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

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**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* ≥ 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⁻¹ (8), fruit yield plant⁻¹ (1.67 kg) and total yield (43.2 tons ha⁻¹) were observed in variety Roma VF. Maximum days to first flower were observed in variety Bambino (37). Maximum number of fruits plant⁻¹ (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.

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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⁻¹, days to first flowering, number of fruits plant⁻¹, fruit length (cm), fruit width (cm), fruit yield plant⁻¹ (kg), total yield (tons ha⁻¹) 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⁻¹ N, 80 kg ha⁻¹ P and 40 kg ha⁻¹ K along with organic manure of 25 ton ha⁻¹ before seedlings transplantation. Ten tomato germplasm were assessed in the experiment. On 17th 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 2nd May, while last harvest was accomplished on 17th 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 Metalaxy + Mancozeb. 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⁻¹: 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⁻¹: 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⁻¹ (kg): At every picking, the fresh fruit yield plant⁻¹ 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⁻¹): Total yield per plot from all pickings was computed and yield in tons ha⁻¹ was calculated with the help of following formula.

\[
\text{Yield (tons ha}^{-1}\text{)} = \frac{\text{Yield per plot (kg)}}{\text{Area of plot (m}^2\text{)} \times 10000}\n\]

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 (105.3 cm) was recorded for variety Kalam, followed by variety Bambino (93.7 cm). While minimum plant height was recorded for germplasm Cherry tomato (60.7 cm).

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

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

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

**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\(^{-1}\) (43.2) was obtained from in variety Roma VF, followed by tomato variety Kalam (40.6 tons ha\(^{-1}\)). While the lowest fruit yield tons ha\(^{-1}\) 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.

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

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⁻¹. 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⁻¹. 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.

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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\(^{-1}\)) 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 (Doganlar et 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 thanks 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.

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http://dx.doi.org/10.15740/HAS/IJPP/8.1/152-156


