pedicels exceeding the foliage. The pistillate flowers are single with short peduncle and hairy ovary.

Bottle gourd variability has been studied by many researchers, including Heiser (1979), Morimoto and Mvere, (2004) [16] etc. Studies in India demonstrated the significant regional variability (Sivaraj and Pandravada, 2005) [20]. In spite of being in cultivation since ancient times and the presence of the wide germplasm, conscious evaluation and exploitation of germplasm has not been attended to until recently (Harika *et al.*, 2012) [10].

The extent of genetic variability of existing genotype of a crop plant is an index of its genetic dynamics. Plant breeding revolves around selection which can be effectively practiced only in the presence of variability of desired traits.

Heritability and genetic advance are important parameters. Heritability is good index of transmission of characters from parents to their offspring (Falconer, 1960) [7]. Genetic advance is the measure of genetic gain under selection. Thus, genetic advance denotes the improvement in the mean genotypic value of selected population over the parental population. Heritability estimates along with genetic advance are more helpful in predicting the improvement that can be made in a crop by selecting the elite genotypes for various characters.

Materials and Methods

The present experiment was conducted at Main Experiment Station of Department of Vegetable Science at the Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) during *summer season* 2018. Thirty morphologically diverse bottle gourd genotypes (Table-1) were collected from different places in India. The experiment was conducted in Randomized Block Design with three replications to evaluate thirty morphologically distinct bottle gourd genotypes. Individual plot dimension was 3 m × 3 m with a row to row spacing of 3 m and plant to plant spacing of 50 cm. Thus, six plants were maintained in individual plots. All the recommended agronomic package of practices and plant protection measures were followed to raise a healthy crop stand. The observation was recorded for six selected plants for twelve quantitative characters *viz*., node number to first staminate flower anthesis, node number to first pistillate flower anthesis, days to first staminate flower anthesis, days to first pistillate flower anthesis, days to first fruit harvest, fruit length (cm), fruit circumference (cm), average fruit weight (kg), number of fruits per plant, vine length at the time of last harvest (m), number of primary branches per plant and average fruit yield (kg/plant). Using the OPSTAT programme, the data was evaluated for different genetic factors such as variability, heritability, and genetic progress. The analysis of variance, genotypic and phenotypic coefficients of variation (Burton, 1952) [2], heritability (Hanson *et al.*, 1956) [9], and genetic progress were all done using standard statistical procedures (Johnson *et al.*, 1955) [12].

Table 1: List of bottle gourd genotypes used for the study and their source of origin

S. No.	Name of genotypes	Source of origin
1.	NDBG-21	N.D.U.A.&T, Ayodhya
2.	NDBG-22	N.D.U.A.&T, Ayodhya
3.	NDBG-23	N.D.U.A.&T, Ayodhya
4.	NDBG-24	N.D.U.A.&T, Ayodhya
5.	NDBG-25	N.D.U.A.&T, Ayodhya
6.	NDBG-26	N.D.U.A.&T, Ayodhya
7.	NDBG-27	N.D.U.A.&T, Ayodhya
8.	NDBG-28	N.D.U.A.&T, Ayodhya
9.	NDBG-29	N.D.U.A.&T, Ayodhya
10.	NDBG-30	N.D.U.A.&T, Ayodhya
11.	NDBG-31	N.D.U.A.&T, Ayodhya
12.	NDBG-32	N.D.U.A.&T, Ayodhya
13.	NDBG-33	N.D.U.A.&T, Ayodhya
14.	NDBG-34	N.D.U.A.&T, Ayodhya
15.	NDBG-60	N.D.U.A.&T, Ayodhya
16.	NDBG-61	N.D.U.A.&T, Ayodhya
17.	NDBG-62	N.D.U.A.&T, Ayodhya
18.	NDBG-63	N.D.U.A.&T, Ayodhya
19.	NDBG-64	N.D.U.A.&T, Ayodhya
20.	NDBG-65	N.D.U.A.&T, Ayodhya
21.	NDBG-66	N.D.U.A.&T, Ayodhya
22.	NDBG-67	N.D.U.A.&T, Ayodhya
23.	NDBG-68	N.D.U.A.&T, Ayodhya
24.	NDBG-69	N.D.U.A.&T, Ayodhya
25.	NDBG-70	N.D.U.A.&T, Ayodhya
26.	NDBG-71	N.D.U.A.&T, Ayodhya
27.	NDBG-72	N.D.U.A.&T, Ayodhya
28.	NDBG-73	N.D.U.A.&T, Ayodhya
29.	Pusa Naveen (C)	IARI New Delhi
30.	NDBG-104 (C)	N.D.U.A.&T, Ayodhya

Result and Discussion

Analysis of variance was carried out twelve characters for thirty genotypes from the experiment were subjected to analysis of variance. Mean sum of squares due to genotypes were highly significant for all the characters (Table-2), indicating that there are significant differences among the genotypes with respect to the characters under study. The mean performance of thirty bottle gourd genotypes for twelve characters presented in Table-3. The maximum days of first staminate flower anthesis was recorded in NDBG-104 C (50.33 days) and minimum from NDBG-21 (41.67 days). The genotype NDBG-26 was recorded highest days to first pistillate flower anthesis 57.67 days and minimum (43.67 days) in case of NDBG-22. The highest node number to first male flower appearance was observed in case of NDBG-29 (11.17), while the lowest value was recorded by NNBG-67

(5.87). The genotype Pusa Naveen (7.71) check was recorded the lowest node number of first female flower anthesis while NDBG-34 (15.40) was highest value for this character. The days of first harvest was recorded from NDBG-73 (67 days) and minimum in NDBG-27 (55 days). The genotype NDBG-32 was observed maximum fruit length (47.53 cm) and minimum in NDBG-66 (31.50 cm). The maximum fruit circumference was exhibited for NDBG-27 (34.50 cm) and minimum NDBG-60 (14.57 cm). The maximum number of primary branches per plant was recorded from NDBG-61 (4.63) and minimum in NDBG-65 (3.16). The genotype NDBG-104 was recorded highest Vine length (6.61 m) and minimum in NDBG-22 (3.32 m). The highest fruit weight was recorded from NDBG-34 (1.49 kg) and minimum in NDBG-22 (0.68 kg). The genotype NDBG-32 was recorded maximum number of fruits per plant (10.16) and lowest in NDBG-64 (5.09). The highest fruit yield per plant (11.17 kg) was recorded with NDBG-32 and the lowest yield per plant (5.48 kg) was observed in NDBG-26. The genotypes mentioned above may serve as promising parents / donors for fruit yield and other characters for which they showed high performance. These findings are similar as reported by Dwivedi (2000), Singh (2004) and Thakur *et al.* (2015) [6, 19].

The estimates of genotypic and phenotypic coefficients of variation for twelve characters of bottle gourd germplasm collections are present in (Table-4.) The estimates of coefficients of variation relieved that magnitude of phenotypic coefficients of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the characters. High estimates of genotypic coefficients of variation were observed in case of number of fruits per plant (19.48) followed by fruits yield per plant (18.68), while moderate variation were noted in case of node number to first pistillate flowers (17.19), average fruit weight (16.75), vine length (15.45), node number to first staminate flowers (13.57), fruit circumference (cm) (13.08), number of primary branches per plant (10.91), fruit length (10.09), while lowest for days to first pistilate flower anthesis (6.44), days of first fruit harvest (3.93) and days to first staminate flower anthesis (2.95). The estimates of phenotypic coefficient of variation (PCV) for different characters. The phenotypic coefficient of variation was observed for number of fruits per plant (21.03) followed by fruits yield per plant (19.55), while moderate variation was noted in case of node number to first pistillate flowers (18.65), average fruit weight (17.98), vine length (17.66), node number to first staminate flowers (15.49), fruit Circumference (cm) (15.20), number of primary branches per plant (12.63), fruit length (12.20) and lowest days to first pistilate flower anthesis (8.29), days of first fruit harvest (6.64) and days to first staminate flower anthesis (6.33). The present findings are accordance with the findings of (Dwivedi, 2000 and Singh, 2004), Damor *et al.* (2016), Panirahi and Duhan (2018) [6, 19, 3, 17].

Heritability estimates is an informative parameter to the breeders for selecting the genotypes for further use. Higher magnitude of heritability (Table-4.) suggests the major role of genotypic factor in the expression of the characters. In the present, investigation almost high heritability values were recorded ranging from 21.70% to 91.30% for all the characters under study.

High estimates of heritability (>75%) were recorded for fruit yield/plant (91.30), average fruit weight (86.80), number of fruit/plant (85.80), node number to first pistillate flower (84.90), node number to first staminate flowers (76.70), vine length (m) (76.50). whereas, moderate heritability (50-70%) was recorded for number of primary branches per plant (74.60), average fruit circumference (cm) (74.10), fruit length (cm) (68.30) and days to first pistillate flower anthesis (60.40). Days to first fruit harvest (34.90) and days to first staminate flower anthesis (21.70), which show low heritability (20-40%). The highest value of genetic advance (Table-4.) in per cent of mean (>20%) was shown by number of fruits per plant (37.16%), fruit yield/plant kg (36.78), node number to first pistillate flower (32.63), average fruit wt /fruit (Kg) (32.16), vine length (m) (27.85), node number to first staminate flowers (24.48) and fruit circumference (cm) (23.20). whereas, moderate genetic advance in per cent of mean (10-20%) for number of primary branches per plant (19.41), fruit length (cm) (17.17), days to first pistillate flower anthesis (10.31) while lowest genetic advance in per cent of mean (<10%) days of first fruit harvest (4.78) and days to first staminate flower anthesis (2.83). The above estimates gave an indication that substantial genetic improvement can be achieved in these characters. Kumar (2006), Kumar *et al.* (2007), Ram *et al.* (2007), Yadav *et al.* (2008), Vaidya *et al.* (2016) and Damor *et al.* (2016) [14, 15, 18, 23, 22, 3] suggested that high estimates of heritability coupled with high genetic advance in bottle gourd, indicating that most likely, heritability was due to additive gene effects and selection would be effective.

Table 2: Analysis of variance for 12 characters of the bottle gourd germplasm

S. No.	Traits	Source of variation	Mean squares		
			Replicate	Treatments	Error
		df	2	29	58
1	Days to first staminate flower anthesis		57.21**	11.53*	6.29
2	Days to first pistillate flower anthesis		56.14**	35.56**	6.39
3	Node number to first staminate flowers		0.25	5.18**	0.48
4	Node number to first pistillate flower		2.27	15.04**	0.84
5	Days of first fruit harvest		45.51*	29.28**	11.21
6	Fruit length (cm)		5.99	55.55**	7.45
7	Fruit Circumference (cm)		4.98	37.87**	3.95
8	Number of primary branches per plant		0.05	0.55**	0.06
9	Vine length (m)		0.42*	1.36**	0.13
10	Average fruit wt /fruit (Kg)		0.004	0.102**	0.005
11	Number of fruits /plants		0.15	6.11**	0.32
12	Fruit yield/plant kg		0.62*	6.07**	0.19

Table 3: Mean performance of 30 bottle gourd genotypes for 12 characters

S. No.	Genotypes	Days to first staminate flower anthesis	Days to first pistillate flower anthesis	Node number to first staminate flowers	Node number to first pistillate flower	Days of first fruit harvest	Fruit length (cm)	Fruit Circumference (cm)	Number of primary branches per plant	Vine length (m)	Average fruit wt /Fruit (Kg)	Number of fruits /plants	Fruit yield/plant kg
1	NDBG -21	41.67	45.00	9.90	15.08	58.33	44.25	26.94	3.67	3.73	1.20	8.33	9.97
2	NDBG -22	47.00	43.67	9.07	10.93	57.67	38.27	25.43	3.80	3.32	0.68	9.73	6.62
3	NDBG -23	45.33	48.33	9.02	13.13	57.00	34.75	29.13	3.63	3.60	1.11	7.72	8.59
4	NDBG -24	48.33	57.00	10.65	13.80	65.33	42.67	24.93	4.23	4.16	0.75	7.74	5.75
5	NDBG -25	46.00	47.67	10.02	11.25	61.67	34.27	26.67	4.10	3.88	0.84	7.97	6.70
6	NDBG -26	46.67	57.67	7.33	15.00	63.67	46.45	21.53	4.33	3.60	1.05	5.27	5.48
7	NDBG -27	43.67	44.33	10.37	12.64	55.00	45.00	34.50	4.30	3.38	1.33	5.58	7.40
8	NDBG -28	43.00	45.00	10.15	14.90	61.67	33.27	26.87	3.67	3.36	0.87	8.10	7.03
9	NDBG -29	43.00	47.67	11.17	15.07	61.33	46.07	24.77	4.47	3.71	1.08	6.63	7.13
10	NDBG -30	45.33	46.33	9.40	13.08	61.67	41.90	25.87	3.70	5.26	1.25	6.82	8.49
11	NDBG -31	43.33	48.67	8.30	16.31	62.00	41.40	25.67	3.40	4.32	1.26	5.98	7.55
12	NDBG -32	43.00	45.33	10.87	16.67	68.67	47.53	27.13	3.63	4.10	1.10	10.16	11.17
13	NDBG -33	47.33	51.33	10.20	9.43	65.00	39.47	28.00	3.80	4.77	1.19	6.23	7.41
14	NDBG -34	44.00	53.00	10.03	15.40	61.33	42.37	24.88	3.90	3.75	1.50	5.63	8.42
15	NDBG -60	45.00	46.33	8.97	13.50	64.67	35.13	14.57	3.97	4.22	0.98	8.37	8.18
16	NDBG -61	42.67	50.33	10.40	12.77	63.67	41.44	25.00	4.63	4.26	1.14	9.00	10.27
17	NDBG -62	45.33	49.33	7.61	11.77	61.00	36.10	23.99	3.23	4.00	0.95	7.68	7.30
18	NDBG -63	45.00	46.67	9.63	11.84	63.00	37.09	23.97	3.63	4.08	0.72	7.91	5.72
19	NDBG -64	46.33	51.67	8.63	12.76	62.33	41.81	25.78	3.20	4.08	1.20	5.09	6.10
20	NDBG -65	43.00	51.33	10.33	9.83	63.33	40.70	23.97	3.17	4.24	1.09	5.76	6.31
21	NDBG -66	45.00	45.67	6.40	11.34	65.33	31.50	25.66	3.20	3.70	0.85	7.50	6.36
22	NDBG -67	43.00	49.33	5.87	13.26	65.00	41.35	23.90	3.67	3.92	1.17	5.70	6.53
23	NDBG -68	44.00	44.67	9.08	11.62	56.67	33.99	21.33	3.37	3.92	1.06	5.57	5.88
24	NDBG -69	44.33	52.00	8.30	12.00	64.67	37.33	25.00	4.50	4.00	1.08	6.51	7.03
25	NDBG -70	43.33	47.00	8.02	12.86	65.00	37.37	32.33	3.53	4.28	1.19	6.16	7.33
26	NDBG -71	44.33	46.33	8.85	15.09	64.67	40.73	31.88	3.60	4.22	1.21	7.29	8.80
27	NDBG -72	42.67	48.67	10.57	12.46	64.33	36.33	25.77	3.27	4.68	0.95	9.67	9.16
28	NDBG -73	45.00	46.33	10.51	9.52	67.00	36.38	23.55	3.20	4.15	1.08	8.17	8.78
29	Pusa Naveen (C)	47.33	48.00	8.14	7.71	62.33	40.97	27.20	3.57	5.43	1.17	5.77	6.75
30	NDBG-104 (C)	50.33	48.00	9.13	8.78	62.00	45.35	24.77	3.27	6.61	1.12	5.95	6.66
	Mean	44.81	48.42	9.23	12.66	62.51	39.71	25.70	3.72	4.16	1.07	7.13	7.50
	C.V.	5.60	5.22	7.47	7.24	5.36	6.87	7.73	6.37	8.55	6.53	7.94	5.76
	S.E.	1.45	1.46	0.40	0.53	1.93	1.58	1.15	0.14	0.21	0.04	0.33	0.25
	C.D. 5%	4.10	4.13	1.13	1.50	5.47	4.46	3.25	0.39	0.58	0.11	0.93	0.71
	C.D. 1%	5.45	5.50	1.50	1.99	7.28	5.93	4.32	0.52	0.77	0.15	1.23	0.94
	Min	41.67	43.67	5.87	7.71	55.00	31.50	14.57	3.17	3.32	0.68	5.09	5.48
	Max	50.33	57.67	11.17	16.67	68.67	47.53	34.50	4.63	6.61	1.50	10.16	11.17

Table 4: Estimates of genetic variability and expected genetic advance as per cent of mean for the 12 characters in bottle gourd germplasm

Traits	Average Mean	Mean		GCV	PCV	Heritability	Genetic Advancement 5%	Genetic Advancement 1%	Genetic Advance as % of Mean 5%	Genetic Advance as % of Mean 1%
		Min.	Max.							
Days to first staminate flower anthesis	44.81	41.67	50.33	2.95	6.33	21.70	1.27	1.63	2.83	3.63
Days to first pistillate flower anthesis	48.42	43.67	57.67	6.44	8.29	60.40	4.99	6.40	10.31	13.21
Node number to first staminate flowers	9.23	5.87	11.17	13.57	15.49	76.70	2.26	2.90	24.48	31.37
Node number to first pistillate flower	12.66	7.71	16.67	17.19	18.65	84.90	4.13	5.29	32.63	41.82
Days of first fruit harvest	62.51	55	68.67	3.93	6.64	34.90	2.99	3.83	4.78	6.13
Fruit length (cm)	39.71	31.5	47.53	10.09	12.20	68.30	6.82	8.74	17.17	22.00
Fruit Circumference (cm)	25.7	14.57	34.5	13.08	15.20	74.10	5.96	7.64	23.20	29.74
Number of primary branches per plant	3.72	3.17	4.63	10.91	12.63	74.60	0.72	0.93	19.41	24.88
Vine length (m)	4.16	3.32	6.61	15.45	17.66	76.50	1.16	1.48	27.85	35.69
Average fruit wt /Fruit (Kg)	1.07	0.68	1.5	16.75	17.98	86.80	0.35	0.44	32.16	41.21
Number of fruits /plants	7.13	5.09	10.16	19.48	21.03	85.80	2.65	3.40	37.16	47.62
Fruit yield/plant kg	7.5	5.48	11.17	18.68	19.55	91.30	2.76	3.53	36.78	47.14

Conclusion

It is concluded that the PCV and GCV were high for number of fruits per plant followed by fruit yield per plant. This indicates possibility of obtaining higher selection response in respect of these two traits for yield improvement.

High heritability among with high genetic advance in per cent of mean of genetic advance were recorded for node number of first staminate to pistillate flower appearance, vine length,

average fruit weight, number of fruits per plant and fruits yield per plant these six characters are provide very high selection response indicating that most likely, heritability was due to additive gene effects.

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