



## Effect of Spraying with Nano-Fertilizer NPK and the Distance between Rows on the Growth and Productivity of *Nigella Sativa* L.

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Received:

5/3/2023

Accepted:

30/3/2023

Published:

### Abstract

A field experiment was conducted on the black seed plant during the winter season of 2021-2022 in the fields of the College of Agriculture at the University of Kirkuk, the experiment included the study of two main factors, the first: three concentrations (0, 2, and 4) g.l<sup>-1</sup> of NPK nano fertilizer were used, and the second was three distances for cultivation between the rows (20, 30, and 40) cm, was carried out according to the RCBD design. The results showed significant differences in the study factors of the nano-fertilizer and the distances as well as the interaction and for most of the studied traits, the level of the third nano-fertilizer (4) g.l<sup>-1</sup> in gave the number of flowering was 137.00 days, a number of capsule per plant, which reached 5.61, and the seed yield which amounted to 1.61 g, while the second level was (2) g.l<sup>-1</sup> number of seeds per capsule was 88.25, and the weight of 1000 seeds was 3.49 g, the first distance excelled in the number of flowering, as it reached 137.83 days, the height of the plant was 28.51 cm, and the weight of 1000 seeds was 3.52 g, the second distance was in seed yield which was 1.47 g, and the third distance was in the number of seeds per capsule which amounted to 82.48, the interaction between fertilizers levels and planting distances showed a superior first distance with third level in number of flowering, plant height, number of fruiting branches, and number of capsule per plant which reached 137.00, 30.80, 3.95, and 6.40 respectively, the correlation between the studied traits were significant for most of the studied traits.

**Keywords:** Distance between the rows, Nano-Fertilizer NPK, *Nigella Sativa*.

### Introduction

*Nigella sativa* L. belongs to the fraternal family Ranunculaceae, and it is one of the important medicinal plants that have been used in the treatment of many diseases, including rheumatic diseases, diabetes, and inflammatory diseases, in addition to improving liver and kidney functions in cases of aging and increasing the activity of an immune cell (Houghton et al., 1995) and (Bashandy, 1996).

One of the most important features that have encouraged the use of medicinal herbs and plants as a treatment in recent times is the lack of side effects because the low concentrations of the active substances in these plants and herbs are accepted by the body in their natural form. (UNESCO Soures, 1992)

Fertilizer management is one of the most important success factors in the planting of crops, whose final effect is on the quality, quantity, and quality of the yield. At present, environmental protection has become a priority for agriculture while maintaining sustainable agriculture, and since the excessive use of various chemical fertilizers is one of the most important reasons that It degrades the soil and the environment, Therefore, the idea of using nano-fertilizers, which is one of the most important and most advanced modern fertilizers in feeding and preparing crops with all they need of nutrients and mineral nutrients, came in contrast to chemical fertilizers, which lose many of the nutrients that the plant needs and that meet its different needs by washing, the matter



Which leads to a reduction in the efficiency of the use of ordinary fertilizers and an increase in the efficiency of the use of nano-fertilizers. (Subbarao, et al 2013).

The plant density and the way plants are distributed have a major role in determining the ability of the crop to exploit the resources available to the plant such as water, nutrients, and lighting. (Abdul Redman et al 2009)

### Material and method

A factorial experiment was conducted during the winter season of 2021-2022 in the fields of the College of Agriculture – at the University of Kirkuk Located between two latitudes 35.389781, and 44.3401130. The experiment included the study of two factors, the first: three concentrations of 0, 2, and 4 g.l<sup>-1</sup> of NPK nano fertilizer were used the product is from (KHAZRA) Fertilizer Company, of Iranian origin, and the second three distances for planting between the rows are 20, 30, and 40 cm The experiment was carried out according to the RCBD design. Nine treatments were applied in three replicates and the area of the experimental unit was 1×2 m<sup>2</sup> the rates were compared according to Duncan's Multiple Range Test at a probability level of 5% (Dawod and Abdulyas 1990). The seeds were planted in pits within one line, the distance between one pit and another is 25 cm. The experimental units were sprayed at a rate of six sprays during the season, at a rate of one spray every week, and the first spray was on 3/17-2022 Ten plants were taken from the midlines randomly to study flowering, plant height cm, number of fruiting branches, number of capsules per plant, and number of seeds per capsule, the weight of a thousand seeds, and the seed yield per plant. The values of the correlations between the pairs of different traits were estimated using the following equations (Walter 1975):

$$r = \frac{\sigma_{xy}}{\sqrt{\sigma^2 x \cdot \sigma^2 y}}$$

### Result and Dissection

#### Number of flowering

Table (1) show the effect of spraying with NPK fertilizer and the distance between the rows on the number of flowering. It is noted that the third fertilizer level was superior by giving it the least number of days with an average of 137.33 in contrast to the first level which gave the largest number of days reaching 138.83, the reason for this can be due to the importance of NPK nano-compound fertilizer in stimulating the plant to flower due to its activation of auxins which led to speeding up the process of the number of days flowering.

As for the distances, the first and second distances outperformed with a mean of 137.83 and 138.00, respectively, in contrast to the third distance which gave a mean of 138.66, this may be due to the limited materials processed from the carbon metabolism process due to the increased shading of the leaves which led to the plant's continuation of vegetative growth and then the delay in the appearance of flowers and that the differences in agricultural distances affected the time required for the emergence of flowers or the reason for this was due to the availability and readiness of growth factors such as sunlight water and minerals and nutrients for each plant and certainly this is reflected in the number amount of materials manufactured at the number source.

As for the interaction between fertilizer levels and planting distances, the combined treatment of the third level of fertilizer outperformed the first and second distances with an average of 137.00 for each of them in contrast to the harmonic treatment of the first fertilizer level with the third distance, which gave an average of 139.50

**Table (1) Effect of spraying NPK nano fertilizer and planted distances on flowering (day).**

| Fertilizer g/L | Plant Distance cm |           |           | Fertilizer mean |
|----------------|-------------------|-----------|-----------|-----------------|
|                | 20                | 30        | 40        |                 |
| 0              | 139.00 ab         | 138.00 cd | 139.50 a  | 138.83 a        |
| 2              | 137.50 de         | 139.00 ab | 138.50 bc | 138.33 b        |
| 4              | 137.00 e          | 137.00 e  | 138.00 cd | 137.33 c        |
| Distance mean  | 137.83 b          | 138.00 b  | 138.66 a  | 138.16          |



The same letter for each trait is not significantly different from each other according to Duncan's test

### Plant height (cm)

Table (2) shows the effect of spraying with NPK fertilizer and the distance between the rows on the plant height trait, it is noted that there are no significant differences between the levels of fertilizer in this trait. As for the distances, the first and second distances excelled with an average of 28.51 and 28.00 cm, respectively, in contrast to the third distance, which gave an average of 25.20. This result is not consistent with Süleyman KIZIL and Özlem TONÇER (2005) that they found differences between planting distances used in this trait, and this may be explained by the fact that the increase in the plant height when the distance between plants is narrowed led to an increase in competition for growth requirements especially light which leads to the length of the internodes and the increase in the height of the plant or the reason for this is due to an increase in the concentration of auxin in the stem and then the increase in the height of the plant (Issa,1990). As for the interaction between fertilizer levels and planting distances, the combined treatment of the third level of fertilizer outperformed the first two distances with a mean of 30.80, which did not differ from most of the other trivial treatments, in contrast to the combinatorial treatment of the first level of fertilizer with the third distance which gave an average of 22.55.

**Table (2) Effect of spraying NPK nano fertilizer and Plant distances on plant height(cm).**

| Fertilizer g/L | Plant Distance cm |          |         | Fertilizer mean |
|----------------|-------------------|----------|---------|-----------------|
|                | 20                | 30       | 40      |                 |
| 0              | 28.60 ab          | 27.95 ab | 22.55 c | 26.36 a         |
| 2              | 26.15 b           | 28.20 ab | 26.45 b | 26.93 a         |
| 4              | 30.80 a           | 27.85 ab | 26.60 b | 28.41 a         |
| Distance mean  | 28.51 a           | 28.00 a  | 25.20 b | 27.23           |

The same letter for each trait is not significantly different from each other according to Duncan's test

### Number of fruit branches per plant

Table (3) shows the effect of spraying with NPK fertilizer and the distance between the rows on the number of fruiting branches in the plant it is noted that there are no significant differences between the levels of fertilizer in this trait. As for the distances, there are no significant differences between the planting distances in this trait, this result is not consistent with Süleyman KIZIL and Özlem TONÇER (2005) that they found differences between planting distances used in this trait, perhaps the reason this quantity is appropriate in processing the soil contains the necessary elements such as nitrogen phosphorous and potassium which led to an increase in the number of fruiting branches and this is consistent with what was stated (Ghosh et al., 1981).

As for the interaction between fertilizer levels and planting distances, the combined treatment of the third level of fertilizer outperformed the first two distances with a mean of 3.95, which did not differ from most of the other treatments, unlike the combine treatment of the first level of fertilizer with the third distance which gave a mean of 2.75

**Table (3) Effect of spraying NPK nano fertilizer and Plant distances on No. of fruiting branches**

| Fertilizer g/L | Plant Distance cm |         |         | Fertilizer mean |
|----------------|-------------------|---------|---------|-----------------|
|                | 20                | 30      | 40      |                 |
| 0              | 3.45 ab           | 3.50 ab | 2.75 b  | 3.23 a          |
| 2              | 3.70 a            | 3.35 ab | 3.80 a  | 3.61 a          |
| 4              | 3.95 a            | 3.15 ab | 3.30 ab | 3.46 a          |
| Distance mean  | 3.70 a            | 3.33 a  | 3.28 a  | 3.43            |

The same letter for each trait is not significantly different from each other according to Duncan's test



### The number of capsules per plant

Table (4) The effect of spraying with NPK fertilizer and the distance between the rows on the number of capsules per plant it is noted that the third level of fertilizer was superior by giving it a mean of 5.61 for the most number of capsules in contrast to the first level which gave the less number of the capsule which amounted to 3.13, This result is consistent with Khalid and Shedeed (2015) that they found differences between the levels of fertilizer used in this trait. As for the distances, there are no significant differences between the planting distances in this trait. As for the interaction between the levels of fertilizer and the cultivation distances, the combined treatment of the third level of fertilizer outperformed the first two distances with a mean of 6.40 unlike the complementary treatment of the first fertilizer level with the third distance which gave the least number of capsule the amount of It's a mean is 2.60 and the rest of the transactions were taken with a difference between the highest and lowest value.

**Table (4) Effect of spraying NPK nano fertilizer and Plant distances on No. of capsules per plant**

| Fertilizer g/L | Plant Distance cm |         |        | Fertilizer mean |
|----------------|-------------------|---------|--------|-----------------|
|                | 20                | 30      | 40     |                 |
| 0              | 3.05 ef           | 3.75 de | 2.60 f | 3.13 c          |
| 2              | 3.25 def          | 3.55 de | 3.90 d | 3.56 b          |
| 4              | 6.40 a            | 4.85 c  | 5.60 b | 5.61 a          |
| Distance mean  | 4.23 a            | 4.05 a  | 4.03 a | 4.10            |

The same letter for each trait is not significantly different from each other according to Duncan's test

### Number of seeds per capsule

The number of capsules is one of the traits of the components of the yield so increasing or decreasing the number of capsules will affect the production of seed yield in the *Nigella sativa* .L plant. Table (5) shows the effect of spraying with NPK fertilizer and the distance between the rows on the traits of the number of seeds per capsule it is noted that the level of the second fertilizer is superior by giving it the highest mean amounted to 88.25 for the number of seeds in contrast to the first level which gave the lowest number of seeds amounted to 70.06 this result is consistent with Rezaei-Chiyaneh et al (2018) that they found differences between the levels of fertilizer used in this trait, the reason can be due to the fact that nano-fertilizer has a vital role in the formation of fruits or it may be due to the fact that this fertilizer combination of nano-fertilizer has equipped the plant with the necessary elements for physiological processes which led to an increase in cells and an increase in nutrients accumulated in the process of photosynthesis which led to an increase the number of seeds per capsule (Issa,1990), or the reason for the increase in the number of seeds per capsule may be due to the role of nano-fertilizer in increasing the specific weight content of the leaves, the duration of the leaf area, the duration of dry matter production, the relative growth rate of the plant, the crop growth rate, the absolute growth rate and the net photosynthesis rate, which was reflected on the number of seeds in the capsule, and the number of seeds per capsule was significantly positively correlated with the trait of seed yield table (8). As for the distances, there were no differences between the cultivation distances in this trait, this result is consistent with Süleyman KIZIL and Özlem TONÇER (2005) that who found differences between planting distances used in this trait. As for the interaction between the levels of fertilizer and the cultivation distances the combined treatment of the second level of fertilizer outperformed the first distance with a mean of 100.50 unlike the complementary treatment of the level of the first fertilizer with the first distance which gave the least number of seeds reached it's a mean is 61.51. The rest of the transactions were taken with a difference between the highest and lowest value.



**Table (5) Effect of spraying NPK nano fertilizer and Plant distances on No. of seeds per capsule**

| Fertilizer g/L | Plant Distance cm |          |          | Fertilizer mean |
|----------------|-------------------|----------|----------|-----------------|
|                | 20                | 30       | 40       |                 |
| 0              | 61.51 e           | 66.18 e  | 82.50 c  | 70.06 b         |
| 2              | 100.50 a          | 83.86 bc | 80.40 cd | 88.25 a         |
| 4              | 70.40 de          | 95.35 ab | 84.55 bc | 83.43 a         |
| Distance mean  | 77.47 a           | 81.79 a  | 82.48 a  | 80.58           |

The same letter for each trait is not significantly different from each other according to Duncan's test

### Weight of 1000 seeds

The weight of a thousand seeds is one of the indicators of the fullness of the seed as a result of the increase in biosynthesis from the source to the estuary, this adequate supply of the plant with nutrients, and is also one of the important components of the yield. Table (6) shows the effect of spraying with NPK fertilizer and the distance between the rows in the weight 1000 it was noticed that the second level of fertilizer was superior by giving it the highest mean of 3.49 for the weight of 1000 seeds in contrast to the first level which gave the lowest weight of 1000 seeds which amounted to 3.09, this result is consistent with Rezaei-Chiyaneh et al (2018) that they found differences between the levels of fertilizer used in this trait, in seeds and increase their weight or the reason for that to the importance of nano-fertilizer in increasing, as for the distances the first distance outperformed as it reached the highest weight of 3.52 in contrast to the third distance which gave the lowest weight of 3.09 This result is consistent with Süleyman KIZIL and Özlem TONÇER (2005) that they found differences between planting distances used in this trait, and this may be due to the small number of capsule and the number of seeds in the capsule in the narrow distances between plants, positively in increasing the weight of seeds in the narrow spaces between plants or the reason for the increase in the weight of 1000 seeds may be due to the role of nano-fertilizer in increasing the speed of transfer of nutrients from the leaves to the fruits through its formation of centers of attraction for nutrients as well as its role in increasing the interception of light and its positive reflection in increasing the efficiency of photosynthesis and increasing the resulting compounds such as sugars, amino acids and protein Its transmission to the fruits leads to an increase in the weight of 1000 seeds. Werner et al. (2001). As for the interaction between fertilizer levels and planting distances the combined treatment outperformed the second level of fertilizer with the second distance with a mean of 3.94 in contrast to the combined treatment of the first fertilizer level with the third distance which gave the lowest weight to 1000 seeds with a mean of 2.97 and the rest of the treatments took the disparity between the highest and lowest value.

**Table (6) Effect of spraying NPK nano fertilizer and Plant distances on the weight of 1000 seeds (g).**

| Fertilizer g/L | Plant Distance cm |          |         | Fertilizer mean |
|----------------|-------------------|----------|---------|-----------------|
|                | 20                | 30       | 40      |                 |
| 0              | 3.24 bc           | 3.06 c   | 2.97 c  | 3.09 b          |
| 2              | 3.46 abc          | 3.94 a   | 3.08 c  | 3.49 a          |
| 4              | 3.87 ab           | 3.28 abc | 3.22 bc | 3.45 ab         |
| Distance mean  | 3.52 a            | 3.43 ab  | 3.09 b  | 3.34            |

The same letter for each trait is not significantly different from each other according to Duncan's test

### Seed yield (g) plant<sup>-1</sup>

The seed yield trait can be considered a function of all traits of vegetative and fruitful growth, and it is an outcome of all physiological processes that occur in the plant. Table (7) shows the effect of spraying with NPK fertilizer and the distance between the rows in the trait of seed yield per



plant it is noted that the level of the third fertilizer is higher by giving it the highest seed yield reaching 1.61 for the seed yield in contrast to the first level which gave the lowest seed yield per plant which was 0.79 This result is consistent with (Khalid and Shedeed, 2015) that they found differences between the levels of fertilizer used in this trait, perhaps due to the plant's superiority in most components of the yield for the second fertilizer level, which was reflected in the seed yield table (4), (5), and (6), or The reason for the increase in the total seed yield may be due to the role of nano-fertilizer in increasing photosynthesis, making proteins and respiration, which increased the vital processes of the plant, which led to an increase in the number of branches, the number of pods and the number of seeds per pod, which was positively reflected on the increase in the total seed yield of the plant.

As for the distances, the second distance outperformed, as it reached the highest seed yield of 1.47, in contrast to the first and third distances which gave the lowest seed yield of 0.92 and 1.26 for the two distances respectively. This season for increased plants in the area whether between the rows and this is reflected positively in the increase in the economic yield this result is consistent with Süleyman KIZIL and Özlem TONÇER (2005) and Abdolrahimi et al (2012), who found differences in planting distances used in this trait. As for the interaction between fertilizer levels and planting distances, the combined treatment outperformed the third level of fertilizer with the second distance with a mean of 1.86, in contrast to the complementary treatment of the first fertilizer level with the first distance, which gave the lowest seed yield with a mean of 0.61, and the rest of the treatments took the disparity between the highest and lowest value.

**Table (7) Effect of Spraying NPK Nano Fertilizer and Plant Distances on seed yield (g).**

| Fertilizer g/L | Plant Distance cm |        |        | Fertilizer mean |
|----------------|-------------------|--------|--------|-----------------|
|                | 20                | 30     | 40     |                 |
| 0              | 0.61 f            | 1.05 d | 0.71 f | 0.79 c          |
| 2              | 0.90 e            | 1.50 b | 1.33 c | 1.24 b          |
| 4              | 1.24 c            | 1.86 a | 1.73 a | 1.61 a          |
| Distance mean  | 0.92 c            | 1.47 a | 1.26 b | 1.21            |

The same letter for each trait is not significantly different from each other according to Duncan's test

### Simple correlation

Table (8) shows the Pearson correlation values between the studied traits it is noted that the correlation values for the number of days flowering trait are not significant with the rest of the studied traits. 0.613\*\* and with the weight of 1000 seeds reached 0.443\* and did not reagent moral limits with the rest of the attributes. As for the number of fruiting branches the correlation was significant with the number of capsules which amounted to 0.485\* and also significant with the weight of 1000 seeds which amounted to 0.553\*\* and the correlation did not reach the limits of significance for the rest of the traits, for the number of capsule per plant with the weight of 1000 seeds which amounted to 0.441\* and with the seed yield was 0.645\*\* and the number of seeds per capsule for the trait with the seed yield was 0.441\* and the correlation did not reach the significant limits for the rest of the traits this result is consistent with Süleyman KIZIL and Özlem TONÇER (2005) and Abdolrahimi et al (2012), that they found significantly different between this studied trait.

**Table (8) Correlation values of Pearson's analysis between the studied traits**

| Traits                   | flowering | plant height (cm) | No. of fruiting branches | No. of capsules per plant | No. of seeds per capsule | weight of 1000 seeds (g) |
|--------------------------|-----------|-------------------|--------------------------|---------------------------|--------------------------|--------------------------|
| plant height (cm)        | 0.027     |                   |                          |                           |                          |                          |
| No. of fruiting branches | 0.272     | 0.668**           |                          |                           |                          |                          |



|                                   |        |         |         |         |        |       |
|-----------------------------------|--------|---------|---------|---------|--------|-------|
| No. of capsules per plant         | -0.271 | 0.613** | 0.485*  |         |        |       |
| No. of seeds per capsule          | 0.072  | 0.014   | 0.240   | 0.170   |        |       |
| weight of 1000 seeds (g)          | 0.282  | 0.443*  | 0.553** | 0.441*  | 0.348  |       |
| seed yield g. plant <sup>-1</sup> | -0.174 | 0.262   | 0.144   | 0.645** | 0.430* | 0.336 |

## Conclusion

There is a response to the levels of nano-fertilizer, especially the level of fertilizers 2 and 4, for most of the studied traits, including the yield and its components. The two distances exceed 20 and 30 cm between the rows in most of the characteristics, including the yield and its components. The interaction superior first distance with third level in most of the studied traits, the correlation between the studied traits were significant for most of the studied traits.

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## تأثير الرش بالسماذ النانوي NPK والمسافة بين الخطوط في نمو وإنتاجية الحبة السوداء *Nigella Sativa* L.

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### خلاصة

أجريت تجربة حقلية على نبات الحبة السوداء خلال الموسم الشتوي ٢٠٢١-٢٠٢٢ في حقول كلية الزراعة جامعة كركوك، وتضمنت التجربة دراسة عاملين رئيسيين الأول: ثلاثة تراكيز (٠، ٢، ٤) سم، تم استخدام (٤) غم/لتر-١ من سماذ النانو NPK، والثاني ثلاث مسافات للزراعة بين الخطوط (٢٠، ٣٠، ٤٠) سم، وتم تنفيذها وفق تصميم RCBD. أظهرت النتائج وجود فروق معنوية في عوامل الدراسة للسماذ النانوي والمسافات وكذلك التداخل ولأغلب الصفات المدروسة أظهر مستوى السماذ النانوي الثالث (٤) غم/لتر-١ في عدد التزهير وبلغ ١٣٧.٠٠ يوماً، وبلغ عدد الكبسولة لكل نبات ٥.٦١، وبلغ حاصل البذور ١.٦١ غم، أما المستوى الثاني فكان (٢) غم/لتر-١ وكان عدد البذور في الكبسولة الواحدة ٨٨.٢٥، ووزن ١٠٠٠ بذرة. كانت ٣.٤٩ جرام، المسافة الأولى تفوقت في عدد التزهير حيث بلغت ١٣٧.٨٣ يوم، ارتفاع النبات ٢٨.٥١ سم، ووزن ١٠٠٠ بذرة ٣.٥٢ غم، المسافة الثانية في محصول البذور ١.٤٧ غم. أما المسافة الثالثة فكانت في عدد البذور في الكبسولة الواحدة والتي بلغت ٨٢.٤٨، كما أظهر التداخل بين مستويات الأسمدة ومسافات الزراعة تفوق المسافة الأولى مع المستوى الثالث في عدد التزهير وارتفاع النبات وعدد الأفرع الثمرية وعدد الأفرع. كبسولة لكل نبات بلغت ١٣٧.٠٠، ٣٠.٨٠، ٣.٩٥، ٦.٤٠ على التوالي، وكان الارتباط بين الصفات المدروسة معنوياً لأغلب الصفات المدروسة.

الكلمات المفتاحية: المسافة بين الخطوط، الأسمدة النانوية NPK، حبة البركة.