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Performance of bottle gourd (*Lagenaria siceraria* L.) hybrid genotypes in Prayagraj agro-climatic conditions

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Abstract
An experiment on the "Performance of Bottle Gourd [*Lagenaria siceraria* (Molina) Standl.] Hybrid Genotypes in Prayagraj Agro-Climatic Conditions" was conducted during February to May 2021, in field of Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) India. The results of the present investigation, regarding the performance of 16 hybrids of Bottle Gourd i.e. (BOGHYB-1, BOGHYB-2, BOGHYB-3, BOGHYB-4, BOGHYB-5, BOGHYB-6, BOGHYB-7, BOGHYB-8, BOGHYB-9, BOGHYB-10, BOGHYB-11, BOGHYB-12, BOGHYB-13, BOGHYB-14, STAR-1160 and ASHWANI) obtained from different sources evaluated for plant growth, yield and quality have been discussed and interpreted in the light of previous research work done in India. The experiment was conducted in Randomized block design, where each hybrid genotype replicated thrice. From the present experimental findings it is found that hybrid genotype BOGHYB-2 was recorded with the maximum number of fruits plant^{-1} (12.27 fruits), average fruit length (46.39 cm), fruit diameter (17.76 cm), fruit yield/plant (10.06 kg), yield q/ha (446.87 q) male female ratio (21.67) and with maximum Benefit Cost Ratio (1:3.5).

Keywords: Bottle gourd, hybrid genotypes, agro-climatic conditions, growth, yield and quality

Introduction
Bottle gourd [*Lagenaria sicerarla* (Mol.) Standl.] belongs to the Cucurbitaceae family with chromosome number 2n = 22, originated from Southern Africa. Bottle gourd is commonly known as Lauki and white flowered gourd. It is one of the important cucurbitaceous vegetable crop cultivated in India. The names "lagenaria" and "siceraria" are derived from Latin words "lagena" for bottle and "sicera" for drinking utensil (Deepti, 2013) [7].

It is a diploid, monoecious, climbing or prostrate plant, solitary flowers and it is cross pollinated due to its monoecious nature, the plants bear more male flowers and less female flowers separately on the same plant (Sahu, 2016) [26]. Major pollinators in bottle gourd are bees. Bottle gourd plants are day neutral in nature and it is grown as a summer and rainy season crop. It is widely cultivated in tropics and subtropics, mostly grown for its fruit, which are different size and shape *viz*; globular, cylindrical, bottle-shaped or club-shaped. The fruits are fleshy and multi seeded and also fruits are either sweet or bitter in taste. The sweet fruits are edible and also useful for medicinal purposes.

Economically it is an important crop which is cultivated worldwide for vegetable purpose. There are numerous health benefits reported in bottle gourd including its anti-cancerous, general tonic, cardio protective, diuretic, aphrodisiac and also antidote to certain poisons and scorpion stings, alternative purgative and cooling effects (Badmanaban and Patel, 2010) [2]. The bottle gourd fruits are used for variety of purposes, tender fruits used as vegetable and for preparing sweet dishes, raita and pickle. 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) [33]. Bottle gourd is commonly grown twice a year during February-March and June-July. Seed sown in February-March are harvested in May-June. Seed sown in June-July is harvested in September October. It requires loose, fertile, well drained and neutral soil for growth. Local variety, Louki, is cultivated on a large scale in our country that produces a lower yield due to lack of high yielding varieties/hybrids is one of the most important factors that limit bottle gourd productivity. All the cultivars cannot be grown successfully in each region.

Some cultivars are successfully adapted to a region while others show poor performance in the same region.

At present, urgent need of the farmers is to develop early maturing and high yielding hybrid genotype. Preliminary identification of early maturing hybrids can be done based on characters like days to opening of female flowers, node number to first female flowering and days to fruit picking. Collection and evaluation of hybrids a pre-requisite for their utilization and detailed evaluation determines the potential of an accession in specific crop improvement program. Therefore, a trial for characterization and evaluation of presently available bottle gourd hybrid was carried out in order to identify the potential cultivar for different horticultural characters.

Materials and Methods

The experiment was conducted in the Central Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom, University of Agriculture, Technology and Sciences, Prayagraj (U.P) during 2020 – 2021. The experiment was laid out in randomized block design (R.B.D.) having 14+2 treatments with 3 replications of hybrid genotypes tabulated in Table- 1. Bottle gourd hybrid genotypes were sown in the field at a spacing of 3m × 0.75m in plot of 7.5 m × 3 m size. Recommended dose of fertilizers i.e., 250:100:100 @ N: P_2O_5: K_2O kg ha^{-1}. Normal cultural practices and plant protection measures were followed during the cultivation process. Plants were selected at random from each plot of each hybrid varieties as representative sample for recording the data.

Table 1: List of Hybrid Genotypes.

SI. No.	Symbols	Name of Hybrid Genotypes	Sources
1	G_1	BOGHYB -1	IIVR, Varanasi
2	G_2	BOGHYB -2	IIVR, Varanasi
3	G_3	BOGHYB -3	IIVR, Varanasi
4	G_4	BOGHYB -4	IIVR, Varanasi
5	G_5	BOGHYB -5	IIVR, Varanasi
6	G_6	BOGHYB -6	IIVR, Varanasi
7	G_7	BOGHYB -7	IIVR, Varanasi
8	G_8	BOGHYB -8	IIVR, Varanasi
9	G_9	BOGHYB -9	IIVR, Varanasi
10	G_{10}	BOGHYB -10	IIVR, Varanasi
11	G_{11}	BOGHYB -11	IIVR, Varanasi
12	G_{12}	BOGHYB -12	IIVR, Varanasi
13	G_{13}	BOGHYB -13	IIVR, Varanasi
14	G_{14}	BOGHYB -14	IIVR, Varanasi
15	G_{15}	STAR-1160	Star Agrotech PVT. Ltd.
16	G_{16}	ASHWANI	Akash Ganga Seed

Statistical analysis

The data recorded during the course of investigation were subjected to statistical analysis as per method of analysis of variance **Fisher (1950)**. The significance and non-significance of the treatment effect were judged with the help of 'f' value (variance ratio) was compared with the table value at 5% level of significance. If calculated value exceeded then the value, the effect of considered to be significant. The significant difference between the means was tested against the critical difference at 5% level of significance.

Chemical analysis of soil

Composite soil samples are collected randomly before the layout of experiment was laid so as to determine the soil properties initially. The soil samples are collected from 0-15 cm depth and were dried under shade, then powdered with the help of a wooden pestle and mortar then sieved through a 2 mm sieve and was then subjected to further analysis. The physical properties of soil were evaluated by using the Bouyoucos hydrometer method outlined by Bouyoucos (1927) [4] and for organic carbon by Wet method Walkely and Black (1956) [35]. Available nitrogen was estimated by alkaline permanganate method by Subbiah and Asia (1956) [30], available phosphorus by Clasen's Calorimeter method by Jackson (1967) [11], available potassium was determined by use of Flame Photometric method (Perur *et al*., 1973) [23].

Results and Discussion

A. Growth Parameters

Data pertaining to growth parameters which are Day to germination, Days to first true leaf emergence, Days to second true leaf emergence, Days to first male flower emergence, Days to first female flower emergence, Nodes at first male flower emergence, Nodes at first female flower emergence, Sex ratio, Days to first picking and Average vine length were recorded and tabulated in Table- 2.

Days to germination

The minimum days to seed germination (12.60) was associated with BOGHYB-7 followed by BOGHYB-1 (12.80), BOGHYB-10 (12.80), BOGHYB-13 (13.13), STAR-1160 (13.20), BOGHYB-12 (13.33), BOGHYB-2 (13.53), BOGHYB-3 (13.73), BOGHYB-11 (13.87), ASHWANI (13.87), BOGHYB-9 (13.93), BOGHYB-14 (14.07), which were on par with each other and maximum days to seed germination (15.60) was recorded in BOGHYB-8. The number of days to germination is an important character. which indicate earliness or lateness of the crop in general. Better germination in this hybrid may be due to genetic potential or having the better permeability of seed coat to water and hence earlier initiation of germination.

Days to first true leaf emergence

The minimum days to first true leaf appearance (18.93) was associated with BOGHYB-10 followed by BOGHYB-2 (19.80), BOGHYB-9 (19.80), STAR-1160 (19.87), BOGHYB-12 (20.27), which were on par with each other and maximum days to first true leaf appearance was (23.00) recorded in BOGHYB-14. Because of the capacity of genotype to intake more water and ability of the genotype to grow fast in the conditions like sunlight moisture and temperature and the number of days to first true leaf emergence indicates earliness or lateness of flower.

Days to second true leaf emergence

The minimum days to second true leaf appearance was (23.47) associated with BOGHYB-10 followed by BOGHYB-3 (24.73), STAR-1160 (24.93), BOGHYB-2 (25.13), BOGHYB-12 (25.27), BOGHYB-1 (25.53), BOGHYB-9 (25.60), which were on par with each other and maximum days to first true leaf appearance was (27.93) recorded in -6. Because of the capacity of genotype to intake more water and ability of the genotype to grow fast in the conditions like sunlight moisture and temperature and the number of days to first true leaf emergence indicates earliness or lateness of flower.

Days to first male flower emergence
The minimum days to first appearance of male flower was (48.33) associated with BOGHYB-1 followed by BOGHYB-3 (48.8). which were on par with each other and maximum days to first appearance of male flower was (59.80) recorded in STAR-1160. The Days to First male flower emergence play an important role in deciding the earliness or lateness of crop in general. The variation in the first female flower emergence might have been due to internodal length, number of inter nodal and vigour of the crop.

Days to first female flower emergence
The minimum days to first appearance of female flower was (51.73) associated with BOGHYB-3 followed by BOGHYB-1 i.e., (52.53), which were on par with each other and maximum days to first appearance of female flower was (63.87) in the genotype STAR-1160. The Days to first female flower emergence play an important role in deciding the earliness or lateness of crop in general. The variation in the first female flower emergence might have been due to internodal length, number of inter nodal and vigour of the crop.

Nodes at first male flower emergence
The minimum number of nodes to first male flower appearance was (3.47) associated with BOGHYB-5 followed by BOGHYB-7 (3.60), BOGHYB-10 (3.67), BOGHYB-4 (3.73), STAR-1160 (3.73), BOGHYB-12 (3.80), BOGHYB-1 (3.87), BOGHYB- 3 (3.93), BOGHYB- 9 (3.930, BOGHYB-6 (4.13), BOGHYB-14 (4.13), ASHWANI (4.13), BOGHYB-8 (4.2), BOGHYB-13 (4.27), which were on par with each other and maximum number of nodes to first male flower appearance was genotype in BOGHYB-2 i.e., (5.47).

Nodes at first female flower emergence
The minimum number of nodes to first female flower appearance was (5.27) associated with BOGHYB-3 followed by BOGHYB-6 i.e., (6.60), which were on par with each other and maximum number of nodes to first female flower appearance was genotype BOGHYB-2 i.e., (10.47).

Sex ratio
The maximum sex ratio was (21.67) associated with BOGHYB-2 followed by BOGHYB-1 i.e., (19.80), which were on par with each other and minimum sex ratio was genotype ASHWANI i.e., (12.40). The Male: Female ratio is an important character which indicates earliness or lateness of the crop in general. The variation in Male: Female ratio might have been due to number of vigor of crop.

Days to first picking
Days to first fruit picking ranged from 69.20 to 77.67 days. Significantly earliest days for first fruit picking was (69.20) recorded in BOGHYB-1 followed by BOGHYB-2 i.e., (70.27), BOGHYB-3 (71.31), which were on par with each other and maximum days for first fruit picking was recorded in STAR-1160 i.e., (77.67).

Average vine length
The maximum length of vine (m) was (5.88) observed in the treatment BOGHYB-7 followed by BOGHYB-6 (5.71), BOGHYB-2 (5.57), which were on par with each other and minimum was with ASHWANI i.e., (3.03 m). The variation in plant height might be due to specific genetic makeup of different genotypes, inherent properties and vigour to crop.

Table 2: Growth parameters of bottle gourd hybrid genotypes

Genotypes	Days to germination	Days to 1st true leaf appearance	Days to 2nd true leaf appearance	Days to 1st male flower emergence	Node at 1st male flower emergence	Days to 1st female flower emergence	Node at 1st female flower emergence	Sex ratio	Days to 1st picking	Average vine length (m)
G_1	12.80	20.80	25.53	48.33	3.87	52.53	8.33	19.80	69.20	5.37
G_2	13.53	19.80	25.13	51.40	5.47	54.47	10.47	21.67	70.27	5.57
G_3	13.73	21.80	24.73	48.80	3.93	51.73	5.27	17.60	71.13	4.81
G_4	14.73	22.27	26.53	50.00	3.73	55.80	7.13	18.23	73.20	5.37
G_5	15.53	21.93	26.87	52.00	3.47	55.60	7.73	17.90	71.60	4.65
G_6	15.25	22.87	27.93	54.20	4.13	57.73	6.60	18.10	73.87	5.71
G_7	12.60	20.33	26.13	56.67	3.60	60.33	9.93	18.07	73.67	5.88
G_8	15.60	22.27	27.33	55.00	4.20	57.73	9.20	17.77	73.67	4.41
G_9	13.93	19.80	25.60	53.27	3.93	56.60	8.13	16.70	74.07	4.33
G_{10}	12.80	18.93	23.47	54.27	3.67	56.80	8.53	16.57	72.73	4.59
G_{11}	13.87	21.67	26.53	55.07	4.47	58.20	7.13	13.07	74.60	4.67
G_{12}	13.33	20.27	25.27	58.00	3.80	61.13	7.80	15.47	75.80	4.61
G_{13}	13.13	21.47	26.93	56.53	4.27	59.93	7.53	14.70	75.73	4.23
G_{14}	14.07	23.00	26.60	55.80	4.13	58.93	9.73	13.47	74.87	4.39
G_{15}	13.20	19.87	24.93	59.80	3.73	63.87	7.00	13.00	77.67	3.07
G_{16}	13.87	20.93	26.00	58.33	4.13	61.93	7.53	12.40	75.93	3.03
S.Ed (±)	0.77	1.17	1.12	0.78	0.43	0.77	0.81	1.02	1.07	0.16
CD (5%)	1.58	2.39	2.28	1.60	0.87	1.58	1.66	2.08	2.19	0.33

B. Yield Parameters: Data pertaining to yield parameters which are Average number of fruits plant^{-1}, Average fruit weight (g), Average fruit length (cm), Average fruit diameter (cm), Average fruit yield plant^{-1} (kg) and Average fruit yield (q/ha.) were recorded and tabulated in Table- 3.

Average number of fruits plant^{-1}
The maximum number of fruits plant^{-1} was (12.27) associated with the treatment BOGHYB-2 followed by BOGHYB-1 i.e. (10.60). However, the minimum number of fruits plant^{-1} in the genotype ASHWANI i.e. (8.00). The Fruit per plant is one of the major factors for deciding the yield of the crop. The variation in fruit per plant have been to sex ratio and fruit set percentage.

Average fruit weight (g): The maximum weight of fruits (g)

at maturity time was (830.47) associated BOGHYB-13 followed by BOGHYB-12 (824.53), BOGHYB-10 (823.8), BOGHYB-2 (819.93), BOGHYB-11 (817.67), BOGHYB-3 (809.87), which were on par with each other and the minimum weight of fruits (g) was with hybrid ASHWANI i.e. (716.93).Increased fruit weight in different hybrids, might be due to enhanced photosynthesis accumulation of carbohydrates and Favourable effect on vegetative growth which increased the fruit variety besides increasing fruit size and weight.

Average fruit length (cm)

The maximum length of fruit (cm) was (46.39) associated with BOGHYB-2 followed by BOGHYB-11 i.e., (44.00). However, the minimum length of fruit (cm) was with hybrid BOGHYB-8 i.e., (37.57). Increased fruit size in different hybrids, might be due to enhanced photosynthesis accumulation of carbohydrates and Favourable effect on vegetative growth which increased the fruit variety besides increasing fruit size.

Average fruit diameter (cm)

The maximum diameter of fruit (cm) was (17.76) associated with BOGHYB-2 followed by BOGHYB-4 i.e., (16.75) However, the minimum diameter of fruit (cm) was with hybrid ASHWANI i.e., (13.27). Increased fruit size attributed in different hybrids might be due to enhanced photosynthesis, accumulation of carbohydrates and favourable effect on vegetative growth which increased the fruit variety besides increasing the fruit size.

Average fruit yield plant^{-1} (kg)

The maximum yield plant^{-1} (kg) at harvesting time was (10.06) associated with BOGHYB-2 followed by BOGHYB-1 i.e. (8.31). However, the minimum yield plant^{-1} (kg) was with hybrid ASHWANI i.e. (5.74). Significant variation might be due to fruit set percentage and number of fruits per plant, fruit weight and fruit diameter and the increase in yield and yield attributes to enhanced photosynthesis, accumulation of carbohydrates, development of cell wall and cell differentiations as they boost up overall vegetative growth, biological activity of the plants and retention of more flowers and fruits which increased number of fruits and size of fruits besides increasing yield.

Average fruit yield (q/ha.)

The maximum yield hectare^{-1} (Quintals) at harvesting time was (446.87) associated with BOGHYB-2 followed by BOGHYB-1 i.e. (369.42). However, the minimum yield hectare^{-1} (Quintals) was with hybrid ASHWANI i.e. (254.92). The Significant variation might be due to fruit set percentage and number of fruits per plant, fruit weight and fruit diameter and the increase in yield and yield attributes to enhanced photosynthesis, accumulation of carbohydrates, development of cell wall and cell differentiations as they boost up overall vegetative growth, biological activity of the plants and retention of more flowers and fruits which increased number of fruits and size of fruits besides increasing yield.

Table 3: Yield parameters of bottle gourd hybrid genotypes.

Genotypes	Number of fruits plant^{-1}	Fruit weight (g)	Fruit length (cm)	Fruit Diameter (cm)	Fruit yield (kg/plant)	Fruit Yield (q/ha)
G_1	10.60	784.33	41.15	16.39	8.31	369.42
G_2	12.27	819.93	46.39	17.76	10.06	446.87
G_3	8.87	809.87	40.49	16.01	7.18	319.00
G_4	10.33	770.87	40.29	16.75	7.96	353.81
G_5	9.27	730.07	37.64	15.79	6.76	300.52
G_6	9.67	758.67	42.51	15.95	7.33	325.84
G_7	9.33	795.87	41.04	16.27	7.42	329.71
G_8	9.20	800.40	37.57	15.06	7.36	327.17
G_9	8.67	735.67	41.90	14.86	6.37	283.13
G_{10}	8.60	823.80	41.42	16.01	7.08	314.54
G_{11}	8.13	817.67	44.00	14.97	6.65	295.34
G_{12}	8.47	824.53	41.47	15.10	6.98	310.31
G_{13}	8.33	830.47	43.12	14.08	6.91	307.08
G_{14}	8.20	745.13	42.54	15.67	6.11	271.49
G_{15}	8.07	743.60	42.45	13.45	6.00	266.37
G_{16}	8.00	716.93	42.16	13.27	5.74	254.92
S.Ed (±)	0.39	13.02	0.44	0.18	0.29	4.26
CD (5%)	0.79	26.59	0.89	0.37	0.59	8.70

C. Quality Parameters

Fruit shape

As regards to fruit shape, result found that the hybrid genotypes BOGHYB-1, BOGHYB-2, BOGHYB-3, BOGHYB-4, BOGHYB-5, BOGHYB-6, BOGHYB-7, BOGHYB-8, BOGHYB-9, BOGHYB-10, BOGHYB-11, BOGHYB-13, BOGHYB-14, STAR-1160 and ASHWANI observed cylindrical in shape. Whereas the hybrid genotypes BOGHYB-12 are found in oblonged shape.

Fruit colour

In case of fruit colour in bottle gourd hybrid genotypes. BOGHYB-1, BOGHYB-3, BOGHYB-4, BOGHYB-5, BOGHYB-7, BOGHYB-8, BOGHYB-10, BOGHYB-11, BOGHYB-12, BOGHYB-14, STAR-1160 and ASHWANI were observed in Light green in colour, while the hybrid genotypes BOGHYB-2, BOGHYB-6, BOGHYB-9 and BOGHYB-13 observed in Creamy in colour.

Summary and Conclusion

The results from the present investigation concluded that Bottle gourd hybrid genotype BOGHYB-2 was recorded with the maximum number of fruits plant^{-1} (12.27 fruits), average fruit length (46.39 cm), fruit diameter (17.76 cm), fruit yield/plant (10.06 kg), yield q/ha (446.87 q) male female ratio (21.67) and with maximum Benefit Cost Ratio (1:3.5).

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