Original Research Article

Assessment of Bottle Gourd [*Lagenaria siceraria* (Mol.) Standl.] Genotypes for Quality Traits.

Abstract

An experiment was conducted at the Vegetable Research Farm, Maharajpur, Department of Horticulture, JNKVV, Jabalpur in *kharif* season of 2022 and 2023. The current study evaluated the performance of 23 bottle gourd genotypes, including 6 parental lines, their 15 diallel crosses, and 2 checks, focusing on their quality traits. Over two years of pooled data, genotype, JBG-4×JBG-5 was found to possess maximum TSS (3.93 °Brix), followed by JBG-2×JBG-4 (3.77 °Brix). JBG-4×JBG-5 was found to have maximum ascorbic acid content (14.48 mg 100^{-1} g) followed by JBG-4 (14.01 mg 100^{-1} g). Rind thickness was found maximum in JBG-2×JBG-4 (3.36 mm) followed by JBG-2×JBG-3 (3.28 mm). This study found a substantial association between the total soluble solids (TSS) and ascorbic acid content with the yield of bottle gourd genotypes. Among the genotypes, JBG-4×JBG-5 demonstrated the highest yield per plant, along with the highest total soluble solids (TSS) and ascorbic acid content. Regarding heterosis, JBG-4×JBG-5 has found the highest heterosis for total soluble solids and ascorbic acid content. JBG-4 and JBG-2 have been found to be the best general combiners for TSS, ascorbic acid content, and rind thickness. JBG-4×JBG-5 has found the best specific combiner for TSS and ascorbic acid content.

1. Introduction

The Bottle gourd [*Lagenaria siceraria* (Molina) Standl.; 2n = 22] is a cultivated annual monoecious plant with a high yield potential and adaptability to different weather conditions. This cucurbitaceous fruit crop is widely farmed in tropical regions like India, Sri Lanka, Indonesia, Malaysia, China, Turkey, Africa, Europe, and South America (Yogendra *et al*; 2021).

In India, bottle gourd is grown on 0.157 million hectares, producing 2.683 million tons with a productivity of 17.09 tonnes per ha (Anonymous, 2018).

Although germplasm has been grown since ancient times, its appraisal and application have only lately received attention. Bottle gourd, the first public sector F_1 hybrid, is unappreciated because of a lack of consumer awareness about its nutritional advantages as compared to other cucurbits. An experiment was carried out to evaluate bottle gourd genotypes by the their crosses, in order to select appropriate cultivars for various qualitative traits. The purpose of this study is to examine the quality traits of bottle gourd. Germplasm is a valuable resource for crop development programs, establishing the foundation for future improvements.

TSS (Total Soluble Solids) is an important trait for evaluating the quality of bottle gourd (Lagenaria siceraria). TSS is frequently used to evaluate sugar concentration, which corresponds directly with the sweetness and overall flavor of the fruit. TSS may vary significantly with bottle-gourd genotypes, which is essential for breeders and farmers aiming to maximize yield and quality. Ascorbic acid (vitamin C) content is another crucial quality parameter for bottle gourd (*Lagenaria siceraria*). It varies significantly across different genotypes and can be influenced by genetic and environmental factors. Rind thickness in bottle gourd (*Lagenaria siceraria*) is an important factor influencing the fruit's mechanical strength, shelf life, and marketability. This property varies significantly among genotypes, making it a focus of breeding strategies (Patel *et al*; 2019).

2. Materials and methods

The experiment was conducted during the kharif season of 2022 and 2023 at the Vegetable Research farm, Maharajpur, Department of Horticulture, JNKVV, Jabalpur. The evaluation was done in a randomized block design (RBD) with three replications. 6 parental lines (JBG-1, JBG-2, JBG-3, JBG-4, JBG-5, and Pusa Naveen), 15 diallel crosses (JBG-1×JBG-2, JBG-1×JBG-3, JBG-1×JBG-4, JBG-1×JBG-5, JBG-1×Pusa Naveen, JBG-2×JBG-3, JBG-2×JBG-4, JBG-2×JBG-5, JBG-2×Pusa Naveen JBG-3×JBG-4, JBG-3×JBG-5, JBG-3×Pusa Naveen, JBG-4×JBG-5, JBG-4×Pusa Naveen and JBG-5×Pusa Naveen) and 2 checks (Samrat-1and Anokhi) of bottle gourd were evaluated for quality traits. Sowing was done in July in both seasons of 2022 & 2023, at a spacing of 3 m row to row and 1 m plant to plant in a plot of 6 m x 3 m and accommodating 12 plants per plot. The observations were recorded on five randomly selected plants with respect to characters viz. TSS Percent, Ascorbic acid content of fruits (mg/100gm), Rind thickness (mm). Total soluble solids (TSS) of the fresh fruit juice from each genotype were measured with a portable hand refractometer. The TSS values were recorded as ^{0}°Brix for the juice samples. Rind thickness measurements of the fruits from each plot were taken using a vernier caliper. In each plot, we have selected five fruits, which were cut in three parts to measure the thickness of the outer rind. Ascorbic acid content in the fruits was measured using the analytical method detailed by Rangana (1977).

$$\text{Ascorbic acid(mg/100g)} = \frac{\text{Titre} \times \text{Dye factor} \times \text{Volume made up} \times 100}{\text{Aliquot of extract taken} \times \text{Weight of smaple for estimation}}$$

According to the approach proposed by Hayes et al. (1955), heterosis was represented as a percentage increase or reduction in the mean values of F_1's over better parent (heterobeltiosis) and over mid-parent (relative heterosis).

$$\textbf{Relative heterosis: } \frac{F1-MP}{MP} \times 100$$

Where,

F_1: Mean of hybrids

MP: Mean of mid-parents

$$\textbf{Heterobeltiosis} = \frac{F1-BP}{BP} \times 100$$

Where,

F_1: Mean of hybrids

BP: Mean of better parents

3. Results and discussion

3.1 Performance of bottle gourd genotypes of different quality traits

Among the quality traits, the total soluble solids (TSS) content of the fruit pulp varied significantly, and the genotypes mean ranged from 1.77 to 3.93 °Brix with an overall pooled mean value of two years; this might be due to the hydrolysis of complex carbohydrates present in fruit pulp (Yogendra *et al*; 2021) or the variation may be due to the inherent character and genetic makeup of the genotypes and environmental condition (krutika *et a*l; 2023). the highest TSS content was recorded in JBG-4×JBG-5 (3.93 °Brix) followed by JBG-2×JBG-4(3.77 °Brix). The lowest TSS content was recorded in JBG-4×Pusa Naveen (1.77 °Brix). This study discovered a significant relationship between total soluble solids (TSS) and the yield of bottle gourd genotypes. Genotype JBG-4×JBG-5 was found the highest yield per plant, as well as the highest TSS. The results are similar to those confirmed by Rambabu *et al*. (2017) and Navdeep *et al*. (2020).

The two years average mean for ascorbic acid content of the pulp ranged from 8.51 to 14.04 mg 100^{-1} g. This variation might be due to inherent traits of genotypes and enzymatic and non-enzymatic reactions (Yogendra *et al*; 2021) or the variation may be due to the inherent character and genetic makeup of the genotypes and environmental condition (krutika *et al*; 2023). the highest ascorbic acid content was recorded in JBG4×JBG5 (14.48 mg 100^{-1} g) followed by JBG-4(14.01 100-1 g). The lowest ascorbic acid content was recorded in JBG-2×JBG-5 (8.79 mg 100^{-1} g). This study discovered a significant relationship between ascorbic acid concentration and yield of bottle gourd genotypes. Genotype JBG-4×JBG-5 had the highest yield per plant, as well as the highest ascorbic acid content. The results are similar to those confirmed by Rambabu *et al*. (2017) and Iqbal *et al*. (2019).

The corresponding value was obtained during the pooled average of the two years. The highest rind thickness was observed in JBG2×JBG4 (3.36 mm) followed by JBG2×JBG3 (3.28 mm) and the lowest in JBG-4 (1.99 mm). Significant differences in the rind thickness might be due to the genetic composition of the genotypes. These variations in rind thickness among genotypes indicate the possibility of selection among genotypes for desired rind thickness. The inherent traits of cultivars and rind thickness increase with an increase in the size of the fruit. The study found that the genotypes JBG-2×JBG-4, followed by JBG-2×JBG-3, exhibited the highest rind thickness. These genotypes demonstrated superior shelf life and marketability compared to the other genotypes. The results are similar to those obtained by Kandasamy et al. (2019), Pandiyan et al. (2019), and Navdeep et al. (2020) in bottle gourd. Harika et al. (2012) reported that differences in rind thickness could be attributed.

3.2 Heterosis of bottle gourd genotypes of different quality traits

The range and the magnitude of pooled data of heterosis over mid-parent and better parent for qualitative traits is depicted in Tables 2, 3 and 4. In the present study, maximum positive and significant heterosis over the mid parent was observed in the cross JBG-4×JBG-5 (27.16 %) followed by JBG-3×JBG-4 (25.86 %). Maximum positive and significant heterosis over the better parent was observed in the cross JBG-3×JBG-4 (24.11%) followed by JBG-4×JBG-5 (23.43%) for TSS. Maximum positive and significant heterosis over the mid parent was observed in the cross JBG-4×JBG-5 (13.08%) and maximum positive and heterosis over the better parent was observed in the cross JBG-4×JBG-5 (3.45%) for ascorbic acid content. Maximum positive heterosis over the mid-parent was observed in the cross JBG-3×JBG-4 (54.42 %) followed by JBG-1×JBG-3 (46.56 %). Maximum positive and significant heterosis over the better parent was observed in the cross JBG-3×JBG-4 (54.17%) followed by JBG-1×JBG-4 (43.50%) for rind thickness. The positive and significant heterosis for this character was also studied by Sit and Sirohi (2002) and Rambabu et al. (2021).

Table: 1 Performance of bottle gourd genotypes of different quality traits

Genotypes	TSS (%)			Ascorbic acid content			15. Rind thickness (Tenderness)		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
JBG-1	3.48	3.24	3.36	11.10	14.12	12.61	1.91	2.13	2.02
JBG-2	3.81	3.60	3.71	11.93	12.67	12.30	2.68	2.82	2.75
JBG-3	3.15	3.43	3.29	10.98	11.99	11.49	2.21	2.33	2.27
JBG-4	2.78	3.05	2.92	13.66	14.37	14.01	1.73	2.25	1.99
JBG-5	3.29	3.08	3.19	11.23	12.00	11.61	2.49	2.54	2.51
Pusa Naveen	2.93	2.69	2.81	13.60	12.92	13.26	2.42	2.45	2.43
JBG-1×JBG-2	2.75	2.97	2.86	8.51	10.52	9.52	2.88	2.35	2.62
JBG-1×JBG-3	2.71	2.81	2.76	10.61	11.01	10.81	2.97	3.29	3.13
JBG-1×JBG-4	3.04	3.20	3.12	12.79	12.28	12.53	2.84	2.90	2.87
JBG-1×JBG-5	2.19	2.24	2.22	10.85	11.44	11.14	1.97	2.26	2.11
JBG-1×Pusa Naveen	2.67	2.83	2.75	9.65	11.08	10.36	2.40	2.94	2.67
JBG-2×JBG-3	2.88	2.56	2.72	9.47	9.28	9.38	3.40	3.16	3.28
JBG-2×JBG-4	3.95	3.60	3.77	14.04	13.40	13.72	3.39	3.34	3.36
JBG-2×JBG-5	2.67	2.45	2.56	8.73	8.84	8.79	2.84	3.20	3.02
JBG-2×Pusa Naveen	2.63	2.91	2.77	8.89	9.38	9.14	2.08	2.59	2.33
JBG-3×JBG-4	3.85	3.60	3.72	11.58	13.57	12.57	2.98	3.19	3.08
JBG-3×JBG-5	2.01	2.17	2.09	9.34	9.55	9.45	2.12	2.45	2.28
JBG-3×Pusa Naveen	3.56	3.34	3.45	12.18	11.85	12.02	2.89	2.95	2.92
JBG-4×JBG-5	4.07	3.80	3.93	13.26	15.71	14.48	2.41	2.71	2.56
JBG-4×Pusa Naveen	1.73	1.82	1.77	10.41	11.24	10.83	2.37	2.43	2.40
JBG-5×Pusa Naveen	2.55	2.76	2.66	11.53	12.03	11.78	2.66	2.69	2.67
Samrat-1	3.00	2.77	2.88	12.26	14.31	13.28	2.07	2.12	2.09
Anokhi	2.21	2.31	2.26	11.42	12.17	11.80	1.92	2.31	2.11
Mean	2.95	2.92	2.94	11.22	11.99	11.60	2.51	2.67	2.59
S. E.	0.08	0.06	0.07	0.37	0.35	0.33	0.10	0.06	0.07
C.D.	0.23	0.18	0.19	1.06	1.00	0.93	0.28	0.16	0.21
C.V. @ 5%	4.66	3.72	3.85	5.73	5.08	4.87	6.74	3.74	4.90

Table 2: Heterosis of TSS in bottle gourd

F_1	TSS (%)					
	2022-23		2023-24		Pooled	
	MP	BP	MP	BP	MP	BP
JBG-1×JBG-2	-19.18 **	-27.80 **	-10.10 **	-17.59 **	-14.71 **	-22.84 **
JBG-1×JBG-3	-11.71 **	-13.77 **	-12.66 **	-18.09 **	-12.20 **	-16.02 **
JBG-1×JBG-4	5.19	1.33	5.73 *	4.8	5.46	4
JBG-1×JBG-5	-30.30 **	-33.40 **	-26.32 **	-27.27 **	-28.34 **	-30.44 **
JBG-1×Pusa Naveen	-9.79 **	-10.89 **	-0.59	-5.78	-5.28	-8.33 *
JBG-2×JBG-3	-19.40 **	-28.00 **	-31.06 **	-36.00 **	-25.34 **	-32.00 **
JBG-2×JBG-4	16.42 **	-1.33	2.08	-10.00 **	9.11 **	-5.67 *
JBG-2×JBG-5	-26.69 **	-33.17 **	-30.70 **	-38.67 **	-28.66 **	-35.92 **
JBG-2×Pusa Naveen	-23.97 **	-34.17 **	-13.06 **	-27.33 **	-18.61 **	-30.75 **
JBG-3×JBG-4	33.10 **	28.22 **	18.94 **	17.90 **	25.86 **	24.11 **
JBG-3×JBG-5	-36.02 **	-38.87 **	-28.51 **	-29.44 **	-32.33 **	-34.31 **
JBG-3×Pusa Naveen	20.13 **	18.67 **	17.47 **	11.33 **	18.83 **	15.00 **
JBG-4×JBG-5	29.24 **	23.48 **	25.00 **	23.38 **	27.16 **	23.43 **
JBG-4×Pusa Naveen	-41.73 **	-42.44 **	-35.99 **	-39.33 **	-38.92 **	-40.89 **
JBG-5×Pusa Naveen	-13.84 **	-14.89 **	-2.93	-8.00 *	-8.50 **	-11.44 **

Table 3: Heterosis of Ascorbic Acid content in bottle gourd

F_1	Ascorbic Acid content					
	2022-23		2023-24		Pooled	
	MP	BP	MP	BP	MP	BP
JBG-1×JBG-2	-25.79 **	-28.68 **	-21.06 **	-24.81 **	-24.79 **	-26.82 **
JBG-1×JBG-3	-3.49	-3.58	-15.26 **	-21.33 **	-11.72 **	-16.85 **
JBG-1×JBG-4	3.72	-6.37	-13.43 **	-14.54 **	-7.22 *	-10.58 **
JBG-1×JBG-5	-2.4	-3.38	-12.04 **	-18.31 **	-9.47 **	-14.28 **
JBG-1×Pusa Naveen	-21.57 **	-29.07 **	-17.73 **	-20.90 **	-21.08 **	-21.86 **
JBG-2×JBG-3	-17.55 **	-21.06 **	-25.77 **	-28.64 **	-20.14 **	-21.83 **
JBG-2×JBG-4	9.42 *	2.78	-2.06	-6.73	5.47	-2.12
JBG-2×JBG-5	-24.83 **	-27.25 **	-29.26 **	-31.97 **	-25.59 **	-26.78 **
JBG-2×Pusa Naveen	-30.49 **	-34.58 **	-27.62 **	-27.85 **	-27.67 **	-31.11 **
JBG-3×JBG-4	-6.1	-15.23 **	2.89	-5.59	0.52	-10.30 **
JBG-3×JBG-5	-15.96 **	-16.81 **	-20.40 **	-20.41 **	-16.46 **	-18.68 **
JBG-3×Pusa Naveen	-0.95	-10.42 *	-4.87	-8.26 *	-0.92	-9.37 *
JBG-4×JBG-5	5.1	-5.31	20.83 **	12.21 **	13.08 **	3.45
JBG-4×Pusa Naveen	-24.59 **	-25.67 **	-16.47 **	-19.69 **	-20.58 **	-22.67 **
JBG-5×Pusa Naveen	-6.23	-15.20 **	-3.42	-6.86	-6.72 *	-11.16 **

Table 4: Heterosis for rind thickness in bottle gourd

F_1	Rind thickness (mm)					
	2022-23		2023-24		Pooled	
	MP	BP	MP	BP	MP	BP
JBG-1×JBG-2	23.08 **	7.46	-2.35	-16.55 **	10.11 *	-4.85
JBG-1×JBG-3	40.82 **	34.04 **	51.93 **	41.26 **	46.56 **	37.94 **
JBG-1×JBG-4	52.50 **	42.33 **	36.36 **	28.70 **	43.74 **	43.50 **
JBG-1×JBG-5	-12.40 *	-21.02 **	-0.44	-11.02 **	-6.35	-15.92 **
JBG-1×Pusa Naveen	8.6	-0.83	32.23 **	20.16 **	20.36 **	9.58 *
JBG-2×JBG-3	30.31 **	13.22 **	18.65 **	5.33	24.68 **	9.44 *
JBG-2×JBG-4	43.24 **	13.00 **	27.16 **	11.33 **	34.71 **	12.11 **
JBG-2×JBG-5	3.58	-5.22	15.52 **	6.67 *	9.67 **	0.78
JBG-2×Pusa Naveen	-23.37 **	-30.78 **	-5.02	-13.78 **	-14.16 **	-22.22 **
JBG-3×JBG-4	59.46 **	48.83 **	49.84 **	41.42 **	54.42 **	54.17 **
JBG-3×JBG-5	-5.42	-14.73 *	7.78 *	-3.67	1.18	-9.15 *
JBG-3×Pusa Naveen	30.77 **	19.42 **	32.53 **	20.44 **	31.48 **	19.70 **
JBG-4×JBG-5	7.35	-3.21	19.53 **	6.82 *	13.59 **	1.99
JBG-4×Pusa Naveen	7.09	-2.2	9.45 **	-0.54	8.19	-1.5
JBG-5×Pusa Naveen	20.21 **	9.78	-1.35	-10.44 **	-1.78	-11.00 **

3.3 Combining ability of bottle gourd genotypes of different quality traits

The range and the magnitude of pooled data of Combining ability for qualitative traits is depicted in Table 5. In the present study, the maximum positive and significant general combing ability was observed in the parent JBG-4 (0.168) followed by JBG-2 (0.161) for TSS. Maximum positive and significant general combing ability was observed in the JBG-4 (1.446) for ascorbic acid content. Maximum positive and significant general combing ability was observed in the JBG-2 (0.210) for rind thickness. Maximum positive specific combining ability was observed in the cross JBG-4×JBG-5 (0.91) followed by JBG-3×Pusa Naveen (0.64) for TSS. Maximum positive specific combining ability was observed in the cross JBG-4×JBG-5 (1.74) followed by JBG-2×JBG-4 (1.44) for ascorbic acid content. Maximum positive specific combining ability was observed in the cross JBG-2×JBG-4 (0.54) followed by JBG-1×JBG-3 (0.52) for rind thickness. This varying magnitude of combing ability effects may be due to environmental effects and genotypes, respectively. Janaranjani et al. (2016) and Sriom and Yadav (2021) also reported similar results.

Table 5: Combining ability of quality parameters in bottle gourd

Genotypes	TSS (%)			Ascorbic Acid content			Rind thickness (mm)		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
General combing ability									
JBG-1	-0.071*	-0.02	-0.048*	-0.439*	0.19	-0.13	-0.124*	-0.124*	-0.125*
JBG-2	0.201*	0.122*	0.161*	-0.576*	-0.790*	-0.684*	0.258*	0.162*	0.210*
JBG-3	0.05	0.077*	0.064*	-0.371*	-0.480*	-0.424*	0.113*	0.087*	0.100*
JBG-4	0.160*	0.177*	0.168*	1.409*	1.482*	1.446*	-0.05	0.01	-0.02
JBG-5	-0.102*	-0.141*	-0.122*	-0.24	-0.19	-0.22	-0.113*	-0.075*	-0.094*
Pusa Naveen	-0.238*	-0.211*	-0.224*	0.22	-0.21	0.01	-0.081*	-0.062*	-0.071*
Specific combining ability									
JBG-1×JBG-2	-0.36	-0.09	-0.23	-1.64	-0.74	-1.19	0.19	-0.4	-0.1
JBG-1×JBG-3	-0.25	-0.21	-0.23	0.26	-0.56	-0.15	0.42	0.61	0.52
JBG-1×JBG-4	-0.04	0.09	0.03	0.66	-1.26	-0.3	0.47	0.3	0.38
JBG-1×JBG-5	-0.62	-0.55	-0.59	0.37	-0.43	-0.03	-0.35	-0.25	-0.3
JBG-1×Pusa Naveen	0	0.1	0.05	-1.29	-0.77	-1.03	0.05	0.41	0.23
JBG-2×JBG-3	-0.36	-0.6	-0.48	-0.74	-1.32	-1.03	0.47	0.2	0.34
JBG-2×JBG-4	0.6	0.34	0.47	2.05	0.84	1.44	0.63	0.45	0.54
JBG-2×JBG-5	-0.41	-0.49	-0.45	-1.61	-2.05	-1.83	0.14	0.4	0.27
JBG-2×Pusa Naveen	-0.32	0.04	-0.14	-1.91	-1.49	-1.7	-0.66	-0.23	-0.44
JBG-3×JBG-4	0.65	0.39	0.52	-0.62	0.7	0.04	0.36	0.38	0.37
JBG-3×JBG-5	-0.92	-0.72	-0.82	-1.2	-1.65	-1.43	-0.43	-0.28	-0.36
JBG-3×Pusa Naveen	0.76	0.51	0.64	1.18	0.67	0.92	0.3	0.21	0.26
JBG-4×JBG-5	1.02	0.81	0.91	0.93	2.55	1.74	0.02	0.06	0.05
JBG-4×Pusa Naveen	-1.18	-1.11	-1.14	-2.38	-1.9	-2.14	-0.05	-0.23	-0.14
JBG-5×Pusa Naveen	-0.09	0.15	0.03	0.4	0.56	0.48	0.3	0.11	0.2

4. Conclusion

The investigation indicated that JBG-4×JBG-5 was the best bottle gourd genotype for TSS and ascorbic acid concentration in fruits, whereas JBG-2×JBG-4 had the thickest rind among the genotypes. Regarding heterosis, JBG-4×JBG-5 has found the highest heterosis for total soluble solids and ascorbic acid content. JBG-4 and JBG-2 are the best general combiners for TSS, ascorbic acid content and rind thickness. JBG-4×JBG-5 has found the best specific combiner for

TSS and ascorbic acid content. After repeated experiments, the genotypes JBG-4×JBG-5 and JBG-2×JBG-4 may be used in farmer levels for TSS, ascorbic acid content, and rind thickness.

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