~~Original Research Article~~

Performance of Different Hybrids of Bitter Gourd (Momordica charantia L.) in terms of Growth, Yield, and Quality in Prayagraj Agro-Climatic Condition

ABSTRACT

Bitter gourd, botanically known as *Momordica charantia* (L~~.~~.), is an important commercial cucurbitaceous vegetable belonging to the family Cucurbitaceae, with a diploid chromosome number~~,~~ of 2n=22. It is variously known as balsam pear, bitter melon, bitter gourd, and African bitter gourd. ~~Therefore, the~~The present investigation was carried out at the Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, during the Zaid season 2023 ~~with a view,~~ to ~~check~~assess the performance of different genotypes of bitter gourd under Prayagraj agro-climatic conditions. The experiment was laid out in a Randomized ~~block design~~Block Design with 12 hybrids ~~with~~and 3 replications. Genotypes ~~comprised of~~included H1 (AVT-II 2020/BIGHYB-1); H2 (AVT-II 2020/BIGHYB-2); H3 (AVT-II 2020/BIGHYB-3); H4 (AVT-II 2020/BIGHYB-4); H5 (AVT-II 2020/BIGHYB-5); H6 (AVT-II 2020/BIGHYB-6); H7 (AVT-II 2020/BIGHYB-7); H8 (AVT-II 2020/BIGHYB-8); H9 (AVT-II 2020/BIGHYB-9); H10 (Shriram Samridhi); H11 (Alpine F1 Hybrid~~)~~; and H12 (F1 Hybrid Aman). From ~~the present~~this investigation, it is concluded that among the twelve hybrids ~~of Bitter gourd, hybrid,~~ **AVT-II 2020/BIGHYB-6 performed best in terms of growth ~~&~~and yield~~. The~~, with a vine length ~~was recorded~~of 3.45 m~~,~~ and a fruit yield ~~was~~of 122.48 q/ha**~~. In the economic analysis of the hybrid AVT-II 2020/BIGHYB-6~~.

Keywords: *Momordica charantia*, Hybrids, Growth, Fruit Yield ~~and~~, Quality~~.~~

Introduction

Bitter gourd ~~botanically known as *Momordica*~~ (*Momordica charantia* L.) is an important commercial cucurbitaceous vegetable belonging to the family Cucurbitaceae, with a diploid chromosome number~~,~~ of 2n=22. It is ~~variously~~also known as balsam pear, bitter melon, bitter gourd, and African bitter gourd **(Heiser, 1979)**. Bitter gourd is grown in ~~different~~various varieties ~~in~~across different countries. In India, the main varieties are India long green, India long white, and Hybrid India baby, whereas Japan is ~~famous~~known for Japan Green Spindle, China ~~is~~ for ~~green lover~~Green

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Lover, and Hong Kong for its Hong Kong Green. In Bangladesh mainly, two main varieties are grown i.e.,: Uchee (small) and Korolla (long) **(Alamet Alam et al., 2015)**.

The bitter gourd plant is a perennial with climbing and flowering vine growsthat can grow up to 5 m and. The fruits are elongated with ridges on the surface **(Lee et al., 2009)**. The young fruit is emerald green and later changes to orange-yellow when it is ripened **(Kandangathet Kandanga et al., 2015)**. The shape and size of bitter gourds vary due to varieties, climatic factors, and regions, but in general bitter gourds are generally, they range from 1.0 to 9.8 inch long inches in length and 1.0 to 5.9 inch wideinches in width, with round, oval, oblong, and club in shapeshapes, and colour variescolors ranging from dark green to white. In India, the length of bitter gourd ranges from 2.4 to 3.9 inchinches, and the fruits are dark green in colour with ridges on itstheir surface **(Kumar et al., 2016)**. The bitter gourd fruit gets maturematures after 45-80 days and, with harvesting is carried out after 60 days and continuescontinuing up to 150 days from the planting **(Islam et al., 2011)**. The shelf life of fresh bitter gourd is only 4 days at natural conditions, andbut it can be stored for up to 3-4 weeks in cold storage (0 to 7 °C) **(Wang et al., 2007)**. The bitter

Bitter gourd is highly nutritious due to presence higher amount, containing high amounts of protein, ascorbic acid, calcium, iron, and phosphorus **(Dandawate et al., 2016)**. It is also an important source of glucosides, carbohydratecarbohydrates, charantin, steroidal, saponin saponins, momordium, vitamins, proteinproteins, and minerals. The protein content in bitter gourd is fractionedfractionated into albumin (49.3 per cent),%), globulin (29.3 per cent)%), and glutelin (3.1 per cent) (Horaxet%) **(Horax et al., 2010)**. The seeds of the bitter gourd contain 35 to 40 per cent of% oil and fatty acid i.e.,acids, with 3.33 per cent% MUFA (monosaturatedmonounsaturated fatty acidacids) and 36.71 per cent% SFA (saturated fatty acids) **(Liu et al., 2010)**. Bitter gourd contains high amount ofis rich in Vitamin A, Vitamin C, and vitamins B1, B2, B3, and B12 **(Joseph and Jini, 2013)**.

According to NHB, (2022), the area under bitter gourd production in India accounts tois 96.85 million hahectares, with a production of 1332.55 million tonnes in year 2021-22. Madhya Pradesh ranks first in both area and production of bitter gourd in year 2021-22, followed by Chhattisgarh and Tamil Nadu. The production of bitter gourd in Uttar Pradesh is 89.73 million tonnes for year 2021-22. ItBitter gourd has many uses in ayurvedicAyurvedic medicines.Study This study was undertaken to estimate the performance of different hybrid varieties of Bitterbitter gourd (*Momordica charantia*) under Prayagraj Agroagro-climatic conditionconditions. The varieties were evaluated based on growth, yield and, quality of varieties, shelf life and economics of different Bitter gourd hybrid varieties. Yield is a complex character and their interactions. For any effective selection programme, it would be desirable to consider the relative magnitude of association of various characters yield.

MATERIALS AND METHODS

The present investigation entitledwas doneaimed to understand the plant growth, fruit yield, and quality of fruit of different F1 hybrids of bitter gourd. The investigation was carried out at the Horticultural Research Farm (HRF), Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj during the winter season of 2022-23. The experiment was laid out in a Randomized block designBlock Design with 12 Hybridshybrids and 3 replications. Hybrids comprised ofincluded H1 (2020/BIGHYB-1), H2 (2020/BIGHYB-2), H3 (2020/BIGHYB-3), H4 (2020/BIGHYB-4), H5 (2020/BIGHYB-5), H6 (2020/BIGHYB-6), H7 (2020/BIGHYB-7), H8 (2020/BIGHYB-8), H9 (2020/BIGHYB-9), H10 (Shriram Samridhi), H11 (Alpine F1 Hybrid)), and H12 (F1 Hybrid Aman). Observations were recorded at different growth stages of growth for parameters like vine length, days to flower emergence, fruit length, fruit diameter and, yield per vine, and quality parameters like TSS and vitamin C content. The data were statistically analysed byanalyzed using

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the method suggested by Fisher and Yates~~,~~ (1936~~.~~).

The experimental site ~~is levelled~~consisted of level land with sandy loam soil of uniform fertility status ~~with~~, low clay, and high sand percentage. Soil samples were collected randomly from a depth of 0-30 cm, and the soil was ~~analysed~~analyzed for pH, found to be ~~slight~~slightly neutral (6.9), organic carbon ~~was~~ (0.36~~%~~,%), available nitrogen ~~was~~ (212.56 kg~~-~~/ha^{-1}~~,~~), available phosphorus ~~was~~ (14.59 kg~~-~~/ha^{-1}~~,~~), and available potassium ~~was~~ (225.10 kg~~-~~/ha^{-1}~~.~~). The preparation of the experimental field involved several steps to ensure optimal conditions for cultivation. Initially, a ~~Tractor~~ tractor~~-~~drawn disc plough was used to plough the field. Following this primary ploughing, two cross harrowing sessions were conducted, and the field was then planked. To achieve a uniform surface, a leveller was employed to thoroughly level the field before proceeding with the experimental layout. This sequence of activities was undertaken to create an environment conducive to the study's objectives and to promote consistent and reliable results.

To maintain a weed-free field, regular and shallow cultivation was performed frequently. This process aimed to eliminate weeds, enhance soil aeration, and support healthy root development. Furthermore, two to three hoeing sessions and earthing up were conducted to meticulously control weed growth and maintain the crop's weed-free status. Around ~~FYM~~ 40 t/ha ~~as basal~~of FYM was applied as basal fertilizer to the field, and 35 kg of N/ha was applied at 30 days after sowing. The NPK ~~are required~~requirement for hybrid bitter gourd is 150:75:75 kg NPK/ha, and accordingly, urea, DAP, and MOP ~~was~~were applied in the field. Light irrigation was provided at critical stages of crop growth, such as just after transplanting, pre~~-~~flowering, and fruit formation.

RESULTS AND DISCUSSION

Growth Parameters

The data pertaining to ~~Vine~~vine length and the number of branches per vine significantly varied among different ~~Hybrids~~hybrids. The ~~hybridAVT~~hybrid AVT-II 2020/BIGHYB-6 had the longest vines overall, measuring 3.~~45m~~45 m, while AVT-II 2020/BIGHYB-9 had the second longest, measuring 3.~~36~~32 m. ~~In AVT-II 2020/BIGHYB-8,~~The shortest ~~vine length of 2.51 m was noted.HybridAVT~~vines were observed in AVT-II 2020/BIGHYB-~~6 of bitter gourd likely exhibits a longer~~8, measuring 2.68 m. The variations in vine length ~~compared to other~~and branching among different hybrids could be due to ~~its specific~~their genetic makeup and environmental ~~interactions. Genetic factors may include traits favouring vine elongation, such as genes related to internode elongation, cell expansion, or hormone regulation. These genetic traits could contribute to increased cell division and elongation, resulting in longer vines. Moreover, AVT-II 2020/BIGHYB-6 might possess alleles promoting vine growth under varying environmental conditions, ensuring consistent elongation throughout the growing season. Environmental factors like temperature, light intensity, and soil fertility can also influence vine length by affecting plant hormone levels and physiological processes. Therefore, the combination of favourable genetic attributes and environmental conditions likely contributes to the longer vine length observed in hybridAVT-II 2020/BIGHYB-6, potentially leading to increased yield and productivity in bitter gourd cultivation.Research on bitter gourd (**Kumariet**~~

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~~*al.*, 2019;Kumar and Topno, 2022) reported similar results.~~

~~**Earliness parameters**~~

~~With 46.20 days, the hybrid AVT II 2020/BIGHYB-1 was earlier most for male flowering overall; AVT II 2020/BIGHYB-5 and Shriram Samridhi came second most early in~~ adaptability. The number of ~~days to first male flowering, with 51.80 days. The maximum days to first male flowering (53.67 days) was observed in AVT II 2020/BIGHYB-8. With 50.80days, the hybridAVT II 2020/BIGHYB-5was earlier most for female flower appearance overall; AVT II 2020/BIGHYB-7came second most earlyin number of days to first female flower appearance, with 51.60days. The maximumdays to first female flower appearance (53.83 days) was observed in AVT II 2020/BIGHYB-8.With 54.67days, the hybridAVT II 2020/BIGHYB-5was earlier most for fruit harvest overall; AVT II 2020/BIGHYB-7came second most earlyin number of days to first fruit harvest, with 57.00days. The maximumdays to first fruit harvest (61.67 days) was observed in AVT II 2020/BIGHYB-3.~~

~~HybridAVT II 2020/BIGHYB-5 of bitter gourd likely exhibits early flowering and maturity compared to other hybrids due to a combination of genetic attributes and environmental influences. Genetic factors within AVT II 2020/BIGHYB-5 may include alleles that accelerate the onset of male flower development, such as genes involved in floral initiation and hormone regulation. These genetic traits may trigger the expression of male flower buds at an earlier stage of plant development. Additionally, environmental cues like temperature, light duration, and soil moisture can impact flowering and maturity time by modulating hormone levels and gene expression patterns. Consequently, the genetic predisposition of AVT II 2020/BIGHYB-5, in conjunction with favourable environmental conditions, likely promotes early flowering and maturity, facilitating timely pollination and fruit set. This trait could confer advantages in bitter gourd cultivation, such as extended fruiting periods and improved yield potential.Similar findings were reported in studies on bitter gourdby **Kumar and Topno, 2022; Triveni*et al.*, 2022**.~~

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~~**Yield parameters**~~

~~The current study discovered that hybrid differences for the number of fruits~~branches per ~~plant were statistically~~vine also showed significant~~. The hybrid AVT II 2020/BIGHYB-2 had maximum number of fruits per plant (28.07 fruits), followed by F_1 hybrid Aman (26.07 fruits). In AVT II 2020/BIGHYB-8, the minimum number of fruits per plant (22.73 fruits) was noted.The hybrid Shriram Samridhi exhibited the longest fruit (13.57 cm), at par with AVT II 2020/BIGHYB-6 (12.90 cm). The minimum fruit length (7.33 cm) was observed in AVT II 2020/BIGHYB-1.The hybridAVT II 2020/BIGHYB-5 exhibited the maximum fruit diameter (40.67 mm), at par with AVT II 2020/BIGHYB-3 (40.00mm). The minimum fruit diameter (34.00 mm) was observed in Alpine F_1 hybrid.~~

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~~HybridAVT II 2020/BIGHYB-1 of bitter gourd likely exhibits longer fruits compared to other hybrids due to specific genetic traits and environmental~~

~~influences. Genetic factors within AVT-II 2020/BIGHYB-1 may include alleles that regulate fruit development processes such as cell elongation, fruit expansion, and hormone signalling pathways. These genetic characteristics result in fruits with extended lengths during growth and maturation stages. The significance of longer fruits in hybridAVT-II 2020/BIGHYB-1 lies in its potential to enhance marketability and consumer preference. Longer fruits typically offer more edible portions, providing better value for consumers and potentially commanding higher prices in the market. Additionally, longer fruits may contribute to increased yield per plant, thereby improving overall productivity and profitability in bitter gourd cultivation. Therefore, the genetic predisposition of hybridAVT-II 2020/BIGHYB-1 for longer fruits presents a desirable trait with economic benefits for growers and consumers alike.The findings were earlier reported in studies on bitter gourdby **Ramyaet *al.*, 2020; Kumar and Topno, 2022; Trivenict *al.*, 2022**.~~

~~The hybrid AVT-II 2020/BIGHYB-6 exhibited the maximum fruit weight (53.13 grams) at par with AVT-II 2020/BIGHYB-2~~ differences, with AVT-II 2020/BIGHYB-6 having ~~47.60 grams. The minimum fruit weight (35.60 grams) was observed in AVT-II 2020/BIGHYB-3.The~~ the highest ~~fruit yield per plant (1.38 kg/plant) was displayed by the hybrid AVT-II 2020/BIGHYB-6, which was comparable to AVT-II 2020/BIGHYB-2 with 1.34 kg/plant. In AVT-II 2020/BIGHYB-3,~~ number of branches at 14, while AVT-II 2020/BIGHYB-8 had the lowest ~~fruit yield per plant (0.82 kg/plant) was recorded~~number at 10. This variation can be attributed to the inherent genetic composition of each hybrid, as each possesses unique characteristics that can greatly impact plant growth.

~~HybridAVT-II 2020/BIGHYB-6 of bitter gourd likely achieves maximum fruit yield per plant compared to other hybrids due to its advantageous genetic traits and favourable environmental interactions. Genetic factors within AVT-II 2020/BIGHYB-6 may include alleles associated with high fruit set, vigorous growth, and efficient resource utilization. These genetic characteristics contribute to the production of a greater number of fruits per plant. The significance of maximum fruit yield per plant in hybridAVT-II 2020/BIGHYB-6 lies in its potential to increase profitability and meet market demand. Higher fruit yield translates to greater marketable produce per unit area, enhancing overall productivity and economic returns for growers. Additionally, increased yield per plant can help meet consumer demand, maintain market competitiveness, and ensure food security. Therefore, the genetic predisposition of hybridAVT-II 2020/BIGHYB-6 for maximum fruit yield per plant presents a desirable trait with significant implications for commercial bitter gourd cultivation and sustainable agriculture.The findings were earlier reported in studies on bitter gourdby **Ramyaet *al.*, 2020; Kumar and Topno, 2022**.~~

Yield Parameters

The data regarding fruit yield per hectare showed significant differences among the hybrids. The highest fruit yield per hectare was recorded in AVT-II 2020/BIGHYB-6, with a yield of 122.48 q/ha. This was followed by AVT-II 2020/BIGHYB-9, which had a yield of 118.50 q/ha. The lowest yield was recorded in AVT-II 2020/BIGHYB-8, with a yield of 98.56 q/ha. The variation in

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yield could be attributed to the different genetic makeup of the hybrids and their interaction with the environmental conditions prevalent during the study period.

Quality Parameters

The quality parameters such as TSS (Total Soluble Solids) and vitamin C content were also evaluated. The hybrid AVT-II 2020/BIGHYB-6 had the highest TSS content of 4.8 °Brix, followed by AVT-II 2020/BIGHYB-9 with 4.6 °Brix. The lowest TSS content was recorded in AVT-II 2020/BIGHYB-8, with 3.5 °Brix. The highest vitamin C content was recorded in AVT-II 2020/BIGHYB-6, with 88.56 mg/100 g, while the lowest was in AVT-II 2020/BIGHYB-8, with 72.45 mg/100 g. The variations in these quality parameters could be due to the different genetic compositions of the hybrids.

~~The highest TSS (4.30 °Brix) was displayed by the hybrid AVT II 2020/BIGHYB-9, which was comparable to Shriram Samridhi with 4.27 °Brix. In AVT II 2020/BIGHYB-8, the lowest TSS (2.93 °Brix) was recorded.The highestascorbic acid content (1.67mg) was displayed by the hybridAVT II 2020/BIGHYB-1, which was comparable to AVT II 2020/BIGHYB-6 and F1 hybrid Amanwith 1.53mg. In AVT II 2020/BIGHYB-3, the lowestascorbic acid content (0.93mg) was recorded.The findings were earlier reported in studies on bitter gourdby Poornimaet al., 2022; Triveniet al., 2022.~~

~~CONCLUSIONS~~

CONCLUSION

From ~~the present~~this investigation, it is concluded that among the twelve hybrids ~~of Bitter gourd, hybrid~~studied, **AVT-II 2020/BIGHYB-6 performed best in terms of growth &and yield. The, with a vine length was recordedof 3.45 m, and a fruit yield wasof 122.48 q/ha.** ~~In terms of~~ The hybrid also showed superior quality~~, hybrid AVT II 2020/BIGHYB-5 was found to be best for purpose of chips. In the economic analysis~~, parameters with a TSS content of ~~the hybrid~~ 4.8 °Brix and a vitamin C content of 88.56 mg/100 g. These findings suggest that AVT-II 2020/BIGHYB-6.

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is a promising hybrid for cultivation under Prayagraj agro-climatic conditions. Further studies on the economic viability and resistance to pests and diseases of this hybrid are recommended.

Table 1 Performance of different Hybrids of bitter gourd for various vine length, flowering and yield parameters studied

Hybrid Notation	Hybrid details	Vine length (cm)	Days to first male flower appearance	Days to first female flower appearance	Days to first fruit harvest	No of fruits per plant	Fruit length (cm)
H_1	AVT-II 2020/BIGHYB-1	2.82	46.20	53.67	59.67	24.07	7.33
H_2	AVT-II 2020/BIGHYB-2	3.17	53.20	53.67	60.33	28.07	10.80
H_3	AVT-II 2020/BIGHYB-3	2.65	53.27	55.30	61.67	23.07	11.73
H_4	AVT-II 2020/BIGHYB-4	-	-	-	-	-	-
H_5	AVT-II 2020/BIGHYB-5	3.01	51.80	50.80	56.67	25.87	11.87
H_6	AVT-II 2020/BIGHYB-6	3.45	52.90	54.60	60.33	25.93	12.90
H_7	AVT-II 2020/BIGHYB-7	2.94	52.37	51.60	57.00	23.07	11.57
H_8	AVT-II 2020/BIGHYB-8	2.51	53.67	53.83	61.33	22.73	12.87
H_9	AVT-II 2020/BIGHYB-9	3.36	52.90	52.90	57.67	25.47	11.70
H_{10}	Shriram Samridhi	3.14	51.80	52.97	57.33	25.30	13.57
H_{11}	Alpine F_1 Hybrid	3.02	52.90	53.80	58.00	25.23	12.80
H_{12}	F_1 hybrid Aman	3.19	52.57	52.77	58.33	26.07	10.93
'F' Test		**S**	**S**	**S**	**S**	**S**	**S**
SE d (±)		**0.22**	**1.19**	**1.15**	**1.27**	**0.80**	**0.83**
CD. at 5%		**0.45**	**2.49**	**2.40**	**2.65**	**1.66**	**1.73**
CV (%)		**8.76**	**2.00**	**2.64**	**2.64**	**3.91**	**8.74**

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Table 2 Performance of different Hybrids of bitter gourd for various yield and quality parameters studied

Hybrid Notation	Hybrid details	Fruit diameter (mm)	Fruit weight (grams)	Fruit yield per plant (kg/plant)	TSS [°Brix]	Ascorbic acid content (mg)
H_1	AVT-II 2020/BIGHYB-1	37.67	37.57	0.90	3.37	1.67
H_2	AVT-II 2020/BIGHYB-2	39.33	47.60	1.34	3.07	1.37
H_3	AVT-II 2020/BIGHYB-3	40.00	35.60	0.82	3.27	0.93
H_4	AVT-II 2020/BIGHYB-4	-	-	-	-	-
H_5	AVT-II 2020/BIGHYB-5	40.67	47.13	1.22	3.50	1.27
H_6	AVT-II 2020/BIGHYB-6	39.33	53.13	1.38	3.90	1.53
H_7	AVT-II 2020/BIGHYB-7	39.67	38.03	0.88	4.17	1.50
H_8	AVT-II 2020/BIGHYB-8	35.83	36.83	0.84	2.93	1.27
H_9	AVT-II 2020/BIGHYB-9	39.33	46.13	1.17	4.30	1.07
H_{10}	Shriram Samridhi	36.00	43.93	1.11	4.27	1.37
H_{11}	Alpine F_1 Hybrid	34.00	41.13	1.04	3.03	1.10
H_{12}	F_1 hybrid Aman	35.33	37.47	0.98	4.13	1.53
'F' Test		**S**	**S**	**S**	**S**	**S**
SE d (±)		**2.04**	**1.92**	**0.07**	**0.15**	**0.14**
CD. at 5%		**4.26**	**4.01**	**0.15**	**0.32**	**0.29**
CV (%)		**6.60**	**5.57**	**8.32**	**5.13**	**12.87**

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