

PERFORMANCE AND QUALITY ATTRIBUTES OF TOMATO CULTIVARS UNDER AGRO CLIMATE OF BAGROTE VALLEY, GILGIT-BALTISTAN

MAQSOOD HUSSAIN^{*1}, SARTAJ ALI¹, SHER WALI^{2*}, AZHAR HUSSAIN¹,
FURUKH FAIZ¹ AND SAYEDD HUSSAIN³

¹Department of Agriculture and Food Technology, Karakoram International University Gilgit, Pakistan

²Sher Wali Department of Biological Sciences, Karakoram International University Gilgit, Pakistan

³Department of Horticulture, Abdul Wali Khan University, Mardan, Pakistan

*Corresponding author's email: wazirmaqsood@kiu.edu.pk; dr.sher.wali@kiu.edu.pk

Abstract

A field experiment was conducted to evaluate growth, yield and quality parameters of four tomato cultivars (Roma, Riogrand, Fmx and Savera) in Bagrote valley Gilgit-Baltistan. The results obtained showed significantly difference ($p < 0.05$) between the cultivar as maximum plant height (73.0cm), maximum number of branches (6.46), longest leaf length (10.26cm) and maximum number of days for flowering was observed in cultivar Roma. While lowest plant height (48.66cm), shortest leaf length (7.47cm) and minimum number of days (64.33) for fruit set was observed in cultivar Riogrand. However cultivar Savera showed intermediate behavior for different growth characteristics among the other cultivars. Roma showed maximum yield (29.4t ha⁻¹) followed by Fmx and Savera (25.8 t ha⁻¹ and 24.21 t ha⁻¹), whereas the minimum yield (22.5 t ha⁻¹) was found in Riogrand. Quality parameters i.e. pH, acidity, TSS and ascorbic acid were also found significantly different at $p < 0.05$ among all four cultivars. Roma showed highest value of Ascorbic acid (21.36mg), Fmx showed lowest pH value (4.13), while highest TSS value (5.5⁰B) was observed in Savera. It was concluded from the study that among the four tested cultivars, Roma performed better in terms of growth yield and quality parameters, hence, it is suggested that Roma is most promising cultivar for the climatic conditions of the valley. The study further reiterates that proper selection of higher yielding varieties of crop and vegetables is imperative for farming communities to enhance productivity and increase house hold income for food security of the mountainous region.

Key words: Central Karakoram National Park, Titratable acidity, Vitamin C, Growth and yield.

Introduction

Tomato (*Lycopersicon esculentum* Mill) is very famous vegetable among other vegetables in Pakistan, it belongs to the family "Solanaceae". The cultivation of tomato is comparatively most recent addition in world's significant food crops, and ranked as one of the most famous and widely used vegetable crop, (Tigchelaar, 1986). Tomato can be successfully grown in different climatic conditions of the world from tropical, to temperate regions. The maximum tomato producing countries include China, USA, India, Egypt, Turkey, Iran, Mexico, Brazil and Indonesia (Anon., 2006). Pakistan annually produces two crops of tomato, during the fall season seeds are sown in the month of November and seedlings become ready for transplantation in the month of February. The next crop starts as seeds are sown in the month of June and seedlings become ready for transplantation in August. However, it depends upon prevailing climatic conditions that can cause change in sowing times (Khattak *et al.*, 2007).

Tomatoes optimally grows well in acidic soil conditions ranges from (pH 6.0- 6.8), while organic farming needs more fertility managements as compare to inorganic farming. Biological activity, organic matter content, temperature and moisture are main factors which can influence the mineralization rate (Jones, 2008). (Jilani *et al.*, 20013) observed significant variation in the yield of the tomato cultivars grown under different climate of Dera Ismail Khan. The maximum yield was observed in Vegnesh cultivar of tomato 36.85 t/ha, while the minimum yield of tomato fruit was observed in Nema-1200 (4.00 t/ha). (Zahoor *et al.*, 2006) taken minimum

days to flowering (51.33), days to ripening (90.33), plant height (81.67 cm) and highest yield (24.17 t/ha) was recorded in TT0302, whereas maximum fruit set cluster (71.62%) and number of fruit/kg (24.33) were recorded in Swat local. Nutritional assessment of tomato revealed valuable composition which has high significance for the consumer's health. Investigations for the presence of vitamins confirmed that it has great potential of having vitamin A, B and particularly ascorbic acid. Tomato is regarded as excellent source of vitamin C (200mg/kg) next to citrus fruits (Vallejo *et al.*, 2002). Nature has enriched fruits, vegetables and nuts with essential macro and micro nutrients which are compulsory for the continuation and maintenance of a healthy life. The bioactive compositional constituents that make them important are antioxidants, vitamins, proteins, sugars phytochemicals and macro and micro mineral elements, which are pivotal for metabolic processes. These nutritional and non-nutritional ingredients keep consumers fit by keeping away many health hazardous ailments like cardiovascular problems, diabetes, gastrointestinal health, various types of cancer and cures many serious maladies (Murphy *et al.*, 2012). The Gilgit-Baltistan region of Pakistan, contributes 6,455 metric tons tomatoes to the country, the total area under cultivation is about (805 hectares). Out of which (3194 MT) are consumed locally, about (2293 MT) are marketed, while (968 MT) goes waste (Anon., 2009).

The climate of the Central Karakoram National Park (CKNP) area is highly encouraging for the production of fruits and vegetables; however this climatic suitability is not being fully employed. The farmers of the area mostly rely on fruit and vegetable crops for their livelihood.

Among the vegetables; tomato occupies second position after potato as cash crop of the area and earns a good return to the mountain farmers. But the inappropriate agronomic practices, imbalance application of fertilizers, poor selection of higher yielding varieties effects on growth, yield and nutritional value of fruits and vegetables. Thus due to lack of awareness about modern crop management practices the production level of the area is low. Nature has gifted with great variations among the species for their morphological yield and nutritional/quality features, hence this phenomenon provide us space for selection of genotype for particular character and environment. Therefore, present study was conducted to identify the high yielding and nutritionally enriched tomato cultivars suitable for the climatic conditions of the Bagrot valley of CKNP area to enhance the productivity of tomato.

Material and Methods

In this study four cultivars of tomato i.e. 'Roma', 'Rio Grande', 'Savera' and 'Fmx' has been selected to study the growth, yield and quality parameters of tomato under the agro climatic conditions of Bagrote valley of CKNP Gilgit during 2016-17. The valley is approximately 17km from Gilgit Town situated in the North-West of Gilgit extend from 36°01.751 Latitude and from 74°36.094'7 Longitude with elevation 3130m. The experiment was carried out in Randomized Complete Block Design (RCBD) with three replications. The sub plot size was kept at 3.6×3.6m² with four rows, 32 plants were grown in each sub plot. Four weeks seedlings were taken from the Department of Agriculture, Gilgit and transplanted in well prepared beds. During this study all the agronomic practices adopted were uniformed for all cultivars. Data were obtained to study different parameters such as plant height (cm), number of branches per plant, leaf length (cm), days to flowering, days to fruit set, No. of fruits per plant, fruit length (cm), fruit diameter (cm), single fruit weight (g), weight of fruits per plant (kg), average fruit yield (t h⁻¹) and quality characteristic of tomato fruit.

For this purpose five plants were randomly selected from each sub plot to study plant height was measured from the surface of soil to the tip of the plant, and total no of main branches per plant counted. Leaf length was measured in (cm) with the help of measuring tape. Days to flowering, number of days to flowering was calculated from the date of transplanting of seedlings to the initiating of flowering. Fruit setting; the first fruit setting was calculated from transplanting to first fruit set; Number of fruits per plant: The total number of mature fruits was calculated during all pickings. Average fruit weight in (g); was calculated by weighing the weight single fruit in electric balance. Yield (t ha⁻¹) was calculated by following formula:

$$\text{Yield t ha}^{-1} = \frac{\text{Yield per plot (kg)} \times 10000}{\text{Plot (m)}^2 \times 1000}$$

Quality parameters (TSS, Titratable acidity pH and Ascorbic acid): The tomatoes were ground in a blender and juice was used to determine the total soluble solids (TSS) by using Refractometer according to the recommended method of (Anon., 2006). Titratable acidity was determined using 10 ml of fruit juice was taken in to

100 ml volumetric flask and made volume to 100 ml with deionized water and titrated against 0.1N NaOH according to recommended method of AOAC (Anon., 2006). pH of each cultivar was measured by of digital pH meter according prescribed method of AOAC (Anon., 2006). Ascorbic acid concentration was obtained by using titrimetric method of Anon., (2006).

Statistical analysis: Statistical analysis was carried out by using a Statistica 8.1, Analysis of variance was conducted and mean comparison was carried out by LSD test where p<0.05 was considered as significance level.

Results and Discussion

The results obtained from this investigation showed significant variations among the cultivars in growth yield as well as in nutritional/quality attributes.

Plant height (cm): Data regarding plant height showed significant difference among cultivars, it was exhibited from the Table 1, that the highest plant height (73.0cm) was observed in Roma followed by Savera and Fmx (67.66cm) and (58.66cm) respectively. While the shortest height of plant (48.66 cm) in Riogrand. Our results regarding plant height are in agreement with the findings of Ali *et al.*, (2016), who observed significant difference in plant height among different cultivars of tomato.

Number of branches plant⁻¹: Number of branches per plant for all four tested cultivars showed highly significant variation among others. Data showed from Table 1 that Roma showed highest no of branches (6.46) followed by Savera & Riogrand (5.90) and (4.8) respectively, whereas the Fmx have lowest no of branches (4.2). These results are closely conformity with previous findings of Hussain *et al.*, (2001) who had observed maximum number (4.1) of primary branches in Samarzano followed by Sorranito (4.0) while minimum branches (3.1) were recorded in Chico III. Similar kind of results was also described by Ali *et al.*, (2016).

Leaf length (cm): Leaf length among all the cultivars were found highly significant different, as results showed from Table 1 leaf length ranged from (7.47cm) to (10.26cm) the longest length of leaf was observed in Roma (10.26cm), followed by Savera and Fmx were (9.36cm) and (8.60cm) respectively, while the cultivar Riogrand have the shortest leaf length (7.47cm). These results are in conformity with the results of Ali *et al.*, (2012) described longest leaf length was in tomato hybrid T-7008 (10.42cm) followed by T-7030 (10.27cm), TP-001 (9.49cm) respectively.

Days to flowering: It is revealed from the Table 1 that Roma took longer period of time (43.3) days from date of transplanting of seedlings to the flowering, followed by Savera & Roma (39.66) and (39.00) respectively while the Fmx flowered earlier (38.66 days). These results are closely in conformity with the findings of Naz *et al.*, (2011) who had reported cultivars Roma and 'Rio Fuegd' were taken (37.7 and 39.0) days, while Yaqui took relatively longer time (47.0) days.

Table 1. Variation in growth characteristics among different cultivars.

Cultivar	Plant height	Number of branches per plant	Leaf length	Days to flowering	Days to fruit setting
Roma	73.000 ^A	6.4667 ^A	10.267 A	43.333 ^A	65.667 ^A
Riogrand	48.667 ^c	4.8000 ^{BC}	7.470D	39.000 ^B	64.333 ^A
Savera	67.667 ^{AB}	5.9000 ^{A^B}	9.360 B	39.667 ^{AB}	66.333 ^A
FMX	58.667 ^{BC}	4.2000 ^C	8.603 C	38.667 ^B	65.21 ^A
LSD	11.787	1.5604	3.1414	3.9399	7.9916
SE	4.8170	0.6377	1.2838	1.6102	3.2660

Means with the same letters in each column were not significant different at $p < 0.05$

S.E: Standard error of means

Table 2. Pomological variation among fruits of different cultivars and their yield.

Cultivar	Number of fruits plant ⁻¹	Fruit length (cm)	Fruit diameter (cm)	single fruit weight (g)	Fruit weight plant ⁻¹ in (kg)	Yield T ha ⁻¹
Roma	27.667 ^A	4.5333 ^A	4.3000 A	42.650 ^{BC}	1.190 ^A	29.460 A
Riogrand	22.333 ^B	4.5667 ^A	3.9000 A	41.433 ^C	0.950 ^D	22.503 B
Savera	19.000 ^C	4.6000 ^A	4.6333 A	49.247 ^{AB}	1.030 ^B	24.217 B
FMX	18.000 ^C	4.8333 ^A	4.0000 A	56.433 ^A	1.010 ^C	25.080 B
LSD	1.5969	1.5579	0.8156	7.5233	0.0200	3.0053
SE	0.6526	0.6367	0.3333	3.0746	8.165	1.2282

Means with the same letters in each column were not significant different at $p < 0.05$

S.E: Standard error of means

Table 3. Quality parameters of four cultivars of tomato.

Cultivar	pH	T. acidity (%)	TSS (°B)	Ascorbic acid mg/100g
Roma	4.6300 A	0.3300 C	4.2000 C	21.363 A
Riogrand	4.3467B	0.4200 B	5.0333 B	18.530 C
Savera	4.2300C	0.4400 B	5.5000 A	20.740 B
Fmx	4.1300D	0.4700 A	4.3000 c	17.560 D
LSD	0.0258	0.0231	0.1631	0.3683
SE	0.0105	9.428	0.0667	0.1505

Means with the same letters in each column were not significant different at $p < 0.05$

S.E: Standard error of means

Days to fruit setting: Data regarding days taken from transplanting to fruit setting were non-significant statistically among all cultivars. It was revealed from Table 1 that maximum days were taken for fruit setting by cultivar Savera (66.33) days followed by Fmx and Roma were (65.21) and (65.66) days respectively. Riogrand was taken minimum (64.33) days for fruit setting. These results are in agreement with the results of Ali *et al.*, (2012) found almost similar kind of results i.e. tomato hybrid 68-F1 and PT M-1603 took (66.00) and (68.00) days respectively while highest number of days were taken by hybrid T-7010 hybrid (91.00).

Number of fruits per plant⁻¹: Data pertaining number of fruits plant⁻¹ as shown in Table 2, highest number of fruits plant⁻¹ (27.66) were found in Roma followed by Riogrand (23.33), whereas no of fruits plant⁻¹ in Savera (19.0) and Fmx (18.0) were shown statistically non significant behavior. Our results get support from the results of Hussain *et al.*, (2002) who had reported highest number of fruits were found in Sorrento (36.5), followed by Samarzano (20.0), Roma (12.0), Riogrand (11.3) while the lowest no of fruits were in Vesuvio (9.3).

Fruit length (cm): Results regarding physical character fruit i.e. length, it was revealed that all four cultivars showed a non-significant behaviour statistically against others. Table 2 showed that longest fruit length (4.83 cm) was found in Fmx followed by Savera and Riogrand (4.600 cm) and (4.56 cm) respectively, while Roma showed shortest fruit length (4.53 cm). These results are in agreement with the results of Ali *et al.*, (2012) who had found tomato hybrids T-7001 maximum fruit length (6.42cm) while the minimum fruit length (5.50cm) was found in hybrid 68F1.

Fruit diameter (cm): Data analyzed showed from the Table 2 that the maximum fruit diameter was produced by cultivar Fmx (4.63cm) then followed by Roma and Savara (4.3cm) and (4.0cm) respectively, whereas the minimum fruit diameter was produced by Riogrand (3.9cm). Our results are agreement with earlier findings of Rahman *et al.*, (2000) who found that maximum diameter of fruit was in Eva (5.65cm) followed by Riogrand (5.30cm) and Roma (4.9cm) respectively and minimum fruit diameter was found in local round (2.03cm).

Individual fruit weight (gm): Data from Table 2, it is evident that there is significant variation among different cultivars in terms of individual fruit weight. Maximum weight of single fruit was observed in Fmx (56.43gm) followed by Savera (49.24 gm) and Roma (42.65 gm), while the minimum weight of individual fruit was found in Riogrand (41.43 gm). These findings get support from the previous findings of Rehman *et al.*, (2000) who had reported weight of different tomato cultivars Roma (39.13gm), Riogrande (41.50gm), Savio (44.88gm), Lima (42.63gm), Festen (46.75gm) Marglobe (52.25gm). Hussain *et al.*, (2001) was also stated variations in fruit weight among 10 different cultivars of tomato, ranging from 48.7gm in Sorrento to 88.3gm in Nadir.

Fruit weight plant⁻¹: Fruit weight plant⁻¹ in all cultivars exhibited significant variation among others. Results from Table 2 it showed that highest weight of fruits plant⁻¹ was observed in Roma (1.19kg) followed by Savera and Fmx (1.03kg) and (1.01kg) respectively, statistically both were at par with each other. whereas cultivar Riogrand had lowest fruit weight per plant (0.95kg). These results get support from previously work done by Hussain *et al.*, (2001) who had reported maximum weight of fruits plant⁻¹ (1.55 kg) in cultivar Tanja closely followed by Chico III having (fruit weight per plant 1.51 kg). While minimum weight of fruits per plant (0.98kg) was recorded in Rio Grande.

Yield (t ha⁻¹): There is a positive relation in number of fruits plant⁻¹ and larger fruit size with the fruit yield plant⁻¹. Mostly the cultivars which have better sized fruits and higher number of fruits per plant produced higher yield. Data from Table 2 it showed that Roma had produced highest yield (29.46 t ha⁻¹) followed by Fmx and Savera (25.08 t ha⁻¹) and (24.21 t ha⁻¹), respectively which were non-significant statistically, while Riogrand was observed minimum yield (22.50 t ha⁻¹). The findings of this study are in conformity with the previous work done by Jilani *et al.*, (2013) who had reported that tomato cultivar Vegnesh and 131 produced (36.850 t/ha) and (33.66 t ha⁻¹) yield respectively. While the Sorya-66 and TM-532-et had yielded (24.67 t ha⁻¹) and (23.83 t ha⁻¹) respectively. Similar kind of results also found from findings of Ali *et al.*, (2016) who had reported that highest yield (23.31 t ha⁻¹) in tomato Cv. Roma and Bambino produced (23.32 t ha⁻¹) respectively, whereas the lowest yield (17.98 t ha⁻¹) was reported in Cv. Money Maker. Other investigators i.e. Chaudhary *et al.*, (1999) and Khokar *et al.*, (2000) had reported yield difference among tomato varieties.

pH, Titratable acidity, T.S.S, and Ascorbic acid: All cultivars were significantly different for quality parameters of fruit, highest pH value (4.63) was found in Roma, followed by Riogrand and Savera (4.346) and (4.23), while the lowest value of pH (4.13) was found in Fmx. The highest Titratable acidity (0.47%) value, was found in Fmx, followed by Savera (0.44%) and Riogrand (0.42%) both were statistically non-significant among others (Table 3). whereas the lowest value of Titratable acidity (0.33%) was found in Roma. TSS values among

the all cultivars were found significantly different, highest TSS level (5.5⁰B) was found in Savera and lowest (4.2⁰B) was found in Roma. Ascorbic acid content was found significantly different among the cultivars (Table 3) highest content (21.36mg/100g) was observed in Roma followed by Savera (20.74mg/100g) and then (18.53 mg/100g) in Riogrand, while the Fmx have lowest content (17.56 mg/100g). These results are in agreement with Ali *et al.*, (2016) they had found significant variation of Vitamin C, TSS and Titratable acidity among different cultivars of tomato.

Conclusion

On the basis of above obtained results, cultivar Roma is found as promising cultivar in terms of higher yield and quality parameters. The identification of cultivars with higher nutritive value, represent a useful approach to choice tomato cultivars with better health-promoting properties.

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