IMPACT OF SEAWEED EXTRACT-BASED CYTOKININS AND ZEATIN RIBOSIDE ON CREEPING BENTGRASS HEAT TOLERANCE

E.H. Ervin[1], X. Zhang[1], and G. Seaver[2].

ABSTRACT

Creeping bentgrass (*Agrostis stolonifera* L.) is adapted to cool-humid climates, but golfer demand for premier putting surfaces has pushed its use into subtropical regions. Heat tolerance of newer cultivars has improved but it is still the primary factor limiting summer performance and survival. Exogenous applications of cytokinins such as zeatin riboside (ZR) have been shown to play a role in bentgrass physiological adaptation to heat stress. Seaweed extracts (SWEs) from various sources have been determined to contain bioactive levels of cytokinins. Our research group, working with foliar applications of an *Ascophyllum nodosum*-based KOH extract containing approximately 70 µg g^{-1} ZR, reported that increased endogenous ZR contents were associated with increased bentgrass physiological adaptation to drought stress. These reports, and those of many others, continue to show that cytokinins are one of the active constituents in SWEs, but little attention in the scientific literature has been paid to the effects of the extraction procedure (temperature, pressure, solvent concentration) on cytokinin quantity and subsequent plant effects. Our objective was to compare the effects of two differentially-processed SWEs to synthetic ZR when applied at equivalent cytokinins concentration on the heat tolerance of 'L-93' creeping bentgrass. We tested liquid concentrates from two sources, Acadian Seaplants and Ocean Organics, whose extraction processes differ in terms of water temperature and KOH concentration (J. Norrie and G. Seaver, personal communications). The Acadian liquid concentrate contained 14.4% solids and a ZR content of 867 µg g^{-1} as determined by enzyme linked immunosorbent assay (ELISA). The Ocean Organics liquid concentrate contained 8% solids and 1554 µg g^{-1}. Each treatment was applied to the foliage in a solution to provide ZR at 3.5 mg L^{-1} and compared to a water-control and an ashed SWE control. Treatment applications occurred at d 1 and d 28 of the two 56 d trials. Plants were grown in a hydroponic nutrient solution culture system under constant heat stress (35°C) for 49 d. Data responses were consistent across the two trials, so the pooled data are presented here. At 14 d of heat stress, leaf tissue ZR contents were greater than the control for all three cytokinin-containing compounds (Fig. 1).

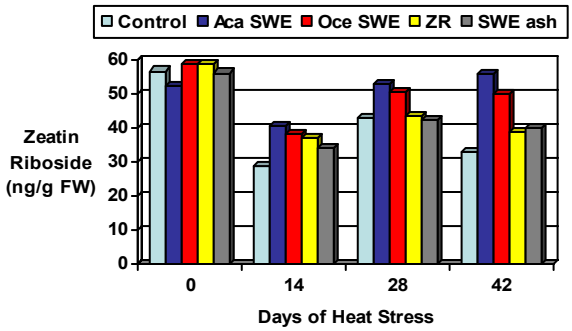

Fig. 1. Cytokinin-containing compound effects on bentgrass leaf zeatin riboside content under heat stress

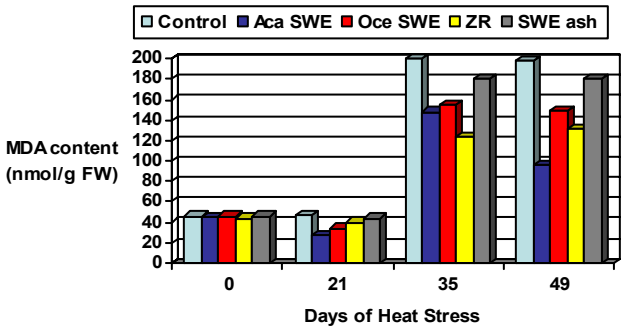

Fig. 2. Cytokinin-containing compound effects on bentgrass leaf lipid peroxidation under heat stress

[1] Crop and Soil Environmental Sciences Department, Virginia Tech, Blacksburg, VA 24061-00404 USA

[2] Ocean Organics, 1009 Dutch Neck, Waldoboro, ME 04572 USA

Greater ZR continued to be measured due to the Acadian and Ocean Organics treatments at 42 d of heat stress. Less leaf senescence due to all three cytokinin-containing compound treatments was seen visually and confirmed physiologically as greater photochemical efficiency was measured at 42 d of heat stress. Greater stability of the photosynthetic apparatus due to the SWE and ZR treatments appeared to be associated with higher superoxide dismutase activities and less lipid peroxidation at 35 and 49 d of heat stress (Fig 2). Root fresh weight was greater for the Acadian SWE at 35 and 49 d of heat stress, while greater root viability was measured on these sample dates for the Ocean Organics SWE. Although the Acadian and Ocean Organics SWE sources differed in ZR concentration, when applied at equivalent ZR concentration (3.5 mg L^{-1}), they improved creeping bentgrass heat tolerance similarly. The responses measured appeared to be a cytokinin-effect as the synthetic ZR treatment gave similar results to the two SWEs, while the ashed SWE treatment responded like the control. Our results indicate that foliar applications of KOH-extracted *A. nodosum* increased endogenous cytokinin levels leading to improved creeping bentgrass heat tolerance.