THE RELATIONSHIP BETWEEN ENHANCED CHILLING RESISTANCE AND OXIDATIVE STRESS IN MAIZE PRE-TREATED WITH SEAWEED EXTRACT

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ABSTRACT

The effects of seaweed extract application on plant development, metabolism, and physiology are quite diverse, as is the range of potential compounds known to be present in seaweed extract formulations. Previous work has shown that applications of Acadian Seaplants Ltd.'s Soluble Seaweed Extract Powder (SSEP) improves the chilling tolerance of maize as measured by chlorophyll fluorescence (Fig. 1). Active oxygen species (AOS) are known to be induced by chilling stress, and these AOS can degrade the D1 protein of the PSII reaction centre, thus negatively affecting chlorophyll fluorescence (Fv/Fm). As oxidative stress plays a major role in chilling sensitivity of plants, a preliminary examination of the effect of seaweed extract on accumulation of malondialdehyde (MDA; a secondary indicator of lipid peroxidation) and on total antioxidant capacity was performed. Three week-old maize (cv. Miracle) plants grown for 18 d at 25°C in a growth chamber were split in half; one set were treated with SSEP (200 mL/pot of 100 mg/L), while the control set received 200 mL/pot of water. After 3 days, the plants were placed in a 7.5°C chamber for four days. MDA was measured spectrophotometrically while total antioxidant capacity (hydrophilic and lipophilic) was assessed using the AAPH-based oxygen radical absorbing capacity (ORAC) system. Preliminary results indicate that although MDA levels (nmol $\cdot g^{-1}$ FW) accumulated in response to chilling treatment, SSEP application had no effect, implying that SSEP does not reduce the amount of oxidative stress experienced by the chilled maize (Fig. 2). However, SSEP application increased total (hydrophilic and lipophilic) antioxidant capacity (Trolox equivalents $\cdot g^{-1}$ DW), even prior to the chilling treatment (Fig. 3). As the SSEP-associated increase in hydrophilic antioxidant capacity was lost when the plants were chilled, it is possible that this extra water-soluble capacity was used up in protecting the maize plants against the chilling-induced increase in oxidative stress (as evinced by increased MDA), manifesting as protection of the photosynthetic pathway as measured by chlorophyll fluorescence.

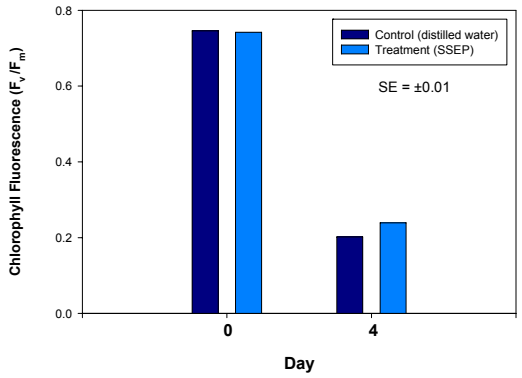

Fig 1. Chlorophyll fluorescence (Fv/Fm) of maize treated with SSEP at 25°C (Day 0) and following 4 days of chilling at 7.5°C (Day 4). Temp. interaction P=0.000, Treat. interaction P=0.031, Temp x Treat P=0.011.

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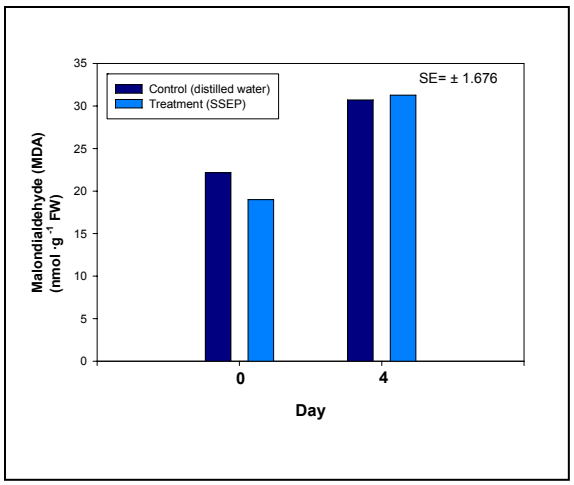

Fig. 2. MDA content of maize treated with SSEP at 25°C (Day 0) and following 4 days of chilling at 7.5°C (Day 4). Temp. interaction P= 0.007.

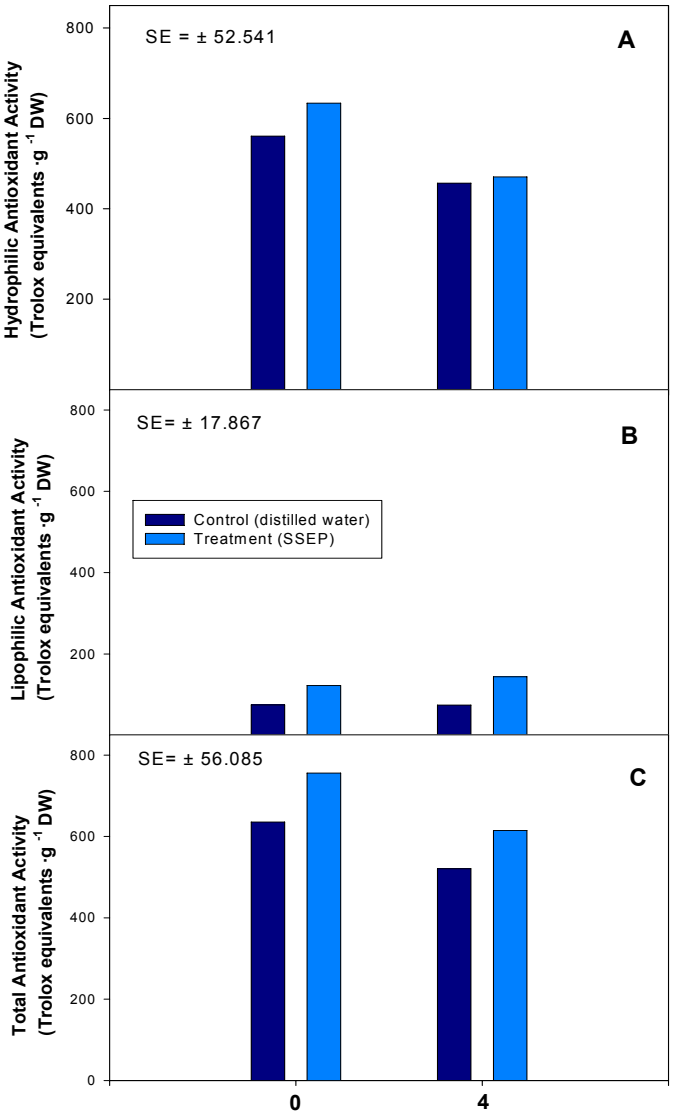

Fig. 3. Hydrophilic (A), lipophilic (B), and total (C) antioxidant capacity of maize treated with SSEP at 25°C (Day 0) and following 4 days of chilling at 7.5°C (Day 4). Treat. Interactions Hydro P=0.01, Lipo P=0.048, Total P = 0.036.