Annals of Arid Zone 25 (2) 105-110, 1986

INTERACTION BETWEEN SODIUM, CALCIUM AND MAGNESIUM CHLORIDES AFFECTING GERMINATION AND SEEDLING GROWTH OF *SECURIGERA SECURIDACA* LINN.

L.K. AL-JIBURY & M. A. CLOR

Agricultural and Water Resources Research Centre, Scientific Research Council, Jadiriya, P. O. Box 2416, Baghdad, Iraq

ABSTRACT

Seed germination of *Securigera securidaca* Linn. was sharply reduced from 100 per cent in water to about 50 per cent in solutions of NaCl, $CaCl_2$, and $MgCl_2$ at OP 4 atm. Practically no germination took place at concentrations above 5 atm. Early seedling growth was inhibited even more drastically. However, germination and seedling growth were remarkably synergised with the combinations of NaCl+ $MgSO_4$, $Na_2SO_4+MgSO_4$, $NaCl+MgCl_2$ and $CaCl_2+MgCl_2$.

INTRODUCTION

An understanding of the salt tolerance of seeds is important for an effective approach to solve the salinity problem, which is of widespread occurrence. The excessive accumulation of soluble salts in the rhizosphere is a potential limiting factor for the productivity of irrigated crops (Bernstein and Hayward, 1958). Basic research on salt tolerance of plants is, therefore, necessary in relation to the use of salt affected soils. Germinability of seeds under different salt concentrations predicts the probable growth performance and yield.

In our earlier studies, seed germination and early seedling growth of bitter lentil, *Securigera securidaca* (Al-Jibury *et al.*, unpublished) were found to be highly sensitive to sodium chloride and the sulfates of sodium and magnesium used individually. Interestingly, magnesium sulfate, combined with sodium chloride or with sodium sulfate, removed the inhibitory effects of these salts and also remarkably boosted both the processes. Magnesium appeared to play a major role in such synergistic effect. In the present investigation, the effects of sodium, calcium and magnesium chlorides and their combinations were further studied in relation to germination and seedling growth of bitter lentil.

MATERIAL AND METHODS

Solutions of chlorides of sodium, calcium and magnesium and their combinations at various concentrations ranging from 1 to 16 atmospheric OP were used to study their effects on seed germination and seedling growth of bitter lentil, *Securigera*

DISCUSSION

To obtain a better and composite picture of the effects of various salts and their combinations on germination and seedling growth of bitter lentil, some of the relevant results of our previous work (Al-Jibury *et al.*, unpublished) will also be discussed. Bitter lentil is a glycophyte highly salt-sensitive with respect to germination and early seedling growth. The germination percentage sharply reduced from 100 per cent in water to about 50 per cent in solutions of NaCl, Na_2SO_4, $CaCl_2$ and $MgCl_2$, at OP 4 atm and practically no germination took place at concentrations above 5 atm. In case of $MgSO_4$, on the other hand, germination inhibition was gradual, relatively moderate, and rather smooth up to the OP 5 atm (the previous work). It is thought, therefore, that inhibition of germination resulted from high accumulation of Na^+ and/or Cl^-, reaching the so called ion excess level (Ryan *et al.*, 1975; Miller and Chapman, 1978; Greenway and Munns, 1980; Clarkson and Hanson, 1980). It is known that less tolerant species accumulate more Na^+ and Cl^- than the tolerant ones (Bernstein and Hayward, 1958; Greenway and Munns, 1980; Hafeez and Marshall, 1981). Although osmotic and ion excess effects could not be distinguished, yet in the case of $MgSO_4$ where no Na^+ or Cl^- was involved, the gradual decrease in germination percentage, especially in lower concentrations, could be explained primarily in terms of classical osmotic theory.

In terms of early seedling growth in response to the different salt treatments, bitter lentil was even more sensitive as the active processes like cell division, cell expansion and differentiation might be affected rapidly and more directly by ion excess.

The most significant and striking aspect of the results, however, is the remarkable synergism between NaCl and $MgCl_2$ and between $CaCl_2$ and $MgCl_2$ for both germination and seedling growth, similar to that between NaCl and $MgSO_4$ and between Na_2SO_4 and $MgSO_4$ as reported earlier by Al-Jibury *et al.* It appears, therefore, that Mg^{++} is somehow involved in this typical interaction and possible explanation for this synergistic interaction could be that Mg^{++} alone or in combination with Ca^{++} moderated the osmotic effect and/or overcame the excess Cl^-.

This is based on the idea that there are membrane mechanisms for driving Na^+, Cl^- and Ca^{++} efflux leaving the cytosol dominated by Mg^{++} (Clarkson and Hanson, 1980). However, this simple concept alone does not explain the remarkable synergistic effects observed, and additional factor (s) might also be involved, e.g., Mg^{++} could perhaps effect a better compartmentation of the various ions inside the cell which in turn led to more favourable water balance and turgor pressure necessary to growth (Flowers *et al.*, 1977, Greenway and Munns, 1980).

REFERENCES

Bernstein, L. and Hayward, H.E. 1958. Physiology of salt tolerance. *Ann. Rev. Plant Physiol. 9* : 25-46.

Clarkson, D.T. and Hanson, J.B. 1980. The mineral nutrition of higher plants. *Ann. Rev. Plant Physiol. 31* : 239-298.

Flowers, T.J., Troke, P.E. and Yeo, A.R. 1977. The mechanisms of salt tolerance in halophytes. *Ann. Rev. Plant Physiol. 28* : 89-121.

Greenway, H. and Munns, R. 1980. Mechanisms of salt tolerance in Nonhalophytes. *Ann. Rev. Plant Physiol. 31* : 149-190.

Hafeez, K.A. and Marshall, C. 1981. Salt tolerance within populations of chewing fescue (*Festuca rubra* L.). *Commun. in Soil Sci. Plant Anal. 12* (12) : 1271-1281.

Miller, T.R. and Chapman, S.R. 1978. Germination responses of three forage grasses to different concentrations of six salts. *J. Range Management. 31* : 123-124.

Pauling, L. and Pauling, P. 1975. *Chemistry. The osmotic pressure of solutions.* Freeman and Company, San Fransisco, U.S.A. 767 p.

Ryan, J., Myamato, S. and Stroklein, J.L. 1975. Salt and specific effects on germination of four grasses. *J. Range Management. 28* : 61-64.