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Effects of Salinity and Temperature on Germination of Dill (*Anethum graveolens* L.)

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Abstract: Experiments were carried out to investigate seed germination responses of dill *Anethum graveolens* L. at different salinities (0, 2.5, 5, 7.5, 10 and 12.5 dS m^{-1} NaCl) and under different temperature regimes (10:20, 15:25, 20:30 and 25:35 °C), both in a 12 h dark : 12 h light photoperiod. The highest percentage of germination (about 100%) was obtained at 0, 2.5 and 5 dS m^{-1} NaCl at 20:30 °C and a further increase in salinity resulted in a gradual decrease in germination. Less than 5% of seeds germinated at 12.5 dS m^{-1} NaCl. Germination under salinity treatment at 15:25 °C was slightly more inhibitory than the optimal temperature regime, whereas under both 10:20 and 25:35 °C temperature regimes, seed germination was substantially reduced and few seeds germinated at concentrations higher than 5 dS m^{-1} NaCl. Germination rate was fastest at 20:30 °C and slowest at 10:20 °C.

Key words: Salinity, temperature, germination, *Anethum graveolens*, seeds, dill

INTRODUCTION

Dill (*Anethum graveolens* L.) is an annual and sometimes biennial herb of the family *Apiaceae*, which is nativesouth-west Asia or south-east Europe and has been cultivated since ancient times (Bailer *et al*., 2001). It is used as a vegetable, a carminative, an aromatic and an antispasmodic (Hornok, 1992; Sharma, 2004) and as an inhibitor of sprouting in stored potatoes (Score *et al*., 1997; Zehtab-Salmasi *et al*., 2006).

Salinity in soil or water is one of the major stresses and especially in arid and semi arid regions, can severely limit crop production (Shannon, 1998). Salinity impairs seed germination, reduces nodule formation, retards plant development and reduces crop yield (Greenway and Munns, 1980). The plants that grow in saline soils have diverse ionic compositions and a range in concentrations of dissolved salts (Volkmar *et al*., 1998). These concentrations fluctuate because of changes in water source, drainage, evapotranspiration and solute availability (Volkmar *et al*., 1998). Successful seedling establishment depends on the frequency and the amount of precipitation as well as on the ability of the seed speciesgerminate and grow while soil moisture and osmotic potentials decrease (Roundy, 1987). These salts interfere with seed germination and crop establishment (Fowler, 1991). Germination and seedling characteristics are the most viable criteria used for selecting salt tolerance in plants (Boubaker, 1996). Salinity stress can affect seed germination through osmotic effects (Welbaum *et al*., 1990).

Temperature interacts with salinityaffect the germination of crop seeds. The adverse effect of high salinity is further aggravated by either an increase or decrease in temperature (Khan *et al*., 2001). Germination of many plants occurs at times when there is an optimal combination of day length, temperature regime and salinity (Gutterman *et al*., 1995; Khan *et al*., 2001).

The aim of the present study, was to determine percent germination and rate of germination of dill under various salinity and temperature conditions.

MATERIALS AND METHODS

Seeds of dill (*Anethum graveolens* L. var. Mammoth) were surface sterilized using sodium hypochlorite (0.52%) for 1 min, followed by thorough rinsing with distilled water and air drying. Germination was carried out using 5 cm diameter, tight-fitting plastic Petri plates with 5 mL of test solution prepared by using distilled water. Each dish was placed in a 10 cm diameter plastic Petri plate as an added precaution against the loss of water by evaporation. Four replicates of 25 seeds each were used for each treatment. Seeds were consideredbe germinated at the emergence of the radical about 2 mm.

To determine the effect of temperature, seeds were germinated in incubators at four alternating temperature regimes of 10:20, 15:25, 20:30 and 25:35 °C. A 24-h cycle was used, where higher temperatures (20, 25, 30 and 35 °C) coincided with a 12-h light period and lower temperatures

(10, 15, 20 and 25°C) coincided with a 12-h dark period. Seeds were germinated at six salinities (0, 2.5, 5, 7.5, 10 and 12.5 dS m^{-1} NaCl) as a result of preliminary tests, which determined the range of salinity tolerance.

Percent germination was recorded after 20 d. Rate of germination was estimated by using a modified Timson's index of germination velocity, germination velocity = ΣG/t, where G is the percentage of seed germination at 2-d intervals and t is the total germination period (Khan and Ungar, 1997). The higher the value, the more rapid the germination.

RESULTS

Maximum seed germination in light was obtained in non-saline control under all temperature regimes (Fig. 1). Exposuredifferent salinity levels resulted in a gradual decrease in percent germination and this reduction varied with the change in temperature regime (Fig. 1). Best germination under saline conditions was observed at 20:30°C treatment, where germination in 2.5 and 5 dS m^{-1} NaCl was not significantly different from the control. A further increase in salinity decreased germination and only 5% of seeds germinated at 12.5 dS m^{-1} NaCl. Seed germination at 15:25 °C was comparatively lower than germination under the optimal temperature regime. Exposurelower (10:20 °C) and higher (25:35 °C) temperature regimes substantially inhibited germination in all salinity treatments (Fig. 1) and the lowest germination

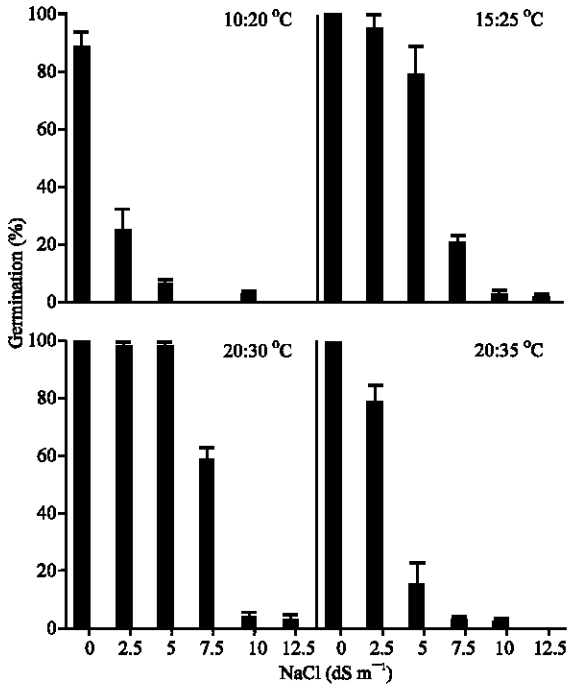

Fig. 1: Mean final percent germination of dill (*Anethum graveolens*) in various salinity and temperature conditions. Bars represent mean±SE

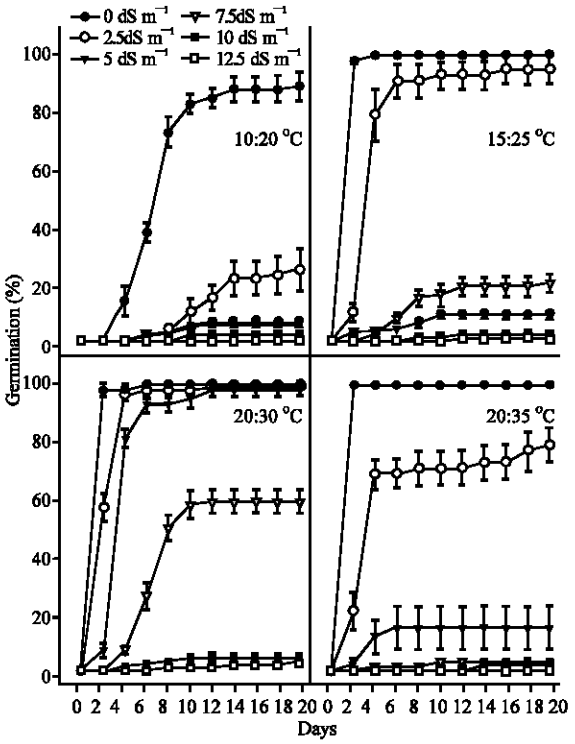

Fig. 2: Cumulative mean percent germination of dill (*Anethum graveolens*) seeds over time in 0, 2.5, 5, 7.5, 10 and 12.5 dS m^{-1} NaCl in 12 h light : 12h dark photoperiod. Bars represent mean±SE

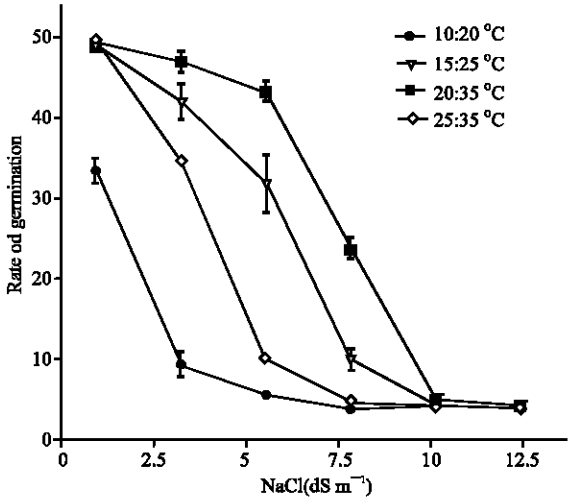

Fig. 3: Rate of germination of dill (*Anethum graveolens*) seeds under various salinity and thermoperiod treatments ars represent mean±SE

was obtained at 10:20°C, where 25% seed germination was obtained in 2.5 dS m^{-1} NaCl. Temperature also affected speed of germination under both saline and non-saline conditions (Fig. 2). Maximum germination in the distilled water control was obtained after 2 d under all temperature regimes except for 10:20°C, where it was attained in 14 d (Fig. 2). In saline solutions, maximum germination varied from 6-18 d. Under the optimal temperature regime, germination at lower salinity (2.5 and 5 dS m^{-1} NaCl) peaked in 6 d and it was about 10 d in higher salinity treatments. However, seed germination peaked at 10 d for all salt concentrations at 15:25°C (Fig. 2).

Rate of germination was highest in non-saline controls except at 10:20°C and addition of NaCl slowed the rate of germination (Fig. 3). Temperature also influenced rate of germination. At lower and higher temperatures, seeds showed a slower rate of germination from 2.5-7.5 dS m^{-1} NaCl than at 20:30°C and 15:25°C (Fig. 3).

DISCUSSION

The available reports indicate that dicotyledonous species vary in their salinity tolerance during germination, our results showed dill is a moderately salt-tolerant plant at germination when compared with other local medicinal species, but it has the ability to germinate at salinity levels of up to 12.5 dS m^{-1} NaCl.

Temperature and salinity interact to affect the germination of crops (Khan and Ungar, 1997). Seed germination of dill was also influenced by temperature. We found 20:30°C to be the optimal temperature for germination and any increase or decrease in temperature inhibited germination. This inhibition progressively increased with salinity.

Several reports have indicated that the rate of germination is more sensitive to salinity than is overall percent germination (Marcar, 1987). Seeds of *Anethum graveolens* germinated rapidly in control and in up to 5 dS m^{-1} NaCl at 20: 30°C temperature regime.

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