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# The effect of using Nano-iron and gibberellic acid on some growth traits of Brachychiton populneus seedlings, Spraying on the vegetative system.

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## ABSTRACT

The study was conducted from (2023/4/1) to (2024/4/1). using the plastic greenhouse of the College of Agriculture and Forestry/ University of Mosul. to evaluate the efficiency of Nano Fe and GA3 acid by spraying on the *Brachychiton populneus*. he spraying process was conducted using two factors: the first factor was Nano Fe fertilizer at four concentrations (0, 1, 3, 5) mg.$L^{-1}$ and the second factor was GA3 acid at four concentrations (0, 250, 500, 750) g.$L^{-1}$. The seedlings were arranged using a completely randomized design with three replications, where each replication contained 16 treatments, and each treatment included five seedlings. The results showed that seedlings treated with Nano Fe at a rate of 3 g/$L^{-1}$ significantly outperformed in several growth traits. These included an increase in stem diameter growth by 15.891mm. seedling$^{-1}$, an increase in the number of vegetative branches by 2.072 branches. Seedling$^{-1}$ and an increase in the dry weight of the vegetative mass by 24.515 g. Additionally, spraying with GA3 at a concentration of 500 mg. $L^{-1}$ had a significant effect, with seedlings showing an increase in stem diameter growth by 13.539 mm. Seedling$^{-1}$ and an increase in the dry weight of the vegetative mass by 20.095 g. On the other hand, the interaction between Nano Fe at a concentration of 3g. $L^{-1}$ and GA3 acid at a rate of 500 mg. $L^{-1}$ had a significant effect, with seedlings showing an increase in stem diameter growth by 18.630 mm. Seedling$^{-1}$ and an increase in the dry weight of the vegetative mass by 27.110 g. Furthermore, the results showed that the interaction between spraying with 5 g. $L^{-1}$ Nano Fe and 500 mg. $L^{-1}$ of GA3 acid had a significant effect on increasing stomatal density, which reached 0.107 stomata.$mm^{-2}$.

***Keywords*:** Foliar application, Nano Fe, *(Brachychiton populneus.)*, GA3, Foliar fertilization.



## INTRODUCTION

Many diverse methods have emerged to stimulate plants to grow faster, while also improving their qualities to produce forest seedlings in a short period. One of the methods that has an impact and effectiveness is Foliar application, as it is considered one of the effective methods in feeding plants and one of the essential methods, as it allows the plant to be supplied with nutrients by spraying fertilizer solutions directly on the leaves. It is considered a necessary feeding system to meet the plant's needs through the leaves [1]. Foliar fertilization is an excellent method for its efficiency, effectiveness and low cost to provide the plant's need for micro and macro elements. On the other hand, foliar fertilization can be used for root rot and insufficient moisture in the surface layer to absorb nutrients and in the case of high soil pH. Foliar fertilization provides a rapid growth response using small amounts of fertilizers. Foliar spraying can also be mixed with insecticide sprays [2]. Nano-fertilisers are defined as forms of fertilisers or microbial, plant or animal extracts that are prepared using physical, chemical or biological techniques supported by technology. Nano. Nano fertilizers penetrate the leaf and enter through the stomata or hairy bases to move to different plant tissues, which can cause different responses in different parts of the plant and to the same nanoparticles [3]. [4] They transport chemicals and DNA inside the plant and contribute to the transfer of compounds to the target parts, whether leaves, roots or other parts of the plant, by increasing the activity of photosynthesis by increasing the chlorophyll content of the leaves [5].

Plant hormones play an effective role in increasing the amount of active organic matter and promoting plant growth. Plant growth factors are produced by plants in precise concentrations in specific locations and are transported to other areas. GA3 acid is a tetracyclic diterpenoid compound that is one of the growth regulators that stimulate plant growth and development, as it stimulates the elongation and division of stem cells, increases the efficiency of photosynthesis and encourages growth, in addition to the role of gibberellin acid in the manufacture of auxin [6]. *Brachychiton populneus* is an environmentally adaptable ornamental tree belonging to the Sterculiaceae family of the Malvaceae family. It contains approximately 30 species [7]. It is considered a relatively slow-growing species, as its height at maturity ranges from 10 to 15 m. Its trunks are used in the manufacture of shields, and its bark is used in producing fibres. The leaves are used as emergency fodder for livestock affected by drought. Its seeds are also used in addition to coffee. It has a deep root system and the ability to store water, thus resisting stress during drought [8]. *Brachychiton populneus* tree is characterized by a moderate to slow growth rate and holds

significant importance. Therefore, this study aimed to use two materials (Nano Fe and GA3) to accelerate growth and achieve the production of strong seedlings with good specifications in a short period of time. The study also sought to use low-cost alternatives instead of traditional fertilizers, which are high-cost and have negative environmental impacts.

**Materials and methods:**

One-year-old seedlings were distributed, almost homogeneous in terms of length and diameter, using a completely random design with three replicates, with five seedlings in each treatment for each replicate, and a distance of 5 cm was left between each experimental unit and the other. The experiment included two factors: Nano Fe at four concentrations (5, 3, 1, 0) g. $L^{-1,}$ and the second was GA3 acid at four concentrations (0, 250, 500, 750) mg. $L^{-1}$. The materials were weighed using an electric balance and mixed with distilled water at one litre for each gram of fertilizer sprayer. They were sprayed on the seedlings until they became completely wet in the early morning, at a rate of two spring and two autumn sprays. During the spraying process, the seedlings were irrigated one day before the spraying process. All characteristics (diameter, number of vegetative branches, dry weight of the vegetative group, and stomatal density) were measured at the beginning of the experiment and before applying the treatments. And at the end, the same process was carried out, then the increase rate was extracted, and the results were statistically analyzed according to Duncan's test.

**Results and discussion**

**1- Increase in the diameter of the seedling (mm)**

As shown in Table 1, the seedlings treated with nano Fe at a rate of 3 g. $L^{-1}$ significantly outperformed the rate of increase in the diameter of the seedling, which reached 15.891 mm was followed by seedlings exposed to a concentration of 1 $g.L^{-1}$, as the rate of increase in the diameter growth of the seedling reached 13.109 mm. $seedling^{-1}$, while the lowest increase was in seedlings treated with a concentration of 5 $g.L^{-1}$ of Nano Fe fertilizer, as it reached 10.860 mm. At the same time, the comparison treatment gave a rate of increase in diameter growth of 11.182 mm. As for GA3 acid, we can note from the same Table that spraying at a rate of 500 $mg.L^{-1}$ had a significant effect on the trait of increase in diameter growth, as it reached 13.539 mm, with an increase of 12.506% compared to the comparison treatment, followed by the treatment with gibberellin acid at a concentration of 750 $mg.L^{-1}$, as the increase in diameter growth of the seedling reached 13.032 mm, and the lowest increase with spraying was 250 $mg.L^{-1}$ 12.437 Regarding the interaction between Nano Fe at a rate of 3 $g.L^{-1}$ and GA3 acid at a rate of 500 $mg.L^{-1}$, it was significantly superior in the characteristic of increasing the diameter of the plant and reached 18.630 mm, followed by the treatment at a rate of 3 $g.L^{-1}$ of Nano Fe and 750 $mg.L^{-1}$ of GA3 acid 16.780 mm, then the treatment at a rate of 3 $g.L^{-1}$ of Nano Fe and 250 $mg.L^{-1}$ of GA3 acid 15.146 mm, while the lowest rate of increase in diameter was recorded when treating at a rate of 5 $g.L^{-1}$ of Nano Fe fertilizer and 750 $mg.L^{-1}$ of GA3 acid, as it reached 10.396 mm.

Table (1): The effect of different concentrations of Nano Fe fertilizer and GA3 acid and the interaction between them on the characteristic of increasing the diameter growth of *Brachychiton populneus* seedlings.

| Nano Fe $gr.L^{-1}$ | $GA_3$ $gr.L^{-1}$ | | | | Nano Fe $gr.L^{-1}$ |
|---|---|---|---|---|---|
| | 0 | 250 | 500 | 750 | |
| 0 | 10.716<br>I J | 11.370<br>G-I | 11.566<br>G H | 11.076<br>H-J | 11.182<br>C |
| 1 | 12.570<br>F | 12.586<br>F | 13.403<br>DE | 13.876<br>D | 13.109<br>B |
| 3 | 13.010<br>EF | 15.146<br>C | 18.630<br>A | 16.780<br>B | 15.891<br>A |
| 5 | 11.840<br>G | 10.646<br>J | 10.556<br>J | 10.396<br>J | 10.860<br>D |
| $GA_3$ $gr.L^{-1}$ | 12.034<br>D | 12.437<br>C | 13.539<br>A | 13.032<br>B | |

* Numbers containing letters similar to the individual factors and their interactions do not reflect significant differences according to the Redkin multiple range test at the 0.05 probability level.

**2- Increase in the number of vegetative branches of the seedling (branch. seedling-1)**

Table (2) shows that the seedlings treated with Nano Fe at a rate of 3 g. $L^{-1}$ achieved a significant superiority in the rate of increase in the percentage of the number of vegetative branches of the seedling, as it reached 2.072 branches. seedling$^{-1}$, followed by treatment at a concentration of 1 g. $L^{-1}$, as it reached 1.637 branches. seedling$^{-1}$, while spraying at a rate of 5 g. $L^{-1}$ of Nano Fe fertilizer gave the lowest rate of increase in the number of vegetative branches, reaching 1.180 branches. seedling$^{-1}$. In contrast, the comparison treatment showed the lowest rate of increase in the number of vegetative branches, reaching 1.389 branches. seedling$^{-1}$. Regarding GA3 acid, there were no significant differences between the averages in increasing the number of vegetative branches of seedlings. The interaction between Nano Fe 3 g.$L^{-1}$ and GA3750 mg.$L^{-1}$ acid showed the best increase (2.333 branches. seedling$^{-1}$), followed by other treatments at a concentration of 3 g.$L^{-1}$ of Nano Fe with 500 or 250 mg.$L^{-1}$ of GA3 (2.200 and 2.133 branches/seedling) respectively. The lowest increase was with Nano Fe 5 g.$L^{-1}$ and GA3750 mg.$L^{-1}$ acid (0.933 branches. seedling$^{-1}$). Fe.

Table (2): The effect of varying concentrations of Nano Fe fertilizer and GA3 acid and their interaction on the trait of increasing the number of vegetative branches of *Brachychiton populneus* seedlings.

| Nano Fe gr.$L^{-1}$ | $GA_3$ gr.$L^{-1}$ | | | | Nano Fe gr.$L^{-1}$ |
|---|---|---|---|---|---|
| | 0 | 250 | 500 | 750 | |
| 0 | 1.360<br>E | 1.383<br>DE | 1.450<br>DE | 1.363<br>هـ | 1.389<br>C |
| 1 | 1.500<br>DE | 1.523<br>C-E | 1.740<br>BC | 1.786<br>B | 1.637<br>B |
| 3 | 1.623<br>B-D | 2.133<br>A | 2.200<br>A | 2.333<br>A | 2.072<br>A |
| 5 | 1.480<br>DE | 1.340<br>E | 0.966<br>F | 0.933<br>F | 1.180<br>D |
| $GA_3$ gr.$L^{-1}$ | 1.490<br>A | 1.595<br>A | 1.589<br>A | 1.604<br>A | |

* The results containing letters similar to the individual factors and their interactions do not reflect significant differences according to the Redkin multiple range test at the 0.05 probability level.

**3-Increase in dry weight of the vegetative group (g)**

Table 3 shows that the seedlings treated with Nano Fe fertiliser at a rate of 3 g. $L^{-1}$ had a significant effect on the rate of increase in the dry weight of the vegetative group of the seedling, as it reached 24.515 g, then the seedlings were treated with a rate of 1 g. $L^{-1}$ followed in terms of increase, reaching 21.129 g, while the treatment was at a rate of 5 g. $L^{-1}$ of Nano Fe fertilizer gave the lowest rate of increase and reached 15.237 g, while the comparison treatment achieved an increased rate of 15.540 g, and the percentage of treatment with 3 g. $L^{-1}$ Nano Fe reached 57.754%, compared to the seedlings of the comparison treatment. For GA3 acid, the treatment with 500 mg.$L^{-1}$ showed the highest significant increase of 20.095 g, followed by the treatment with GA3 acid with 750 mg.$L^{-1}$, which reached 19.965 g, and the treatment with GA3 acid with 250 mg.$L^{-1}$, which reached 18.555 g, and the control treatment recorded the lowest rate for this trait, 17.805 g. As for the interaction between Nano Fe 3 g.$L^{-1}$ and GA3 acid 500 mg.$L^{-1}$, it gave the highest increase (27.110 g), followed by the treatment of 3 g.$L^{-1}$ Nano Fe with 750 mg.$L^{-1}$ (26.243 g), and the lowest increase was with a concentration of 5 g.$L^{-1}$ of Nano Fe and 250 mg.$L^{-1}$ of GA3 (14.703 g).

Table (3): Effect of varying concentrations of Nano Fe fertilizer and GA3 acid and their interaction on increasing the dry weight of the vegetative group of *Brachychiton populneus*.

| Nano Fe gr.$L^{-1}$ | $GA_3$ gr.$L^{-1}$ | | | | Nano Fe gr.$L^{-1}$ |
|---|---|---|---|---|---|
| | 0 | 250 | 500 | 750 | |

| | | | | | |
|---|---|---|---|---|---|
| 0 | 15.593<br>FG | 15.413<br>FG | 15.550<br>FG | 15.603<br>FG | 15.540<br>C |
| 1 | 18.570<br>E | 19.850<br>D | 22.816<br>C | 23.280<br>BC | 21.129<br>B |
| 3 | 20.453<br>D | 24.253<br>B | 27.110<br>A | 26.243<br>A | 24.515<br>A |
| 5 | 16.606<br>F | 14.703<br>G | 14.903<br>G | 14.736<br>G | 15.237<br>C |
| $GA_3$ gr.$L^{-1}$ | 17.805<br>C | 18.555<br>B | 20.095<br>A | 19.965<br>A | |

* Numbers containing letters similar to the individual factors and their interactions do not reflect significant differences according to the Redkin multiple range test at the 0.05 probability level.

**4-Increase in stomatal density (stoma.mm$^{-2}$)**

As shown in Table 4, there is no significant effect on the statistical function when treated with nano-Fe fertilizer on the characteristic of increasing the stomatal density of the plant. As for the effect of GA3 acid, we note that there is no significant effect on the characteristic of increasing the stomatal density of the plant. As shown in Table (4), the binary interaction between spraying with Nano Fe fertilizer at a concentration of 5 g.$L^{-1}$ and GA3 acid at a concentration of 500 mg.$L^{-1}$ was significantly superior in the characteristic of increasing the plant's stomatal density and reached 0.107 stomatal mm$^{-2}$, followed by the interaction of Nano Fe at a concentration of 0 g.$L^{-1}$ and GA3 acid at a concentration of 0 mg.$L^{-1}$ 0.106 stomatal mm$^{-2}$. In contrast, the treatment at a rate of 3 g.$L^{-1}$ of Nano Fe fertilizer and the application at 750 mg.$L^{-1}$ of GA3 acid increased the plant's stomatal density at 0.098 stomata mm$^{-2}$. In contrast, the lowest increase was recorded with the application at a rate of 0 g.$L^{-1}$ of Nano Fe and 250 mg.$L^{-1}$ of GA3 acid, which reached 0.034 Gap.mm$^{-2}$.

Table (4): The effect of varying concentrations of Nano Fe fertilizer and GA3 acid, and their interaction, on the stomatal density trait *Brachychiton populneus* seedlings.

| Nano Fe gr.$L^{-1}$ | $GA_3$ gr.$L^{-1}$ | | | | Nano Fe gr.$L^{-1}$ |
|---|---|---|---|---|---|
| | 0 | 250 | 500 | 750 | |
| 0 | 0.106<br>A | 0.034<br>B | 0.077<br>AB | 0.0685<br>AB | 0.0717<br>A |
| 1 | 0.069<br>AB | 0.098<br>AB | 0.043<br>AB | 0.061<br>AB | 0.0683<br>A |
| 3 | 0.065<br>AB | 0.069<br>AB | 0.090<br>AB | 0.098<br>AB | 0.080<br>A |
| 5 | 0.061<br>AB | 0.081<br>AB | 0.107<br>A | 0.085<br>AB | 0.084<br>A |
| $GA_3$ gr.$L^{-1}$ | 0.075<br>A | 0.070<br>A | 0.079<br>A | 0.078<br>A | |

* Numbers containing letters similar to the individual factors and their interactions do not reflect significant differences according to the Redkin multiple range test at the 0.05 probability level.

The data in Tables (1, 2, 3) for each trait (diameter growth, number of vegetative branches, dry weight of the vegetative group) respectively showed that spraying with Nano Fe fertilizer at a concentration of 3 g. $L^{-1}$ significantly affected the radial growth, dry weight of the vegetative group, and number of branches, as spraying at this concentration helps improve radial growth by enhancing many essential biological functions, which was confirmed by [9] as for GA3 acid, treatment with 500 mg. $L^{-1}$ had a significant effect on radial growth and dry weight of the vegetative group, as it caused an increase in the elongation of the stem and plant tissues, the production of organic materials, and enhanced the absorption of water and nutrients, and the storage of dry materials, thus improving the general shape and increasing the dry weight, which was confirmed by [10], while the interaction between 3 g. $L^{-1}$ Nano Fe and 500 mg. $L^{-1}$ of GA3 acid significantly affected most of the studied traits because Nano Fe enhances photosynthesis and contributes to plant growth. At the same time, GA3 stimulates cell growth and increases organic production, a synergistic interaction can occur that significantly enhances the agricultural performance of plants. This is the consensus [11].

**Conclusions**

1. Seedlings treated with Nano Fe at a concentration of 3 g. $L^{-1}$ were significantly superior in the rate of increase for each of them (the diameter of the seedling, the number of green branches of the seedling, and the dry weight of the vegetative group).
2. As for the effect of GA3 acid at a concentration of 500 mg. $L^{-1}$ was significantly superior in the rate of increase for each of the diameter of the seedling and the dry weight of the vegetative group.
3. As for the dual interaction between spraying (Nano Fe at a concentration of 3 g. L-1 and GA3 acid at a concentration of 500 mg. $L^{-1}$), it was significantly superior in the increase characteristic in (the diameter of the plant, the increase in the dry weight of the vegetative group of the plant).
4. The results showed the two-way interaction between spraying at a concentration of 5 g. $L^{-1}$ Nano Fe and a concentration of 500 mg. $L^{-1}$ GA3 acid was significantly superior in increasing the plant stomatal density.

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# تأثير أستخدام الحديد النانوي وحامض الجبرليك في بعض صفات النمو لشتلات Brachychiton populneus رشاً على المجموع الخضري.


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الخلاصة

اجريت هذه الدراسة في الفترة من (*2023/4/1*) إلى(*2024/4/1*) باستخدام البيت البلاستيكي التابع لكلية الزراعة والغابات/جامعة الموصل بهدف تقييم كفاءة *Fe* النانوي وحامض *GA3*عبر الرش على نبات *Brachychiton populneus.* وقد اجريت عملية الرش باستخدام عاملين الاول سماد *Fe* النانوي بواقع أربع تراكيز (*5,3,1,0*) غم.لتر-**1**والعامل الثاني حامض *GA3* بواقع أربع تراكيز (*750،500،250،0*) ملغم.لتر-**1**. تم توزيع الشتلات باستخدام التصميم العشوائي الكامل بثلاث مكررات، حيث احتوى كل مكرر على *16* معاملة وتضمنت كل معاملة *5* شتلات. اظهرت النتائج أن الشتلات المعالجة بـ *Fe* النانوي بتركيز *3* غم.لتر-**1** قد تفوقت معنويًا في أغلب صفات النمو، حيث سجلت زيادة في النمو القطري بمعدل *15.891* ملم.شتلة-**1** وزيادة في عدد الأفرع الخضرية بمعدل *2.072* فرع.شتلة-**1** وزيادة في الوزن الجاف للمجموع الخضري بمعدل *24.515* غم. كما تبين أن الرش بحامض *GA3* بتركيز *500* ملغم.لتر-**1** كان له تأثير معنوي، إذ سجلت الشتلات زيادة في النمو القطري بمعدل *13.539* ملم.شتلة-**1**، وفي الوزن الجاف للمجموع الخضري بمعدل *20.095*غم. من جهة أخرى أظهر التداخل بين *Fe* النانوي بتركيز *3* غم.لتر-**1** وحامض *GA3* بتركيز *500* ملغم.لتر-**1** تأثيرًا معنويًا ملحوظًا، حيث سجلت الشتلات زيادة في النمو القطري بمعدل *18.630*ملم.شتلة-**1** وفي الوزن الجاف للمجموع الخضري بمعدل *27.110*غم. كما أظهرت النتائج أن التداخل بين الرش بتركيز *5* غم.لتر-**1** من *Fe* النانوي و*500* ملغم.لتر-**1** من حامض *GA3* كان له تأثير معنوي في زيادة الكثافة الثغرية حيث بلغت *0.107* ثغرة.ملم-**2** .

الكلمات المفتاحية: أضافة ورقية, *Fe* النانوي ، . *Brachychiton populneus*، حامض*GA3* ، التسميد الورقي.