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BRIEF COMMUNICATION

Seed germination of *Triglochin maritima* as influenced by salinity and dormancy relieving compounds

M.A. KHAN* and I.A. UNGAR**

Department of Environmental and Plant Biology, Ohio University,
Athens, Ohio 45701-2979, USA

Abstract

Triglochin maritima had only 40 % germination in distilled water, but germination was substantially enhanced when seeds were exposed to ethephon, fusicoccin, proline, kinetin, and thiourea. Also, the effect of low salinity on germination was alleviated by fusicoccin, kinetin, nitrate and thiourea, whereas, the reduction in germination at high salinity was partially countered by ethephon, kinetin, thiourea and nitrate.

Additional key words: betaine, ethephon, fusicoccin, gibberellic acid, halophytes, kinetin, proline, thiourea.

Triglochin maritima L. (*Juncaginaceae*) is distributed in brackish and fresh water marshes and bogs in North America (Sheltler and Skog 1978). It grows in almost pure stands in wetter areas with soil solution salinities ranging from 0.5 - 1 % (Ungar 1974). The source of seeds for this investigation was in a saline wetland community at Faust, Utah where *Triglochin maritima* was growing with other halophytes. Maximal seed germination was in distilled water at a temperature optimum of 5 °C - night: 25 °C - day and germination decreased with an increase in salinity, with no seeds germinating at 400 mM NaCl (Khan and Ungar 1999).

Most salt marsh and salt desert halophytes have some form of physiological dormancy (Baskin and Baskin 1998). Dormancy alleviating compounds such as proline, betaine, fusicoccin, GA_3, kinetin, nitrate, thiourea and ethephon can reduce the inhibitory effect of salinity on the germination of halophytes (Ungar 1977, Ismail 1990, Yaniv *et al.* 1995, Plyler and Proseus 1996, Khan and Ungar 1997). Our study is designed to investigate the role dormancy-relieving compounds play in alleviating the innate and salinity-enforced dormancy in *Triglochin maritima.*

Seeds of *Triglochin maritima* L. were collected during August 1995 from a salt marsh near the Great Salt Lake, at Faust, Utah. Seeds were separated from the inflorescence and brought to Ohio University where they were stored at 4 °C. Germination studies were started in January 1996. Seeds were surface sterilized using the fungicide *Phygon*. Germination was carried out in 5-cm tight-fitting plastic Petri dishes (*Gelman No. 7232*, Ann Arbor, USA) with 5 cm^3 of test solution. Each dish was placed in a 10-cm plastic Petri dish as an added precaution against loss of water by evaporation. Four replicates of 25 seeds each were used for each treatment. Seeds were considered germinated with the emergence of the radicle.

Seeds were germinated in an incubator at a day/night temperature of 25/5 °C and 12-h photoperiod (*Sylvania* cool white fluorescent lamps, irradiance of 25 $\mu mol\ m^{-2}\ s^{-1}$, 400 - 700 nm), and 0, 100, 200, and 400 mM NaCl. Dormancy relieving compounds, 20 mM nitrate, 10 mM

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*Present address: Department of Botany, University of Karachi, Karachi-75270, Pakistan
**Corresponding author, fax: (+740) 593 1130, e-mail: ungar@oak.cats.ohiou.edu

thiourea, 10 mM ethephon, 5 μM fusicoccin, 3 mM gibberellic acid, 0.05 mM kinetin, 1 mM proline, 1 mM betaine, were used because they stimulated germination in other species. Percent germination was recorded every alternate day for 20 d. Germination data were arcsine transformed before statistical analysis. An *ANOVA* analysis was used to determine if significant differences were present among means. When significant differences were found among means, a Bonferroni post hoc test was carried out to determine if significant differences ($P < 0.05$) occurred between individual treatments.

Seed germination of *T. maritima* was inhibited with an increase in salinity and no seeds germinated at 400 mM NaCl. Fusicoccin, proline, kinetin, nitrate and thiourea partially alleviated the inhibitory effects of salinity, but ethephon, GA_3 and betaine showed no effect (Fig. 1). Dormancy enforced by salinity was partially alleviated by fusicoccin (Fig. 1*A*) and this may be due to stimulation of ATPase production, since it rapidly increased during the early phases of germination to facilitate proton extrusion (Stout 1988).

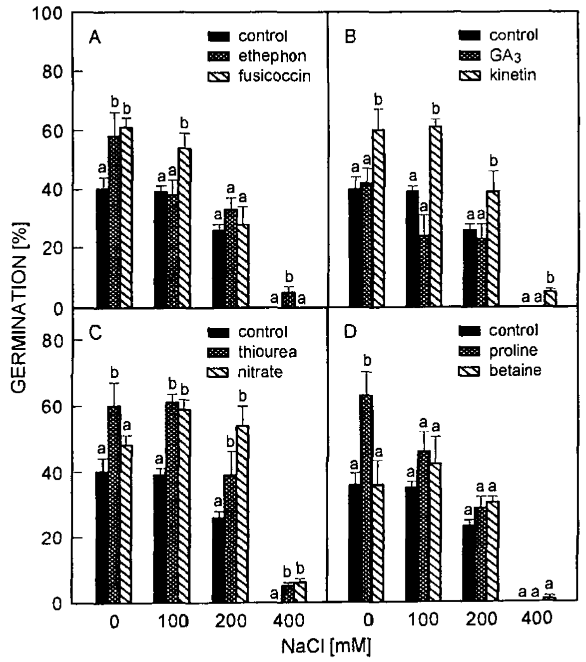

Fig. 1. Percent germination of *Triglochin maritima* seeds in 0, 100, 200 and 400 mM NaCl, 10 mM ethephon, 5 μM fusicoccin, 3 mM GA_3, 0.05 mM kinetin, 10 mM thiourea, 20 mM nitrate, 1 mM proline, and 1 mM betaine. Values for each of the dormancy relieving compounds having the same letter are not significantly different ($P > 0.05$) from the control (Bonferroni test).

Application of ethephon relieves dormancy in seeds of some species (Bewley and Black 1994) and may reverse the inhibitory effects of ABA and osmotic stress (Schonbeck and Egley 1981). Germination is not always promoted by ethylene (Ismail 1982), and *T. maritima* seeds treated with ethephon had no increase in germination at 100 and 200 mM NaCl (Fig. 1*A*).

The promotion of seed germination by nitrogenous substances such as thiourea, nitrite, and nitrate has been reported (Bewley and Black 1994). Both thiourea and nitrate stimulated the germination of *T. maritima* and the inhibitory effect of salinity on germination of *T. maritima* seeds was partially alleviated in the nitrate and thiourea treatments at all salinities (Fig. 1*C*). Thiourea counteracts the effect of increased ABA and reduced levels of cytokinins in plant tissues exposed to water stress induced by drought, salinity or high temperatures (Kabar and Baltepe 1989). Treatment with thiourea is highly effective in alleviating the inhibition of germination by salinity or high temperatures (Gul and Weber 1998).

GA_3 failed to alleviate the inhibitory effect of salinity on the germination of *T. maritima* seeds, whereas, kinetin promoted germination both under saline and non-saline conditions (Fig. 1*B*). Both GA_3 and kinetin are known to alleviate the inhibitory effect of salinity on germination in some halophytic species but GA_3 was ineffective in other halophytes such as *Suaeda fruticosa* (Khan and Ungar 2000).

Compatible osmotica like proline and betaine have some effect in alleviating dormancy (Khan *et al.* 1998). Poljakoff-Mayber *et al.* (1994) showed that proline and betaine could not relieve the dormancy induced by salinity in *Kosteletzkya virginica.* Gul and Weber (1998) reported that both proline and betaine reduced the inhibitory effect of salinity on *Allenrolfea occidentalis* seeds. Our results with *T. maritima* showed that proline stimulated germination in controls, but no significant alleviation of the inhibitory effects of salinity on germination were found for either proline or betaine (Fig. 1*D*). The capacity of germination regulating compounds to promote seed germination under saline and non-saline conditions varied with the species investigated (Ungar 1991). Specific responses of halophyte seeds to salinity and growth regulators should be investigated further to determine if any general trends in response occur among species.

Salinity prevents germination of seeds either by reducing water availability or interfering with some aspect of metabolism, such as altering the balance of growth regulators. Our investigation showed that the compatible osmoticum proline increased seed germination under non-saline conditions but had little effect in alleviating the inhibitory effects of high salinity. However, growth regulators, such as fusicoccin, kinetin, nitrate and thiourea, were capable of alleviating the effect of salinity on the germination of seeds.

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