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# EFFECTS OF AMINOLEVULINIC ACID AND ACETYLTHIOPROLINE ON WEED-FREE AND WEED-INFESTED ST. AUGUSTINE TURFGRASS

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*Abstract.* **Experiments were conducted in Gainesville, Florida to determine the effect of foliar-applied aminolevulinic acid (ALA) and acetylthioproline (AP) on the growth and aesthetic quality of weed-free and green kyllinga-infested St. Augustine turfgrass. ALA and AP (300 mg $L^{-1}$) were applied seven times at 20-days intervals. St. Augustine turfgrass density, leaf area, aboveground and belowground dry weight, and aesthetic quality were determined. Shoot dry weight was determined in green kyllinga. Applications of ALA and AP resulted in increased density, leaf area, aboveground and belowground dry weight in weed-free and green kyllinga-infested St. Augustine turfgrass. In weed-free St. Augustine turfgrass, biostimulant treatments enhanced aesthetic quality. However, in weedy St. Augustine turfgrass, both biostimulants increased green kyllinga shoot dry weight, resulting in reduced aesthetic quality in the turfgrass, in spite of improved turfgrass density and leaf area. This research showed that AP and ALA may be useful to improve weed-free residential St. Augustine turfgrass growth and aesthetic quality, but the use of these biostimulants may not be advisable in green kyllinga-infested St. Augustine turfgrass, due to their unsightly stimulatory effect on weed shoot growth.**

St. Augustine grass (*Stenotaphrum secundatum* Kuntze.) is among the most commonly used turfgrasses for residential and recreational areas in Florida (Cisar et al., 1992; Trenholm et al., 2000). Weed management in turfgrass is one of the major components of Florida residential turfgrass management (Unruh et al., 2003). More than $90 million were spent in turfgrass weed management in Florida each year (Hodges et al., 1994). Green kyllinga (*Kyllinga brevifolia* Rottb.) is among the most common and troublesome weeds in Florida turfgrasses (Busey, 2001).

Biostimulants based on humates, amino acids, peptides, and algae and plant extracts are commonly used in turfgrass to improve overall aesthetic quality, increase lateral growth, and enhance tolerance to stressful conditions (Kernok, 2000; Liu and Cooper, 2000; Verkleij, 1992; Zhang and Schmidt, 2000). For example, in creeping bentgrass (*Agrostis palustris* Huds.) applications of humic acid and seaweed (*Ascophyllum nodosum*) extracts rich in cytokinins and saccharides significantly increased root growth (Zhang et al., 2002) and tolerance to dollar spot disease (Zhang et al., 2003). Dudeck and Peacock (1985) reported that gibberellic acid and carboxin enhanced the aesthetic quality of Bermudagrass growing under suboptimal temperatures in Florida, and Morales-Payan and Stall (2004) found that a cytokinin and saccharide-rich seaweed (*Ascophyllum nodosum*) extract, a glycine-rich mixture of amino acids and peptides, a mixture of cysteine and folic acid, and a terpenic acid-rich extract of Siberian fir (*Abies sibirica*) improved post-winter regrowth in St. Augustine turfgrass in North Central Florida.

The aforementioned reports pertain to results obtained with biostimulants and growth regulators in weed-free turfgrasses. However, there are no reports of the effects on biostimulants on the growth and aesthetic quality of weed-infested turfgrass. Since turfgrass may be difficult to maintain completely weed-free in residential lawns and other turfgrass settings, knowledge on the effect of biostimulants on weedy turfgrass may aid residential (and other) turfgrass managers in deciding if a given biostimulant may improve their turf in spite of the weeds present. The extent of the effects of biostimulants and growth regulators is known to vary from one plant species to another, and even between varieties within a given species (Csizinszky, 2002; Hussey and Stacey, 1984; Palmer and Smith 1969; Xu et al., 1998). Thus, it may be pos-

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sible that to use selected biostimulants to manipulate physiological processes that favor turfgrass performance to a larger extent than weed performance. Such a differential weed/turfgrass response to biostimulants may result in increased turfgrass quality despite the presence of weeds.

Acetylthioproline (AP) has been described as an enzymatic activator, having anti-oxidant activity in plant cells, enhancing water efficiency and mitochondrial activity, and being associated with increased nutrient uptake and utilization and growth increase (Bueno Soto, 1985; Oeriu et al., 1969). Aminolevulinic acid (ALA) is a natural precursor of chlorophyll and heme in plants, and its application has been associated with increased photosynthetic activity, overall vegetative growth enhancement, increased production of reproductive organs, and enhanced tolerance to salinity and suboptimal temperature exposure in several agronomic, horticultural, and wood species (Bindu Roy and Vivekanandan, 1998; Drazic and Mihailovic, 1998; Wang et al., 2004; Yoshida et al., 2003). The objective of this research was to determine the effect of two biostimulants (aminolevulinic acid and acetylthioproline) on weed-free and green kyllinga-infested St. Augustine turfgrass in residential conditions in north central Florida.

## Materials and Methods

Experiments were conducted in a residential setting in Gainesville, Fla., in April-July and May-August (120 d each), 2003. Established St. Augustine turfgrass was managed with an intermediate intensity level (mowed to 10 cm [~4 inches] at approximately 10-d intervals, irrigated daily with sprinklers, fertilized with Scott's 12-12-12 bimonthly at a N rate of 5 g $m^{-2}$). The treatments were water (control), aminolevulinic acid (ALA), or acetylthioproline (AP) foliar applications to weedy and weed-free turfgrass. Plots were made weedy by establishing green kyllinga (*Kyllinga brevifolia*) at a fixed density of 25 plants per $m^2$ 10 d before the first biostimulant application. ALA and AP were applied at the rate of 300 mg $L^{-1}$ (manufacturer recommended rate) seven times at 20-d intervals. The experiment was established as a split-plot with presence or absence or weed as the main plot and biostimulants as subplots (2 × 2 m), with four replications.

The variables evaluated in St. Augustine turfgrass were turf density (number of leaf blades per soil area), leaf area, aboveground and belowground dry weight, and aesthetic quality. Turf density was determined by counting the number of St. Augustine leaf blades in a 30 × 30 cm square towards the center of each plot 1 d prior to each mowing. Leaf area was determined after each mowing by collecting all the leaf cuttings from a 30 × 30 cm square towards the center of each plot, and measuring the total blade area of the cuttings with a scanner equipped with the digital imagery software ASSESS (APS Press, St. Paul, Minn.). Aboveground dry weight was determined after each mowing by collecting the leaf cuttings and from 1 $m^2$ in each plot, drying them in an oven at 90 °C for 36 h and weighing them. Belowground dry weight was determined once in each plot, at the end of the experiment, collecting the roots and rhizomes from soil sample from a square 30 × 30 cm in area and 20 cm depth. The soil was washed from the roots, which were then dried in an oven at 90 °C for 36 h and weighed. Turfgrass aesthetic quality was assessed using a visual scale of 1 to 10 adapted from Liu and Huang (2003), based on turfgrass shoot coloration, density, and apparent vigor. In this scale, 1 equaled brown and sparse turfgrass, 7 equaled acceptably green and dense turfgrass, and 10 equaled copiously dense, vigorous, and dark green turfgrass with excellent appearance. When St. Augustine turfgrass was grown with green kyllinga, the difference in shoot coloration between the turfgrass and the weed was also taken into account to assess aesthetic quality. In green kyllinga, shoot dry weight was determined at 10-day intervals (immediately prior to mowing) by cutting the shoots at ground level and drying them in an oven at 90 °C for 36 h. Analysis of variance (5% significance level) and separation of means (Fisher's LSD, 5% significance level) were performed on resulting data.

## Results and Discussion

St. Augustine turfgrass (SAT) leaf area, density, aboveground and belowground dry weight, and aesthetic quality were significantly affected by green kyllinga interference. The extent of the effects of the biostimulants on SAT depended on the presence of green kyllinga.

SAT leaf area was significantly lower (by approximately 20%) when growing with green kyllinga than when growing weed free (Fig. 1). When AP and ALA were applied to green kyllinga-infested SAT, the loss of leaf area in the turfgrass was reduced to approximately 10% as compared to the weed-free control. However, when AP and ALA were applied to weed-free SAT, leaf area increased by 20 and 25% above that of the weed-free SAT control, respectively, and approximately 30 and 40% above that of green kyllinga-infested SAT, respectively (Fig. 1).

SAT density was significantly affected by green kyllinga interference and by the biostimulants. AP and ALA application had little effect on the density of SAT growing with green kyllinga. However, when applied to weed-free SAT, AP and ALA resulted in significantly higher turf density (approximately 20% with ALA and 25% with AP) as compared to the weed-free SAT control (Fig. 2).

The aboveground dry weight of SAT was reduced by an average of 13% by green kyllinga interference, regardless of biostimulant application. However, applying AP or ALA increased SAT shoot dry weight by approximately 20% as compared to the untreated weed-free SAT (Fig. 3). These results

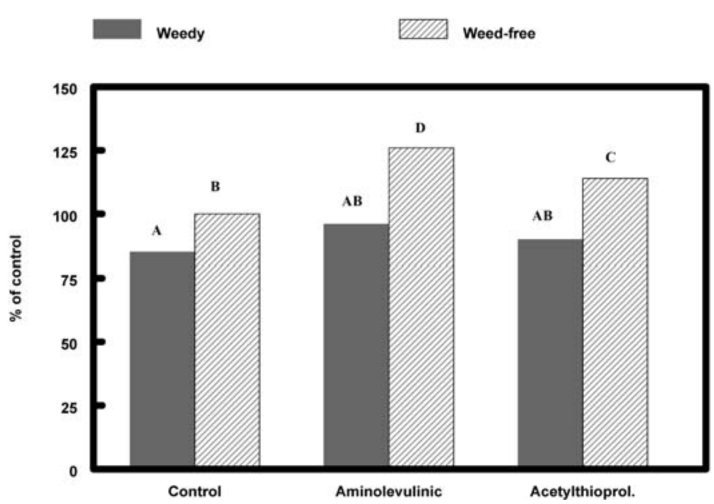


Fig. 1. Effects of acetylthioproline and aminolevulinic acid on the leaf area of weed-free and green kyllinga-infested St. Augustine turfgrass. Values are averages of two experiments. Bars with the same letter are not significantly different.

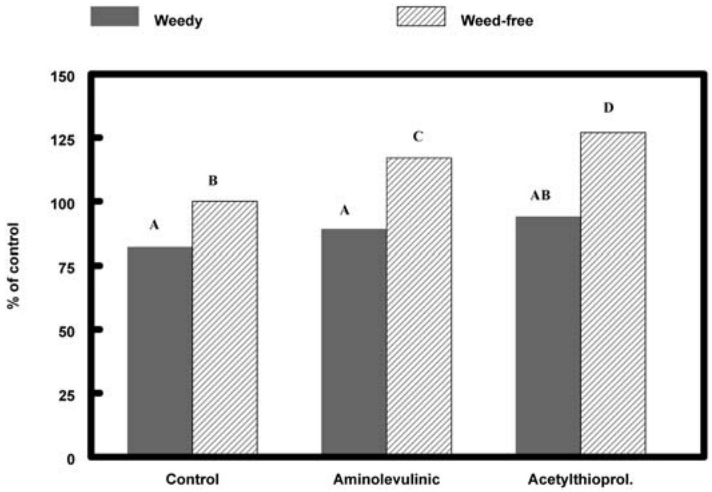


Fig. 2. Effects of acetylthioproline and aminolevulinic acid on turf density in weed-free and green kyllinga-infested St. Augustine turfgrass. Values are averages of two experiments. Bars with the same letter are not significantly different.

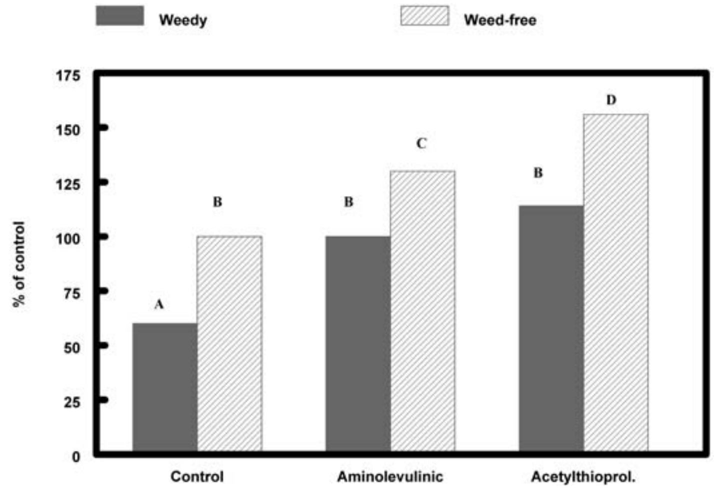


Fig. 4. Effects of acetylthioproline and aminolevulinic acid on the root dry weight of wee-free and green kyllinga-infested St. Augustine turfgrass. Values are averages of two experiments. Bars with the same letter are not significantly different.

are similar to those of Yoshida et al. (2003), who found that when ALA was applied to spinach (*Spinacea oleracea*) shoot dry weight increased by 29%.

Green kyllinga interference reduced SAT belowground dry weight by approximately 40% when biostimulants were not applied. Even when AP and ALA were applied, SAT belowground dry weight was significantly lower in green kyllinga-infested SAT than in weed-free SAT (Fig. 4). In contrast, when ALA and AP were applied to weed-free SAT, belowground dry weight increased by approximately 30 and 60%, respectively, as compared to untreated weed-free SAT (Fig. 4).

AP and ALA significantly increased green kyllinga shoot dry weight. The effect of ALA on green kyllinga shoot dry weight was more pronounced (approximately 31% increase) than that of AP (approximately 24% increase) (Fig. 5). Because the coloration of green kyllinga shoots was noticeably different from that of SAT shoots, an increase in the aboveground biomass of this weed resulted in heightened green kyllinga visibility as well. As a result, AP and ALA did not significantly enhance the aesthetic quality of SAT growing with green kyllinga (Fig. 6). In contrast, when AP and ALA were applied to weed-free SAT, the aesthetic quality of SAT wan enhanced from 8.8 in untreated plots to 9.8 (nearly perfect) in AP- and ALA-treated plots (Fig. 6). These findings agree with those of Iwai et al. (2003), who found that ALA-treated creeping bentgrass had darker green color and higher aesthetic quality than untreated creeping bentgrass.

In this research, the mechanism(s) of physiological stimulation in SAT and green kyllinga were not determined. However, the effects of AP and ALA on SAT and green kyllinga growth may be due to their direct activity on increasing photosynthesis, antioxidant effects on various enzymatic systems, and/or enhanced nutrient uptake and utilization, as previously reported by several authors (Bindu and Vivekanandan, 1998; Drazic and Mihailovic, 1998; Oeriu et al., 1969; Wang et al., 2004; Yoshida et al., 2003). This research showed that in SAT infested with green kyllinga (density of 25 plants per $m^2$), AP or ALA application may be counterproductive, as the

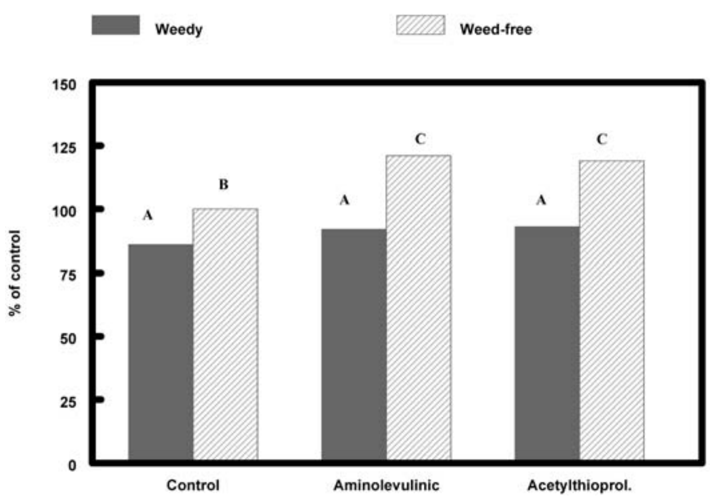


Fig. 3. Effects of acetylthioproline and aminolevulinic acid on the shoot dry weight of weed-free and green kyllinga-infested St. Augustine turfgrass. Values are averages of two experiments. Bars with the same letter are not significantly different.

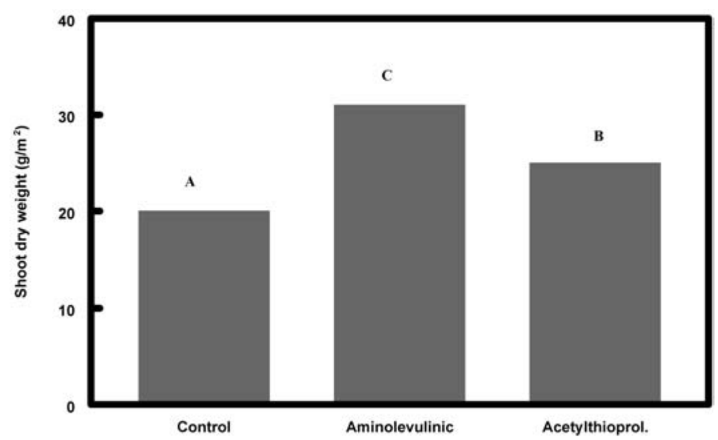


Fig. 5. Effects of acetylthioproline and aminolevulinic acid on the shoot dry weight of green kyllinga growing with St. Augustine turfgrass. Values are averages of two experiments. Bars with the same letter are not significantly different.

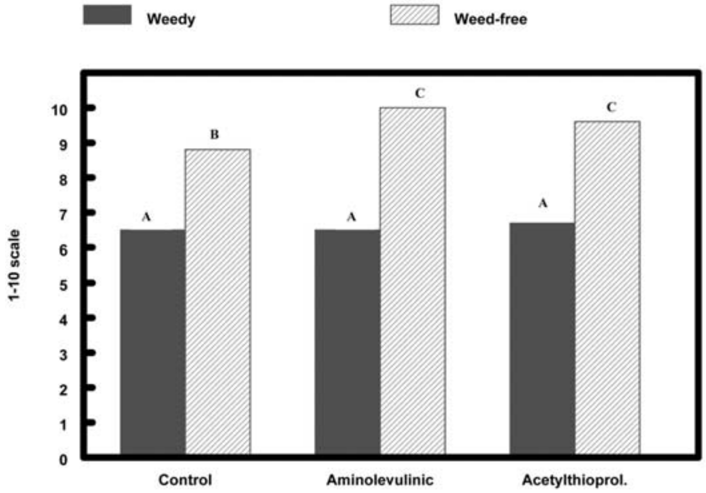


Fig. 6. Effects of acetylthioproline and aminolevulinic acid on the density of weed-free and green kyllinga-infested St. Augustine turfgrass. Values are averages of two experiments. Bars with the same letter are not significantly different.

growth of the weed and the turfgrass may be stimulated without improving SAT aesthetic quality due to the unsightly effect on increased weed shoot growth. However, our results also showed that AP and ALA may be used to enhance overall growth and aesthetic quality in weed-free SAT under residential management in North Central Florida. In general, ALA had a stronger effect on SAT leaf area than AP, whereas AP had a stronger effect on SAT root dry weight and leaf density than ALA. Thus, AP may be especially useful to increase leaf density and root growth in weed-free SAT with sparse shoot density and/or poor root systems.

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