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Production Systems

Growth and yield of pomato under the Syrian coastal mountains conditions

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Abstract. *The world has always been striving to increase and intensify agricultural production, and there are several attempts to acheive that, such as grafting tomato on potato to obtain two crops from one plant. This investigation was conducted during 2020 in open field in Nahl village, Baniyas, Tartous Governorate, Syria. The vegetative and generative growth and yield have been studied for pomato (grafted tomato on potato) and compared to each tomato and potato separately. Tomato plants were significantly superior in plant height to pomato plants after 23 days of planting until the end of the experiment. On the other hand, there were significant differences between tomato plants and pomato plants in the leaf area after 23, 51 and 65 days of planting. Also, tomato plants significantly outperformed pomato plants in the number of flowers and fruits per plant and the tomato fruit set percent. Anyway, tomato plants were significantly superior in the average yield of tomato fruits per plant (1657 g.plant*$^{-1}$*) to pomato plants (185 g.plant*$^{-1}$*), while there were insignificant differences in the average yield of potato tubers per plant between pomato which failed to produce tubers and potato (48.25 g.plant*$^{-1}$*). Studying the tomato fruit fresh weight showed a significant superiority of tomato plants (54.37 g.fruit*$^{-1}$*) to pomato plants (35.97 g.fruit*$^{-1}$*), while there were insignificant differences in the other physical (tomato fruit height, diameter and shape index) and chemical (tomato fruit content of total acids, total soluble solids and dry matter, %) properties.*

Keywords: generative, graft, potato, rootstock, tomato, vegetative

Introduction

In light of the increase in the global population and poverty and the shortage of food and water resources, it was necessary to rationalize the consumption of food and water sources, and seek to increase food production by using many techniques such as intensive and continuous cultivation, and even the cultivation of more than one crop in the same season, and here grafting may have a great benefit in obtaining two crops from one plant, as is the case when grafting tomato on potato and get the pomato plant.

Grafting tomato is one of the best solutions to fight the soil-borne problems and improves the yield quantity and quality by using durable rootstocks which are compatible with the scion and adapted to the surrounding environment (Besri, 2008). Ibrahim (2012) found that grafting tomato contributed to increase the growth and yield. Anyway, the effect of grafting on the growth, yield and fruit characteristics varied according to the rootstock.

Pek et al. (2007) revealed that grafting delayed the fruit internal development, but gave larger fruit and greater yield compared with ungrafted plants. According to Mohammed et al. (2009), tomato production was improved significantly by 21%, and fruit content of total soluble solids was also increased by grafting, while ungrafted plants were superior to grafted plants in fruit diameter. Gajc-Wolska et al. (2010) established that tomato fruit content of dry matter and total sugars was increased by grafting, while the results of Ulukapi and Onus (2007) showed that there were no significant differences in yield, total soluble solids and total acidity of grafted tomato plants compared to ungrafted ones. Kelly and Somers (1948) found that ascorbic acid content of potato tubers was regulated by the genetic constitution of the underground portion regardless of the genetic constitution of the aerial portion of the plant (whether it is potato or tomato).

Pomato is a grafted plant developed by grafting tomato on potato to obtain both potato and tomato yield from one plant. Islam et al. (2019) revealed that pomato plant produced copious branches and flowers. The average number of tomato fruits per pomato plant was 35 fruits, average fruit weight 78 g and yield was about 2729.79 g of fruits per plant. Edible potato tubers were about 4-5 tubers weighting 211 g from each pomato plant. In addition to producing both fruits and tubers from one plant, Parthasarathi et al. (2021) suggested that grafting tomato on potato rootstocks may be a good strategy for improving tolerance to saline water.

Thus, we obtain pomato by heterografting which means grafting two different species to achieve a plant that produces

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both tomato fruits and potato tubers. Some qualitative characteristics like total soluble solids and soluble sugars of tomato fruit were improved by potato rootstocks and fruit number per plant was increased, but the content of total acids and tomato fruit weight were decreased. Grafting significantly promoted the tuber sprouting and decreased the tuber number per plant. The starch and vitamin C in the potato tubers were significantly decreased after grafting. The changes in scion and rootstock caused by grafting may be caused by the accumulation and distribution of photosynthetic products and the interaction between scion and rootstock (Zhang and Guo, 2019).

Pervin (2015) studied the optimal cytocompatibility of pomato plants and noticed significant differences between the genotypes of all traits tested. Compared with the local potato rootstocks, BARI Tomato11 genotype was the best graft of the foreign potato rootstocks, because plant height, number of branches and clusters per plant, fruits per cluster and per plant, tubers per plant, fruit length and diameter, fruit and tuber yield per plant increased. Arefin et al. (2019) pointed out that the variation and age of grafts had a significant impact on the yield of pomato fruits and tubers. Plant height, number of leaves, branches and clusters, number of fruits per cluster and per plant, fruit length, fruit diameter, fruit weight, fruit yield per plant, number of tubers per plant, tuber weight and tuber yield were higher in BARI Tomato-11 when grafted at 25 days of age on Cardinal and Asterix potato rootstocks compared to other combinations. However, plant growth regulators for tuber formation, fruit development and vegetative growth must be balanced.

Plant hormones can induce or suppress tuberization (Fernie and Willmitzer, 2001). Cytokinins break tuber dormancy and exhibit very early sprouting (Galis et al., 1995), while gibberellins inhibit tuber formation and play a role in photoperiod control of tuber formation by preventing tuber formation in long days (Xu et al., 1998). However, the exact role of abscisic acid is unclear, but it has been found that the ratio of abscisic acid to gibberellins is higher in potato plants grown in short days compared to potato plants grown in long days (Machácková et al., 1998). Therefore, although the critical photoperiod between different genotypes may be different, short days are preferable for potato tuber formation. For example, the critical photoperiod of some wild potatoes is usually 12-13 hours, while the critical photoperiod of other potato varieties is 15 hours or longer (Ewing and Wareing, 1978).

Peres et al. (2005) observed that photoperiod and plant hormones control many developmental responses of the plant, such as tuberization in potato. In any case, the tomato scions is not always as effective as the potato ones in promoting tuber formation. The highest tuber formation was obtained from chromophore deficient. Gibberellin deficient scions were the most sprouting-inducing. These results indicate that hormones and photomorphogenesis play a key role in the formation of tubers, and that the tomato grafts cannot produce the substances involved in the transformation of stolons into tubers. Conversely, Kudo and Harada (2007) grafted potato on tomato rootstocks, and the results showed that a graft-transmissible RNA from the tomato rootstock without any leaves could change leaf morphology of the potato scion. This grafting combination and RNA transport could help to improve varieties of horticultural crops.

In addition to grafting, Okamura (1994) mentioned that potatoes have been improved by introducing useful traits from wild relatives through sexual interbreeding. However, wild tomato species have not been exploited due to their sexual incompatibility with potato, so somatic fusion can provide a means of incorporating the characteristics of sexually incompatible species into potato. For example, *L. pimpinellifolium* has useful potato enhancing properties, such as resistance to soft rot, black leg and high temperatures. Melchers et al. (1978) successfully produced somatic hybrids of potato and tomato regenerated from protoplasts fusion.

Tomato (*Lycopersicon esculentum* Mill.) and potato (*Solanum tuberosum* L.) cultivation in Syria is considered an important economic cultivation. In 2019 Syria produced 771,649 tons of tomato from 14,040 ha and 635,519 tons of potato from 24,795 ha according to the official statistics of the Ministry of agriculture and agrarian reform of Syria.

The importance of the research is to consider the possibility of grafting tomato on potato in order to obtain two crops from one plant, thus saving the planted area and costs. The research aims to study the success of growing the pomato plant, which resulted from grafting tomato (hybrid Mandaloun F_1) on potato (Spunta potato variety), in the environment of the Syrian coastal mountains in summer.

Material and methods

Area and period of the study

The research was carried out during 2020 in open, non-sterile and previously uncultivated soil, which rises about 640 m above sea level, in Nahl village which is in the countryside of Baniyas, Tartous Governorate, Syria.

Plant material

Scion: Mandaloun F_1 tomato hybrid, which is characterized by unlimited growth appropriate for greenhouse, high productivity, low temperature tolerance, big size, excellent coloring and homogeneous fruit, from Westfrisian seeds company was used as scion.

Rootstock: Spunta potato variety was used as rootstock, which is characterized by the half earliness, tubers with elongate shape, eyes are superficial, pulp with white color and dormancy period of tubers is medium.

Grafting and planting

Potato sprouts of the rootstock Spunta were planted on 7.03.2020, and seeds of the scion Mandaloun F_1 were sown on 4.04.2020. Grafting was done using tube grafting technique on 28.04.2020 when seedlings had approximately the same diameter and 2-3 true leaves at grafting time. The grafted plants were kept in a humid and warm place to ensure the healing of the grafting area, while following up the various service operations of irrigation, fertilizing with nutrients and pest control till they were completely healed. Pomato, ungrafted tomato and potato plants were transplanted to the field on 27.05.2020. The planting was in single rows, 40 cm between rows, 60 cm between plants in the same row, so the plant density was 4.17 plant.m^{-2}. Pomato and tomato plants were grown in 2 stems (the main stem and the sucker below the first fruit cluster), while potato plants were left to grow freely with no pruning.

Statistical design and data analysis

A randomized complete block design was adopted with 2 treatments for 2 experiments (pomato vs each tomato and potato) and 3 replications, each replicated plot was consisting of 5 plants. All plants were evaluated for the measurements. So, the number of studied plants = 3 treatments x 3 replications x 5 plants = 45 plants.

Data were analyzed statistically by one-way ANOVA in a general linear model using 'SPSS for Windows' and the differences between the means were compared using the LSD test (p=0.05). The results were presented as mean ± standard deviation of mean (n=3).

Measurements and observations

The following measurements and observations were done in the study:

1) Characteristics of growth

The evolution of plant height (cm), number of branches per plant, number of leaves per plant, leaf area (cm^2.plant^{-1}) and leaf area index were estimated by taking measurements after 3, 23, 37, 51 and 65 days of planting in the field. Stem diameter (mm) was determined by a manual caliper after 65 days of planting. Shoot dry weight (g. plant^{-1}) was also determined by air drying after 106 days of planting.

2) Characteristics of generative growth, yield, physical and chemical properties of tomato fruits and potato tubers

The number of clusters per main and secondary branch and per plant, number of flowers and tomato fruits per cluster and plant and tomato fruit set percent (%) were estimated. Yield measurements were recorded on ripe tomato fruits which were hand-harvested from 9.08.2020 till uprooting all plants and harvesting potato tubers on 10.09.2020. So, the yield of tomato fruits per plant (g.plant^{-1}), number of potato tubers per plant, yield of potato tubers per plant (g. plant^{-1}) were determined.

A total of 10 fruits/tubers were randomly taken from each replication at harvest time to measure the average fruit/tuber fresh weight (g), fruit/tuber height and diameter (cm) and fruit/tuber shape index by a manual caliper. Percentage of total acids in fruit/tuber juice (TA) was determined by titration with NaOH (Palikiva, 1988). Proportion of total soluble solids in juice (TSS) was measured by using the hand refractometer. Fruit/tuber content of dry matter (%) was also studied by drying the fruit/tuber juice at 105°C until the weight was completely stable.

Results

Characteristics of growth

The evolution of plant height: The results of studying the average of plant height (Table 1) show that tomato plants were significantly superior to pomato plants after 23 days of planting until the end of the experiment, while pomato plants (92.67±2.52 cm) were significantly superior to potato plants (65.33±5.03 cm) after 51 days of planting only since there were insignificant differences in other reading appointments.

Table 1. Evolution of plant height (cm)

Treatment	After 3 days of planting	After 23 days of planting	After 37 days of planting	After 51 days of planting	After 65 days of planting
Tomato	10.67±1.53^{A}	57.67±6.51^{A}	100.33±6.03^{A}	143.67±8.50^{A}	165.33±5.03^{A}
Pomato	21.33±8.02^{Aa}	49.33±9.02^{Ba}	78.33±2.08^{Ba}	92.67±2.52^{Ba}	100.33±0.58^{Ba}
Potato	19.00±1.00^{a}	33.67±2.52^{a}	61.67±8.51^{a}	65.33±5.03^{b}	90.33±10.02^{a}
LSD 5%	16.164	6.252	9.937	27.328	12.422
lsd 5%	22.405	28.579	26.095	6.252	24.843

*Figures that share the same letter in the column (Uppercase letters for comparing between tomato and pomato according to LSD test - p>0.05, and lowercase letters for comparing between pomato and potato according to LSD test - p>0.05) have no significant differences.

Evolution of number of branches per plant: The results of studying the average of branches per plant shown in Table 2 reveal that potato plants were significantly superior to pomato plants after 51 days of planting until the end of the experiment, because potato plants were left to grow freely with no pruning, while there were insignificant differences between tomato and pomato plants since they were grown in 2 stems during the entire experiment period.

Table 2. Evolution of number of branches per plant

Treatment	After 3 days of planting	After 23 days of planting	After 37 days of planting	After 51 days of planting	After 65 days of planting
Tomato	1.00±0.00^{A}	1.00±0.00^{A}	2.00±0.00^{A}	2.00±0.00^{A}	2.00±0.00^{A}
Pomato	1.00±0.00^{Aa}	1.00±0.00^{Aa}	1.67±0.58^{Aa}	1.67±0.58^{Ab}	1.67±0.58^{Ab}
Potato	1.00±0.00^{a}	1.67±0.58^{a}	4.67±1.53^{a}	8.00±0.00^{a}	16.00±1.00^{a}
LSD 5%	0.000	0.000	1.434	1.434	1.434
lsd 5%	0.000	1.434	4.969	1.434	1.434

*Figures that share the same letter in the column (Uppercase letters for comparing between tomato and pomato according to LSD test - p>0.05, and lowercase letters for comparing between pomato and potato according to LSD test - p>0.05) have no significant differences.

Evolution of number of leaves per plant: As shown in Table 3, there were insignificant differences between tomato and pomato in the number of leaves per plant, while potato plants were significantly superior to pomato plants after 23 and 65 days of planting.

Table 3. Evolution of number of leaves per plant

Treatment	After 3 days of planting	After 23 days of planting	After 37 days of planting	After 51 days of planting	After 65 days of planting
Tomato	2.67±0.58[A]	8.67±0.58[A]	15.33±2.08[A]	25.67±0.58[A]	37.67±2.52[A]
Pomato	4.67±2.52[Aa]	7.67±1.53[Ab]	12.67±2.52[Aa]	18.33±4.04[Aa]	22.67±6.51[Ab]
Potato	5.33±0.58[a]	12.67±2.52[a]	15.33±1.15[a]	42.67±8.50[a]	71.33±9.02[a]
LSD 5%	4.969	2.484	11.203	8.725	22.359
lsd 5%	7.590	2.484	3.795	31.063	38.514

*Figures that share the same letter in the column (Uppercase letters for comparing between tomato and pomato according to LSD test - p>0.05, and lowercase letters for comparing between pomato and potato according to LSD test - p>0.05) have no significant differences.

Evolution of leaf area: The results shown in Table 4 show that there were significant differences between tomato plants and pomato plants in the leaf area after 23, 37, 51 and 65 days of planting, because the average area of the single leaf in tomato plant was larger than that in pomato plant in which the overall growth characteristics were smaller. On the other hand, pomato plants were significantly superior to potato plants only after 37 days of planting.

Table 4. Evolution of leaf area ($cm^2.plant^{-1}$)

Treatment	After 3 days of planting	After 23 days of planting	After 37 days of planting	After 51 days of planting	After 65 days of planting
Tomato	242.64±52.53[A]	1771.27±52.53[A]	5078.37±1206.62[A]	10134.71±40.21[A]	16006.60±1439.60[A]
Pomato	424.62±228.99[Aa]	1188.94±37.88[Ba]	3669.26±469.51[Aa]	5487.26±957.41[Ba]	6877.50±1752.26[Ba]
Potato	161.76±17.51[a]	829.02±261.50[a]	1152.54±109.36[b]	3510.64±745.70[a]	5983.77±790.83[a]
LSD 5%	452.100	180.840	4147.819	2300.026	7928.481
lsd 5%	609.047	709.625	984.893	4210.969	6308.973

*Figures that share the same letter in the column (Uppercase letters for comparing between tomato and pomato according to LSD test - p>0.05, and lowercase letters for comparing between pomato and potato according to LSD test - p>0.05) have no significant differences.

Stem diameter and shoot dry weight: The results of studying the stem diameter after 65 days of planting (Table 5) indicate the significant superiority of tomato plants (10±0.00 mm) to pomato plants (7.67±0.58 mm), while there were insignificant differences between pomato and potato plants (7.77±1.27 mm). Also, the results of studying the shoot dry weight after 106 days of planting show the significant superiority of tomato plants (208.65±0.34 $g.plant^{-1}$) to pomato plants (30.72±5.83 $g.plant^{-1}$), while there were insignificant differences between pomato and potato plants (34.58±10.28 $g.plant^{-1}$).

Table 5. Stem diameter (mm) after 65 days of planting and shoot dry weight ($g.plant^{-1}$) after 106 days of planting

Treatment	Tomato	Pomato	Potato	LSD 5%	lsd 5%
Stem diameter	10.00±0.00[A]	7.67±0.58[Ba]	7.77±1.27[a]	4.353	6.156
Shoot dry weight	208.65±0.34[A]	30.72±5.83[Ba]	34.58±10.28[a]	14.870	39.987

*Figures that share the same letter in the row (Uppercase letters for comparing between tomato and pomato according to LSD test - p>0.05, and lowercase letters for comparing between pomato and potato according to LSD test - p>0.05) have no significant differences.

Generative growth, yield, physical and chemical properties of tomato fruits and potato tubers

The results of the study of the generative growth (Table 6) show a significant superiority of tomato plants in the number of clusters per main branch, the number of flowers and fruits per cluster, the number of flowers and fruits per plant and the tomato fruit set percent to pomato plants, while there were insignificant differences between tomato and pomato plants in the number of clusters per secondary branch and per plant. Otherwise, the results of the studying the average yield of tomato fruits per plant indicate the significant superiority of tomato plants (1657±280.96 $g.plant^{-1}$) to pomato plants (185±73.65 $g.plant^{-1}$), while there were insignificant differences in the average yield of potato tubers per plant between pomato (0 $g.plant^{-1}$) and potato (48.25±28.47 $g.plant^{-1}$), though potato plants were significantly superior to pomato plants in the number of potato tubers per plant (1.67±0.58 and 0 tubers per plant, respectively). However, the average yield of potato tubers per plant remained very low and with no economic benefit in potato plants because of the long days conditions which prevent tuberization.

As given in Table 6, studying the tomato fruit fresh weight show a significant superiority of tomato plants (54.37±2.41 $g.fruit^{-1}$) to pomato plants (35.97±8.46 $g.fruit^{-1}$), while there were insignificant differences in the other physical and chemical properties of tomato fruits between tomato and pomato plants, though the tomato fruit content of TA, TSS and dry matter (%) were higher in pomato plants.

Table 6. Generative growth, yield, physical and chemical properties of tomato fruits and potato tubers

Treatment	Tomato	Pomato	Potato	LSD 5%	lsd 5%
Number of clusters per main branch	6.67±0.58[A]	5.00±0.00[B]	-	1.434	-
Number of clusters per secondary branch	4.67±0.58[A]	1.67±1.53[A]	-	4.969	-
Number of clusters per plant	11.33±1.15[A]	6.67±1.53[A]	-	6.252	-
Number of flowers per cluster	5.46±0.27[A]	4.42±0.16[B]	-	0.617	-
Number of flowers per plant	61.67±4.51[A]	29.33±6.02[B]	-	26.095	-
Number of tomato fruits per cluster	2.69±0.35[A]	0.75±0.05[B]	-	0.794	-
Number of tomato fruits per plant	30.67±6.51[A]	5.00±1.00[B]	-	18.646	-
Tomato fruit set percent, %	49.39±6.99[A]	17.07±0.37[B]	-	17.155	-
Yield of tomato fruits per plant, $g.plant^{-1}$	1657.00±280.96[A]	185.00±73.65[B]	-	875.344	-
Number of potato tubers per plant	-	0.00±0.00[b]	1.67±0.58[a]	-	1.434
Yield of potato tubers per plant, $g.plant^{-1}$	-	0.00±0.00[a]	48.25±28.47[a]	-	70.730
Tomato fruit and potato tuber fresh weight, g	54.37±2.41[A]	35.97±8.46[B]	26.75±9.76	15.590	-
Tomato fruit and potato tuber height, cm	4.12±0.17[A]	3.79±0.29[A]	5.87±1.21	0.360	-
Tomato fruit and potato tuber diameter, cm	4.46±0.16[A]	3.94±0.38[A]	2.93±0.26	0.559	-
Tomato fruit and potato tuber shape index	0.92±0.02[A]	0.96±0.03[A]	1.99±0.24	0.050	-
Tomato fruit and potato tuber content of TA, %	0.58±0.06[A]	0.75±0.04[A]	0.69±0.12	0.224	-
Tomato fruit and potato tuber content of TSS, %	4.17±0.29[A]	5.50±0.50[A]	5.00±0.00	1.434	-
Tomato fruit and potato tuber content of dry matter, %	5.99±0.14[A]	7.21±0.71[A]	6.63±0.41	2.050	-

*Figures that share the same letter in the row (Uppercase letters for comparing between tomato and pomato according to LSD test - p>0.05, and lowercase letters for comparing between pomato and potato according to LSD test - p>0.05) have no significant differences.

Discussion

The significant superiority of ungrafted tomato plants to pomato plants in the growth characteristics such as plant height, leaf area, stem diameter and shoot dry weight can be explained by the uncompatibility between the scion (Mandaloun F_1 tomato hybrid) and the rootstock (Spunta potato variety) in the conditions of the local experiment since the relatively high summer temperature conditions and long days in the summer are not suitable for growing potato plants either as a rootstock or when planted alone.

Anyway, the insignificant differences between tomato and pomato plants in the number of leaves per plant, which was limited to the apparent superiority only, in most reading appointments, indicate the presence of a dwarfing effect of the rootstock (Spunta potato variety) on the scion (Mandaloun F_1 tomato hybrid) represented in the shortness of phalanges and the small area of the leaf in grafted tomato plants. Despite the significant superiority of potato plants in the number of leaves per plant to pomato plants, one of the reasons for which is the free growth of potato plants compared to the growing of only two branches of pomato plant, but the environmental conditions of the experiment did not help potato plants to outperform pomato plants in the leaf area, stem diameter and shoot dry weight, and here the mutual effect of both scion and rootstock appeared, as the scion (tomato) had a role in trying to increase the vegetative growth in environmental conditions considered suitable for it, such as relatively high temperatures and long days conditions, contrary to rootstock (potato), which thrives in moderate temperatures, short days and medium texture soil. These results contradict the results of Arefin et al. (2019) that showed plant height, leaf number and branch number were increased by grafting BARI Tomato-11 genotype on Cardinal and Asterix potato varieties compared to other combinations.

Otherwise, the significant superiority of ungrafted tomato plants to pomato plants in the various growth indicators contributed to increase the generative growth in tomato plants represented by the number of clusters per main branch, the number of flowers and fruits per cluster, the number of flowers and fruits per plant, tomato fruit set percent, yield and the fruit fresh weight compared to pomato plants. Anyway, the results are not completely compatible with the results of Islam et al. (2019) and Zhang, and Guo (2019) that showed pomato plants produced more flowers and fruits with a lower average weight per fruit.

The poor vegetative and generative growth and yield in pomato plants is due to the negative effect of the rootstock (Spunta potato variety) in trying to inhibit vegetative growth in order to direct growth towards the formation of tubers, but the environmental conditions of the experiment represented by the long days conditions and the relatively high temperature contributed to the formation of small tubers in potato plants which were unfit for consumption and marketing, while the scion (Mandaloun F_1 tomato hybrid) tendency towards vegetative growth and formation of tomato fruits prevented the formation of these tubers completely in pomato plants. The results of the study are consistent with the results of Zhang and Guo (2019) that grafting tomato on potato reduces the number of tubers per plant, and these results are consistent with the results of Peres et al. (2005) who noticed that photoperiod and plant hormones control many plant developmental responses, including tuber formation. Therefore, the long day conditions and tomato grafts cannot produce the substances involved in the transformation of stolons into tubers. On the other hand, the research results are inconsistent with the results of Pervin (2015) and Arefin et al. (2019) who recommended BARI Tomato-11 genotype as a scion for grafting on all tested potato rootstocks since many vegetative and generative growth characteristics were increased.

Grafting tomato on potato positively affected the proportion of total soluble solids (TSS), total acids (TA) and dry matter in fruit juice. Although this effect was insignificant, this could be explained by the small size and number of the fruits in pomato plants which contributed to the concentration of nutrients in them in comparison with the large number of the largest fruits on ungrafted tomato plants. These results are consistent with the results of Zhang and Guo (2019) regarding the increase in TSS, while they disagree with them regarding the decrease in TA when grafting tomato on potato, and that may be related to the accumulation and distribution of photosynthetic products and scion-rootstock interactions.

In short, the results of the study correspond to the results of Peres et al. (2005) and Arefin et al. (2019) that indicated the effects of hormones and photomorphogenesis on growth, tuberization and fruit development of the pomato plant, and that was explained by Ewing and Wareing (1978), Galis et al. (1995), Machácková et al. (1998), Xu et al. (1998) and Fernie and Willmitzer (2001) about the role of photoperiod and plant hormones, such as cytokinins, gibberellins, abscisic acid and jasmonic acid that induce or repress tuber formation.

Conclusion

From the results of this research it can be concluded that planting pomato plants in summer conditions contributes to poor vegetative and generative growth and yield. Anyway, it is still possible to grow pomato plant and obtain two crops from it by conducting more researches to define the means and conditions that help in adopting this plant and improve its growth attributes and yield, thus saving the planted area and costs.

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