

## PERFORMANCE OF BARI TOMATO VARIETIES UNDER LATE WINTER PLANTING IN DINAJPUR REGION

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### Abstract

An experiment was carried out at Agricultural Research Station, Bangladesh Agricultural Research Institute (BARI), Dinajpur during the *rabi* seasons of 2020 and 2021 to find the suitable tomato variety for late planting, when tomato demand and price remain higher on the market. A split-plot design with three replications was used where four planting dates viz., 15 January, 30 January, 15 February and 28 February in main plot and four varieties viz., BARI Tomato-15, BARI Tomato-16, Local (Rani) in sub-plot. The result showed that both variety and planting dates were a significant effect on tomato fruit yield and yield contributing traits. In case of variety, BARI Tomato-16 gave the maximum fruit yield (51.31 t ha<sup>-1</sup>) compared to other varieties. Regarding of planting date, 15 January was found suitable time for getting the highest tomato fruit yield (56.79 t ha<sup>-1</sup>). The interaction effect showed that var. BARI Tomato-16, which was planted on 15 January yielded the higher fruit yield (66.16 t ha<sup>-1</sup>) followed by BARI Tomato-15 (54.40 t ha<sup>-1</sup>). Local (Rani) cultivar planted on 28 February produced the lowest yield (25.10 t ha<sup>-1</sup>). The results of the economic analyses showed that the var. BARI Tomato-16 planted on 15 February had the highest gross return (Tk. 2255000 ha<sup>-1</sup>), gross margin (Tk. 2057100 ha<sup>-1</sup>) and benefit cost ratio (11.39) followed by BARI Tomato-16 planted on 28 February.

Keywords: Tomato, Off- season, Fruit yield, Cost-benefit ratio

### Introduction

Tomato (*Lycopersicon esculentum* L.) is one of the most popular and nutrient rich vegetables in the globe as well as in Bangladesh. It is a good source of calcium, iron, vitamin C, and vitamin A. Due to its adaptability to a wide range of soil and climate, it is grown all across the Bangladesh. Due to its superior nutritive and processing features, demand for it on both the domestic and international markets have multiplied. BARI has taken the initiative to develop off-season tomatoes in light of the rising demand and significance of the tomato. Although there is a high demand for tomatoes throughout the year but country's output is centered in the winter months. Fruit setting and subsequent

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development are inhibited by high temperatures before and after the brief winter season. The predominant high summer temperatures are primarily to blame for tomato being unavailable throughout the summer and rainy seasons (Abdalla and Verkerk, 1968). Around 30°C is the recommended temperature for tomato flower setting. Up to 35°C, they can still maintain their blooms, but after that point, they will start to fade. The petals drop off before they can form a tomato after 30°C for any period of time, and fruit yield declines quickly (www.early-tomato.com. 2009). Under high temperature circumstances (over 30°C), there are significant differences across cultivars in terms of flowering and fruiting. Bangladesh's off-season tomato farming is severely hampered by high temperatures and extremely high rainfall.

Farmers in the Dinajpur areas are growing tomatoes that produce late. The farmers are getting more interested in growing late tomatoes than any other crop since they are more profitable in the Dinajpur region. About 1200 hectares of land were used to grow late tomatoes in 2020-2021. (DAE, 2021). However, the majority of farmers use native or Indian varieties, which are particularly sensitive to pests and disease and provide low yields. Some tomato cultivars that can produce a higher yield than the native ones have been developed by Bangladesh Agricultural Research Institute (BARI). Therefore, by picking the right variety and timing for planting, it is still possible to harvest tomatoes until the late season. During the pick season, tomatoes are very cheap. However, following that, the cost of the tomato continuously increases. By growing tomatoes in the late season, the supply of tomatoes can be increased. The potential of the tomato cultivars that BARI released in the Dinajpur region's agro-ecology has yet to be determined. Therefore, the study was conducted to find out tomato varieties responded to the region's agro-climatic conditions during the late *rabi* season.

## Materials and Method

### Experimental site description

The experiment was carried out at the Agricultural Research Station, Bangladesh Agricultural Research Institute (BARI), Dinajpur, during two consecutive late rabi season of 2020 and 2021. The experimental site was located at Latitude: 25°386.09' N and Longitude: 88°393.17' E at an elevation of 38 m above mean sea level and it belongs to the Agro-ecological Zone-1 (Old Himalayan piedmont plain) in Bangladesh (FRG, 2018). The initial soil sample (0-15 cm) was tested at the Soil Resources Development Institute (SRDI), Dinajpur, Bangladesh. The soil at the experimental area was medium-high and clay loam texture having 2.11% organic matter, pH 6.11, 0.09% total nitrogen (N), 0.11 meq 100 g<sup>-1</sup> soil potassium (K), 45.20 µg/g phosphorus (P), 7.12 µg/g sulfur (S), 0.90 µg/g zinc (Zn) and 0.30 µg/g boron (B).

### **Experimental design and treatments**

The experiment was laid out in a split plot design with 3 replications. The experiment was consisted of four planting dates viz. 15 January, 30 January, 15 February and 28 February and three varieties viz. BARI Tomato-15, BARI Tomato-16 and one Local (Rani) as treatments. Planting dates were assigned in the main plot and varieties in the sub-plot. The unit plot size was 2.4 m×2 m.

### **Crop husbandry**

Tomato var. BARI Tomato-15, BARI Tomato-16 along with one local cultivar was used in this experiment. Seeds of BARI variety was collected from Olericulture Division, HRC, Bangladesh Agricultural Research Institute, Bangladesh. The crop was fertilized with 10 tons of cowdung and 100-34-104-27-1.5-1.3 kg ha<sup>-1</sup> N-P-K-S-Zn-B through urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively (FRG'20). Total amount of cow dung, one third of MOP and full dose of P, S, Zn and B were applied during final land preparation. Urea and rest of MOP were applied in two equal installments at 21 and 35 Days After Transplanting (DAT) followed by light irrigation. Thirty days old seedling were planted as per treatment maintaining 60cm × 40cm spacing between and within rows. Leaf curl is a viral disease and is spread by white flies. Since the virus is spread by whitefly infestation to control white fly spray Admire/Tido plus or Emitaf 0.5ml/L of water at least twice in 15 consecutive days from one week after planting to flowering.

### **Data collection**

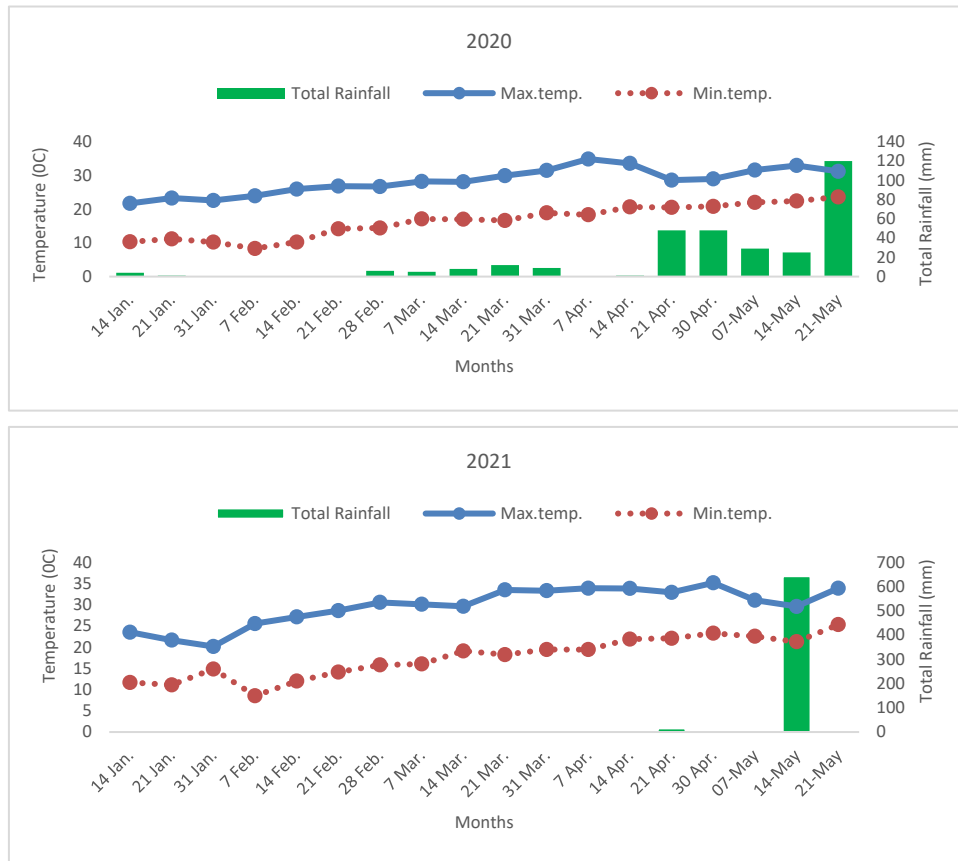
Data on the yield components were taken from 5 randomly selected plants from each plot. At harvest, the yield was recorded from the whole plot and then calculated per hectare basis. Data on number of clusters per plant, number of flowers per cluster, number of fruits per cluster, fruit length, fruit diameter, average fruit weight, number of fruits per plant and yield were taken and analyzed statistically by using R software packages and mean differences for each character were compared by Least Significant Difference (LSD) test at 5% level of probability (Gomez and Gomez. 1984).

### **Assessment of economic indices**

The economic analysis took total variable costs (TVC) and gross returns (GR) into account. The variable costs included human labour, machinery rent and production inputs (seed, fertilizer, pesticides). Gross returns were determined by multiplying crop economic yield by price at harvesting time. The difference between GR and TVC was used to determine the gross margin (GM) (GM=GR -TVC). Benefit-cost ratio was calculated to determine the benefit and effect of competition among the treatments.

**Weekly maximum and minimum air temperature and total rainfall**

The detailed meteorological data in respect of air temperature and total rainfall recorded by meteorological Department, Dinajpur during the period of study have been presented in Figure 1. The highest maximum air temperature was observed in 1<sup>st</sup> week of April (34.89<sup>o</sup>C) and the lowest (21.72<sup>o</sup>C) in 1<sup>st</sup> week of January in 2020. The highest maximum air temperature was observed in 1<sup>st</sup> week of April (35.12<sup>o</sup>C) and the lowest (20.15<sup>o</sup>C) in last week of January in 2021. On the other hand, the highest minimum air temperature (23.64<sup>o</sup>C) was observed in 3<sup>rd</sup> week of May and the lowest minimum air temperature (8.34<sup>o</sup>C) in 1<sup>st</sup> week of February in 2020. The highest minimum air temperature (25.29<sup>o</sup>C) was observed in 3<sup>rd</sup> week of May and the lowest 8.34<sup>o</sup>C in 1<sup>st</sup> week of February and the lowest minimum air temperature (8.53<sup>o</sup>C) in 1<sup>st</sup> week of February in 2021. Maximum rainfall 120 mm occurred in 3<sup>rd</sup> week of May in 2020 and 642mm rainfall in 2<sup>nd</sup> week of May in 2021 during the growing periods.



**Fig. 1. Weekly average maximum and minimum temperature and total rainfall during the cropping period from 2020 and 2021 at ARS, BARI, Dinajpur**

## Results and discussion

### Effect of planting date

The late winter planting period has a significant impact on tomato growth, yield and yield-related factors. The quantity, weight and production of tomatoes were steadily reduced by delayed planting. Regarding yield and yield qualities, there was a considerable variations between the planting dates (Table 1). Planting dates had a substantial effect on tomato clusters per plant. Early planting (January 15) followed by January 30 planting produced the largest number of clusters per plant (16.78). Planting on January 15 generated the most flowers per cluster (11.24) whereas February 28 produced the fewer flowers per cluster (6.10) in both years. This outcome was consistent with Hossain et al., 1986 and Ahammad et al., 2009's results that early planting increased the overall quantity of blossoms per plant. A nearly same pattern was discovered for fruit setting per cluster (Table 1). Early planting produced fruits that were larger than those planted in two subsequent years (5.92 cm×5.32 cm).

The January 15 planting produced the maximum average fruit weight (61.30 g), which was followed by the January 30 planting (59.86 g) in two consecutive years. The planting on January 15 produced the most fruits per plant (18.19), while the planting done later produced the fewer fruits per plant (12.70). This outcome was in agreement with those of Taha et al., 1984 and Yasmin et al., 2019. Because high temperatures and heavy rains reduced flower formation and/or caused bud and blossom drop, the crop grew from January 15 planting generated the highest marketable fruit yield (56.79  $\text{tha}^{-1}$ ) and the lowest (32.53  $\text{tha}^{-1}$ ) were from February 28 planting dates in both years. This might be as a result of enhanced photosynthesis accumulation in the fruits and improved photosynthesis translocation from source to sink. Levy et al., 1978; Dane et al., 1991; Sato et al., 2006 and Bhattarai et al., 2016 reported that high temperature between 15°C and 20°C is optimum for fruit setting of tomato. In January and February, the flower and fruit production were hampered by the average daytime temperature of 23.30°C to 27.5°C. According to Abdul and Harris, 1978; Sasaki et al., 2005; Beppu et al., 2001; Leonard and Kinet, 1982 temperature has an impact on the concentration of endogenous hormones. They discovered that immature leaves with low temperatures had lower levels of several gibberellins, which was linked to more blooms. This could be the reason for the increased fruit and blossom production after the 15 January planting.

**Table 1. Effect of planting date on the fruit yield and yield contributing character of tomato (pooled of two years)**

Planting date	No. of clusters/plant	No. of flowers/cluster	No. of fruits/cluster	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (g)	No. of fruits/plant	Fruit Yield (t ha <sup>-1</sup> )
Jan.15	16.78	11.24	5.61	5.92	5.32	61.295	18.19	56.79
Jan.30	10.97	9.25	4.78	5.42	5.02	59.865	16.77	48.87
Feb.15	10.48	7.44	3.77	5.24	4.82	59.085	14.00	40.34
Feb.28	9.90	6.10	3.04	4.58	4.50	58.565	12.70	32.53
LSD (0.05)	2.07	1.28	1.31	7.58	7.78	1.51	3.55	2.00
CV (%)	3.62	6.33	12.14	4.24	2.37	2.48	2.43	4.17

**Effect of Variety**

The varieties sown in the late rabi season had a substantial effect on tomato yield and yield components (Table 2). In two consecutive years, var. BARI Tomato-16 generated the most clusters per plant (13.62) while Local variety produced the fewer clusters per plant (11.11). In both years, BARI Tomato-16 had the most blooms per cluster (9.66), whereas Local variety had the fewer (7.95). In both years, the local variety had the lowest number of fruits per cluster (3.97) while the BARI Tomato-16 had the highest number of fruits per cluster (5.00). The variety BARI Tomato-16 followed by BARI Tomato-15 (5.34 cm) had the longest fruits (5.91 cm), whereas the Local variety had the shortest fruits (4.62 cm) in both years. However, BARI Tomato-16 and BARI Tomato-15 at par with largest fruit diameter (5.15 cm), while the smallest fruit diameter (4.65 cm) was measured in a local variety. BARI Tomato-16 had the maximum average fruit weight (66.38 g), followed by BARI Tomato-15 (61.83 g), and local variety had the lowest average fruit weight (50.90 g) in both years. In two consecutive years, the variety BARI Tomato-16 had the largest amount of fruits (19.94), while a local variety had the fewer fruits (11.99). Mohammed (1995) and Mahmoud (1995) both reported comparable outcomes (2005). The BARI Tomato-16 gave the highest marketable fruit yield (51.31 t ha<sup>-1</sup>), whereas the local variety produced the lowest fruit yield (38.75 t ha<sup>-1</sup>) in both years. This might be as a result of its maximum fruit size, average fruit weight and no. of fruits per plant.

**Table 2. Effect of variety on the yield and yield contributing character of tomato (pooled of two years)**

Variety	No. of clusters/plant	No. of flowers/cluster	No. of fruits/cluster	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (g)	No. of fruits/plant	Fruit Yield (t ha <sup>-1</sup> )
BARI Tomato-15	11.37	7.91	3.94	5.34	4.95	61.83	14.32	43.85
BARI Tomato-16	13.62	9.66	5.00	5.91	5.15	66.38	19.94	51.31
Local	11.11	7.95	3.97	4.62	4.65	50.90	11.99	38.75
LSD (0.05)	0.57	0.64	0.57	1.62	1.29	2.79	0.67	1.15
CV (%)	4.24	7.76	11.69	4.52	2.38	2.85	4.59	2.77

**Combined effect of planting date and varieties on the performance of tomato**

Different yield characteristics were impacted by the combined effect of planting time and variety (Table 3). BARI Tomato-16 with January 15 planting showed greater performance than other combinations in terms of cluster size (19.92), flowers per cluster (13.91) and quantity of fruits per cluster (6.96). However, compared to other planting dates in both years, the fruit size of the BARI Tomato-16 with January 15 planting was greater (6.64 cm×5.62 cm). The BARI Tomato-16 with a planting date of January 15 produced the most average fruit weight (67.91g). On the other hand, BARI Tomato-16, planted on January 15, produced the most fruits per plant (22.40), followed by January 30 of same variety (22.37) in both years. BARI Tomato-16, planted on January 15, produced the highest marketable fruit output (66.16 t ha<sup>-1</sup>) followed by BARI Tomato-15 (54.40 t ha<sup>-1</sup>) and BARI Tomato-16 (53.87 ha<sup>-1</sup>) while the local variety, planted on February 28 produced the lowest yield (25.10 t ha<sup>-1</sup>) for two consecutive years.

**Cost benefit analysis**

Cost-benefit study was conducted in two years' value of tomato fruit yield shown in table 4. The variety BARI Tomato-16 planted on February 15 had the highest gross return (Tk. 2255000 ha<sup>-1</sup>), net return (Tk. 2057100 ha<sup>-1</sup>), and benefit cost ratio (11.39), followed by BARI Tomato-16 planted on February 28. The BCR showed that every treatment combination between variety and planting date was profitable and practical economically viable. However, because of the late sowing situation, a good tomato harvest can be generated if the farmers adopt all essential management practices. Low tomato prices are expected to persist on the market through the middle of the rabi season. When tomato output and supply fell but consumer demand remained high, the price started to rise in late March and early April. Because of this situation late planting conditions were found more advantageous to farmers in terms of high economic return, even though tomato yield was found to be lower in 15 February and 30 February planting of tomato seedling compared to 15 January and 30 January planting of tomato seedling.

**Table 3. Interaction effect of planting date and variety on the yield and yield contributing character of late planting tomato (pooled of two years)**

Treatment combination	No. of clusters/plant	No. of flowers/cluster	No. of fruits/cluster	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (g)	No. of fruits/plant	Fruit Yield (t ha <sup>-1</sup> )
P <sub>1</sub> V <sub>1</sub>	14.23	10.91	3.95	5.61	5.43	62.89	17.75	54.40
P <sub>1</sub> V <sub>2</sub>	19.92	13.91	6.96	6.64	5.62	67.91	22.40	66.16
P <sub>1</sub> V <sub>3</sub>	16.19	8.88	5.90	5.50	4.9	53.09	14.41	49.81
P <sub>2</sub> V <sub>1</sub>	10.31	8.92	4.90	5.62	4.89	60.70	15.08	48.61
P <sub>2</sub> V <sub>2</sub>	12.25	9.92	4.92	5.99	5.37	67.40	22.37	53.87
P <sub>2</sub> V <sub>3</sub>	10.75	8.90	4.50	4.63	4.78	51.49	12.83	44.14
P <sub>3</sub> V <sub>1</sub>	9.81	6.88	3.50	5.32	4.75	62.04	13.01	39.95
P <sub>3</sub> V <sub>2</sub>	11.33	8.89	4.91	5.88	5.09	64.85	18.41	45.10
P <sub>3</sub> V <sub>3</sub>	10.29	6.53	2.92	4.49	4.61	50.36	10.58	35.97
P <sub>4</sub> V <sub>1</sub>	10.12	5.91	3.03	4.77	4.52	61.70	11.42	32.41
P <sub>4</sub> V <sub>2</sub>	10.95	6.48	3.17	5.10	4.72	65.33	16.53	40.08
P <sub>4</sub> V <sub>3</sub>	8.63	5.80	2.91	3.84	4.27	48.66	10.14	25.10
LSD <sub>(0.05)</sub>	1.14	1.27	1.14	3.24	2.59	2.79	1.33	2.29
CV (%)	4.24	7.76	11.69	4.52	2.38	2.85	4.59	2.77

P<sub>1</sub>=15 January, P<sub>2</sub>=30 January, P<sub>3</sub>=15 February, P<sub>4</sub>=28 February, V<sub>1</sub>=BARI Tomato-15, V<sub>2</sub>=BARI Tomato-16, V<sub>3</sub>=Local (Rani)

**Table 4. Benefit-cost analysis of late planting tomato in respect to different treatments**

Treatment combination	Gross return (Tk. ha <sup>-1</sup> )	Total variable cost (Tk. ha <sup>-1</sup> )	Gross margin (Tk. ha <sup>-1</sup> )	BCR
P <sub>1</sub> V <sub>1</sub>	1632000	197900	1434100	8.25
P <sub>1</sub> V <sub>2</sub>	1984800	197900	1786900	10.03
P <sub>1</sub> V <sub>3</sub>	1494300	197900	1296400	7.55
P <sub>2</sub> V <sub>1</sub>	1458300	197900	1260400	7.36
P <sub>2</sub> V <sub>2</sub>	1616100	197900	1418200	8.17
P <sub>2</sub> V <sub>3</sub>	1324200	197900	1126300	6.69
P <sub>3</sub> V <sub>1</sub>	1997500	197900	1799600	10.09
P <sub>3</sub> V <sub>2</sub>	2255000	197900	2057100	11.39
P <sub>3</sub> V <sub>3</sub>	1798500	197900	1600600	9.08
P <sub>4</sub> V <sub>1</sub>	1620500	197900	1422600	8.19
P <sub>4</sub> V <sub>2</sub>	2004000	197900	1806100	10.13
P <sub>4</sub> V <sub>3</sub>	1255000	197900	1057100	6.34

Average market price: Tomato 30 Tk.kg<sup>-1</sup> (Treat. Comb.1-6) and 50 Tk.kg<sup>-1</sup> (Treat. Comb.7-12)

P<sub>1</sub>=15 January, P<sub>2</sub>=30 January, P<sub>3</sub>=15 February, P<sub>4</sub>=28 February, V<sub>1</sub>=BARI Tomato-15, V<sub>2</sub>=BARI Tomato-16, V<sub>3</sub>=Local (Rani)



### Conclusion

Tomato var. BARI Tomato-16, which was planted on January 15 produced the maximum fruit yield, followed by BARI Tomato -15 in both the years. However, the variety BARI Tomato-16 planted on February 15 gave the highest benefit-cost ratio (11.39), followed by BARI Tomato-16 planted on February 28 BCR (10.13). Since the market price of tomato during the winter season often remains low and declined until the end of February, it then increased in March and beyond. Because of this, it's possible that the tomato varieties BARI Tomato-15 and BARI Tomato-16 planted on 15 February and 28 February (during the late rabi season) could be more profitable and economically feasible for tomato producers in the Dinajpur region.

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