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Original Research Article

Effect of macro and micro elements foliar spray on the qaulity and quantity of tomato (*Solanum lycopersicum*)

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In order to investigate the effect of macro and micro grow more fertilizers on the quality and quantity of tomato (*Solanum lycopersicum* L.)an experiment was conducted on Karoon cultivar in Kamyaran town in the crop year 2013.This experiment was conducted in a Randomized Complete Block Designs (RCBD) with three-replication. The fertilizer treatments including multi-purplex, sulopotas, iron chelate, gro folan, feugo base, NPK, calcium, zinc, a mixture of all treatments (Mix), and control (no fertilizer). The results showed that mix treatment had the highest fruit yield with the amount of 402.1kg per 100 plants and control had the lowest yield, 156.9kg per 100 plants. Feugo Base and control, 4.8 and 2.9mg per 25g fruit, produced the highest and lowest amounts of vitamin C respectively, which significantly differ from other fertilizer treatments. The amounts of vitamin C in other fertilizer treatments were between these two treatments. Sulopotas had the highest amount of soluble solids, 11.73, which was significantly different from other treatments. Calcium, Iron Chelate, and Sulopotas led to the highest amount of flesh firmness, 6.36, 6.13, and 5.67g/ cm^2, respectively; and control resulted in the lowest amount, 3.66 g/cm^2.

Key words: Macro and micro fertilizers, *solanum lycopersicum* L, quality, quantity

INTRODUCTION

Tomato, scientifically known as *Solanum lycopersicum* L is a Solanaceae plant family as well as a Native South and Central American one, which was brought through Spain to other areas around the world and today different types of it are grown worldwide (Daneshvar, 2010). According to FAO Statistics, around 146,000,000 tons of tomatoes were produced in 2010 in the world. At that year, China, producing a quarter of the world production (mostly consumed domestically), got the first place and USA, India, Turkey, Egypt, Italy, and Iran were the largest producers after China. Totally, 17 countries produce 83% of the world tomato and Iran belongs to this list (i.e. it is one of these countries).Under cultivation area of tomato in Iran is 147,000 hectares, a total of 5,256,000 tons, the average yield of 35.76 tons each hectare (FAO, 2010).

Tomato is regarded as one of the valuable products in truck farming in the Middle East, which economically takes the 2nd place after potato in the world. This product originates in central and South America, more likely western coasts of South America. Tomato is said to be consumed in Peru in the 5thcentury BC. In Mexico, this plant was first known as Tomatol, and later in Spain and Portugal was called Tomatah. Today, however, it is internatinally known as Tomato (Dink et al., 1984). Tomato and its alterant products are considered as the most alternate industries in the world. Between 30 and 35 million tons of fresh potatos are produced in factories annually. Based on recent years studies, lycopene,which is abundantly found in tomato and its alternate products, may prevent prostate cancer, increase breast milk, protect the skin against ultraviolet radiation, prevent oxidation of LDL cholesterol, and therby prevent Atherosclerosis and many gastrointestinal tract-related diseases (Arinas, 2002). Per capita consumption of tomato products in North America is 30 kg; this amount for fresh tomato in Europe is 23kg, and in EU countries this rate is 18kg. in total, America and Europe consume approximately two thirds of these products, while per capita consumption of tomato in Asia is 0.3kg, in Africa 5kg, and in South America 4kg, and for Iran it is 25kg (FAO, 2010).

Many research has been conducted in terms of the yields of tomato and other crops using macro and micro fertilizers

Table 1. Some physical and chemical characteristics of used soils

Soil texture class	%Sand	%Silt	%Clay	K (ava.) P.P.M	P (ava.) P.P.M	Total %N	%O.C	%T.N.V	pH	EC*10^3	S.P
Clay silt	17.2	40	42.8	200	13.5	0.1131	1.131	21.75	7.67	0.925	53.5

in Iran and other countries. For instance, a study on the effect of potassium on the quality of tomato has been carried out in Khorasan (a province in Iran). The results indicated that potassium use improved the fruit yield, which led to water use efficiency (Sharayei et al., 2006). The effect of potassium nutrition by irrigation on quality and fruit yield of tomato was investigated and the results indicated that the increase in potassium affected the concentration of dissolved solids (Hartz et al., 2005). Eskandarpour et al. (2011) observed that the increase in the levels of Potasium in plant led to an increase in fruit weight and fruit quality.

Also, the impact of calcuim foliar spraying on tomato quality was investigated and the results illustrated that an increase of calcium concentration in each cultivar would lead to less fruit corruption and as a result fruit strage time would increase significantly. According to this study, aso, calcium as a fertilizer, increasedthe resistance of tomato during maintanence and trasportation process (Aminpour et al., 2006). Calcium bonds as apectate in intermediate blades is necessary forcell wall and plant tissue strength.Pectate destruction is done by Polygalacturonase. However, once enough amount of calcium exists, the destruction is halted (Malakouti and Rezaie, 2001). Tavasoli et al. (2010), investigated the effect of fertilizer on tomato fruit yield, the findings showed that Zinc, at the probability level of 5%, had a significant impact on the fruit yield. In India the effect of soluble fertilizers on tomato was examined and it was observed that such fertilizers significantly increased fruit yields, number of branches, the rate of fruit, average weight of fruit, length of it, as well as its diameter and firmness (Chaurasia et al., 2005). In fruit and vegetables (citrus, banana, tomato, potato, onion, and so on), adequate amount of potassium improves their size, color, taste, and peeling property (Havlin et al., 2013). Sharma (2002)showed increased levels of potassium in the plant always increased fruit weight and fruit quality.Therefore, the current research was performed in order to evaluate the effect of foliar spraying macro and micro elements on the qaulity and quantity of tomato (*Solanum lycopersicum* L.).

MATERIALS AND METHODS

Geographical coordinates and soil characteristics of experiments site

The current experiment has been conducted during the crop year 2013, in a research station (run by Jihad Agriculture Organization) based in Varmahang village, belongs to Kamyaran town, between 47 degrees and 34 minutes north latitude and 46 degrees and 54 minutes east longitude of the Greenwich meridian. In order to investigate the effect of foliar spraying micro and macro elements on the qauality and quantity of tomato, cultivar Karoon was employed because it is big, delicious and has high fruit yield and medium storage capacity. The physical and chemical characteristics of research stations soil are showed in Table 1.

Plant materials

Karoon is a middle maturity and fruitful variety which produced round, coarse and stiff fruits with bright red color to the average weight of 150 to 170 g. The plants of this variety is strong and big, also, it has resistance in front of unsuitable conditions and many diseases such as fusarium and verticillium. Karoon fruit is suitable for industrial uses and consumed fresh and has a very good post-harvest shelf life.

Characteristics of experimental design and studied treatments

This experiment was conducted in a Randomized Complete Block Designs (RCBD) with three-replication. The treatments included , Multi-purplex ,Sulopotas, Iron Chelate, Gro Folan, Feugo Base, NPK, Calcium, Zinc, a mixture of all treatments (Mix), and controlwhich they were all taken from Grow More American company and used according to the manufacturer's recommended instructions on the cans(http://www.growmore.com).

Farming operations

Land preparation operation process was automated. Tomato seedlings at 5-leaf stage on May third, 2013 were transferred to the farm manually. They were cultured in plots (experimental units) in 5 lines, each 3 meters long. The distance between lines was 90cm and the distance of plants on line were 20cm. In order to eliminate the effect of margin and to avoid the integration of different fertilizer treatments, the distance of plots within replication was 2 meters and the distance of replication was considered 4 meters. Drop irregation was done and the speed was determined using a tensiometer. When the osmotic potential of the soil was read 40 bar by tensiometer, the irrigation continued for 5 hours. Fifteen days after seedlings transfer (transplanting), foliar spraying of

Table 2.Analysis of variance for Randomized Complete Block Designs (RCBD) for qualitative and quantitative features of tomato, Karoon cultivar

SoV	df	Yield	Vitamin C	TSS	Firmness (fruit texture)
Block	2	0.74 ns	0.34ns	0.229ns	2.13*
Fertilizer Treatment	9	15.93*	1.17*	0.716*	2.036**
Error	18	5.58	0.34	0.22	0.46
CV%	-	14.67	14.45	4.24	13.08

Note: The numbers in the table are mean squares.
*And **, respectively significant at the level of 5 % and 1%.

fertilizer treatments was started and the amount of recommended fertilizer treatments, determined by the company, was administered to tomato.Top dressing fertilizer treatments was done in 4 stages, 15 days after seedling transfer to the farm, flowering stage, fruiting stage, and full fruit ripenning stage. In order to prevent plant necrosis and to have more influence, foliar spraying process was done manually in the evenings, using a pump held on back. While carrying outfoliar spraying, all leaves and stalks of plants in one plot were covered.

Traits Measurement

Harvesting started on September 6th, 2013 and continued till October 22nd, 2013. Using accurate scales, the amount of products gathered from each plot were measured and at the end of season of growth, the total amount of harvested product at different times was considered as the fruit yield of that plot. For each plot, from the middle lines (two lines), the amount of Vitamin C (ascorbic acid) using iodine titration, firmness rate using Penetrometer, and the total soluble solids in the fruit using Refractrometer were calculated.

The rate of firmness of 5 healthy tomatoes (the same size), which were at the ripenning time simultaneously were measured using Penetrometer. The force implemented by Penetrometer for all samples in all treatments was from the side of the fruit, perpendicular to the junction of fruit to the bush. The average of obtained numbers(N/cm^2) were recorded for the rate of firmness for treatments. To measure fruit total soluble solids, 5 healthy fully-ripened tomatoes (the same size) from middle bushes of each plot were selected and the average of the obtained numbers were recorded as Brix treatment. It should be noted that the after each experiment, the machine was calibrated and cleaned. To measure the yields of tomato (per unit area), 3 by 6m plot were used and final harvest was done on October 22nd, 2013.

Statistical Analysis

Normality test for raw data was done using $SAS_{9.3}$ software and univariate procedure. In other words, after making sure about the normality of the data, the analysis of variance and means comparison of treatments by Duncan's multiples range test at the level of 5%were done using $SAS_{9.3}$saftware and anovaprocedure. The diagrams and tables were drawn using Excel.

RESULTS AND DISCUSSION

Fruit yield

Acording to the table of variance analysis (Table 2), at the statistic level of 5%, the applied treatment fertilizers were significant in terms of the fruit yield. Based on the figure of means comparisons (Table 2), mix treatment (a mixture of all fertilizers) had the highest fruit yield, 402.1kg per 100 plants and control treatment had the lowest fruit yield, 156.9kg. it seems that the fruit yield was significantly influenced by the combination of used fertilizers in mix treatment. Based on the means of treatments (Table 2), calcium and Iron Chelate had the same fruit yields, so they were statastically put in the same group. Also, Gro Folan, Zinc, and Multi-purplex were put in one group; Feugo Base, Sulopotas, and NPK were put in another group and finally control, with the lowest fruit yield, was put in a separate group. In an experiment, it was shown that the Zinc and Manganeseincreased the fruit yield of tomato and pepper. This is because of drought tolerance and increase in the intensity of photosynthesis (Tavasoli et al., 2010).

Micronutrients are considered as vital elements in crop production. Although micronutrients, comparing to micro and macro elements, are of less importance, it has been proved that they are essential in better growth of plants, resistance to pests and diseases, and proper yield both qualitatively and quantitatively. The best strategy to make for the lack of such elements in crops is foliar spraying them at various times of growth, which compensates for the problem of fixation and are quickly absorbed into the plants. The consumption rate of such elements in different countries with high-tech agriculture contain approximately 2-4% of total consumed fertilizers. These elements are more observed in calcareous soils, compared to acidic soils (Pezeshkpour and Khosravi, 2014). The most important application of Iron Chelate is its presence in enzyme system of plant which is responsible for respiration. Iron is essential for chlorophyll synthesis. However, it should be noted that unlike magnesium, iron ions is not the

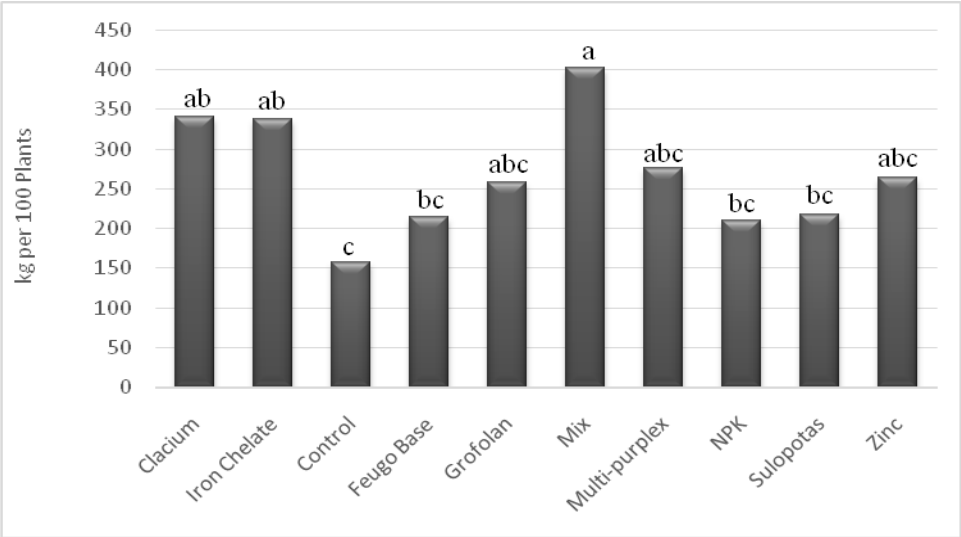

Figure 1: Means comparison of fertilizer treatments for tomato fruit yieldusing Duncan's multiple range test at the level of 5%.

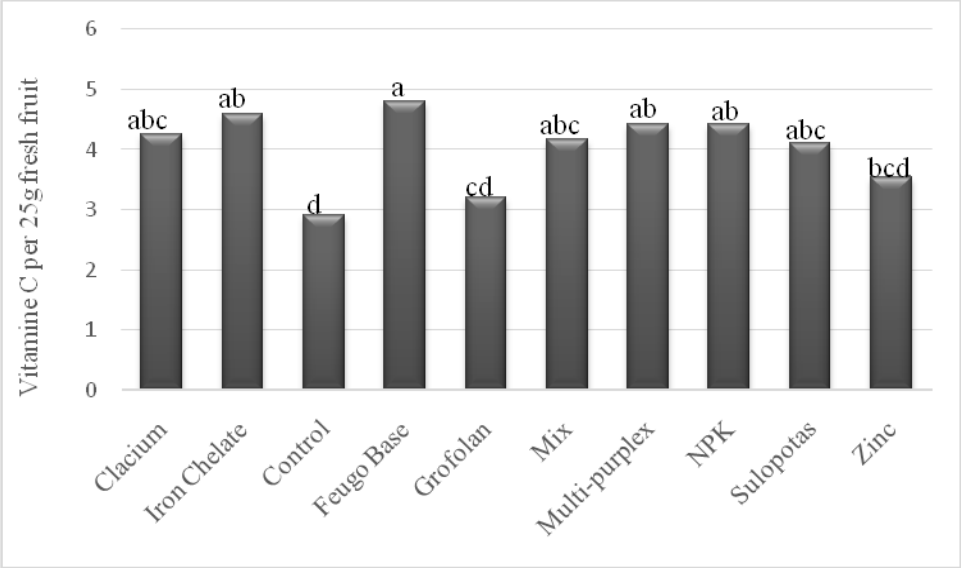

Figure 2: Means comparison of fertilizer treatments in tomato for Vitamin C using Duncan's multiple range test at the level of 5%.

component of chlorophyll molecule. Also, iron plays a special role in the structure of cytochrome. The availability of this element is of great importance for the plant. As another fertilizer in this experiment,Calcium had high yieldand is also another elememt which tomato requires. It plays a key role in the stability of the cell wall and cell membrane, cation and anion balance, root development as well as prevention of frost damage(Pezeshkpour and Khosravi, 2014). Calcium plays a significant role in the quality and shelf life of fruit. Increasing the amount of calcium leads to reduction in fruit cracking in tomato as well as other physiological disorders that result in the deterioration of fruit quality (Lichter et al., 2002).

Vitamin C (ascorbic acid)

Vitamin C is an antioxidant, which neutralizes the chemical effect of substances that damage the body tissues, when it is placed in blood flow. It also protects the skin against sunlight Ultraviolet.

Th results of variance analysis(Figure 1) show that the effects of fertilizer treatments on Vitamin C of tomato have been significant at the statistical level of 5%. The results of mean comparison of treatments (Figure 2) indicated that Feugo Base contained the highest amount of Vitamin C (4.8g in 25g fresh fruit) and control treatment contained the lowest amout (2.9g in 25g fresh fruit). Also, Iron

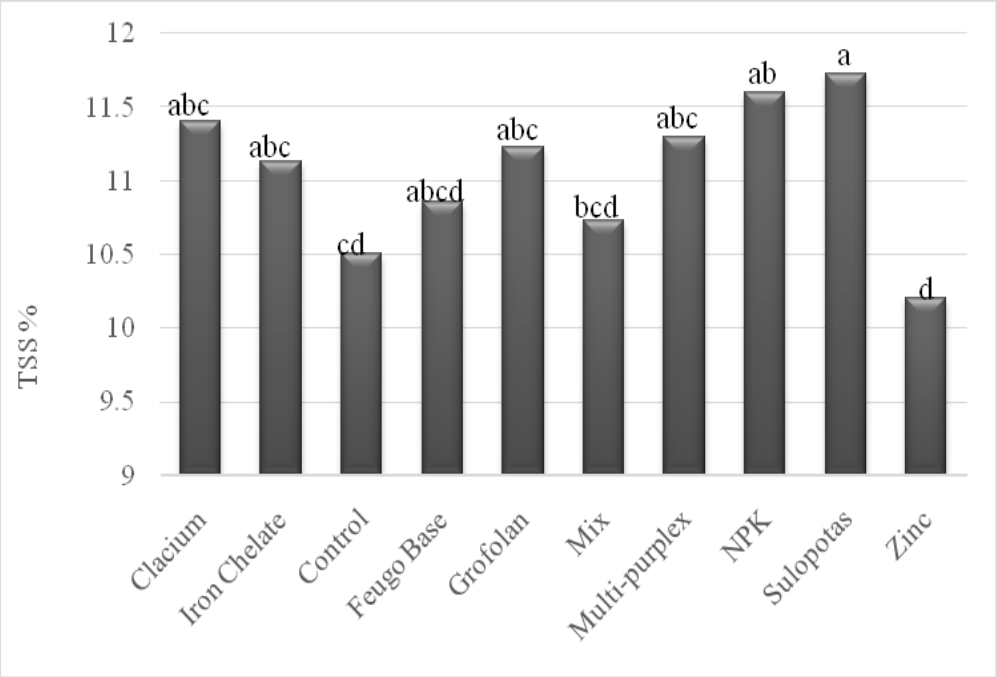

Figure 3: Means comparison of fertilizer treatments in tomato for TSS using Duncan's multiple range test at the level of 5%.

Chelate, Multi-purplex, and NPK were statistically put in the same group, with 4.6, 4.33, and 4.33g Vitamin C in 25g fresh tomato, respectively. Calcium, Mix, and Sulopotas contained 4.26, 4.16, and 4.11g Vitamin C in 25g fresh tomato.Feugo Base is a combination of natural extracts of plants, amino acids, and polypeptides that contain organic nitrogen, natural chelated materials and micronutrients as well as enzymes. The consumption rate at vegetable farms of 1 to2 per thousandin combination with water, which could be used up to 4 stages at growth season. Feugo Base composes the followng components:

5.4% nitrogen dissolved in water, 0.5% P_2O_5, 2.9% K_2O, 0.1% Iron Chelate, 22.7% Amino acids, and 11.7% organic carbon.

The effect of existing potash on Feugo Base is a driving force behind the increase of Vitamin C in this treatment, in which its impact on Vitamin C and quality of tomato have been investigated through different experiments. Different studies have suggested that the increase in potassium, will increase the quality of tomato and as a result increase in production.Hartz et al.(2005) reported that the increase in the amount of potassium improved the color of tomato and causes reduction in pigmentation disorders. Zinc (3.53milligram Vitamin C per 25g fresh fruit) was put in group. Also, Gro Folan(3.21milligram Vitamin C per 25g fresh fruit)was put in another statistical group.

Foliar spraying of micronutrient on orange trees led to increase in Vitamin C (Moradi et al., 2007). In another experiment it was proved that Zinc foliar spraying on grapes resulted in yield and Vitamin C increase (Baka et al., 2010).

Tomato Total Soluble Solid (TSS)

Tomato Total Soluble Solid is referred to as the remaining materials after evaporating a certain volume of sample, which has been dried in an oven at a given temperature (Martinez et al., 1987). TSS is a contributing factor in the preparation of paste. The more the TSS exists in tomato, the more the paste will be. TSS is also one of leading factors in the quality of tomatoes (Henare et al., 2010).Variance analysis (Table 2) shows that fertilizer appliocation made a significant difference in terms of Total Soluble Solid at statistical level of 5%.Means comparison of fertilizer treatments (Figure 3) show that Sulopotas had the highest amount of Total Soluble Solid (11.73%) and Zinc (10.2%) had the lowest amount. Sharayei et al. (2006) proposed thatthe increase in the amount of potasium would increase the amount of TSS. NPK (11.6%) was put in the second statistical group. As Gro Folan, Multi-Purplex,Iron Chelate, and Calcium had similar amounts, they were put in the same statistical group.Feugo Base and Mix were each put inseparate groups. Ibrahim and Fadni (2013) stated that organic fertilizers application increased growth, yield and quality of tomatoes specially tomato total soluble solid significantly.

Foliar spraying of nitrogen and micronutrients in orange caused increase in fruit, Brix (TSS), Vitamin C, and fruit volume (Rezaie, 2014).Diksit et al*.* (1987), remarked that foliar spraying of micronutrients in Zinc deficiency citrus led to increase in percentage of juice, TSS, and Vitamin C. Also, in another experiment (Kavousi and Hosseini Farahi, 2008), it was suggested that the impact of Zinc foil spraying

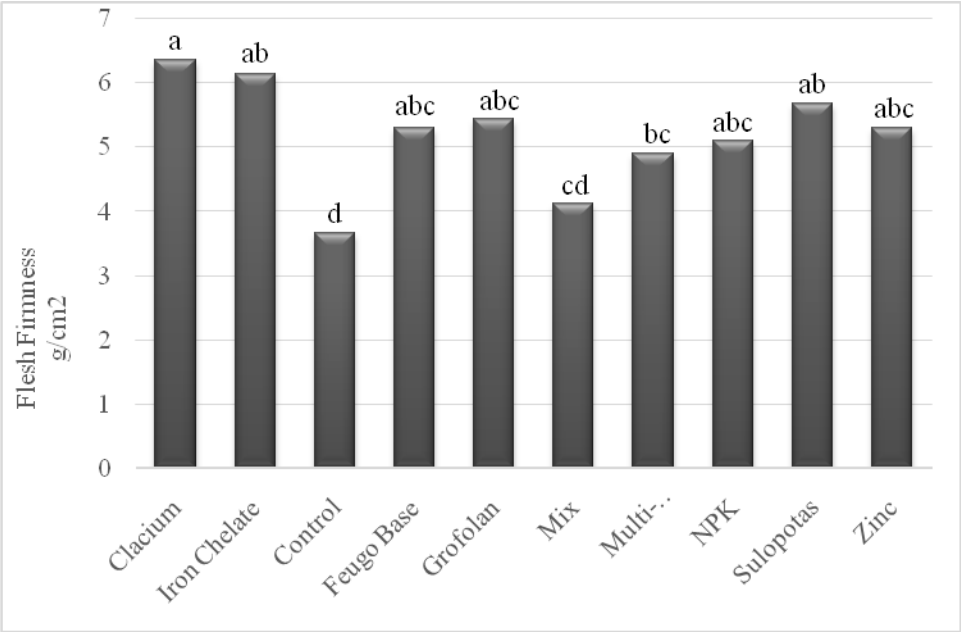

Figure 4: Means comparison of fertilizer treatments in tomato for flesh firmnessusing Duncan's multiple range test at the level of 5%

on qualitative features and grapes yield as well as TSS was significant.

Fruit Firmness

The results of variance analysis (Table 2) show that fertilizer treatments on the flesh firmness at the statistical level of 0.1% was significant. Based on means comparison of treatments (Figure 4), calcium had the highest rate of firmness (6.36 g/cm^2); the firmness for Iron Chelate and Sulopotas were 6.13 and 5.66 g/cm^2. The reason for the increase in the firmness of fruit in calcium is said to be its role in the strength of tomato tissue. Calcium bonds as apectate inintermediate blades is necessary forcell walland plant tissues strength. Pectate destruction is done by Polygalacturonase. However, once enough amount of calcium exists, the destruction is halted (Malakouti and Rezaie, 2001).Gro Folan, Feugo Base, Zinc, and NPK were put in the same group with the firmness rate of 5.43, 5.3, 5.1 and 5 g/cm^2, respectively. Multi-Purplex,Mix, and control had the lowest rates of firmness, 4.9, 4.13 and 3.66 g/cm^2, respectively. Due to its soft texture and being watery, tomato is more likely to be corrupted after the harvest time; especially when it is soft, the distance between production site and consumption place is far, and transport condition is not appropriate, the percentage of waste increases. The highert he firmness is, the less the ratio of fruit water to the flesh will be and as the result the fruit will be more resistant to the damages caused by transportation (Rezaie, 2014). Any observed sign of contamination, decay, and softening in the fruit will make it a less friendly-market product (Esna-Ashar et al., 2008).

In an experiment, cucumbers fed by Iron fertilizer weremore long-lasting in terms of firmness and more friendly-market. Also, green ripe tomatoes were put in a solution of calcium chloride and calcium nitrate, and it was observed,when compared to the control treatment, thattomato-tonalityis delayed and firmness as well as storage time increase (Rezaie, 2014). In another study, Shornikova et al. (1971), suggested that calcium chloride has positive effect on maintenance of tomato. It increases the resistance of tomato during storage time and transportation process and this is because of the impact of micronutrients on flesh firmness of tomato.

Conclusion

The results of this research clearly showed a comparison of the effects of fertilizer treatments on fruit yield and qualitative characteristics of tomato, which were in line with the research purposes. As proved, Mix, which was a mixture of all treatments, had the highest fruit yield and this showed the positive effect of this treatment on tomato, which was the main purpose of this study. One important characteristics of tomato is the amount of Fruit Vitamin C. The applied treatments, at probability level of 5%, had a significant effect on this characteristic.Feugo Base had the highest amount of Vitamin C, so it can be used to increase the amount of Vitamin C in crops. Sulopotas had the highest amount of TSS and Zinc had the lowest. Sulopotas is derived from potassium sulphate and has high solubility. For its role in the synthesis and transport of photosynthetic products to plants reproductive and storage tissues (seed, fruit,

tubers) and their later conversion to carbohydrates, proteins, fats,and other compounds, potassium is effective in most qualitative features of crops. The fruit firmness increasesthe storage capability of tomato, its ability to transport to consumption market as well its markeability. Therefore, it plays a significant role in tomato crop production. Its firmness depends on crops genetic as well as environmental factors including the amount of macro and micro consumption elements.The investigated fertilizer treatments in this experiment (at the level of 1%) had a significant difference in terms of firmness of fruit texture. Sulopotas, Calcium , and Iron Chelate had similar amount (the highest) in this regard. Although these three treatments statistically had no significant difference, calcium had the highest amount quantitatively. One reason for the higher firmness of the fruit in calcium is said to be its role in firming the texture of tomato.

Competing interests

The authors declare that they have no competing interests

REFERENCES

Aminpour R, Mortazavibak A, Mobli M (2006). Effects of Different Application Methods of Copper and Iron on Onion (*Allium Cepa* L.). J. Hortic. Sci. Technol., 7(4): 265-274.

Arinas B (2002). Effect of drip irrigation and subsurface drip irrigation on tomato crop. Crop Production & Improve Agriculture, 27: 705-719.

Baka A, Olympios CM, Drosopoulos J, Passam HC (2010). Effect of nitrogen form and concentration on the distribution of ions within cucumber fruits. Scientia Hort, 95:175-183.

Chaurasia SNS, Singh KP, Mathura R (2005). Effect of foliar application of water soluble fertilization on tomato (*Lycopersiconesculentum* L). Sri lanka J. Agric. Sci., 42: 66-70.

Daneshvar M (2010). Vegetable farming. Chamran University Press, 461 pp.

Diksit KK, Jordan D, MacDonald A (1987). Entrobacteragglomerans, phosphate solubilizing bacterial activity in soil: Effect of carbon sources. Soil Biology and Biochem., 86: 995-1003.

Dink B, Lee E (1984). Growth of plug seedlings of *Capsicum annuum* as affected by ion concentration and NH4:NO3 ratio of nutrient solution. Acta Hort, 481: 425.

Eskandarpour S, Kazem-Soury M, Tawhidlou GH (2011). Evaluation of the growth and fruit yield 3 varieties of strawberry under 3 levels of potassium/calcium nutrient solution in hydroponic culture. First National Conference on new issues in agriculture, Saveh, Iran.

Esna-Ashar M, Zakaie- Khosroshahi M (2008). Physiology and post-harvest technology. Bou Ali Sina Press, 658 pp.

FAO. (2010).http://www.fao.org/statistics/en/.

Hartz TK, Johnson PR, Francis DM, Miyao EM (2005). Processing tomato yield and fruit quality improved with potassium fertilization. Horti Sci., 40:1862-1867.

Havlin JL, Tisdale SL, Nelson WL, Beaton JD (2013). Soil Fertility and Fertilizers: An Introduction to Nutrient Management (8th Edition). Prentice Hall, 528 pp.

Henare M, Rezai HJ, Doulati H, Motalebi AR (2010). Effects of calcium chloride spraying and cultivar on the shelf life of tomato. Food Res. J., 1(20/3): 47-72.

Ibrahim KHHM, Fadni OAS (2013). Effect of Organic Fertilizers Application on Growth, Yield and Quality of Tomatoes in North Kordofan (Sandy soil) western Sudan. Greener J. Agric. Sci., 3:299-304.

Kavousi B, Hosseini Farahi M (2008).The effect of flower induction and foliar spraying with nitrogen, zinc and boron on qualitative characteristics of blackcurrant. J. Res. Agric. Sci., 4(1): 73-82.

Lichter A, Dvir O, Fallik E, Cohen S, Golan R, Shemer Z, Sagi M (2002). The cracking potential of cherry tomatoes in solution. Postharvest Biol. Technol., 26: 305-31.

Malakouti MJ, Razaie H (2001). The role of sulfur, calcium and magnesium on the quantity and improve the quality of agricultural products. Agriculture Education Press.

Martínez V, Cerdá A, Fernandez FG (1987). Salt tolerance of four tomato hybrids. Plant and Soil, 97: 233–242.

Moradi B, Ebadi H (2007). The effects of urea foliar spray on yield and quality of orange (Thomson navel). Tenth Congress of Soil Science, Tehran, Iran.

Pezeshkpour P, Khosrovi K (2014). The complete guide tomato cultivation. Agricultural publishing and education press, 178 pp.

Rezaie H (2014). The Improving and Production of forage crops. The University of Tehran Press. Iran, 428 pp.

Sharayei P, Sobhani AR, Rahimian MH (2006). Effect of different levels of irrigation water and potassium on water productivity and quality of tomato (peto early CH). J. Agric. Eng. Res., 7(27): 75-86.

Sharma RR (2002). Growing Strawberry. International Book Distributing Co. Indian, 164 pp.

Shornikova NM, Tananina TA, Borisova MS (1971). Use of $CaCl_2$ in tomato preservation. Trudy-Vsesoyuznyi-Nauchno-Lssledovatel,skii-Institut-Kanservano-i-Ovoschchesushil, no-Promyshlennosti, 14: 35-37.

Tavasoli A, Ghanbari A, Ahmadian A (2010). The effect of magnesium and zinc nutrition on the fruit yield and nutrient concentrations in greenhouse tomato Hydroponic cultivation. J. Sci. Technol. greenhouse plantation, 1: 1-5