Original Research Article

Assessment of physiological traits of bottle gourd (*Lagenaria siceraria* (Mol) Standl) genotypes

Abstract

A study was carried out at the Vegetable Research Farm, Maharajpur, Department of Horticulture, JNKVV, Jabalpur. In this study, 23 genotypes of bottle gourds (6 parental lines, 15 diallel crosses, and 2 checks) were assessed for performance with an emphasis on physiological characteristics. The maximum leaf area index (11.17) and leaf area duration (241.26) was obtained for the genotype JBG-2 at 75 DAS and 60-75 DAS respectively. However, the maximum specific leaf area was recorded In Samrat-1 (2189.66). At 60 DAS, the highest specific leaf weight (0.90) of JBG-4×Pusa Naveen (2189.66) was recorded. The maximum chlorophyll content index was reported at 60 DAS for JBG-4×JBG-5 (53.88). At 60 DAS, JBG-2×Pusa Naveen (10.16) and JBG-3×Pusa Naveen (65.31%) had the highest energy interception and light transmission ratios, respectively. It is easier to choose genotypes with the best physiological attributes for increased growth and yield when one is aware of the relationships between these traits. For example, genotypes with high levels of LAI and LAD are probably more capable of photosynthetic processes, which improves overall performance. Likewise, characteristics such as increased CCI and SLW could indicate outstanding resilience and photosynthetic health, all of which are essential for crop improvement initiatives.

Introduction:

In India Bottle gourd (*Lagenaria siceraria* (Mol) Standl) is a major vegetable crop, during both the rainy and summer seasons. It belongs to the Cucurbitaceae family and has chromosome number 2n = 22. It is a highly cross-pollinated crop due to its monoecious and andromonoecious nature (Swiander *et al*., 1999). This plant is diploid, monoecious, climbs or prostrates, has solitary blooms, and is cross-pollinated (Sahu, 2016).

Bottleguard fruit is a nutritious addition to the diet. The fruit makes a delicious supplement to the human diet, and 100 g of fruits contain nearly 96 g of water, 0.2 g of protein, 0.1 g of fat, 2.5 g of carbohydrate, 0.6 g of fiber, 0.5 g of minerals, 20 mg of calcium, 10 mg of phosphorus, 0.7 mg of iron, 0.3 mg of thiamine, 0.01 mg of riboflavin, 0.2 mg of niacin, and 1.2 cal of energy. The seeds are good sources of lipids and proteins, containing 45% oil and 35% protein (Gaonkar *et al.*, 2023; Ogunbusola, 2018). According to humans, bottle gourd has several health advantages, including anti-cancer, cardio-protective, diuretic, aphrodisiac, antidote to poisons and scorpion stings, alternative purgative, and cooling properties (Badmanaban and Patel, 2010). Around the world, people cultivate bottle gourd as a substantial and advantageous crop for vegetable production. Previously, the assessment of its genotype was not considered crucial for its breeding status as an important vegetable crop due to the fact that crops are susceptible to environmental factors, which can impact leaf area, yield, and growth (Chartzoulakis, 1994). Therefore, we studied physiological parameters such as leaf area and leaf area index, which are crucial in research on plant development, light interception, greenness duration, and specific growth responses. This has a significant impact on assimilation, fruit quality, fruit self-life, and nutrient fortification.

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Materials and methods

The experiment was conducted at the Vegetable Research Centre, Maharajpur, Department of Horticulture, JNKVV, Jabalpur. For the present investigation, the experimental materials consisted of 23 genotypes. The present study used 23 genotypes, including 15 crosses (Dialel crosses), 6 parental lines, and 2 checks (Table 1) laid out the experiment in a randomized block design with three replications. Each genotype was sown in each block at a row-to-row spacing of 3 m and 1 m plant-to-plant in a 6 m by 3 m plot, accommodating 12 plants per plot. The following physiological traits characteristics *viz.*, leaf area index, leaf area duration, specific leaf area, specific leaf weight, chlorophyll content index (SPAD value), light transmission ratio, and energy interference had been taken to understand the physiological activities in the genotypes.

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Table 1: List of Bottle gourd g**enotypes used in the physiological traits investigations**

parents	Crosses	
1. JBG-1	1. JBG1×JBG2	10. JBG3×JBG4
2. JBG-2	2. JBG1×JBG3	11. JBG3×JBG5
3. JBG-3	3. JBG1×JBG4	12. JBG3×Pusa Naveen
4. JBG-4	4. JBG1×JBG5	13. JBG4×JBG5
5. JBG-5	5. JBG1×Pusa Naveen	14. JBG4×Pusa Naveen
6. Pusa Naveen	6. JBG2×JBG3	15. JBG5×Pusa Naveen
Checks	7. JBG2×JBG4	
1. Samrat-1 (hybrid)	8. JBG2×JBG5	
2. Anokhi (hybrid)	9. JBG2×Pusa Naveen	

Result and discussion

Leaf area index

Among the genotypes, the maximum LAI was recorded in genotype JBG-2 (11.17), which was statistically on par with JBG-4×JBG-5 (9.58) at 75 DAS and the minimum LAI was recorded in JBG-4×Pusa Naveen (5.18) at 75 DAS. The leaf area index was found to be increasing in bottle gourd and it was highest during the reproductive stages. Higher LAI values are often associated with increased canopy development, which provides more surface area for photosynthesis. This can lead to larger biomass accumulation and possibly more effective fruit production in cucumber (Marcelis *et al*: 1998).

Leaf area duration

Among the genotypes maximum LAD was recorded in JBG-2 (241.26 M^2. Day) followed by JBG-4×JBG-5 (210.84 M^2. Day) and minimum LAD was recorded by the genotype JBG-4×Pusa Naveen (108.38 M^2. Day) at 60-75 DAS. Because of more LAD, the dry matter production is higher in JBG-2 and it may be attributed to more photosynthesis in the genotype. Marcelis *et al*. (1998) found that optimum light interception and consequent fruit output required continuous and effective leaf area (high LAD). They observed that maintaining leaf area throughout the growing season promotes constant photosynthetic activity in cucumber.

Specific leaf area

Among the genotypes maximum SLA was recorded in Samrat-1 (2189.66 M^2 Kg^{-1}) followed by JBG-3×JBG-4 (2100.15 M^2 Kg^{-1}) and minimum SLA was recorded by the genotype JBG-4×Pusa Naveen (558.85 M^2 Kg^{-1}) at 60 DAS. The reduction in SLA is associated with an increase in leaf thickness. It is determined by the thickness of the constituent cell tissues, such as upper and lower epidermal cells, and palisade tissue. At low light intensity, the plants were only able to develop one layer of palisade tissue while at high light intensity, the plants were able to develop two layers of palisade tissue (Sundari *et al*., 2008). Palisade tissue contains a lot of chloroplasts which are very important in increasing the efficiency of photosynthesis. The results showed that the thickness of the leaf tissue was influenced by light intensity, which at high light intensity, the leaf tissue was thicker than at low light intensity Aragao *et al*. (2014).

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Specific leaf weight

Among the genotypes maximum SLW was recorded in JBG-4×Pusa Naveen (0.90 M^2. g) followed by JBG-5 (0.64 M^2. g) and minimum SLW was recorded by the genotype Samrat-1 (0.23 M^2. g) at 60 DAS. Genotypes with greater SLW may be more suited to tolerate environmental challenges such as drought or nutrient constraints due to their strong leaf structure. Thicker leaves with higher SLW can help minimize water loss and increase water use efficiency (Sanchez *et al*; 1983). Studying SLW assists in identifying genotypes suitable for various growth scenarios. For example, high SLW genotypes may perform better in stressful situations, whereas low SLW genotypes might do well in favorable environments (Wright *et al*; 2004).

Chlorophyll content index

The maximum value for SPAD was recorded in the genotype JBG-4×JBG-5 (53.88) which was found to be statistically on par with JBG-4×Pusa Naveen (51.70), whereas the minimum was recorded in JBG2×JBG4 (31.42) at 60 DAS. The chlorophyll content varies with the nitrogen content in the plant as nitrogen is an important element in the formation of chlorophyll pigment (Ghosh *et al*., 2000). The high chlorophyll content might have increased the photosynthate production and their translocation to developing fruits, thereby increasing the fruit yield. (Bange and Milroy, 2004).

Light transmission ratio

Among the genotypes maximum LTR was recorded in JBG-3×Pusa Naveen (65.31%) followed by JBG-4×JBG-5 (58.70%) and minimum LTR was recorded by the genotype JBG3×JBG5 (39.88%) at 60 DAS. The better use of resources can be supported by observations on LTR, which showed significant difference due to different genotypes. The higher light interception in JBG-3×Pusa Naveen was due to quick growth and good vegetative cover, which helped in the better interception of light. This was due to better spatial use of light by the leaf canopy or root system, which might have made better spatial use of nutrients and water. It is also clear from the investigation that, the yield advantage in JBG-3×Pusa Naveen was due to better overall use of resources than when crops were grown (Udhaya and Latha; 2015).

Energy Interception (cal cm^{-2} min^{-1})

Among the genotypes maximum Energy Interception was recorded in JBG2×Pusa Naveen (10.16 cal cm^{-2} min^{-1}) followed by Pusa Naveen (9.26 cal cm^{-2} min^{-1}) and minimum Energy Interception was recorded by the genotype JBG3×JBG5 (5.53 cal cm^{-2} min^{-1}) at 60 DAS. Genotypes with higher energy interception often have superior growth and production because of more efficient use of available lighting. Understanding and choosing genotypes based on energy interception capabilities may help breeding initiatives targeted at increasing fruit yield (Muller *et al*; 2001).

Conclusion

The study concluded that the genotype JBG-2 exhibited the highest LAI and LAD, indicating superior photosynthetic capability. JBG-4×Pusa Naveen showed the highest SLW, while JBG-4×JBG-5 had the greatest chlorophyll content index. High energy interception and light transmission ratio were observed in JBG-2×Pusa Naveen and JBG-3×Pusa Naveen, respectively. These findings highlight the potential of selecting genotypes with superior physiological attributes to enhance growth and yield in bottle gourd.

Table: 2 Study of bottle gourd genotypes for physiological traits

Genotypes	LAI	LAD	SLA	SLW	CCI	LTR	EI
	75 DAS	(60-75 DAS)					
JBG-1	7.04	146.37	1593.12	0.31	46.71	54.67	8.27
JBG-2	11.17	241.26	1717.94	0.29	47.49	58.27	7.42
JBG-3	8.62	183.30	1473.63	0.34	45.32	54.56	7.96
JBG-4	8.18	173.45	1430.99	0.35	35.67	50.48	7.31
JBG-5	8.35	177.74	783.95	0.64	46.57	48.12	7.73
Pusa Naveen	9.51	204.95	1481.02	0.34	51.02	50.29	9.26
JBG-1×JBG-2	8.65	179.31	1180.79	0.42	38.03	48.93	8.65
JBG-1×JBG-3	8.65	182.32	952.52	0.53	39.53	49.61	8.76
JBG-1×JBG-4	9.14	189.64	1252.21	0.40	35.11	54.46	8.07
JBG-1×JBG-5	6.49	138.89	1259.20	0.40	36.04	54.52	5.81
JBG-1×Pusa Naveen	9.84	208.13	1051.31	0.48	33.57	48.00	7.38
JBG2×JBG3	8.19	176.47	1166.93	0.43	36.49	51.36	7.54
JBG2×JBG4	8.96	192.59	969.18	0.52	31.42	56.27	8.00
JBG2×JBG5	8.91	195.50	1056.02	0.47	38.17	46.59	8.78
JBG2×Pusa Naveen	8.68	185.65	1062.11	0.47	37.45	44.59	10.16
JBG3×JBG4	9.08	194.56	2100.15	0.24	47.93	54.25	8.53
JBG3×JBG5	6.98	148.59	1124.68	0.45	40.92	39.88	5.99
JBG3×Pusa Naveen	8.49	181.69	941.14	0.53	49.57	65.31	5.53
JBG4×JBG5	9.58	210.84	1012.47	0.50	53.88	58.70	5.86
JBG4×Pusa Naveen	5.18	108.38	558.85	0.90	51.70	48.49	7.51
JBG5×Pusa Naveen	9.17	197.24	1646.97	0.30	46.88	46.09	8.95
Samrat-1 (Check-1)	8.33	179.11	2189.66	0.23	38.49	46.87	9.16
Anokhi (Check-2)	8.36	178.84	1335.97	0.38	39.87	49.19	8.12
Mean	8.50	181.51	1275.69	0.43	42.08	51.28	7.86
S. E.	0.29	5.87	51.38	0.02	1.06	0.47	0.08
C.D.	0.83	16.72	146.45	0.05	3.02	1.33	0.23
C.V. @ 5%	5.94	5.60	6.98	7.47	4.36	1.57	1.78

LAI-Leaf Area Index, **LAD-**Leaf Area Duration, **SLA-**Specific leaf area, **SLW-**Specific leaf weight, **CCI-**Chlorophyll content index, **LTR-**Light transmission ratio, **EI-**Energy Interception

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