World of Science: Journal on Modern Research Methodologies

Volume 2 Issue 10, Year 2023
ISSN: 2835-3072
https://univerpubl.com/index.php/woscience

Effect of Kinetin Pretreatment on Some Macroelements in Salt-Grown Bean (*Vicia Faba L.*) Plants

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Article Information

Received: Aug 28, 2023
Accepted: Sep 20, 2023
Published: Oct 21, 2023

Keywords: *Faba bean; kinetin; seeds soaking; NaCl; macroelements.*

ABSTRACT

The experiment was carried out using plastic pots during the growing season 2019-2020 to study the influence of seeds soaked in kinetin at 0, 50, and 100 mg.L-1 in faba beans (Vicia faba L.) grown under saline soil conditions was investigated with NaCl at 0, 50, and 100 mM and their interactions on some nutrients (N, P, K, Ca, Mg, Na, and Cl) in vegetative part of faba bean plants. The experiment was designed according to a completely randomized design (CRD) with three replicates. The results showed that the nutrients N%, P%, K%, Ca%, and Mg% decreased significantly as the NaCl concentration increased, treatment with kinetin resulted in a significant increase with the above rates, especially under the effects of salt stress conditions, while an increase in the concentration of NaCl led to a significant increase in the percentages of Na and Cl. Soaking the seeds in kinetin led to a significant decrease in the percentages of Na and Cl compared with the control treatment. Results also showed a significant effect of the interaction between the two factors of the study and the concentration of 100 mg L-1 of the kinetin which gave the highest mean of nutrients percentage.

Introduction

Soil salinity is one of the most negative abiotic factors affecting crop growth and productivity, It was connected to significant economic effects, including the loss of large sections of agricultural land and lower crop yields [1-3]. Crop growth and productivity were being affected all around the world as a result of it [3,4]. The salt in plants causes osmotic stress, because of the high absorption of Na and Cl ions in cells, this has a significant effect on metabolic processes and later causes ionic toxicity [5]. The amount of water available to plant roots is limited by salinity's negative osmosis potential, also Na and Cl ionic toxicity affects the germination dynamics of plant seeds [6]. Salinity-induced water insufficiency, as well as nutritional deficiencies such as Ca^{2+}, K^{+}, Fe^{2+}, and Zn^{2+} deficiency in plants, cause photosynthesis disruption and oxidative stress [7]. As a result of the excess reactive oxygen species (ROS) produced by plants exposed to salinity, they experience increased oxidative stress [8], As a result of oxidative damage to cellular components such as lipids, proteins, and nucleic acids, a variety of cellular activities in plants are inhibited [9,10]. Salinity stress decreases growth and inhibits developmental processes in a variety of ways, according to several studies, osmotic imbalance, cytotoxicity produced by excrescent Na+ and Cl-, and nutritional irregularity are all factors to consider [11,12]. Bean plants had lower levels of nitrogen, phosphorus, and potassium, as well as higher levels of sodium and chloride [13]. There is a significant decrease in nitrogen, phosphate, and potassium when saline water is used in river water [14]. Plant growth regulators were utilized to prevent the harmful impacts of sodium chloride [15], They improve the plant's ability to tolerate salt, this

includes cytokines like kinetin, which alter sugar transport by stimulating genes that produce nitrate reduction enzymes and stimulating genes that produce nitrate reduction enzymes [16]. When a plant is exposed to salinity, its tolerance to salinity decreases as a result of a decrease in the cytokines that prepare the roots as a result of gene expression changes [17].

Kinetin's ability to improve plant growth under salt stress by reducing sodium toxicity and increasing potassium levels inside the plant has been widely studied, Kinetin also has a role in enzyme activation [18,19]. It has been reported to improve soybean salt tolerance through its interaction with other growth hormones [20]. Kinetin treatments improved root dry weights and N, P, and K content in leaves, as well as increased POX and CAT activity and decreased sodium levels in leaves, reducing the negative effects of salty water [6].

Vicia faba L., a member of the Fabaceae family, is the world's third-largest legume crop and is grown in over 60 countries as a cool-season legume [21]. Due to the importance of its green pods or fresh or dry seeds, as well as being a green crop for animals, it was one of the most significant and common leguminous crops in the world [22]. It was the largest pod crop, with a high protein content ranging from 25 to 40%, making it an important human food source, it also has a high carbohydrate content, making it an important part of poor economies' food supply [23]. Faba seeds are high in dietary fiber, minerals, vitamins, lipids, aminobutyric acid, and phenolic compounds, all of which are beneficial to the human body's antioxidant system and biological processes [24]. It also has a function in increasing nitrogenous compounds in the soil by coexisting with root nodule bacteria, which improves soil properties [25]. In semi-arid areas, saline soils severely limit *Vicia faba* L. productivity [26].

Because of the importance of the faba bean plant as a food crop in Iraq's economy on the one hand, and the expansion of saline lands on the other, this research aims to see if soaking seeds in kinetin could reduce the damage caused by sodium chloride in the concentration of elements (N, P, K, Ca, Mg, Na, and Cl) in the bean plant's vegetative parts.

Materials and methods

During the 2019-2020 growing season, a pot experiment was conducted with a mixture of textured soils, the soil was air-dried, then crushed and sieved with a sieve with holes diameter of 2 mm, and it was filled into 5 kg plastic pots. 1.6 g of NPK (17: 17: 17) compound fertilizer was added per pot. Faba bean seeds of equal size and shape were chosen, and the seeds were rinsed in distilled water before being sterilized for 3 minutes with a 1 % sodium hypochlorite solution. The seeds were then rinsed again with distilled water before being soaked in a kinetin solution with concentrations of 0, 50, and 100 mg. L^{-1} at room temperature for 12 hours, for the control treatment, distilled water was used. Five seeds per pot were planted on 21/11/2019. To reach 50% of the field capacity, the pots were irrigated with distilled water, when the fourth leaf appeared, it was irrigated with sodium chloride solution concentrations of 0, 50, and 100 mM, and irrigation was carried out as required. A completely randomized design (CRD) with three replications was used to experiment.

Kinetin and NaCl Treatments

A 1000 mg.L^{-1} kinetin stock solution was prepared, followed by 50 and 100 mg.L^{-1} of the required concentrations were produced by using the dilution law, following the dilution law, a stock solution of sodium chloride was prepared at a concentration of 1 molar, and concentrations of 50 and 100 mM were prepared from it.

Determination of N, P, K, Ca, Mg, Na, and Cl

At the end of the agricultural season the shoot dry weight after drying the plants in an electric oven at a temperature of 65°C until the weight was stable, the dried materials of 0.2 g were digested in H_2SO_4, and H_2O_2 according to the method [27]. Then the percentage of nutrients is

estimated:

According to the procedure [28], nitrogen was determined using the Kjeldahl apparatus. phosphorus was measured with a spectrophotometer using the method [29]. and potassium was estimated using the flame photometer and according to the method [30]. calcium and magnesium were measured according to [31], and sodium was measured using a flame photometer [32]. while chloride was determined using [33].

Statistical analysis

Statistical computations were carried out using the SAS software program [34] to investigate the treatment influence. The Least Significant Difference (LSD Test) was used to compare the means of treatments with a probability level of 0.05.

Results

The results of Table (1) indicate a decrease in the percentage of nitrogen in the plant's vegetative part as the concentration of NaCl increases, when treatment of 100 mM was used, the lowest rate was 1.71% when treatment of 0 mM was used, the greatest percentage of nitrogen was 2.90%. Kinetin had a significant effect on the average percentage of nitrogen with the superiority of treatment 100 mg.L^{-1}, as it gave the highest rate of 2.49%, while the lowest rate was 2.27% when the control treatment. The interaction effect between the two factors was significant and the highest nitrogen value was 2.96% at 0 mM of sodium chloride and 100 mg. L^{-1} of kinetin.

Table 1. Influence of seeds soaking with kinetin and its interaction with NaCl on nitrogen percentage (%)

Kinetin mg. L^{-1}	NaCl (mM)			Mean
	0	50	100	
0	2.84	2.43	1.54	2.27
50	2.90	2.57	1.72	2.40
100	2.96	2.65	1.86	2.49
Mean	2.90	2.55	1.71	
LSD 0.05	NaCl = 0.018, Kinetin =0.018, Interaction = 0.032			

From the results of Table (2), with an increase in NaCl concentration, there is a significant decrease in the percentage of phosphorus. treatment 100 mM had the lowest phosphorous rate of 0.234%, whereas the control treatment had the highest rate of 0.345%. It's also important to note that kinetin has a significant impact on phosphorous percentage, treatment with 100 mg.L^{-1} had the highest rate of 0.312% and the lowest rate of 0.253% in the control treatment. There was no significant interaction between the two parameters, and the highest phosphorus value was 0.376% at 0 mM of sodium chloride and 100 mg. L^{-1} of kinetin.

Table 2. Influence of seeds soaking with kinetin and its interaction with NaCl phosphorus percentage (%)

Kinetin mg. L^{-1}	NaCl (mM)			Mean
	0	50	100	
0	0.313	0.240	0.206	0.253
50	0.346	0.276	0.233	0.285
100	0.376	0.296	0.263	0.312
Mean	0.345	0.271	0.234	
LSD 0.05	NaCl =0.008, Kinetin = 0.008, Interaction = N.S			

The results of Table (3) showed that an increase in sodium chloride concentration led to a significant decrease in the average potassium percentage, the potassium rate in treatment 100

mM was 1.956 %, while the potassium rate in the control treatment was 2.661%. the results also showed significant differences in kinetin treatments, with the concentration of 100 mg.L^{-1} getting the highest potassium rate of 2.356% and the control treatment having the lowest potassium rate of 2.270%. the interaction between NaCl and kinetin was significant, with treatment with 100 kinetin and 0 mM NaCl having a 2.687% superiority and the lowest potassium rate of 1.893% when treated with 100 mM of NaCl and not treated with kinetin.

Table 3. Influence of seeds soaking with kinetin and its interaction with NaCl on potassium percentage (%)

Kinetin mg. L^{-1}	NaCl (mM)			Mean
	0	50	100	
0	2.630	2.287	1.893	2.270
50	2.667	2.310	1.970	2.316
100	2.687	2.377	2.003	2.356
Mean	2.661	2.324	1.956	
LSD 0.05	NaCl = 0.013, Kinetin =0.013, Interaction =0.023			

The results of Table (4) show that the concentrations of NaCl are not significantly different, with a decrease in the percentage of calcium, and an increase in NaCl, with the highest rate of calcium at 1.346% when the control treatment was used, and the lowest rate of calcium was 0.960% when the treatment 100 mM was used. The same table shows that there are no significant differences when kinetin is used, with the concentration of 50 mg.L^{-1} was superior to the concentrations at a rate of 1.220%, while the lowest rate of calcium was 1.107% when the control treatment was used. The same table shows that there are no significant differences when kinetin is used. and the highest calcium value was 1.383% at 0 mM of sodium chloride and 50 mg. L^{-1} of kinetin.

Table 4. Influence of seeds soaking with kinetin and its interaction with NaCl on calcium percentage (%)

Kinetin mg. L^{-1}	NaCl (mM)			Mean
	0	50	100	
0	1.303	1.117	0.900	1.107
50	1.383	1.237	1.040	1.220
100	1.350	1.183	0.940	1.158
Mean	1.346	1.179	0.960	
LSD 0.05	NaCl = N.S, Kinetin = N.S, Interaction = N.S			

The results of Table (5) indicate a decrease in the percentage of magnesium in the plant's vegetative part as the concentration of NaCl increases, the lowest percentage of magnesium was 0.673% in treatment 100 mM, while the greatest percentage was 1.023% in the control treatment. kinetin had a significant effect on the average percentage of magnesium, with treatment 100 mg.L^{-1} having the greatest rate of 0.898%, while the control treatment had the lowest rate of 0.797%. There was no significant interaction effect between the two parameters, and the highest magnesium value was 1.076% at 0 mM of sodium chloride and 100 mg. L^{-1} of kinetin.

Table 5. Influence of seeds soaking with kinetin and its interaction with NaCl on magnesium percentage (%)

Kinetin mg. L^{-1}	NaCl (mM)			Mean
	0	50	100	
0	0.967	0.813	0.610	0.797
50	1.027	0.853	0.697	0.859

100	1.076	0.903	0.713	0.898
Mean	1.023	0.857	0.673	
LSD 0.05	NaCl = 0.018, Kinetin = 0.018, Interaction =N.S			

From Table (6), with an increase in NaCl concentration, there is a significant increase in Na accumulation; the highest rate of Na was 1.979 % at a concentration of 100 mM, whereas the lowest rate was 1.234 % in the control treatment. the treatment with kinetin resulted in significant differences in the percentage of sodium, as shown in the table, the lowest rate of Na accumulation was 1.261 % at a concentration of 100 mg.L^{-1}, while the highest rate of Na accumulation in the control treatment was 2.004 %. the interaction effect between the two factors was significant and the lowest Na value was 1.167% at 0 mM of sodium chloride and 100 mg. L^{-1} of kinetin.

Table 6. Influence of seeds soaking with kinetin and its interaction with NaCl on Sodium percentage (%)

Kinetin mg. L^{-1}	NaCl (mM)			Mean
	0	50	100	
0	1.300	2.010	2.703	2.004
50	1.237	1.687	1.893	1.606
100	1.167	1.277	1.340	1.261
Mean	1.234	1.658	1.979	
LSD 0.05	NaCl = 0.032, Kinetin =0.032, Interaction =0.056			

From the results of Table (7), It is apparent that when the concentration of NaCl increased, the rate of chloride accumulation in the vegetative part increased as well, the highest rate of chloride accumulation was 0.114 % at a concentration of 100 mM, while the lowest rate of chloride accumulation was 0.035 % in the control treatment. from the same table's results, It was shown that kinetin treatment resulted in a significant reduction in the rate of chloride accumulation, the lowest rate was 0.066 % when the treatment was 100 mg.L^{-1}, whereas the highest rate of chloride was 0.083 % when the control treatment was used. the interaction effect between the two factors was significant and the lowest Cl value was 0.029% at 0 mM of sodium chloride and 100 mg. L^{-1} of kinetin.

Table 7. Influence of seeds soaking with kinetin and its interaction with NaCl on chloride percentage (%)

Kinetin mg. L^{-1}	NaCl (mM)			Mean
	0	50	100	
0	0.041	0.083	0.126	0.083
50	0.035	0.074	0.114	0.074
100	0.029	0.068	0.101	0.066
Mean	0.035	0.075	0.114	
LSD 0.05	NaCl =0.0012, Kinetin =0.0012, Interaction = 0.0021			

Discussion

The percentages of N, P, K, Ca, and Mg decreased as a result of salinity stress, The loss of nutrients in the vegetative part of the plant as a result of high Na and Cl concentrations in the growth medium could be due to competition between elements for absorption locations on the plasma membrane of root cells' surface [35], or it could be an ionic imbalance [36]. Alternatively, increasing reactive oxygen species (ROS) that attack the cell membrane during saline stress, leads to lipid oxidation and thus cell membrane destruction, reducing nutrient

absorption [8, 37]. The direct competition of sodium and chloride on nutrient uptake was affected by salinity, as it was the permeability of cell membranes by membrane proteins and the integrity of the plasmalemma [38,14]. Some studies confirmed these results [39]. The rate of N, P, and K in cabbage plants decreases as the salinity of the water increases. Salt stress reduced NPK concentration while increasing Na in lettuce leaves [40]. They attributed this to the effect of sodium ions and chloride on the availability of nutrients, which inhibited their transport and absorption by roots [41]. Salinity induced considerable decreases in calcium ions in the roots and shoots of cowpea plants, according to [42]. Sodium ions have been found to compete with calcium ions for membrane binding sites. As a result, it's been suggested that high calcium levels protect the cell membrane from the negative effects of salinity. Salinity stress induced a highly significant increase in the content of Na^{+} and Cl^{-} and a decrease in the percentage of K^{+}, Mg^{2+}, and Ca^{2+} in the roots and leaves of radish plants, according to [43]. Kinetin treatment increased the content of (N, P, K, Ca, and Mg) in the vegetative part, especially when salt stress was applied Because salt stress affects hormonal balance, including an increase in ABA concentration in leaves and a probable decrease in cytokinesis, kinetin treatment may be beneficial in these conditions, It's essential to mention that exogenous PGRs can change. By their absorption, endogenous phytohormones [44]. The relation between internal mineral elements was largely influenced by kinetin treatments, which could be due to kinetin's ability to reduce membrane injury and improve nutrient uptake. [45].

Conclusion

We concluded that soaking the seeds in kinetin increased the rate of nutritional content while reducing the negative effects of sodium chloride on the elements, due to improved plant growth. and the kinetin concentration of 100 $mg.L^{-1}$, which had the highest mean percentage of nutrients.

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