Effect of (N.P.K) Nano and Mineral Fertilizer on Some Growth Characteristics of Pinus Brutia Ten. Seedlings by Foliar Application

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Abstract

The study was carried out in the greenhouse of the Department of Forestry / College of Agriculture and Forestry / the University of Mosul for the period from 15/9/2020 to 15/8/2021 to study the effect of spraying with N.P.K nano and mineral fertilizer on some growth characteristics of Pinus brutia seedlings. The spraying process was carried out using two types of N.P.K nano fertilizer, the first is (20: 20: 20) and the second is (12:12:36), and N.P.K mineral fertilizer was used in two types, the first is (20: 20: 20) and the second is (12:12:36) at a concentration of 5 g. L⁻¹ for both nano and mineral, and by four sprays (2 autumns + 2 spring). The results showed the superiority of nano fertilizer (20:20:20) over the rest of the treatments in terms of the increase in longitudinal and diagonal growth, root length and diameter, and the wet and dry weight of the vegetative mass, which amounted to 28.3167 cm, 3.8383 mm, 58.5333 cm, 5.5200 mm, 32.4703 g and 13.9210 g respectively. The mineral fertilizer (20:20:20) also showed significant superiority over all treatments as it gave 27.4833 cm, 3.5939 mm, 57.1778 cm, 5.2627 mm, 29.7901 g and 13.3387 g for the studied traits, respectively, an increase in longitudinal and diagonal growth, root length, root diameter and wet and dry weight of the stem. The interaction between the two fertilizers N.P.K nano (20:20:20) and mineral N.P.K (20:20:20) was significantly superior by giving the highest average growth of all studied traits, as it gave 30.717 cm, 4.2680 mm, 61.000 cm, 5.8493 mm, 36.135 g and 15.8160 g respectively.

Keywords: Foliar application, Nano fertilization, Mineral fertilization, Pinus brutia.

1. Introduction

Pinus brutia Ten. One of the most important coniferous species for its many uses[1], a large tree belonging to the Pinaceae family, is considered one of the light-loving species and can have relatively low and high temperatures, and it resists drought to some extent [2]. It is slow-growing, and the tree reaches a height of more than 35 meters. It has a straight stem and few branches. Pinus brutia is widely used in afforestation operations in Iraq, whether in natural forest areas or in areas devoid of trees, as its wood is used in various fields, including furniture, box making, coal industry, and others [3]. It also has a role in providing indirect services such as protecting soil and water resources, preserving biodiversity, climate change and combating desertification, all of which make it an indispensable forest species [2].

Foliar fertilization is a widely adopted strategy today, as it is used to accelerate growth, treat nutrient deficiencies, and overcome soil fertilization limitations such as leaching, sedimentation of insoluble fertilizers, in addition to increasing plant resistance to diseases, insects and pests, and increasing its tolerance to drought and frost [4]. As well as its role in improving nutritional balance, which leads to increased evidence of growth [5].

Nano-fertilizers play an important role in plant nutrition, whether they are added to the ground treatments or by spraying them on the vegetative system, as they work to increase the activity of photosynthesis processes, increase the active substances in the plant and increase the plant’s ability to withstand various stress conditions as well as maintain the required genetic characteristics and also increase Plant resistance to disease [6], and It has properties that enable it to enter plant cells, as well as transfer chemicals and DNA inside the plant, in addition to its contribution to the transfer of compounds to the target parts, whether leaves, roots or the rest of the plant parts [7].

Also, nano-fertilizers are distinguished by their prices that are competitive with conventional fertilizers. Mineral fertilizers increase the plant's nutrient content. These include nitrogen, phosphorous and potassium compound fertilizers: such as N.P.K compound fertilizer [8]. As these fertilizers improve growth and increase production [9]. Because the Pinus brutia tree is slow-growing, some fertilizers must be used to accelerate its growth and increase the plant's nutrient content. Therefore, this study aimed to demonstrate the effect of foliar spraying with N.P.K and chemical nano-fertilizer in stimulating and developing the growth of Pinus brutia tree seedlings.
2. Materials and Methods

Two beds were selected within the forest department nursery to place Pinus brutia seedlings there. Seedlings of Pinus brutia Ten. were selected from the Ninawa Governmental Forest plantation with a total of (270 seedlings) of one year of age. The seedlings (experimental units) were distributed as ten seedlings for each treatment. A distance of 10 cm was left between one treatment and another, and the length, diameter and number of branches for each seedling were measured before the transactions were carried out and recorded in the field log of the experiment. The length, diameter and number of branches for each seedling were measured before conducting the transactions and recorded in the field log of the experiment. Soil samples were taken and analyzed to find out the nitrogen, phosphorous and potassium ratios in the soil.

The experiment was conducted with two factors: The first factor: Nano N.P.K fertilizer produced by the Iranian Green Company, and two types of this fertilizer were used, the first is a balanced fertilizer (20:20:20) and the second is a fertilizer (12:12:36) at a concentration of 5 g. litre \(-1\) each. The second factor: N.P.K chemical fertilizer and two types of this fertilizer were used, the first is a balanced or neutral fertilizer (20:20:20) and the second is (12:12:36) at a concentration of 5 g. litre \(-1\) each. The spraying process was carried out in the early morning until the degree of complete wetness, according to the study plan.

Statistical analysis of the results was carried out using the SAS (SAS System V9.0) program, and the means of the transactions were compared according to Duncan’s polynomial test at a probability level of 0.05 [10].

2.1. Studied Traits

- Increase in the length growth of the main stem of the seedling (cm)
- Increase in the diagonal growth of the main stem (mm).
- The length of the main root.
- The main root diameter (mm).
- Wet and dry weight of the shoot (g).

| Table 1. Factorial coefficients of spraying process with nano fertilizer and mineral fertilizer. |
|---------------------------------------------------------------|
| Transaction number | Nano N.P.K (at a concentration of 5 g. L\(^{-1}\)) | Chemical N.P.K (at a concentration of 5 g. L\(^{-1}\)) |
| 1                  | Distilled water (without fertilizer) | Distilled water (without fertilizer) |
| 2                  | Distilled water (without fertilizer) | (12:12:36) 5 g. L\(^{-1}\) |
| 3                  | Distilled water (without fertilizer) | (20:20:20) 5 g. L\(^{-1}\) |
| 4                  | (12:12:36) 5 g. L\(^{-1}\)         | Distilled water (without fertilizer) |
| 5                  | (12:12:36) 5 g. L\(^{-1}\)         | (12:12:36) 5 g. L\(^{-1}\) |
| 6                  | (12:12:36) 5 g. L\(^{-1}\)         | (20:20:20) 5 g. L\(^{-1}\) |
| 7                  | (20:20:20) 5 g. L\(^{-1}\)         | Distilled water (without fertilizer) |
| 8                  | (20:20:20) 5 g. L\(^{-1}\)         | (12:12:36) 5 g. L\(^{-1}\) |
| 9                  | (20:20:20) 5 g. L\(^{-1}\)         | (20:20:20) 5 g. L\(^{-1}\) |

3. Results and Discussion

3.1. Increase in the length growth of the main stem of the seedling(cm)

It appears from Table (2) that the seedlings treated with N.P.K nano fertilizer (20:20:20) were significantly superior in the characteristic of the increase in the longitudinal growth of the stem, as it reached (28.3167 cm), recording an increase in this characteristic of (37%) compared to the comparison treatment. Followed by the increase in seedlings treated with nano-fertilizer N.P.K (12:12:36), where the rate of increase for the longitudinal growth of seedlings reached (26.2111 cm). While the comparison treatment gave the lowest rate in this trait which was (20.6567 cm). As for the effect of spraying seedlings with mineral fertilizer (20:20:20), the highest rate for this trait was (27.4833 cm), with an increase of (27%) compared to the comparison treatment. Also, spraying with mineral fertilizer (12:12:36) gave an average of (26.1444 cm) for this trait While...
the comparative treatment gave an increase in the longitudinal growth with an average of (21.5567 cm). From the same table, we note the effect of the interaction between nano-fertilizer N.P.K (20:20:20) and mineral N.P.K fertilizer (20:20:20), as it reached the highest rate of increase in longitudinal growth (30.717 cm), which did not differ significantly in its effect from the treatment of The interaction between nano-N.P.K (20:20:20) and mineral N.P.K fertilizer (12:12:36), which increased the rate of longitudinal growth (30.267 cm), but they significantly outperformed the rest of the other interactions, while the lowest rate of increase in stem length was (16.003 cm). These results support with what was mentioned [11], that nano-fertilizers enhance metabolic processes as well as enhance anabolic activities that lead to increased apical growth. This explains the increase in the longitudinal growth of seedlings treated with foliar spraying with nano-fertilizer compared to the effect of spraying with mineral fertilizer. As indicated by [12], that the use of nano-fertilizers is a promising and effective way through which to increase and improve plant growth in general.

**Table 2.** Effect of nano (N.P.K) and metal (N.P.K) fertilizer levels and their interactions on the stem length growth of *Pinus brutia* seedlings(cm).

| N.P.K Nano Fertilizer Concentration (%) | N.P.K Mineral Fertilizer Concentrations (%) | Effect of N.P.K Nano Fertilizer Concentration (%) |
|----------------------------------------|-------------------------------------------|-----------------------------------------------|
| 0:0:0                                  | 16.003                                    | 20.656                                        |
| 12:12:36                               | 24.7                                      | 26.211                                        |
| 20:20:20                               | 23.967                                    | 28.316                                        |

*Numbers with characters similar to individual factors and their overlaps do not differ morally among themselves according to the Dunkin’ multi-border test at a probability level of 0.05.*

### 3.2. Increase in the diagonal growth of the main stem (mm)

It was shown from Table (3) that the seedlings treated with nano-N.P.K fertilizer (20:20:20) gave the highest rate in the characteristic of the increase in the diametrical growth amounted to (03.8383 mm), followed in terms of the increase treated with nano-N.P.K fertilizer (12:12:36), which gave an average for this trait of (3.4934 mm), while the comparison treatment gave the lowest average of (2.4340 mm). As for the mineral N.P.K fertilizer, spraying seedlings with a fertilizer (20:20:20) recorded an average of (3.5939 mm) for the increase in diametrical growth, and outperformed the comparison treatment, which recorded an average of (2.7634 mm). As for the effect of the binary interaction between nano-N.P.K fertilizer (20:20:20) and mineral N.P.K fertilizer (20:20:20), an average of (4.2680 mm) was recorded for the characteristic of the increase in diagonal growth, followed by the effect of the interaction between nano-N.P.K fertilizer (20:20:20) and fertilizer Mineral N.P.K (12:12:36), which gave an average of (4.0460 mm) for this characteristic, while the comparison treatment recorded the lowest average (1.8857 mm). It is clear from the results of the increase in the diametrical growth that the nano-fertilizer is superior in its effect on increasing the diametrical growth of seedlings compared to the effect of the mineral fertilizer. This is because the nano-fertilizers have smaller diameters than the pores of the plant cell wall, and therefore these nanoparticles easily permeate through the plant cell wall and reach the plasma membrane [13]. This was also confirmed by [14], who indicated that ordinary or conventional fertilizers cannot easily penetrate through the plant cell wall because the diameters of their particles are larger than the size of the pores of the plant cell wall.

### 3.3. Main root length (cm)

The results presented in Table (4) showed a significant superiority of the treatment of spraying with nano-fertilizer (20:20:20) in the characteristic of root length, as it recorded the highest rate of (58.5333 cm) over the rest of the treatments, and the treatment of spraying with the same fertilizer recorded (12:12:36) an average For this trait, it reached (56.7000 cm), while the lowest rate was (51.0667 cm) when the comparison treatment.

The effect of spraying with mineral fertilizers (20:20:20) also resulted in giving an average root length of (57.1778 cm), and it significantly outperformed the effect of the comparison treatment, which recorded the lowest average root length of (52.6000 cm). There was no significant difference between the effect of spraying with mineral fertilizer (20:20:20) and the effect of spraying with manure (12:12:36), where the average root length was recorded (56.5222 cm).
The same table shows the effect of the bilateral interaction between nano-N.P.K fertilizer (20:20:20) and N.P.K mineral fertilizer (20:20:20), which gave the highest root length rate (61,000 cm) and outperformed its effect on all treatments. And a significant increase of (13.867%) was recorded compared to the comparison treatment, which gave the lowest rate for this trait amounted to (47.133 cm).

These results are in support with what was found [15] who reported that spraying with nano-fertilizers (Mn NP) resulted in an increase of root length up to 70% compared to the effect of using conventional fertilizers. These results also Support with what [16] mentioned that the effect of N.P.K nano fertilizer had a significant role in root length compared to other treatments.

**Table 3. Effect of nano (N.P.K) and Mineral (N.P.K) fertilizer levels and their interactions on the diagonal growth of Pinus brutia seedlings (mm).**

| N.P.K Nano Fertilizer Concentration (%) | N.P.K Mineral Fertilizer Concentrations (%) | Effect of N.P.K Nano Fertilizer Concentration (%) |
|----------------------------------------|-------------------------------------------|-----------------------------------------------|
| 0:0:0                                   | 0:0:0                                      | 1.885                                        |
|                                        | 12:12:36                                   | 2.670                                        |
|                                        | 20:20:20                                   | 2.745                                        |
| 12:12:36                                | 0:0:0                                      | 3.203                                        |
|                                        | 12:12:36                                   | 3.508                                        |
|                                        | 20:20:20                                   | 3.768                                        |
| 20:20:20                                | 0:0:0                                      | 3.201                                        |
|                                        | 12:12:36                                   | 4.046                                        |
|                                        | 20:20:20                                   | 4.268                                        |
| Effect of N.P.K                         | Mineral Fertilizer Concentrations(%)       | 2.763                                        |
|                                        |                                            | 3.408                                        |
|                                        |                                            | 3.593                                        |

*Numbers with characters similar to individual factors and their overlaps do not differ morally among themselves according to the Dunkin' multi-border test at a probability level of 0.05.*

**Table 4. Effect of nano (N.P.K) and metal (N.P.K) fertilizer levels and their interactions on the root length of Pinus brutia seedlings (mm).**

| N.P.K Nano Fertilizer Concentration (%) | N.P.K Mineral Fertilizer Concentrations (%) | Effect of N.P.K Nano Fertilizer Concentration (%) |
|----------------------------------------|-------------------------------------------|-----------------------------------------------|
| 0:0:0                                   | 0:0:0                                      | 47.133                                        |
|                                        | 12:12:36                                   | 53.133                                        |
|                                        | 20:20:20                                   | 52.933                                        |
| 12:12:36                                | 0:0:0                                      | 55.400                                        |
|                                        | 12:12:36                                   | 57.100                                        |
|                                        | 20:20:20                                   | 57.600                                        |
| 20:20:20                                | 0:0:0                                      | 55.267                                        |
|                                        | 12:12:36                                   | 59.333                                        |
|                                        | 20:20:20                                   | 61.000                                        |
| Effect of N.P.K                         | Mineral Fertilizer Concentrations(%)       | 52.600                                        |
|                                        |                                            | 56.522                                        |
|                                        |                                            | 57.177                                        |

*Numbers with characters similar to individual factors and their overlaps do not differ morally among themselves according to the Dunkin' multi-border test at a probability level of 0.05.*

### 3.4. Main root diameter (mm)

It is evident from Table (5) that spraying with nano-fertilizer N.P.K showed a significant effect on root diameter, where fertilizer (20:20:20) gave the highest values (5.52000 mm), which recorded an increase of (27%) compared to the control treatment. This was followed by an increase in the fertilizer spraying treatment (12:12:36), which amounted to (5.28778 mm), while the comparison treatment recorded the lowest values (4.3367 mm). Spraying with N.P.K mineral fertilizer (20:20:20) led to a significant increase in root diameter (5.26278 mm), which gave an increase of (13%) compared to the control treatment. While fertilizer (12:12:36) gave an average of (5.25756 mm) in root diameter, and the comparison treatment recorded (4.62111 mm), And there was no significant difference between mineral fertilizer (20:20:20) and (12:12:36). The binary interaction between nano fertilizer (20:20:20) and mineral fertilizer (20:20:20) had a significant effect on root diameter, as it recorded the highest value of (5.8493 mm), while the comparison treatment gave the lowest value of (3.6900 mm).

This is what was Supported upon [17] who confirmed that spraying with nano-fertilizer led to a significant increase in the characteristic of the root diameter when using it on the seedlings of Citrus reticulata.
Table 5. Effect of nano (N.P.K) and metal (N.P.K) fertilizer levels and their interactions on the root diameter of Pinus brutia seedlings (mm).

| N.P.K Nano Fertilizer Concentration (%) | N.P.K Mineral Fertilizer Concentrations (%) | Effect of N.P.K Nano Fertilizer Concentration (%) |
|----------------------------------------|---------------------------------------------|-------------------------------------------------|
| 0:0:0                                   | 0:0:0                                       | 3.690 G                                          |
| 12:12:36                                | 12:12:36                                    | 5.057 E                                      |
| 20:20:20                                | 20:20:20                                    | 5.116 C                                        |
| Effect of N.P.K Mineral Fertilizer Concentration (%) | 4.621 b                                       | 5.257 a                                        |

Numbers with characters similar to individual factors and their overlaps do not differ morally among themselves according to the Dunkin’ multi-border test at a probability level of 0.05.

3.5. The wet and dry weight of the shoot (g)

The data in Table (6) showed a significant superiority in the wet weight of seedlings treated with N.P.K nano fertilizer (20:20:20), which recorded (32.4703 g) with an increase of (53%) compared to the control treatment. Followed by the seedlings treated with fertilizer (12:12:36), which recorded (29.3169 g), while the control treatment recorded the lowest wet weight of (21.1572 g). As for the mineral fertilizer, we notice from the same table a significant superiority in the spraying treatment using N.P.K fertilizer (20:20:20), which gave the highest wet weight (29.7901 g) with an increase of (23%) compared to the control treatment. It did not differ significantly from the treatment of spraying with manure (12:12:36), where the average wet weight was recorded (29.1247 g), and the comparison treatment recorded the lowest wet weight of (24.0297 g).

And the bilateral interaction between the levels of nano fertilizer and mineral fertilizer showed significant superiority in the spraying treatment with nano N.P.K fertilizer (20:20:20) and mineral N.P.K fertilizer (20:20:20) with a value of (36.135 g), while the comparison treatment gave the lowest values (17.661 g).

Table 6. Effect of nano (N.P.K) and metal (N.P.K) fertilizer levels and their interactions on the wet weight of the leg of Pinus brutia seedlings (g).

| N.P.K Nano Fertilizer Concentration (%) | N.P.K Mineral Fertilizer Concentrations (%) | Effect of N.P.K Nano Fertilizer Concentration (%) |
|----------------------------------------|---------------------------------------------|-------------------------------------------------|
| 0:0:0                                   | 17.661 e                                      | 21.157 C                                        |
| 12:12:36                                | 27.104 D                                      | 29.316 b                                        |
| 20:20:20                                | 27.324 C                                      | 32.470 a                                        |
| Effect of N.P.K Mineral Fertilizer Concentration (%) | 24.029 b                                       | 29.790 a                                        |

Numbers with characters similar to individual factors and their overlaps do not differ morally among themselves according to the Dunkin’ multi-border test at a probability level of 0.05.

It is noted from Table (7) that the dry weight of the stem is significantly affected by the treatment of N.P.K nano fertilizer (20:20:20) compared with the control treatment, where the highest values were recorded (13.9210 g) with an increase of (40%) While fertilizer (12:12:36) recorded an average for this trait of (12.4227 g), and the comparison treatment recorded the lowest values (9.9311 g). The results of the previous table showed a significant effect of mineral fertilizers, as the spraying treatment with N.P.K fertilizer (20:20:20) gave the highest dry weight of (13.3387 g) with an increase of (31%). Which did not show any significant difference between it and fertilizer (12:12:36), which recorded an average dry weight for this trait of (12.7906 g), while the comparison treatment recorded (10.1456 g) dry weight.

The results of the interaction between nano-fertilizer (20:20:20) and mineral (20:20:20) showed a significant difference, as it gave the highest dry weight (15.8160 g), while the comparison treatment recorded the lowest dry weight (8.2787 g).
### Table 7. Effect of nano (N.P.K) and metal (N.P.K) fertilizer levels and their interactions on the dry weight of the leg (g) of Pinus brutia seedlings.

| N.P.K Nano Fertilizer Concentration (%) | N.P.K Mineral Fertilizer Concentrations (%) | Effect of N.P.K Nano Fertilizer Concentration (%) |
|----------------------------------------|-------------------------------------------|-----------------------------------------------|
| 0:0:0                                  | 0:0:0                                      | 9.931                                         |
| 0:0:0                                  | 12:12:36                                   | C                                             |
| 0:0:0                                  | 20:20:20                                   | C                                             |
| 12:12:36                               | 0:0:0                                      | 9.931                                         |
| 12:12:36                               | 12:12:36                                   | C                                             |
| 12:12:36                               | 20:20:20                                   | C                                             |
| 20:20:20                               | 0:0:0                                      | 9.931                                         |
| 20:20:20                               | 12:12:36                                   | C                                             |
| 20:20:20                               | 20:20:20                                   | C                                             |

*Numbers with characters similar to individual factors and their overlaps do not differ morally among themselves according to the Dunkin’ multi-border test at a probability level of 0.05.

It is clear from the results of this trait that foliar spraying with N.P.K nano fertilizer had a significant role in obtaining a significant increase in most growth indicators, including the wet and dry weight of the vegetative group compared to the effect of foliar spraying with mineral fertilizer, since nano fertilizers, as mentioned previously, are more efficient than mineral fertilizers [16] Which he pointed out that all treatments with nano-fertilizers had a significant effect on the wet weight, while the comparison treatment recorded the lowest wet weight, and the dry weight of the vegetative group had the same path as the wet weight.

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