The effect of usage two methods of garlic extraction (foliar and ground application) on the growth of the tomatoes (Solanum lycopersicum) plant

Radhiyah Ali Hasan Ahmad*

1Department of Biology, College of Education for Pure Science (Ibn Al-Haitham), University of Baghdad, Baghdad, Iraq.

*E-mail: radia.a.h@ihcoedu.uobaghdad.edu.iq

Abstract. Garlic is rich in nutritional and medicinal value as it has been found that the water extract of garlic plant contains 31% carbohydrates and rich in elements calcium, phosphorus, magnesium, potassium, sodium, iron, zinc, manganese, vitamin C, thiamine, riboflavin, niacin and pyridoxine. The aim of this study was to investigate the effect of garlic extract (Allium sativum L.) on tomatoes (Solanum lycopersicum L.) plant. The trend is to use plant extracts in foliar and ground fertilization. Three levels of foliar application (4, 6, 8%), three levels of ground application (10, 20, 40%), one treatment 6% of foliar and 20% ground application together and the treatment of control (0) were used. The results showed that the usage of garlic extract led to a significant increase in the height of the plant 98.00 cm, chlorophyll content 46.33 spadm, increase the Carbohydrates 7.95%, the number of branches, the number of leaves, the foliar area, the dry weight of vegetative group, the number of flowers, the leaves content of nitrogen, protein and carbohydrates, fruit weight, fruit size, measurement T.S.S. and solidity of treated plant compared to control plants.

Keywords. Fruit quality, Garlic, Plant extracts, Tomato.

1. Introduction

Tomatoes esculentum belonged to Solanaceae family, its native habitat is South America and is one of the most consumed vegetables in the world with more than 120 million metric tons of global production [1], and is the second most important vegetable after potatoes in many countries of the world [2]. In Iraq, according to Food and Agriculture Organization (FAO) statistics for 2011 reported, the area under cultivation was 61,042 hectares and the production rate was 17.36 tonne. h-1. It is represent an important source of minerals, vitamins and antioxidants [3], so is grown either in open field or in covered farming systems. Statistics indicate high annual consumption rates, due to the high nutritional value, as its fruits contain ascorbic, citric and malic acid, some minerals, vitamins and pigments such as carotene and lycopene, which are a major source of antioxidants [4]. The researchers adopted the foliar application method of nutrients in supplying plants with the necessary elements to sustain their continued improvement in their growth and to achieve qualitative and quantitative improvement in the outcome [5]. Plant extracts are the products of the newly used substances to
stimulate and encourage the vegetative and flowering growth. While, the yield are considered as a
source of nutrients and natural growth regulations as well as they are easy to absorb and contain
effective and effective substances and natural chemical compounds that vary by different species and
plant parts and may be stimulating or inhibitory to growth [6]. Allium sativum L. was known by many
civilizations it is mentioned in many Egyptian, Greek, Indian and Chinese authors. It is a vegetable
annually herbaceous crop belong to Liliaceae family [7] regenerated annually and reproductive with
bulb and seeds characterized by a special scent containing active substances as: Allicin and Alliin, an
effective antibiotic that contains yeasts and vitamins [8, 9]. Garlic is rich in nutritional and medicinal
value as it has been found that the water extract of garlic plant contains 31% carbohydrates and rich in
elements calcium, phosphorus, magnesium, potassium, sodium, iron, zinc, manganese, vitamin C, thiamine, riboflavin, niacin and pyridoxine [10]. The study aim to investigate the effect of using garlic extract in the methods of foliar and ground application growth, yield and fruit quality of tomatoes.

2. Materials and Methods

The experiment was conducted using Plastic pots 5 kg soil and 30 cm diameter in the botanical garden
of Biology Department in College of Education for Pure Sciences (Ibn Al-Haitham) for the growth
season 2017-2018. The seeds of the hybrid tomatoes called Jinan were obtained from agricultural
equipment in the local markets planted seeds in the pots by 10 seeds in each pots on 15 January 2018,
took 10 gm. of fresh garlic cloves and added 100 ml of distilled water and was mashed in an electric
mixer and filtered with a soft cloth and considered the stock solution according to [11], method and
the concentrations used in the experiment was prepared as follow:

- Treatment (0) without treatment (control)
- Treatment (1) foliar application at a concentration of 4%
- Treatment (2) foliar application at a concentration of 6%
- Treatment (3) foliar application at a concentration of 8%
- Treatment (4) ground application at a concentration of 10%
- Treatment (5) ground application at a concentration of 20%
- Treatment (6) ground application at a concentration of 40%
- Treatment (7) foliar application at a concentration of 6% and ground application at a concentration of
  20% together.

The plants were sprayed in the early morning until the total wetness when the plant became phase 4-5
real leaves on two periods. The first date is 20/3/2018 and the second date is 20/4/2018 then took
measurements on 20/5/2018. The following parameters were studied:

2.1. Vegetative growth parameters

2.1.1. Measuring chlorophyll content in leaf by Spad

Spad it's calculated with a device Chlorophyll meter equipped by a Minolta company by taking mean
of three readings of three plants randomly selected from each treatment. This was done by placing the
most exposed part of the leaf under the arm of the device and pressing it then taking the reading.
2.1.2. The height of the plant (cm)

Measured by a measuring tape from the area of contact the plant with the soil to the highest point in the main branch of the stem at the end of the growth season.

2.1.3. Number of total branches per plant at the end of the growing season.

2.1.4. Number of leaves (leaf.plant\(^{-1}\)) end of growing season.

2.1.5. Leaf area (dcm\(^{2}\).plant\(^{-1}\))

The leaf area was designed on the basis of dry weight as it took 30 foliar disks known area and dried until the weight in an electric oven stabilized at a temperature of 70 °C and from the total dry weight of the plants leaves calculated the foliar area in the following equation: Foliar area (dcm\(^{2}\))= foliar area of discs × total dry weight of plant leaves / dry weight of discs [12].

2.1.6. Dry weight (gm) for the vegetative total

It was taken at the end of the season.

2.2. Specific qualities

Estimate the percentage of nitrogen in the leaves according to their component content based on dry weight using a Microkjeldahal device [13]. Calculating the percentage of protein in the leaves according to the following equation: Protein ratio = nitrogen × 6.25% [14] Estimating the percentage of carbohydrates in the leaves was done using a Spectrophotometer device [15].

2.3. Flowering parameters

Number of flowers in inflorescence (flowering. inflorescence\(^{-1}\)).

2.4. Fruit parameters

2.4.1. Number of fruits (fruit.plant\(^{-1}\))

2.4.2. Weight of fruit (gm.fruit\(^{-1}\))

2.4.3. The size of the fruit (cm\(^{3}\))

The size of the fruit were measured by a method of the graduated cylinder and displaced distilled water. A known volume of water was placed in the graduated cylinder and the fruits were flooded at the rate of six fruits of regular growth inside the cylinder and the size was measured by finding the difference between the water level in the two cases then extracting the rate of the fruit size by dividing the difference of size by the number of fruits and calculated in a unit of cm\(^{3}\).

2.5. Fruit quality parameters

2.5.1. The proportion of total soluble solids in the fruits

It was estimated by Hand Refractometer and the reading was corrected by laboratory temperature at the measurement [16] (Ibrahim, 2010).
2.5.2. Measuring fruit hardness (kg cm$^{-2}$)

Hardness measured by a Pentrometer device [17].

2.6. Statistical analysis

The statistical analysis was carried out according to Randomized Complete Block Design (RCBD) by triplicates sample per treatments, examined the results according to the analysis of variance then compared the means using the test of the least significant difference (LSD) at the probability level of 5% [18].

3. Results and Discussion

The results indicated that the foliar ground application with fresh garlic extract have a significant effect on the content of the chlorophyll in the leaves of Table (1), while it is noted that the treatment of 6 and 7 gave the highest content of chlorophyll in the leaves which was 45.33 and 46.33 respectively. While the comparison treatment (0) gave the lowest chlorophyll content in the leaves was 31.06. As for the height of the plant, it was a clear significant increase between treatments where the treatment 7 outperformed all treatments by giving the highest rate of height of the plant length reached 98.00 cm and did not differ significantly the treatments 3 and 5 from each other and gave 88.19 and 88.95 cm respectively while the treatment 0 gave the lowest rate of height of the plant length reached 54.45 cm. The treatments 6 and 7 did not differ from each other significantly in the number of plant branches and gave the highest rate of the number of plant branches reached 12.55 branches for both treatments and outperformed the rest of the treatments while the comparison treatment gave the lowest rate on the number of plant branches by giving it 5.55 branches, while the number of leaves did not recorded a significant differences between treatments 5, 6 and 7, where they gave the highest rate on the leaves number reached 12.88, 12.77 and 12.88 leaves respectively, while the treatment 0 gave the lowest rate on the leaf number reached 10.33 leaves, which did not differ significantly from treatment 1 which gave 10.55 leaves. As for the foliar area of the table results, it is clear that the treatments gave a clear significant difference where the treatment of application 7 outperformed by giving it the highest value reached 153.58 dcm$^{2}$.plant$^{-1}$, which did not differ significantly from the treatment 6 which gave 152.67 dcm$^{2}$ compared to the measurement treatment that gave the lowest value with a foliar area of 120.29 dcm$^{2}$.plant$^{-1}$ and did not differ significantly from treatments 1 and 2, which gave 121.77 and 121.99 dcm$^{2}$.plant$^{-1}$ respectively.

Table 1. The effect of foliar and ground application with garlic extract on the content of the chlorophyll in the leaves, plant height, number of branches and leaves and foliar area of the tomatoes plant.

| Treatments | Chlorophyll content in the leaf SPAD | Plant height (cm) | Number of branches. plant$^{-1}$ | Number of leaves. plant$^{-1}$ | Leaf area (dcm$^{2}$, Plant$^{-1}$) |
|------------|-------------------------------------|------------------|-------------------------------|-------------------------------|----------------------------------|
| 0          | 31.06                               | 54.45            | 5.55                          | 10.33                         | 120.29                           |
| 1          | 32.60                               | 58.06            | 7.00                          | 10.55                         | 121.77                           |
| 2          | 42.30                               | 64.85            | 8.11                          | 11.11                         | 121.99                           |
| 3          | 43.71                               | 88.19            | 9.55                          | 11.88                         | 126.07                           |
| 4          | 44.15                               | 91.34            | 10.89                         | 12.11                         | 137.44                           |
| 5          | 44.81                               | 88.59            | 11.00                         | 12.88                         | 144.36                           |
| 6          | 45.33                               | 94.63            | 12.55                         | 12.77                         | 152.67                           |
| 7          | 46.33                               | 98.00            | 12.55                         | 12.88                         | 153.58                           |
Table 2 shows the effect of foliar and ground application with garlic extract on the measured parameters where the treatment of application 7 exceeded significantly in giving the highest level of nitrogen in the leaves of the plant reached 2.843%, which did not differ significantly from treatment 6, which gave a ratio of 2.733 compared to the treatment of comparison 0 which gave the lowest nitrogen ratio of 1.430, which leads us to exceed the treatments 6 and 7 with the content of the protein in the leaves reached 17.08 and 17.77, which did not differ between them significantly compared to the measurement treatment which gave the lowest value 8.94. As for the percentage of carbohydrates in the leaves, the table showed that the treatment of application 6 and 7 gave a significant differences to the rest of the treatments by giving them the highest percentage of carbohydrates in leaves and reached 6.96 and 7.95 respectively while they did not differ significantly while the treatment of application 0 gave the lowest percentage of leaf carbohydrates, which reached 1.88, that did not differ significantly from the comparison treatment of 1.96, and the treatment of application 7 had a significant superiority over the rest of the treatments by giving it the highest rate of plant flowers where it reached 22.56 flowers, while the treatment compared with control gave the lowest rate of the number of flowers reached 11.56 flowers, which did not differ significantly from the treatment 1 which gave 12.11 flowers.

Table 2. The effect of foliar and ground application with garlic extract on the percentage of protein, nitrogen, carbohydrates in the leaves, number of flowers and dry weight of the tomatoes plant.

| Treatment | N%  | Percentage of protein in the leaves | Percentage of carbohydrates in the leaves | Number of flowers. Plant¹ | Dry weight of plant  |
|-----------|-----|------------------------------------|------------------------------------------|---------------------------|---------------------|
| 0         | 1.430 | 8.94                          | 1.96                                     | 11.56                     | 55.81               |
| 1         | 1.623 | 10.15                         | 1.88                                     | 12.11                     | 66.74               |
| 2         | 1.653 | 10.33                         | 3.58                                     | 13.22                     | 75.47               |
| 3         | 1.767 | 11.04                         | 4.05                                     | 15.11                     | 77.70               |
| 4         | 2.180 | 13.62                         | 4.74                                     | 17.62                     | 80.44               |
| 5         | 2.597 | 16.23                         | 6.11                                     | 19.26                     | 88.92               |
| 6         | 2.733 | 17.08                         | 6.96                                     | 21.11                     | 90.38               |
| 7         | 2.843 | 17.77                         | 7.95                                     | 22.56                     | 93.97               |
| LSD5%     | 0.172 | 1.076                         | 1.649                                    | 1.456                     | 4.601               |

As for the dry weight, the treatments 6 and 7 outperformed the rest of the treatments and gave the highest dry weight rate reached 90.38 and 93.97 gm respectively and did not differ significantly between them, while the lowest dry weight at the treatment 0 was 55.81 gm, and did not differ significantly at the treatment of application 1, which gave a dry weight rate of 66.74gm from the results of Table 3, which shows the effect of foliar and ground application with garlic extract on the number, weight and size of fruits and measurement of the Total Soluble Solids (TSS) and hardness of tomatoes fruits. The results showed the presence of a significant effect of application with garlic extract on the number of fruits where the treatment 7 gave the highest rate of fruit numbers and reached 11.62 fruits while the lowest rate of fruits when the measurement treatment 0 and reached 4.96. As for the weight of the fruit, the treatments 6 and 7 did not differ significantly from each other by giving them 78.10 and 84.07 gm respectively superior to the rest of the treatment while the treatment 0 gave the lowest weight of the fruits and reached 43.37 gm., which did not differ significantly from the treatment 1, which gave a weight rate of 45.32 gm. As shown by the table the effect of application on the size of the fruits where the treatments 6 and 7 showed significant superiority over the rest of the treatments and gave the highest rate of the fruit size reached 98.22 and 98.72 cm3 respectively, while they did not differ significantly, compared with the lowest rate of the fruit size reached 37.19 in the compared with control. As for the measurement of Total Soluble
Solids (TSS), the treatment of application 7 exceeded the rest of the treatments by giving the highest measure and reached 9.070 while the treatments 5 and 6 did not differ significantly, which gave 8.577 and 8.477 respectively, while the measurement treatment gave the lowest percentage measurement of Total Soluble Solids (TSS) reached 6.653. As evidenced by the results of the table the effect of the garlic extract application on the hardness of the fruits, where the measurement treatment gave the highest rate of solidity of the fruits reached 16.99 kg.cm⁻², while the treatment 7 gave the lowest rate of hardness reached 12.74kg.cm⁻² which did not differ significantly with treatment 6 which gave a hardness rate of 12.96 kg.cm⁻². The processes of application with garlic extract in both types of foliar and ground application treatments to improve the physiological, morphological and quality characteristics in the tomatoes plant where it gave clear significant differences compared to the control treatment of garlic effective role in it, that the garlic plant contain vitamins, mineral salts and elements such as sulfur, phosphorus, calcium, potassium and iron as well as 31% carbohydrates and organic acids such as citric, malic and amino acids such as valine, leucine and glutamine [10]. All these compounds contribute to the process of photosynthesis and increase the products of photosynthesis and the cycle of Krebs and all of this contribute to the construction of the main compounds in the plant and improve its physiological characteristics. Garlic extract contains an effective compound and has all the properties of garlic and turns into many compounds such as Allicin, Allylsulfid included allyl methyltrisulfide and diallyl disulfides which a volatile substances and have many effects [19]. In a study on the cucumber plant, noted [20] that the foliar application with garlic extract by a concentration of 2.5 ml.L⁻¹ led to a significant increase in the length of the plant, the number of leaves and foliar area and the content of total chlorophyll in the leaves, the proportion of the nodes and Total Soluble Solids (TSS), which is due to the fact that the water extract of the garlic plant contains 30% carbohydrates and is rich in the elements of potassium, iron, magnesium, phosphorus, thiamine, riboflavin, niacin and ascorbic acid in addition to volatile oils. [21] stated that the inclusion of garlic extract on amino acids such as Cysteine and Methionin, which have an important role in the biological processes of the plant and led to a significant increase in the vegetable growth characteristics, the number of fruits, the yield of the one plant when application the tomatoes plant with garlic extract at a concentration of 40 ml.L⁻¹. [22] pointed that the use of foliar application with a 30% concentration on chickpeas led to a significant increase in the content of chlorophyll in the leaves and the proportion of carbohydrates and protein in the seeds. [23] confirmed that the application of cherry tomatoes with Agrosol at a concentration of 6 gm.L⁻¹. [24] pointed that the ground application of Schefflera araboricola plant by garlic extract at a concentration of 250 ml.L⁻¹ led to a significant increase in the number of leaves, foliar area, leaf content of chlorophyll, dry weight of the vegetative total and the percentage of carbohydrates in the leaves compared to the treatment of foliar application of the plant led to improve the most of the vegetative parameters, root and flower growth in open and covered agriculture. In a study on Beta vulgaris var. cicla plant stated [25] the use of peppermint leaf powder and celery at 5 and 10 gm per kg of soil alone or together work to improve the morphological and physiological characteristics of the plant through an increase in the height of the plant, the number of leaves, dry weight and the content of chlorophyll in the leaves, nitrogen, phosphorus and potassium compared to the treatment of control. The content of garlic extract from the elements of phosphorus, potassium, nitrogen and iron, which worked to increase the height of the plant, the number of leaves, their content of chlorophyll and dry weight helped to synthesize biological components such as proteins and carbohydrates, which worked to improve the physiological characteristics of the plant where these elements enter in the synthesis of cellular membranes and work to increase the number of cells and cellular divisions as well as being involved in the synthesis of chlorophyll such as nitrogen and iron, potassium acts to regulate the opening and closing of the stomata as well as the regulator of biological processes in the plant. The presence of elements a lot provide the requirements for the synthesis of biological ingredients in the plant as well as transmitted with water through the roots, which makes the cells in the plant in a state of fullness and therefore perform their normal functions better [26, 27].
Table 3. The effect of foliar and ground application with garlic extract on the number, weight, size of fruits, and measurement of TSS and hardness of fruits for the tomatoes plant.

| Treatment | Number of fruits, plant | Weight of fruits (gm) | Size of fruits (cm³) | TSS (%) | Hardness of fruits kg.cm⁻¹ |
|-----------|-------------------------|-----------------------|---------------------|---------|---------------------------|
| 0         | 4.96                    | 43.37                 | 71.92               | 6.653   | 16.99                     |
| 1         | 5.80                    | 45.32                 | 76.20               | 7.147   | 14.74                     |
| 2         | 6.44                    | 59.38                 | 81.95               | 7.947   | 14.70                     |
| 3         | 7.10                    | 63.04                 | 86.64               | 7.777   | 15.04                     |
| 4         | 7.81                    | 56.87                 | 90.84               | 8.147   | 13.54                     |
| 5         | 7.85                    | 67.75                 | 93.59               | 8.577   | 13.75                     |
| 6         | 8.96                    | 78.10                 | 98.22               | 8.477   | 12.96                     |
| 7         | 11.62                   | 84.07                 | 98.74               | 9.070   | 12.74                     |
| LSD5%     | 0.874                   | 7.155                 | 2.951               | 0.440   | 1.241                     |

4. Conclusion

To conclude that, the usage of garlic extract in two methods of foliar and ground application, were led to a significant differences in the parameters of growth in the characteristics studied for all treatments. Moreover, the higher effect was a significantly usage of both methods and the concentration of 6% foliar application+ 20% ground application in all the characteristics studied for the tomatoes plant.

5. References

[1] FAO 2011 *Production Year Book*. Rome, Italy.
[2] Heuvelink E 2005 *Tomatoes, Crop Production Science* In Horticulture Series Cromwell Press, Trowbridge. UK 352.
[3] Grieson D and Kader AA 1986 *Fruit ripening and quality* The tomato crop. Chapman and Hall, London 240.
[4] Gerszberg A, Hnatuszko-Konka K, Kowalczyk T and Kononowicz AK 2015 Tomato (*Solanum lycopersicum* L.) in the service of biotechnology *Plant Cell Tiss Organ Cult.* 120 881.
[5] Kathiirson GAD 2000 Fluency In of untried levels on séance in different seasons sesame and safflower *News Lett.* 15 42.
[6] Ric EL 1984 *Allepathy* 2nd ed. Academic Press. New York.
[7] Al-Kateb YM 1988 *Classification of seed plants* University of Baghdad. Ministry of Higher Education and Scientific Research 342.
[8] Qanbes AJ 2007 *Human adviser in food and drugs. Herbal Medicine and Nutrition Dictionary* Dar Al-Bashair for Printing, Publishing and Distribution. Damascus, Syria:. 95-111.
[9] Talass M 2008 *Herbal medical Dictionary*. Dar Talass Library, Damascus, Syria 557.
[10] Moursi, HAS, Al-Khatib MH and Alshabibi MMA 1981 Determination of same active component of *Allium cepa* and *Allium sativum*. Abstract presented to the first Arab determinations Amman Jordan, 7.
[11] Harbone JB 1984 *Phytochemical methods*. A guide to modern techniques of plant analysis (2nd ed) chapman and Hall, London: 282.
[12] Watson DJ and Watson MA 1953 Comparative physiological studies on the growth of yield crops III-Effect of infection with beet yellow *Ann. Appl. Biol.* 40 1.
[13] Jackson ML 1958 Soil *Chemical Analysis* Prentice Hall, Inc. Englewood Cliff, N.J. USA. 276.
[14] Dalaly BK and Al-Hakim S H 1987 Food Analysis Directorate of the House of Books for Printing and Publishing University of Al-Mosul, Iraq.
[15] Herbert D, Philips PJ and Strage RE 1971 Methods in microbiology. Acad. Press. London.
[16] Ibrahim HIM 2010 Plant samples collected and analyzed First edition. Dar Al-Fajr for Publishing and Distribution, Egypt.
[17] Abbas MF and Muhsin JA 1992 Care and storage of fruits and vegetables practical. Ministry of Higher Education and Scientific Research University of Basra. Dar Al Hekma Press. Iraq.
[18] Al-Rawi KM and Khalafallah AAM 2000 Design and analysis of agricultural experiments Ministry of Higher Education and Scientific Research, Iraq.
[19] Staba E, Lash JL and Staba E J 2001 A Commentary on the effects of Garlic Extraction and formulation on product composition J. Nutr. 131 11185.
[20] Hussain WA 2002 Effect of spraying garlic extract, licorice and urea in the characteristics of flowering growth of Cucumis sativus L. and the yield of cucumber plant MSc. Thesis. College of Agriculture, University of Baghdad.
[21] Saadoun AHS, Merzah TK and Rahman RK 2004 The effect of spraying garlic extract and licorice roots with a mixture of zinc and iron on the growth and yield of two varieties of tomatoes J. Coll. Iraqi Agric. Sci. 55 35.
[22] Al-Kaisy WA, Mahmood RW and Al-Hayani EH 2013 Effect of Garlic (Allium sativum) extract and root extract of Ginger (Zingiber officinale) on growth and yield of Chick plant (Cicer arietinum) Baghdad Sci. J. 10 1120.
[23] Salman AD 2014 Growth variants and quantitative and qualitative yield of Cherry tomatoes by Agrosol and Enraizal application under open cultivation conditions and greenhouse MSc Thesis College of Agriculture University of Baghdad.
[24] Jumaa RMA 2015 The effect of some natural extracts on the growth and chemical components of Schefflera araboricola plant MSc. Thesis, College of Agriculture. Cairo University.
[25] Al-Kaisy WA, Al-Hallaq, AM, Hassan RA and Al-Adhami LQA 2019 The effect of Mentha viridis and Apium graveolens leaves on growth of Beta vulgaris var. cilica J. Coll. Basic Educ. 25 545.
[26] Devlin RM and Witham FH 1982 Plant Physiology 4th ed Willard Grant press. Boston 113.
[27] Verma SK and Verma M 2008 A textbook of Plant Physiology, Biochemistry and Biotechnology Chand S and Company, LTD. Ram Nager, New Delhi.