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Effect of irrigation with saline water and spraying with Nano silica on the growth and yield of several cultivars of wheat (*Triticum* aes*tivum* L.)

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Abstract

A field experiment was conducted at the Second Agricultural Experiment Station of Al-Muthanna University, during the winter season (2021-2022) in order to study the growth and yield of three cultivars of bread wheat (Furat, Mawaddah, and Russi) to study the effect of spraying with Nano-silica (0, 100 ppm) it was added in two stage and irrigation with saline water (2.5, 5, 10 ds m^{-1}). The experiment was applied in a split-split plot design with three replications, where the most important factor was the cultivars and the sub plot was Nano-silica factor (N), the main panels included the saline irrigation (S). The results of the statistical analysis showed significant differences in the effect of salinity in some of the traits, a decrease was recorded as the number of days to maturity and the spike length, as well as most of the components of the yield also decreased, such as the spikes number, the grains number per spike, grain yield and the biological yield. The Nano-silica also showed a positive effect on the spike length. Regarding the cultivars, Furat excelled in most traits such as plant height, number of tillers, number of days until 50% flowering and to maturity, and number of spikes, while Mawaddah cultivar excelled in 1000-grain weight trait.

Keywords: Wheat, Salinity, Nano silica, cultivar.

Introduction

Wheat is the largest field crop in terms of cultivated area, estimated at (217 million hectares), and it is one of the most important cereal crops grown in different environments due to its adaptive nature all over the world, and its production reached (189 million tons) in the world [1]. Wheat meets more than 20% of people's daily caloric needs, and contains the highest content of carbohydrates and protein among grains [2], and is exploited as a source of straw to feed animals, so its production is directly related to food security [3], and it is a good source for nutrients and energy that contain the main components of food such as vitamins, especially riboflavin, thiamine, niacin and vitamin E, it is also rich in minerals such as phosphorous, magnesium, copper, iron and zinc, and about 36% of the world's population uses wheat as a staple food [4]. Under field conditions, the wheat crop often faces various biotic and abiotic stresses that negatively affect the plant [5], including salinity, as a result of a series of physiological and biochemical changes that affect plant growth and devel-

opment, which is also reflected in productivity [6]. The trait of wheat tolerant to salinity can be improved by employing breeding and genetic improvement methods such as cross-breeding with salinity-tolerant cultivars [7] or introducing and adapting salt-tolerant cultivars or genetic structures, or by adopting genetic engineering techniques and molecular markers [8] or by adding some Nano-fertilizers to improve and raise the efficiency of the plant on nutrient absorption and reduce sodium absorption [9]. The Iraqi wheat cultivars suffer from the problem of sensitivity to salinity, which contributed significantly to reducing their growth rates and production, and on this basis our study came with the aim of: Studying the growth and yield traits of cultivars of bread wheat by the effect of spraying with Nano-silica and irrigation with salt water.

Materials and Methods

Executing the experiment

A field experiment was carried out at the second agricultural research station, on 17th November 2021.

Field preparation and agricultural operations:

The aim of studying the growth and yield traits of cultivars of bread wheat by the effect of spraying with Nano-silica and irrigation with saline water. The study included three factors, the first Saline water: (2.5, 5, 10) ds m^{-1}, (control: 2.5 river water), and irrigation was started with saline water a month after the first irrigation. And the second factor: Nano-silica at a concentration (50 ppm) In addition to the control treatment (spraying with normal water), we added 50 mg of Nano- Silica powder (containing 11-13 nm silica prepared from Alfa company of Iran) per 1 liter of water and sprayed on the plant leaves in two stages (tiller stage and booting stage). And the third factor: three cultivar of bread wheat (Furat, Mawaddah and the Russi cultivar). The plot was prepared and divided and the treatments were distributed in a split-split plot design using (R.C.B.D). The salinity factor S was set in the main plots and the Nano-silica factor N in the sub plots, while the third factor (cultivars) by cutting In the sub-sub plots.The experiment field was plowed by two orthogonal plows, then it was smoothed and then leveled, and it was divided into panels with an area of (2 m^2), as the number of experimental units reached 54 with a distance of 0.5 m between them. each unit includes 10 lines of length 1 m, with a distance of 20 cm between the lines.

Soil was analyzed in the USciences laboratory before planting as shown in table (1), then seeds were sown with an amount of (2.4) g per line in order to achieve a plant density (120 kg ha^{-1}) [10]. Fertilization operations were carried out by adding triple superphosphate fertilizer (P2O5%46) at a rate of 100 kg ha^{-1} and in one batch before planting, and the nitrogen fertilization process was carried out using urea fertilizer (N 46%) as a source of nitrogen at a rate of 200 kg ha^{-1} in two batches in the stages of tillering and booting, and 60 kg ha^{-1} of potassium fertilizer was added in the

form of potassium sulfate (41.5% K) and in two batches tillering and booting stage. Irrigation and weeding operations were also carried out as needed .

Table (1): Some chemical and physical properties of the experimental soil before planting

chemical properties	(pH)	ECe (ds m^{-1})	N (mg kg^{-1})	P (mg kg^{-1})	K (mg kg^{-1})
	8.07	16.13	48.02	20.67	186.33
physical properties	Sand (g kg^{-1})	Silt (g kg^{-1})	Clay (g kg^{-1})	Soil texture	
	50.46	40.22	9.32	Loam	

Attributes and measurements studied during the experiment:

Days number to 50% flowering, Days number to physiological maturity, Plant height, Total tillers number, Spike length, Number of fertile spikes, Grains number per spike, Weight of 1000 grains, Grains yield and the biological yield.

Results and Discussion

Effect of salinity, Nano-silica and cultivars on vegetative growth traits

The results of table No. (2) showed that there were insignificant differences in the plant height trait. The trait of the days number to 50% flowering showed non-significant differences. the number of days to maturity showed that there were significant differences, as the first salinity level recorded the highest average (153.28) days compared to the third salt concentration, which gave the lowest average (151.89) days. Salt stress leads the plant to end its life cycle by accelerating the process of grain formation and filling speed and reducing the period of overcoming the stress stage [11]. The results showed that there were insignificant differences in the effect of salinity for the trait of the number of tillers.

The trait of spike length was significantly affected under salinity levels, which gave the highest average of (10.66) cm in the first salinity concentration, compared to the third salinity level gave the lowest average for this trait, which reached (9.09) cm. It may also reduce the orientation of the manufactured dry matter from the source towards the spikes, which causes a reduction in the spike length [12].

Table (2): Effect of salinity levels on vegetative growth traits

Salinity	Height (cm)	Days number to 50% flowering	days to maturity	Tillers (m^{-2})	spike length(cm)
S1 (2.5) ds m-1	89.28	109.89	153.28	617.22	10.66
S2 (5) ds m-1	84.50	110.33	152.28	504.44	9.53

S 3(10) ds m-1	88.06	110.06	151.89	537.80	9.09
L.S.D (0.05)	N.S	N.S	0.367	N.S	0.6864

The results of Table No. (3) showed that the effect of Nano silica on plant height (cm) was not significant.

Its effect was not significant for the Days number to 50% flowering. As for its effect on the trait of the number of days to physiological maturity (day), it was not significant. As for the number of tillers, it was not significant.

As for the trait of spike length, it recorded a significant variation, giving N1 an average of (10.19) cm, while the treatment of N0 gave an average of (9.33) cm. Spraying with Nano silica had a little effect on some traits, as it stimulated the salt tolerance mechanism due to increasing potassium absorption and decreasing sodium absorption, thus enhancing the ratio of potassium/sodium selectivity in leaves [13].

Table (3): Effect of spraying with Nano silica on vegetative growth traits

Nano silica	Height (cm)	days up to 50% flowering	days to maturity	Tillers (m^{-2})	spike length (cm)
0 ppm	88.11	109.89	152.70	548.51	9.33
100 ppm	86.44	110.30	152.26	557.77	10.19
L.S.D (0.05)	N.S	N.S	N.S	N.S	0.7200

From the results of Table (4), it is clear the moral effect of the cultivars on the plant height, as the Furat cultivar gave the highest average of (102.89) cm, while the Mawaddah cultivar recorded the lowest average of (79.06) cm. Genetically, the cultivars differ in most growth traits, especially the lengths of the internodes and the spike lengthholder, which represents nearly half of the plant height in some genotypes. This is consistent with what he found [14]. The cultivars showed a significant difference in the Days number to 50% flowering, as the Furat cultivar gave the highest average of (115.72) days, while the Mawaddah cultivar recorded the lowest average of (107.00) days. It recorded a significant difference in the number of days to maturity, as the Furat cultivar gave the highest average of (160.67) days, while the Mawaddah cultivar reached (143.94) days. This discrepancy was attributed to the extent to which it is affected by the surrounding environmental conditions [15]. And it showed a significant difference in the number of tillers, as the Furat cultivar gave the highest average of (632.22) tiller m^{-2}, while Mawaddah cultivar had the lowest average of (483.33) tiller m^{-2}. Cultivars differ in their ability to form tiller [16]. The results of the same table also showed no significant difference in the length of the spike.

Table (4): Effect of cultivars on vegetative growth traits

Cultivar	Height (cm)	Days number to 50% flowering	Days to maturity	Tillers (m^{-2})	Spike length (cm)
V1 (FURAT)	102.89	115.72	160.67	632.22	9.98
V2 (MAWADDAH)	79.06	107.00	143.94	483.33	9.70
V3 (RUSSI)	79.89	107.56	152.83	543.88	9.60
L.S.D (0.05)	3.574	0.912	0.563	50.45	N.S

Effect of salinity levels and spraying with Nano-silica and cultivars on yield traits

The results of Table (5) showed significant differences in the number of spikes m^{-2} due to salinity, as S2 gave the lowest average for this trait, reaching (437.77) spike m^{-2} compared to S1, which gave the highest mean of (544.44) spike m^{-2}. It affects the failure of spike formation because of its harmful effect, such as reducing the availability of nutrients and the intense competition for the products of the photosynthesis between the main stem and the rest of the tiller, which leads to a reduction in the number of spike-bearing tiller [17]. and the results also showed significant differences in the grains number in the spike, as S1 gave the highest mean for this trait, reaching (57.11) grains $spike^{-1}$, compared to S3, which gave the lowest average of (49.93) grains $spike^{-1}$. the salinty leads to a reduction in the period of spike differentiation, which caused a reduction in the number of fertile florets and the grains number in the spike [18]. While the trait of the weight of 1000 grains showed non-significant differences.The grain yield had a significant difference, as S1 gave the highest average for this trait, which amounted to (4.87) tons ha^{-1}, compared to S3 which gave the lowest average of (3.97) tons ha^{-1}. the sensitivity of the plant to stress in the flowering stage also affects the grain yield [19].

The results showed a significant effect of salinity on the trait of biological yield, as S3 gave the lowest average of (10.17) tons ha^{-1} compared to S1 which gave the highest mean of (13.18) tons ha^{-1}. the reasons [20] are that the reduction of biological yield due to salt stress It may be due to osmotic pressure, ionic imbalance and ionic toxicity.

Table (5): Effect of salinity levels on yield traits

Salinity	spikes m^{-2}	Grains $spike^{-1}$	weight of 1000 grains (gm)	grain yield tons ha^{-1}	biological yield tons ha^{-1}
S1 (2.5) ds m-1	544.44	57.11	44.31	4.87	13.18
S2 (5) ds m-1	437.77	52.85	43.26	4.49	11.62

S 3(10) ds m-1	491.11	49.93	44.07	3.97	10.17
L.S.D (0.05)	48.82	2.66	N.S	0.4965	0.726

Table (6) shows the effect of Nano-silica on All yield components, grain yield and biological yield were not significantly affected.

Table (6): Effect of spraying with Nano silica on yield traits

Nano silica	spikes m^{-2}	grains in the spike	weight of 1000 grains (gm)	grain yield tons ha^{-1}	biological yield tons ha^{-1}
0 ppm	479.25	50.36	44.03	4.28	11.50
100 ppm	502.96	56.23	43.73	4.61	11.81
L.S.D (0.05)	N.S	N.S	N.S	N.S	N.S

From table (7), the cultivars showed a significant variation in the number of spikes as the Furat cultivar gave an average of (585.00) spike m^{-2}, and the lowest average in the Russi cultivar (436.11) spike m^{-2}. This difference may be due to the different cultivars and genetic variance between them [20]. and It showed a significant variation in the grains number in the spike, as the Furat cultivar gave the lowest average of (41.04) grains $Spike^{-1}$, and the highest average in the Russi cultivar reached (64.32) grains $spike^{-1}$. and it gives a significant difference in the weight of 1000 grains, as the Furat cultivar recorded the lowest average of 36.23 g, while the Mawaddah cultivar recorded the highest average of 52.72 g. It also showed a significant variation in grain yield, as the Furat cultivar gave the lowest average of (3.35 tons ha^{-1}), while Mawaddah cultivar recorded the highest average of (5.25 tons ha^{-1}). As for the components of the yield, there are several factors that affect the weight of the final grain, including determining the size of the inflorescence and then determining the size of the resulting grain [21]. While it recorded an insignificant difference in the biological yield.

Table (7): The effect of cultivars on the traits of the yield

Cultivar	spikes m^{-2}	grains in the spike	weight of 1000 grains (gm)	grain yield tons ha^{-1}	biological yield tons ha^{-1}
V1 (FURAT)	585.00	41.04	36.24	3.35	11.81
V2 (MAWADDAH)	452.22	54.53	52.73	5.25	11.82
V3 (RUSSI)	436.11	64.32	42.67	4.73	11.34
L.S.D (0.05)	44.25	2.585	1.943	0.3563	N.S

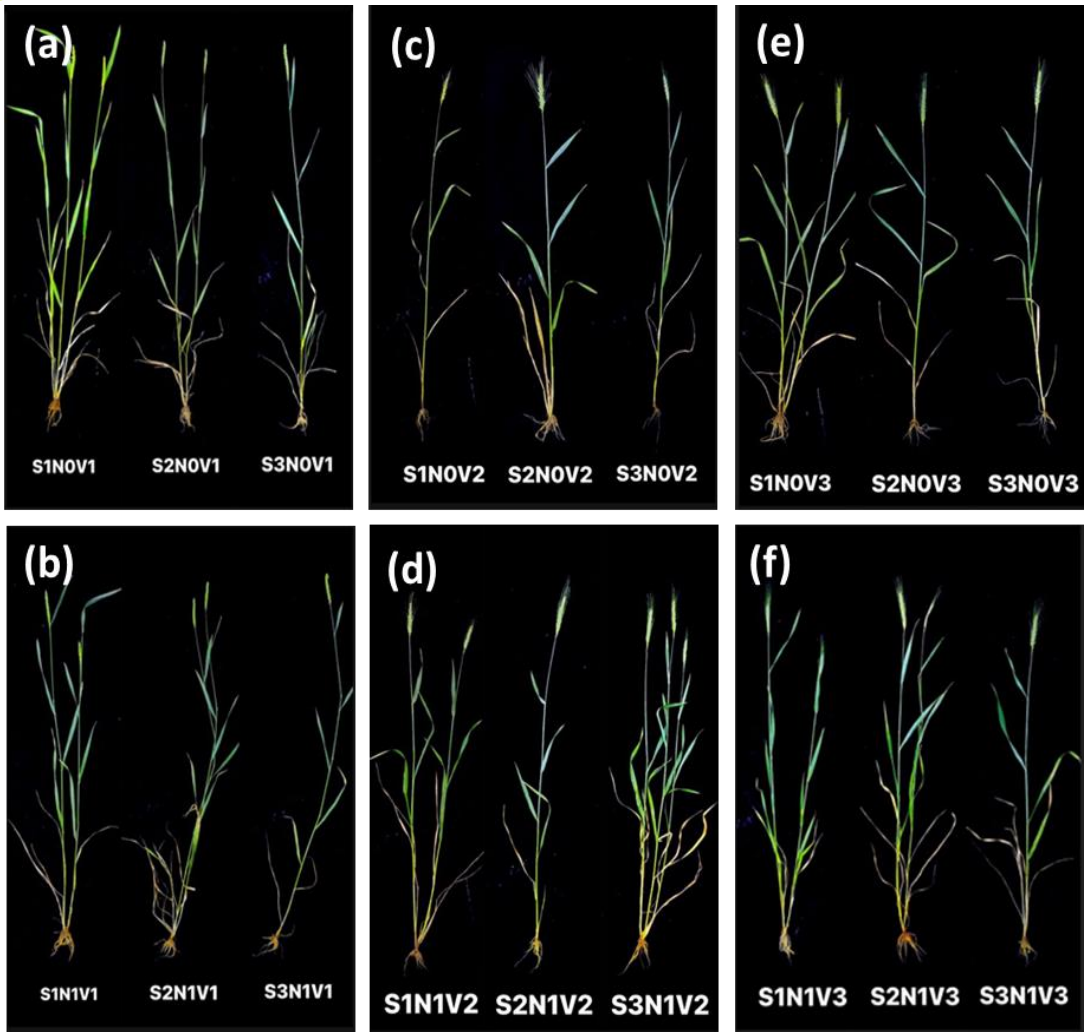

Figure (1): Shows the phenotypic variance of cultivars under different salt stress levels: Furat: (a) Without Nano silica; (b) With Nano silica. Mawaddah: (c) Without Nano silica; (d) With Nano silica. Russi: (e) Without Nano silica; (f) With Nano silica.

References

1) FAO. (2021). World Food and Agriculture – Statistical Yearbook 2021. Rome.
2) Peng, J. H.; Sun, D. and Nevo, E. (2011). Domestication evolution, genetics and genomics in wheat. Molecular Breeding, 28(3): 281-301.
3) Jing, F.; Chen, C.; Chen, X.; Liu, W.; Wen, X.; Hu, S. and Yu, Q. (2020). Effects of wheat straw derived biochar on cadmium availability in a paddy soil and its accumulation in rice. Environmental Pollution, 257: 113592.
4) Bhanu, A. N.; Arun, B. and Mishra, V. K. (2018). Genetic variability, heritability and correlation study of physiological and yield traits in relation to heat tolerance in wheat (*Triticum aestivum* L.). Biomedical Journal of Scientific & Technical Research, 2(1): 2112-2116.
5) Saddiq, M. S.; Iqbal, S.; Hafeez, M. B.; Ibrahim, A. M.; Raza, A.; Fatima, E. M. and Ciarmiello, L. F. (2021). Effect of salinity stress on physiological changes in winter and spring wheat. Agronomy, 11(6): 1193.

6) Asghari, R. and Ahmadvand, R. (2018). Salinity Stress and its impact on Morpho-Physiological Traits of Aloe Vera. Pertanika Journal of Tropical Agricultural Science, 41(1):44-59.

7) Akbar, M.; Khush, G. and Hillerislambers, D. (1985). Genetics of salt tolerance in rice, 399-409. Proceeding of International Rice Genetics Symposium. 27-31.

8) Al-Burki, F. R. (2020). Plant breeding and improvement. Ministry of Higher Education and Scientific Research. College of Agriculture, University of Al-Muthanna. 401.

9) Al-Zwaini, G. S. (2021). Effect of spraying with kinetin and potassium Nanoparticles on the tolerance of maize to salinity levels of irrigation water. PhD thesis, College of Education for Pure Sciences, University of Karbala.

10) Guidance Bulletin .(2012). Agricultural Extension Department, p. 36. Baghdad - Iraq.

11) Francois, L. E.; Grieve, C. M. and Maas, E. V. (1994). Salinity affects the timing of phasic development in spring wheat. Crop Science, 34(6): 1544-1549.

12) Al-Saadi, A. J.; Hussein, A.K.; Ahmed H. and Mahmoud, G. (2010). The role of proline acid in mitigating the negative effect of salinity on the yield components of wheat plants. Anbar Journal of Agricultural Sciences, 8 (4): 1992-7479.

13) Mukkram Ali Tahir Tariq Aziz &Rahmatullah (2009). Silicon-Induced Growth and Yield Enhancement in two Wheat Genotypes Differing in Salinity Tolerance/Pages: 395 407.

14) Al-Yasiri, H. H. H. (2018). Modeling the effect of alternating sprinkler irrigation water quality on soil salinity and yield of different cultivars of wheat using the SALTMED program. Doctor of Philosophy in Agricultural Engineering Sciences / Soil and Water Resources Sciences (Soil Chemistry), University of Baghdad.

15) Al-Noman, H. (2018). Performance of some local and introduced soft wheat cultivars in the conditions of the first settling zone. Damascus University Journal of Agricultural Sciences. 34(1):33-45.

16) Al-Burki, F. R.; Mohsin, H.A.; Sarheed, A.F. (2021). Season Response of Bread Wheat Cultivars (*Triticum aestivum* L.) to Different Planting Dates Under Samawa Desert Condition. IOP Conf. Series: Earth and Environmental Science 923. 012089: 1-6.

17) Al-Salem, S. H. F.; Muhammad, M.S.; Al-Idlaby, R. and Mahmoud, N.S. (2017). Correlation study and path analysis between grain yield and some traits of wheat crop. Al-Qadisiyah Journal of Agricultural Sciences, 7 (1): 74:84.

18) Grieve, C. M. and Francois, L. E. (1992). The importance of initial seed size in wheat plant response to salinity. Plant and soil, 147(2): 197-205

19) Azimi, M. S.; Daneshian, J.; Sayfzadeh, S. and Zare, S. (2013). Evaluation of amino acid and salicylic acid application on yield and growth of wheat under water deficit. International Journal of Agriculture and Crop Sciences, 5(7): 709-712

20) Saqib, M.; Abbas, G.; Akhtar, J. (2020). Root-mediated acidification and resistance to low calcium improve wheat (*Triticum aestivum* L.) performance in saline-sodic conditions. Plant Physiol. Biochem., 156, 201–208.

21) Klepper, B. E. T. T. Y.; Rickman, R. W.; Waldman, S. and Chevalier, P. E. G. G. Y. (1997). The physiological life cycle of wheat: Its use in breeding and crop management. In Wheat: Prospects for Global Improvement (pp. 419-425). Springer, Dordrecht