Vitality and Vigour Seed of Wheat Affected By Storage and Soaking With MnNPs

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Abstract The experiment was carried out in the Seed Technology Laboratory of the Field Crops Department - College of Agriculture - University of Baghdad for the 2018 season, with the aim of determining the effect of soaking wheat seeds with nanoparticles (MnNPs) at concentrations of 500, 1000 and 1500 mg/L-1 in addition to the two comparison treatments (distilled water and dry seeds), and for a period Soaking 6, 12 and 24 hours in the germination and seedling strength and using the best concentration and the best soaking time for nanoscale iron fertilizer for use in subsequent field and laboratory experiments. The treatments were distributed using the complete random design (CRD) with four iterations. The results of the study showed the superiority of the nano fertilizer over the two comparison treatments (soaking in distilled water and dry seeds) in giving the highest average for all the standard germination and seedling strength characteristics. In addition. The 24-hour soaking time outperformed the periods 6 and 12 hours in giving the highest average for all the studied traits.

1. Introduction
Wheat is one of the most important economic and strategic cereal crops for the majority of the world's population, as it is grown in large areas of the world about 220.4 million hectares with a productivity rate of about 765.0 million tons in 2019. Among the most important factors for increasing production of the wheat crop is the seeds used in agriculture. High-quality seeds are the main key to giving a high economic return. Seed germination is affected by many factors, the most important of which are internal factors such as the physiological and hormonal status of the seeds and external factors, including environmental conditions during the development of seeds as well as the harvest, Post-harvest operations and seed storage. Fertilizers have proven their important role in improving crop production, and despite the role of fertilizers and their contents, whether major or minor elements, recently, it has been noticed that the production of many crops has declined due to the impact of fertilizers on the soil through the decrease of organic matter, thus reducing the efficiency of the use of nutrients to a very low level. To solve this problem, the technology of coating fertilizers with nano-materials was discovered, and because of the small size of the nano-materials, they show unique properties, including the speed of absorption by the seeds. Manganese is one of the important microelements necessary for plant growth, which contributes in various physiological processes and photosynthetic reactions, accelerates seed germination by activating many enzymes,
contributes to the synthesis of RNA and improves the performance of photosynthetic systems in plants [10].

Many practices have been developed to raise the vitality of seeds and increase their activity and emergence rates, which depend in their entirety on the process of activation or soaking with substances that stimulate germination, especially soaking with nutrients, and the situation developed into the use of materials and fertilizers nanoparticles because of the many benefits of this technology, as nanoparticles were used in agricultural practices, such as pesticides and nano-fertilizers, where nano-materials used in the agricultural field are economical, environmentally friend, and non-toxic [6]. Some studies have shown that nano-materials have the ability to penetrate the seed layer and enhance the capacity of water absorption and utilization, which stimulates the enzymatic system and improves germination and seedling growth [1]. Therefore, this study was carried out to find out the best concentration of nano-manganese and to determine the best period of soaking with this fertilizer depending on the germination characteristics and seedling vigour.

2. Materials and Methods

A laboratory experiment was carried out in the Seed Technology Laboratory to study the effect of soaking wheat seeds (Buhooth10 variety) at three concentrations of nano-manganese fertilizer in addition to the control treatment on the characteristics of standard laboratory germination and choosing the best concentration. The experiment was carried out according to a completely randomized design (CRD) with four replicates in the order of factorial experiments. The treatments included: MnNPs at concentrations of 500, 1000 and 1500 mgL$^{-1}$ and control treatment (distilled water). 200 seeds were soaked for each treatment for 6, 12 and 24 hours and were planted in filter papers with a diameter of 30 cm. Alcohol was used for sterilization to avoid infection with microorganisms. 50 seeds were alternately placed on the germination paper. The winding method was used and then placed in sterile bags and placed in the growth chamber at a 25 ± 2 °C and a humidity of 70% for eight days [5].

**Studied traits**

1. Standard laboratory germination in the first count (%): four days after placing the seeds in the growth chamber, the number of natural seedlings was calculated and then converted to a percentage according to the following equation: [4].

   Germination in the first count (%) = \( \frac{\text{No.of natural seedlings after 4 days}}{\text{No.of Total seeds}} \times 100 \)

2. Standard laboratory germination in the final count (%): Eight days after placing the seeds in the growth chamber [4], the total number of natural seedlings was calculated and then converted to a percentage according to the following equation:

   Germination in the first count (%) = \( \frac{\text{No.of natural seedlings after 8 days}}{\text{No.of Total seeds}} \times 100 \)

3. Radicle and shoot length (cm): Ten natural seedlings were taken, then the radicle and shoot was separated from their point of contact with the seed, and then the length of the radicle and shoot was measured separately by using the ruler. [7]

4. Seedling dry weight (mg): Ten natural seedlings were taken and placed in perforated paper bags and dried in an electric oven at 80 °C for 24 hours [3], then their weight was taken by using a sensitive scale.

5. Seedling strength index: It was calculated by using the following equation [7]

   Seedling strength = \( \text{Standard germination in the final count} \times \left( \frac{\text{root length}}{\text{shoot length}} \right) \)

The data were statistically analyzed for all the studied traits by using Gnestat program, and the least significant difference (L.S.D) test was used to compare between means at a level of probability 0.05.
3. Results and Discussion

Standard laboratory germination in the first count (%)
The results in Table (1) indicate that the soaking of wheat seeds with MnNPs at a 1500 mg L\(^{-1}\) significantly superior and achieved the highest standard laboratory germination in the first count (82.42%) compared with control treatment which achieved the lowest (79.08%). Also, the seeds soaking for 24 hour significantly superior and gave the highest standard laboratory germination in the first count (82.25%) compared with seeds soaking for 6 hour which gave the lowest (78.62%). This may be due to the effect of the soaking period on the overall biological and chemical activities in the seed, which leads to acceleration of seed germination. The interaction between two factors had a significant effect on this trait, the seeds soaking with MnNPs at a 1500 mg L\(^{-1}\) for 24 hours had a highest value (83.25%) without significant difference with seeds soaking with MnNPs at a 1500 mg L\(^{-1}\) for 12 hour (82.75%), while the seeds soaking with distilled water for 6 hour had a lowest value (74.75%).

| MnNPs (mg.L) | First count (%) | Final count (%) |
|--------------|----------------|-----------------|
|              | Soaking time (hour) | Avera | Soaking time (hour) | Avera |
| 500          | 6. 12. 24. ge      | 79.83 | 6. 12. 24. ge      | 90.75 |
| 1000         | 75. 25. 50.       | 75.25 | 92. 93. 94.        | 93.17 |
| 1500         | 75. 81. 82.     | 81.08 | 25. 00. 25.        | 87.17 |
| Water        | 74. 80. 81.     | 79.08 | 78. 83. 85.        | 82.17 |
| LSD 5%       | 1.89            | 1.09  | 1.88              |      |
| Average      | 0.96            |       |                   |      |

3.1. Standard laboratory germination in the final count (%)
The results in table (2) show that the soaking of wheat seeds with MnNPs at a 1000 mg L\(^{-1}\) significantly superior and gave the highest standard laboratory germination in the final count (93.17%) compared with control treatment which gave the lowest (82.17%). The reason of the superiority of the soaking treatment at a 1000 mg L\(^{-1}\) compared with 1500 mg L\(^{-1}\) could be due to the fact that high concentrations of nano-manganese have accumulated in the cell wall, which may be caused oxidation and production of types of free radicals (ROS) that affect the inhibition of germination and growth by damaging cell membranes and may be also lead to nucleic acid damage. Regarding the soaking period, the seeds soaking for 24 hour significantly superior and achieved the highest standard laboratory germination in the final count (90.19%) compared with seeds soaking for 6 hour which achieved the lowest (86.06%). The interaction between two factors had a significant effect on this trait, the seeds soaking with MnNPs at a 1000 mg L\(^{-1}\) for 24 hours had a highest value (94.25%) without significant difference with seeds soaking with MnNPs at 1500 mg L\(^{-1}\) for 12 hour (93.00%), while the seeds soaking with distilled water for 6 hour had a lowest value (78.25%).

Radicle length (cm)
The results in Table (3) reveal that the soaking of wheat seeds with MnNPs at a 1000 mg L\(^{-1}\) significantly superior and gave the highest mean of radicle length (11.69 cm) compared with control treatment which gave the lowest (8.24 cm) without significant difference with seeds soaking with MnNPs at 1500 mg L\(^{-1}\) (8.74 cm). Regarding the soaking period, the seeds soaking for 24 hour significantly superior and achieved the highest mean of radicle length (10.90 cm) compared with seeds soaking for 6 hour which achieved the lowest (8.48 cm). The reason of increase may be attributed to the effect of the soaking period in accelerating seed germination and then increasing the division and growth of root cells, which led to an increase the root length. These results are in

| MnNPs (mg.L) | First count (%) | Final count (%) |
|--------------|----------------|-----------------|
|              | Soaking time (hour) | Avera | Soaking time (hour) | Avera |
| 500          | 6. 12. 24. ge      | 79.83 | 6. 12. 24. ge      | 90.75 |
| 1000         | 75. 25. 50.       | 75.25 | 92. 93. 94.        | 93.17 |
| 1500         | 75. 81. 82.     | 81.08 | 25. 00. 25.        | 87.17 |
| Water        | 74. 80. 81.     | 79.08 | 78. 83. 85.        | 82.17 |
| LSD 5%       | 1.89            | 1.09  | 1.88              |      |
| Average      | 0.96            |       |                   |      |
agreement with [3] The interaction between two factors had a significant effect on the root length; the seeds soaking with MnNPs at a 1000 mg L⁻¹ for 24 hours had a highest value (13.26 cm) whereas the seeds soaking with distilled water for 6 hour had a lowest value (7.37 cm) without significant difference with seeds soaking with MnNPs at a 500 mg L⁻¹ for 6 hour (7.55 cm).

Table 2. The effect of soaking the seeds with MnNPs on radicle and shoot length (cm)

| MnNPs (mg.L) | Radicle length (cm) | Shoot length (cm) |
|--------------|---------------------|-------------------|
|              | Soaking time (hour) | Average | Soaking time (hour) | Average |
| 500          | 6                   | 7.5     | 12                  | 8.4     | 24    | 9.9    | 6.77 |
|              | 5                   | 5       | 6                   | 7.78    | 9.48  | 11.19  | 6.80 |
| 1000         | 10                  | 11.98   | 11                  | 11.69   | 9.47  | 11.19  | 6.80 |
|              | 15                  | 11.17   | 13                  | 12.40   | 9.96  | 11.19  | 6.80 |
| 1500         | 15                  | 11.17   | 26                  | 11.10   | 9.96  | 11.19  | 6.80 |
| Water        | 7                   | 9.92    | 2                   | 11.95   | 9.96  | 11.19  | 6.80 |
|              | 7                   | 9.92    | 27                  | 11.95   | 9.96  | 11.19  | 6.80 |
| 0.35         | 7                   | 9.92    | 2                   | 11.95   | 9.96  | 11.19  | 6.80 |
| Average      | 8                   | 9.92    | 10                  | 11.95   | 9.96  | 11.19  | 6.80 |
| LSD 5%       | 0.30                | 0.30    | 90                  | 0.37    | 0.37  |

3.2. Shoot length (cm)
The results in Table (4) indicate that the soaking of wheat seeds with MnNPs at a 1000 mg L⁻¹ significantly superior and achieved the highest mean of shoot length (12.40 cm) compared with control treatment which achieved the lowest (7.41 cm). Regarding the soaking period, the seeds soaking for 24 hour significantly superior and achieved the highest mean of shoot length (11.19 cm) compared with seeds soaking for 6 hour which achieved the lowest (9.26 cm). The interaction between two factors had a significant effect on the shoot length; the seeds soaking with MnNPs at a 1000 mg L⁻¹ for 24 hours had a highest value (13.38 cm) while the seeds soaking with distilled water for 6 hour had a lowest value (6.62 cm).

3.3. Seedling dry weight (mg)
The results in Table (5) indicate that the soaking of wheat seeds with MnNPs at a 1000 mg L⁻¹ significantly superior and gave the highest mean of seedling dry weight (12.10mg) compared with control treatment which gave the lowest (8.38mg). The reasons of an increasing of seedling dry weight when the soaking of seeds with MnNPs at a 1000 mg L⁻¹ may be due to superior in the radicle length (Table 3) and shoot length (Table 4). Regarding the soaking period, the seeds soaking for 24 hour significantly superior and achieved the highest mean of seedling dry weight (11.95 mg) compared with seeds soaking for 6 hour which achieved the lowest (902 mg). The interaction between two factors had a significant effect on the seedling dry weight; the seeds soaking with MnNPs at a 1000 mg L⁻¹ for 24 hours had a highest value (13.29mg) while the seeds soaking with distilled water for 6 hour had a lowest value (5.91mg).
Table 2. The effect of soaking the seeds with MnNPs on seedling strength index and seedling dry weight (mg)

| MnNPs (mg.L) | Seedling dry weight (mg) | Seedling strength index |
|--------------|--------------------------|-------------------------|
|              | Soaking time (hour)      | Avera                   |
| 500          | 6                        | 9.1                     |
|              | 12                       | 10.1                    |
|              | 24                       | 10.21                   |
|              | 4                        | 96                      |
|              | 8                        | 08                      |
| 1000         | 10                       | 12.10                   |
|              | 19                       | 07                      |
|              | 22                       | 05                      |
|              | 24                       | 0                       |
| 1500         | 10                       | 12.7                     |
|              | 17                       | 07                      |
|              | 19                       | 05                      |
|              | 22                       | 03                      |
|              | 24                       | 00                      |
| Water        | 5.9                      | 8.38                    |
|              | 10                       | 10.22                   |
|              | 9                        | 10.48                   |
|              | 9                        | 10.53                   |
|              | 4                        | 10.42                   |
| 0.53         | 0.93                     | 0.53                    |
| Average      | 9.0                      | 10.15                   |
|              | 11.9                     | 10.17                   |
|              | 15                      | 17                      |
|              | 200                      | 62                      |
| LSD 5%       | 0.46                     | 54                      |

3.4. Seedling strength index
The results in Table (6) show that the soaking of wheat seeds with MnNPs at 1000 mg L⁻¹ significantly superior and gave the highest mean of seedling strength index (2190) compared with control treatment which gave the lowest (1288). Regarding the soaking period, the seeds soaking for 24 hour significantly superior and achieved the highest mean of seedling strength index (2003) compared with seeds soaking for 6 hour which achieved the lowest (1541). The reason of an increasing of seedling strength index when the soaking of seeds with MnNPs at a 1000 mg L⁻¹ may be due to superior in the standard laboratory germination in the final count (Table 2), radicle length (Table 3) and shoot length (Table 4). The interaction between two factors had a significant effect on the seedling strength index; the seeds soaking with MnNPs at a 1000 mg L⁻¹ for 24 hours recorded the highest value (2460) whereas the seeds soaking with distilled water for 6 hour recorded the lowest value (1096).

4. Conclusion
We conclude that the nano-manganese, especially at a 1000 mg L⁻¹ concentration has an important and positive role in improving the germination characteristics and growth of wheat seedlings in a way that can contribute to improving the field establishment and improve the later growth stages of the plant and its yield.

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