RESPONSE OF POMEGRANATE TREES CV. SAWA TO Foliar Application with NPK fertilizer and LICORICE ROOT EXTRACT

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- **Date of research received 22/7/2022and accepted 15/8/2022.**
- **Part of MSc. Dissertation for the second author.**

Abstract

The experiment was conducted during the growing season of 2021 on twelve-year old Sawa pomegranate trees (*Punica granatum* L.) in a local orchard in Darashakran - Erbil Governorate, Kurdistan - Iraq, to study the effect of foliar spray of Four levels with NPK (10-10-40) (0 , 1 , 2 , 3 $g.l^{-1}$) and three levels of licorice root extracts (0 , 5 , 10 $g.l^{-1}$) and their interactions on growth and yield of pomegranate trees, and all selected trees sprayed twice, The first foliar spray of NPK was on 17/May/ 2021 after two weeks of complete fruit set, at 6 AM. and second spray of NPK was on 23/July/2021 when the fruit pill was changed in color. Also The first foliar of licorice root extract was performed on 18/May/2021 after two weeks of complete fruit set, and the second spray was conducted on 24/July/2021 when the fruit pill was changed in color. The study applied as a factorial experiment in Randomized Complete Block Design (RCBD) with three replications by using one tree as the experimental unit thus the number of trees will be used in this study (4 x 3 x 3 = 36 trees). The results showed that the most incremental application and the interaction between NPK and Licorice root extracts rates especially at high concentrations, (3 $g.l^{-1}$ NPK and 10 $g.l^{-1}$ Licorice root extracts) led to significant increase and gave the highest value of the most of the studied characteristics, leaf content of nitrogen, phosphor and potassium 2.493 %, 0.150 % and 1.192 % respectively, tree yield 77.38 kg, juice percentage 29.500 %, TSS/T.A ratio 34.675%, anthocyanin mg.100 ml^{-1} 13.370, and Vit-C mg.100 ml^{-1} 13.363.

Key words: Pomegranate, NPK, Licorice root extract, foliar spray.

استجابة لأشجار الرمان (*Punica granatum* L.) صنف ساوا (sawa) للتسميد بـ NPK ومستخلص جذور عرق السوس

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- تاريخ استلام البحث22/7/2022 وقبوله 15/8/2022
- البحث مستل من رسالة ماجستير للباحث الاول .

الخلاصة

اجريت هذه الدراسة خلال موسم النمو لسنة 2021 على اشجار الرمان (*Punica granatum* L.) لصنف ساوا بعمر 12 سنة في بستان محلي في منطقة دارا شكران الواقعة ضمن محافظة اربيل ، اقليم كوردستان – العراق ، لدراسة تأثير الرش الورقي بأربعة مستويات لسماد المركب NPK (10-10-40) (0 , 1 , 2 , 3) غم.لتر$^{-1}$ و بثلاثة مستويات بمستخلص جذور عرق السوس (0 , 5 , 10) غم.لتر $^{-1}$ والتداخل بينهما على صفات النمو الخضري والحاصل ، وان جميع الاشجار المختارة تم رشها مرتين ، تمت الرشة الاولى بعد اسبوعين من عقد الثمار ، بينما اجريت الرشة الثانية عند تغيير لون قشرة الثمرة. تم تطبيق هذه الدراسة بتجربة عاملية بتصميم القطاعات العشوائية الكاملة (RCBD) وبثلاث مكررات. اظهرت النتائج بان التراكيز العالية للعوامل المفردة والتداخل بين السماد المركب (NPK) ومستخلص جذور عرق السوس وخاصة عند التركيز (3 غم.لترNPK $^{-1}$) و (10 غم.لتر$^{-1}$ مستخلص جذور عرق السوس) ادى الى زيادة معنوية واعطت اعلى القيم لمعظم الصفات المدروسة ، محتوى الاوراق من النتروجين والفسفور والبوتاسيوم 2.493 % و 0.150 % و 1.192 % على التوالي ، وحاصل الشجرة 77.38 كغم.شجرة$^{-1}$ ونسبة العصير 29.50 % ، والنسبة بين نسبة المواد الصلبة الذائبة الكلية الى نسبة الحموضة الكلية 34.675 % ، ومحتوى عصير الثمار من صبغة الانثوسيانين 13.370 ملغم.100 مل$^{-1}$ عصير، ومحتوى عصير الثمار من فيتامين C – 13.363 ملغم.100 مل$^{-1}$ عصير.

الكلمات المفتاحية : الرمان ، NPK ، مستخلص جذور عرق السوس ، الرش الورقي.

Introduction

Pomegranates are belonging to the Punicaceae families. Punicaceae consists of one genus and two species. *Punica granatum* L., which grows in wide areas across the world, this is due to a rapid increase in cultivation and production globally (Al-Abbasi et al., 2019). The pomegranate tree is widely considered native in the region from Iran to northern India with apparently wild plants in many forests in these areas (Braidy, 2015). Others suggest that it is cultivated has long been widely in the Mediterranean region (Sheikh and Manjula, 2012). Pomegranate are old fruit-bearing deciduous shrubs are grown all over the world, including in tropical and subtropical regions, thanks to their ability to adapt to many climates and soil conditions. (Conidi et al., 2020).

The fresh fruits, pomegranate extract supplements and juices are widely consumed as well as jam, jelly, vinegar, wine, and jelly (Zaouay et al., 2012). In addition, it content carbohydrates, vitamins C, protein, fat, water, fruits also contain many vitamins. The whole plant contains beneficial phytochemicals that have anti-oxidant and anti-microbial properties, so pomegranates also have some medicinal and therapeutic uses. Pomegranate fruits are large and classified as berries. They

vary from light yellow to dark maroon to black and contain arils filled with sweet or tart-sweet flavors (Al-Abbasi et al., 2019).

Among the various factors responsible for increasing crop production, the use of balanced fertilizer at right time, right quantity, source, and method plays a vital role in enhancing productivity. (Thanari and Suma., 2018).

N plays an active role in the synthesis of proteins, nucleic acids, chlorophyll, and various phytohormones and secondary metabolites; its bioavailability affects their cellular content. N deficiency results in pale, light green to yellowish and damaged vegetation. (Lyu et al., 2020). Phosphorous (p) is an essential macro element, after nitrogen, which is necessary for plants to grow. To achieve optimal crop production, adequate P fertilization is required. A high level of P fertilization, however, can lead to P losses in surface and groundwater. (Taliman et al., 2019). In-plant growth and physiology, potassium plays a critical role. Optimal levels of K increase sucrose loading, transport, and unloading in the phloem. It increases resistance to drought and salinity stress in plants (Safa et al., 2020).
In pomegranates, potassium helps improve growth, sugar content, ascorbic acid content, and anthocyanin content, both visible and invisible phenomena (Pathania et al., 2018).
Several studies have demonstrated that plant extracts such as licorice extract can have a similar impact on the root and vegetative growth properties of plants. This plant contains several chemical compounds with a sweet taste, including gleserezin, glycyrrhizin, and licorice acid compounds including glabridin and glaring. These compounds contain a wide range of elements and nutrients and have similar effects to growth regulators to improve the vegetative and flowering characteristics of various plants. It reducing transpiration rates, inhibiting cellular evaporation, and preserving cellular fullness, licorice extract can minimize water loss. (Nasser et al., 2014).

The main goal of this study was to response of NPK and Licorice root extract on growth and yield qualitative characteristic of pomegranate trees.

Material and Methods

Experimental Design and Statistical Analysis:

We conducted the experiment during the growing season of 2021 in a local orchard, located in Darashkran, 43 kilometers from south-western Erbil city, Kurdistan - Iraq. Located at 36,41 N, 44,01 E, and 414 meters above sea level. The pomegranate tree (*Punica granatum* cv. Sawa) was chosen as the subject of the experiment. The tree was 12 years old and cultivated 4x3m. All trees had uniform vigor and were trained to three stems, as well as being under a drip irrigation system.
For this experiment, we used a foliar application of Four levels with NPK (10-10-40) (0, 1, 2, 3 $g.l^{-1}$) and three levels of licorice root extracts (0, 5, 10 $g.l^{-1}$. The experiment is designed according to a Randomized Completely Block Design (RCBD) with three replications by using one tree as the experimental unit thus the number of trees will be used in this study (4 x 3 x 3

= 36 trees). The mean values will be compared using Duncan multiple range tests (DMRT) at 0.05 of probability. (Al-Rawi and Khalafalla, 2000). And the data was analyzed by utilize SAS (SAS Institute. 2015) Institute.

Treatments:

This study was carried out to reveal the effect of foliar application of brand (atlantica) which consist of N, P, and K (10:10:40) and the solution were prepared at concentration (0, 1, 2, 3 $g.l^{-1}$), and the licorice root extract. The solution of this extract prepared at the concentration (0, 5, 10 $g.l^{-1}$) on growth and yield characteristics on (12) years old Pomegranate fruit trees. The solution was prepared at different concentrations of licorice root extract. Firstly, applied 350 gm of this extract to 20 liters of hot water at 50 °C for 24 hours with continuously shacking to mixed well. Then, the solution was filtered by using a cotton cloth and re-filtered through filter paper. After that, and the same process was done to prepare 650gm of licorice root extract. Each tree of pomegranate was sprayed twice at two different times throughout the growing season. The first foliar spray of NPK was on 17/5/ 2021 after two weeks of complete fruit set, at 6 AM. The second spray of NPK was on 23/7/2021 when the fruit pill was changed in color. Also The first foliar of licorice root extract was performed on 18/5/2021 after two weeks of complete fruit set, and the second spray was conducted on 24/7/2021 when the fruit pill was changed in color.

Studied characteristics:

Leaf content (N, P and K %). (Bhargava and Raghupathi 1999)**.**

Leaf Area (cm2)

Twenty-five leaves of each tree were collected randomly from the top, middle, and bottom of the tree canopy. Leaf area was measured non-destructively using the Easy Leaf Area by (image soft wear windows.

Tree yield (kg).

It was calculated according to the following equation:

Tree yield = No. of fruit per tree X Average weight of fruit

The average weight of Pomegranate juice of 100 Arils (g).

Juice percentage (%): The juice percentage was calculated by weighing the juice using this equation:

$$\text{Juice \%} = \frac{\text{Weight of juice of 100 Arils (g)}}{\text{Weight of 100 Arils (g)}} \times 100$$

TSS/T.A ratio (%)

It was determined by the following equation:

TSS/TA Ratio = Total soluble solids (TSS) / Total acidity (T.A).

The content of Anthocyanin pigment in the pomegranate juice (mg per 100 ml juice). (Spayed and Morris, 1980)

$$Anthocyanin\ content\ (\%) = \frac{Abs\ 535 * Ve * Tv}{Vu * Wts} \text{ X } 100$$

Vitamin – C (mg.100 ml^{-1} juice). (Hussein et. al. 2010)

Result

Effect of NPK and Licorice root extract on growth and yield:

Table (1): Effect of NPK and Licorice root extract application and their interactions on vegetative and yield characteristic on pomegranate tree cv. Sawa.

Treatments / g .l^{-1}		N%	P%	K%	Leaf area	Tree yield	Juice %
NPK	0	1.621 b	0.132 b	0.651 b	6.620 a	39.992 b	23.878 b
	1	1.744 b	0.134 b	0.678 b	7.158 a	55.637 ab	26.800 a
	2	2.034 a	0.139 ab	0.777 b	7.528 a	58.186 ab	27.444 a
	3	2.128 a	0.145 a	1.056 a	7.326 a	64.548 a	28.889 a
Licorice root extract	0	1.730 b	0.134 b	0.759 a	7.430 a	52.828 a	26.558 a
	5	1.802 b	0.137 ab	0.790 a	7.034 a	60.308 a	26.767 a
	10	2.144 a	0.141 a	0.822 a	7.011 a	50.637 a	26.933 a
0	0	1.453 c	0.123 c	0.539 c	6.140 d	36.11 bc	22.900 b
	5	1.613 bc	0.135 bc	0.740 bc	7.230 abcd	55.24 abc	24.167 ab
	10	1.796 bc	0.137 ab	0.675 c	6.490 cd	28.63 c	24.567 ab
1	0	1.686 bc	0.133 bc	0.832 bc	8.546 a	61.02 abc	28.000 ab
	5	1.713 bc	0.134 bc	0.616 c	6.146 d	65.54 ab	27.233 ab
	10	1.833 b	0.136 bc	0.585 c	6.783 bcd	40.35 bc	25.167 ab
2	0	1.813 bc	0.137 ab	0.674 c	8.383 ab	68.92 ab	26.500 ab
	5	1.956 b	0.137 ab	0.822 bc	7.463 abcd	49.45 abc	27.333 ab
	10	2.333 a	0.142 ab	0.836 bc	6.740 bcd	56.19 abc	28.500 ab
3	0	1.966 b	0.143 ab	0.991 ab	6.650 cd	45.26 abc	28.833 a
	5	1.926 b	0.143 ab	0.984 ab	7.296 abcd	71.01 ab	28.333 ab
	10	2.493 a	0.150 a	1.192 a	8.033 abc	77.38 a	29.500 a

*Values within each column followed by the same letter are not significantly different from each other according to Duncan's Multiple Range Test at a 5% level.

Leaf content of (N %)

According to the table (1), the foliar application of NPK, significantly affected the leaf content of N. The greatest leaf content of N (2.128%) was recorded at the level (3 $g.l^{-1}$) and the lowest (1.621%) was noted in controls. Moreover, the leaf content of N was significantly affected by the foliar application of licorice root extract. The highest value of N (2,144%), was recorded at a level (10 $g.l^{-1}$), while the lowest result (1,730%) was obtained from the control treatment. NPK and Licorice root extract exhibited significant effects on leaf N % content. Thus, at the level of **(**3 $g.l^{-1}$**)** of NPK and **(**10 $g.l^{-1}$**)** of licorice root extract, the highest value of leaf content of N (2,493%) was recorded.

Leaf content of (P %)

It's obvious from the table (1) that foliar application of NPK significantly affected the leaf content of P. the highest value of P (0.145%) was recorded from level (3$g.l^{-1}$), and the lowest reading of P (0.132%) was taken from the control treatment.

The obtained result from the same table indicated that foliar application of licorice root extracts significantly affected leaf content of P as compared with control the highest value of P (0.141%) was recorded from concentration (10 $g.l^{-1}$) and the lowest value of P (0.134%) was recorded from control treatment. Results clearly show in the table (1) that interaction between NPK and licorice root extract significantly influenced leaf content of P%. The obtained result revealed that foliar application of NPK and licorice root extract on pomegranate trees significantly influenced leaf content of (P). The highest value of P (0.150%) was recorded from concentration (3 $g.l^{-1}$) of NPK and (10 $g.l^{-1}$) of licorice root extract.

Leaf content of (K %)

As shown in Table (1), the use of foliar sprays with NPK had a significant effect on leaf K content. The highest value of K in the consist of leaf (1.056%) was recorded at a level of (3 $g.l^{-1}$**)**), while the lowest value (0.651%) was recorded at the control. As indicated in the same table, foliar spray with licorice root extract did not significant affected on (k) content of leaf. It was the combination of foliar spray with NPK and licorice root extract that resulted in a significant increase in leaf content of K. The maximum value (1.192 %) was recorded at levels (3 $g.l^{-1}$) of NPK and (10 $g.l^{-1}$),) of licorice root extract.

Leaf area (cm)

The results from the table (1) indicate that foliar spraying with NPK on the pomegranate tree was not significantly different from the control. Similarly, the foliar application of licorice root extract had an insignificant effect on the pomegranate leaf area. But as shown results of the same table demonstrated that a combination of NPK and licorice root extract was applied as foliar to the

pomegranate tree. Significantly influenced leaf area. The most successful result was recorded (8.546 cm) at level (1 $g.l^{-1}$) of NPK and (0 $g.l^{-1}$) with licorice root extract

Tree yield (kg)

The obtained results in the table (1) indicated that foliar application of NPK had a significant effect on yield per tree. The highest yield (64.548 kg) was obtained from NPK at concentration (3 $g.l^{-1}$), and the least desirable yield was observed from the control treatment (39.992 kg). The same table revealed that foliar application of licorice root extract did not significantly affect the yield per tree. The obtained result from the above-mentioned table indicated that the interaction of NPK and licorice root extract significantly influenced yield per tree, the highest yield (77.38 kg) was recorded from the interaction of **(**3 $g.l^{-1}$) of NPK and (10 $g.l^{-1}$) of licorice root extract, while the lowest value (28.63 kg) was obtained at the level of (0 $g.l^{-1}$) NPK and (10 $g.l^{-1}$) of licorice root extract.

Pomegranate juice of 100 Aril (%)

As shown in the table (1) spraying the pomegranate tree with NPK has a significant effect on the percentage of juice per 100 aril in all treatments as compared with control treatments. As a result, the maximum result (28.889%) was obtained for (3 $g.l^{-1}$) of NPK, and the minimum result (23.878%) obtained from control. On the other hand, the recorded data indicates that spraying pomegranates with licorice root extract did not have a significant effect on the juice percentage of 100 aril recorded in the same table. It was found that the combination of NPK and licorice root extract had a significant effect on the juice content of 100 aril, as treated the pomegranate tree by this mixture. Whereas the highest result (29.500%) was recorded from (3 $g.l^{-1}$) of NPK and (10 $g.l^{-1}$) of licorice root extract.

Table (2): Effect of NPK and Licorice root extract application and their interactions on chemical characteristic on pomegranate tree cv. Sawa.

Treatments / g .l^{-1}		TSS/T. A Ratio	Anthocyanin	Vit - C
NPK	0	19.799 c	10.061 c	8.258 c
	1	24.430 b	11.646 b	9.125 c
	2	27.009 b	12.250 b	10.216 b
	3	32.186 a	13.033 a	11.848 a
Licorice root extract	0	23.905 a	11.312 b	9.276 b
	5	26.045 a	11.663 b	9.691 b
	10	27.617 a	12.268 a	10.619 a
0	0	16.391 d	9.351 d	7.650 f
	5	19.911 cd	9.686 d	8.443 ef
	10	23.094 bcd	11.146 c	8.683 def
1	0	23.683 bcd	11.210 c	8.673 def
	5	23.515 bcd	11.760 bc	9.056 cdef
	10	26.092 bc	11.970 bc	9.646 bcde
2	0	25.146 bc	12.020 bc	9.390 cdef
	5	29.274 ab	12.143 abc	10.476 bcd
	10	26.607 abc	12.586 ab	10.783 bc
3	0	30.402 ab	12.666 ab	11.393 b
	5	31.482 ab	13.063 ab	10.790 bc
	10	34.675 a	13.370 a	13.363 a

*Values within each column followed by the same letter are not significantly different from each other according to Duncan's Multiple Range Test at a 5% level.

TSS/T.A Ratio (%)

Data in the table (2) showed that foliar application of NPK caused significantly affected the treatment of (TSS/T.A) as compared with control. The concentration of (3 $g.l^{-1}$) of NPK scored the maximum result of (TSS/T.A) ratio (32.186%) while the minimum result scored with control (19.799%). In the same table, the obtained result indicated that foliar application of licorice root extract did not have a significant affected on this parameter. The interaction between foliar application of NPK and foliar application of licorice root extract as shown in the table (1) significantly affected on (TSS/T.A) ratio, the highest value (34.675%) was scored from (3 $g.l^{-1}$) of NPK and (10 $g.l^{-1}$) of licorice root extract.

Anthocyanin (mg.100 ml^{-1} juice)

The result in the table (2) shows that spraying the pomegranate tree with NPK affected significantly the anthocyanin in pomegranate juice. The highest value (13.033 mg per 100 ml^{-1} juice) was recorded from the concentration (3 $g.l^{-1}$) of NPK. The lowest value was recorded from the control (10.061 mg per 100 ml^{-1} juice**).** Also, the obtained result showed that foliar application with Licorice root extracts significantly affected the mentioned parameter in the same table. The highest value (12.268 mg per 100 ml^{-1} juice) was obtained from (10 $g.l^{-1}$) of licorice root extract.

The combination between NPK and licorice root extract revealed that was a significant influence on the anthocyanin in pomegranate juice. That is clearly shown in the table (2), the maximum result (13.370 mg per 100 ml^{-1} juice) was scored from concentration (3 $g.l^{-1}$) of NPK and (10 $g.l^{-1}$) of licorice root extract.

Vitamin – C (mg.100 ml^{-1} juice)

Table (8) show the effect of NPK and Licorice root extract on Vitamin – C it is clear from this table that foliar application of NPK significantly affected the mentioned parameter. The maximum data (11.848 mg.100 ml^{-1} juice) was observed from the concentration (3 $g.l^{-1}$) of NPK. While the minimum data (8.258 mg.100 ml^{-1} juice) was observed from the control. In the same table, the recorded data indicated that foliar application with Licorice root extract also significantly affected the (Vitamin – C) content in fruit. The best value (10.619 mg.100 ml^{-1} juice) was recorded from the concentration (10 $g.l^{-1}$) of. The interaction between foliar application of NPK and licorice root extract on pomegranate tree significantly affected the (vitamin – C) content in pomegranate fruit. The best value (13.363 mg.100 ml^{-1} juice) was scored from concentration (3 $g.l^{-1}$) of foliar NPK and (10 $g.l^{-1}$) of foliar Licorice root extract.

Discussion:

According to the data in tables (1) on pomegranate vegetative growth and yield characteristic, it is apparent that spraying pomegranate trees with NPK had a significant impact on the leaf N, P, and K contents as well as the leaf surface area. Results are in agreement with the findings of El-Boray

et al., (2016); Zayan et al., (2016); Al-abassi et al., (2019); and Hamza et al., (2019). The increase of NPK in leaf content is due to the addition of compound fertilizer (NPK) which increases the level of nitrogen, phosphorus, and potassium in leaves.

Al-Abbasi et al., (2019) describe Nitrogen as a crucial element in cell division for the increase of the number of cells and the size of the leaves, the effect of application NPK due to, they play an integral role in synthesizing proteins, enzymes, pigments, and chlorophyll. In addition, this aids in the stimulation of photosynthesis, cell division, and elongation processes, ultimately promoting vegetative growth it causes the leaf area increase, which helps to increase the leaf area as a result of its interaction with amino acids and nucleic acids, which are essential in the expansion of cells and the production of amino acids, such as Tryptophan, which enters the biosynthesis pathway for auxins. (Al-Sereh et al., 2020).

The results presented in tables (1) also show that spraying licorice root extract on pomegranate trees greatly influenced the content of N and P in the leaves. The results agree with those reported by Shakir and Al-Rawi, (2017); Al-Sereh et al., (2020); Al-Salhy and Aljabary, (2020) and Hussein et al., (2021).

As indicated used of the foliar application of licorice root extract on pomegranate significantly impacted the leaf content of N, P and K. This may be due to the licorice root extract which contains many proteins, amino acids (Asparagine), monosaccharaides, minerals compounds (Aluminum, calcium, iron, magnesium, cobalt, zinc, phosphorus, sodium, silicone and potassium) with bitter principles, which are crucial for leaf mineral and hormonal content. There is a possibility that this is due to the fact that the extract has a similar effect to gibberellin, in that Mevalonic acid contained in it improves plant growth and leaf mineral and hormonal content as a result of the enzymes needed to convert complex compounds into simple ones then converting energy for growth. (Shakir and Al-Rawi 2017).

In the subject of effect of NPK on yield and chemical content, it is obvious from table (1 and 2) that application of NPK as foliar influenced the yield and chemical characteristic. Such as; the fruit set, fruit size, fruit weigh and juice percentage of 100 arils which they lead to increase in the yield production. Moreover, application of NPK increased some chemical contents in the fruit such as TSS/TA, anthocyanin and vitamin-c those result are harmony with El-Boray et al., (2016); Davarpanah et al., (2018); Gawade et al., (2018); and Joody., (2019).

Increasing potassium rates along with moderate levels of nitrogen and phosphorous during fruit development stage is known to regulate the transpiration and water conductance in plant cells, thereby increasing the photosynthetic activity which in turn cause greater synthesis, increasing TSS/T.A ratio, translocation and accumulation of carbohydrates producing larger size fruits. (Thejaswini et al., 2022).

Increase in set and fruit size can be associated to the vital roles of K in plants, in particular the role it plays in cell expansion that leads to the formation of a large central vacuole in fruit cells. On the other hand the role of potassium in encouraging translocation complex sugars, may cause

modifying in osmotic pressure of the fruits and increase both weight and size. As a result of the increase in weight and size of the crop, the yield of the tree will increase. (Zayan et al., 2016).

Regarding the chemical parameter, there are many reasons that contribute to its increase, such as: The variation in these parameters could be due to higher K and N content in these treatments. Titrable acidity and ascorbic acid content in pomegranate fruit juice may be due to; higher levels of nitrogen stimulate synthesis and catalytic activity of several enzymes and co-enzymes which are instrumental in ascorbic acid synthesis. (Tanari et al., 2019).

Potassium is a critical to the synthesis of anthocyanin because it plays a role in sugar translocation, as well as providing a cofactor and stimulator to enzymes including flavonoid-3-o-glicosil transferase. (Davarpanah et al., 2018).

Spraying of pomegranate with licorice increased the fruit characteristics as shown in tables (1 and 2), a significant increase was found in most quantitative traits such as the yield, by effective caused an increase in fruit weight although, which caused increase in fruit yield per tree and juice percentage of100 aril, were recorded, because it contains most of the micronutrients and macronutrients in addition to Mevalonic acid, which contributes to the synthesis of Gibberellin, increasing the level of Gibberellin within the plant, and the storage of carbohydrates and salts by the plant, resulting in an increase of plant vegetative and root growth, allowing more water and nutrients from the soil to be absorbed by the roots, resulting in more abundant fruits and improved yields. (Hussein et al., 2021).

Licorice extract could enhance the increases the TSS within the plant. In addition, as a result of decreasing of total acidity with applying licorice root extract application, the content of vitamin C will increase with in the fruit as it has been mentioned same result by (El-Morsy et al., 2017).

The results showed spraying with licorice extract resulted in a low titratable acidity; we can have explained the reason According to (Alsalhy and Aljabary, 2020). There is a possibility that these acids are consumed in physiological processes like respiration.

The increase of anthocyanin, may also be attributed to licorice root extract spraying, according to (Alsalhy and Aljabary, 2020) licorice root extract applied as a foliar application on grape vine which caused an increase in total sugars and anthocyanin pigment, which may be due to its role in turn helps the fruit to absorb nutrients. Consequently, as more sugars are present in the berries, the formation of anthocyanin is dependent on large amounts of soluble sugars.

Conclusion

According to the previous results It can be concluded from this research that use of NPK and licorice root extract as foliar application separately and interaction between them on pomegranate (Sawa cv), significantly affected in most of vegetative, yield and chemical characteristics. The superior effect of all parameters was observed, and the best value was observed at concentration (3 $g.l^{-1}$) of NPK and (10 $g.l^{-1}$) of licorice root extract, for vegetative growth, yield and chemical component parameters, and the interaction of foliar application of NPK and Licorice root extract positively affected on most vegetative growth and reproductive parameters.

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