

# The Yield and Diseases-Pest Performance of Breeding Materials for Tomatoes (*Lycopersicon esculentum*) Sourced from Different Exotic Sources

Akm Quamruzzaman\*, Limu Akter

Olericulture Division, Horticulture Research Center, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh  
Email: \*akmqzs@gmail.com

**How to cite this paper:** Quamruzzaman, A. and Akter, L. (2024) The Yield and Diseases-Pest Performance of Breeding Materials for Tomatoes (*Lycopersicon esculentum*) Sourced from Different Exotic Sources. *American Journal of Plant Sciences*, 15, 766-776.  
<https://doi.org/10.4236/ajps.2024.159049>

**Received:** May 17, 2024

**Accepted:** September 17, 2024

**Published:** September 20, 2024

Copyright © 2024 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).  
<http://creativecommons.org/licenses/by/4.0/>



Open Access

## Abstract

A study was conducted with 36 tomato germplasm [PGRC (19), The Netherlands (7), Japan (2), and Bangladesh (9)] with 3 check varieties in the research field of the Olericulture Division of Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Gazipur during the winter season of 2022-23 to identify promising tomato breeding germplasm. All the germplasm showed differences in most of the parameters studied. Considerable variation was observed for fruit yield per hectare varied from 39 to 144 tons, while the highest fruit yield per hectare was harvested from the germplasm viz., BD 7759B, BD 7757, BD 7751, BD 7301, QM, BD 7759A, BD 7762, QF, BD 7753, BD 8886, BD 10351, NL-1A, SLA-19. The number of locules, total soluble solids (TSS) and plant height at last harvest varied from 2 to 6.6, 2.6 to 5.9%, and 66 to 154cm, respectively. The TYLCV infection (%) and leaf-sucking pest infestation (%) were observed with a 1 to 20% range in the field condition in both cases. So, we can select that germplasm has zero per cent infestation. Considering the plant growth habit, earliness, different yield contributing horticultural traits, virus and pest infestation thirteen germplasm viz., BD 7759B, BD 7757, BD 7751, BD 7301, QM, BD 7759A, BD 7762, QF, BD 7753, BD 8886, BD 10351, NL-1A, SLA-19 were selected as breeding materials for further tomato improvement program.

## Keywords

*Lycopersicon esculentum*, Tomato, TYLCV, Leaf-Sucking Pest, Fruit Yield

## 1. Introduction

Tomato (*Solanum lycopersicum*) is the second most important world consumable vegetable after potatoes, ranks first among the processing crops [1] and belongs to the Solanaceae family [2]. It is one of the most important vegetables in Bangladesh. Its demand is increasing day by day in our country. However, its national average yield is 15.17 t/ha, which is very low compared to other tomato-growing countries due to a lack of high-yielding tomato varieties. They are nutritious and contain vitamins A, B, and C, iron, and phosphorus [3]. They also contain antioxidants like carotenes, ascorbic acid, and phenolic compounds which help to prevent some diseases [4]. As it is a relatively short-duration crop and gives a high yield, it is economically attractive and the area under cultivation is increasing daily. Moreover, tomatoes contribute to a healthy, well-balanced diet and are rich in minerals, essential amino acids, sugars, and dietary fibers. Tomato fruits are consumed fresh in salads or cooked in sauces, soup, and meat or fish dishes [5]. It is rich in a plethora of natural antioxidants and bioactive compounds. The regular ingestion of an adequate amount of fresh tomatoes or processed tomato products has been inversely correlated with the development of widespread human diseases [6].

This protective effect has been mainly attributed to the carotenoid constituents of the fruits, particularly lycopene and *beta-carotene*, which act as antioxidants in detoxifying free radicals [7].

It is reported that both fresh and processed tomatoes constitute significant amounts of the produced vegetable crops. In addition to the large production values, the tomato is an important source of antioxidant intake. The essential phytonutrients found in the tomato fruit are lycopene,  $\beta$ -carotene,  $\alpha$ -tocopherol, polyphenols, and ascorbic acid, and antioxidant activity depends on the cultivar, environmental parameters, and method of production and processing. The ripe tomatoes have important outside quality characteristics: uniform size, red colour, and good aroma and texture, but these external qualities do not reflect perfectly the nutritional content.

Bangladesh Agricultural Research Institute (BARI) has developed a good number of tomato varieties. Since farmers' and consumers' preferences have diverged, more tomato varieties need to be developed. Germplasm collection and evaluation is the first and continuous process to develop a new tomato variety. As part of this activity, BARI has collected some tomato germplasm from Plant Genetic Resources Center (PGRC) of BARI, The Netherlands, Japan and local sources. Therefore, the study was undertaken to evaluate the performance of the collected 36 tomato germplasm for selecting superior breeding materials.

## 2. Materials and Methods

### 2.1. Experimental Site

The experiment was conducted at the Olericulture Division of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Bangladesh. The

experimental field was at the sub-tropical region of 23.9920°N Latitude and 90.4125°E Longitudes having an elevation of 8.2 m from sea level.

## 2.2. Treatments and Plant Materials

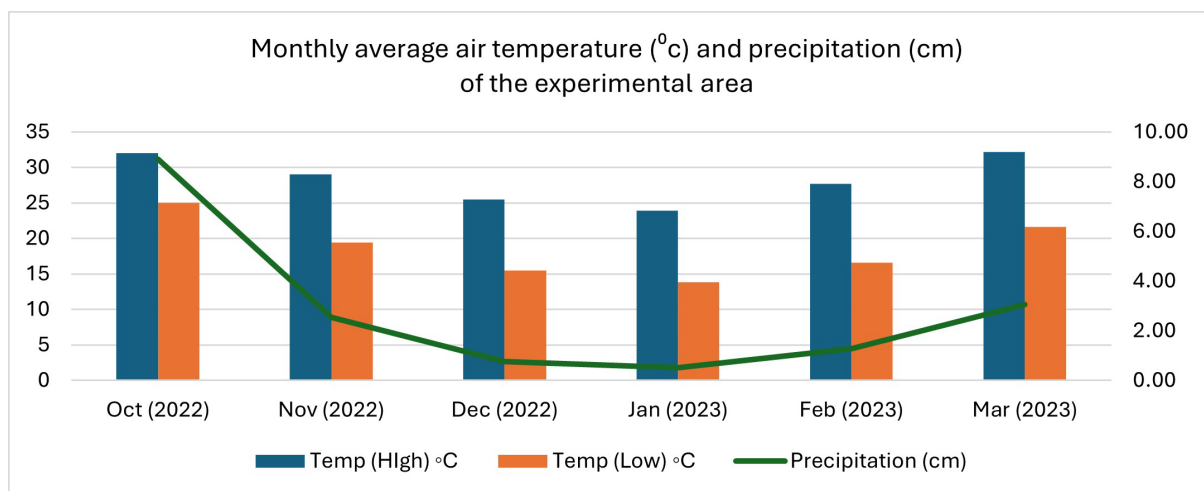
Thirty nine tomato germplasm/varieties [PGRC (19), The Netherlands (7), Japan (2), and Bangladesh (9) and 3 check varieties] were incorporated in this study. The 39 tomato germplasm/varieties seeds were sown on the polyplot on 01 October 2022. Thirty days old seedlings were transplanted in the main field on 01 November 2022.

## 2.3. Land Preparation and Fertilization

The experiment was laid out in a Randomized Complete Block design with three replications. The unit plot size was 5.0 × 1.0m, maintaining 60 × 50 cm spacing and a 0.5m drain. The experimental area was enriched with organic manure, Nitrogen, Phosphorus, Potassium, Sulphur, Zinc and Boron @ 3,000, 250, 90, 125, 20, 3 and 2 kg/ha, correspondingly. One-third of the organic manure, 50% Phosphorus and full of Sulphur, Zinc and Boron were incorporated for the period of last land-dwelling preparation. The rest of the organic fertilizer Phosphorus and 1/3 of Potassium were applied as basal in the pit. The organic manure plays an important role towards plant growth and development [8]. The entire quantity of Nitrogen and the rest of the Potassium were applied in three equal portions beginning 20 days after transplanting. The remaining three portions were fertilized at 20, 40 and 60 days after transplanting. The intercultural operations (weeding, irrigation, etc.) were done as and when necessary.

## 2.4. Air Temperatures and Precipitation of the Experimental Area

Data for the monthly temperatures (°C) and precipitation (cm) were measured during the experimental period. The average maximum and minimum temperatures and precipitation (cm) are shown in **Figure 1**.



**Figure 1.** Air temperatures and precipitation of the experimental area.

## 2.5. Data Collection and Statistical Analysis

Data on days to 1<sup>st</sup> harvest, no. of flower cluster/plant, no. of fruit/ cluster, no. of fruit/plant, single fruit wt. (g), fruit yield (kg/plant), fruit yield (t/ha), fruit length (cm), fruit diameter (cm), pericarp thickness (cm), no. of locules, TSS (%), plant height at last harvest (cm), TYLCV infection (%), leaf sucking pest (%) were recorded from three randomly selected plants per plot. The information on different characters was statistically analyzed. Plot means for 7 quantitative characters were used for the statistical analysis. Statistical analyses were carried out using R 3.6.3 software.

## 3. Results and Discussion

Significant differences were observed among the 39 tomato germplasm/varieties of tomato. The results of the experiment for different characters are presented in **Table 1**. Days to first harvest varied ranged from 95 to 109 days. It indicated earliness was observed among the tomato germplasm. The number of flower clusters per plant and number of fruits per cluster also varied among the germplasm which were 11 to 22 and 3.2 to 26, respectively. The number of fruit per plant and single fruit weight were varied from 15 to 510 and 6.6 to 180 g. The variation in the number of fruits per plant may be due to genetic differences among the germplasm since they were grown under the same environmental conditions. The finding is in agreement with Alam *et al.*, 2010; Biswas *et al.*, 2016; and Gautam *et al.*, 2018. Ahmad also found the range of single fruit weight to be from 5.25 g to 43.38 g among 25 heat-tolerant germplasm, which supports the findings of the present study [9]. The studies corroborate the findings of Agarwal *et al.* [10], Marbhal *et al.* [11], and Solieman *et al.* [12] (**Tables 1 - 3**).

**Table 1.** Days to 1<sup>st</sup> harvest, no. of flower cluster/pl, no. of fruit/ cluster, no. of fruit/ plant of 39 tomato germplasm/varieties.

Germplasm/Variety	Days to 1 <sup>st</sup> harvest	No. of flower cluster/plant	No. of fruit/ cluster	No. of fruit/ plant
BD 7278	95	12.0	6.4	55
BD 7276	100	14.0	5.6	70
BD 7301	100	15.0	4.8	38
BD 7751	95	17.0	22.6	322
BD 7752	98	17.0	7.3	65
BD 7753	101	11.0	10.2	40
BD 7754	104	16.0	5.0	22
BD 7756	98	15.0	7.2	46
BD 7757	106	15.0	3.8	325
BD 7758	103	13.0	3.8	41
BD 7759A	103	13.0	4.3	55
BD 7759B	103	12.0	4.3	99
BD 7762	95	13.0	4.4	77

**Continued**

BD 8886	103	16.0	5.4	41
BD 9776	105	17.0	6.5	30
BD 10321	102	15.0	5.2	42
BD 10351	101	13.0	5.0	58
BD 10949	103	16.0	6.5	50
BD 10951	99	17.0	7.8	42
NL-1A	98	18.0	26.0	510
NL-1	98	21.0	26.0	330
NL-2	99	22.0	25.0	65
NL-3	98	17.0	5.5	125
NL-4	99	16.0	6.3	205
NL-7	99	15.0	5.3	29
NL-8	104	15.0	5.0	15
JP-1	98	16.0	6.3	44
JP-2	99	15.0	6.3	25
QF	98	14.0	4.8	70
QM	101	14.0	4.4	67
SLA-19	99	16.0	7.4	45
SLA-24	104	14.0	3.2	70
SLA-26	102	19.0	9.0	36
SLA-27	109	17.0	5.6	46
SLA-33	106	15.0	4.8	27
SLA-35	106	15.0	3.8	35
BARI Tomato-2	98	15.0	4.4	22
BARI Tomato -11	98	16.0	10.0	196
BARI Tomato -15	102	15.0	5.0	22
Range	95 - 109	11 - 22	3.2 - 26	15 - 510
St. dev.	3.37	2.22	6.12	107.7
SE	0.54	0.36	0.98	17.3

St. dev. = Standard Deviation; SE = Standard Error.

The single fruit weight is important to evaluate the tomato germplasm, there was significant variation was observed among the germplasm. The range of the germplasm for single fruit weight was 6.6 - 180. The higher fruit weight germplasm were NL-8 (180.0g), BD 7754 (145.5g), BARI Tomato-2 (136.4g), SLA-33 (122.2g), BD 9776 (110.0g). The fruit yield per plant varied from 1.3 to 4.8 kg, while the higher yielder germplasms were BD 7759B (4.8 kg), BD 7757 (4.3 kg), BD 7751 (4.1 kg), BD 7301 (4.0kg), QM (4.0 kg), BD 7759A (3.9 kg), BD 7762 (3.9 kg), QF

(3.9 kg). A higher fruit yield per plant in some germplasm may be due to the production of a higher number of fruits with a greater single fruit weight. The development of fruit size depends on several factors such as the leaf-fruit ratio, genetic and climatic factors, position in the plant and the branch, plant age, number of seeds, and water and nutrient supply [13]. The fruit length, fruit diameter and pericarp thickness also varied among the germplasm according to the size of the fruit, which was 2.7 to 6.1 cm, 2.3 to 7.6 cm and 0.2 to 0.9 cm, respectively.

**Table 2.** Single fruit wt. (g), fruit yield (kg/pl), fruit yield (t/ha), fruit length (cm), fruit diameter (cm), of 39 tomato germplasm/varieties.

Germplasm/Variety	Single fruit wt. (g)	Fruit yield (kg/pl)	Fruit length (cm)	Fruit diameter (cm)
BD 7278	47.3	2.6	4.0	4.0
BD 7276	40.0	2.8	4.0	4.2
BD 7301	105.3	4.0	4.4	5.0
BD 7751	12.7	4.1	3.3	4.2
BD 7752	47.7	3.1	5.1	4.4
BD 7753	90.0	3.6	4.8	4.8
BD 7754	145.5	3.2	5.8	7.1
BD 7756	71.7	3.3	5.0	5.0
BD 7757	13.2	4.3	3.1	2.7
BD 7758	70.7	2.9	5.2	5.4
BD 7759A	70.9	3.9	4.0	4.2
BD 7759B	48.5	4.8	4.0	4.2
BD 7762	50.6	3.9	4.2	4.0
BD 8886	92.7	3.8	4.3	4.4
BD 9776	110.0	3.3	6.1	6.7
BD 10321	73.8	3.1	4.3	5.5
BD 10351	60.3	3.5	4.7	4.8
BD 10949	55.0	2.8	4.6	5.5
BD 10951	66.7	2.8	5.7	5.4
NL-1A	6.9	3.5	2.7	2.3
NL-1	6.7	2.2	2.7	2.3
NL-2	38.5	2.5	3.3	3.0
NL-3	18.0	2.3	3.0	3.4
NL-4	14.6	3.0	2.7	3.8
NL-7	100.0	2.9	5.6	6.2
NL-8	180.0	2.7	5.4	7.6
JP-1	56.8	2.5	5.3	4.2
JP-2	104.0	2.6	5.4	6.3
QF	55.7	3.9	4.8	5.1

Continued

QM	59.7	4.0	4.7	5.2
SLA-19	77.8	3.5	6.0	5.9
SLA-24	41.4	2.9	4.3	4.3
SLA-26	77.8	2.8	4.8	4.9
SLA-27	48.9	2.3	4.2	4.5
SLA-33	122.2	3.3	5.4	4.9
SLA-35	81.4	2.9	4.8	4.0
BARI Tomato-2	136.4	3.0	5.9	6.2
BARI Tomato -11	6.6	1.3	3.8	2.4
BARI Tomato -15	77.3	1.7	5.9	4.9
Range	6.6 - 180	1.3 - 4.8	2.7 - 6.1	2.3 - 7.6
St. dev.	39.94	0.72	0.98	1.25
SE	6.40	0.12	0.16	0.20

St. dev. = Standard Deviation; SE = Standard Error.

The range of fruit yield per hectare was 39 to 144 tons, while the highest fruit yield per hectare was harvested from the germplasm viz., BD 7759B, BD 7757, BD 7751, BD 7301, QM, BD 7759A, BD 7762, QF, BD 7753, BD 8886, BD 10351, NL-1A, SLA-19 (Figure 2).

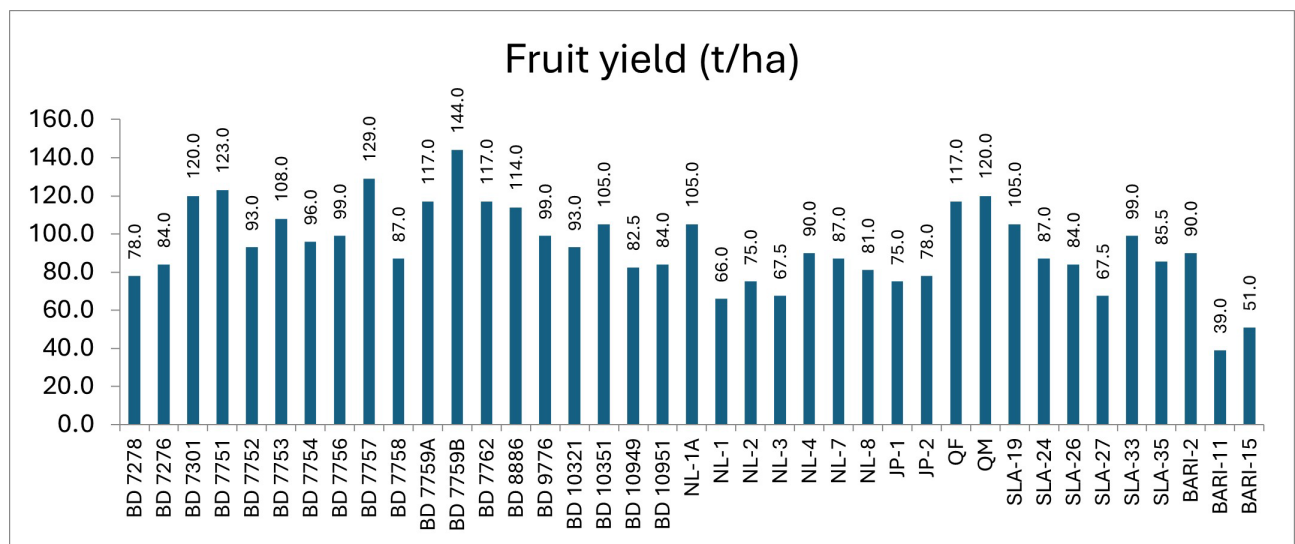


Figure 2. The fruit yield (t/ha) of 39 tomato germplasm/varieties.

The pericarp thickness, number of locules, total soluble solids (TSS) and plant height at last harvest varied from 0.2 to 0.9 cm, 2 to 6.6, 2.6 to 5.9%, and 66 to 154 cm, respectively.

**Table 3.** Pericarp thickness (cm), number of locules, TSS (%), Plant height at last harvest (cm), TYLCV infection (%), leaf-sucking pest (%) of 39 tomato germplasm/varieties.

Germplasm/Variety	Pericarp thickness (cm)	No. of locules	TSS (%)	Plant height at last harvest (cm)
BD 7278	0.60	3.6	4.9	84
BD 7276	0.60	2.0	5.5	82
BD 7301	0.62	2.0	5.2	124
BD 7751	0.38	2.0	5.1	115
BD 7752	0.66	2.0	5.4	152
BD 7753	0.60	3.0	5.9	140
BD 7754	0.62	3.0	5.6	116
BD 7756	0.66	4.0	5.6	152
BD 7757	0.44	2.4	5.3	102
BD 7758	0.66	2.0	5.3	93
BD 7759A	0.64	2.0	5.4	114
BD 7759B	0.64	2.0	5.4	114
BD 7762	0.64	3.0	5.4	77
BD 8886	0.62	2.2	5.5	114
BD 9776	0.74	4.0	5.3	153
BD 10321	0.56	6.6	5.7	77
BD 10351	0.52	4.0	5.4	87
BD 10949	0.52	6.6	4.7	153
BD 10951	0.74	2.0	5.6	99
NL-1A	0.20	2.0	5.7	154
NL-1	0.20	2.0	5.7	154
NL-2	0.30	2.4	5.4	152
NL-3	0.32	2.2	5.6	106
NL-4	0.20	2.3	5.7	102
NL-7	0.40	5.6	4.3	105
NL-8	0.60	6.6	5.6	99
JP-1	0.60	2.0	4.5	109
JP-2	0.50	5.3	5.7	105
QF	0.54	3.2	4.7	66
QM	0.54	3.2	4.8	66
SLA-19	0.78	2.8	4.3	92
SLA-24	0.38	2.4	4.2	77
SLA-26	0.90	3.0	4.4	145
SLA-27	0.50	3.0	2.6	82
SLA-33	0.62	2.8	4.2	101

Continued

SLA-35	0.66	2.0	5.7	102
BARI Tomato-2	0.70	4.0	5.1	114
BARI Tomato -11	0.30	2.0	5.3	140
BARI Tomato -15	0.58	3.2	5.0	115
Range	0.2 - 0.9	2 - 6.6	2.6 - 5.9	66 - 154
St. dev.	0.16	1.74	0.95	27.55
SE	0.03	0.28	0.15	4.41

St. dev. = Standard Deviation; SE = Standard Error

The TYLCV infection (%) and leaf-sucking pest infestation (%) were observed with a 1 to 20% range in the field condition in both cases. So, we can select that germplasm having zero per cent infestation (Figure 3).

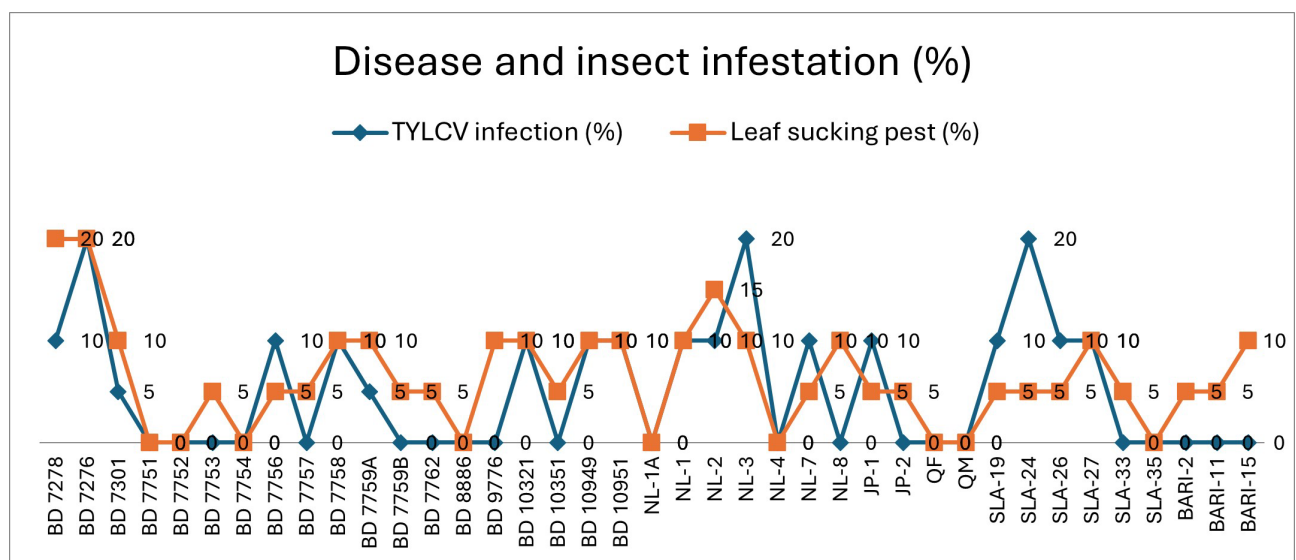


Figure 3. The Disease and insect infestation (%) of 39 tomato germplasm/variety.

### 4. Conclusion

Enhancing yield is the ultimate aim of this research program, which is connected to other plant features and biotic and abiotic challenges either directly or indirectly. There was a lot of variation found in 39 tomato varieties and germplasm. Significant variation was observed in the fruit yield per plant and fruit yield per hectare varied from 1.3 to 4.8 kg and 39 to 144 tons, while the highest fruit yield per hectare was harvested from the germplasm viz., BD 7759B, BD 7757, BD 7751, BD 7301, QM, BD 7759A, BD 7762, QF, BD 7753, BD 8886, BD 10351, NL-1A, SLA-19. The number of locules, total soluble solids (TSS) and plant height at last harvest varied from 2 to 6.6, 2.6 to 5.9%, and 66 to 154 cm, respectively. The TYLCV infection (%) and leaf-sucking pest infestation (%) were observed with a 1 to 20% range in the field condition in both cases. Considering the plant growth habit,

earliness, different horticultural traits, virus and pest infestation thirteen germplasm viz., BD 7759B, BD 7757, BD 7751, BD 7301, QM, BD 7759A, BD 7762, QF, BD 7753, BD 8886, BD 10351, NL-1A, SLA-19 were selected as breeding materials for further tomato improvement program.

### Acknowledgements

This study was completed with the financial support of AFACI under the project “Development of vegetable varieties in Asia Region”.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

### References

- [1] FAO (2018) FAOSTAT 2018. <http://faostat3.fao.org>
- [2] Encyclopedia Britannica. “Tomato”. <https://www.britannica.com/plant/tomato>
- [3] Khokhar, K.M. (2013) Present Status and Prospects of Tomatoes in Pakistan. Agricultural Corner-Farmers to Global Market, 1-21.
- [4] Mary, J. (2021) The Influence of Organic Manure on Tomato Growth in Rakai District Uganda. Bachelor of Science Research Report, Makerere University.
- [5] Musa, M., Bashir, K.A. and Tadda, S.A. (2017) Response of Cowpea (*Vigna unguiculata* L. Walp) Varieties to Phosphorus Levels in Sudan Savanna of Nigeria. International Multidisciplinary Research Journal, 7, 23-29. <https://doi.org/10.25081/imrj.2017.v7.3380>
- [6] Prakash, A. and Kumar, A. (2014) Implicating the Role of Lycopene in Restoration of Mitochondrial Enzymes and BDNF Levels in  $\beta$ -Amyloid Induced Alzheimer’s Disease. *European Journal of Pharmacology*, 741, 104-111. <https://doi.org/10.1016/j.ejphar.2014.07.036>
- [7] Kotíková, Z., Lachman, J., Hejtmánková, A. and Hejtmánková, K. (2011) Determination of Antioxidant Activity and Antioxidant Content in Tomato Varieties and Evaluation of Mutual Interactions between Antioxidants. *LWT-Food Science and Technology*, 44, 1703-1710. <https://doi.org/10.1016/j.lwt.2011.03.015>
- [8] Mayele, J.M. and Abu, F.R. (2023) Determining the Effects of Selected Organic Fertilizer on Growth and Yields of Tomato (*Lycopersicon esculentum*: Var. Rio Grande Tomatoes) in Mundri West County, Western Equatoria State, South Sudan. *Agricultural Sciences*, 14, 1343-1374. <https://doi.org/10.4236/as.2023.149089>
- [9] Alam, M., Sultana, N., Ahmad, S., Hossain, M. and Islam, A. (1970) Performance of Heat Tolerant Tomato Hybrid Lines under Hot, Humid Conditions. *Bangladesh Journal of Agricultural Research*, 35, 367-373. <https://doi.org/10.3329/bjar.v35i3.6442>
- [10] Agarwal, A., Arya, D.N., Ranjan, R. and Zakwan, A. (2016) Heterosis, Combining Ability and Gene Action for Yield and Quality Traits in Tomato (*Solanum lycopersicum* L.), *Helix*, 2, 511-515.
- [11] Marbhal, S.K., Ranpise, S.A. and Kshirsagar, D.B. (2016) Heterosis Study in Cherry Tomato for Quantitative Traits. *International Research Journal of Multidisciplinary Studies*, 2, 1-6.
- [12] Solieman, T.H.I., El-Gabry, M.A.H. and Abido, A.I. (2013) Heterosis, Potence Ratio

- and Correlation of Some Important Characters in Tomato (*Solanum lycopersicum* L.). *Scientia Horticulturae*, **150**, 25-30. <https://doi.org/10.1016/j.scienta.2012.10.024>
- [13] Dennis, F.G. (1996) Fruit Development. In: Maib, K.M., Andrews, P.L., Lang, G.A. and Mullinix, K., Eds., *Tree Fruit Physiology: Growth and Development*, Good Fruit Grower, 107-116.