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Gibberellic acid effect and different salt concentrations on barley germination quality

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Abstract

Soil salinity has a negative effect on germination and seedling growth, therefore, it is preferable to ensure a high germination rate and strong early growth in saline soils in order to obtain the best productivity of grain crops. Gibberellic acid (GA3) is one of the most important plant growth regulators which decrease the effect of salinity A laboratory experiment was conducted to study the effect of Gibberellic acid (GA3) and some salinity levels on the germination of barley seeds, using a completely random design in three replications, where the seeds were treated before planting with Gibberellic acid at a concentration of 300 ppm (soaking for 24 hours), compared to soaking in distilled water (control) under the influence of different concentrations of NaCl salt (4000, 9000) ppm compared with control. The results of variance analysis (ANOVA) showed extremely significant ($p < 0.05$) when soaking barley seeds in Gibberellic acid (GA3) compared to control under different levels of NaCl concentration, as there was a positive effect on barley germination and root system where using Gibberellic acid such as germination energy (%), laboratory germination (%), germination force%, weight 100 feathers gr., weight 100 root gr., length feather (cm) and length roots (cm).

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Introduction

Currently, abiotic environmental pressures directly or indirectly affect agricultural production in general such as high salinity, heat stress, drought, and toxic heavy metals, as they may damage up to 70% of food crop yields (Abi Saab, M.T., *et al.,* 2014, Andarzian, B., *et al.,* 2011).

Salinity is considered one of the most primary limiting factors that can harmfully the performance of crops and yield, which most of the lands of arid and semi-arid regions suffer. Where increasing salts concentration in soil solution or irrigation water has been considered one of the oldest agricultural and environmental problems (Sally, E. El-Wakeel, *et al.,* 2019). We also find that the negative effects of increasing soil salinity lead to an annual loss of $27.3 billion, where affecting nearly one-fifth of the irrigated lands in arid and semi-arid regions (FAO, 2010, Qadir, M., *et al.,* 2014).

Recently, most researchers have been interested in improving the tolerance of plants to salinity through the application of some practices that limit its negative impact on agricultural production in general, such as chemical treatment or the use of growth regulators and plant hormones, where found that the use of gibberellic acid inhibit the effects of salinity as it improves germination and growth in general, as well as the increased efficiency of water use (Shaddad *et al.*, 2013). Gibberellic acid is one of the most important growth regulators that plays a very important role in improving grain germination (EL-Barghathi and EL-Bakosh, 2005).

In 2019 Anju Chauhan *et al.*, demonstrated the positive effect of the gibberellic acid application on oat germination. Which found the application of GA3 attenuated the effects of salinity stress and improved germination and physiological parameters where attributed that they increase the amino acid content in the embryo and stimulate the syntheses of hydrolytic enzyme required for digestion of endospermic starch. As well as, by increasing vigor, anti-oxidative enzymes activity and accumulation of osmolytes (Shekafandeh *et al.,* 2017).

Cereals are one of the main sectors of the agricultural system. The widespread distribution of cereals in all agricultural regions determines a wide variety of biological characteristics of these crops and their varieties, which account for about 60% of the world's agricultural land. Where, production of cereal crop is the main criterion for the well-being and food independence of countries (Abd El Hamid S.E.A., and Bugaev P. D. 2020).

Barley (*Hordeum vulgare*) ranks fourth among cereal crops in the world in terms of importance and productivity, as well as the important cereal crop in the arid and semi-arid marginal regions in the world.

Libya is one of those marginal regions, and because of the increase in the salinity rate that spreads in the agricultural lands, which negatively affected the cultivation of crops in Libya, it was necessary to apply some agricultural practices and solving to overcome the effect of salinity. Therefore, gibberellic acid was used to improve the germination process of barley seeds to improve barley yield under salinity stress.

Materials and methods

Experiment location

The experiments were carried out in the laboratory of Environmental Sciences Department, Faculty of Natural Resources and Environmental Sciences, Tobruk University, Libya

Treatment and experimental design

The experiment was conducted during the season 2020-2021 to perform the morpho-physiological assessment of seedlings as well as the quality of the barley seeds (Mexican variety). By using a completely random design in 3 replications each one includes 100 seeds, where were soaked seeds in gibberellic acid 300 ppm which compare with distilled water (for 24 hours) pre-sowing, and three concentrations of NaCl salt (0, 4000, and 9000 ppm).

Measurements

Germination energy (GE) had been determined after 4 days of sowing as the percentage of seeds germination to the whole number of tested seeds, as well as laboratory germination percentage within 7 days of the sowing of the seeds according to (Abd Elhamid S. E. A., and Bugaev P. D., 2020, Abd Elhamid S. E. A., and Bugaev P. D., 2018). In another hand, the morpho-physiological assessment of barley seedlings was carried out by measuring the length of roots and feathers, as well as the weight of 100 seedlings within 14 days of the sowing.

Statistical analysis

Data were analyzed by analysis of variance (ANOVA) by using the statistical program SPSS 20 and significant treatments means were compared using the least significance difference (LSD) test at 0.05 probability level according to Gomez and Gomez.

Results and discation

The data in Table (1) showed that a significant effect (p 0.05) when barley seeds were treated with gibberellic acid (300 ppm) pre-sowing compared to the control. Where increased Germination energy (%), Laboratory germination (%), and Germination force (%) by 10.3%, 9.02%, and 10.8%, respectively.

On the other hand, we find that the higher the concentration of salinity, this led to a decrease in all the characteristics of the germination under study, as the germination energy, the laboratory germination, and the germination force decreased by 50%, 50%, 46% when the salinity increased to 9000 ppm respectively, compared with control.

Table 1. Effect of Gibberellic acid (GA_3) and NaCl concentrations on barley seeds germination characteristics.

Seed treatment (A)	NaCl Concentrations (B)	Germination energy (%)	Laboratory germination (%)	Germination force (%)
Control	Control	92	96	88
	4000 ppm	79	83	76
	9000 ppm	42	44	39
Gibberellic acid	Control	95	98	93
	4000 ppm	89	92	85
	9000 ppm	51	53	47
LSD $_{0.05}$	(A)	3.8	2.4	3.6
	(B)	2.88	1.8	2.5
	(A*B)	1.24	1.17	1.3

When studying the interaction between the two factors of the study, we observed that barley seed germination was decreased by increasing salinity concentrations, and the negative effect on salinity-induced seed germination was mitigated by GA_3.

Where it was found that when using gibberellic acid at a concentration of 300 ppm, led to a significant increase under the influence of different salinity levels in all characteristics of germination of barley. Where growth regulators like GA_3 alleviate the inhibitory effect of salinity on germination, and application of it improved and enhanced the negative effect of salinity levels on germination rate. The results in (Table 2) showed the influence of Gibberellic acid (GA_3), and NaCl concentrations on barley seedling vigor, where indicates that the treatment of barley seeds pre-sowing led to a significant increase in the length of the roots and feathers. As well as increasing both the wet weight of the roots and the feathers alike.

Table 2. Influence of Gibberellic acid (GA_3) and NaCl concentrations on barley seedling vigor.

Seed treatment (A)	NaCl Concentrations (B)	Wet weight 100 feathers (gr.)	Wet weight 100 roots (gr.)	Length feather (cm)	Length roots (cm)
Control	Control	13.5	10.5	15.9	13.4
	4000 ppm	7.9	8.2	10.2	8.5
	9000 ppm	5.3	5.7	7.2	7.8
Gibberellic acid	Control	16.2	13.9	17.5	15.3
	4000 ppm	10.6	9.4	13.4	10.2
	9000 ppm	7.2	7.9	8.5	9.1
LSD $_{0.05}$	(A)	2.14	2.02	1.87	1.69
	(B)	1.88	1.74	1.45	1.64
	(A*B)	1.14	0.98	1.11	0.89

But there was variation in that effect under different salinity concentrations. It was noticed that the seedling vigor improved when treated seeds pre-sowing with gibberellic acid compared to the control, where the average feather length increased 18%. While that improvement under levels different salinity was less than that, as it decreased feather length by 29.3% and 53.0% when the salinity level increased to 4000 ppm, and 9000 ppm, respectively compared with control (0 salinity).

This positive effect was evident by treating the grains before sowing with gibberellic acid also along the root length, which led to a reduction in the effect of salinity on the growth of the root system. The results show that the root length increased by 20.0%, and 16.7% under salinity levels 4000 ppm and 9000 ppm, respectively, compared to the untreated seeds. The results also show the negative effect of increasing salinity, which led to a reduction in root length by 34.8%, and 58.9% when salinity increased to 4000 ppm and 9000 ppm, respectively, compared to the control (0 salinity). The fresh weight of the roots and the feather also increased when seeds treated with gibberellic acid by 2.4 gr. and 2.3 gr., respectively, compared to the control. On the other hand, the fresh weight of roots and feathers decreased when salinity was increased to 4000 ppm by 6.5 and 3.4 gr., and when salinity was increased to 9000 ppm, the weight was also reduced by 6.8 gr. and 4.5 gr., respectively, compared to the control.

It is clear from the results that despite the effective effect of applying the use of gibberellic acid in improving and enhancing the germination characteristics and strength of barley seedlings under the influence of salinity, which is one of the most important biotic factors that negatively affect the production and growth of barley, the positive effect of it may decrease by increasing the concentration of salinity at a certain limit.

Conclusion

Treating barley seeds (Mexican variety) pre-sowing (soaking) with gibberellic acid (GA_3) at a concentration of 300 ppm had a positive effect on the salinity resistance of irrigation water. Where its use under different concentrations of NaCl salt improved the germination characteristics as it increased germination energy, laboratory germination, seedling vigor, growth strength, and enhanced root system.

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Author contributions

All authors contributed equally in all parts of this study.

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