Original Research Article

Performance Analysis of Tomato cultivars under Hill Agroclimate of Assam

ABSTRACT

Aim: A field experiment was conducted to assess the performance of tomato hybrids Arka Abhed and Arka Rakshak under farmers' field conditions in the Hill agro-climatic zone of Assam.

Study design: The trial was laid out in a Randomized Block Design (RBD) with seven replications.

Place and Duration of the study: All the seven replications were the seven villages representing three blocks of the district during 2022-23, 2023-24 and 2024-25.

Methodology: Three varieties were taken as treatments in the study namely Arka Abhed, Arka Rakshak and Rocky (check). Five plants were selected randomly from every treatment to record data on various yield and growth parameters.

Results: Results indicated that Arka Abhed outperformed all other tested varieties, including the local check (Rocky), in terms of yield and yield-contributing parameters. Among the three cultivars, Arka Abhed recorded the highest fruit yield (402.06 q/ha), followed by Arka Rakshak (363.42 q/ha) and Rocky (282.36 q/ha). Arka Abhed also exhibited superior performance in terms of number of branches per plant (110.53), average fruit weight (126.47 g), and number of fruits per plant (71.22), while Arka Rakshak recorded 12.1 branches, 91.66 g average fruit weight, and 53.66 fruits per plant. The local variety Rocky showed the lowest values for these parameters, with 10.3 branches, 86.87 g fruit weight, and 44.36 fruits per plant. Economic analysis revealed that Arka Abhed achieved the highest gross profit (Rs. 804,120.00/ha) and benefit-cost ratio (5.75), compared to Rocky, which had the lowest gross profit (Rs. 451,776.00/ha) and benefit-cost ratio (3.44).

Conclusion: Based on these findings, Arka Abhed demonstrates significant potential for adoption in the region and may be recommended for wider cultivation to enhance yield and economic returns for farmers in the Hill zone of Assam.

Keywords: *Tomato, Arka Abhed, Karbi Anglong, Hill zone, Multiple disease resistant*

1. Introduction

Tomato (Solanum lycopersicum), a member of the family Solanaceae, is one of the most popular and important vegetables grown throughout the North Eastern region of India, both in the plains and hills. It is cultivated worldwide, both in outdoor and indoor conditions, owing to its wide adaptability and nutritional significance (Singh *et al*., 2014). Tomato is widely used in Indian cuisine-whether cooked, processed, or consumed raw in salads due to its antioxidant and nutritional benefits. It is rich in vitamins, carotenoids, lycopene, and phenolic compounds, making it an important dietary and commercial crop (Palop *et al*., 2010). Lycopene and carotene, in particular, are valued for their anticancer properties (Radzevičius *et al*., 2009). In addition to being consumed as a fresh vegetable, tomato is extensively used in processed products like ketchup, puree, soup, powder, and whole canned fruits. It can be grown in a wide range of soils but performs best in well-drained soils with an optimum temperature of 15°C to 20°C for fruit setting (Anon., 2020).

Karbi Anglong is one of the districts which come under the Hill zone of Assam. The average annual rainfall in the district is 1200 mm, with a maximum temperature of 29°C and a minimum of 17°C. Tomato is one of the major vegetable crops grown in the district, cultivated by both marginal farmers and commercial growers for the fresh market. It is grown over an area of about 608 hectares, producing approximately 12,169 metric tonnes. The main tomato-growing areas in Karbi Anglong include Barlangpher, Diphu, Bokolia, Rajapathar, Bokajan, Natun Basti, Lekthe Basti, and Hogolakota. Most farmers in the hills or interior areas still cultivate traditional varieties, while a few growers in the plains are aware of and use hybrid and improved varieties. Although many hybrid varieties are available in the market, farmers often find them inconsistent in performance across seasons. Additionally, the use of unknown seed sources, poor seed quality and germination, as well as high disease and insect pest incidence, remain significant challenges at the farmers' level. Keeping these issues in view, an On-Farm Testing (OFT) was conducted by Krishi Vigyan Kendra (KVK), Karbi Anglong, Assam Agricultural University, Diphu, at farmers' fields to evaluate the best tomato variety with desirable yield-attributing traits for the district.

2. Materials and Methods

The present experiment was conducted at farmers' fields across seven locations-Shantibasti, Khotkhoti, Barlangpher, Sedang Terang Gaon, Rajapathar, Bokolia, and Diphu during the Rabi seasons of 2022-23, 2023-24, and 2024-25. The experiment was conducted using three treatment options (TO), which included the following tomato varieties: Arka Abhed (TO1), Arka Rakshak (TO2), and Rocky (Farmers' practice) as the check. Both Arka Abhed and Arka Rakshak are multiple disease-resistant varieties, showing resistance to Tomato Leaf Curl Virus, Bacterial Wilt, and Early Blight. Additionally, Arka Abhed is also resistant to Late Blight, in addition to the diseases.

The study was laid out in a Randomized Block Design (RBD) with three treatments and seven locations serving as replications. Seedlings were raised in nursery beds of 2 m × 1 m size, elevated 5 cm above the soil surface to ensure proper drainage. Seeds were sown in rows spaced 15 cm apart and lightly covered with fine soil.

Transplanting was done using a spacing of 60 cm between plants and 45 cm between rows. All other cultivation practices were carried out according to the recommended Package of Practices of Assam Agricultural University (2023) to ensure healthy crop growth. Regular monitoring and frequent field visits were conducted to maintain proper care of the experimental plots.

For data collection, five tomato plants were randomly selected to record observations on plant height, number of fruits per plant, average fruit weight, fruit length, and fruit breadth. The mean data collected over three years were pooled and statistically analyzed as per the method described by Panse and Sukhatme (1967).

3. Results and Discussion

3.1 Growth parameters

Plant height is a key agronomic trait influencing the overall growth and vigour of plants (Premalakshmi et al., 2017). As shown in Table 1, the variety Arka Abhed recorded the greatest plant height (110.56 cm), while the check variety Rocky had the shortest (83.43 cm). The observed variation in plant height among hybrids may be attributed to inherent genetic differences, consistent with the findings of Hazarika and Phookan (2005). Regarding the number of primary branches per plant, Arka Abhed exhibited the highest count (14.6), followed by Arka Rakshak (12.10), whereas Rocky had the lowest (10.30). A greater number of branches in a particular hybrid may be influenced by favourable agro-climatic conditions (Prasad and Bahadur, 2019). Additionally, variation in branching among different varieties may result from their genetic makeup or genotype–environment interactions across locations (Iqbal et al., 2011; Tujuba and Ayana, 2020).

The study also revealed that Arka Abhed required the fewest days to reach 50% flowering (33.65), followed by Arka Rakshak (36.60), whereas the check variety Rocky took the longest time

(39.47 days). These findings align with those reported by Monirul et al. (2011). Earliness in flowering often leads to early yield (Wang, 2004), which might be due to the cultivar's enhanced capacity to efficiently distribute assimilates throughout the plant, including the apical portions prior to flower initiation (Dieleman and Heuvelink, 1992).

Table 1: Performance evaluation of tomato cultivars for growth parameters (pooled data)

Treatment options (TO)	Plant height (cm)	No. of branches	Days to 50 % flowering
TO1: Arka Abhed	110.56	14.6	33.65
TO2: Arka Rakshak	98.21	12.1	36.60
Check: Rocky (FP)	83.43	10.3	39.47
SE_d	1.56	0.38	1.03
CD	3.44	0.83	2.27

3.2 Reproductive characters

The number of fruits per plant is one of the crucial traits to consider while selecting a cultivar for tomato cultivation. In this study, significant differences were observed among the varieties for this trait. Among all the tested varieties, Arka Abhed recorded the highest number of fruits per plant (71.22), while the lowest number was recorded by Rocky (44.36). This variation might be attributed to the fact that an increase in the number of branches leads to a higher number of fruit-producing buds, which ultimately results in a greater number of fruits. These findings are in agreement with earlier reports by Islam *et al*. (2012), Marbhal *et al*. (2016), Kayess *et al*. (2017), and Vijeth *et al*. (2018), all of whom noted that most hybrids performed significantly better than control varieties in terms of total fruit production. Eshteshabul *et al*. (2010) and Falak *et al*. (2011) also reported a wide range of variation in the average number of fruits per plant, ranging from 4.46 to 98.30. In addition to fruit count, fruit size is another important character, as it affects the market appeal and overall quality of the produce. According to the data in Table 2, Arka Abhed also recorded the highest fruit length (5.8 cm) and fruit diameter (6.1 cm), whereas the lowest values were again observed in Rocky (4.8 cm length and 5.1 cm diameter). The variability in fruit size among the varieties may be attributed to genetic differences, as reported by Ali *et al*. (2012), Saleem *et al*. (2013), Said *et al*. (2014), and Singh *et al*. (2020). Furthermore, biotic and abiotic stresses during the growing period, and each variety's ability to withstand such stresses especially during the reproductive phase may also contribute to differences in fruit development (Tujuba and Ayana, 2020).

In terms of fruit weight, the highest value was recorded by Arka Abhed (126.47 g), followed by Arka Rakshak (91.66 g), while Rocky recorded the lowest fruit weight (86.87 g). Significant differences in yield were also found among the varieties. Arka Abhed once again exhibited superior performance, recording the highest yield of 402.06 quintals per hectare, followed by Arka Rakshak (363.42 quintals per hectare), with Rocky showing the lowest yield (282.36 quintals per hectare). This variation in yield could be due to the genetic potential of the variety, greater fruit set, and favorable agro-climatic conditions (Jindal et al., 2018). Additionally, increased yield might also be attributed to traits like greater plant height and higher number of branches, which enhance photosynthetic activity, leading to optimum assimilates utilization and partitioning and thereby increasing the number of active fruit buds (Tujuba and Ayana, 2020).

Table 2: Performance evaluation of tomato cultivars for reproductive characters (pooled data)

Treatment options (TO)	Fruit length (cm)	Fruit diameter (cm)	No. of fruits per plant	Average fruit weight (g)
TO1: Arka Abhed	5.8	6.1	71.22	126.47
TO2: Arka Rakshak	4.9	5.5	53.66	91.66
Check: Rocky (FP)	4.8	5.1	44.36	86.87
SE_d	0.22	0.10	1.94	1.05
CD	0.49	0.23	4.28	2.33

4. Economics

As shown in Table 3, the highest gross profit was recorded for Arka Abhed (Rs. 804,120.00) with a benefit-cost ratio of 5.75, followed by Arka Rakshak (Rs. 654,156.00) with a benefit-cost ratio of 4.69. In contrast, the lowest gross profit was observed in the case of Rocky (Rs. 451,776.00), which had a benefit-cost ratio of 3.44. The higher gross returns observed in Arka Abhed and Arka Rakshak can be attributed to a greater number of fruits and higher yield per hectare, which consequently resulted in higher benefit-cost ratios.

Table 3: Economics of tomato cultivars (pooled data)

Treatment options (TO)	Yield (q/ha)	Gross cost (Rs./ha)	Gross profit (Rs./ha)	B:C ratio
TO1: Arka Abhed	402.06	139847	804120	5.75
TO2: Arka Rakshak	363.42	131636	654156	4.69
Check: Rocky (FP)	282.36	131200	451776	3.44

5. Conclusion

Based on the above discussions and results, it can be concluded that the tomato variety Arka Abhed performed exceptionally well under the agro-climatic conditions of the Karbi Anglong district. This variety outperformed others in terms of plant height, number of branches, number of fruits per plant, fruit weight, and overall yield. Additionally, Arka Abhed helps reduce the additional costs associated with managing bacterial blight, leaf curl virus, early blight, and late blight diseases. Therefore, it is recommended for tomato cultivation to achieve higher yield, productivity, and economic returns. Furthermore, Arka Abhed may be promoted for large-scale demonstration and adoption in the Karbi Anglong district of Assam.

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