

# EFFECT OF SELENIUM SALTS ON DEVELOPMENT OF ALFALFA (*Medicago sativa* L.) UNDER WATERLOGGING

## INTRODUCTION

In the last decades, the growth of agriculture has displaced livestock towards marginal environments, where animals coexist with floods and other extreme weather events. Alfalfa (*Medicago sativa* L.) is the main forage species in Argentina and it is the base of meat and milk production in the Pampa Region [1]. The spread of this crop is based on its high yield and excellent nutritional quality; however, it is very sensitive to salinity, acidity and waterlogging of the soil [2,3]. On the other hand, some mineral elements such as selenium have given protection to certain plants against abiotic stress conditions, showing for example the ability to improve water status of plants under drought stress and to reduce the adverse effects generated by saline stress [4].

## OBJECTIVE

The aim of the work was to analyse the effect of selenium application on the development of alfalfa seedlings grown under conditions of continuous waterlogging.

## MATERIALS AND METHODS

Treatments consisted of continuous irrigation by immersion in 50% Hoagland solution with different doses of selenate or selenite (0, 3, 12 and 48  $\mu\text{M}$ ), from sowing and for 24 days. The seedlings were grown in a plant chamber with a photoperiod of 16 h and daytime temperature of  $21 \pm 1^\circ\text{C}$  and a night temperature of  $16 \pm 2^\circ\text{C}$ . At the end of the trial, different morphological parameters of aerial and root parts, yield (tissue weights) and root activity [5] were evaluated in a total of 8 randomly selected seedlings from a total of 24 per treatment. Likewise, vegetation cover area was determined from aerial images with Canopeo® application [6]. A factorial design with three repetitions was used and data were analysed by analysis of variance (ANOVA) and means were compared by Fisher's LSD test with a significance level of  $P < 0.05$ . In all cases, the conditions of normality of residuals, homogeneity of population variances and absence of interaction between factors were fulfilled.

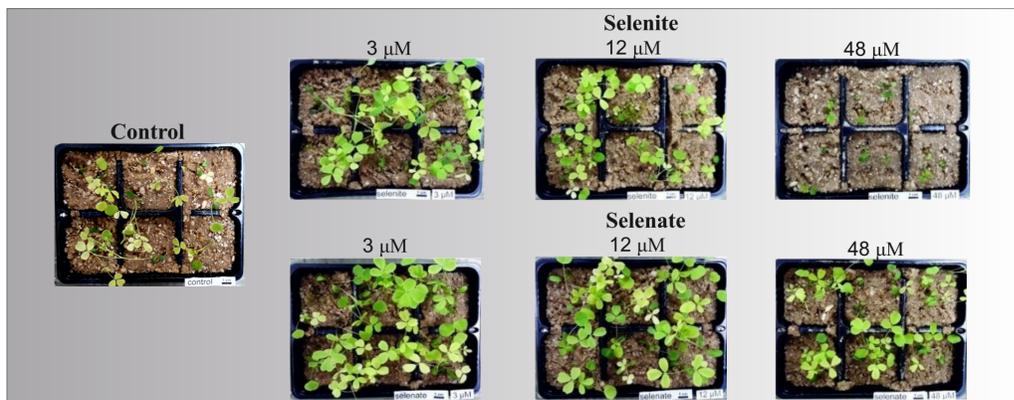
## RESULTS

Figure 1 shows phenotypic changes in alfalfa seedlings subjected to different doses and species salts of selenium under continuous waterlogging. Morphological changes are mainly manifested in the development of the aerial part, as well as in radical architecture.



**Figure 1.** Phenotypic comparison of alfalfa seedlings treated for 24 days with different doses and species of selenium under continuous waterlogging.

Likewise, it can be seen that different treatments applied induced changes in the area of plant cover (Figure 2).



**Figure 2.** Aerial view of alfalfa seedlings treated for 24 days with different doses and species of selenium under continuous flooding.

Analysis of the results indicated that the seedlings treated with 3  $\mu\text{M}$  and 12  $\mu\text{M}$  selenate significantly increased height with respect to control (Table 1). In contrast, treatment with 48  $\mu\text{M}$  selenite reduced this parameter.

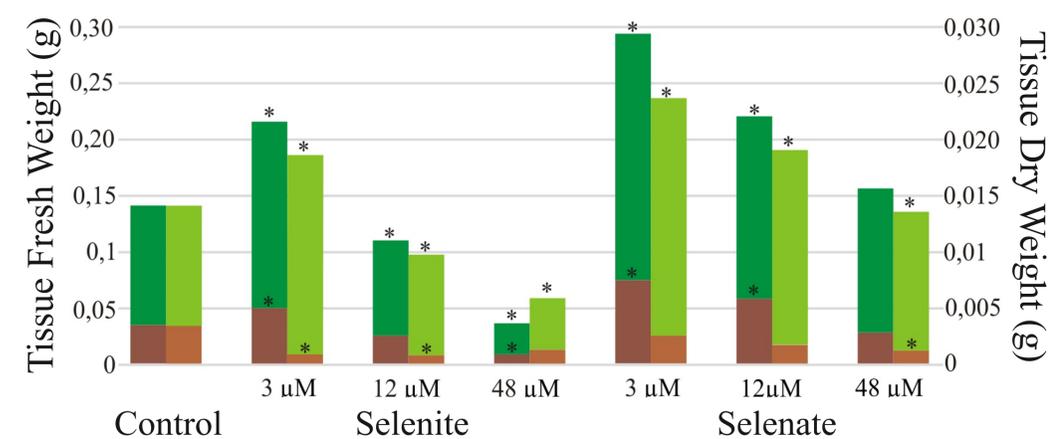
On the other hand, the length of the main root only was altered to applying treatments with 3 and 48  $\mu\text{M}$  selenite; reducing its size compared to control.

Evaluation of vegetation cover area determined that, except for the dose of 48  $\mu\text{M}$  selenite, applied treatments significantly increased this parameter relative to control.

Treatments	Seedling height (cm)	Root length (cm)	Vegetation cover area (%)
<b>Control</b>	$3.73 \pm 0.51a$	$0.40 \pm 0.021a$	$12.28 \pm 2.25a$
<b>Selenite</b>	3 $\mu\text{M}$	$4.72 \pm 0.46a$	$26.59 \pm 3.13c$
	12 $\mu\text{M}$	$2.99 \pm 0.49a$	$18.38 \pm 2.39d$
	48 $\mu\text{M}$	$1.37 \pm 0.10c$	$0.18 \pm 0.030c$
<b>Selenate</b>	3 $\mu\text{M}$	$5.35 \pm 0.30b$	$32.27 \pm 2.62b$
	12 $\mu\text{M}$	$4.75 \pm 0.48b$	$26.86 \pm 3.01bc$
	48 $\mu\text{M}$	$3.50 \pm 1.06ab$	$0.35 \pm 0.007ab$

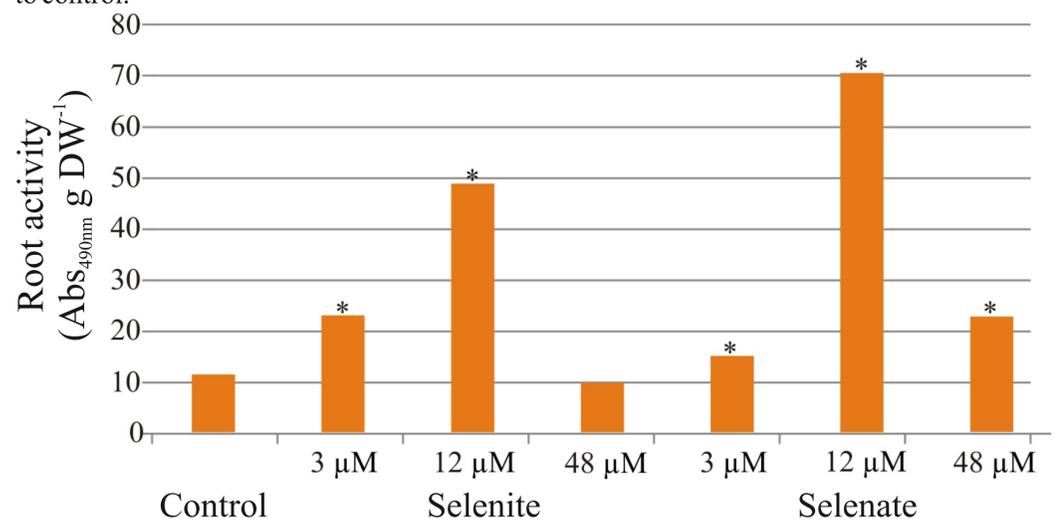
**Table 1.** Morphological parameters as a function of different treatments with selenium under waterlogging. The results are expressed as the mean ( $n = 8$ )  $\pm$  SE. Different letters indicate significant differences ( $p < 0.05$ ) according to Fisher's LSD test.

Yield parameters indicated the presence of significant differences in fresh and dry weights of both the aerial part and roots, for most treatments applied (Figure 3). Doses of 3  $\mu\text{M}$  selenite or selenate and 12  $\mu\text{M}$  selenate increased fresh and dry weights of aerial parts between 50% and 90%, with respect to control. However, a significant reduction in yield could be observed with 12  $\mu\text{M}$  and 48  $\mu\text{M}$  selenite. Likewise, the fresh weights of roots increased with the treatments of 3  $\mu\text{M}$  selenite or selenate and with 12  $\mu\text{M}$  selenate, compared to control.



**Figure 3.** Partition of fresh and dry weights of the aerial part and roots of alfalfa seedlings subjected for 24 days to different species and concentrations of selenium under waterlogging. The upper bars correspond to the aerial part and the lower bars to the root. Asterisks indicate a significant difference compared to control (Fisher's LSD,  $p < 0.05$ ).

Finally, it was determined that in most cases the different treatments with selenium induced significant increases in radical activity (Figure 4). The greatest differences were observed after application of 12  $\mu\text{M}$  of both selenium salts (selenite or selenate). On the other hand, seedlings that were treated with 48  $\mu\text{M}$  selenite did not show significant differences respect to control.



**Figure 4.** Root activity of alfalfa plants after 24 days of waterlogging. The bars with an asterisk differ significantly from the control treatment (Fisher's LSD,  $p < 0.05$ ).



## CONCLUSIONS

From data obtained and analysed, it could be suggested that selenium has a dual effect on the development of alfalfa seedlings under waterlogging; depending on the dose and type of salt used. Thus, it was established that selenite produces phytotoxicity from 12  $\mu\text{M}$ . Also, it was not possible to determine the threshold toxicity for selenate according doses evaluated here. However, there are doses of selenium that significantly increased morphological and yield parameters; and that could be linked to the higher radical activity observed, in the case of selenate. **Therefore, the application of selenium during the initial phase of alfalfa cultivation could be useful to expand the cultivated area towards floodable areas, considered as marginal or not very productive.** Nevertheless, additional studies are required to obtain more knowledge about the doses and phenological times of application, in order to detect with greater certainty the influence of these variables on the changes made by this element and the magnitude of the benefits generated.

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