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The Effect of Salinity (NaCl) on the Germination and Seedling of Sugar Beet (*Beta vulgaris* L.) and Cabbage (*Brassica oleracea* L.)

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ABSTRACT

This study was carried out to investigate seed germination and seedling of cabbage and sugar beet in four treatments of salinity including 0 (control), 0.5, 1.0 and 1.5% NaCl. The results showed that different treatments of salinity had considerable effects on the germination and root and shoot length of cabbage and sugar beet. Percent of germination in both species showed significant decrease with increasing salinity up to 1.5% NaCl. This decrease was more evident in cabbage when compared to sugar beet. The required time for germination increased with high levels of salinity. The seedling growth of both species were inhibited by all salinity levels. Particularly at 1.0 and 1.5% NaCl, no measurable length was observed in cabbage and sugar beet. At 0.5% NaCl root growth of both plant species was more affected as compared to shoot growth by salinity.

Key words : salinity, germination, seedling growth, sugar beet, cabbage

INTRODUCTION

Salinity is a big problem for agricultural productivity in many parts of the world and especially in land areas that have become arid. Salinity is one of the major environmental stresses that limit plant growth and productivity (Boyer, 1982). Some 20% of the potentially exploitable saline soils of the world are in the humid regions of south and Southeast Asia and about half of these (30×10^6 ha) are coastal saline soils (Ponnamperuma and Band-yopadhya, 1980).

Seed germination and seedling growth are important life stages often subject to high mortality rates. Seeds and seedlings may be less stress resistant than adults or may be exposed to the more extreme environmental fluctuations at or near the soil surface. Determination of germination potential of seeds in saline conditions could appear as a simple and useful parameter for several reasons. First, salinity resistance at this stage was shown to be a heritable trait which could be used as an efficient criterion for the selection of salt resistant populations (Ashraf *et al.*, 1987). Salt and water stresses could reduce germination either by limiting water absorption or by the seeds (Dodd and Donovan, 1999). Germination in saline seed beds may be restricted by low soil moisture and osmotic potential or by toxic concentrations of specific ions (Roundy, 1987). Successful seedling establishment depends on the frequency and the amount of precipitation as well as on the ability of the seed species to germinate and grow

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while soil moisture and osmotic potentials decrease (Roundy, 1985).

Cabbage is moderately sensitive to salinity but sugar beet is one of the most salt tolerant crop Species. It is reported to be less tolerant of salinity during germination, emergence, and in the seedling stage (Maas, 1986). Due the increasing salinity problem, researchers should emphasize the important crops on which humans depend. The present study was therefore initiated to investigate the extent of salinity on the germination and early vegetative growth of sugar beet and cabbage.

MATERIALS AND METHODS

Seeds of both plant species, sugar beet (*Beta vulgaris* L.) and cabbage (*Brassica oleracea* L.) differing in salt sensitivity, were used in the experiment. The seed of sugar beet and cabbage cultivars were obtained from China.

In this experiment, the effect of different NaCl concentrations on germination and on root and shoot length of the seedlings were tested. For the experiment plastic Petri dishes (87 mm diameter, 15 mm height) with a tight-fitting lid were used. The solution consisted of 0 (control), 0.5, 1.0 and 1.5% NaCl. For each plant species 40 seeds for each of the four NaCl treatments were used. Seeds were hand sorted to eliminate broken and small seeds. Seeds were allowed to germinate in laboratory condition on filter paper (Whatman No 2) in Petri dishes soaked in a solution of the respective salt concentration.

Seed germination was evaluated after every 24 h. After 48 h seeds started to germinate (seeds were considered to be germinated with the emergence of the radical). The germinating seeds were counted at daily intervals. The lengths of roots and shoots of the germinated seeds which were more than 2 mm in length were measured and recorded after 10 and 15 days of sowing. In all treatments a continuous increase in the number of germinating seeds as well as in the lengths of roots and shoots was observed during the subsequent days of germination.

The experiment was established by using a randomized complete block design with three replications. The varieties were placed in the main plots, with the salt concentrations in submain plots. Analysis of variance was performed using standard techniques, and differences between the means were compared through LSD (Least significant difference) test ($P < 0.05$) (Li, 1964).

RESULTS AND DISCUSSION

Effect of NaCl salinity on seed germination and germination rate

Germination percentage of sugar beet and cabbage was strongly affected by all salt treatments Increased salt concentration caused a decrease in germination. The reduction was more sever particularly at the higher level of salt treatments compared to control. The germination efficiency was more decrease in cabbage compared to sugar beet. The germination of sugar beet and cabbage was strongly inhibited by both 1.0 and 1.5% NaCl applications. The percentage of germination was less than 10% at of 1.5% NaCl for both of these plant species (Fig. 1).

Fig. 1 also shows the lowest concentration at which a significant reduction was observed and the concentration at which germination was projected to reach nearly zero. It is assumed that in addition to toxic effects of certain ions, higher concentration of salt reduces the water potential in the medium which hinders water absorption by germinating seeds and thus reduces germination (Maas and Nieman, 1978). These results are also similar to the Myers and Morgan (1989). They determined that the salt-resistant grass *Diplachne fusca* reduced seed germination from 70% in distilled

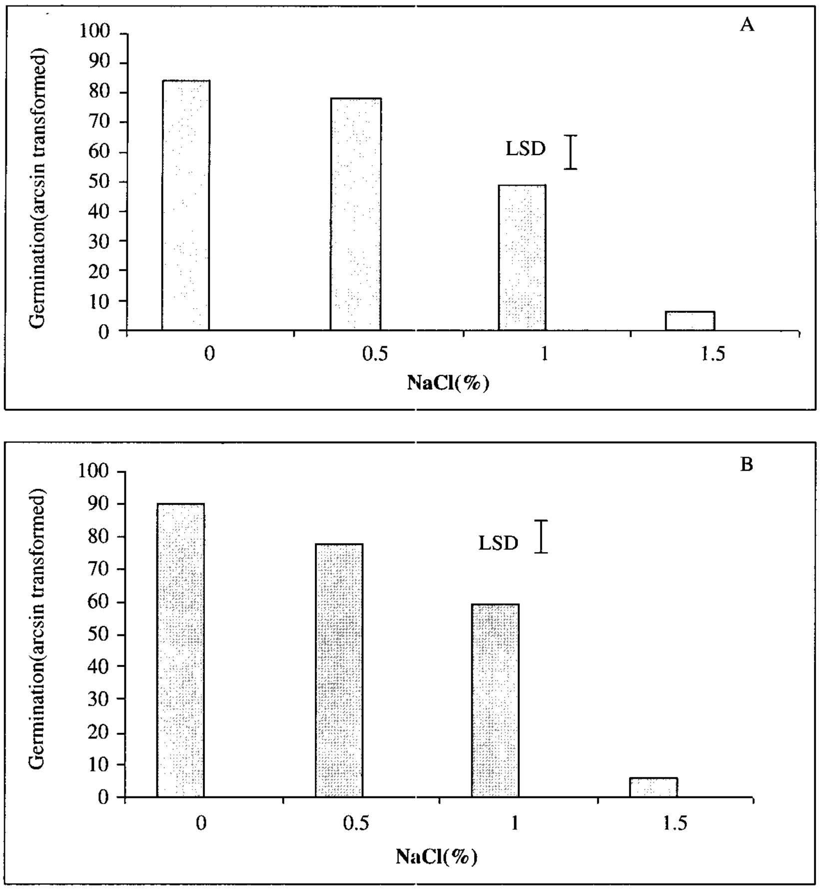


Fig. 1. Effect of NaCl on the germination of cabbage (A) and sugar beet (B) seeds.

water to 50% in 150 mM NaCl, and down to 7% in 300 mM NaCl. The differential genotypic response to salinity at germination stage has also been reported (Helal and Mengek 1981; Jana *et al.*, 1980). Increases in salinity lead to decreases in germination (Mooring *et al.*, 1971)

The germination response of both plant species under investigation showed marked differences in the timing of initiation and completion of germination. Germination started within 48 h and was complete on the 6th day. The final germination rate of seeds of these plant species under various conditions of salinity was expressed as a 1/t50 percentage of the germination of seeds of the same population in control. Germination delay as the level of salinity increased. Fig. 2 indicated that Sugar beet completed germination earlier as compared to cabbage. These results are similar in line with Francois et al. (1984). They found that soil salinity up to 50 mM did not significantly inhibit germination of Sorghum bicolor seeds, but salt levels greater than 100 mM delayed germination. Some of the results obtained in this study are similar to those of some other workers who showed that in general, increased salinity results in decrease in germinability and delayed rate of germination (Palmer *et al.*, 1969; El-Sharkawi and Springuel, 1979).

Effect of NaCl salinity on root and shoot length

Root and shoot lengths are the most important

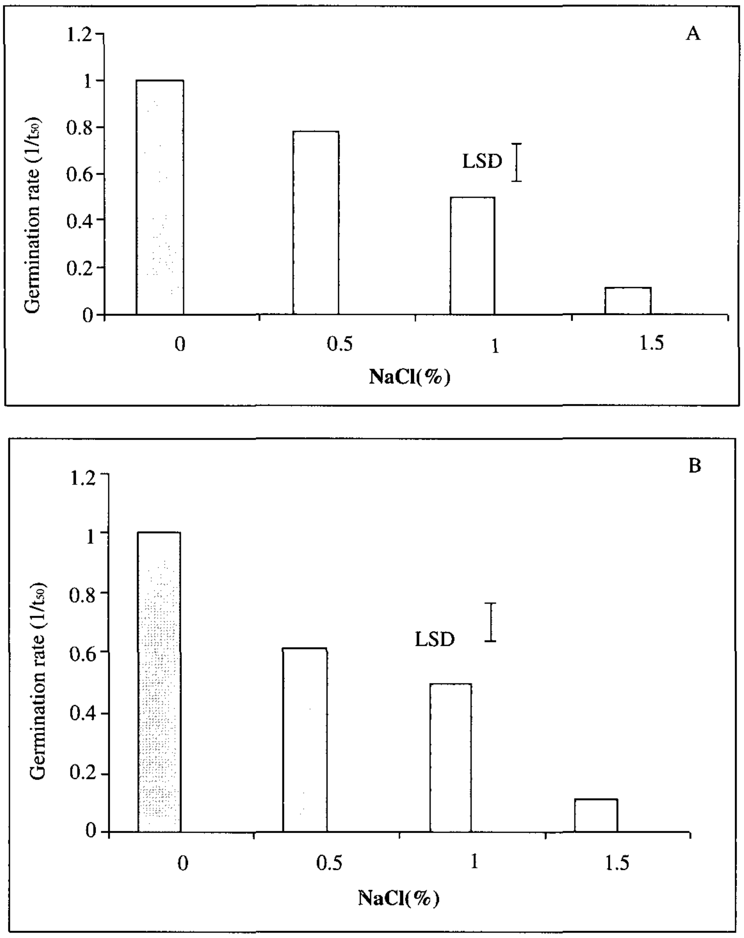
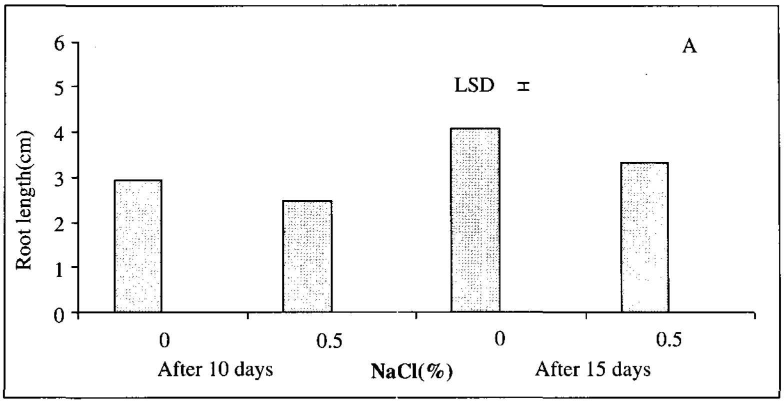


Fig. 2. Effect of NaCl on germination rate (1/t50) of cabbage (A) and sugar beet (B) seeds.

characters for salt stress because roots are in contact with soil and absorb water from soil and shoot supply it to the leaf of the plant. For this reason, root and shoot length provides an important clue to the response of plants to salt stress.

Studies were carried out to evaluate the influence of salinity (NaCl) on seedling vigor of germinating seeds. The result indicated that an increased salinity level caused delayed emergence of root and shoot compared to controls. A continuous increase in length of root and shoot was observed in subsequent hours of germination in both plant species in the control as well as salt treatments. Data on the average length (Fig. 3) of root and shoot of the seedlings of the both plant species raised in increasing levels of salt solutions shows that sugar beet, and cabbage showed a strong inhibition. There was no measurable length of roots and shoot of these plant species, particularly at the highest level of salinity (1.0 and 1.5% NaCl).

Great inhibition, particularly in root growth, occurred with NaCl treatments for sugar beet and cabbage seedlings but shoot growth shows no inhibition. Instead of that in cabbage shoot length increased at 0.5% NaCl as compared to control. Decrease in length of root was more pronounced as compared to shoot in particular at 0.5% NaCl salt treatments in sugar beet and cabbage. In contrast, the lowest inhibition of shoot growth was observed in sugar beet (Fig. 3 and 4).



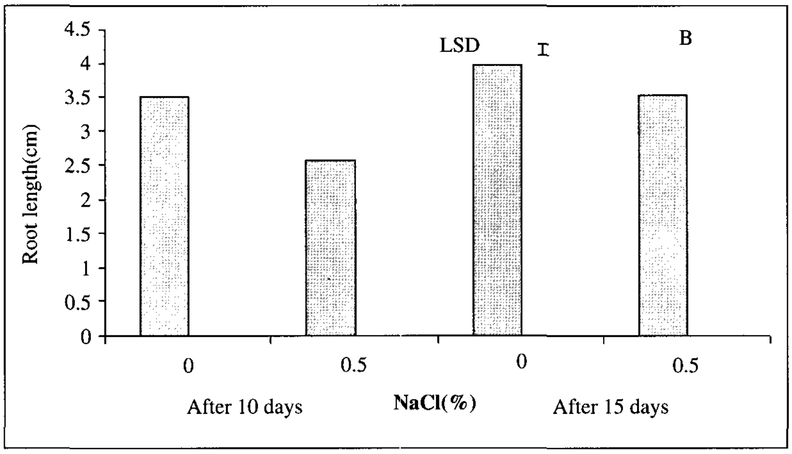


Fig. 3. Effect of NaCl on root length of cabbage (A) and sugar beet (B) after 10 and 15 days.

It was also observed that the degree of reduction increased with the increasing concentration of salt. Inhibition of plant growth by salinity may be due to the inhibitory effect of ions. Another reason for reduced shoot and root development may be due to toxic effects of the salts used as well as unbalanced nutrient uptake by the seedlings. Demir and Arif (2003) also obtained similar results. They observed that the root growth of safflower was more adversely affected compared to shoot growth by soil salinity. Our results were also similar with the findings of Hussain and Rehman (1995, 1997) and Horashy *et al.* (1972). They found that the roots of seedlings were more sensitive than the shoots. Epstein and Norylin (1977) reported that genotypic response to shoot and root growth at different salinity levels is obvious and genetically controlled.

CONCLUSION

Salinity reduced seed germination, germination rate and root and shoot length. However, sugar beet performed well as compared to cabbage at germination stage and also completes germination in less time. But on the other hand root and shoot length of sugar beet was more affected as compared to cabbage. These results suggested that it may be unwise to rely on only one measurement of growth to estimate the salt tolerance of a particular species at germination and seedling stage.

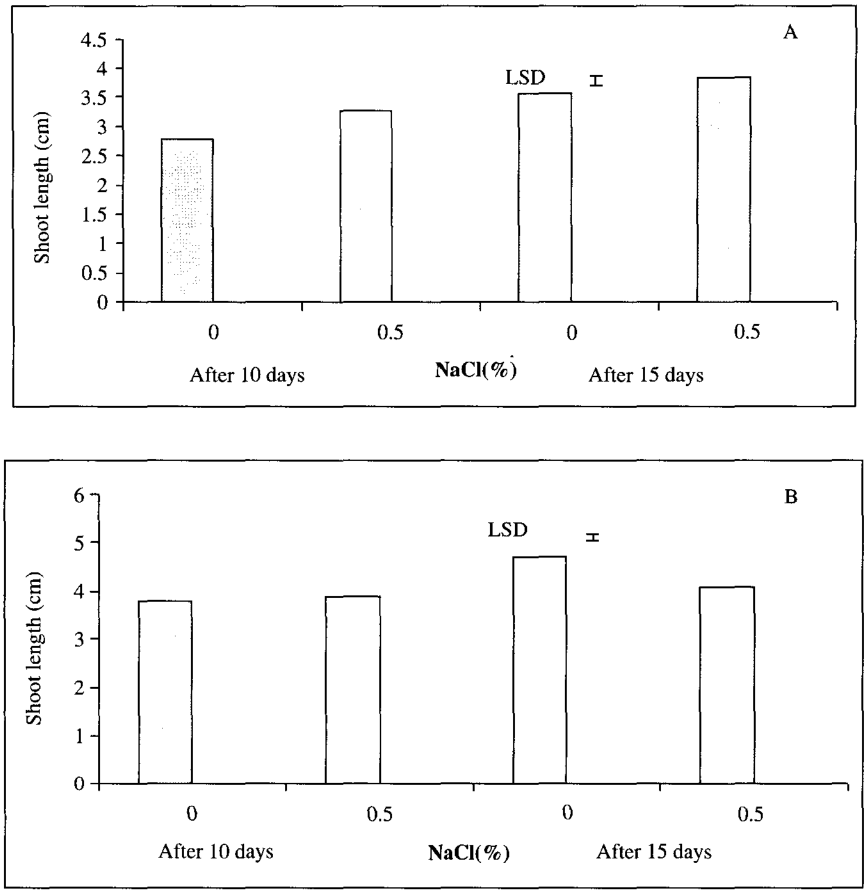


Fig. 4. Effect of NaCl on shoot length of cabbage (A) and sugar beet (B) after 10 and 15 days.

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