Effect of Spraying with Nano Silica and Water Salinity Levels on Growth and Yield of Wheat

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Abstract

A field experiment was carried out during the winter season 2020-2021 at research station of the College of Agriculture, University of Al-Muthanna (Al - Bandar) to study the effect of spraying with nano silica and salinity levels of irrigation water on the growth and yield of wheat. The experiment was applied in a strip split plot design. With three replications, the spraying included three concentrations of silica (3, 6, 9 ppm) and three concentrations of irrigation water salinity (3, 6, 9 ds m⁻¹). The results indicated that the level of 9 ppm sprayed exceeded significantly in the following traits and gave the highest means.: plant height 84.26 cm, number of tillers 354.10 m⁻² tillers, area of flag leaf 40.19 cm², spike length 9.89 cm, number of spikes 288.93 m⁻² and yield 4.27 tons ha⁻¹. The results also indicated that the increase in salinity level led to a decrease in the characteristics of plant height 82.22 cm, number of tillers 319.43 m² tillers, area of flag leaf 39.93 cm², spike length 9.19 cm, number of spikes 260.13 m², and yield, which amounted to 3.86 tons ha⁻¹.

Keywords: Salinity, Spraying, Wheat, Nano.

1. Introduction

Wheat is one of the medium-tolerant crops to salinity, and its production is greatly affected by environmental factors, especially alkalinity and salinity of irrigation water. Salinity affects the reduction of wheat plant growth by negatively affecting the ability of the plant to absorb water from the soil, as well as negatively affecting the metabolic activities [1]. It was found that treating the plant with silica compounds leads to the entry of silica into the composition of the cell walls and the formation of polymers (large molecules) containing silicon that make the cell walls more solid and thus resistant to the penetration of fungi and the plant becomes more resistant to fungal diseases. In studies on the toxicity of heavy metals to plants and environmental stress resulting from soil salinity, irrigation water, drought, high temperatures or frost, so treatment with silica compounds had protective effects as it activates antioxidant enzymes such as the enzyme Sawyer oxide dismutase and the enzyme catalase, which play a role Significant in plant resistance to environmental stress. Silicon is one of the nutrients and plays an important role in raising the efficiency of water use. A study showed that plants treated with 5 mmol of water showed 50% higher water use efficiency than the comparison plants, and it increased to 12% when plants were shown For water and saline stress, due to decreased transpiration from stomata and increased accumulation of proline, calcium ion and chlorophyll, and an excellent thick layer of silica gel bound to cellulose of epidermal cell walls was found to help reduce water loss [2].

It is about 20% of the irrigated land in the world is exclusively affected by salinity, which is classified as arid and desert and constitutes 25% of the total area of our planet [3]. Stresses creates ionic and osmotic on plants [4]. These pressures can vary with salinity’s [3]. Salt stress is abiotic stress that can affect growth plant and physiological and bio activities such as photosynthesis activity and chlorophyll content [5,6]. Chlorophyll leaves under salt stress damage and that causes decreased photosynthesis [7]. It also reduces the chlorophyll content in leaves of barley plants under saline conditions [8]. Osmotic pressure due to Na⁺ increase and environment inhibition reduces the osmotic potential of the soil solution and subsequently plant root water uptake [9]. this study aimed to introduced the effect of the spraying nano-silica and the salinity levels of water on the growth and yield of wheat.

2. Materials and Methods

A field experiment in winter season 2020-2021 at research station of the College of Agriculture, Al-Muthanna Un. (Al-Bandar region) with the aim of knowing the effect of nano-silica spraying and salinity levels of Salts water on the growth and yield of wheat in soils whose specifications are in Table (1), the experiment was applied in the strip split plot design, with
three replications, included three concentrations of nano-silica (3, 6, 9 ppm) and three concentrations of irrigation water salinity (3, 6, 9 ds m⁻¹), and the experimental unit was with an area of 2 m² and included Five lines with a length of 2 meters for each line, the distance between the lines is 20 cm, with a seeding rate of 120 kg hectares. Also, 46% nitrogen fertilizer was added urea at a rate of 200 kg per hectare and in two stages, the first at planting and the second after 45 days of planting and phosphate fertilizer in the form of triple superphosphate (pure). Irrigation and weeding were also conducted when needed. Ten plants were taken from the experimental units and randomly from the experimental units, and the following characteristics were measured, including plant height, flag leaf area, number of spikes, number of spikes, spike length, number of spikelet’s and yield. The data were statistically analyzed using the Genstat 12 program. Comparisons were also made by testing the least significant difference at a significant level.

| soil texture | sand % | clay% | silt% | K) mg/kg soil( | P ) mg/kg soil( | N) mg/kg soil( | EC(ds.m) | PH |
|-------------|--------|-------|-------|---------------|---------------|-------------|---------|-----|
|             | 38     | 24.00 | 38    | 0.75          | 8.12          | 18          | 3.2     | 8.1 |

3. Results and Discussion

3.1 Plant Height (cm)

The results of table (2) showed a significant effect of the levels of silica spray and salinity. It is clear from the results of Table (2) that the increase in the level of silica achieved increase at the high of plant. The spraying level was significantly superior to 9 ppm and gave the highest mean plant height of 84.26, with increase 3% compared to concentrate 3 ppm, which was 82.37 cm. A reason is the role of silicon in increasing the efficiency of water use under stress by increasing calcium, potassium and antioxidants and maintaining the chlorophyll content and this was reflected in maintaining the swelling and elongation of cells positively, these results agree with [10,11]. results at Table (2) also refers a decrease in plant height with an increase in salinity level. The treatment of 3 ds m⁻¹ gave the highest plant height, reaching 85.37 cm, while treatment 9 ds m⁻¹ gave the lowest plant height, reaching 82.22 cm. The reason may be due to the fact that the increase in salt stress on the crop for the growth stages from the tillers until the completion of flowering, which includes the elongation stage, has affected the shortening of the internodes, which led to a negative effect on the height of the plant. This result is found by [12].

| salinity concentrations (ds m⁻¹) | Silica levels (ppm) | Mean |
|---------------------------------|---------------------|------|
|                                 | 3                   | 6    | 9    |
| 3                               | 83.22               | 86.22| 86.67| 85.37|
| 6                               | 82.11               | 83.78| 82.67| 82.85|
| 9                               | 81.78               | 81.44| 83.44| 82.22|
| Mean                            | 82.37               | 83.81| 84.26|      |
| L.S.D0.05                       | S                   | Si   | S*   | Si   |
|                                 | 2.19                | 2.19 | Ns   |

3.2 Number of tillers m²

The results of Table (3) showed a significant effect of silica spray, salinity levels and the interaction between them on the number of tillers / m². the results of Table (3) showed that the increase in the level of silica achieved a significant increase in the number of tillers / m², the spraying level was significantly superior to 9 ppm and gave the highest mean number of tillers / m² amounted to 354.10 tillers / m² with increase 2% compared to the treatment 3 ppm that gave 348.60 tillers / m². results of Table (3) also indicated a decrease number of tillers / m² with increase in the level of salinity, and the treatment of 3 ds m⁻¹ reached the highest number of tillers / m² as it was 376.93 tillers / m² while the treatment of 9 ds m⁻¹ gave the lowest number of tillers / m² as it amounted to 319.43 tiller / m². The reason may be due to the increased salt stress on the crop for the stages of growth from tillering to completion of flowering. The interaction between silicon and salinity had a significant effect if the combination of (3 ds m⁻¹ + 9) ppm gave the highest height of 393.0 tillers/m².
Table 3. Effect of silica spray and salinity of irrigation water on Number of tillers/m².

| salinity concentrations (ds m⁻¹) | Silica levels (ppm) | Mean   |
|----------------------------------|---------------------|--------|
| 3                                |                     |        |
| 3                                | 358.6               | 379.2  |
| 6                                | 365.4               | 349.2  |
| 9                                | 321.8               | 331.9  |
| Mean                             | 348.60              | 353.43 |
| L.S.D0.05                        | S*Si                | 2.54   |

3.3 Area of the flag leaf (cm²)

The results of Table (4) showed that there was a significant effect of the levels of silica spray and salinity and the interaction between them on the leaf area cm². The results in Table (4) showed that increase in the level of silica achieved a significant increase in the Area of the flag leaf, the spraying level was significantly superior to 9 ppm and gave 40.19 cm² increase of 2% compared to treatment of 3 ppm it was 39.30 cm² and the increase is attributed to the fact that silicon helps to increase the size of the chloroplasts and increase the number of cells and increase the number of grana units [13] and these results agree with [12]. The results Table (4) also a decrease in the leaf area cm² with an increase in the level of salinity, and the treatment of 3 ds m⁻¹ gave the highest leaf area cm² as it reached 42.04 cm² while the treatment 9 ds m⁻¹ gave the lowest leaf area as it reached 39.93 cm². The interaction between silicon and salinity had a significant effect if the combination of (3 ds m⁻¹ * 9 ppm) gave the highest leaf area 44.89 cm².

Table 4. Effect of spraying silica and salinity of irrigation water on the area of the flag leaf cm².

| salinity concentrations (ds m⁻¹) | Silica levels (ppm) | Mean   |
|----------------------------------|---------------------|--------|
| 3                                |                     |        |
| 3                                | 38.78               | 42.44  |
| 6                                | 40.00               | 37.00  |
| 9                                | 39.11               | 41.00  |
| Mean                             | 39.30               | 40.15  |
| L.S.D0.05                        | S*Si                | 0.39   |

3.4 Spike length (cm)

The results showed table (5) there was effect of the levels of silica spray and salinity on the length of the spike (cm) was significant. It is clear from the results Table (5) that the superior in the level of silica achieved a significant increase in the length of the spike. The spray level was significantly superior to 9 ppm and gave the highest mean length of the spike. (cm) was 9.89 cm and increase 6% compared to 3 ppm, was reach 9.33 cm. results of Table (5) also indicated a decrease in the spike length (cm) with an increase in the salinity level, and the treatment of 3 ds m⁻¹ gave the highest spike length cm² as it reached 9.96 cm, while the treatment 9 ds m⁻¹ gave the lowest spike length, which amounted to 9.19 cm. The interaction silicon with salinity had a high significant if the combination of (3 ds m⁻¹ * 6 ppm) gave the highest spike length of 10.33 cm.

Table 5. Effect of spraying silica and salinity of irrigation water on spike length cm.

| salinity concentrations (ds m⁻¹) | Silica levels (ppm) | Mean   |
|----------------------------------|---------------------|--------|
| 3                                |                     |        |
| 3                                | 9.89                | 10.33  |
| 6                                | 8.89                | 9.89   |
| 9                                | 9.22                | 8.67   |
| Mean                             | 9.33                | 9.63   |
| L.S.D0.05                        | S*Si                | 0.28   |

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3.5 Number of spikes m²

The results of Table (6) showed a significant effect of the levels of silica spray and salinity and the interaction between them on the number of spikes m². It is clear from the results of Table (6) that the increase in the level of silica achieved a significant increase in the length of the spike, the spraying level was significantly superior to 9 ppm and gave the highest mean number of spikes m² where it amounted to 297.83 spikes / m² with increase 4% compared to 3 ppm it was 288.93 spikes m² the effective of silica in the photo-synthesis process and the rate of synthesis (a,b) through the increase in the proportion of photo-chlorophyll and the behavior of stomata and the reduction of The rate of transpiration in the leaves, which means an increase in the efficiency of photosynthesis. The results of Table (6) also indicated a decrease in the number of spikes m² with an increase in the level of salinity, and the treatment of 3 ds m⁻¹ gave the highest number of spikes m², which amounted to 307.63 spikes m², while the treatment of 9 ds m⁻¹ gave the lowest number of spikes m², which amounted to 260.13 spikes m². The interaction between silicon and salinity had a significant effect if the combination of (3 ds m⁻¹ * 3 ppm) gave the highest number of spikes 314.9 spikes m².

Table 6. Effect of silica spray and irrigation water salinity on the number of spikes/m².

| salinity concentrations (ds m⁻¹) | Silica levels (ppm) | Mean |
|---------------------------------|---------------------|------|
| 3                               | 3                   | 311.9 |
| 6                               | 6                   | 296.1 |
| 9                               | 9                   | 307.63|
| Mean                            |                     | 287.1 |
| L.S.D0.05                       | S                   | 8.33  |
|                                 | Si                  | 8.33  |
|                                 | S* Si               | 14.42 |

3.6 number of spikelet’s

The results of Table (7) showed a significant effect of salinity levels on the number of spikelets and interaction with silica levels. The results of Table (7) also indicated a decrease in the number of spikelets with an increase in the level of salinity, treatment of 3 ds m⁻¹ gave a high number of spikelets, as the number of spikelets was 18.26 spikelets, while the treat of 9 ds m⁻¹ gave the lowest number of spikelets of 17.78 spikelets, and the interaction between silicon and salinity had a significant effect, treatment (3 ds m⁻¹ * 6 ppm) gave The highest number of spikes is 18.89 spikelets.

Table 7. Effect of silica spray and irrigation water salinity on the number of spikelets.

| salinity concentrations (ds m⁻¹) | Silica levels (ppm) | Mean |
|---------------------------------|---------------------|------|
| 3                               | 3                   | 17.78 |
| 6                               | 6                   | 18.26 |
| 9                               | 9                   | 17.78 |
| Mean                            |                     | 18.04 |
| L.S.D0.05                       | S                   | 0.56  |
|                                 | Si                  | 0.97  |
|                                 | S* Si               | 17.55 |

3.7 Yield (ton ha⁻¹)

The results of Table (8) was a significant effect the silica spray and salinity and the interaction between them on the total yield. It is clear from the results of Table (8) that the increase in the level of silica achieved a significant increase in the total yield. The spraying level was significantly superior 9 ppm and gave the highest mean of the total yield. It reached 4.27 tons ha⁻¹, increase of 6% compared to treatment 3 ppm, it reached 4.02 tons ha⁻¹. The results of Table (8) also indicated a decrease in the total yield with an increase in the level of salinity, and the treatment of 3 ds m⁻¹ gave the highest total yield, which amounted to 4.47 tons ha⁻¹, while the treatment of 9 ds m⁻¹ gave the lowest total yield, which amounted to 3.86 tons ha⁻¹. Silicon and salinity had a significant effect if the combination of (3 ds m⁻¹ * 6 ppm) gave the highest grain yield of 4.68 tons ha⁻¹.
Table 8. Effect of Silica spray and salinity of irrigation water on yield, ton/ha.

| Salinity concentrations (ds m⁻¹) | Silica levels (ppm) | Mean  |
|----------------------------------|--------------------|-------|
| 3                                | 4.46  4.68  4.28  4.47 |
| 6                                | 4.29  4.26  4.26  4.27 |
| 9                                | 3.30  4.01  4.27  3.86 |
| Mean                             | 4.02  4.32  4.27  |
| L.S.D.0.05                       | 0.06  0.06  0.11  |

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