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Sodium Fluoride Induced Growth and Metabolic Changes in *Salicornia brachiata* Roxb

Muppala P. Reddy · Meenakshi Kaur

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Abstract Fluoride, a common phytotoxic air, water and soil pollutant is commonly released to the environment by a number of industrial processes. Agricultural soils high in fluoride are common due to long term accumulation of fluoride from multi-sources and extensive application of phosphate fertilizers. The effect of sodium fluoride (0, 50,100,150 mM) on growth, pigments content, changes in biochemical parameters, along with fluoride and other ions accumulation was investigated in *Salicornia brachiata* grown in solution cultures under controlled conditions. With fluoride treatment growth as fresh or dry mass accumulation increased marginally. However, higher concentrations decreased the biomass and shoot tip became blunt; margin of the shoot changed its colour to reddish brown and developed necrotic spots. Photosynthetic pigments (chlorophylls and carotenoids) content decreased, while, anthocyanin content increased significantly with fluoride treatment. Peroxidase (POX), superoxide dismutase (SOD), ATPase and acid phosphate activities were negatively regulated. In addition F^{-}, Na^{+}, Mn^{2+} and Fe^{2+} ions concentration increased while, K^{+}, Ca^{2+} and Mg^{2+} contents decreased with fluoride treatment. To our knowledge this is the first report on fluoride tolerance in a marshy halophytes using as high as 150 mM concentration and the results suggest that *S. brachiata* is a moderately fluoride tolerant annual halophyte and may be useful to vegetate the fluoride contaminated marshy lands.

Keywords Fluoride · Ion accumulation · Halophyte · Pigments · *Salicornia brachiata* · Necrotic spots

M. P. Reddy (✉) · M. Kaur
Discipline of Phytosalinity,
Central Salt and Marine Chemicals Research Institute,
Bhavnagar, Gujarat 364002, India
e-mail: mpr@csmcri.org

1 Introduction

Fluoride, a common phytotoxic air, water and soil pollutant is commonly released to the environment by a number of industrial processes (EPA 1978). Certain soils also contain high levels of natural fluorides (Weinstein 1977). Accumulation of fluoride is mainly from weathering of volcanic ashes (Cronin et al. 2003) application of phosphate fertilizers in agriculture (Loganathan et al. 2001) and several industrial sources (Arnesen and Krogstad 1998; Mackowiak et al. 2003). Fluoride induces morphological symptoms like chlorosis; tip and marginal necrosis are known (Klumpp et al. 1996, 2000; Fornasiero 2001, 2003). Differences in the sensitivity of various species and among the species of various cultivars to fluoride are reported (Posthumus 1983; Scholl 1987). Fluoride interferes with phosphorylation of phosphoproteins in cellular membranes (Chang and Kaufman 2000; Struglics et al. 2000) enzyme activities (Zwiazek and Shay 1988; Facanha and Meis 1995; Fornasiero 2001, 2003)