Influence of Gibberellic Acid (GA_3) Concentrations on Seedling Growth of Two Pomegranate Cultivars (*Punica granatum* L.)

Mustafa Natheer Mustafa [1*], Ahmed T Al-Abbasi [2]
[1] Department of Plant Production Technologies, Agricultural Technology College, Northern Technical University, Iraq
[2] Department of Horti culture & Landscape Design, College of Agric, Forestry -Mosul University, Iraq

* Corresponding Author: **Mustafa Natheer Mustafa**

Article Info

P-ISSN: 3051-3421
E-ISSN: 3051-343X
Volume: 06
Issue: 02
July-December 2025
Received: 04-06-2025
Accepted: 06-07-2025
Published: 12-07-2025
Page No: 01-05

Abstract
The study was conducted during the growing season 2025 on seedlings of two varieties of Halabja pomegranate and a Wonderful American variety in greenhouses belonging to the nursery of the Agricultural Technical College / Northern Technical University / Mosul. To find out the effect of spraying with gibberellic acid GA_3 for two varieties of pomegranate Halabja and American (Wonderful) in a number of qualities of vegetative growth of seedlings. Three levels of gibberellic acid (zero, 100, 200) $mg.L^{-1}$ GA_3 were used in the study two varieties of Halabja pomegranate and a Wonderful American variety . The results showed that the spraying treatment with gibberellic acid at a level of 200 ppm, which gave the highest averages for the height of seedlings, the diameter of the main stem, the number of branches and the number of leaves. The Variety had a clear impact on most of the studied traits, as the Halabja variety recorded a moral superiority in most of the studied traits over the American variety, including the diameter of the main stem and the number of leaves, as for other studied traits, the Halabja variety recorded a non-moral increase over the American variety, especially in the height of seedlings and the number of branches. The overlap between the studied factors (spraying levels with gibberellin and the two varieties of the study) caused a clear effect on the studied qualities, as the treatment (spraying with gibberellin at a concentration of 200 ppm and for the Halabja variety) gave the highest averages for the height of seedlings, the diameter of the main stem, the number of branches and the number of leaves for seedlings.

DOI: https://doi.org/10.54660/JADR.2025.6.2.01-05

Keywords: Pomegranate, Halabja Cultivar, Wonderful Cultivar, Gibberellic Acid, GA_3.

Introduction

Pomegranate (*Punica granatum* L.) is a fruit tree that thrives in temperate regions and belongs to the family Punicaceae. Numerous scientific sources indicate that its original homeland extends to Central Asia, particularly Persia (modern-day Iran), while other studies suggest that China, Iraq, and India may also be among the regions where pomegranate first originated (Bal, 2005, Stove & Mercure, 2007) [6, 20]. It is believed that pomegranate was first cultivated around 4000 BCE and was mentioned in ancient literature by both Dioscorides and Hippocrates. It also appears in the Bible and the Holy Quran.Recent scientific studies have revealed significant health benefits associated with pomegranate fruits (Gil *et al*., 2000, Jurenka. 2008, Haidari *et al*., 2009, Okatan *et al*., 2015) [9, 13, 10, 18]. Pomegranate seedlings can grow in various types of soils differing in texture, fertility, and nutrient content. They are widely cultivated even in relatively low-fertility soils, where studies have shown the potential for successful cultivation under such conditions (Raghupathi & Bharagava, 1998) [19]. Pomegranate cultivation is highly successful in Iraq due to favorable environmental conditions; however, the fruits require protection from direct exposure to intense summer sunlight. Several local cultivars are grown in Iraq, among which the "Halabja" variety is the most widely spread in the northern regions of the country (Al-Jumaili & Abu Al-Saad, 1989) [2].

Due to its numerous health benefits, pomegranate has been labeled a "super fruit," which has led to increased consumption and a rise in global production. Nevertheless, its production remains somewhat limited due to physiological disorders, pest and disease problems, and postharvest issues. According to (Langley, 2000) [15] pomegranate symbolizes renewal, life, and marriage in Greek mythology. It is also believed that pomegranate originated in Iran and later spread across the globe. While reliable global production statistics are scarce, some estimates suggest that worldwide production reached approximately 3 million tons in 2014 and increased to around 3.8 million tons by 2017. Due to the rapid growth in production, accurately calculating total yield remains a challenge. The leading pomegranate-producing countries include India, Iran, Turkey, China, the United States, Israel, Egypt, Spain, Afghanistan, Tunisia, Azerbaijan, Morocco, Argentina, Brazil, Chile, Peru, South Africa, Australia, and Italy (Levin, 1994, Kahramanoğlu & Usanmaz, 2016) [16, 14].
In a study conducted by (Fathi *et al*. 2011) gibberellic acid was applied at concentrations of 0, 10, and 20 mg/L on 20-year-old fig trees of the 'Costata' cultivar, spaced at 4 × 4 meters. The results showed significant increases in branch length, diameter, chlorophyll content, and leaf number. Similarly.
The 'Wonderful' cultivar has specific climatic requirements for optimal growth and fruit quality. It thrives under hot days and cool nights, with a growth period from flowering to harvest lasting between 160 to 190 days. Although fruit production begins in the third year, commercial-quality yields are typically achieved in the fifth or sixth year. Cold weather during the ripening period, along with substantial differences in day and night temperatures, enhances peel coloration. Despite the cultivar's adaptability to a wide range of climatic conditions, soil types, and water sources, its performance is greatly influenced by local environmental factors such as temperature, rainfall, and soil type (Ashton, 2016, Ayars *et al*., 2017) [4, 5].
The Halabja cultivar is well-known in the Halabja region, located in northern Iraq about 15 km west of the Iranian border, 61 km southeast of Sulaymaniyah, and 241 km northeast of Baghdad. This locally inherited high-quality pomegranate cultivar is naturally grown, well adapted to the local climate, and considered a key source of income and livelihood for the region's residents (Al-Jabbari, 2007) [1].
This study aims to enhance the vegetative growth of grafted pomegranate seedlings by producing high-quality, uniform plants with optimal height and diameter. This would help accelerate fruiting onset and achieve uniform crop yield. Additionally, the study aims to provide vigorous seedlings that meet farmers' needs and encourage the expansion of pomegranate orchards. The research also evaluates the response of different cultivars to fertilization in terms of vegetative growth and development, aiding in identifying the most suitable cultivars for local environmental conditions.

Materials and Methods

The experiment was conducted in the greenhouses of the nurseries at the Technical Agricultural College, Northern Technical University, Iraq, during the 2025 growing season to study the effect of different concentrations of gibberellic acid (GA_3) on the growth of two pomegranate cultivars: Halabja and the American cultivar 'Wonderful'. The study was arranged in a Completely Randomized Design (CRD) with two factors, including three concentrations of GA_3 (0, 100, and 200 $mg \cdot L^{-1}$) applied as foliar sprays to the vegetative parts of the plants and two pomegranate cultivars (Halabja and Wonderful). The combination of these factors resulted in six treatment groups, each replicated three times with five seedlings per experimental unit in each replicate. The GA_3 was sprayed early in the morning until complete wetting of the foliage, using the surfactant Tween 20 to ensure uniform distribution of the solution, while the control treatment was sprayed with water only. The first application was conducted on April 1 and the second on April 15. Regular horticultural practices such as irrigation and weed control were carried out throughout the growing season. Seedling height was measured from the soil surface to the apex of the plant using a measuring tape, and the main stem diameter was recorded using a digital Vernier caliper. The number of lateral branches formed on the main stem of each seedling was counted, as well as the total number of leaves per seedling in mid-May. In addition, the dry weight of both the shoot and root systems was determined for each experimental unit, Also, the dry weight of the vegetative and vegetative sum (g) was calculated in the laboratory ovens for 72 hours and at a temperature of 70 °C. The collected data were statistically analyzed using the SAS software package, while Microsoft Excel was used for data organization. Treatment means were compared using Duncan's Multiple Range Test at a significance level of 0.05.

Results and Discussion

The height of the main leg of pomegranate seedlings (cm): is evident from table data (1) that spraying GA_3 has a clear effect on increasing the main leg of pomegranate seedlings. The superiority of the treatment of spraying with GA_3 with a concentration of 200 ppm and 100 ppm is (94.17 and 85.83) respectively, a moral superiority over the treatment of the control zero and adult (79.83) cm, and the reason is due to the effect of GA_3 acid in increasing the height of the main leg of the seedlings to the vital role of GA_3 by encouraging growth and regulating the elongation of the leg by its effect in the division or breadth Treating GA_3 in controlling the elongation of the main leg of the plant as well as the vital role of the GA_3 that stimulate and form the natural oxygen that encourages growth, especially the auxin Diffusion and Auxin Diffusion auxinas and oxygen that stimulates growth within the plant (Hopkins, 1999 and Singh, 2003).

Table 1: The effect of spraying with GA_3 gibberellic acid and each variety separately and overlapping with each other in the height of the main stem (cm) of seedlings of two varieties of pomegranate Halabja and American (Wonderful).

Effect of cultivar	Gibberellic Acid Levels GA_3			Effect of cultivar
	Zero	100 ppm	200 ppm	
American	78.33 b	83.67 ab	90.67 ab	84.22 a
Halabja	81.33 ab	88.00 ab	97.66 a	89.22 a
Gibberellic Acid GA_3	79.83 b	85.83 ab	94.17 a	

From the data of the same schedule, the superiority of the category is noted by the American class in the description of the main leg of the seedlings, but this superiority was not moral, as the values reached (89.22 and 84.22) cm and consecutive. Table (1) overlap data indicates the superiority of the treatment of (GA_3 spray with 200 ppm, the category of (Halabujah) morally (97.66) cm, while the treatment of the control was recorded the lowest values zero, American class

and reached (78.33) cm. This increase is due to the common effect of the level of spraying with GA_3 and the genetic capacity of the variety in its difference in growth on the other variety.

The main leg diameter of pomegranate seedlings (mm): The table data (2) shows a clear effect of spraying GA_3 in increasing the diameter of the main leg of the pomegranate seedlings, as the treatment of GA_3 spraying at a 200 ppm level (5.13) mm compared to the treatment of GA_3 spraying at the level of 100 ppm, amounting to (4.75) mm and the treatment of the Control (4.60) mm. The increase in the average diameter of the legs of the pomegranate seedlings may be attributed to the spraying of the GA_3 acid solution, which has a vital role in increasing growth through stimulating the division of cells and their Elcene, especially the encouragement of Cambial Activity and the increase in the division of Campium cells, increased its growth and changing the level of cell division. An increase in Qatar (thickness) leg in increasing the length in the Mercetim area under the top (Hopkins and Huner, 2004) [12]. in addition to that spraying with gabrolic acid works to create wood and increase the cells that are intended to increase the concentrations used from it (Andjarikmawati & Mudyantini, 2005) [3]. as well The results of the light construction process in the various vital processes, especially in the stimulation of the Campium, which leads to the increase in the diameter of the main leg of the pomegranate seedlings. His response to spraying GA_3.

Table 2: The effect of spraying with GA_3 gibberellic acid and each variety on the individual and overlapping between them in the main stem diameter (mm) of seedlings of two varieties of pomegranate Halabja and American (Wonderful).

Effect of cultivar	Gibberellic Acid Levels GA_3			Effect of cultivar
	Zero	100 ppm	200 ppm	
American	4.60 bc	4.40 c	4.92 abc	4.64 b
Halabja	4.60 bc	5.10 ab	5.33 a	5.01 a
Gibberellic Acid GA_3	4.60 b	4.75 ab	5.13 a	

The triple interference data of Table (2) between the studied factors indicate the significant superiority of the treatment (spraying with GA_3 ppm 200 and for the Halabja variety) on a number of coefficients, at which the maximum stem diameter was (5.33) mm, while the spraying coefficients with GA_3 (100 ppm and zero for both varieties) reached the lowest values, reaching (4.40, 4.60) mm respectively. These increases are due to the increase in the level of spraying with gibberellic acid as mentioned in the interpretation of each factor separately, as well as the genetic susceptibility of the variety in its variation in growth over the other variety.

Number of branches of pomegranate seedlings (branch. seedlings^{-1}): It is clear from the data of Table (3) that the effect of spraying with gibberellic acid GA_3 has a clear effect in increasing the number of branches for pomegranate seedlings, as the spraying treatment with GA_3 200 ppm recorded a significant superiority of (23.83) over the treatment of (zero and 100 ppm), which amounted to (15.83, 14.50) respectively. The reason may be due to the role of GA_3 gibberelic acid in increasing the vegetative growth of pomegranate seedlings, improving the nutritional status of seedlings and increasing the concentrations of carbohydrates in seedlings, which are closely related to stimulating the growth of lateral shoots to grow (Drogoudi & Pantelidis, 2022) [7]. The data of the same table indicate that there are no significant differences in the effect of the variety, but there is a slight increase in the Halabja variety on the American variety, where the values reached (18.33, 17.77) respectively.

Table 3: The effect of spraying GA_3 gibberellic acid and the class is separately and overlapping with each other in the number of branches of two seedlings of pomegranate Halabujah and an American (Wonderful)**.**

Effect of cultivar	Gibberellic Acid Levels GA_3			Effect of cultivar
	Zero	100 ppm	200 ppm	
American	16.67 b	15.33 b	23.00 a	18.33 a
Halabja	12.33 b	16.33 b	24.67 a	17.77 a
Gibberellic Acid GA_3	14.50 b	15.83 b	23.83 a	

Table data (3) is noted that the studied factors overlap the GA_3 spraying transactions, and both categories have a number of transactions at a level of 200 ppm, where values amounted to (24.67, 23.00) and consecutive. While the treatment of the zeroppm control and the category has been recorded the lowest values (12.33), these increases are due to the common effect of both spraying with GA_3 and the effect of the genetic variation of the variety in the other variety.

The number of leaves (leaf. seedlings^{-1}): shows from the table (4) a clear effect on the characteristic of the number of leaves by spraying at different levels of GA_3, where the superiority of spraying with GA_3 200 ppm, which amounted to (219), was observed on my transaction (zero, 100 ppm where values reached (172 and 186.17) and consecutive. Perhaps leaf spraying with gabrolic acid increased the number of leaves by increasing the opening of the side buds, increasing the number of signs table (3), increasing their lengths, and encouraging the growth of these branches to grow, which may increase the number of leaves for seedlings. GA3 may lead to the opening of lateral buds in many plant species, which result in branches and then leaves as well as GA_3 delays the aging and falling of leaves (Mostafa & Saleh, 2006) [17]. The data of the same table shows that the treatment of the variety Halabja is significantly superior to the American variety and the values reached (210.11 and 177.89) The reason for the variation in the number of leaves for the two varieties studied may be due to the variation in the genetic structure and the rate of seedling lengths and the variation in the number of branches and the strength of the growth of seedlings by variety, which led to the significant difference in the number of leaves.

Table 4: The effect of spraying with gibberellic acid GA_3 and the variety separately and the overlap between them in the number of leaves for seedlings of two varieties of pomegranate Halabja and American (Wonderful).

Effect of cultivar	Gibberellic Acid Levels GA_3			Effect of cultivar
	Zero	100 ppm	200 ppm	
American	143.00 c	149.00 ab	213.22 a	177.89 b
Halabja	201.00 ab	204.67 ab	224.67 a	210.11 a
Gibberellic Acid GA_3	172.00 b	176. 83 ab	219.00 a	

Table (4) overlap data indicates that there is a moral

superiority in the description of the number of leaves and for each study, as the treatment of spraying with GA_3 (200 ppm, Halabage and American class) exceeded a number of transactions, and values reached (224.67 and 213.22) and consecutive. While the treatment of (zero ppm and the American class) was recorded the lowest values and reached (143.00). These increases are due to the common influence of both spraying with GA_3 and the genetic capacity of the variety in its difference in growth on the other variety.

Dry weight of the vegetative total (gm): It is shown through the table data (5) that the effect of spraying with gibberellic acid GA_3 has a clear effect in increasing the number of branches for pomegranate seedlings, as the spraying treatment with GA_3 recorded 200 ppm a moral superiority of (15.63) over the treatment (zero and 100 ppm), which amounted to (12.50, 9.97), respectively. The reason may be due to the role of gibberellic acid GA_3 in increasing the vegetative growth of pomegranate seedlings, improving the nutritional status of seedlings and increasing the concentrations of carbohydrates in seedlings, which are closely related to stimulating the growth of lateral shoots to grow. The data of the same table indicate that there were no significant differences in the effect of the variety, where the values were (12.80, 12.59), respectively.

Table 5: The effect of spraying with gibberellic acid GA_3 and the variety separately and the overlap between them in the Dry weight of the vegetative for seedlings of two varieties of pomegranate Halabja and American (Wonderful).

Effect of cultivar	Gibberellic Acid Levels GA_3			Effect of cultivar
	Zero	100 ppm	200 ppm	
American	9.28 d	12.15 bc	16.99 a	12.80 a
Halabja	10.66 cd	12.84 bc	14.27 ab	12.59 a
Gibberellic Acid GA_3	9.97 c	12.50 b	15.63 a	

The overlap data of the table (5) indicate that there is a significant superiority in the dry weight of the vegetable aggregate and for both classes of the study, where the spraying treatment with gibberellic acid GA_3 (200 ppm and Halabja class) surpassed a number of transactions, reaching (16.99), respectively. While the transaction (zero ppm and for the American variety) recorded the lowest values and amounted to (10.66). These increases are due to the combined effect of spraying with gibberellic acid and the genetic susceptibility of one variety in its variation in growth on the other variety.

Dry weight of the root aggregate (gm): It can be seen from the data of the table (6) that the effect of spraying with gibberellic acid GA_3 has a clear effect in increasing the number of branches for pomegranate seedlings, as the spraying treatment with GA_3 recorded a 200 ppm moral superiority of (14.91) over the treatment of (zero and 100 ppm), which amounted to (9.87, 10.23), respectively. The reason may be due to the role of gibberellic acid GA_3 in increasing the vegetative growth of pomegranate seedlings, improving the nutritional status of seedlings and increasing the concentrations of carbohydrates in seedlings, which are closely related to stimulating the growth of lateral shoots to grow. The data of the same table indicate that there are no significant differences in the effect of the variety, where the values were (11.62, 11.71), respectively .

Table 6: The effect of spraying with gibberellic acid GA_3 and the variety separately and the overlap between them in the Dry weight of the root aggregate for seedlings of two varieties of pomegranate Halabja and American (Wonderful).

Effect of cultivar	Gibberellic Acid Levels GA_3			Effect of cultivar
	Zero	100 ppm	200 ppm	
American	10.20 b	10.48 b	14.19 a	11.62 a
Halabja	9.53 b	9.98 b	15.63 a	11.71 a
Gibberellic Acid GA_3	9.87 b	10.23 b	14.91 a	

It is noted from the data of Table (6) the overlap of the studied factors that the coefficients of spraying with gibberellic acid GA_3 of both varieties exceeded a number of coefficients at the level of 200 ppm, where the values reached (14.19, 15.63), respectively. While the control treatment of zero ppm and the Halabja variety recorded the lowest values (9.53), these increases are due to the combined effect of spraying with gibberellic acid GA_3 and the effect of the genetic variation of one variety in growth on the other variety.

Conclusions

1. Spraying with gibberellic acid GA_3 concentration of 200 ppm led to a significant improvement in the studied vegetative qualities (height of the seedling, the diameter of the main stem, the number of branching, the number of leaves).
2. The Halabja variety showed a moral superiority over the American variety (Wonderful) in most qualities, especially in the diameter of the main stem and the number of leaves.
3. In such qualities as the height of seedlings and the number of branching, the Halabja variety recorded an insignificant increase over the American variety.
4. The overlap of the highest concentration of gibberellic GA_3 (200 ppm and Halabja variety) recorded the best results for all studied traits.

References

1. Al-Jabbari AMO. Effect of GA3 and some nutrients of pomegranate fruit (*Punica granatum* L.) splitting and storability cv. Salakhani [master's thesis]. Sulimanni: University of Sulaimani; 2007.
2. Al-Jumaili AAM, Abu Al-Saad MAA. Deciduous fruit. Baghdad: Authority of Technical Institutes, Ministry of Higher Education and Scientific Research; 1989.
3. Andjarikmawati DW, Mudyantini W. Perkecambahan dan pertumbuhan delima putih (*Punica granatum* L.) dengan perlakuan asam indol asetat dan asam giberelat [Internet]. 2005 [cited 2016 May 10]. Available from: http://biosains.mipa.uns.ac.id/B/B0702/B070204.pdf
4. Ashton R. The incredible pomegranate: plant and fruit. Tempe: Third Millennium Publishing; 2006.
5. Ayars JE, Phene CJ, Phene RC, Gao S, Wang D, Day KR, *et al*. Determining pomegranate water and nitrogen requirements with drip irrigation. Agric Water Manag. 2017;187:11-23.
6. Bal JS. Fruit growing. 3rd ed. New Delhi: Kalyani Publishers; 2005.
7. Drogoudi P, Pantelidis G. Comparative effects of gibberellin A3, glycine betaine, and Si, Ca, and K fertilizers on physiological disorders and yield of pomegranate cv. Wonderful. J Sci Food Agric.

2022;102(1):259-67.
8. Fathi MA, Mohamed IA, Abd El-Bary A. Effect of Sitofex (CPPU) and GA3 spray on fruit set, fruit quality, yield and monetary value of "Costata" persimmon. Nat Sci. 2011;9(8):40-9.
9. Gil MI, Tomas-Barberan FA, Hess-Pierce B, Holcroft DM, Kader AA. Antioxidant activity of pomegranate juice and its relationship with phenolic composition and processing. J Agric Food Chem. 2000;48(10):4581-9.
10. Haidari M, Ali M, Casscells SW, Madjid M. Pomegranate (*Punica granatum*) purified polyphenol extract inhibits influenza virus and has a synergistic effect with oseltamivir. Phytomedicine. 2009;16(12):1127-36.
11. Hopkins WG. Introduction to plant physiology. Toronto: John Wiley and Sons; 1995.
12. Huner NPA, Öquist G, Sarhan F. Photosynthesis in the cold: regulation of photosynthetic gene expression. Physiol Plant. 2004;121(2):175-81.
13. Jurenka J. Therapeutic applications of pomegranate: a review. Altern Med Rev. 2008;13(2):128-44.
14. Kahramanoğlu İ, Usanmaz S. Pomegranate production and marketing. Boca Raton: CRC Press; 2016.
15. Langley P. Why a pomegranate? BMJ. 2000;321(7269):1153-4.
16. Levin GM. Pomegranate (*Punica granatum*) plant genetic resources in Turkmenistan. Plant Genet Resour Newsl. 1994;97:31-6.
17. Mostafa EAM, Saleh MMS. Influence of spraying with gibberellic acid on behaviour of Anna apple trees. 2006.
18. Okatan V, Akca Y, Ercisli S, Gozlekci S. Genotype selection for physico-chemical fruit traits in pomegranate (*Punica granatum* L.) in Turkey. Acta Sci Pol Hortorum Cultus. 2015;14(2):123-32.
19. Raghupathi HB, Bhargava BS. Diagnosis of nutrient imbalance in pomegranate by diagnosis and recommendation integrated system and compositional nutrient diagnosis. Commun Soil Sci Plant Anal. 1998;29(19-20):2881-92.
20. Stover E, Mercure EW. The pomegranate: a new look at the fruit of paradise. HortScience. 2007;42(5):1088-92.