International Journal of Plant & Soil Science

Volume 35, Issue 17, Page 102-108, 2023; Article no.IJPSS.102051
ISSN: 2320-7035

Effect of Different Training System on Growth, Yield and Quality of Bottle Guard (*Lagenaria siceraria* L.) under Prayagraj Agro-Climatic Condition

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i173188

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/102051

Original Research Article

Received: 20/04/2023
Accepted: 26/06/2023
Published: 01/07/2023

ABSTRACT

The present investigation was planned to know the feasibility of training systems of growing vis-a-vis traditional method and their effects on growth, yield and quality traits in bottle gourd [*Lagenaria siceraria* (Mol.) Standl]. The results revealed that trailing method had significantly higher vine length (495.21 cm), number of nodes/vine (11.55) and chlorophyll content (40.32) at 90 DAS. The reduction in number of days to anthesis to first male flower (55.13 days) and female flower (62.30 days) in trailing as compared to other trailing systems. The fruit development attributes, viz. number of fruits plants^{-1} (9.47), fruit weight (4119.15 gm) were recorded significantly higher in trailing but significantly less fruit width (64.10m), were recorded in training system. Fruit yield attributes, i.e. the

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number of total fruit plant^{-1} (9.47), fruit yield plot^{-1} (9.84 kg), seed yield ha^{-1} (246.45 qha-1) was significantly higher in bower training system. The significant increase in germination (97.54%) was recorded in trailing system as compared to traditional system (95.21%). Similarly, seedling length (42.66 cm), and seedling dry weight (6.56 mg) were significantly higher in training systems. B:C ratio (4.60%) were also significantly superior in Inverted "V" trellis. The presence of fungi was lower in trailing than traditional among the infected fruits.

Keywords: Bottle gourd; training systems; netting; "V" trellis; growth; quality and yield.

1. INTRODUCTION

A significant annual cucurbitaceous crop growing all across the nation is the bottle gourd (*Lagenaria siceraria* L.). Being a warm-season crop, it does well in warm, muggy weather, although at the moment, in the plains of northern India, off-season farming has been gradually extended all year long. De Candolle (1882) reported seeing bottle gourd in its natural form in South Africa and India. The variety of the seeds and fruits, according to Cutler and Whitaker (1961), lead them to believe that it is likely native to tropical Africa. The delicate fruits of bottle gourds can be eaten as a vegetable or used to make pickles, kofta, and desserts like halva, kheer, petha, and burfi. Pectin content in the fruit is also high, which bodes well for making jelly. The seeds and seed oil can also be consumed. The fruits have a moisture content of 96.3%, a carbohydrate content of 2.9%, a protein content of 0.2%, a fat content of 0.1%, a mineral content of 0.5%, and a vitamin C content of 11 mg per 100 g of fresh weight (Thamburaj and Singh, 2005).

"The traditional method of planting of bottle gourd involves creating small hills that give the vines plenty of room to grow which is critical for a crop that possesses heavy foliage which tends to restrict light penetration to lower leaves and thus reduces the photosynthetic efficiency of the crop. The dense vining canopy also hampers proper air circulation and enhances high humidity that can promote the occurrence and spread disease. Traditional method of hybrid seed production involves more physical work, in bagging of flowers and pollination thus it enhances the cost of production and reduces the efficiency of labours". [1] Moreover, it occupies a lot of space due to which farmers hesitate to take up seed production. "As vining plants, bottle gourd grows best with support, which keeps them off the ground and encourages straight fruit growth. To grow on a stake, train a primary runner or main shoot to the stake and tie at 12-14 inch intervals with wire mesh/plastic rope arch. Since trailing allows vertical growth instead of sprawling all over the seed production plot not only keeps the produce off the ground, it also allows to grow more plants in a smaller area" [1].

"The term training means to force or make the plant grow in a certain architecture or structure or trellis shape by allowing them to grow over different structures and grooming/trimming them in respect to give them the specific shape and structure so that they can bear the heavy load of the fruits and produce quality harvest". (Sen & Chatterjee, 2019) The training provides good opportunity for growth and expansion of fruiting area and as a results the number of fruits are more and thereby there is increase in yield per square unit area. Since the complete vegetative growth and fruiting portion remain considerably high above the ground there is cleaner harvest, the incidence of fruit fly and fungal diseases is also low. The fruits remain pendent due to which they grow straight and slightly longer. Proper illumination of light enhances the growth and productivity of the vines. The operations like spraying, dusting and harvesting have become easier as they are easy to spot and at arms distance. "Training is a force or make the plant grow in a certain architecture or structure or trellis. Allowing them to grow over different structures and grooming/ trimming them in respect to give them the specific shape and structure. So that they can bear the heavy load of the fruits and produce quality harvest". (Sen & Chatterjee, 2019)

2. MATERIALS AND METHODS

Experiment comprises different training systems of growing, viz ground trailing, stake and weave, cages, bower systems, "V" trellis, inverted "V" trellis and netting with bottle gourd cv. SW-906 was raised at local market and following observations, viz. vine length, length of internodes, chlorophyll content, no. of nodes to first flowering, days taken to first male & female flower and 50% flowering, days taken to first picking, sex ratio, no. of fruit plant^{-1}, fruit

diameter, fruit weight, yield ha^{-1} and B:C ratio were carried out at field and testing lab of Division of Horticulture, SHUATS Prayagraj during *Zaid* 2022. The furrows were opened by middle buster at the spacing of 2.5 m and 3 m in training systems, respectively in well prepared field. The channels were finally prepared and pressed both the sides manually. The seeds were soaked overnight in Bavistin solution @ 2 g per kg of seeds and shade dried for two hours. The treated seeds were planted in to the tray pot after soaking for the preparation of seedlings. The plants were thinned out 25 days after sowing by keeping single healthy seedlings. In ground training, the vines were allowed to grow over ground naturally whereas in other training systems, eight feet length bamboo poles (1.5-inch diameter) were fixed in the soil at 10 feet distance and two poles were connected with 10 feet long bamboo with pole and supported with other bamboos in one side to form right triangle. On the poles, at a height of one meter onwards five to seven rows of flat white plastic rope were tied. The vines were loosely tied with jute thread and trailed over a crisscross network of plastic ropes. Seventy-two plants were randomly selected in trailing and traditional plots for recording the growth, yield and quality parameters. All the test was carried out manually except chlorophyll content. The observations on the growth parameters such as vine length, length of internodes and chlorophyll content at 30, 60 and 90 days were recorded during early growing stage. Chlorophyll content was recorded by the SPAD meter. The quantitative data generated were analyzed statistically for testing the heterogeneity of means adopting the t-test at 5% probability (P=0.05).

2.1 Methodology Followed for Training Systems

According to (Sen & Chatterjee, 2019)

2.1.1 Ground trailing

Growing vines left to trail over the ground or on mulch. Can be practiced during the dry months. Not recommended during the rainy season. Prone to various soil borne disease and rotting

2.1.2 Stake & weave

Usually practiced where the stems or vines a little bit stronger. The vines are supported by lines of twines or ropes tied to the stakes driven between every other plant.

2.1.3 Cages

“A sheet of mesh folded into a cylindrical or cubical shape to make a cage and pressed under the ground. Plants can be grown either inside or outside. Easy to build and maintain, other vegetables can also be grown. e.g. Tomato, Useful in small gardens, Lower yield, Difficult to harvest fruits produced inside the caged structure”. (Sen & Chatterjee, 2019)

2.1.4 Umbrella system

Less laborious, easy to practice & understand. The vines are tied to a vertical wire of certain height and the growing point is pinched. All the lateral vines are removed from the main stem leaving two vines. These two vines are trained over the wire to hang down on both the sides of the main stem to one third of the way downwards. When all the fruits of this vines are harvested the vines are removed and other two laterals are allowed to grow replacing them and the process continues. This renewal system maintains the productivity for the long time.

2.1.5 Bower system

“Easy to build and maintain. High yield, mostly practiced by Indian farmers, structures can be made permanent as all type of cucurbit can be grown over it. Costly, require large area Bower System, the auxiliary buds and side branches are removed till the vine reaches the bower then the tip of the vine is removed 15 cm below the bower, two auxiliary buds are allowed to grow and allowed to trail over the bower”. (Sen & Chatterjee, 2019)

2.1.6 Inverted “v” trellis

“An Inverted V structure is made by joining the tips of pole and the structure is pressed in ground, the inner space is netted by nylon wire one iron mesh, The Plants are trailed over the netted structure”. (Sen & Chatterjee, 2019)

2.1.7 “V” trellis

“The wooden or iron posts are set 20 to 30 degrees from vertical post and are joined by a line of wire or rope. When the buds break, new fruiting laterals are encouraged to grow outward. Greater light penetration, air circulation into the canopy; higher yields and less disease pressure than single post. Horizontal wires can be moved up or down to according to cultivar’s vigour in "V" trellis”. (Sen & Chatterjee, 2019)

2.1.8 Netting

"Two supporting pillars are set on the ground of desired height at a certain distance and the space between these two pillars are netted by nylon wire or metal wire. The distance between the poles should be such that the netting should not hang lower when the plants trailed over it starts bearing". (Sen & Chatterjee, 2019)

3. RESULTS AND DISCUSSION

The present investigation was conducted during March 2022 to June 2022 at Vegetable Research field, department of Horticulture – Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj U.P. The area of the research land is 96 m^2. The experiment comprised of a total of eight treatments with eight levels of training systems *viz*., T0 (Ground trailing), T1 (Stake & weave) T2 (Cages), T3 (Umbrella system) T4 (Bower system) T5 (Inverted "v" trellis) T6 ("V" trellis) T7 (Netting). The experiment was laid out, following Completely Factorial Randomized Block Design (CFRBD) with three replications. Observations were recorded for fourteen different characteristics related to vegetative growth, yield and quality attributing traits These observations recorded were vine length (cm), length of internodes (cm), chlorophyll content (µmol),days taken to first flowering, days taken to first male flowering, days taken to first female flowering, sex ratio, days taken to 50% flowering, days taken to first harvest, number of fruits per vine, fruit length (cm), fruit diameter (cm), fruit weight (g), yield per vine (kg), yield per plot (kg), yield per hectare (q/ha), marketable yield (q/ha) and The data recorded for various characters were subjected to statistical analysis were carried out in accordance to Panse and Sukhatme [2].

3.1 Effect of Different Training System on Plant Growth

The data pertaining to vine length (cm), internodal length (cm), leaf chlorophyll content (SPAD units) showed significant difference among different growing media combinations at 30 DAT, 60 DAT and final harvest (Table 1). Among different combinations of training system, T5 *i.e.,* Inverted "V'' Trellis recorded maximum vine length (495.21 cm) with leaf chlorophyll content (40.82 SPAD units) in T6 ("V'' Trellis) at final harvest. Highest internodal length (11.55 cm) was recorded in T7 (Netting) at final harvest. These results are in congruence with recent studies of Yadav et.al. (2020) in cucumber, Kanupriya et al [3].

3.2 Effect of Different Training System on Yield and Quality

In yield and yield attributes no significant difference was observed among different training system in days to final harvest. The, minimum number of nodes to first flower (8.47) in T1 (Stake and weave), Inverted "V" trellis recorded least number of days to first female flower appearance (12.97 days), minimum days to first flowering/male flowering (59.97 days), minimum days taken to 50% flowering (70.30 days) in T7, maximum number of male flowers per plant is recorded in T7 (26.13), Maximum no. of female plant is recorded in T6 (6.47), maximum sex ratio recorded in treatment T2 (4.55) minimum days taken to first picking is recorded in T2 (72.66) and minimum number of nodes to first flowering

Table 1. Effect of different training systems on growth parameters

Treatments	Vine length (cm)			Internodal length (cm)			Chlorophyll content (µmol)		
	30 days	60 days	90 days	30 days	60 days	90 days	30 days	60 days	90 days
T0	11.87	88.26	386.08	1.35	8.55	10.41	34.07	33.38	38.92
T1	17.65	107.95	468.26	1.33	9.55	11.37	37.87	34.60	37.22
T2	19.76	111.57	460.83	1.38	6.93	11.17	33.73	34.97	37.58
T3	22.82	190.70	460.63	1.55	9.42	11.40	39.13	35.58	39.20
T4	17.21	97.73	466.47	1.40	6.42	11.40	36.20	38.33	36.43
T5	17.65	116.52	495.21	1.46	7.33	11.25	38.70	35.22	39.45
T6	18.02	145.18	463.49	1.54	9.62	11.53	39.40	34.53	40.82
T7	20.14	213.11	465.06	1.60	9.10	11.55	43.27	37.87	39.87
F-test	S	S	S	S	S	S	NS	S	S
S.Ed. (±)	2.26	16.61	15.95	0.003	0.58	0.27	3.6	1.09	0.91
C.D.	4.95	35.98	34.55	0.13	1.26	.59	3.6	1.09	0.91
C.V.	15.29	14.66	4.26	5.25	8.54	2.98	--	2.37	1.97

Table 2. Effect of different training systems on quality attributes

Treatments	Number of nodes to first flower	Days taken to first flowering/ male flower	Days taken to first female flower	Days taken to 50% flower	Number of male flowers per plant	Number of female flowers per plant	Sex ratio	Days taken to first picking	Fruit diameter (mm)
T0	10.80	56.30	64.13	71.80	21.13	4.97	4.44	21.13	64.10
T1	8.47	57.80	63.13	73.13	18.63	4.47	4.16	18.63	66.12
T2	10.30	59.97	63.47	71.80	20.80	5.49	4.55	20.80	69.22
T3	11.63	58.63	64.97	72.63	21.80	5.47	3.98	21.80	69.92
T4	12.30	55.80	65.13	71.97	23.80	5.47	4.35	23.80	69.02
T5	12.97	58.13	64.80	71.80	17.97	5.80	3.09	17.97	73.20
T6	10.47	57.63	65.13	70.47	23.97	6.47	3.74	23.97	69.97
T7	9.97	55.13	62.30	70.30	26.13	5.97	4.37	26.13	67.58
F-test	S	S	NS	S	S	S	S	S	S
S.Ed. (±)	0.84	1.08	1.08	0.37	1.31	0.53	0.40	1.31	1.98
C.D.	1.82	--	--	0.81	2.83	--	0.88	2.83	4.29
C.V.	9.52	2.06	2.06	0.64	7.37	11.97	12.17	7.37	3.54

Table 3. Effect of different training systems on yield attributes

Treatments	Number of fruit/plants	Yield/plant (kg/plant)	Total yield/ha (q/h)
T0	3.47	3.57	89.27
T1	7.30	6.79	169.72
T2	9.47	9.84	246.13
T3	6.97	6.55	163.71
T4	9.30	9.86	246.45
T5	8.80	8.62	215.60
T6	8.97	8.69	217.44
T7	7.80	7.02	175.50
F-test	S	S	S
S.Ed. (±)	0.48	0.37	9.37
C.D.	0.86	0.81	20.28
C.V.	6.27	6.03	6.02

is recorded in T1 (8.47). Highest fruit diameter (73.20 mm) was observed in T5 *i.e.,* Inverted ''V'' Trellis, which is on par with T0 *i.e.,* Ground trailing (64.10 mm). Highest fruit yield per plant (9.47 kg), fruit yield per plot (9.86 kg) and estimated fruit yield (246.45 q/ha) were observed in T4 *i.e.,* Bower System. Among different training system, T5 *i.e.,* inverted "v" Trellis showed least performance in B: C ratio.

These results are in congruence with recent studies of Yadav et.al. (2020) in cucumber, Sharma et.al. [4] in bottle gourd, Prasad et.al 2015 in bottle gourd and Kumar et.al. [5] in cucumber [6-9].

4. CONCLUSION

From the present investigation, it is concluded that treatment T_5 (Inverted "v" Trellis) performed best in terms of growth; Vine length (495.21cm), Length of internodes (11.25cm) Chlorophyll content (39.45 µmol) and in terms of Flowering parameters; No. of nodes to first flower (12.97), Days taken to first flowering (58.13), Days taken to first female flower initiation (64.80), Days taken to 50% flowering (71.80), Days taken to first picking (80.67), And Sex ratio (3.09) and also best in terms of Yield; No. of fruits Plant^{-1} (8.80), Fruit diameter (73.20 mm), Fruit weight (8.62 kg plot^{-1}), Yield ha^{-1} (215.60 q ha$^{-1)}$. The highest B:C ratio was also found in the same treatment with (4.60).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/102051