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ORIGINAL ARTICLE

THE EFFECT OF FOLIAR SPRAY WITH PRO.SOL FERTILIZER AND LICORICE EXTRACT ON SOME VEGETATIVE GROWTH INDICATORS FOR YOUNG POMEGRANATE (*PUNICA GRANATUM* L.) SEEDLINGS CV. 'SALEMI'

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Abstract: The study was conducted to investigate the effect of foliar spray with PRO.SOL fertilizer and licorice extract on improving some vegetative growth indicators for young pomegranate seedlings of 'Salemi' cultivar. The results showed that the treatment of foliar spray with PRO.SOL fertilizer was significantly superior in the concentration of 4 ml L^{-1} in the height of seedlings, number of leaves per seedling, number of branches per seedling, leaf area, N, P and K, total chlorophyll, soluble carbohydrates and protein content in the leaf compared to the other treatments. The results also indicate that the treatment of foliar spray with licorice extract at a concentration of 10 g L^{-1} was significantly superior in all the vegetative indicators mentioned in the above compared to the control treatment. But the seedlings that were sprayed with the control treatment recorded the lowest values in all indicators studied. The study recommends spraying young pomegranate seedlings of 'Salemi' cultivar with PRO.SOL fertilizer to improve vegetative growth.

Key words: Chlorophyll, *Glycerrhiza glabra*, Fertilization, Protein, Vegetative growth.

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1. Introduction

Pomegranate (*Punica granatum* L.) is a deciduous fruit tree/shrub that belongs to the Lythraceae family. Pomegranate is a shrub naturally branching at the soil surface into several main branches and has a dense appearance [Singh *et al.* (2006), Holland *et al.* (2009)]. When planted, it can grow as a small tree up to 5 meters high. Under normal conditions, it can sometimes reach a height of more than 7 m [Levin (2006)]. Pomegranate requires a long, hot and dry season to produce a good quality fruit crop. Pomegranate is native to Central Asia. However, the pomegranate tree has adapted to a wide range of climates and soil conditions as it is cultivated in many different geographical regions including the Mediterranean basin, Asia and California. Modern scientific research has confirmed that it is used as a traditional medical treatment as these researches indicate that the tissues of pomegranate fruits, flowers, bark and leaves contain vital phytochemicals that are anti-microbial, reduce blood pressure and work against serious diseases such as diabetes and cancer [Holland *et al.* (2009). The nutritional value in pomegranate fruits includes its high content of antioxidant compounds, such as polyphenols, flavonoids especially anthocyanin, vitamin C, tannins, fatty acids, proline, and these fruits also contain proteins, carbohydrates and some important minerals such as potassium, calcium, phosphorus and magnesium [Pareek *et al.* (2017), Wu and Tian (2017), Pinilla *et al.* (2019)]. The nutrient solutions that plants are sprayed with foliar fertilization can be easily

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absorbed by the plant parts that grow above the soil surface. They transfer within the leaf tissues through the living membranes of cells due to the difference in the water potential and the concentration between the nutrient solutions and the leaf cells [Blythe *et al.* (2003)]. The study conducted by Hassan (2017) indicated that the foliar spraying of naval orange seedlings with a PRO.SOL fertilizer resulted in a significant increase in the number of branches and leaves and their total chlorophyll content. While this fertilizer did not significantly affect the height of the plant, stem diameter and leaf area. The plant extracts contain organic substances that have beneficial effects because they contain some plant growth regulators, bio-stimulants and minerals that affect plants positively [El-Morsy *et al.* (2017)]. Licorice extract (*Glycyrrhiza glabra*) is one of these important plant organic extracts that are extracted from the roots of licorice plant belonging to the Leguminoseae family. This extract contains more than 100 compounds including saponin triterpene and phenolic compounds [Shibata (2000), Shabani *et al.* (2009)]. It is also used as a bio-fertilizer rich in amino acids, vitamins, bio-stimulants and phytohormones [Badr *et al.* (2013)]. Besides this, it contains many minerals such as potassium, phosphorous, magnesium and iron [Laroche *et al.* (2001)]. Numerous studies have found that foliar fertilization of licorice extracts for many horticultural plants has improved growth, vegetative and fruity characteristics [Almehemdi *et al.* (2011), Babilie *et al.* (2015) Elrys and Merwad (2017), El-Morsy *et al.* (2017)]. The main aim of foliar spray with PRO.SOL fertilizer and licorice root extract is to improve vegetative growth, the physical and chemical characteristics of the pomegranate seedlings of 'Salemi' cultivar.

2. Materials and Methods

The experiment was carried out in the Nursery Wooden Canopy in the Department of Horticulture and Landscape Design, Faculty of Agriculture, Basra University, Basra city, Iraq. 25 one-year-old pomegranate seedlings were chosen that were homogeneous in growth and height. The young seedlings were grown in 10 kg plastic pots containing a mixture of fine sand and peat moss in a ratio of 1: 2. The experiment included five treatments as follows:

1. Control treatment: The seedlings of this treatment sprayed in distill water.
2. 2 ml L^{-1} PRO.SOL fertilizer.
3. 4 ml L^{-1} PRO.SOL fertilizer.
4. 5 g L^{-1} licorice extract.
5. 10 g L^{-1} licorice extract.

Each transaction was represented by five replications. Foliar fertilizing solution for each treatment added 3-4 drops of tween 20 (Poly sorbate 20) to reduce surface tension and increase the absorption of the solution by the vegetative growth of seedlings.

PRO.SOL fertilizer: 2 and 4 ml L^{-1} of fertilizer solution were taken by the American PRO.SOL Company, which ingredients are shown in Table 1.

Licorice extract: 5 and 10 g L^{-1} of the powder of licorice root were taken and soaked in distill water for 24 hours. Then put it in the electric blender for 5 minutes. Then the extract was filtered by Whatman filter paper No.1. Keep the extract in the refrigerator at 5 °C until the time of use.

Table 1: The product composition of the PRO.SOL fertilizer.

The material	Concentration
Total Nitrogen (N)	20%
Total Phosphate (P_2O_5)	20%
Total Potassium (K_2O)	20%
Sodium borate (B)	200 mg L^{-1}
Chelated Copper (Cu)	500 mg L^{-1}
Chelated Iron (Fe)	1000 mg L^{-1}
Chelated Manganese (Mn)	500 mg L^{-1}
Chelated Zinc (Zn)	500 mg L^{-1}
Sodium Molybdate (Mo)	5 mg L^{-1}

2.1 The experiment of foliar fertilization

The experiment of foliar fertilization of young pomegranate seedlings began on 2nd January in 2018.Pomegranate seedlings were sprayed in all treatments triple by a 5-liter hand sprayer until full wetness in the early morning. The interval between at the spray and another was one month. The indicators of vegetative growth of pomegranate seedlings were recorded at the end of the experiment on 2nd April in 2018 (Three months after the first spray of foliar application).

2.2 The vegetative growth indicators of

pomegranate seedling

1. The seedling height (cm).
2. The number of seedling leaves (Leaves number per seedling).
3. The number of seedling branches (Branches number per seedling).
4. The leaf area: It is measured by Portable laser leaf area meter (cm^2).
5. Total chlorophyll content in leaf: Total chlorophyll was estimated in mg g^{-1}fresh weight of leaf tissue as described in Goodwin (1976).
6. Total soluble carbohydrates content in leaf (mg g^{-1} dry weight): Carbohydrates are estimated in Modification of Phenol Sulphuric Acid Colorimetric Method described by Dobois *et al.* (1956).
7. The mineral content in leaf: The dry samples of the leaves of the shoots were digested according to the method described by Cresser and Parsons (1979). Total nitrogen concentration in leaves (%) was estimated using Micro Kjeldahl. The content of the phosphorus in leaves of the shoot was estimated at the percentage (%). The amount of potassium in the leaves of the shoots was estimated in the percentage(%) according to the methods described by Page *et al*. (1982).
8. Total protein content in leaf: % of Protein content (Dry weight) = % of Nitrogen × 6.25.

2.3 Experimental design and Statistical analysis

Randomized complete blocks design was used with five replicates. The data were subjected to the analysis of variance and mean values were compared using revised-LSD as described by Snedecor and Cochran (1980).

3. Results

Table 2 shows the significant effect of PRO.SOL fertilizer and licorice extract on some of the vegetative characteristics of young pomegranate seedlings of Salemi cultivar. The treatment of foliar fertilization with PRO.SOL fertilizer was significantly superior in the concentration of 4 ml L^{-1} in the height of seedlings, number of leaves per seedling, number of branches per seedling and leaf area compared to other treatments. This treatment recorded the highest values in these vegetative characteristics which reached 138.30 cm, 96.80 leaves/seedling, 7.20 branches/ seedling and 11.27 cm^2, respectively.

Whereas, the results from the same table indicate that the treatment of the PRO.SOL fertilizer with a concentration of 2 ml L^{-1} was significantly superior in all the vegetative characteristics of the seedlings of other treatments except for the treatment of the PRO, SOL fertilizer at 4 ml L^{-1}. This treatment recorded 135.50 cm, 91.60 leaves/seedling, 6.2 branches/ seedling and 10.41 cm^2, respectively. The results also indicate that the treatment of foliar fertilization with licorice extract at a concentration of 10 g L^{-1} was significantly superior to the control treatment in all vegetative characteristics. This treatment was recorded 128.20 cm, 88.40 leaves/seedling, 5.20 branches/ seedling and 9.51 cm^2, respectively. But the control treatment was recorded the lowest values in all vegetative characteristics, which reached 118.20 cm, 68.40 leaves/seedling, 2.80 branches/seedling and 8.15 cm^2, respectively.

The results in Table 3 show that there were significant differences between the treatments in the leaf content of nitrogen, phosphorus and potassium in the pomegranate seedlings 'Salemi' cultivar. The treatment 4 ml L^{-1} of PRO.SOL fertilizer was significantly superior in the leaf content of N, P and K compared to other treatments. This treatment recorded the highest percentage of the three minerals at 3.32%, 0.23% and 2.20%, respectively. The results also indicate that the treatment of foliar fertilization with licorice extract concentration of 10 g L^{-1} has significantly superior in the leaf content of minerals in comparison with other treatments except for the treatment of 4 ml L^{-1} of PRO.SOL fertilizer which reached 3.14%, 0.21% and 1.96%, respectively. While the results indicated that the control treatment recorded the lowest percentages in the leaf content of the minerals, reached 2.44%, 0.14% and 1.66%, respectively.

The results from Table 4 show that there were significant differences between the treatments in some chemical compounds in the leaves of young pomegranate seedlings of 'Salemi' cultivar. The results in the table show that the treatment of foliar fertilization with PRO.SOL fertilizer with concentration of 4 ml L^{-1} recorded a significant superiority over other treatments in the leaf content of total chlorophyll,

Table 2: Effect of PRO.SOL fertilizer and licorice extract on some vegetative growth of pomegranate seedlings of 'Salemi' cultivar.

Treatment	Seedling height (*cm*)	No. of leaves per seedling	No. of branches per seedling	Leaf area (cm^2)
Control	118.20	68.40	2.80	8.15
2 ml L^{-1} PRO.SOL	135.50	91.60	6.20	10.41
4 ml L^{-1} PRO.SOL	138.30	96.80	7.20	11.27
5 g L^{-1} licorice extract	122.00	85.20	4.80	8.79
10 g L^{-1} licorice extract	128.20	88.40	5.20	9.51
R-LSD pe"0.05	0.919	1.48	0.958	0.10

Table 3: Effect of PRO.SOL fertilizer and licorice extract on some minerals contensts in leaf of pomegranate seedlings of 'Salemi' cultivar.

Treatment	Nitrogen (%)	Phosphorous (%)	Potassium (%)
Control	2.44	0.14	1.66
2 ml L^{-1} PRO.SOL	2.68	0.18	1.82
4 ml L^{-1} PRO.SOL	3.32	0.23	1.82
5 g L^{-1} licorice extract	2.71	0.16	2.20
10 g L^{-1} licorice extract	3.14	0.21	1.78
R-LSD pe"0.05	0.145	0.019	0.136

Table 4: Effect of PRO.SOL fertilizer and licorice extract on some chemical compounds in leaf of pomegranate seedlings of 'Salemi' cultivar.

Treatment	Total chlorophyll (mg g^{-1} fresh weight)	Total Soluble Carbohydrates (mg g^{-1} dry weight)	Total Protein %
Control	2.30	18.08	15.25
2 ml L^{-1} PRO.SOL	3.06	20.10	16.93
4 ml L^{-1} PRO.SOL	4.40	24.36	20.75
5 g L^{-1} licorice extract	3.20	19.02	16.75
10 g L^{-1} licorice extract	4.14	22.36	19.63
R-LSD pe"0.05	0.198	0.273	0.90

soluble carbohydrates and protein which reached 4,40 mg g^{-1} FW, 24.36 mg g^{-1} DW and 20.75%, respectively. Also, the results in the same table indicate that the treatment of spray with licorice extract at a concentration of 10 g L^{-1} has significantly superior in the leaf content of chemical compounds in comparison with other treatments except for the treatment of 4 ml L^{-1} of the PRO.SOL fertilizer. This treatment was recorded 4.14 mg g^{-1} FW, 22.36 mg g^{-1} DW and 19.63%, respectively. Whereas, the control treatment recorded the lowest values in leaf content of the chemical compounds of 2.30 mg g^{-1} FW, 18.08 mg g^{-1} DW and 15.25%, respectively.

4. Discussion

The reason for the significant superiority of the treatment of foliar spray with the PRO.SOL fertilizer concentration of 4 ml L^{-1} in the indicators of vegetative growth is due to its role in supplying the seedlings with macronutrients such as N, P and K and micronutrients such as Fe, Mn, Cu, Zn and Mo that contribute to proteins, enzymes, pigments and chlorophyll synthesis (Table 1). This contributes to stimulating photosynthesis, cell division and elongation processes, which leads to vegetative growth [Hassan (2017)]. The high response to the foliar spray of PRO.SOL fertilizer and licorice extract by pomegranate seedlings of 'Salemi' cultivar is

due to the rapid absorption by the vegetative system and it is reaching the growth sites compared to the method of soil application [Bondada *et al.* (2006), Hasani *et al.* (2016)].

The reason for the significant increase in the indicators of the vegetative growth of pomegranate seedlings of 'Salemi' cultivar that treated with foliar spray with licorice root extract at a concentration of 10 g L^{-1}, because it contains some compounds, which have an effect similar to those that stimulate growth, have a wide range of minerals (calcium, Potassium, magnesium, iron, zinc, phosphorous), amino acids (alanine, lysine, arginine), vitamins (B1, B2,B6), in addition to carbohydrates and nitrogen. It also contains mevalonic acid used in the synthesis of gibberellins. These active and nutritious components found in licorice extract had an important role in stimulating the bioactivities that occur within cells in plant tissues that lead to cell division and enlargement leading to vegetative growth and positive changes in chemical indicators such as increasing the content of total chlorophyll, carbohydrates and proteins [Badr *et al.* (2013), Babilie *et al.* (2015), El-Morsy *et al.* (2017)].

5. Conclusion

The foliar spray with PRO.SOL fertilizer at a concentration of 4 ml L^{-1} led to the improvement of the vegetative growth and its indicators in pomegranate seedlings 'Salemi' cultivar compared with spraying licorice extract and control treatment. The treatment of foliar spray with licorice extract concentration of 10 g L^{-1}led to the improvement of the growth and vegetative properties of pomegranate seedlings in comparison with the control treatment.

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