**T.R.**
**SIIRT UNIVERSITY**
**INSTITUTE OF SCIENCE AND TECHNOLOGY**
**DEPARTMENT OF HORTICULTURE**

# DETERMINATION OF ROOTING PERFORMANCES IN DIFFERENT IBA DOSES AND OF POMOLOGICAL CHARACTERISTICS OF SALAKHANI AND ZİVZİK POMEGRANATE (*PUNICA GRANATUM* L.) VARIETIES

MASTER'S THESIS

PREPARED
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**June-2017**
**SİİRT**

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**MASTER DEGREE THESIS**

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**Department of Horticulture**

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**Co-Supervisior : Asst. Prof. Dr.Adnan YAVİÇ**

**June-2017**
**SIIRT**

## THESIS ACCEPTANCE AND APPROVAL

The thesis study entitled "Determinationof Rooting Performances in Different IBA Doses and of Pomological Characteristics of Salakhani and Zivzik Pomegranate (*Punica granatum* L.) Varieties" prepared by Khabbat Hasan AL-JABBARI has been accepted as a Master's Thesis at Siirt University, Institute of Science and Technology, Department of Horticulture, by unanimity of votes by the following jury on 16/06/2017.

| **Jury Members** | **Signature** |
|---|---|
| **President**<br>Prof. Dr. Ümran ERTÜRK | ..... |
| **Supervisor**<br>Asst. Prof. Dr. Mine PAKYÜREK | ..... |
| **Member**<br>Asst. Prof. Dr. M. Zeki KARİPÇİN | ..... |

I confirm the above conclusion.

Assoc. Prof. Dr. Koray ÖZRENK
Director of the Institute of
Science and Technology

## THESIS NOTIFICATION

This thesis, prepared in accordance with the thesis writing rules, According to the rules of morality, In the case of using the works of others, in accordance with scientific norms, That the innovation and results contained in the thesis were not taken from another place, No alterations have been made to the data used, I declare that no part of the thesis is presented as a thesis work at this university or any other university.

KHABBAT HASAN AL- JABBARI

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KhabbatHasan AL- JABBARI

SİİRT-2017

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## ABBREVIATIONS AND SYMBOLS

| Abbreviation | Explanation |
|---|---|
| **g** | **:** Gram |
| **cm** | **:** Centimeter |
| **ml** | **:** Milliliter |
| **m** | **:** Meter |
| **mm** | **:** Millimeter |
| **T.S.S** | **:** Total Soluble Solids |
| **NaOH** | **:** Sodium hydroxide |
| **q.d** | **:** Quick dip |
| **s** | **:** Second |
| **MSL** | **:**Mean Sea Level |
| **IBA** | **:**Indole Butyric Acid |

**ppm:** Parts per million, $10^{-6}$

| Symbol | Explanation |
|---|---|
| **°C** | **:** Centigrade |
| **%** | **:** Percent |

## ABSTRACT

## MASTER THESİS

## DETERMINATION OF ROOTING PERFORMANCES IN DIFFERENT IBA DOSES AND OF POMOLOGICAL CHARACTERISTICS OF SALAKHANI AND ZİVZİK POMEGRANATE (*PUNICA GRANATUM* L.) VARIETIES

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**The Degree of Master of Science**

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**2017, 58 Pages**

In this study, the morphological, pomological characteristics and rooting conditions of Salakhani, local variety of Iraq and Zivzik (*Punica granatum* L.), local variety of Siirt, were compared.For this purpose, the effect of different doses of indole butyric acid (IBA) (0.00, 1000, 2000, 4000, 6000 mg / L) on rooting was examined. Cuttings were kept in the rooting environment for five months and rooting rates, root number, root lengths, survival rates, shoot lengths, shoot and leaf number were determined.Salakhani cultivars were found to be the best cultivar only in terms of the root length, sprout length, shoot numberand leaf number. Zivzik cultivars were found to be the best cultivar in terms of the other properties. The hormone dose of 4000 ppm was found to be the best hormone dose in terms of the shoot number, leaf number and root length. The hormone dose of6000 ppm was found to be the best hormone dose in terms of survival rates and rooting rates. The hormone dose of 1000 ppm was found to be the best dose among the doses of hormone only in terms of root number.



**Keywords:**IBA, rooting , pomegranate(*Punicagranatum* L.), Salakhani, Zivzik.

# ÖZET

## YÜKSEK LİSANS TEZİ

## SALAKHANI VE ZİVZİK NAR ÇEŞİTLERİNİN (*Punica granatum* L.) POMOLOJİK ÖZELLİKLERİNİN VE FARKLI IBA DOZLARINDA KÖKLENME PERFORMANSLARININ BELİRLENMESİ

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**Siirt Üniversitesi Fen Bilimleri Enstitüsü**
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Bu çalışmada Irak yerel nar çeşidi Salakhani ile Siirt'in yerel çeşidi olan Zivzik Narının *(Punica granatum* L.) morfolojik ve pomolojik özellikleri ile köklenme durumları karşılaştırılmıştır. Bu amaçla indol bütirik asidin (IBA) farklı dozlarının (0.00, 1000, 2000, 4000, 6000 mg/L) köklenmeye etkisi incelenmiştir. Beş ay boyunca köklenme ortamında tutulan çeliklerin, köklenme oranları, kök sayıları, kök uzunlukları, sürgün verme oranları, sürgün uzunlukları, sürgün sayıları ve yaprak sayıları ölçülmüştür. Salakhani çeşidinin sadece kök oluşumu ve sürgün uzunluğu açısından, Zivzik çeşidinin ise diğer özellikler açısından en iyi sonucu veren nar çeşidi olduğu tespit edilmiştir. 4000 ppm'lik hormon dozunun, elde edilen sürgün sayısı, yaprak sayısı ve kök uzunluğu açısından en iyi hormon dozu olduğu tespit edilmiştir. 6000 ppm IBA uygulamasının, sürgün oluşumu ve köklenme oranı açısından en iyi sonucu veren hormon dozu olduğu tespit edilirken, 1000 ppm IBA uygulamasının, hormon dozları arasında yalnızca kök sayısı eldesi bakımından en iyi sonucu veren doz olduğu belirlenmiştir.

**Anahtar kelimeler:** IBA, köklenme, nar (*Punica granatum*L.), Salakhani, Zivzik.

## 1. INTRODUCTION

Pomegranate (*Punica granatum* L.) is generally known in a distinct family (Punicaceae), which comprises only one genus (*Punica*) and includes two species *Punica granatum*and *Punica proptopunica*(Popenoe, 1974; Samir et al., 2009; Samir, 2010). It is considered to be one of the ancient and sacred fruit trees in the Mediterranean region (Stover and Mercure, 2007).

Pomegranate is one of the first five important fruits together with figs, dates, osurvivals and grapes which are old known cultivated plants.Thedomestication of pomegranate started 3000 – 4000 BC in the North of Iran and Turkey (Usanmaz et al., 2014).It is a perennial plant grown in tropical and subtropical regions (Schubert et al., 1999).Iran and the Himalayas of Northern India are the central origin of pomegranate.Pomegranate grows well in semi-arid mild-temperate to subtropical climate and it is naturally grown in a climate with cool winter and hot summer. Pomegranate is deciduous inthe subtropics and evergreen in the tropical region (Özügan, 1997).

Nowadays, pomegranate is cultivated and grown naturally and is well adapted to the regional climate in Afghanistan, China, Morocco, Palestine, India, Iraq, Iran, Israel, Italy, Cyprus, Egypt, Syria, Saudi Arabia, Thailand, Tunisia, Turkey as well as being grown in some other countries. World pomegranate trade is done on a small scale. Spain, Tunisia and Turkey are the countries exporting pomegranates (Özgüven and Yılmaz, 2000).Currently, Iran is considered to be the main producer of pomegranate fruit followed by India, Turkey and Spain (Owis, 2010).

Pomegranatespeciesneedlittle chilling. Pomegranate is not damaged by late frost in late spring, but fruit in late varieties can be influenced by early autumn frosts. The annual rainfall of 500 mm is considered to be sufficient for the growth of pomegranate, especially in the fall and spring months. This information is taken into consideration for the pomegranate growing in the appropriate region of Turkey; Mediterranean, Aegean and South Eastern Anatolia Region. However, partial air-conditioning can also be donefor pomegranate growing in certain regions (Anonymous 2011a).

Pomegranate is a temperate species that requires high temperatures in summer in order to reach full maturity and achieve commercial production (Melgarejo & Martinez, 1989). For most species of pomegranate, the suitable temperaturedegrees are between 21°C

and 27°C of daytime temperatures and15°C of night-time temperatures (Hartmann & Kester, 1997).

Pomegranate cultivation is done in different soil types, such as sand, gravel, clay and heavy clay soil. The optimal development of pomegranate is observed in deep, permeable, alkali and sandy loam soil. In our country, pomegranate cultivation can be done in all regions, except for very cold regions.Furthermore, pomegranate can withstand the lowest temperature range from -10 ° C up to -15 ° C, while the temperature lower than -20 ºC causes the death of the plant. The period of vegetative growth ranges between 180-215 days. In addition,the flowering period ranges between 50-75 days, and the fruit growth and development period ranges between120-160 days (Onur, 1983).

Pomegranate fruit is rich in vitamins, iron, folic acid, potassium and polyphenol antioxidants, which are used to treat different diseases and pomegranate extract is used as an alternative method for the treatment of especially different types of cancer, such as breast cancer and prostate cancer, skin cancer, colon cancer, and lungcancer.Pomegranate extract includes seed oil and pomegranate juice, pomegranate peel, and different parts of the plant roots, bark and flowers(Kavaklı et al., 2011). Several parts of pomegranate have the biological properties of extracts, which have been used in therapeutics, such as in the prevention of infection, inflammation, cancer, and in other applications (Miguel et al., 2010). Fruit juice is an excellent source of sugars, vitamins (B, C) and minerals, potassium, iron, antioxidants, polyphenols, and some parts of the pomegranate tree, such as leaves, immature fruits, fruit peel, flower buds are used inmedicinal applications and also for the tanning of leather. Wild pomegranate has a very tart flavor and is of a little value, it is used only as a souring factor. The double-flowered pomegranate used for decorative purposes (non-fruitful) is grown in parks and ornamental gardens for its beautiful red flowers and for the beauty of its appearance (Raj and Kanwar, 2010). Recent studies suggest that pomegranate juice contains anticancer, antimicrobial, and antiviral components (Schwartz et al., 2009; Reddy et al., 2007; Kotwal, 2007).

The propagation of pomegranate is performedeither sexually by seeds or by using the vegetative method (asexual) with cuttings and less frequently it is performed using layers, suckers or graftings (Hartmann et al., 1997; Melgarejo et al., 2008; Polat and Caliskan, 2009). The propagation from cutting (cloning) is an easy, quick and economical method which produces a plant of the same characteristics as the mother plant and which is uniform in

sprouting, comes into bearing and fruiting earlier than the seedling and does not need any new techniques in grafting, budding, and layering. The success of this process depends on some factors such as the condition of themother plant, theage of theplant, planting time, temperature, and rooting media (Fery et al., 2006). Cutting is the simple and successful method of pomegranate propagation with 15- 20 cm in length and of the pencil size or bigger in diameter and the use of semi-hardwood or hardwood rooting hormone is possiblein this method (Melgarejo et al.,2008; Saroj et al., 2008; Polat and Çalışkan,2009).The cuttings collected at the end of February have a higher rooting potential than those collected at the beginning of October (Polat and Çalışkan, 2009). Grafting is one of the propagation methods which is used for varieties to be propagated of which there are barely specimens from which cutting can be obtained; this process should be conducted at specific times, in May or in July, although it can also be done at the end of the summer (with dormant buds) (Melgarejo and Martinez, 1992).Tissue culture (micropropagation), which is another method of vegetative reproduction of fruit crops, helps in overcoming problems of sexual propagation, producing new plants of the same characteristicswith their parents, quick, and mass production of planting materials (Samir et al., 2009).

Pomegranate is considered to be one of the most important endemic horticulture crops. Salakhani variety, which is one of the well-known pomegranate cultivars in Halabja region, has been cultivated for centuries in this region, especially in Halabja province (North of Iraq). It is a local pomegranate genotypeof high quality grown naturally and well adapted to the regional climate and cultivation in residential areas is an important source of income and survivallihood for regional residents. Villages and districts, which surround Halabja governorate, are famous for the pomegranate fruit, called asHanary Hawraman (Hawraman pomegranate), and the pruning process.

Prunning process a selective removal of parts of a plant such as dry branches and shoots, is performed in the region. Reasons for pruning plants include dead wood removal, shaping (by controlling or directing growth), improving or maintaining health, reducing risk from falling branches, and increasing the yield or quality of fruits andthe tillage procese are done in early spring in the orchared and the process of irrigation starts in the late April. The irrigation of pomegranate grown in the region is very important. Therefore, irrigation is applied to the whole garden in pomegranate cultivation areas, irrigation is usually performed every 7 days

with daily follow up. The region is characterized by an abundance of water sources and natural springs. There is no shortage of water in this region.

The aim of the present study was to collect and characterize two local varieties of pomegranate (Salakhani) in Halabja province in North of Iraq and (Zivzik) in South Eastof Turkey, selected as the study area, as well to determine pomological characteristics of both varieties and find out the similarities and differences between them.In addition, another important aim of the study was to compare the effects of the application of growth hormones (IBA) on sprouting and rooting behaviours of Salakhani and Zivzik varieties.

## 2.LITERATURE RESEARCH

Gündoğdu et al. (2010), studied the pomological traits of local pomegranate genotypes grown naturally and well adapted to the regional climate of Sirvan town in Siirt province. In the study, fruit weights ranged from 161.45g to 302.35 g; fruit heights ranged from 60.79 mm to 78.67 mm; fruit diameters ranged from 67.27 mm to 86.92 mm; fruit volumes ranged from 177.5 ml to 305.0 ml; fruit juice amounts ranged from 69 ml to 121 ml; fruit densities ranged from 0.84 g cm-3 to 1.17 g cm-3; seed weights ranged from 80.00 g to 162.35 g; calyx heights ranged from 16.58 mm to 34.64 mm; calyx half-diameters ranged from 9.32 mm to 14.27 mm; soluble solid contents (SSC) ranged from 12 brix to 16 brix; pH ranged from 3.63 to 5.87; shape index ranged from 0.84 to 1.03; and total acidity ranged from 0.47% to 1.08%. Moreover, sub-skin colour, upper skin colour, seed hardness, fruit taste, seed colour, upper fruit compartment, sub-fruit compartment, compartment number, compartment appearance, easiness in separating grains and fruit pulp weights were also determined.

Mars and Marrakchi (1999), studied thirty pomegranate (*Punica granatum* L.) accessions to determine the overall degree of polymorphism and to detect similarities among the genotypes grown naturally in Tunisia. In the study, fruit weights ranged from 196 g to 673 g; fruit heights ranged from 46 mm to 96 mm; fruit diameters ranged from 57 mm to 114 mm; shell thickness ranged from to 2.4 mm to 6.1 mm; calyx length ranged from 12 mm to 21 mm; fruit juice amounts ranged ranged from 72 ml to 100 ml; the TSS ranged from 13.3% to 16.9%; pH ranged from 0.93 to 4.6; the titratable acidity ranged from 0:25 to 3:17.

In their study, Gündoğdu et al. (2015), examined the pomological and some chemical properties of fruits in the standard pomegranate varieties grown in Turkey. In their study, fruit weights ranged from 251.01g to 530.25 g; fruit height ranged from 60.30 mm to 89.97 mm; fruit diameter ranged from 75.57 mm to 100.68 mm; fruit volume ranged from 230.00 ml to 542.50 ml; fruit juice amount ranged from 106.66 ml to 186.00 ml; fruit densities ranged from 0.92 to 1.19 g cm-3; Total soluble solid content (T.S.S) ranged from 11.50 to 14.62 %; pH ranged from 3.45 to 4.71 and total acidity ranged from 0.19 to 1.17 %. Moreover, peelcolour, upper peelcolour, seed hardness, fruit taste, grain (grain)colour, upper fruit chambers, sub-fruit chambers, chambers number, chambers appearance, easiness in separating grains were also determined.

Muradoğlu et al. (2006), conducted an experiment to describe the desirable pomological traits of 46 pomegranate genotypes selected from Çukurca district in Hakkari.

The data were recorded as follows: fruit weights ranged from 131 g to 337 g, fruit height ranged from 60.0 mm to 81.0 mm,fruit width ranged from 30.8 mm to 88.9 mm, calyx length ranged from 11.0 mm to 26.1 mm and calyx diameter ranged from 11.2 mm to 18.1 mm. In addition, the total soluble solid content was between 12.2 % and 17.6 %. The values of pH ranged from 2.6 to 3.8. The acidity was between 1.5 % and 2.9 %. Genotypes had green or yellow coloured bottom skins, red or pink colouredgrain, soft, semi-hard and hard seeds. Their grain (grain) percentages changed between 49.5 % and 71.5 %.

Usanmaz et al. (2014), carried out their study to evaluate the yield and pomological characteristics of three pomegranate cultivars: Wonderful, Acco and Herskovitz grown in Cyprus conditions. The results showed that the Wonderful cultivar had the highest fruit weight and second highest yield (481.12 g/fruit and 14.17 kg/tree). The second highest fruit weight was obtained from Herskovitz which had the highest yield (431.04 g/fruit and 15.44 kg/tree). The lowest fruit weight and yield were obtained from Acco (350.31 g/fruit and 11.43 kg/tree). Acco had the highest juice content followed by Wonderful and Herskovitz (40.22% > 35.60% > 29.42%). Wonderful had the highest juice content (5.05 l/tree). Juice content per tree for Acco and Herskovitz was determined to be 4.58 l and 4.53 l, respectively.

Polat et al. (1999), conducted an experiment in Hatay, during which the following results were obtained: fruit weight ranged from 250 g to 461g, 100 grain weight ranged from 29 g to 50g, fruit hieght ranged from 69 mm to 83 mm, fruit width ranged from 80 mm to 94 mm, shell thickness ranged from 3.7 mm to 4.3 mm, grain yield ranged from 54 to 73%, TSS rates ranged from 14 to 15% and acidity ranged between 0.3 and 3.9%.

The study of Yılmaz et al. (1992)was carried out on the regional adaptation of pomegranate in the Mediterranean Region and the following results were obtainedfruit width was 92-104 mm, fruit hieght was 79-91 mm, fruit weight was 411- 568 g, (T.S.S) was 13-16% and acidity% ranged between 0.13-1.63 %.

In her study, Gözlekçi (1997), examined the characteristics of the fruit, and a relationship in the same direction was determined between fruit diameter with fruit weight, fruit diameter with fruit volume, the volume of fruit with fruit weight, fruit length with fruit width, fruit length with fruit weight and juice yield with grain yield, while there was an opposite relationship between the amount of the shell with grain yield, grain yield with TSS and acidity with TSS.

Appropriate pomegranate varieties have been developed in the internal and external markets as a result of breeding works. The peelcolour should be red; titratable acidity less than 1% (sweet), titratable acidity ranging from 1 to 2% (sour-sweet), titratable acidity more than 2% (sour) (Onur et al., 1992).

Muradoğlu et al. (2006), conducted an experiment on 45 types of pomegranate fruit in Çukurca, and the following results were obtained: weight was 131-337 g, pH value was 2.60-8.80, titratable acidity rate ranged between 1.50-2.90 %.

Türkmen and Ekşi (2010), collected pomegranate varieties (Hicaz, Devedişi, Katırbaşı, Ernar, Fellahyemez, Ekşilik, Aşınar) from different provinces of Turkey (Izmir, Gaziantep, Adana, Mersin, Aydın, Antalya, Muğla, Kilis) with the average fruit weight of 374.9 g, shell ratio of 50%, grain ratio of 49.9%, juice efficiency of 34.7 % and fruit juice content of 8.3 % when obtained just from from the aril.

Tehranifar et al. (2010), examined 20 types of Iranian pomegranate, such as Agha Mandali Save, Alak Shirin Save, Bazmani Pust Nazok, Dom Ambaroti, Khazar Bajestani, Lili Post Koloft, Malas Pust Sorkh, Malas Save, Malas Yazdi, Pust Sefeed Dezfol, Save Pust Ghermez, Save Pust sefeed, Shirin Dane Ghermez Ferdows, Shirin Dane Sefeed Ferdows, Shirin Pust Ghermez, Shirin Pust Sefeed, Shishe Kap, Torsh Shahvar Ferdows, Torsh Shahvar Kashmar, Zagh Yazdi, in their study to determine the physicochemical properties. In the study, fruit weight ranged between 196.89-315 g, fruit length ranged between 69.49-81.56 mm, fruit diameter ranged between 64.98-86.88 mm.

Yıldız et al. (2003), conducted a study in Hizan.In their study, fruit weight was 192-388 g, fruit length was 62-78 mm, fruit diameter was 68-90 mm, the number of sepals was 5-8, fruit juice rate was 28-55%, shell thickness was1.3-2.8 mm, TSS was 10-17% and acidity ranged between 0.37-4.3%.

Tibet and Onur (1999), selected 35 pomegranate types from the Aegean Region and South East Anatolia and examined their phenological and pomological characteristics. Fruit weight ranged between 223-493g, fruit width ranged between 78-102 mm, fruit length ranged between 67-88 mm, T.S.S ranged between 12-16%, grain yield ranged between 41-64% and the total acidity ranged between 0.19 – 2.38%.

Melgarejo et al. (2008), reported that the application of exogenous auxins to pomegranate cuttings resulted in the increase of rooting percentages up to three folds. Owais(2010) stated that the application of rooting hormones can increase the rooting

percentage ofpomegranate cuttings at the rate of 49-73%. Rooting is significantly increased by the addition of synthetic auxins (Hartman and Kester, 1983).

Polat and Çalışkan (2009), revealed that some factors, such as the physiological conditions of theparent plant, cutting types, the dates of their taking and medium type, affect the rooting of pomegranate cuttings. They suggested that the cuttings collected at the end of February had a higher rooting potential than those taken at the beginning of October.

According to the result of the study carried out under mist chamber by Singh(2014), it was shown that different concentrations of IBA had a significant effect on some growth characteristics of Hardwood cuttings in (*Punica granatum* L). It was noted that the maximum rooted percentage, root length, sprouted length andleaf number percutting were obtained at the5000 ppmdose of IBA, while the minimum value was reached in the control group.

Alikhani et al. (2011), conducted an experiment to determine the effects of the kind of medium and the kind of pomegranate cuttings on the rooting ability and growth of cuttings under greenhouse conditions. In this experiment, two different medium cultures (sand + peat and sand) and three kinds of pomegranate cuttings (one bud, three buds, more than three buds) were used. At the end of the study, it was revealed that the effect of cutting type on leaf number was significant ($\rho<0.05$). However, it was found out that the effects of medium and interaction between cutting type and medium type on leaf number were not so significant, additionally, the type of the cutting had aninfluence on leaf number. It was noted that the cutting type had a significant effect on shoot number. On the contrary,the effect of medium and interaction between cutting type and medium type on shoot number was not significant. In terms of raised bud numbers, the effect of medium and cutting type was not significant. However, the effect of cutting type on raised bud number and the effect of interaction between medium type and cutting type on raised bud number weresignificant. Eventually, the effect of medium and cutting types and the effect of interaction between them on root length were significant.

Abu-Zahra et al. (2013), examined in their study the application of exogenous auxins to ornamental plants such Rosemary, Hedera, Syngonium and Gardenia (difficult to root without using a rooting hormone) in six different concentrations of NAA (0, 1000, 2000, 3000, 4000 and 5000 ppm NAA).The result of their study showed that the highest rooting percentages as the number of roots, the best length, in comparison to the control treatment, were obtained with 3000 ppm NAA in Rosemary and Hedera cuttings, while the best results

were obtained with 4000 and 1000 ppm NAA in Gardenia and Syngonium cuttings, respectively.

Adekola and Akpan (2012),carried outan experiment to assess the effect of the application of two growth hormones, NAA and IBA, on sprouting and rooting behaviours of Nigerian (*Jatropha*).The growth regulator was applied by adopting the slow dip method (for 24 h). In addition, the untreated replication was accepted as a control group. The results showed that there were no significant treatment differences in the survival percentage and sprouting behaviour of J. curcas. A slight selective response to the application of growth hormones was observed in terms of rooting behaviour, as IBA treated cuttings rooted better thanthe NAA-treated cuttings. However, the untreated cuttings gave the best performance for all the parameters assessed on the sprouting and rooting ability of J. curcas. Hence, the untreated cuttings can be used for the mass production of *Jatropha* since they are good propagating materials.

Sharma et al. (2009), carried out an experiment to improve the rooting and reduce the mortality of rooted cuttings under field conditions.The results clearly indicated that the treatment of IBA 500 ppm with Borax 1% produced the greatest root number and root length in semi-hardwood and hardwood cuttings of pomegranate. Consequently, the semi-hardwood and hardwood cuttings of pomegranate cultivars. Ganesh treated with IBA 500 ppm + Boron 1%, IBA 300 ppm + Borax 2% and IBA 5000 ppm gave 100% survival of the rooted cuttings under field conditions.

Babaie et al.(2014), studied the effect of different IBA concentrations (control, 2000, 4000 and 6000 ppm) and the time of taking acutting (late June and early September) on the rooting growth and survival of *F. Binnendijkii* 'Amstel Queen' cuttings. It was found out that at 6000 ppm and 4000 ppm of IBA and the time of cutting in early September, the highest percentage of rooting ranging from 100% to 96.66%, respectively, the longest root length (16.61 cm) and the greatest number of roots were recorded (15.69 and 14.27, respectively). Whereas the greatest length of new shoots was obtained in the IBA concentration of 2000 ppm and 4000 ppm in late June, the maximum number of new leaves was obtained in the IBA concentration of 2000 ppm and 4000 ppm, with the cutting taken in late June.

Ansari (2010), reported in his investigation that different media and pomegranate cutting separation dates had highly significant effects on rooting characteristics. If suitable media are used, a better cutting separation takes place at theend of theyearin terms of a higher

rooting percent and increasing root number (Singh, 2009; Janner, 2012; Young, 2012).Furthermore, among different media, vermiculite and its mix with sand were the best for a higher rooting percent and root number.

According to the result of the experiment carried out on five pomegranate varieties by Owais(2010), it was determined that all of them had root ability higher than 80% at 9000 ppm IBA treatment, and although the ability of generating roots was enhanced by IBA treatment, it seemed to be that much variability was related to the variety.Hardwood cuttings of pomegranate varieties seem to have a clearly higher root ability than those of semi-hardwood cuttings at different IBA levels for different pomegranate varieties.

Singh et al. (2011),carried out an investigation to study the effect of planting time and IBA (Indole Butyric Acid) on rooting and vegetative growth of pomegranate cuttings (Ganesh) with different concentrations of IBA 50, 100 and 200 ppm (s.d) for (24 h) and IBA 1000, 1500, and 2000 ppm (q. d) for 15 (s), on December 15 and January 15,respectively. The results showed thatthere were significant differences between the time of plantation, IBA treatment concentrations and their interaction with regard to sprouting and last survival percentage of cuttings and statistically significant differences were observed between the dates of plantation and IBA concentrations applied with regard to the number of roots, length of the longest root and root weight characteristics, as well as significant variations between the time of plantation and growth regulator concentrations were observed with regard to the plant height.

According to the result of the study carried out in July, December and January by Kahlon(2007), it was shown that season and shoot part had a significant effect on the sprouting percentage and growth of pomegranate. Also, It was noted that the greatest sprouting was observed in January and the least one in July plantings and a much higher one was observed in January plantings. Furthermore, the sprouting percentage was the highest in the middle part when compared to the basal and sub-apical types of cuttings.

Melgarejo et al. (2000), studied the effect of 2000, 4000, 8000 and 12,000 ppm indole butyric acid (IBA) concentrations and wounding at the cutting base in (*Punicagranatum* L). The results showed that IBA markedly increased the percentage of rooting (although not at all concentrations), with a high concentration of 12,000 ppm producing the best results in the

clones studied. Moreover, wounding carried out at the base of the cutting further increased the percentage of rooting in most of the clones studied.

Mehraj et al.(2013), carried out an investigation to study the influence of IBA (Indole ButyricAcid) on the sprouting and rooting potential of (*Bougainville spectabilis*) stem cutting during the period from May to August, with different concentrations of Indole Butyric Acid (control, IBA in dust form, 500 ppm, 1000 ppm, 2000 ppm). The cuttings were soaked in IBA solution for (24 h) and the IBAdust was attached to the cutting just before the establishment in soil. They found out that IBA at 1000 ppm resulted in most sprouting, rooting and a higher survival percentage of rooted cuttings along with a higher number of roots, sprout buds, maximum root length and diameter.

Singh et al. (2015), carried out an experiment under valley condition to study the effect of different growing conditions (two different conditions, namely, shade house and mist chamber) and various concentrations (control, 1000, 1500, and 2000 ppm) of IBA on the rooting and shooting of hardwood cutting of phalas (Grewia asetica L.) in the month of September. The result showed the greatest success of hardwood cuttings in the mist chamber growing condition, while IBA 2000 ppm gave the highest success rate of cuttings in all aspects, such as rooting percentage, thelength of shoot, thelength of root, thickening of root and leaf sprouting in theshoot.

Singh et al. (2014),carried out an investigation in the mist house to study the effect of different concentrations (control, 1000, 2000, 3000, 4000, 5000 ppm) of IBA on inducing rooting in stem cutting (softwood cutting) of *Duranta erecta var. golden.* Softwood cuttings of *Duranta erecta var. golden*were obtained from 2 to 4-year-old plants and 15 cm long cuttings with theapical part. They found out that IBA at 4000 ppm resulted in the maximum percentage of rooted cuttings, followed by 5000 ppm concentration of IBA and the minimum percentage of rooted cuttings was observed under control.

Fouda and Schmidt (1995), studied the effect of different concentrations (500, 1000, and 2000 ppm) of IBA on root development in *Rosa canica and Rosa rougosa* leafy cuttings.They found out that IBA increased rooting percentage in Rosa canica, the maximum rooting percentage was achieved with the cuttings collectedat the beginning of June and treated with 1000 ppm IBA.

Ghoshet al., (1988), studied the effect of NAA and IBA on adventitious root formation in the stem cutting of pomegranate (*Punicagranatum L.*) under intermittent mist.

They found that IBA was more effective than NAA in inducing rooting of hardwood, semi-hardwood and softwood cutting. IBA at 5000ppm resulted in the maximum rooting success (83.33%), but at higher concentration (10000 ppm), a greater number of roots and increased root length were recorded. The greatest rooting success was obtained with hardwood cutting.

Hegde and Sulikeri (1989), studied the effect of indole butyric acid (IBA) on the rooting in the air layers of pomegranate. In the trials with cv. Jyothi, mature shoots were treated with IBA at 250 – 1500 ppm and air layered between June and August. Rooting increased with IBA concentration from 84,38% at 250 ppm to 93,75% at 1500ppm and 68,75% in the control.

Hansen (1986), carried out an investigation under the controlled greenhouse condition for 13 weeks to study the effects of cutting position and stem length in *Schefflera arboricola* and to develop propagation technique to obtain a fast and uniform root formation. Eight cuttings from the sub-apical to basal regions were excised from each stock plant. The stem length above the node was the same for all cuttings, whereas the stem length below the node was cut to different lengths, ranging from 0.5 to 3.0 cm. He found that cuttings from sub-apical positions rooted more slowly, produced fewer roots and had a lower rooting percentage thancuttings from the more basal regions, furthermore, the number of roots and rooting percentage increased with the length of the stem below the node.

# 3. MATERIAL AND METHOD

## 3.1. MATERIAL

### 3.1.1. Geographical Structure and Climate Features of the Study Area

The study was carried out in 2015-2016,at the Department of Horticulture, Faculty of Agriculture, Siirt University. Siirt province is located between east longitude 41˚- 57' and north latitude 37˚ -55". Siirt provinceis surrounded by Sirnak and Van in the east, Batman and Bitlis in the north, Mardin and Sirnak provinces in the south. A large part of the territory of the province is covered with mountains. The total area of the province is 6,186 $km^2$. (Anonymous, 2003). In Siirt province, that experiences the most significant features of the four seasons, the continental climate prevails. The summers are hot and dry, between June and October precipitation is not observed. More precipitation has been observed in the spring, the amount of moisture with 40% in normal has reached the value over this rate. In the eastern and northern regions of Siirt province that has much difference between day and night temperatures, the winters are rainy and frosty and the southern and western regions are warm. The wind blowing from the east and northeast at night blows from the south and south-westduring the day (Anonymous, 2003).The altitude of the city centre of Pervari district is 1380 m, and agricultural production is performed over 7300 acres(Firat, 2002). The 90-year average of Siirt province climate dataas shown in Table. 3.1 (Anonymmous, 2016).

Halabja province is located in the south-east of the Sulimanni province. It is situated near the border of Iranian with the city of Halabjaand is surrounded by the Hawamian and Sorine mountains in the north-east and north, the Sirwan river in the west,Penguin district in the north, Sharazore district in the west-north, Derbandikhan Lake in the west and south-west. Halabja lies between east longitude ˚45 48.1' -˚46 13.7' and north latitude ˚35 26.4'- ˚35 2.1'.The elevation is about 695 m above sea level (MSL) and the average wind speed is 2.3 m / s in summer, and 1.4 m/s in thewinter season. The estimated cultivation area of fruit trees in the region is approximately 2245 hectares (Alaadin, 2008).The 10-year average (2006-2016) in Halabja province climate dataas shown in Table. 3.2 (Anonymous, 2016a).

**Table 3.1.** The average of climatic data for 90years (1926-2016) in Siirt province (Turkishstate, meteorological service, 2017)(Anonymmous, 2016).

| Months | Average Temperature (˚C) | Average High Temperature (˚C) | Average Low Temperature (˚C) | Highest Temperature (˚C) | Lowest Temperature (˚C) | Average Precipitation (mm) | Average Relative Humidity (%) |
|---|---|---|---|---|---|---|---|
| January | 2.6 | 6.5 | -0.6 | 19.7 | -19.3 | 97.5 | 77 |
| February | 4.2 | 8.7 | 0.5 | 20.6 | -16.5 | 98.2 | 69 |
| March | 8.2 | 13.2 | 4 | 28.5 | -13.3 | 111 | 65 |
| April | 13.7 | 19.1 | 8.9 | 32.9 | -4.1 | 104.4 | 59 |
| May | 19.3 | 25.2 | 13.5 | 36.2 | 2 | 61.8 | 52 |
| June | 25.9 | 32.1 | 18.9 | 40.2 | 8.2 | 8.8 | 36 |
| July | 30.5 | 37 | 23.4 | 44.4 | 13.1 | 1.6 | 30 |
| August | 30.1 | 36.9 | 23.1 | 46 | 14.4 | 0.9 | 29 |
| September | 25 | 32.1 | 18.7 | 39.9 | 8.5 | 5 | 34 |
| October | 17.9 | 24.3 | 12.7 | 36.6 | 0.3 | 49.6 | 47 |
| November | 10.4 | 15.4 | 6.3 | 26 | -4.1 | 81.4 | 64 |
| December | 4.7 | 8.7 | 1.6 | 24.3 | -14.6 | 95.2 | 72 |
| Total | 16 | 21.6 | 10.9 | 46 | -19.3 | 715.4 | |

**Table 3.2.**The average of climatic datafor 10 years (2006-2016) of Halabja Province(Agrometeorology-Sulimanni)(Anonymmous, 2016a).

| Months | Average Temperature (˚C) | Average High Temperature (˚C) | Average Low Temperature (˚C) | Highest Temperature (˚C) | Lowest Temperature (˚C) | Average Precipitation (mm) | Average Relative Humidity (%) |
|---|---|---|---|---|---|---|---|
| January | 7.42 | 11.04 | 2.77 | 16.04 | -2.82 | 97.13 | 56.78 |
| February | 9.18 | 13.69 | 4.89 | 19.89 | -1.24 | 110.43 | 54.6 |
| March | 13.5 | 18.6 | 8.38 | 25.7 | 3.02 | 78.04 | 47.55 |
| April | 18.35 | 23.92 | 12.68 | 31.62 | 6.6 | 80.62 | 45.31 |
| May | 23.97 | 31.69 | 18.88 | 39.51 | 12.54 | 29.71 | 35.7 |
| June | 32.28 | 39.73 | 25.26 | 39.66 | 20.65 | 1.02 | 23.24 |
| July | 35.31 | 42.73 | 28.16 | 45.96 | 24.31 | | 27.13 |
| August | 35.26 | 42.77 | 27.9 | 46.29 | 24.21 | | 26.98 |
| September | 30.24 | 37.51 | 22.94 | 42.8 | 17.48 | 0.77 | 33.3 |
| October | 23.28 | 28.92 | 17.5 | 36.4 | 11.02 | 67.16 | 35.73 |
| November | 14.66 | 19.22 | 9.18 | 25.23 | 4.67 | 88.29 | 51.22 |
| December | 9.19 | 13.71 | 8.79 | 19.4 | 1.65 | 86.91 | 53.17 |
| Total | | | | | | 640.08 | |

### 3.1.2. Collection of plant materials and features cultivation

#### 3.1.2.1. Collection of plant materials

In this experiment, a private orchard of pomegranate (*Punica granatum*) Salakhani and Zivzik were selected, and the plant age ranged between (20-25) years for Salakhani and (20-25) years for Zivzik and trees were selected on the basis of their uniformity in appearance, growth habits and vigour.Salakhani variety is a local pomegranate genotype grown naturally, specifically in Halabja province (Northern of Iraq), and Zivzik variety is considered to be one of the local varieties available in Siirt province in the South East of Turkey. Salakhani variety was collected from their natural area by ourselves and Zivzik variety was collected from Şirvan- ZivzikVillage.

**Figure 3.1.** Private pomegranate orchard in Halabja.

### 3.1.3. Characteristics of varieteis

#### 3.1.3.1.Salakhani pomegranate fruit featuring

The fruits are medium to large size, the peel is thick with reddish to yellow colour, arilfull of juice with pink to red colour, they had a good flavour sour – sweet taste and fruits can be used for fresh consumption or local production of the concentrated pomegranate juice ( Al-jabbari, 2007 ).


**Figure. 3. 2.** The pomegranate fruit and appearance of the pomegranate tree(Salakhani cultivars).

#### 3.1.2.2.Zivzik pomegranate fruit featuring:

The fruits are small to medium size, the peel is thick with pink to green colour, aril (grain) full of juice with pink to dark pink colour,they had a good flavour sour to sour – sweet taste with semi easy in arilseparatingand seed hard (Gündoğdu et al., 2010).

**Figure 3.3.** The pomegranate fruit and appearance of the pomegranate tree(Zivzik variety).

### 3.1.4. The Experiment

The experiment was conducted to study the effect of different concentrations of (IBA) Indole Butyric Acid on rooting percentage, survivalpercentage, branches number, sprout length, root number, root length and leavesnumber of pomegranate cuttings (*Punica granatum*L.) of Salakhani cultivars and Zivzik cultivars, during the period from May to August. Five treatments (control, 1000 ppm, 2000 ppm, 4000 ppm and 6000 ppm) were applied in the experiment with three replications. Ten (10) cuttings were used per treatment including three replications.Therefore, there were thirty (30) cuttings in each treatment and 300 cuttings in total were used in the experiment for both cultivars (Salakhani and Zivzik variety). The dataon the root and shootcharacteristics were collected five months after planting.

### 3.1.5. Culture Media (Rooting Media)

Perlite and peatmoss were used as rooting media. A mix of peatmoss and perlite at a ratio 1:1was used for both varieties.

**Figure3. 4.** Pots and rooting media.

## 3.2. METHODS

Pomegranate genotypes with superior properties were determined according to the selection criteria of fruit and some pomological characteristics were examined. Genotype, fruit weight (g), fruit length (mm), fruit width (mm), Fruit juice volume(ml), fruit volume (ml), calyx diameter (mm), calyx length (mm), peel thickness (mm), aril colour, peel colour, number and appearance of chamber, easiness for arilseparating, the taste of fruit, fruit pulp weight (g), shape index andaril yield (%) were determined. Moreover, Total Soluble Solids(T.S.S) (%), pH and titratable acidity (%) contents. Onur (1983), Yılmaz et al. (1995), Tibet and Onur (1999).

### 3.2.1. Field study

The flowering time of pomegranate fruit in Siirt province starts at the month of May, and the harvested date starts in the middle of the month of October. In order to ensure the best quality, the fruit should be picked at the fully ripened stage, depends on the local climate and pomegranate variety. whereas, the flowering time of Salakhani variety in Halabja Province begins in the middle of the month of April, and the harvest time starts at the beginning of the month of October, depends on climatic conditions and variety of pomegranate. On each tree, the following morphological and Phonological characters were determined: pomegranate local name, tree location, altitude (m), crown height (cm), crown width (cm), trunk number, trunk girth (cm), intensity of branching, cold damage, date of first leafing, flowering date and harvest date.

The fruits at commercially ripe stage from two main pomegranate variety ‘Salakhani’from North Iraq and ‘Zivzik’ from South East of Turkey were harvested from 20 year-old trees in October 2016.The trees were spaced 4 and 3 m between and within rows. The both cultivars were grown under the different geographical conditions. 15 fruits were picked up randomly from each cultivar as a sample were randomly collected at morning and then put in cooler bags to be quickly transferred to the laboratory. The fruit samples were collected during the maturity stage and the analyses were performed in the laboratory of the Faculty of Agriculture, Department of Horticulture, Siirt University. All fruits were first flushed by tap water before the peel, pulp and seed fractions were carefully separated. The peel and pulp were separated manually after measurement of fruit fresh mass and volume. Five replicates were maintained for each analysis and each replicate includes three fruits. The data were analysed and the results were presented as a mean of five replicates.

### 3.2.2. PomologicalProperties

#### 3.2.2.1. Fruit Weight (gr)

15 pomegranate fruits were randomly selected per cultivar and then weighed on a scale with 0.01 g sensitivity and the average fruit weight was calculated (Onur, 1983; Yılmaz et al.,1995; Tibet and Onur., 1999).

#### 3.2.2.2. Fruit height(mm)

15 fruits were randomly selected per cultivar. The height of each fruit (without calyx) was measured by a digital calliper with 0.01 mm accuracy and the average fruit height was calculated (Polat et al., 1999) .

#### 3.2.2.3. Fruit width(mm)

15 fruits were randomly selected per cultivar. The width of each fruit (without calyx) was measured by a digital calliper with 0.01 mm accuracy and the average fruit width was calculated (Polat et al., 1999).

#### 3.2.2.4. Calyx radius (mm)

The widest part of the calyx was measured by a digital calliper with 0.01 mm accuracy and the results were presented as average (Dastemirov and Babaev, 1969).

#### 3.2.2.5.Calyx length(mm)

The length from the top to the base of the calyx part was measured by a digital calliper with 0.01mm accuracy and the results were presented as average (Dastemirov and Babaev, 1969) as shown in Fig3.5..

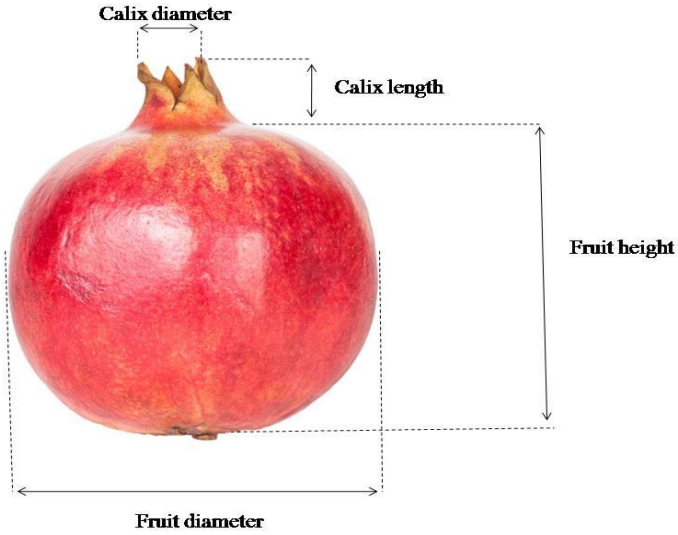


**Figure 3.5.**Fruit and calyx sizes; a: fruit width b: fruit height, c: diameter of calyx, d: calyx length

### 3.2.2.3.Fruit volume

Fruit volume was calculated by liquid displacement method (Akbarpour et al., 2009).

### 3.2.2.4.Fruit juice volume (ml) and Fruit pulp (g)

The pomegranate juice extractor (Pro 120, Moulinex, France)was used by subtracting the water after the pulp separation and by placing the remaining part into the cylinder dimensions.The juice volume (ml) was determined as the amount of fruit juice. The remaining fruit pulp was weighed on a scale with 0.01 g sensitivity, and the pulp weight (g) was determined (Onur, 1983; Yılmaz et al., 1995; Tibet and Onur, 1999).

### 3.2.2.5.Fruit taste

Juice taste (sour, sweet-sour and sweet) was stated by Owais and Abdel-Ghani (2016).

### 3.2.2.6. Aril colour

Arilscolourwas classified as white, light pink, pink and red by Owais and Abdel-Ghani (2016).


**Figure3.6.** Pomegranate grain of Salakhani cultivars.

### 3.2.2.10. Seed hardness

Seed hardness was scored based on a scale of 1-4 (1: Soft, 2: Semi-soft, 3: Semi-hard, and 4: Hard) by Sarkhosh et al. (2009).

### 3.2.2.11. Aril yield (%)

Aril yield (%) can be found as follows(Polat et al., 1999).

**Aril yield % = 100 x (aril weight / fruit weight)**

### 3.2.2.12. Upper fruit peel colour

Light pink, pink, light yellow, yellow and red colours were taken into account (Onur, 1983).

### 3.2.2.13. Bottom fruit peel colour

Green, greenish-yellow, yellow and purple colours were identified by Onur (1983), Yılmaz etal., (1995), Tibet and Onur (1999).


**Figure3.7.** Pomegranate Fruit (Salakhani cultivars).

### 3.2.2.14. Peel thickness

peel thicknesswas measured by a digital calliper with 0.01 mm accuracy, and the average value was taken. Pell thickness two measurementswere recorded from opposite sides of the fruit (Onur, 1983; Yılmaz et al., 1995; Tibet and Onur, 1999).

### 3.2.2.15. Number of chambers

Chambers in the fruit were determined by being counted separately. The average of these values was taken(Onur, 1983; Yılmaz et al., 1995; Tibet and Onur, 1999).

### 3.2.2.16. Clarity of outer chamber appearance

Theouter appearance of the chamber was classified into three groups: clear, semi-clear and unclear by (Gündoğdu, 2006).

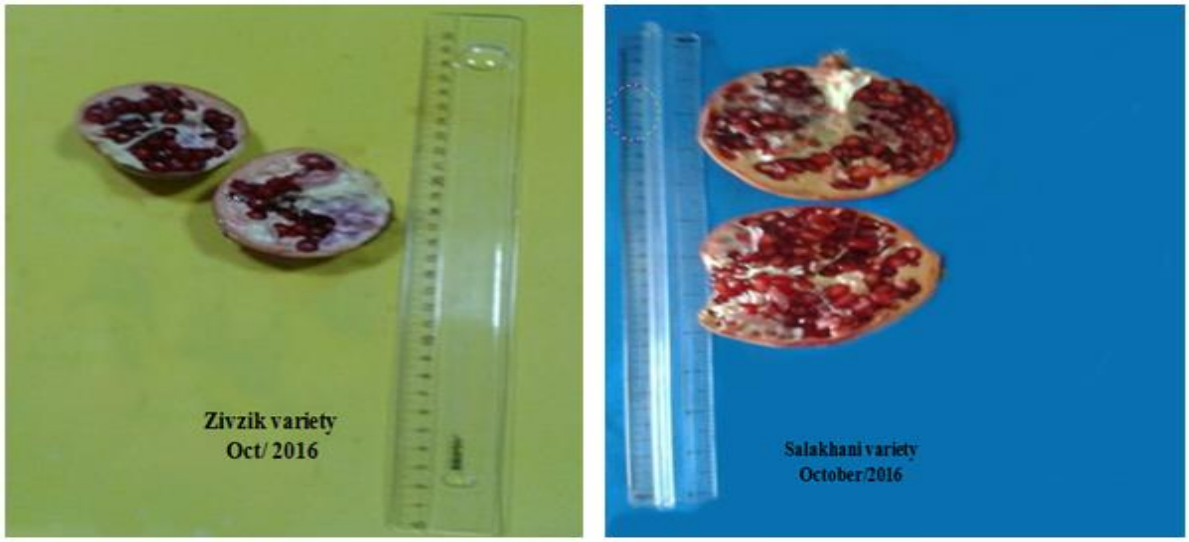


**Figure3.8.**Longitudinal section of pomegranate fruit.

### 3.2.2.17. Easiness ofaril separating

Aril separating was classified as easy, medium, and difficult by (Onur, 1983; Yılmaz et al.,1995; Tibet and Onur, 1999).

### 3.2.2.18. Shape index

Fruit shape wasdetermined by the ratio of fruit length to width (Onur, 1983; Yılmaz et al., 1995; Tibet and Onur, 1999).

$$\text{Shape index} = \frac{\text{Fruit Length}}{\text{Fruit width}}$$

### 3.2.2.19.Total soluble solids (T.S.S) (%)

The total soluble solids (TSS) in the juice (°Brix)was determined by using a portable hand refractometer, as stated by (Shulman et al.,1984).

### 3.2.2.20. Fruit Juice pH

The pH of the juice was measured by a pH meter (Muradoğlu et al., 2006).

### 3.2.2.21. Titrable acidity (%)

Titratable acidity of the juice was determined by the titration technique (Polat et al., 1999).

### 3.2.3. Phenological Observations

In this study, the foliation dates, flowering dates and harvest dates were recorded as phenological observations.

#### 3.2.3.1. The date of first leafing

The date of first leafing was determined following the first foliation period of the cultivars used in this study (Strebkova and Nasacheva., 1969).

#### 3.2.3.2. Flowering time

Flowering timewas determined following the flowering period of the cultivars used in this study.

#### 3.2.3.3. Harvest date

Harvest date was determined over the cultivars used in this study during the harvest (Onur et al., 1992). The colour of the peel and arilwas taken into consideration as harvest criteria.

**Figure 3.9.** Foliation period.

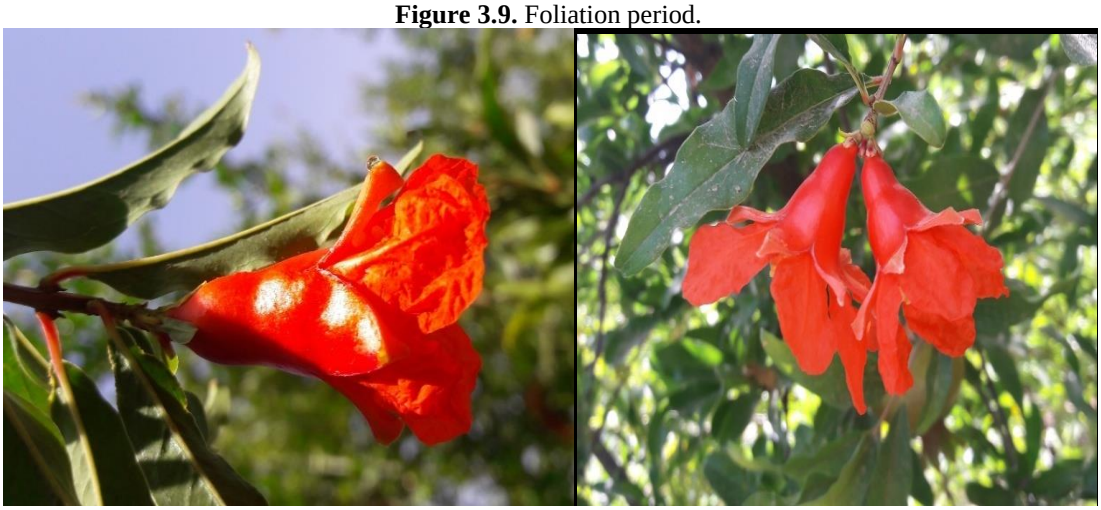

**Figure 3.10.** Flowering period.


**Figure 3.11.** Harvesting time.

### 3.2.4. Parameters and Roots Behavior

The rooting parameters of pomegranate seedlings were measured at the termination of the experimentin the laboratory (Hussain et al., 2012)as follows:

#### 3.2.4.1. Rooting percentage

The percentage of rooting was determined by counting the number of the rooted cuttings per replicateand then divided by the total number of cuttings per replicate(Abu-Zahra et al., 2013).

#### 3.2.4.2. Average number of roots per rooted cutting

All roots produced from the rooted cuttings were counted and then the total numbers of roots were divided by the total number of the rooted cuttings (Abu-Zahra et al., 2013).

#### 3.2.4.3. Average root length per rooted cutting (mm)

All produced roots were removed, their lengths were measured and the sum of the root lengths was divided by the total number of the rooted cuttings(Abu-Zahra et al., 2013).

#### 3.2.4.4. Survival rate

Survivalrate was calculated by dividing the number of sprouted cuttings by the total number of plant cuttings and multiplying by hundred.

#### 3.2.4.5.Averagesproutlength (mm)

All produced branches were sprouted, their lengths were measured and the sum of the sprout lengths was divided by the total number of the sprout cuttings.

#### 3.2.4.6. Average of shoot number:

The sprouted shoot on per cutting were recorded by counting the number of shootsproduced by each cutting and then the total number of shoots was divided by the total number of the sprouted cuttings.

#### 3.2.4.7. Average of leaves number:

The leaves on each sprouted shoot were counted and the average was calculated.

### 3.2.5. Experiment Preparation

#### 3.2.5.1. Preparation of Hormone Solution

In this experiment, five concentrations of IBA were used:0.0, 1000, 2000, 4000 and 6000 ppm. Solutions were prepared by dissolving 0.1, 0.2, 0.4 and 0.6 g, respectively, of IBA pure powder and diluting with 50% alcohol (ethanol), and adding 50% pure water to make 100 ml of each concentration. Pure water and alcohol were used as control treatment.

**Figure 3.12.**Different concentrations of IBA.

#### 3.2.5.2. Preparation of Cuttings

The preparation process of cuttings was conducted in the laboratory of the Department of Horticulture, Agriculture Faculty, Siirt University. Vigorous shoots from the previous year of grown and healthy pomegranate trees wereused for obtaining the cuttings, and the cuttingsof a standard size were washed with tap water. Subsequently,asharp knife was used in the preparation of cuttings for the experiment to avoid the injury of the cutting.The cuttings of uniform lengths, approximately 15cm in length, were taken in the month of February when the plants are dormantwith wounding by making two opposite longitudinal incisions at the base of each cutting. At least three nodes were included in each cutting. The bottom of the cuttings was treated with hormone of Indole Butyric Acid (IBA) at different concentrations. Basal 1- 1.5 cm portion of the cutting was dipped in the growth regulator solution of IBA for 10 seconds (q.d) and immediately inserted in the media at a slight angle to the vertical, to a depth of 10 – 11cmas shown in Figure (3.13.).

**Figure 3.13**. Uniformlengths of cuttings with wounding by making two (2) opposite longitudinal incisions at the base of each cutting.

### 3.2.6. Experimental Procedures

The parameters were measured in the laboratory of the Department of Horticulture, Siirt University. These traits included the rooting percentage, number of roots per cutting, survival cutting rate, number of shoots per cutting,root length(mm), sprout length (mm) and the number of leaves per cutting,which were recorded at the termination of the experiment (after five months), at harvetsing early inAugust. The roots were examined by lifting cuttings carefully from the rooting media and washing them with tap water. The measurementprocesswas conducted by a tape- measure. The data were collected from all of the cuttings and then the mean value was calculated.

### 3.2.7. Experimental Design:

The experimental design used which was factorial design in randomised plots. The treatment in each experiment had three replicates and each pot (container) consisted of 10 cuttings. The results ofthe experiment were statistically analysed andthe meanswere compared using Duncan's Multiple Range Test at the level of 0.05. All analyses were performed by JMP Version 5.0.1statistical software.

**Figure 3. 14.** Replications of the experiment


**Figure .3. 14.** Replications of the experiment

## 4. RESULTS AND DISCUSSION

### 4.1. The results were obtained fromthe field

Studies were carried out in the private orchard in Halabja province. The information were obtained from the questionnaires filled in for Salakhani variety is summarised below. Pomegranates local variety grown in the main production area of Halabja Province and surrounding area. It covers a wide areas of this region, Halabja Province is also well known for pomegranate production and the high quality of its fruits and some other fruits due to appropriate climatic conditions and these areas are ideal places for pomegranate growing.

This area is characterised by a highly fertile and non-stressful conditions. Furthermore, it is considered to be rich in nutrient elements. For this reason, commercial fertilisers are rarely used, while, that the farmyard manure (organic fertilizers) is generally used as a plant fertiliser. Nevertheless, a common fertiliser application is also performed. fertilisers are commonly used for growing all the plants, with application rates depending on soil fertility and economic conditions of the farmers. In orchards, plants are normally trained to a multiple trunks, in order to reduce risk of total tree loss.

Most of the pests deployed in the region such as aphids and trunk borers. Fruit cracking and splitting phenomenon were observed in the region.

## 4.2. Pomological Properties

In this study, two types of pomegranate fruit were selected to examine the physical features, and the averages of the results obtained are shown below.

### 4.2.1. Fruit weight

There were 2 types of pomegranate fruit weighed in this study. The weight of Salakhani fruit was found to be between 389, 43 -578, 51g, while, that the weight of Zivzik fruit ranged between 129, 8- 379, 5 g (Table 4.1.).

### 4.2.2. Fruit height

As demonstrated in Table 4.1., the fruit height of Salakhani varietywas found to be between 87, 70- 99, 49 mm.Whereas, the fruit height of Zivzik varietyranged between 59, 50- 82, 50 mm.

### 4.2.3. Fruit width

The fruit width of Salakhani varietywas found to be between 88, 28-103, 11 mm, while, the fruit width of Zivzik variety ranged between 66,70 - 90, 50 mmas shown in Table 4.1..

### 4.2.4. Fruit volume

The fruit volume of Salakhani variety was found to be between 350 – 600 ml, while the fruit volume ofZivzik varietywas found to be between 250 – 400 ml.as shown in Table4.1..

### 4.2.5. Calyx radius

The calyx radius of Salakhani variety ranged between 6.4- 8.74 mm, while in Zivzik variety it ranged between 7.7- 8.9 mm.as shown in Table(4.1.).

### 4.2.6.Calyx length

The calyx length of Salakhani variety ranged between 21.56- 23.45mm and in Zivzik variety it ranged between 15.7- 22.4 mm.

### 4.2.7. Fruit juice volume (ml) and Fruit pulp (g)

The fruit juice volume of Salakhani variety ranged between 180- 250 ml, while in Zivzik variety it was found to be between 60- 85 ml (Table 4.1.).

The fruit pulp of Salakhani variety ranged between 205- 287g,while thefruit pulp of Zivzik variety ranged between 85-220g(Table 4.1.).

### 4.2.8. Fruit taste

The fruit taste of Salakhani andZivzik varieties were sour sweet (Table 4.1.).

### 4.2.9. Aril colour

The aril colour of Salakhani pomegranate is pink,while, the aril colour of Zivzik pomegranate is dark pink as shown in Table (4.1.).

### 4.2.10. Seed hardness

As demonstrated in Table 4.1.,The seed hardness of Salakhani variety is hard, while the seed hardness of Zivzik variety is semi-hard.

### 4.2.11. Aril yield(%)

The grain yield of Salakhani variety ranged between 59.10- 69.04%,while the grain yield of Zivzik variety was found to be between 51.17 – 61.12% (Table 4.1.).

### 4.2.12. Upper Fruit peel colour

The upper side colour of Salakhani variety is light pink into pink,while the upper side colour ofZivzik variety is redas shwon in (Table 4.1.).

### 4.2.13.BottomFruit peel colour

The bottom side colour of Salakhani variety is pink,while the bottom side colourofZivzik variety is yellow(Table 4.1.).

### 4.2.14. Peel thickness (mm)

The peel thickness of Salakhani variety is found to be between 2.11 – 2.99 mm, while the peel thickness of Zivzik variety is found to be between 2.75 – 4.00 mm (Table 4.1.).

### 4.2.15. Number of chambers

The upper chamber number of Salakhani variety is found to be between 5- 6, while the upper chamber number of Zivzik variety is between 5-7. The bottom chamber number of Salakhani variety is found to be between 3- 4, while the bottom chamber number of Zivzik variety ranged between 4 – 5 as shown inTable(4.1.).

### 4.2.16. Clarity of chambers appearance

The clarityofchamber's appearance of Salakhani variety is clear and the clarityof chamber's appearance of Zivzik variety is semi-clear as shown in(Table 4.1.).

### 4.2.17. Easiness ofaril separating

The aril separating in Salakhani variety is easy, whilethe aril separating in Zivzik variety is semi-easy as shown in Table (4.1.).

### 4.2.18. Shape index

The fruit shape of Salakhani variety was found to be between 0.96- 0.99, while the fruit shape of Zivzik variety was found to be between 0.89- 0.91(Table 4.1.).

Table 4.1. Physicalproperties of pomegranate fruit.

| Fruit Features | Salakhani variety | Zivzik variety |
|---|---|---|
| Fruit weight (g) | 389.43 -578.51 | 129.8- 379.5 |
| Fruit height (mm) | 87.70- 99.49 | 59.50- 82.50 |
| Fruit width (mm) | 88.28-103.11 | 66.70 - 90.50 |
| Fruit volume (ml) | 350 – 600 | 250 – 400 |
| Calyx radius (mm) | 6.4- 8.74 | 7.7- 8.9 |
| Calyx length (mm) | 21.56- 23.45 | 15.7- 22.4 |
| Fruit juice volume (ml) | 180- 250 | 60- 85 |
| Fruit pulp and peel weight (g) | 205- 287 | 85-220 |
| Fruit taste | sour-sweet | sour-sweet |
| Aril colour | Pink | dark pink |
| Seed hardness | Hard | semi-hard |
| Aril yield (%) | 59.10- 69.04 | 51.17 – 61.12 |
| Upper fruitpeel Colour | Light pink- pink | Red |
| Bottom fruit peel colour | pink | Yellow |
| Peel thickness (mm) | 2.11 – 2.99 | 2.75 – 4.00 |
| Upperchamberumber | 5 to 6 | 5 to 7 |
| Bottom chambernumber | 3 to 4 | 4 to 5 |
| Clarity of chamber appearance | Clear | semi-clear |
| Easiness ofaril separating | Easy | semi-easy |
| Shape index | 0.96- 0.99 | 0.89- 0.91 |

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### 4.2.219. Total Soluble Solids (T.S.S) (%)

The soluble solids ratio (%) of Salakhani variety was found to be between 15.1-16.1 %.While thatthe soluble solids ratio (%) of Zivzik variety was found to be between 13-17 % as shown in Table 4.2..

### 4.2.20. Fruit juice pH

As seen in Table 4.2., the pH of fruit juice of Salakhani cultivars was found to be between 3.05- 3.19%.While, inZivzik cultivars it was found to be between 3.6- 4.0.(Table 4.2.).

### 4.2.21. Titrable acidity (%)

The amount of titratable acid in the fruit juice of Salakhani variety was ranged between0.9 – 1.3 %.Whereas, inZivzik variety it was found to be between0.4–0.8% as shown in Table 4.2..

**Table 4.2.** Chemical properties of pomegranate fruit.

| Fruit Features | Salakhani variety | Zivik variety |
|---|---|---|
| T.S.S(%) | 15.1-16.1 | 13-17 |
| pH | 3.05- 3.19 | 3.6- 4.0 |
| Titrable acidity (%) | 0. 9 - 1. 3 | 0.4- 08 |

**Table 4.3.** Genotype fruit, flowering and tree characteristics of Salakhani variety.

| **CULTIVAR NAME** | **Salakhani cultivars** | **Fruit Features** | **Value** |
|---|---|---|---|
| Orchard owner name | : Rizgar A. Hama amen | Fruit Weight (gr) | : 502.34 |
| Name of location | : Halabja | Fruit height (mm) | : 94.01 |
| Location of orchard | : Byawella | Fruit width (mm) | : 95.48 |
| Local name | : salakhani | Fruit volume (ml) | : 470 |
| Altitude (m) | : 695m | Calyx diameter (mm) | : 15.25 |
| The status of irrigation | : Watered in summer | Calyx length (mm) | : 22.7 |
| Status of wind | : middle | Fruit juice volume (ml) | : 220 |
| | | Fruit pulp and shell weight (g) | : 251 |
| **TREE FEATURES** | | Fruit taste | : sweet-sour |
| Crown height (mm) | : 231 | Peel colour | : light pink- pink |
| Crown width (mm) | : 460 | Seed hardness | : hard |
| Trunk number (No) | : 5 | Aril yield (%) | : 68.04 |
| Trunk girth (cm) | : 18 | Wheight of 100 aril (gr) | : 42.3 |
| Density of the branches | : middle | Upper fruit peelcolour | : pink- light pink |
| Cold damage | : NO | Bottom fruit peel colour | : pink |
| | | Peel lthickness (mm) | : 2.72 |
| **OBSERVATIONS** | | Upper chambernumber | :5.8 |
| Date of first leafing: 18th March | | Bottom chambernumber | : 3.4 |
| Flowering time | :22th April | Clearity of chamber appearance | : Clear |
| Harvest date | : 5th October | Easiness of aril seperating | : easy |
| | | Shape index | : 0.984 |
| | | T.S.S (%) | : 15.6 |
| | | pH | : 3.12 |
| | | Titrable acidity (%) | 1.1 |


**Figure.4. 1**. The appearanceofpomegranate Fruit(Salakhani variety).

**Table 4.4.** Genotype fruit, flowering and tree characteristics of Zivzik variety.

| **CULTIVAR NAME** | **Zivzik Cultivars** | **Fruit FeaturesValue** | |
|---|---|---|---|
| Orchard owner name | : Süleyman KÖMEK | Fruit Weight (gr) | : 233.8 |
| Name of location | : Siirt | Fruit height (mm) | : 69.23 |
| OrchardLocation | : Şirvan/ Zivzik Vill. | Fruit width (mm) | : 76.26 |
| Local name | : Zivzik | Fruit volume (ml) | : 225 |
| Altitude (m) (MSL) | : 850 | Calyx diameter (mm) | : 16.4 |
| The status of irrigation | : Watered | Calyx length (mm) | : 19.75 |
| Status of wind | : middle | Fruit juice volume (ml) | : 75 |
| | | Fruit pulp and peell weight (g) | : 119.33 |
| **TREE FEATURES** | | Fruit taste | : sweet |
| | | aril colour | :dark pink |
| Crown height (cm) | :340 | Seed hardness | : semi-hard |
| Crown width (cm) | : 350 | arils yield (%) | : 54.17 |
| Trunk number (No) | : 2 | Weight of 100 arils (gr) | : 45.5 |
| Trunk girth (cm) | : 40-16 | Upper fruit Peel Colour | : Red |
| Density of the branches | : middle | Bottom fruit Peel Colour | : yallow |
| Cold damage | : NO | Peel thickness (mm) | : 3.25 |
| | | Upper chambers number | :5 |
| **SOME PHENOLOGICAL** | | Bottomchambers number | :4 |
| **OBSERVATIONS** | | Clearity of chamber appearance | :semi-clear |
| Date of first leafing | : 13th April | Easiness of aril separating | :semi-easy |
| Flowering time | : 13th may | Shape index | : 0.873 |
| Harvest date | : 18th october | T.S.S (%) | : 16.5 |
| | | pH | : 3.54 |
| | | Titrable acidity (%) | : 0.6 |

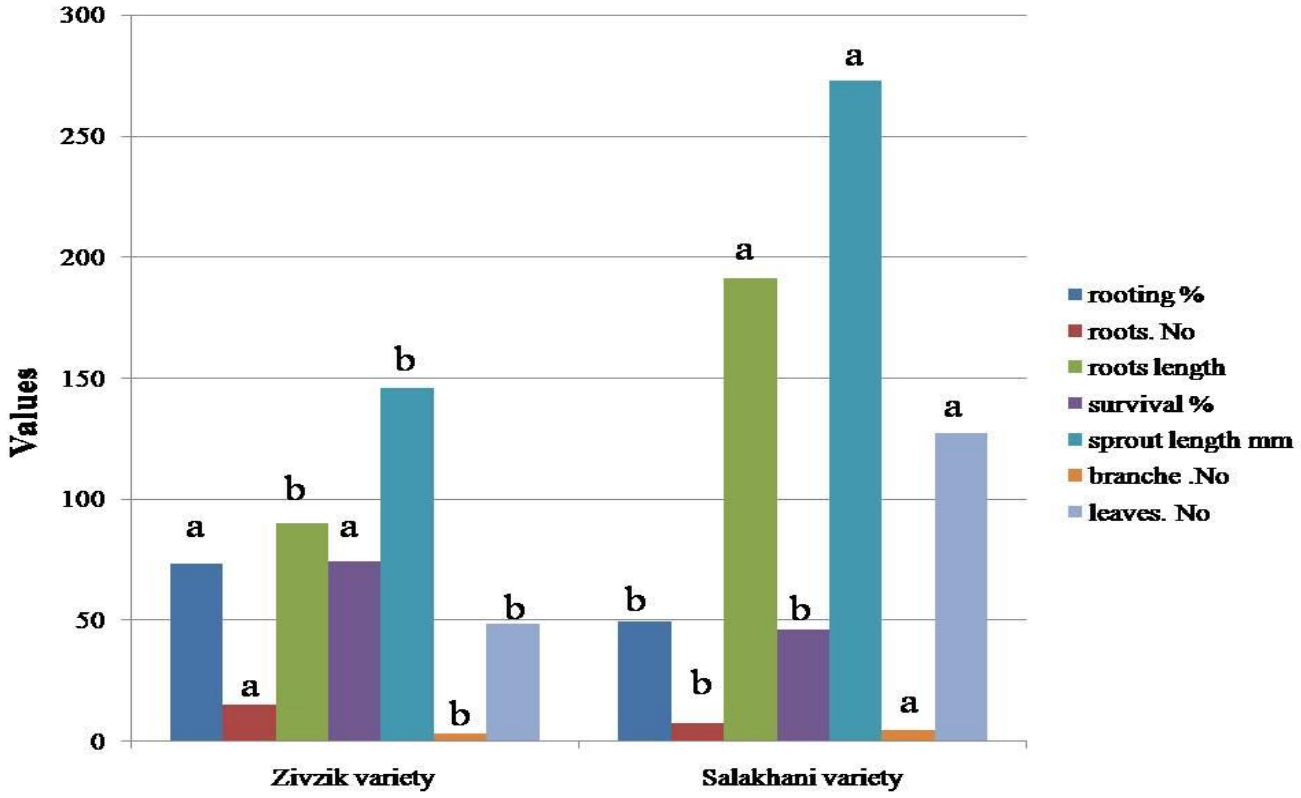

**Figure 4. 2 .**General shape ofpomegranate Fruit(Zivzik variety).

### 4.3. Parameters and roots behavior

When the data on rooting percentage were examined, there was found 1% statistical significance in terms of varieties and hormone doses. While, 5% significance level in terms of IBA type hormone interactions.

#### 4.3.1. Rooting Percentage %

The highest percentage of rooting (73%) was observed in Zivzik variety, Siirt native. While, Salakhani variety was the second and last one with the rooting percentage of 49%, respectively (Figure 4.3). Among the hormone doses used, the highest percentage (72%) of the hormone dose was ademonstrated at 6000 ppm, while, the control group was the second one with 67% rooting percentage (Figure.4.4). The hormone dose group with the lowest percentage of rooting (43%) was the 4000 ppm dose group. The highest (93%) rooting percentage in the variant IBA hormone interactions was found to be related to the 6000 ppm dose applied to Zivzik variety, while the lowest value (23%) was obtained in the case of Salakhani variety with the 4000 ppm dose of IBA (Table 4.5). Hormone use is more effective in clones, especially in rooting fractions (Melgarejo et al., 2000). However, that the untreated stem cuttings had the best performance in terms of rooting of (*Punica granatum. L*) Salakhani variety could be due to the fact that growth hormones may not necessgrainy be the major factor influencing root induction in Salakhani variety pomegranate. The rooting of cuttings may be influenced more by other factors such as the physiological age of cuttings and the status of rooting media in terms of aeration and drainage properties as stated by Narin and Watna (1983).In this experiment, the highest hormone concentration was the most positive effective dose in terms of the rooting percentage. This resultis in conformity with the findings of Melgarejo et al. (2000) and Singh et al. (2015) who reported that the highest percentage of rooting was observed due to the increased hormone concentration.Similar results were also reported by Mehraj et al. (2013), Fouda and Schmidt (1995).Owais (2010) indicated that IBA had a significant effect on the rooting. Abu-Zahra et al. (2013) found different results, so it is thought that the hormones used are derived from different types.




Note: P <0.001; 0.05% level of probability using LSD.

**Figure4.3.**Effect of different treatments among; Zivzik vatiety and Salakhani variety pomegranate.

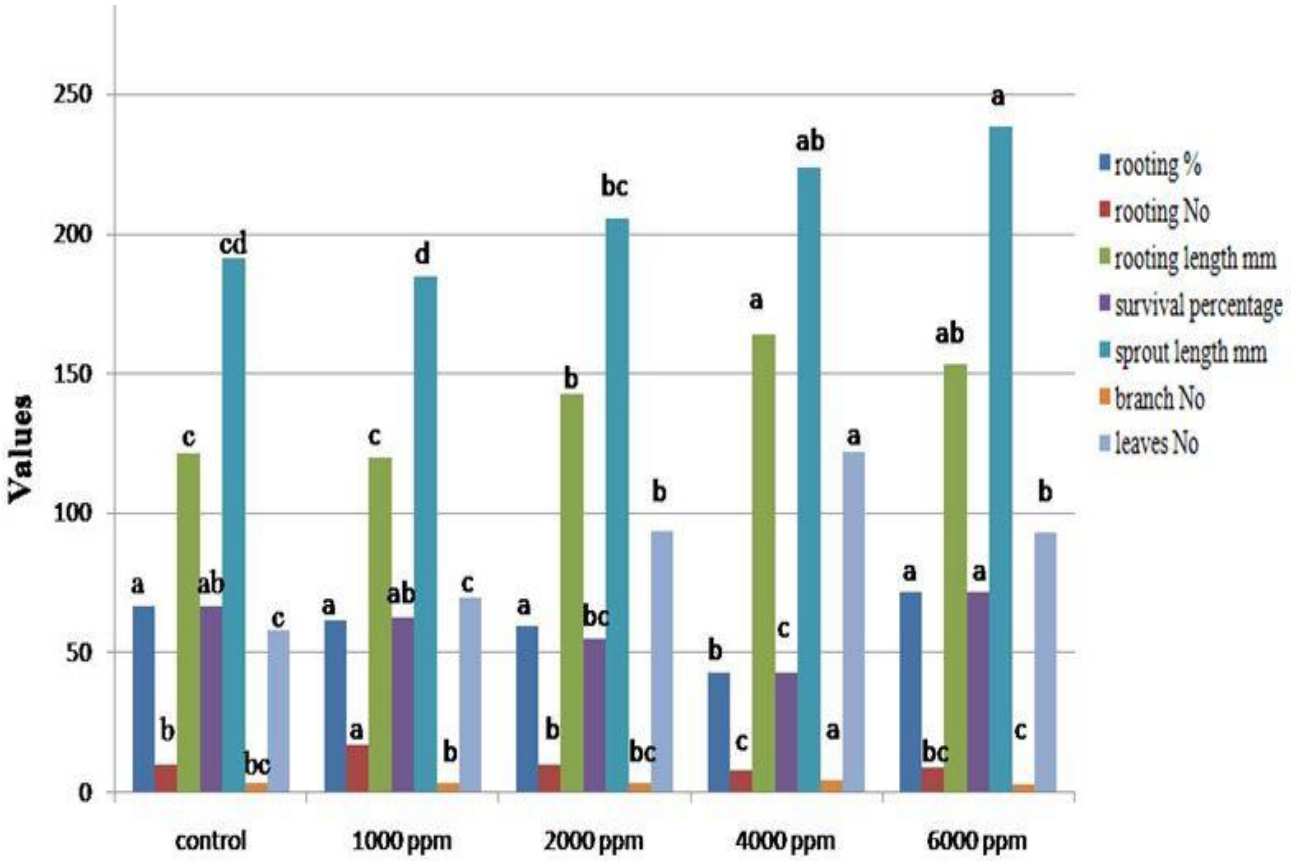



**Figure 4.4.**Effects of IBA concentration on the survival performance and vegetative growth of pomegranate (*Punica granatum L.*).

**Table 4.5.**Effect of the interaction between IBA doses and vegetative growth of pomegranate .

| Cultivars | hormone doses | rooting Percentage | roots number | roots length(mm) | survivalrate (%) | shoot length (mm) | shoot number | leaves number |
|---|---|---|---|---|---|---|---|---|
| | 0 | 0.67 BC | 13.59 B | 89.08 D | 0.67 BC | 110.47 G | 3.13 CD | 23.03 G |
| | 1000 | 0.73 B | 27.08 A | 84.79 D | 0.77 AB | 128.69 FG | 3.17 CD | 39.37 FG |
| **Zivzik** | 2000 | 0.67 BC | 12.74 BC | 98.91 D | 0.70 B | 148.51 EF | 2.58 D | 49.76 EFG |
| | 4000 | 0.63 BC | 10.42 CD | 100.31 D | 0.63 BC | 162.83 DE | 3.17 CD | 71.73 DE |
| | 6000 | 0.93 A | 9.68 D | 76.50 D | 0.93 A | 177.48 D | 2.70 D | 56.38 EF |
| | 0 | 0.67 BC | 7.05 EF | 153.98 C | 0.67 BC | 273.01 AB | 3.68 BC | 93.94 D |
| | 1000 | 0.50 C | 7.03 EF | 155.84 C | 0.50 CD | 241.50 C | 4.31 B | 100.96 CD |
| **Salakhani** | 2000 | 0.53 C | 7.16 EF | 186.98 B | 0.40 DE | 262.62 BC | 4.28 B | 137.70 B |
| | 4000 | 0.23 D | 5.44 F | 227.69 A | 0.23 E | 285.55 AB | 5.44 A | 177.44 A |
| | 6000 | 0.50 C | 8.47 DE | 230.76 A | 0.50 CD | 300.23 A | 3.65 C | 130.19 C |

### 4.3.2. Number of root / cuttings

When the measurements of rooted number were examined for Zivzik and Salakhani pomegranate, it was observed that Zivzik variety increased the number of roots up to two folds compared to Salakhani variety, whereas, the values obtained for both cultivars in the root number percentage were as follows: 14.7 for Zivzik variety and 7.03 for Salakhani variety (Figure 4.3). Considering the root characteristics such as the number of roots per cutting for both varieties (Salakhani and Zivzik cultivars), it was determined thatZivzik cultivars produced the maximum root number and that the IBA treatment at1000 ppm produced the highest root number (17.06) and the lowest number of roots (7,93) was determined with IBA at 4000 ppm (Figure4.4). When the table is examined according to the IBA type hormone interactions in terms of the number of rooted seedlings, it is seen that the number of seedlings rooted at the highest level (27, 08) is in Zivzikvariety at 1000 ppm.In contrast, the lowest number (5, 44) of seedlings rooted is in Salakhani variety, with 4000 ppm of IBA(q.d) treatment (Table 4.5).From the present study, it is revealed that soaking the cutting in IBA solution increases the number of rootson cuttings due to the rooting ability of IBA. Hartmann et al. (1990) stated that the concentration of auxins substantially higher than that normally found in plant tissues may play an inhibitory role for the growth and root formation. Ramdayal et al. (2001) and Gupta et al.(2002) also found the maximum number of rootsat 1000 ppm IBA. The findings related to the number of rooted seedlings were found to be parallel with the findings of Ghosh et al. (1988) who applied doses of 5000-10000 ppm,

Hegde and Sulikeri (1989) who applied 250-1500 ppm IBA and Mehraj et al. (2013) who used doses of 500-1000 and 2000 ppm. The difference in regard to the findings of Abu-Zahra et al. (2013) could be attributed to the difference of hormones used.

### 4.3.3. Length of root (mm)

The highest root length (191.05 mm) was determined in the seedlings belonging to Salakhani variety according to the measurement values of root lengths, while, Zivzik seedlings were in the last place with the length of (89.92 mm) (Figure 4.3). When the effects of hormone doses on root length were examined, it was found out that the longest roots (164 mm) were obtained at a dose of 4000 ppm, whereas, the lowest one (120,32 mm) was obtained at a dose of 1000 ppm (Figure 4.4).At the same time, the control group without hormone treatment had longer lengths (121.53 mm) than the 1000 ppm dose group (Figure.4.4).Based on the analysis of variance of the effect of IBA type hormone interactions on root lengths,the highest root length values (230,76 mm) compared to other subjects were obtained in Salakhani variety with 6000 ppm IBA hormone (q.d) treatment, while the lowest root length values were obtained in Zivzik varietywith 6000 ppm hormone dose (Table 4.5). Statistical significance at the 1% significance level was found in all subjects. The findings of Abu-Zahra et al. (2013) were different, which was due to the differences in the hormones used. The findings of Hartman and Kester (1983), who indicated that rooted seedlings increased significantly, Owais, (2010) and Sharma et al. (2009) who found that the longest roots were derived from hormone-containing plants, Singh et al. (2011) and Ghosh et al. (1988) who identified the statistical differences between practices are similar to the findings in this study.

### 4.3.4. Survival cuttingrates

The highest value (74%) in terms of the survival rate was obtained from Zivzik variety.Whereas,the survivalrate value measured in Salakhani variety used in the experiment was determined to be 46%as shown in Figure 4.3. Parallel results between the rooting rates and survival cuttingrates were determined. When the effects of the hormones used in different doses on survivalrates were examined, it was found that 6000 ppm of hormone application provided the highest survivalrates with 72%, the control group (T0) was the second with 67% survivalrates value while 4000 ppm hormone dose application was the last

(Figure 4.4).When the values of the IBA type hormone interaction were examined in terms of the survivalrates, it was determined that the highest value (93%) belonged to Zivzik variety with IBA at 6000 ppm. The control group of Salakhni variety interaction was better than other interactions. It is observed that Salakhani variety and 4000 ppm hormone dose interaction was in the last place with the value of0.23%survivalrates (Table. 4.5).

### 4.3.5. Length of sprout (mm)

The highest value of sprout length (272. 58 mm) was found in Salakhani variety and the lowest value (145. 59 mm) was found to belong to Zivzikvariety (Figure 4.3). When the effects of hormone doses on sprout length were examined inZivzik and Salakhani varieties, it was found that, among the hormone doses applied, 6000 ppm dose gave the highest (238.85 mm) sprout length and IBA at 1000 ppm hormone dose gave the lowest (185,09 mm) sprout length (Figure. 4.4). Among the IBA type hormone interaction, the highest sprout length (300,23 mm) was determined in Salakhani variety with IBA at 6000 ppm and the lowest sprout length value (110,47 mm) was determined inZivzik variety without hormone treatment (control group) as shown in ( Table 4.5).

### 4.3.6. Number of Shoot

It was determined that the average number of shoot in Salakhani variety (4.27) was higher than inZivzik variety with 2.95 (Figure 4.3). The effects of hormone doses on shoots number were examined; it was found out that the value belonging to 4000 ppm hormone dose application (4.31) was higher than the values of other hormone doses. The lowest shoots number (3,18) was found in 6000 ppm application (Figure 4.4). The shootsnumber of Salakhani variety observed in the hormone and variety interactions is superior to Zivzikvariety. When the interactions were examined, the highest average value of shoots number (5.44) was obtained in Salakhani variety with the 4000 ppm IBA hormone dose and the lowest value of shoot number (2.58) was obtained in Zivzikvariety with 2000 ppm (Table 4.5.). Especially, the number of shoots and survivalrates increased with the use of hormones in parallel with the findings of Janick (1972) and Hartmann and Kester (1983) who determined that the use of natural hormones increases the survival percentageas well as all vegetative developments in seedlings.

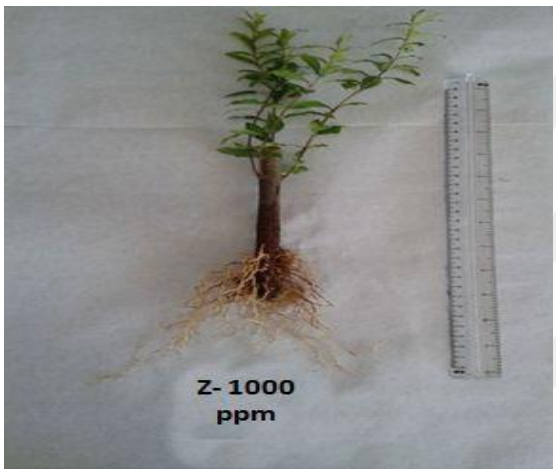
### 4.3.7. Number of leaves / cutting

When the varieties and hormone doses were examined in terms of the number of leaves, it was determined that the highest leaf number average value (127.05) was obtained from Salakhani variety and the lowest leaf number average value (48.05) was obtained from Zivzik variety (Figure 4.3.). It was noted that the hormone doseof 4000 ppm had the highest mean leaf number value (122.09) and the control value was the lowest value of the mean leaf number (58.48) (Figure. 4.4.). It has been determined that the leaf number is influenced by the variety and hormone interaction but not statistically significant. However, the highest leaf number average value (177.44 mm) was obtained from the interaction of Salakhani variety with IBA at 4000 ppm (q.d) treatment and the lowest value (23,03 mm) was obtained from Zivzik variety without hormone treatment (control treatment) (Table 4.5.). Babaie et al. (2014) who performed similar studies and used IBA as a hormone reported that the largest number of leaves was available at doses of 2000 and 4000 ppm. Mehraj et al. (2013) found that the maximum vegetative growth was achieved with 1000 ppm of hormone dosing.

Furthermore, more adventitious roots were observed on the pomegranate seedlings belonging to Zivzik variety. Meanwhile, strong and thick roots were observed on the pomegranate seedling of Salakhani variety which was more when compared to Zivzik cultivars. Moreover, the period required for the first sprouting of Salakhani variety ranged between (10 - 11) days. Whereas, the period required for the first sprouting of Zivzik variety reached(12 - 13) days. The above-mentioned period was considered to be the period between the days of planting the cutting to the day of sprouting the first bud on the cutting.


Z- control


S- control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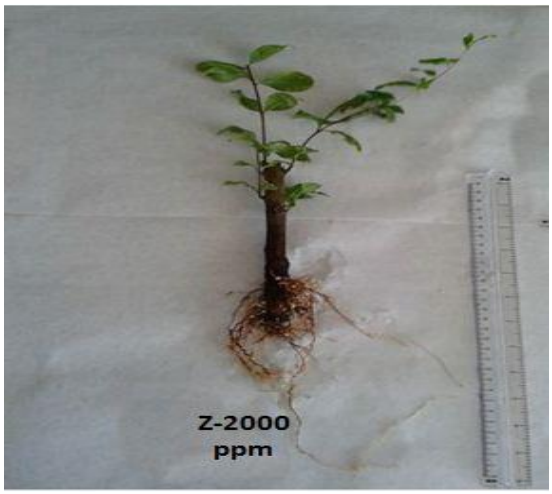
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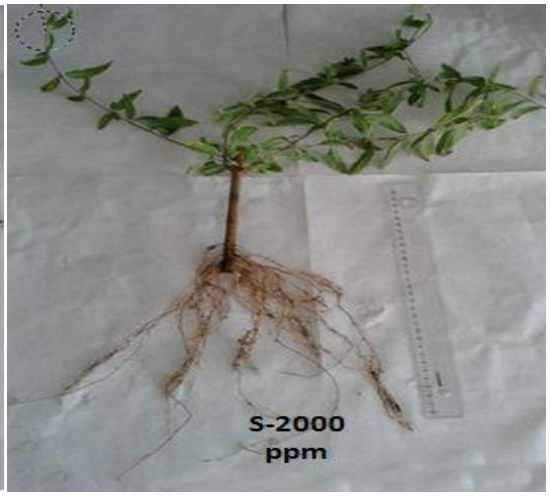
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**Figure 4. 5.**Root formation in pomegranate (*Punica granatum* L.), Zivzik variety and Salakhanivariety, with various concentrations of IBA treatments.

## 5. CONCLUSION AND RECOMMENDATIONS

### 5.1.Conclusion

The following conclusion can be drawn from the results of the present study:

Pomegranate( *Punica granatum* L.**)** fruit specifications of Salakhani and Zivzik varieties can be summarised as follows:

**1-**The fruits of Salakhani cultivars were of middle to large size,with the weight of 389.43-578.51gr,their peelthickness ranged between (2.11- 2.99mm), Peel colour was pink into lightpink, aril colour was pink, they had a good flavour (sour-sweet) taste, aril separating was easy,the outerappearance of the chamber was clear, fruit juice volume was ranged between (180- 250ml), fruits can be used for fresh consumption or local production of the concentrated pomegranate juice called Ruba Hanar.The harvesting of Salakhani cultivars begins at the beginningof the month of October.

**2-**Zivzikvariety is characterised by its small-to-middle size, with the weightof 129.8-379.5gr, peelthickness ranging between (2.75- 4.00mm),fruit juice volume ranging between (60-85ml),Peel colour was red – yellow colour, dark pink aril colour, agood flavour, (sour-sweet to sweet) taste, semi-easiness for aril separatingand semi-clear outerappearance of the chamber.The harvesting of Zivzik variety begins in the middle of October,fruits can be used for fresh consumption or making the pomegranate juice.

**3-**In terms ofpomological properties, such as size, easiness ofaril separating, outer appearance of the chamber, number of chamber, fruit volume, weight, peel thickness, and fruit juice volume,it was determined that the Salakhani variety is superior to Zivzikvariety. Whereas, theZivzik variety was found to be superior to Salakhani variety in terms of T.S.S and pH of fruit juice.

**4-** Upon examining sprouting and rooting behaviour in stem cuttings, highly contrasting responses to IBA addition were indicated among various concentrations of IBA,each variety had superiority to the other one in different aspects. Zivzik variety had a higher value ofrooting number, rooting percentage and survival percentage than Salakhani variety. Whereas, Salakhani variety had a higher value of root length, sprout length, shoots number and the number of leaves than Zivzik variety pomegranate.

**5-** The highest dose of hormone (6000 ppm) was found to be the most effective on rooting percentage, survival percentage and sprout length. While, 4000 ppm was found to be the most effective on root length, shoots number and the number of leaves. The 1000 ppm dose was determinedto significantly increase the root number compared to other doses.

**6-** Regarding to the interaction effect of IBA doses, it was shown that the best performance in terms of rooting percentage, survivalpercentage, root length and sprout length was observed at the 6000 ppm dose of IBA.While, 4000 ppm was found to be the most effective on shoots number and leaves number. The 1000ppm dose was determined to significantly increase root number compared to other doses. Hence, it can be concluded from the present experiment that the higher concentrations of IBA (6000 ppm) and (4000ppm) positively affect the sprouting and rooting ability in the stem cuttings of pomegranate cv. Zivzik and Salakhani.In contrast, the optimum IBA concentration for the number of roots per cutting was found to be 1000ppm.

### 5.2.Recommendations

**1-** Based on the findings of current investigation, the results have proved that Zivzik variety gives better results than Salakhani variety In terms of rooting percentage, survival percentage and roots number in Turkey environmental conditions.

**2-** In terms of pomological properties, Salakhani variety was determined to be superior to Zivzik variety; therefore, we recommend more studies on pomegranate fruit (Salakhani) to investigate the components of pomegranate fruit such as vitamins and other elements.

**3-** From the results obtained in the present experiment and discussion, from the economic point of view, it can be concluded soaking the cut stem on 1000-ppm IBA solution for 10 second (q.d) before the establishment of the stem cuttings show maximum result in terms of root number was obtained at the 1000 ppm dose of IBA and we recommend using 1000 ppm of IBA, which will provide a significant increase in root number compared to other doses.

**4-** Further studies are required on pomegranate cuttings to determine the dose providing the best sprouting and rooting behaviour in stem cuttings of both Salakhani and Zivzik vatiety.

**5-** Because of the large number of pomegranate (*Punica granutum* L) variety in the North of Iraq, we recommend further study on Iraqpomegranate varietiesin terms of pomological Properties.

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