



## Morphological and yield performance of tomato (*Lycopersicon esculentum* L.) Germplasm under agro climatic condition of peshawar

Syed Mubarak Shah<sup>1\*</sup>, Neelam Ara<sup>1</sup>, Shujaat Ali<sup>1</sup>, Asad Ullah<sup>1</sup>, Nasar Ali Khan<sup>1</sup>, Ata Ullah<sup>1</sup>, Mudassar Mushtaq<sup>1</sup>

<sup>1</sup>Department of Horticulture, Faculty of Crop Production Science, The University of Agriculture Peshawar, Peshawar, Pakistan

**Key words:** Climatic condition, Germplasm, growth, Morphological data, yield, performance.

<http://dx.doi.org/10.12692/ijb/14.1.224-230>

Article published on January 11, 2019

### Abstract

The experiment “Morphological and yield performance of tomato germplasm under agro climatic condition of Peshawar” was carried out at The University of Agriculture Peshawar during 2017. The primary objective of this research to evaluate different tomato germplasm for their yield and adaptability in Peshawar. For morphological characterization, the tomato germplasm were three times replicated in Randomized Complete Block Design. Ten tomato germplasm were selected that included Rio Grande, Gala, Kalam, Red Star, Roma VF, Taj, Peshawar Local, Bambino, Roma and Cherry tomato. The statistically analyzed data indicated that tomato germplasm were highly significant ( $P \geq 0.01$ ) in growth and yield contributing parameters. Morphological data indicated that maximum plant height (105.3 cm) was recorded in germplasm Kalam. Maximum number of primary branches plant<sup>-1</sup> (8), fruit yield plant<sup>-1</sup> (1.67 kg) and total yield (43.2 tons ha<sup>-1</sup>) were observed in variety Roma VF. Maximum days to first flower were observed in variety Bambino (37). Maximum number of fruits plant<sup>-1</sup> (36.3) were shown by germplasm Cherry tomato. Maximum fruit length (7.37 cm) was found out in cv. Roma, whereas maximum fruit width (4.83 cm) and 100 seed weight (0.372 g) were recorded in cv. Rio Grande. Based on these results the tomato germplasm performed best in yield and growth contributing parameters should be further evaluated for their potential use in breeding programs. Furthermore, Roma VF and Rio Grande were given best performance in yield and almost morphological characteristics and should be the choice for cultivation in Peshawar.

\* **Corresponding Author:** Syed Mubarak Shah ✉ [sumbarakshah7@gmail.com](mailto:sumbarakshah7@gmail.com)

## Introduction

Tomato (*Lycopersicon esculentum* L.) is an annual crop and important member of family Solanaceae. Among vegetables, tomato is the most cultivated crop in the world and has been ranked third, after potato and sweet potato in global production (Tan *et al.*, 2010). Tomatoes grow worldwide with a global production of 130 million tons, China produced the biggest portion of 41.87 million tons, followed by USA with 12.90 million tons production. Beside fresh tomato consumption, it can be consumed in processed forms like ketchup, canned, juice, paste and powder that make it commercially important.

In Pakistan tomato during 2014-2015, area under cultivation of tomato was 62930 hectares with total production of 599588 tones. Tomato is grown in all provinces of Pakistan, while Khyber Pakhtunkhwa (KPK) provides 32% of total tomato crop grown in the country (MINNFSR, 2015). Tomato is one of the most common vegetable in Pakistan because of its use in cooking and as salad and its demand is very high in Pakistan (Lohano and Mari, 2005).

Tomato is a warm season annual vegetable and plants show abundant of variation in morphological characteristics. The plants may be bushes or vines and plant reach up to different height. Fruit of tomato is true because of its development from ovary, while botanically it is a berry. Fruit color changes from green to red with ripening (Stevens *et al.*, 1977).

Tomato plant may grow on variety of soil conditions, but best grow in sandy loam soil with soil pH in between 5.5 to 7.5 (Baloch, 1994).

Therefore, the present study on tomato germplasm were conducted to investigate the morphological characterization like plant height (cm), number of primary branches plant<sup>-1</sup>, days to first flowering, number of fruits plant<sup>-1</sup>, fruit length (cm), fruit width (cm), fruit yield plant<sup>-1</sup> (kg), total yield (tons ha<sup>-1</sup>) and 100 seed weight (g). The primary objective of this research to evaluate different tomato germplasm for their yield and adaptability in Peshawar.

## Materials and methods

An experiment “Morphological and yield performance of tomato germplasm under agro climatic condition of Peshawar” was conducted at The University of Agriculture, Peshawar Khyber Pakhtunkhwa. The morphological data were taken at Ornamental Horticulture Nursery, Department of Horticulture, The University of Agriculture Peshawar during summer, 2017.

### *Field preparation and transplanting of seedling*

The experimental plots were ploughed, harrowed and leveled. N: P: K was added to the soil at the rate of 100 kg ha<sup>-1</sup> N, 80 kg ha<sup>-1</sup> P and 40 kg ha<sup>-1</sup> K along with organic manure of 25 ton ha<sup>-1</sup> before seedlings transplantation. Ten tomato germplasm were assessed in the experiment. On 17<sup>th</sup> March 2017 tomato seedlings were transplanted to field when they were 9-12 cm in height and had 5-7 compound leaves.

The field was irrigated frequently after seedlings transplantation. All the seedlings were planted at the distance of plant to plant 30 cm and row to row 70 cm. The first fruit picking was done on 2<sup>nd</sup> May, while last harvest was accomplished on 17<sup>th</sup> June, 2017.

### *Design and layout of experiment*

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications.

The Ten germplasm of tomato (Rio Grande, Gala, Kalam, Red Star, Roma VF, Taj, Roma, Cherry tomato, Bambino and Peshawar Local) were tested for their performance.

These tomato germplasm were collected from different Districts of Pakistan. Cultivars Rio Grande, Roma and Gala were procured from National Agriculture Research Center (NARC), Islamabad. Varieties Bambino, Red Star and Peshawar Local were bought in Gurr Mandi Peshawar. Varieties Roma VF and Taj were brought from TakhtBhai Mardan, whereas Kalam and Cherry Tomato line were brought from Mingora Swat.

### Culture practices

Regular irrigation, hoeing and weeding were done throughout the experiment. Insecticide and pesticides were sprayed i.e. Emamectin Benzoat, Imidacloprid and Metalxy +Mancozed. Proper staking were done to each germplasm to support better vegetative growth.

### Parameters studied

The data on different morphological and yield parameters were studied as mentioned below.

**Plant height (cm):** When the apical bud of main stem stop to grow, height of plants were measured by measuring tape from terminal bud of main stem to the first cotyledonary node.

**Number of primary branches plant<sup>-1</sup>:** The branches arising from the main stem were counted in each tomato germplasm and average data were recorded.

**Days to first flower:** The numbers of days taken from date of transplanting to the first flower appearance in all tomato germplasm were recorded and their average was calculated.

**Number of fruits plant<sup>-1</sup>:** Number of fruits per plant was counted and mean were calculated.  
**Fruit length (cm):** Length of each of randomly selected tomato fruits was measured with digital Vernier caliper and their average was computed.  
**Fruit width (cm):** The width of fruit was measured with the help of Vernier caliper and their average was calculated.  
**Fruit yield**

**plant<sup>-1</sup> (kg):** At every picking, the fresh fruit yield plant<sup>-1</sup> of each plant in all treatments was weighed by digital electronic balance and weights of all pickings were added and average was computed.

**Fruit yield (tons ha<sup>-1</sup>):** Total yield per plot from all pickings was computed and yield in tons ha<sup>-1</sup> was calculated with the help of following formula.

$$\text{Yield (tons ha}^{-1}\text{)} = \frac{\text{Yield per plot (Kg)}}{\text{Area of plot (m}^2\text{)} \times 1000} \times 10000\text{m}^2$$

**Hundred seed weight (g):** Dry 100 seeds of tomato were weighed through digital electronic balance and average was recorded.

### Statistical analysis

The data were analyzed statistically with the help of STATISTIX 8.1 statistical software and analysis of variance (ANOVA) and least significant differences (LSD) techniques were applied in order to see any differences between different indigenous tomato germplasm (Steel *et al.* 1997).

## Results

### Morphological behavior

The data regarding morphological characteristics of tomato germplasm were given (Table 1) and showed significant differences under agro climatic condition of Peshawar. The maximum plant height (105.3cm) was recorded for variety Kalam, followed by variety Bambino (93.7cm). While minimum plant height was recorded for germplasm Cherry tomato (60.7cm).

**Table 1.** Mean for morphological performance of tomato (*Lycopersicon esculentum* L.) germplasm under agro climatic condition of Peshawar.

Germplasms	Plant height (cm)	No. of primary branches plant <sup>-1</sup>	Days to 1 <sup>st</sup> flower
Rio Grande	86.7 bc	6.0 abc	22.0 e
Gala	87.0 bc	5.3 bc	22.7 e
Kalam	105.3 a	6.7 ab	28.7 d
Red Star	85.3 bc	4.3 c	30.3 cd
Roma VF	82.7 cd	8.0 a	34.3 ab
Taj	71.0 e	5.7 bc	31.7 bed
Roma	67.3 ef	5.0 bc	22.0 e
Cherry tomato	60.7 f	5.3 bc	18.3 f
Bambino	93.7 b	6.0 abc	37.0 a
Peshawar Local	75.3 de	4.0 c	33.3 bc
LSD at 1%	8.51	2.28	3.16

In case of No. of primary branches plant<sup>-1</sup>, The mean values of germplasm revealed that highest number of branches (8.0) was found in variety Roma VF, followed by variety Kalam (6.7). Whereas, the least number of branches per plant was observed in variety Peshawar Local (4.0) that is closely followed by

variety Red Star (4.3). Likewise, the maximum numbers of days to flowering (37.0) were taken by variety Bambino, followed by Roma VF (34.3). Cherry tomato was the earliest flowering germplasm, taking minimum days (18.3) to flowering.

**Table 2.** Mean for fruits physical performance of tomato (*Lycopersicon esculentum* L.) germplasm under agro climatic condition of Peshawar.

Germplasms	Number of fruits plant <sup>-1</sup>	Fruit length (cm)	Fruit width (cm)
Rio Grande	19.7 e	5.73 bc	4.83 a
Gala	17.7 e	5.90 b	4.73 a
Kalam	29.3 b	5.30 bcd	4.37 a
Red Star	25.3 bcd	4.77 d	4.47 a
Roma VF	26.7 bc	5.47 bcd	4.67 a
Taj	24.3 cd	5.23 bcd	4.60 a
Roma	19.7 e	7.37 a	4.37 a
Cherry tomato	36.3 a	3.40 e	3.70 b
Bambino	21.0 de	5.70 bc	4.70 a
Peshawar Local	27.0 bc	5.10 cd	4.40 a
LSD at 1%	4.61	0.74	0.63

#### Physical characteristics (fruits)

The mean values of number of fruits per plant (Table 2) gives maximum number of fruits per plant (36.3) was observed in Cherry tomato, followed by Kalam (29.0). While lowest number of fruits per plant was counted in cv. Gala (17.7), followed by Rio Grande (19.7) and Roma (19.7). In case of Fruit length (cm), the longest fruits were produced by cv. Roma (7.37 cm), followed by cv. Gala (5.90 cm).

The shortest fruits (3.40 cm) were obtained from germplasm Cherry tomato. In the term of fruit width (cm) significant differences was observed from one another, the cv. Rio Grande gives maximum fruit width (4.83 cm), followed by germplasm Kalam (4.37 cm). While minimum fruit width was noticed in germplasm Cherry tomato (3.70 cm).

#### Yield components

Significant differences were recorded throughout yield and yield component (Table 3). The mean values for fruit yield per plant in different tomato germplasm showed the highest production per plant

(1.67 kg) which was obtained from the variety Roma VF, followed by variety Kalam (1.57 kg). Though the lowest fruit production per plant of 0.87 kg was recorded in germplasm Cherry tomato. Similarly the highest total yield in tons ha<sup>-1</sup> (43.2) was obtained from in variety Roma VF, followed by tomato variety Kalam (40.6 tons ha<sup>-1</sup>). While the lowest fruit yield tons ha<sup>-1</sup> was observed in tomato germplasm Cherry tomato that was 22.5 tons per hectare. In the term of hundred seeds weight revealed that the heaviest seeds (0.372g) were found in tomato cv. Rio Grande, followed by germplasm Taj (0.334g). Although Cherry tomato gives the least seeds (0.242g), closely followed by germplasm Red Star (0.264g).

#### Discussion

The plant height in different tomato germplasm was significantly varied from 25 to 110 cm at different stages of lifespan. The variation in plant height may be attributed to germplasm, proper water management and effect of temperature on the level and activity of growth promoters like Auxins, gibberellins and cytokines (Hossain *et al.*, (2017).

**Table 3.** Mean for yield component performance of tomato (*Lycopersicon esculentum* L.) germplasm under agro climatic condition of Peshawar.

Germplasms	Fruit yield plant <sup>-1</sup> (kg)	Total yield (tons ha <sup>-1</sup> )	100 seed weight (g)
Rio Grande	1.50 ab	38.9 abc	0.372 a
Gala	1.47 ab	38.0 abc	0.298 cd
Kalam	1.57 ab	40.6 ab	0.322 bc
Red Star	1.30 b	33.7 c	0.326 de
Roma VF	1.67 a	43.2 a	0.287 cd
Taj	1.41 ab	36.6 bc	0.334 b
Roma	1.37 ab	35.4 bc	0.288 cd
Cherry tomato	0.87 c	22.5 d	0.242 f
Bambino	1.33 b	34.5 c	0.306 bc
Peshawar Local	1.33 b	34.5 c	0.314 bc
LSD at 1%	0.20	5.27	0.03

Ambule *et al.*, (2015) also reported that plant height in different tomato germplasm were significantly varied from 80.80 to 118.43 cm.

The mean values of germplasm revealed that maximum number of branches was found in variety Roma VF and minimum number of branches per plant was observed in variety Peshawar Local.

The variation in number of branches per plant in tomato germplasm may be due to climatic condition and diversity in Tomato varieties. Similarly, diversity in Tomato varieties has been reported by Aklileet *et al.*, (2014). Taiana *et al.* (2015), who evaluated 21 genotypes to select better parents in tomato using genetic parameters and found significant variation in number of branches plant<sup>-1</sup>. Ahmad *et al.*, (2007) investigated tomato cultivars and significantly differences were in number of branches per plant.

In days to flowering, it is clear that Bombino and Roma VF are the late flower producing Germplasms, while Cherry tomato is the earliest to bloom, followed by Rio Grande, Roma and Gala. Mehmood *et al.*, (2012) reported that earliness and delay in flowering may be due to variation in genetic makeup of varieties. Rio Grande was early fruiting, while Bambino was late fruiting (49.42 days) cultivar in their findings. Ali *et al.*, (2015) found the same result when they grew tomato in inorganic regime.

The germplasm of tomato were significantly affected the number of fruits plant<sup>-1</sup>. Ali *et al.*, (2016) evaluated different tomato cultivars under agro climatic condition of Peshawar and found Money Maker gives maximum number of fruits per plant. While, the difference in number of fruits per plant in different tomato germplasm may be attributed to genetic variation, germplasm suitability to environmental condition and number of flowers remained on plant to form a fruit even in heat stress condition of a plant (Saeed *et al.*, 2007).

The mean data in Table 2 showed that the longest fruits were produced by cv. Roma and the shortest fruits are produced by germplasm Cherry tomato.

The difference in tomato germplasm significantly affected the fruit length Khan *et al.*, (2017). In their analyzed data regarding fruit length, maximum fruit length (6.26 cm) was observed in Line-112, while minimum fruit length was recorded in Line-101.

The maximum fruit width was recorded of Rio Grande, while least fruit width was noted of Cherry tomato. The difference in fruit width among different tomato germplasm was due to genetic variation among tomato germplasm. These results are supported by Saleem *et al.* (2009). Ahmed *et al.*, (2017) also stated that fruit width were significant differences among the tomato lines.

In case of fruit yield per plant, Roma VF showed better performance in fruit yield per plant as they got maximum food assimilation, healthy plants with good height, high number of branches and average fruit weight as compared to the other tomato Germplasms. The results are supported by Khan *et al.*, (2017). Saleem *et al.*, (2009) and Islam *et al.*, (2016). In current research, Roma VF produced maximum total yield as compared to the other germplasm. The same results were found by Ali *et al.* (2015) they stated that the maximum yield (23.3 tons ha<sup>-1</sup>) was recorded for Roma cultivar. Binalfew *et al.* (2016) who stated that tomato varieties varied in yield from 46.8 to 87.1 ton per ha. Ali *et al.* (2016) found significant differences in tomato yield ton per hectare in different tomato cultivars.

In case of 100 seed weight, significant variations were found in different tomato varieties. The increases in locule, seed number and fruit width are due to variation in genetic expression Grandillo *et al.*, (1999). Balcha *et al.* (2015) evaluated nine tomato varieties to select tomato variety for better seed yield under irrigated condition. The variation in 100 seed weight (g) in different tomato germplasm may be attributed to genetic makeup of germplasm and response to the selection pressure for yield, uniform germination and seedling vigor (Doganlaret *al.*, 2000).

### Conclusion

It was concluded that significant differences were shown by different tomato germplasm for all growth, fruits physico characteristics and yield components. Among the ten tomato germplasm, cv. "Roma VF" performed better than other germplasm, followed by cv. Rio Grande in the testing environment. Whereas Cherry tomato had the lowest yield. These two tomato germplasms are recommended to be grown in climatic condition of Peshawar.

### Acknowledgments

The authors would like to thank the University of Agriculture, Peshawar Khyber Pakhtunkhwa to provided financial support for this research work. The

first author, also want to express his deep appreciation of Ms. Neelam Ara for all effort on specific time.

### References

- Ahmad F, Khan O, Sarwar S, Hussain A, Ahmad S.** 2007. Performance evaluation of tomato cultivars at high altitude. *Sarhad Journal of Agriculture* **23**, 581.
- Ahmed N, Hamid FS, Waheed A, Khan MA, Khan S, Ahmed I, Aslam S, Mumtaz S, Gul H.** 2017. Evaluation of Different Tomato Hybrids for Phenotypic Variation and Yield Contributing Attributes at Mansehra. *Moroccan Journal of Chemistry* **5**, 5-2 2305-2310.
- Aklile M, Alemayehu M, Alemayehu G.** 2014. Performance evaluation of tomato varieties for irrigation production system in Mecha District of west Gojiam Zone, Amhara Region, Ethiopia, p 142-177.
- Ali A, Hussain I, Khan A, Khan J, Rehman MU, Riaz A.** 2016. Evaluation of various tomato (*Lycopersicon esculentum* mill.) cultivars for quality, yield and yield component under agro-climatic condition of Peshawar. *ARP. Journal of Agriculture and Biological Sciences* **11**, 59-62.
- Ali I, Khattak AM, Ali M, Ullah K.** 2015. Performance of different tomato cultivars under organic and inorganic regimes. *Pakistan Journal of Agricultural Research* **28(3)**, 245-254.
- Ali Q, Erkan M, Jan I.** 2017. Morphological and agronomic characterization of tomato under field conditions. *Pure and Applied Biology (PAB)* **6**, 1021-1029.
- Ambule AT, Radadia G, Patil D, Toke N.** 2015. Morphological characters of tomato in relation to resistance against tomato fruit borer, *Helicoverpa armigera* (Hubner). *International Journal of Plant Protection* **8**, 152-156.  
<http://dx.doi.org/10.15740/HAS/IJPP/8.1/152-156>



- Balcha K, Belew D, Nego J.** 2015. Evaluation of tomato (*Lycopersicon esculentum* Mill.) varieties for seed yield and yield components under Jimma condition, South Western Ethiopia. *Journal of Agronomy* **14**, 292.  
<http://dx.doi.org/10.3923/ja.2015.292.297>
- Baloch A.** 1994. Vegetable Crops. In Horticulture National Book Foundation. Islamabad p 489-509.
- Binalfew T, Alemu Y, Geleto J, Wendimu G, Hinselmu M.** 2016. Performance of introduced hybrid tomato (*Solanum lycopersicum* Mill.) cultivars in the Rift Valley, Ethiopia **3**, 25-28.
- Doganlar S, Frary A, Tanksley S.** 2000. The genetic basis of seed-weight variation: tomato as a model system. *Theoretical and Applied Genetics* **100**, 1267-1273.  
<https://doi.org/10.1007/s001220051433>
- Grandillo S, Ku H, Tanksley S.** 1999. Identifying the loci responsible for natural variation in fruit size and shape in tomato. *Theoretical and Applied Genetics* **99**, 978-987.  
<https://doi.org/10.1007/s001220051405>
- Hossain EK, Ahamed U, Shamsuzzaman AMM, Haque M, Nahar K.** 2017. Yield and morph-physiological performance of different tomato varieties in winter season. *Middle East Journal of Scientific Research* **25(6)**, 1216-1224.
- Hussain IKI, Ahmed M, Khan SM, Naveed AKK, Ali S, Hussain I, Sajid M.** 2017. Screening of different exotic lines of tomato (*Lycopersicon esculentum* L.) under the agro climatic condition of Haripur. *Pure and Applied Biology (PAB)* **6**, 1251-1259.  
<http://dx.doi.org/10.19045/bspab.2017.600133>
- Islam S, Hossain MK, Hasan R, Bashir A, Huque A, Alam N.** 2016. Quantification of genetic diversity analysis for the improvement of cultivated tomato genotypes. *Bangladesh journal of botany* **45**, 485-491.
- Lohano HD, Mari FM.** 2005. Spatial price linkages in Regional Onion markets of Pakistan. *Journal of Agriculture and Social Sciences* **1**, 318-321.
- Mehmood N, Ayub G, Ullah I, Ahmad N, Noor M, Khan AM, Ahmad S, Saeed A.** 2012. Response of tomato (*Lycopersicon esculentum* Mill.) cultivars to nitrogen levels. *Pure and Applied Biology* **1**, 63.
- MINNFSR.** 2014-2015. Fruit, vegetables and condiments statistics of Pakistan. Ministry of National Food Security and Research Economic wing Islamabad, p 21-22.
- Saeed A, Hayat K, Khan A, Iqbal S.** 2007. Heat tolerance studies in tomato (*Lycopersicon esculentum* Mill.). *International Journal of Agriculture & Biology* **9**, 649-652.
- Saleem MY, Asghar M, Haq MA, Rafique T, Kamran A, Khan AA.** 2009. Genetic analysis to identify suitable parents for hybrid seed production in tomato (*Lycopersicon esculentum* Mill.). *Pakistan Journal of Botany* **41**, 1107-1116.
- Stevens MA, Kader AA, Albright-Holton M.** 1977. Intercultivar variation in composition of locular and pericarp portions of fresh market tomatoes. *Journal of the American Society for Horticultural Science* **102**, 689-692.
- Taiana T, Harun-Ur-Rashid M, Parveen S, Hossain MS, Azadul M.** 2015. Selection strategies to choose better parents in tomato using genetic parameters. *Plant Knowledge Journal* **4**, 33-39.
- Tan H-L, Thomas-Ahner JM, Grainger EM, Wan L, Francis DM, Schwartz SJ, Erdman JW, Clinton SK.** 2010. Tomato-based food products for prostate cancer prevention: what have we learned? *Cancer and Metastasis Reviews* **29**, 553-568.  
<https://doi.org/10.1007/s10555-010-9246-z>