International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(6): 2279-2282

Received: 18-08-2020
Accepted: 23-09-2020

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Estimation of genetic parameters for seed yield and its attributing traits in bottle gourd (*Lagenaria siceraria* (Mol. Standl.) germplasm

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DOI: https://doi.org/10.22271/chemi.2020.v8.i6ag.11112

Abstract
The present investigation was conducted to determine the genetic variability, heritability and genetic advance for the quantitative characters among the available germplasm of bottle gourd. Thirty six genotypes including two checks (Pusa Naveen and Narendra Rashmi) evaluated in randomized complete block design with three replications during summer 2019. Single row plot of 3 m length spaced 3 m apart with 50 cm plant to plant distance was maintained. Observations were recorded on 14 quantitative traits *viz*. days to first staminate flower and pistillate flower anthesis, node number to first staminate and pistillate flower appearance, days to first fruit harvest, green fruit length (cm), green fruit circumstances (cm), mature fruit length (cm), mature fruit circumstances (cm), mature fruit weight(kg), seed weight per fruit(g), number of seed per fruit(g), 100-seed weight(g), seed yield per plant(g). The analysis of variance for the design of experiment indicated highly significant differences among the genotypes for all the characters. Based on mean performance of seed yield and yield components, NDBG-517 (189.67), NDBG-19-4 (176.67), NDBG-63-1-1-1 (140), Pusa Santusti (138.48), NDBG-5-1-1 (133) were identified as most promising genotypes for yield and major component traits. High magnitudes of variability (GCV and PCV) were observed for seed yield per plant (41.70 % and 41.53%) followed by number of seed per fruit(37.02% and 36.67%), 100 seed weight(33.05% and 32.59%) and seed weight per fruit(30.84% and 28.67%). High heritability (broad sense) (>75%) along with high genetic advance in per cent of mean (>30%) were estimated for seed yield per plant (97.21% and 85.20%) followed by number of seed per fruit (98.15% and 74.85%), 100 seed weight(97.21% and 66.19%), seed weight per fruit(86.43% and 54.91%), mature fruit diameter(94.74% and 46.72%), fresh fruit girth(92.66% and 44.65%), node number to staminate (92.18% and 38.48%) and pistillate flower appearance(92.34% and 38.95%), mature fruit weight(78.00% and 31.43%), fresh fruit length (86.60% and 34.90%) and girth(92.66% and 44.65%), mature fruit length(94.01% and 37.98%) and diameter (94.74% and 46.72%).

Keywords: Bottle gourd, genetic variability, heritability, genetic advance and seed yield

Introduction
Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.) is one of the most valuable member of family cucurbitaceae having somatic chromosome number 2n=22. The center of origin for bottle gourd is believed to be in South Africa. The bottle gourd or white flowered gourd is commonly known as Lauki or Ghiya in India. In any crop improvement programme, the collection, maintenance and evaluation of germplasm are the crucial and primary steps. Better understanding of the nature and magnitude of genetic variability present in the breeding material is important for formulating a successful breeding programme.

Yield is a complex character governed by several other yield attributing traits which are generally quantitatively inherited and highly influenced by the environment. Thus, it is difficult to judge whether the observed variability is heritable or not. Therefore, the primary variability parameters like variance, phenotypic variance, genetic advance and heritability are useful in understanding the nature of inheritance of different traits in bottle gourd. The information on such aspects can be of great help in formulating an appropriate breeding strategy for genetic upgradation of this crop.

Material and Methods

The present investigation was conducted during *Zaid*, 2019-20 at 'Vegetable Farm' of Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar, (Kumarganj) Ayodhya (U.P.). Narendra Nagar is situated at 26.47^0N latitude and 82.12^0E longitude at an altitude of 113 metres above the mean sea level. The soil type of experimental site was sandy-loam. The experiment was laid out in completely Randomized Block Design with three replications on March 4th, 2019. Each genotype was planted in 3m x 3m plot size. The distance between rows and plants was kept at 3m and 50cm, respectively. Six plants were maintained in each plot. The recommended agronomic practices were followed to raise a good crop. Observations were recorded on six randomly selected plants from each replication on 14 quantitative traits such as days to first staminate flower and pistillate flower anthesis, node number to first staminate and pistillate flower appearance, days to first fruit harvest, green fruit length (cm), green fruit circumstances (cm), mature fruit length (cm), mature fruit circumstances (cm), mature fruit weight(kg), seed weight per fruit(g), number of seed per fruit(g), 100-seed weight(g), seed yield per plant(g). The assessment of existing variability in the materials was done by computing coefficient of variation at genotypic and phenotypic level by Burton and De Vane (1953) [1]. The heritability in broad sense by Hansen *et al.* (1956) and genetic advance in percent of mean by Johnson *et al.* (1955) [3] were calculated to understand the transmissibility of the characters.

Results and Discussion

The analysis of variance for different characters had been presented in Table-1. The mean sum of squares due to genotypes/treatments was highly significant for all the characters. In other words, the performances of the genotypes with respect to these characters were statistically different indicating the variability among the genotypes due to genetic constitution of materials as well environmental fluctuation for that particular character. These findings suggested that there is ample scope for selection in the available germplasm of bottle gourd as it had been also reported by Panigrahi and Duhan, (2018) [7].

The mean of thirty six genotypes including respective two checks for fourteen characters had been presented in Table -2. The wide range of variation in mean performance of genotypes were recorded for number of seed per fruit (175.67-796.33), day to first fruit harvest (52.33-67), seed yield per plant (46.67-226.11), day to staminate flower anthesis (41.67-51.67), day to pistillate flower anthesis (41.33-55.67), mature fruit weight (1.35-2.69), node number to staminate flower appearance (4.30-10.5), 100 seed weight (7.36-27.95), node number to pistillate flower anthesis (8.75-18).The comparison of mean performance of thirty six genotypes for fifteen traits using critical differences with checks revealed existence of very high level of variability. The yield performance of genotype NDBG-5 17 (189.76 g), NDBG19-4 (176.67), NDBG-63-1-1-1 (140), Pusa Santushti (138.48) and NDBG-5-1-1 (133) gave significantly higher seed yield per plant over the best checks (Narendra Rashmi). These genotypes also showed significantly higher mean performance for other characters. Kamal *et al.* (2012) [4] was also reported similar results in bottle gourd.

Mean, range and estimates of various genetic parameters of 14 different characters of the 36 genotypes of bottle gourd are presented in the Table 3. Wide range of variation was observed for most of the characters like seed yield per plant followed by number of seed per fruit, 100 seed weight and seed weight per fruit. While moderate variation were noted in case of mature fruit length (cm), mature fruit diameter, fresh fruit girth, fresh fruit length, mature fruit weight, node no to staminate flower appearance and node no to pistillate flower anthesis. Magnitude of coefficient of variability for remaining three traits namely days to staminate flower anthesis, day to pistillate flower and days to first fruit harvest were low. presence of such high variability for these parameters will form the basis for effective selection of superior lines in bottle gourd. Phenotypic and genotypic coefficient of variations helps to measure the range of variability in the characters and provide a measure to compare the variability present among various quantitative characters. In general, the phenotypic coefficients of variation were higher than the genotypic coefficients of variation for all the characters under study, indicated the considerable influence of environment on the expression of these characters Singh *et al.* (2008) [9] The maximum value of phenotypic coefficient of variation (PCV) was observed for seed yield per plant followed by number of seeds per fruit, 100 seed weight and seed weight per fruit. Moderate phenotypic coefficient of variability was exhibited by seed weight per fruit, mature fruit diameter, fresh fruit girth, in which node number to staminate and pistillate flower, mature fruit girth and diameter. Low phenotypic coefficients of variations were observed for day to staminate flower anthesis followed by day to pistillate flower anthesis. Therefore selection of the trait with high PCV and GCV may improve through selection on the basis of phenotypic performance. Similar result was also reported by and Singh and Kumar (2002) [8]. High genotypic coefficients of variabilities were observed for seed yield per plant, number of seed per fruit, 100 seed weight and seed weight per fruit. However lowest value of genotypic coefficient of variability was observed for day to staminate flower anthesis, day to pistillate flower, day to first fruit harvest. Pandit *et al.* (2009) [6] reported high phenotypic and genotypic coefficient of variability for seed yield per plant, number of seed per fruit, 100 seed weight. The results indicated that the characters with high GCV and PCV values had maximum chance of improvement through selection, 85 although difference between PCV and GCV, indicate the influence of environment in the expression of these traits.

With the help of GCV alone, it is not possible to determine the extent of variation that is heritable. Thus the estimates of heritability indicate the effectiveness with which selection can be expected to exploit the existing genetic variability. High estimates of heritability (>75%) were recorded for all the fourteen traits except day to staminate flower an thesis (55.92%) which showed moderate heritability (50-70%). The highest value of genetic advance in per cent of mean was shown by seed yield per plant (85.20.%), while days to staminate flower anthesis had lowest value (7.21%) for this parameter. The character showing very high estimate of genetic advance in percent of mean (>30%) were seed yield per plant (85.20%), number of seed per fruit (74.85%), 100 seed weight (66.19%), seed weight per fruit (g) (54.91%), mature fruit diameter (46.72%), fresh fruit girth (44.65%) node number to staminate flower appearance (38.48%), node number to pistillate flower anthesis (38.95%), fresh fruit length (34.90%), mature fruit length (37.98%) and mature fruit weight (31.43%). The moderate estimate for genetic advance resulted in case of day to first fruit harvest (15.21%), day to pistillate flower (12.97%), while the low estimate was observed only for day to staminate flower anthesis (7.21%).

Kumar and Pal (2007) [5] found high heritability 86 estimate for node number to first male and female flower, day to first fruit harvest. The lowest heritability was noted for day to staminate flower anthesis followed by mature fruit weight Yadav *et al.* (2008) [9] also reported high genetic advance for fruit length, day to first female and male flowering and yield per plant in support of above finding. Panigrahi and Duhan (2018) [7] also reported high genetic advance as percent of mean for diameter of fruit, length of fruit and weight of hundred seed these trait were under the strong influence of additive gene action.

High heritability (broad sense) (>75%) along with high genetic advance in per cent of mean (>30%) were estimated for seed yield per plant (97.21% and 85.20%) followed by number of seed per fruit (98.15% and 74.85%), 100 seed weight(97.21% and 66.19%), seed weight per fruit(86.43% and 54.91%), mature fruit diameter(94.74% and 46.72%), fresh fruit girth(92.66% and 44.65%), node number to staminate (92.18% and 38.48%) and pistillate flower appearance (92.34% and 38.95%), mature fruit weight (78.00% and 31.43%), fresh fruit length (86.60% and 34.90%) and girth(92.66% and 44.65%), mature fruit length(94.01% and 37.98%) and diameter (94.74% and 46.72%) which indicated that selection for these traits should be effective for improving economic seed yield of bottle gourd.

Table 1: Analysis of variance for fourteen quantitative characters in bottle gourd

S. No.	Characters	Source of variation		
		Replications	Treatments	Error
	d.f.	2	35	70
1.	Node no. to staminate flower appearance	0.129	237.225**	13.054
2.	Node no. to pistillate flower anthesis	4.166	697.317**	37.503
3.	Days to staminate flower anthesis	2.907	601.657**	250.426
4.	Day to pistillate flower	8.019	1,250.55**	169.981
5.	Days to first fruit harvest	34.389	2,522.00**	271.611
6.	Fresh fruit length	51.151	3,967.85**	389.401
7.	Fresh fruit girth	19.896	3,116.32**	160.357
8.	Mature fruit length	14.385	7,784.44**	323.796
9.	Mature fruit diameter	0.873	6,178.62**	224.688
10.	Mature fruit wt. (kg)	0.093	14.803**	2.545
11.	Seed wt./fruit (g)	245.685	37,097.07**	3,690.32
12.	No. of seed /fruit	2,314.46	2,419,975.66**	30,168.20
13.	100 seed wt. (g)	0.074	3,250.85**	61.536
14.	Seed yield /plant (g)	16.143	169,465.90**	921.783

*Significant at 5% level of probability, **Significant at 1% level of probability

Table 2: Mean performance of forty four genotypes for fourteen characters in bottle gourd

Sl. No.	Characters Genotypes	Node no. to staminate flower appearance	Node no. topistillate flower anthesis	Days to staminate flower anthesis	Day to pistillate flower	Days to first fruit harvest	Fresh fruit length	Fresh fruit girth	Mature fruit length	Mature fruit diameter	Mature fruit wt. (kg)	Seed wt./fruit (g)	No. of seed /fruit	100 seed wt. (g)	Seed yield /plant (g)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	NDBG-01-1	4.30	11.57	45.33	48.33	54.00	27.03	21.49	44.67	31.40	2.38	58.33	387.33	15.24	87.50
2.	NDBG-01	4.38	8.78	45.00	46.67	54.33	25.84	19.72	40.50	29.90	1.77	50.00	306.67	16.31	56.67
3.	NDBG-02	5.38	10.88	45.33	47.00	62.33	36.03	22.39	44.83	31.17	2.19	69.33	392.00	17.31	110.10
4.	NDBG-03	6.27	8.87	45.33	51.00	65.33	42.33	26.72	34.33	30.83	1.55	63.33	260.00	24.37	86.00
5.	NDBG-03-1	4.93	15.53	44.00	46.67	64.33	39.83	26.67	44.67	31.17	2.10	58.33	384.00	15.21	93.08
6.	Pusa Santusti	8.62	15.60	46.67	50.00	66.00	19.06	24.37	28.67	54.83	2.21	76.00	485.00	15.68	138.48
7.	Narendra Prabha	8.73	13.22	45.00	52.67	62.33	41.33	23.70	49.00	28.97	1.67	58.33	281.67	20.76	98.67
8.	NDBG-619-1	8.97	12.87	49.00	52.67	62.67	37.79	21.14	48.40	29.90	2.11	74.00	309.67	23.95	101.67
9.	Narendra Pooja	9.27	13.00	43.33	51.67	54.67	33.61	23.03	35.67	28.00	1.42	50.00	210.67	23.80	46.67
10.	Narendra Pooja-1	7.17	10.57	45.33	47.33	56.00	34.47	22.73	42.50	31.00	1.94	79.33	313.00	25.33	64.33
11.	Narendra Pooja Sel-1	9.83	11.80	42.67	43.33	61.67	41.86	27.59	50.00	29.77	1.91	49.33	204.33	24.17	60.00
12.	Punjob Komal	6.92	12.30	41.67	41.33	63.33	19.50	38.16	22.83	48.57	1.58	49.33	324.33	15.22	65.56
13.	Punjob Komal-2	6.23	10.77	45.33	43.67	62.33	20.97	44.61	22.50	55.83	2.69	49.33	272.00	18.15	59.67
14.	NDBG-49-2	7.70	16.23	42.67	47.67	62.67	21.16	35.52	30.00	53.57	2.28	96.67	355.00	27.32	117.67
15.	NDBG-44	7.55	12.08	51.33	55.67	65.67	34.66	21.50	47.67	27.00	2.15	72.33	295.00	24.59	96.67
16.	Narendra Jyoti	8.73	10.25	51.67	54.67	66.00	30.95	16.08	49.33	25.33	2.63	41.67	307.67	15.80	61.42
17.	NDBG-83-1	8.00	18.00	49.00	50.33	54.00	35.00	25.15	48.00	26.60	1.73	50.00	351.67	14.26	63.44
18.	NDBG-65-1	7.58	10.70	45.00	46.67	56.00	36.59	23.22	50.17	31.83	2.18	50.00	516.33	9.68	58.33
19.	NDBG-65-2	7.44	11.50	48.00	48.33	56.67	33.72	22.62	49.00	29.83	2.66	36.67	456.67	7.36	71.67
20.	NDBG-63-1-1	9.23	16.18	49.00	51.33	56.33	37.66	22.66	53.00	28.60	2.05	70.00	750.67	10.30	89.11
21.	NDBG-63-1-1-1	9.53	18.00	44.33	50.33	54.67	31.22	19.11	53.33	29.40	2.32	100.00	755.67	13.24	140.00
22.	Narendra Rashmi-1	8.37	12.38	45.00	48.00	55.33	31.78	20.77	54.50	31.67	2.54	55.00	517.33	13.18	69.67
23.	NDBG-132	8.16	16.40	44.00	46.00	65.33	36.11	27.33	45.33	30.50	1.65	48.33	276.67	17.48	58.00
24.	NDBG-132-Sel-1	6.32	8.75	44.67	47.00	65.33	32.64	19.16	55.33	26.33	1.35	41.67	175.67	27.95	81.22

25.	NDBG-83-1 Small	7.67	12.73	46.67	47.67	56.00	25.66	23.41	36.00	31.50	1.99	75.00	433.33	17.35	98.75
26.	NDBG-7	10.55	11.60	47.00	48.67	54.00	34.72	21.89	44.83	28.40	1.97	75.00	421.00	17.82	130.89
27.	NDBG-18	7.32	14.33	43.00	45.33	56.00	35.50	20.41	54.33	32.10	2.46	74.00	626.67	11.81	86.78
28.	NDBG-517	7.30	9.73	44.00	44.67	65.00	29.44	20.77	45.50	33.83	2.21	70.00	500.00	14.36	189.67
29.	NDBG-100	8.53	13.72	46.67	44.67	62.33	36.00	22.28	52.83	30.83	2.11	49.33	445.00	11.09	89.45
30.	NDBG-5-1-1	7.38	11.07	43.67	44.33	54.00	28.11	21.89	45.67	28.63	2.41	72.33	437.33	17.27	133.00
31.	NDBG-19-1	7.03	11.60	42.33	42.33	54.33	32.22	20.59	44.90	32.17	2.42	125.00	796.33	15.73	226.11
32.	NDBG-19-2	7.23	12.73	43.67	44.33	52.33	38.22	25.33	52.67	29.50	1.73	50.00	461.00	10.88	82.78
33.	NDBG-19-3	8.23	15.40	43.00	48.33	63.33	39.83	20.49	53.67	31.67	2.55	50.00	340.00	15.08	73.33
34.	NDBG-19-4	8.37	13.67	47.00	44.67	52.67	33.72	21.35	49.00	33.27	2.46	95.00	391.00	24.31	176.67
35.	Pusa Naveen (C)	5.53	17.03	47.00	49.67	63.67	36.50	23.83	40.33	29.43	1.41	57.67	540.67	10.67	87.42
36.	Narendra Rashmi (C)	9.50	15.32	45.67	52.67	67.00	34.22	22.05	49.07	30.90	2.04	60.00	574.33	8.80	127.34
Grand mean		7.62	12.92	45.51	47.94	59.67	32.92	23.88	44.81	32.62	2.08	63.91	412.66	16.99	96.60
S.E.m ±		0.25	0.42	1.09	0.90	1.14	1.36	0.87	1.24	1.03	0.11	4.19	11.99	0.54	2.10
C.D. at 5%		0.71	1.20	3.09	2.54	3.22	3.85	2.47	3.51	2.92	0.31	11.85	33.88	1.53	5.92
Range Lowest		4.30	8.75	41.67	41.33	52.33	19.06	16.08	22.50	25.33	1.35	36.67	175.67	7.36	46.67
Range Highest		10.55	18.00	51.67	55.67	67.00	42.33	44.61	55.33	55.83	2.69	125.00	796.33	27.95	226.11

Table 3: Estimate of range, grand mean, phenotypic (PCV), genotypic (GCV) and environmental (ECV) coefficient of variation, heritability in broad sense, genetic advance (Ga) and genetic advance in per cent of mean for fourteen character in bottle gourd

Sl. No.	Characters	Range		Grand mean	PCV (%)	GCV (%)	Heritability (h^2_{bs}) in broad sense (%)	Genetic advance	Genetic advance in per cent of mean
		Lowest	Highest						
1.	Node no to staminate flower appearance	4.30	10.55	7.62	20.27	19.46	92.18	2.93	38.48
2.	Node no to pistillate flower anthesis	8.75	18.00	12.92	20.47	19.67	92.34	5.03	38.95
3.	Days to staminate flower anthesis	41.67	51.67	45.51	6.26	4.68	55.92	3.28	7.21
4.	Day to pistillate flower	41.33	55.67	47.94	7.67	6.95	82.05	6.22	12.97
5.	Days to first fruit harvest	52.33	67.00	59.67	8.65	7.99	85.42	9.08	15.21
6.	Fresh fruit length(cm)	19.06	42.33	32.92	19.57	18.21	86.60	11.49	34.90
7.	Fresh fruit girth(cm)	16.08	44.61	23.88	23.39	22.52	92.66	10.66	44.65
8.	Mature fruit length(cm)	22.50	55.33	44.81	19.61	19.02	94.01	17.02	37.98
9.	Mature fruit diameter(cm)	25.33	55.83	32.62	23.94	23.30	94.74	15.24	46.72
10.	Mature fruit wt. (kg)	1.35	2.69	2.08	19.56	17.27	78.00	0.65	31.43
11.	Seed wt./fruit (g)	36.67	125.00	63.91	30.84	28.67	86.43	35.09	54.91
12.	No. of seed /fruit	175.67	796.33	412.66	37.02	36.67	98.15	308.87	74.85
13.	100 seed wt. (g)	7.36	27.95	16.99	33.05	32.59	97.21	11.25	66.19
14.	Seed yield /plant (g)	46.67	226.11	96.60	41.70	41.53	99.19	82.31	85.20

Conclusion

There exist significant differences among the genotypes for all the characters. Based on mean performance of seed yield and yield components, NDBG-517 (189.67), NDBG-19-4 (176.67), NDBG-63-1-1-1 (140), Pusa Santusti (138.48), NDBG-5-1-1 (133) were identified as most promising genotypes for seed yield and major component traits. High heritability (broad sense) (>75%) along with high genetic advance in per cent of mean (>30%) was estimated for seed yield per plant (97.21% and 85.20%) which indicated that selection for these traits should be effective for improving economic seed yield of bottle gourd.

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