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EFFECT OF NaCl IN PRESENCE OF CALCIUM AND POTASSIUM ON GERMINATION AND GROWTH OF DURUM WHEAT (*Triticum durum L.*)

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ABSTRACT

The work aims to study the effect of NaCl salt concentration in presence of calcium or potassium on germination and growth of durum wheat. The parameters studied are: water absorption rate, germination rate, length of shoots and roots and production of biomass. The results obtained show that the effect of increased salinity is harmful to all parameters studied. However, the Ca added has a positive effect on the reduction of Na aggressiveness over as potassium effect. The latter gave a favorable effect only for the low dose. So calcium amendment has a remarkable effect on reduction of aggressive effect of Na despite the increase in salinity of the medium.

Keywords: calcium, dose of salt, durum wheat, NaCl, potassium

1. INTRODUCTION

Soil and water salinity is a major problem in many countries of the world (Szabolocs, 1979). Saline soils are generally characterized by physical, chemical, and biological unfavorable properties for plant growth. Indeed, the salts from irrigation water accumulate in the soil, causing the increase in osmotic pressure and therefore reduce the availability of water to plants (Schleiff, 1979; Chartzoulakis, 2003), what results a reduction of growth (Bertrand, 1981; Ben naceur 2001; Cuartero et al, 2003; Flowers et al, 2003; Slama, 2004; Kadri et al., 2009). In addition to the general osmotic effect, it was retained that the excessive salt concentrations have a disruptive effect on physiology of plants either by a direct effect of toxicity of specific ions or by the appearance of nutritional disorders caused by the action of certain ions on absorption and metabolism of nutrients (Bougendre, 1973). Generally the relationship between relative yields and salinity is approximately linear on the basis of comparison of performance of the same culture in saline and no saline soil (Katerji, 1995). The tolerance of plants to salts varies with their stage of development. In general, they are much more sensitive in the early phases of vegetation in particular germination and emergence. Salinity is the principal problem of cereals

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in arid region. The research in this field has a great importance for the development of cereal crops in this area. The objective of our work is to determine the effect of NaCl concentration and calcium or potassium added on germination and growth of durum wheat.

2. MATERIALS AND METHODS

The experiment is carried out in plastic Petri dishes of 4.5cm of diameter, a filter paper is placed on the basis of each dish. Twenty seeds of wheat variety Waha were weighed then introduced into each dish and irrigated by saline solutions. After 24 hours, the seeds are reweighed for to calculate water absorption rate. The amount of irrigation is 5 to 10 ml for each 2 to 3 days according to the need observed. The final rate of germination was determined at the end of the 15 days as well as measurements of shoots, roots and production of fresh matter. Twenty one prepared saline solutions are used in this experiment. The salts used are NaCl, KCl and $CaCl_2$. Three doses of NaCl, 6, 12 and 18g / l are combined or not with three doses 0.5, 1 and 1.5g of $CaCl_2$ (0.5C, 1C, 1.5C) or of KCl (0.5K, 1K, 1.5K) (Table 1). The device used comprises 21 treatments and 03 repetitions. LSD test at 5% is used in the statistical analysis.

Table 1: The treatments

6 g/l NaCl	12 g/l NaCl	18 g/l NaCl
1: NaCl	8: NaCl	15: NaCl
2: NaCl + 0.5g $CaCl_2$	9: NaCl + 0.5g $CaCl_2$	16:NaCl+0.5g $CaCl_2$
3: NaCl + 1g $CaCl_2$	10: NaCl + 1g $CaCl_2$	17: NaCl + 1g $CaCl_2$
4: NaCl +1.5g $CaCl_2$	11: NaCl+ 1.5g $CaCl_2$	18:NaCl+1.5g $CaCl_2$
5: NaCl + 0.5g KCl	12: NaCl + 0.5g KCl	19: NaCl + 0.5g KCl
6: NaCl + 1g KCl	13: NaCl + 1g KCl	20: NaCl + 1g KCl
7: NaCl + 1.5g KCl	14: NaCl + 1.5g KCl	21: NaCl + 1.5g KCl

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3. RESULTS AND DISCUSSION

3.1 Effect of salt dose

Through statistical analysis, it is observed that the dose of salts has a significant effect. It gave three homogenous groups for the majority of the parameters studied: germination, water absorption, plant height and root length, except for the production of fresh matter where it gave a single group in spite the differences between doses. So all parameters are influenced negatively by increased salinity (Table 2).

Table 2: Statistical analysis of salt dose effect

Dose of salt (g/l)	Water absorption (%)	Rate of germination (%)	Plant height (cm)	Root length (cm)	Fresh matter (g)
6	42.41 a	88.00 a	3.77 a	5.30 a	1.61 a
12	40.08 b	71.04 b	2.89 b	3.59 b	1.58 a
18	37.21 c	54.85 c	1.95 c	1.62 c	1.45 a

3.1.1 Water absorption rate

Through the results obtained, it is noted that the water absorption decreased with increasing doses of salts. Statistical analysis indicates that there are three homogeneous groups whose the dose 6g / l presents the highest absorption rate 42.41% and the dose 18g / l presents the lowest rate 37.21%. This can be explained by the osmotic effect. (Table 2, Fig 1).

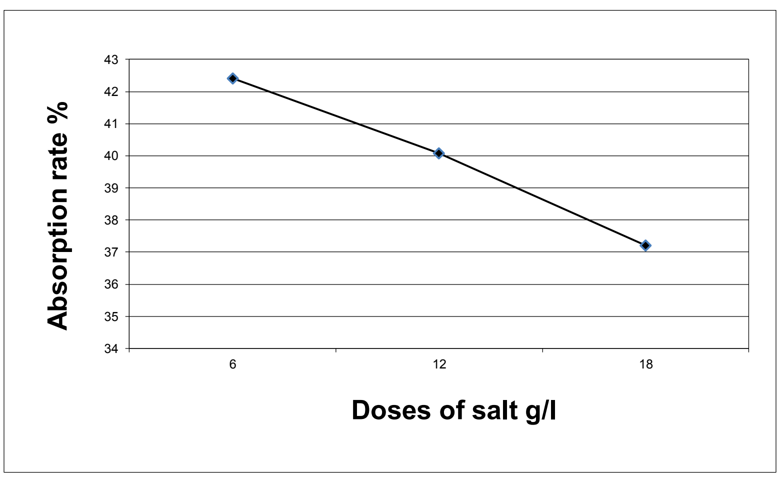

Fig. 1 Effect of salt dose on water absorption rate

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3.1.2 Rate of germination

Seed germination is the principal factor limiting plants establishment under saline conditions (Al-karaki, 2001). Through statistical analysis, it was observed that the dose of salts has a significant effect. It gave three homogeneous groups (Table 2, Fig 1). The dose 6g/l shows the highest rate of germination (88.00 %), however the dose 18g/l shows the weakest rate (54.85 %). Increased salinity has a negative effect on the rate of germination (Ghulam et al., 1997; Duan et al., 2004; Tavili and Biniaz, 2009).

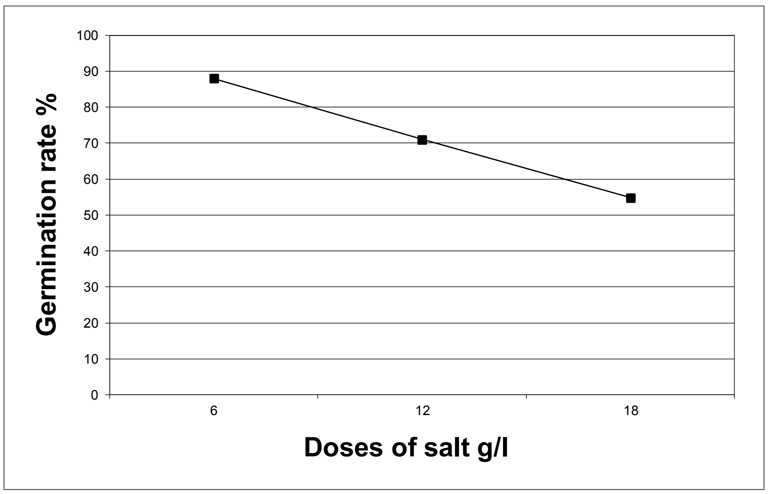

Fig. 2 Effect of salt dose on germination rate

3.1.3 Plant height

Dose of salts has a significant effect characterized by three homogeneous groups (Table 2, Fig 3). The dose 6g/l presents the highest plant length (3.77cm), however the dose 18g/l presents the shortest length (1.95cm). Thus, there is a clear influence of salinity on growth of shoots where the increase in salinity reduces the height of plants (Carter et al., 2005; Azadgoleh and Yasari, 2007; Taware et al., 2009).

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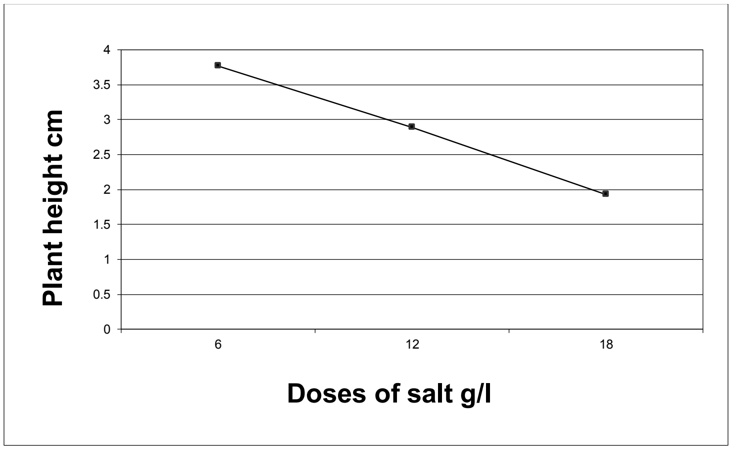

Fig. 3 Effect of salt dose on plant height

3.1.4 Root length

The analysis of variance indicates that there are significant differences expressed by three homogeneous groups according to the results.

As in the case of germination rate and plant height, the evolution is according to the doses. The dose 6g/l presents the longest roots (5.30cm), however the dose 18g/l presents the shortest length (1.62cm) (Table 2, Fig 4). As the result found by Tavili and Biniaz (2009) on barley, the effect of increased salinity is significant over the length of wheat roots.

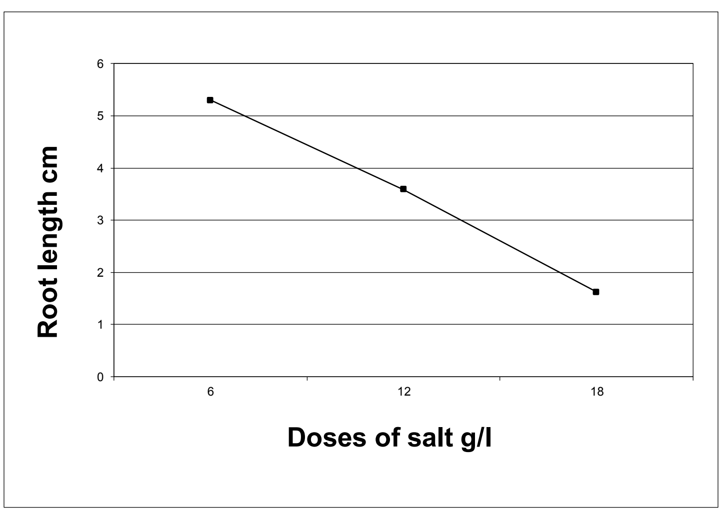

Fig. 4 Effect of salt dose on root length

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3.1.5 Fresh matter

Variance analysis indicates that there is a single homogeneous group of salt dose effect on production of fresh matter in spite the differences between doses. The dose 6g/l shows the highest production rate of fresh matter (1.61g), however the dose 18g/l presents the lowest production rate (1.45g). Indeed, the increase in salinity reduces the production of fresh matter of plant (Ghulam et al., 1997) and this is a consequence of the reduction of water supply for plants (Table 2, Fig 5).

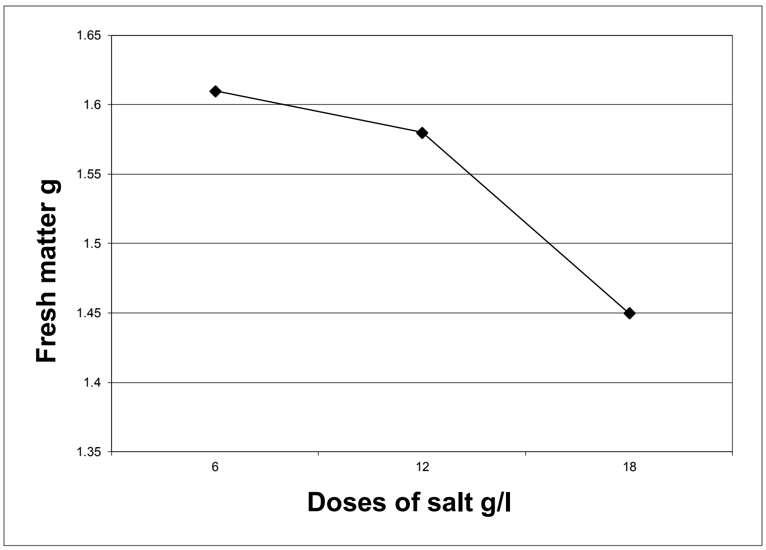

Fig. 5 Effect of salt dose on fresh matter

3.2 Effect of the calcium and potassium treatments

Through statistical analysis, it is observed that calcium and potassium treatments have a significant effect translated into different homogeneous groups for the various parameters studied: germination, water absorption, plant height, root length and production of the fresh matter. Generally, calcium treatments 0.5C, 1C and 1.5C with potassium treatment 0.5K gave the best results (Tab 3).

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Table 3: Statistical analysis of calcium and potassium treatments

Calcium and potassium added	Water absorption (%)	Rate of germination (%)	Plant height (cm)	Root length (cm)	Fresh matter (g)
0.5C	40.22ab	79.55 a	3.40 a	4.80 a	1.61ab
1C	39.37ab	81.33a	3.25ab	4.77a	1.66ab
1.5C	40.06ab	79.11a	3.21abc	4.52a	2.13a
0.5K	40.43ab	72.44ab	2.74abc	2.71b	1.43b
1K	40.61a	60.00c	2.47bc	2.41b	1.43b
1.5K	37.76b	62.66bc	2.52bc	2.60b	1.21b
0	40.86a	64.00bc	2.45c	2.71b	1.36b

3.2.1 Water absorption rate

The effect of calcium and potassium treatments is not very clear on absorption of water, the results are very close to each other and form a single group except 1.5K treatment that is relatively lower (Table 3, Fig 6).

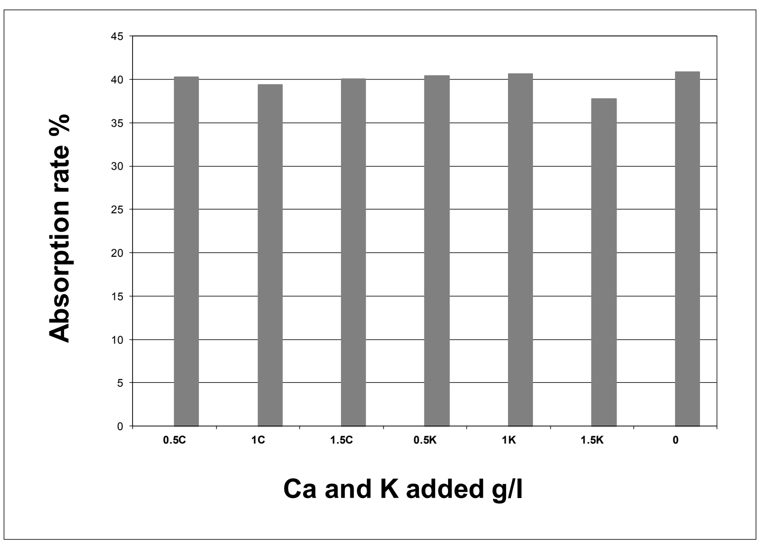

Fig. 6 Effect of Ca and K treatments on water absorption rate

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3.2.2 Germination rate

Calcium treatments have a very significant effect on germination; this is illustrated by the results of treatments 0.5C, 1C and 1.5C. As regards potassium treatment, only 0.5K treatment that has given important results for germination (Table 3, Fig 7). According to Cramer et al. (1989) the Ca can alleviate the inhibitory effect of NaCl.

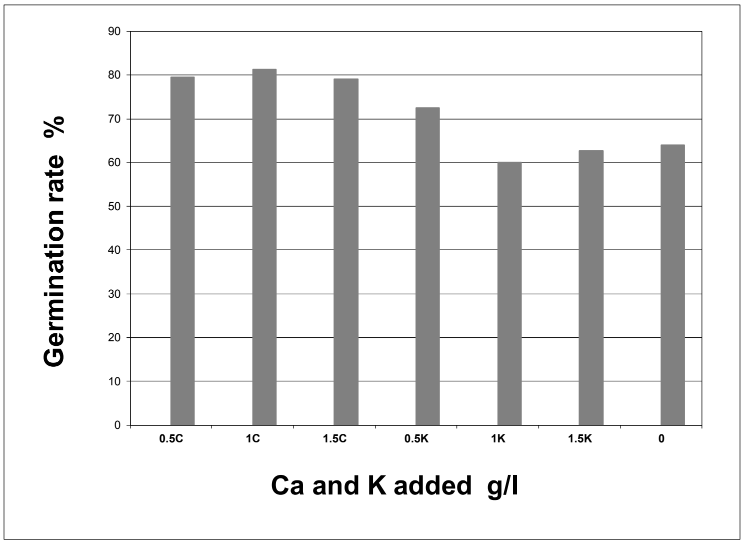

Fig. 7 Effect of Ca and K treatments on germination rate

3.2.3 Plant height

The analysis of variance showed a significant and remarkable effect of calcium treatments 0.5C, 1C and 1.5C with potassium treatment 0.5K compared to other potassium treatments and treatment not amended in spite the increase of concentration in the medium (Table 3, Fig 8). Indeed, the addition of Ca improves plant growth under salt stress (Cramer et al., 1990). It also appears that relatively high doses of added potassium have no favorable effect in our case.

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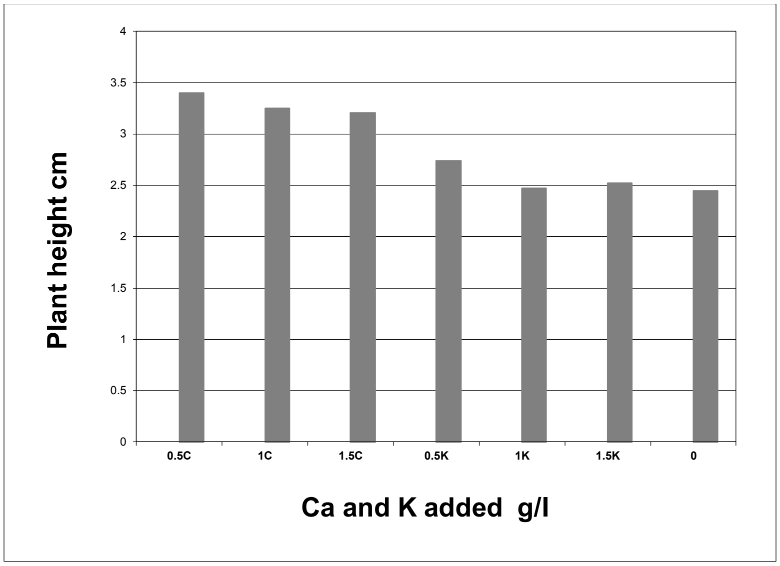

Fig. 8 Effect of Ca and K treatments on plant height

3.2.4 Root length

As we have already mentioned the importance of calcium treatments in shoots, it also has an important effect in root length.

Calcium treatments were the best treatment for root length, the three calcium treatments constitute the first group (Table 3, Fig 9). Indeed, the Ca can reduce inhibitory effect of NaCl and accordingly contributes to improvement of root growth (Cramer et al., 1989; Zhong and Läuchli, 1993; Colmer et al., 1996). As well as Lopez and Satti (1996) found that the addition of Ca to a nutrient salt solution increases root length despite the increased concentration because the toxicity of Ca is very low.

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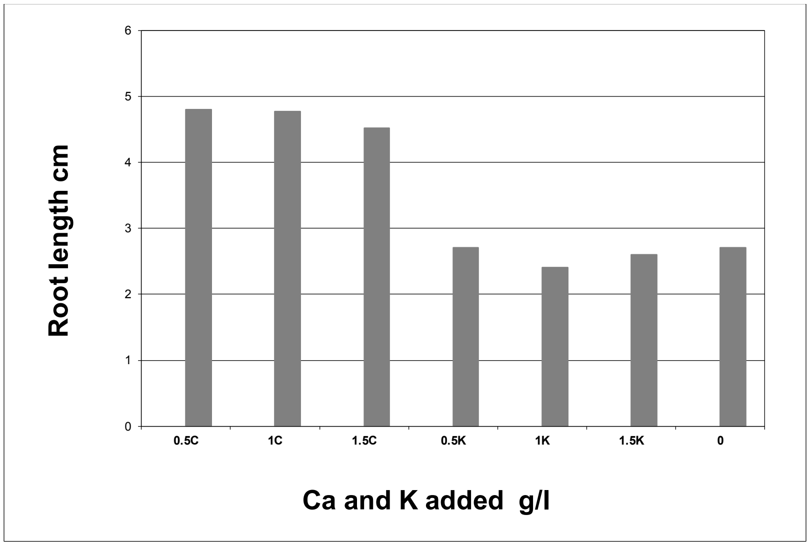

Fig. 9 Effect of Ca and K treatments on root length

3.2.5 Fresh matter

As the shoots and roots, calcium treatments have a significant and best effect on production of fresh matter (Table 3, Fig 10). This can be explained by the effect of Ca which alleviates the negative effect of salinity (Bliss et al, 1986; Jaleel et al., 2007) following to its role in ionic equilibrium and maintaining the selective permeability of the membrane (Akhavan et al., 1991). Lopez and Satti (1996) also found a greater effect of Ca relative to K.

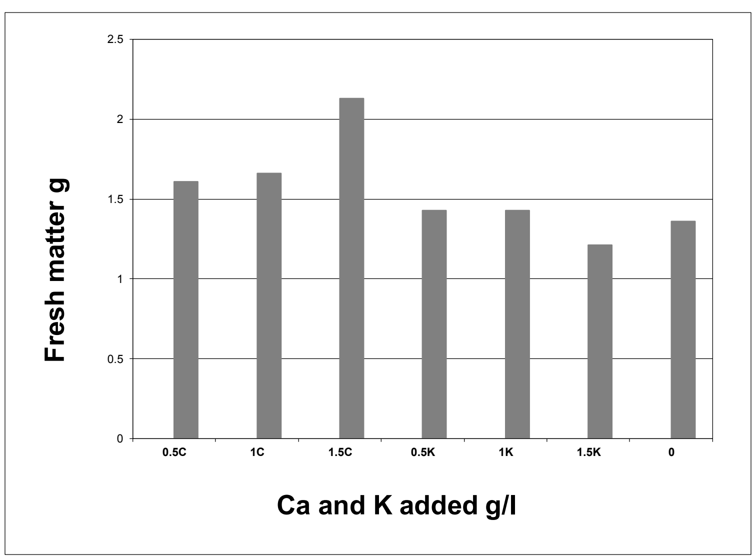

Fig. 10 Effect of Ca and K treatments on fresh mater

4. CONCLUSION

Our results showed that increasing doses of salt have a harmful effect on parameters studied of wheat: decreased germination rate, reduction of growth of shoots and roots and a decrease in production of fresh matter. This coincides with the results of Rahman et al. (2008). The lowest dose 6 g / l gave the best results.

Calcium and potassium treatments significantly affect the parameters studied of wheat, but calcium treatments that have a remarkable effect compared to the treatment not amended on germination, shoots, roots and production of fresh matter in spite of the increase of concentration. For potassium treatments, only 0.5K treatment that has given satisfactory results. Indeed, the Ca added can change the aggressiveness of salt environment by reducing the inhibitory effect of salts (Shaikh et al., 2007).

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