Study of The Effect of Salt Stress and Kinetin and Their Interaction on The Growth and Yield of Wheat (Triticum Aestivum L.)

Zahra Hussein Al-Khafaji¹ and Fouad Razzaq Al-Burki²

¹College of Agriculture, Al-Muthanna University, Iraq.
²Desert Studies Center and Lake Sawa and college of agriculture, Al-Muthanna University, Iraq.

Email: foadrazzaq.fr@gmail.com

Abstract

A field experiment was conducted at the first station of the College of Agriculture/ University of Al-Muthanna for the agricultural season 2020-2021, with the aim of studying the effect of treatment with salinity stress and kinetin on the growth and yield of the wheat (Triticum aestivum L.) cultivar of Bohooth22. The experiment was applied by split plates design using a randomized complete block design (R.C.B.D) with three Replicators of 36 experimental units The main units included levels of irrigation water salinity (2.5, 5, 7.5, 10) ds/m, while the secondary units included levels of kinetin (0, 30, 60 Ppm). The results of the statistical analysis showed a significant difference in the salinity of the high irrigation water in most growth traits such as plant height, flag leaf area, number of tillers plant⁻¹, spike length (cm) and number of days to physiological maturity (day) at a rate of (.5473, 14.912, 3.222, 9.176, 143.67) respectively, and the traits of the yield and its components represented by the number of spikes. m², number of grains per spike, weight of 1000 grains (gm), grain yield (ton ha⁻¹) and biological yield (ton ha⁻¹) at a rate of (300.06, 35.39, 31.60, 3.52, 9.46) respectively, while soaking the seeds with kinetin led to a significant increase in most of the studied traits. Thus, we conclude that salt stress has a negative role on the growth stages of the vegetative plant, and this leads to the reduction of the yield and its components.

Keywords: Salinity, Kinetin, Wheat, Bohooth22.

1.Introduction

Wheat is one of the oldest field crops known to human and one of the first crops to be planted and harvested within the fertile crescent. It is a crop that is grown and consumed as a staple food in more than 40 countries in the world, which provides humans with more than 20-25% of calories to provide 55% of carbohydrates, (65-75) % sugars, (2-6)% lipids and (12-14)% water, as well as micro nutrients and vitamins all distributed unevenly within the tissue parts of the grain [1]. The wheat crop ranked first in Iraq and the world in terms of area cultivated and highly reliable in bridging the food gap with the steady increase in population, the cultivated area in Iraq for the winter season 2019 was estimated at 6331 thousand dunums, with a production of 4343 thousand tons (Directorate of Agricultural Statistics, 2019). The agricultural sector in the world has become facing several challenges, especially in developing societies, and among these challenges are biotic and abiotic stresses that cause physiological disturbance of the plant and affect its growth and yield, which is called stress or plant stress, and salt stress is the second most important abiotic stress after drought, which Significantly affects the expansion of the production of this crop, and this problem will increase in the coming years due to the decreasing water supply and the high percentage of salinity of agricultural lands, as well as other reasons. On the element transport chain, salt stress reduces the activity, activity and ability of cells to divide, which leads to a decrease in agricultural crop production [2]. [3] observed, when studying the effect of four levels of salinity (1.3, 7, 14, 21) ds/m in the wheat plant, a significant decrease in the traits of the flag leaf area, the number of spikes, the number of grains in the spike, and the grain yield at an average of (27.52 cm², 425 m² spike, 34.21 grain spike⁻¹, and 2.88 tons ha⁻¹) respectively[4]. indicated in his study the effect of three levels of irrigation water salinity on the presence of a significant decrease in the traits of plant height, dry weight rate, weight of 1000 grains and grain yield rate when the level of salinity of irrigation water increased, which was confirmed by [5]. The traits of plant height, dry weight, weight of 1000 grains, number of spikes decreased significantly when increasing the salinity concentration in the irrigation water, number of straws, plant-1, flag leaf area, spike length, number of spikes, number of grains per spike, grain yield and biological yield. In order to reduce the effect of salinity on the plant, means can be used to solve this problem, including the use of encouraging plant growth regulators. Cytokines are the most important of those organizations used to reduce the negative effects of this problem [6].

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In recent years, researchers and plant breeders have adopted a number of strategies to improve plant performance under stress conditions that help it to withstand salt stress, such as plant hormones that reduce the effects caused by plant exposure to stress and to control the stimulation or delay of the processes of maturation and aging in the plant [7]. Kinetin is one of the most important cytokines that are important in increasing germination and stimulating the growth of various plants by improving the signal transduction system and aiding cell division [8] and regulating the work of enzymes that transport sugars and reduce nitrates [9], there were significant differences in the yield and qualitative traits of plants when using kinetin as a spray on the plant at two levels of (5, 10 Ppm), which led to an increase in plant height, leaf area, number of spikes, number of grains per spike, and number of spikes. [10], was found that soaking wheat seeds with kinetin increased the yield of grains and its components when irrigated with saline water, as the trait of the number of spikes was recorded as an average of (298) spikes m⁻¹ compared to the control treatment, which recorded (279) spikes m⁻², as for the weight of the 1000 grains, it reached (27.6) gm compared to the control treatment of (23.5) g, and the number of grains of spike was (43.3) with spraying treatment compared to the control treatment of (37.0) grains, spike with spray treatment and the higher grain yield by registering (263.9) gm m⁻² in the soaking treatment compared to the control treatment (190.0) gm m⁻², as noted by (Abdul-Razzaq, 2015) that soaking the seeds with kinetin has an important role in increasing the wheat yield, the two recipes weighing 1000 grains and the harvest guide. The aim of this experiment is Study of the effect of salt stress and kinetin on the growth and yield of wheat (cultivar of Bohooth2).

2.Materials and Methods

A field experiment was carried out during the winter agricultural season (2020-2021) in 15 November at the first agricultural research station of the College of Agriculture, Al-Muthanna University. The chemical and physical analyzes of the field soil shown in the table No. (1) were carried out in the Soil Chemistry Laboratories at the University of Al-Muthanna- College of Agriculture.

| Table 1. Some physical and chemical properties of the experimental field soil. |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Physical properties | Chemical properties |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| O.M | K | P | N | Silt | Sand | Clay | EC | pH |
| kg/ gm | % | ds/m | - |
| 5.1 | 240 | 3.2 | 7.3 | 47 | 6 | 47 | 6.5 | 7.4 |

Split plot design using a randomized complete block design (R.C.B.D) with three replications and at 36 experimental units, (obtained from the Genetic Bank- Field Crops dept., College of Agri., Al-Muthanna univ.) were sown in ten lines within one plate, with a seed quantity of 120 kg ha⁻¹, which is equivalent to (3.4) grams of seeds per line. It included four main units which took the levels of irrigation with saline water (2.5 as a control treatment with river water, 5, 7.5, 10 ds/m) and three secondary units which took three levels of kinetin (0, 30, 60 Ppm) by soaking the seeds, as the seeds were sterilized Seeds with sodium hypochlorite (0.5% for 5 minutes), then the seeds were washed well with distilled water, and then soaked with kinetin concentrations for 3 hours and planted directly in the field with soil of mixed clay texture and salinity rate of 5.6 ds/m in the plates assigned to them, and the concentrations of (30 and 60 Ppm) were obtained from the hormone solution by dissolving (30 and 60) mg of kinetin in a liter of distilled water (Produced by Direvo Industrial Biotechnology /Germany, obtained from Al-Bashir’s office/Baghdad). The weeding process was carried out manually and whenever needed, the field was irrigated as needed and depending on the humidity of the field (the treatment was done with salt water by irrigation the plants after germination was achieved from the first irrigation) and The harvest was carried out after the plants had reached the stage of full physiological maturity and all their parts were yellow. The traits of vegetative growth and yield components were measured and their data were statistically analyzed according to the design of the experiment, and the least significant difference (L.S.D) with a probability level of 0.05 was used, using the Genstat program in order to compare the averages of the treatments.

3.Results and Discussion

The effect of salinity levels on vegetative growth traits. The results of the statistical analysis in table No. (2) showed significant differences in the salinity of irrigation water in the vegetative growth traits. The concentration (10ds/m) showed the lowest average of all the traits: plant height (cm), flag leaf area (cm²), the tiller plant⁻¹ trait, the trait of spike length and the number of days to physiological maturity trait which reached (73.54 cm) plant height, (14.912 cm²) flag leaf area, (3.222) No. tillers Plant⁻¹, (9.176) spike length (cm), (143.67) the number of days to physiological maturity, compared to the lowest salt concentration (2.5 ds/m), which recorded the highest averages of all the traits: plant height (cm), flag leaf area (cm²), the tiller plant-1 trait, the trait of spike length and the number of days to physiological maturity trait which reached (97.24 cm)
plant height, (20.923 cm²) flag leaf area, (4.511) No. tillers Plant⁻¹, (12.711) spike length (cm), (149.89) the number of days to physiological maturity.

Table 2. Effect of salinity on vegetative growth traits.

| Studied traits | Plant height (cm) | Flag leaf area (cm²) | No. tillers Plant⁻¹ | spike length (cm) | No. of days to physiological maturity |
|----------------|-------------------|----------------------|---------------------|------------------|--------------------------------------|
| Salinity levels|                   |                      |                     |                  |                                      |
| S1             | 97.24             | 20.923               | 4.511               | 12.711           | 149.89                               |
| S2             | 97.96             | 21.740               | 3.778               | 11.811           | 152.67                               |
| S3             | 81.31             | 16.869               | 3.333               | 11.444           | 145.56                               |
| S4             | 73.54             | 14.912               | 3.222               | 9.176            | 143.67                               |
| L.S.D (0.05)   | 1.429             | 0.4241               | 0.1947              | 0.2844           | 1.545                                |

The reason of the decrease in plant height is due to its growth in a saline environment (in its early stages of growth, such as tillers and elongation, [10] and the reason for the low content of chlorophyll in the flag leaf is attributed to the water stress caused by salinity, which reduced the amounts of chlorophyll by impeding its accumulation [11]. Concerning the decrease in the number of tillers, it occurred from salinity stimulating the apical dominance, which leads to a reduction in their number, these results are consistent with [12], who indicated decreased vegetative growth characteristics under the influence of salt.

3.1 The effect of salinity on the yield and its components

The results of the statistical analysis in table (3) showed that there were significant differences for the salinity of irrigation water on the yield and its components trait of Bohooth22 cultivar plants. The concentration (10ds/m) showed the lowest average of all the traits: the number of spikes (m⁻²), the number of grains in the spike, the weight of 1000 grains, of the grain yield, the biological yield ton ha⁻¹, which reached (300.06) spike m⁻², (35.39) grain spike⁻¹, (31.60) gm, (3.52) ton ha⁻¹, (9.46) ton ha⁻¹ respectively, compared to the lowest salt concentration (2.5 dS/m), which scored the highest averages of the same traits: (382.02) spike m⁻², (53.87) grains spike⁻¹, (44.28) gm, (4.81) tons ha⁻¹, (11.08) tons ha⁻¹ respectively. The decrease in the number of spikes is due to the water stress caused by irrigation with saline water in the early stages of growth, which causes a 30% decrease in their number [13]. As for the grain yield, it was reduced due to the decrease in its components and the disruption of the relationship between the source and the sink due to salinity [14], these results are consistent with [15], which indicates decreased on the yield and its components traits under the influence of salt.

Table 3. Effect of irrigation water salinity on yield and its components.

| Studied traits | Spikes No. (cm²) | Grains No. in spike | Weight of 1000 grains | Grain yield (ton ha⁻¹) | Biological yield (ton ha⁻¹) |
|----------------|-----------------|--------------------|-----------------------|------------------------|---------------------------|
| Salinity levels|                 |                    |                       |                        |                           |
| S1             | 382.02          | 53.87              | 44.28                 | 4.818                  | 11.087                    |
| S2             | 441.76          | 47.92              | 44.12                 | 4.642                  | 10.891                    |
| S3             | 329.12          | 40.73              | 34.52                 | 3.964                  | 9.874                     |
| S4             | 300.06          | 35.39              | 31.60                 | 3.528                  | 9.463                     |
| L.S.D (0.05)   | 2.040           | 0.617              | 0.938                 | 0.1494                 | 0.2638                    |

3.2 Effect of kinetin levels on vegetative growth traits

The results of the statistical analysis in table (4) showed that there were significant differences when treated with kinetin levels in the vegetative growth traits. The concentration (60 Ppm) recorded the highest average of all the traits: plant height (cm), the flag leaf area (cm²), the number of tiller per plant, the spike length cm, the number of days to physiological maturity, which reached (89.76) cm, (21.797) cm², (4.033), (11.917) cm and (148.25) days respectively, compared to the control treatment, which recorded the lowest average of (84.21) cm, (16,288) cm², (3,433) tillers plant⁻¹, (10.633) cm (147.58) days respectively. The reason of the increase in plant height is due to the role of kinetin in stimulating the division and elongation of plant cells [15], and the increase in the flag leaf is also due to the role of cytokinin in delaying their aging, stimulating the formation of plastids and increasing the elongation of cells [16], these results are consistent with [17], Which indicated an increase in vegetative growth traits under the influence of kinetin.
Table 4. Effect of kinetin on vegetative growth traits.

| Kinetin levels | Plant height (cm) | Flag leaf area (cm²) | No. tillers Plant⁻¹ | spike length (cm) | No. of days to physiological maturity |
|----------------|-------------------|----------------------|----------------------|-------------------|--------------------------------------|
| K1             | 84.21             | 16.288               | 3.433                | 10.633            | 147.58                               |
| K2             | 88.58             | 17.748               | 3.667                | 11.307            | 148.00                               |
| K3             | 89.76             | 21.797               | 4.033                | 11.917            | 148.25                               |
| L.S.D (0.05)   | 1.237             | 0.3673               | 0.1686               | 0.2463            | 1.338                                |

3.3 Response of yield and its components to levels of kinetin

The results of the statistical analysis in table (5) showed a significant effect of kinetin levels in the yield and its components. The concentration (60 Ppm) recorded the highest average of all the traits: the number of spikes m⁻², the number of grains in the spike, weight of 1000 grains, gm, grain yield (tons ha⁻¹) and the biological yield (ton. ha⁻¹) which reached (376.18) spike m⁻², (51.97) grains, (41.80) gm, (4.478) tons ha⁻¹ and (10.801) tons ha⁻¹ respectively, compared to the control treatment, which recorded the lowest average of (345.83) spike m⁻², (37.20) grains, (36.04) gm, (3.989) tons ha⁻¹ and (9.878) tons ha⁻¹, respectively. The increase in the number of spikes is due to the role of kinetin in increasing the tillers (8). The increase in grain yield is also due to the increase in its components resulting from the role of kinetin in promoting growth, while the biological yield may be due to the role of kinetin in increasing plant height and number of tillers through increasing the efficiency of the photosynthesis [18], these results are consistent with [19], who indicated that the use of kinetin led to an increase in yield components, in addition to an increase in the plant height, leaf area, number of tillers.

Table 5. Effect of kinetin on yield and its components.

| Kinetin levels | Spikes No. (cm²) | Grains No. in spike | Weight of 1000 grains | Grain yield (ton ha⁻¹) | Biological yield (ton ha⁻¹) |
|----------------|------------------|--------------------|-----------------------|------------------------|---------------------------|
| K1             | 345.83           | 37.20              | 36.04                 | 3.989                  | 9.878                     |
| K2             | 367.71           | 44.26              | 38.05                 | 4.247                  | 10.308                    |
| K3             | 376.18           | 51.97              | 41.80                 | 4.478                  | 10.801                    |
| L.S.D (0.05)   | 1.767            | 0.534              | 0.813                 | 0.1294                 | 0.2285                    |

3.4 The effect of the interaction between salinity and kinetin on the traits of vegetative growth

Figure 1. The effect of the interaction between the salinity and kinetin on the plant height.
Figure 2. The effect of the interaction between the salinity and kinetin on the flag leaf.

The results of the Figure (1) showed that there was a significant difference in the effect of the interaction between the salinity of irrigation water and the levels of kinetin on the plant height. The interaction treatment (K2S1) gave the highest mean of (99.47) cm compared to treatment (K1S4), which recorded the lowest average of (65.82) cm, these results are consistent with [20]. The results of Figure (2) showed a significant difference in the effect of the interaction between the salinity and the levels of kinetin in the trait of the area of the flag leaf, as the treatment (K3S2) showed the highest mean of (25.947) cm compared to the treatment (K1S4), which gave the lowest average reached (12.213) cm², the reason for the increase in the flag leaf area under the influence of salinity is due to the role of kinetin in reducing the effect of salt stress on the wheat plant by stimulating the photosynthesis process and increasing the pigment content in the leaf [21].

Figure 3. The effect of the interaction between the salinity and kinetin on number of straws plant⁻¹.

The results of Figure (3) showed a significant difference in the effect of the interaction effect between the salinity of irrigation water and the levels of kinetin in the trait of the number of straws. Plant⁻¹, as the treatment (K3S1) gave the highest mean of (5) tiller Plant⁻¹, compared to treatment (K1S4), which recorded the lowest mean of (3.067), the increase in the tillers number under the influence of salinity is due to the role of kinetin in increasing cell division and inhibiting apical dominance, and thus it increases the apical meristem in the plant [22].

Figure 4. The effect of the interaction between the salinity and kinetin on spike length.
The results of Figure (4) showed that there was a significant difference in the effect of the interaction between the salinity of irrigation water and the levels of kinetin in the trait of spike length (cm), as the interaction treatment (K3S1) gave the highest mean of (13.867) cm compared to treatment (K1S4), which recorded the lowest average of (8.533) cm, the increase in spike length under the influence of interference treatment is attributed to the role of growth regulators and fresh water in increasing the number of spikelets in addition to the efficiency of photosynthesis, and this is reflected positively in the increase in spike length, and these results are consistent with what was found [23]. The results of the statistical analysis in Figure (5) also showed a significant difference in the interaction effect between the salinity of irrigation water and the levels of kinetin in the character of the number of days to physiological maturity, as the treatment (K1S2) recorded the highest average of 154.00 days compared to the treatment (K2S4), which gave the lowest average of 142.67 days. The increase in the number of The days in the interference treatment are due to the role of kinetin in giving the plant a longer period to fill the grains and delaying the aging of leaves [24].

3.5 The effect of the interaction between the salinity and kinetin on number of days to physiological maturity.

The results of the statistical analysis in Figure No. (6) showed that there was a significant difference in the effect of the interaction between the salinity of irrigation water and the levels of kinetin in the trait of the number of spikes/m², the treatment (K2S2) recorded the highest average of (458.50) compared to treatment (K1S4) which gave the lowest average of (280.83), these results are consistent with (2), which indicated an increase in the number of spikes under the influence of salt stress and kinetin. The results of the statistical analysis in Figure (7) showed that there was a significant difference in the effect of the interaction between the salinity of irrigation water and levels of kinetin in the trait of the number of grains in the spike, as the treatment (K1S3) recorded the highest average of 64.07 compared to the treatment (K1S4) which recorded the lowest average of 28.60. The increase in the number of grains in the spike is due to the role of growth regulators in encouraging vegetative growth and increasing the area of the flag leaf, as well as the increase in the relative water content, which made a significant contribution to producing the highest average number of grains in the spike, and these results are consistent with [25].
Figure 7. The effect of the interaction between the salinity and kinetin on number of grains in the spike.

The results of the statistical analysis in Figure (8) showed a significant difference in the effect of the interaction effect between the salinity of irrigation water and the levels of kinetin in the weight of 1000 grains. The treatment (K3S2) gave the highest average of (48.13) gm compared to the treatment (K1S4) which recorded the lowest average of (26.30) gm, which is attributed The reason for this increase is the efficiency of absorbing nutrients and the elements necessary for the plant and the speed of the transition of the processed food from the leaves to the fruits and the rest of the components of the crop by forming places to attract nutrients (1), and these results are consistent with [26].

Figure 8. The effect of the interaction between the salinity and kinetin on weight of 1000 grain.

The results of Figure (9) appeared that there was a significant difference in the effect of the interaction between the salinity of irrigation water and levels of kinetin in the trait of grain yield. The interaction treatment (K1S3) gave the highest mean of (5.070) compared to treatment (K1S4) which gave the lowest average of (3.050). The increase in grain yield when adding kinetin is a result of increasing leaf life, delaying its aging, increasing the number of spikes, the number of grains in the spike, and the duration of grain filling, thus the transfer of the largest amount of dry matter to grains [16], and these results are consistent with [17], which indicated an increase in grain yield and an increase in its quality when adding kinetin and treating with salt.

Figure 9. The effect of the interaction between the salinity and kinetin on grain yield.
The results of the statistical analysis in Figure (10) showed a significant difference for the interaction effect between salinity of irrigation water and kinetin levels in the biological yield, only the interaction treatment (K3S1) was recorded the highest average amounted to 11.547 compared to treatment (K1S4), which showed the lowest average amounted to (8.917) tons ha⁻¹, and the increase in biological yield when treating the interference is due to the role of growth regulators in mitigating the effects of salt stress and improving vegetative growth of plants and increasing dry weight [20], these results agree with what was found by [25], that the addition of growth regulators led to an increase in the biological yield in the presence of salt stress.

Figure 10. The effect of the interaction between the salinity and kinetin on biological yield.

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