What Pre-emergent Herbicides Are Safe for Ultradwarf Bermudagrass?

PART 3 of a three-part series on ultradwarf bermudagrass. To see the first two entries, please go to:

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By Patrick McCullough, Bert McCarty, Vance Baird, Haibo Liu and Ted Whitwell

In previous articles we discussed the sensitivity of dwarf-type bermudagrasses to growth regulators and herbicides as well as the susceptibility of the grasses to forming off-type mutations. Despite the improved putting green qualities of the ultradwarf cultivars, problems of off-types developing five to 10 years after planting may still exist. It was also discussed how mitosis-inhibiting pre-emergent herbicides may enhance the formation of off-type mutations in these grasses by disrupting genetic replication and DNA sequences.

Based on this information, pre-emergent herbicide safety will be critical for successful long-term ultradwarf bermudagrass culture. For many years, turf scientists have considered oxadiazon as one of the safest pre-emergent herbicides for high-quality turfgrasses (McCarty and Murphy, 1994). Oxadiazon inhibits the enzyme protoporphyrinogen oxidase necessary in the syntheses of chlorophyll and cytochromes (Rao, 2000). As an uncontrollable accumulation of protoporphyrin IX occurs in the thylakoid membrane, the formation of lipid radicals and lipid peroxidations causes membrane destruction and cell death.

Oxadiazon effectively controls summer and winter annual weeds in bermudagrass turf. On Tifgreen bermudagrass, oxadiazon gave 100-percent control of large crabgrass (*Digitaria sanguinalis* L. Scop.) in three consecutive years (Callahan and High, 1990). When applied 60 days before overseeding, oxadiazon at 2.2 kilogram (kg) hectare per week (ha^1) provided 90-percent annual bluegrass (*Poa annua* L.) control in overseeded bermudagrass putting greens (Toler et al., 2003). Tifway bermudagrass treated with single oxadiazon applications at 1.12 kg ha^1 and 2.24 kg ha^1 provided 70-percent pre-emergent control of Cocks-Comb Kyllinga (*Kyllinga squamulata* Thonn. Ex Vahl) 18 weeks after initial treatments (Bunnell et al., 2001).

A popular pre-emergent herbicide for summer annual weeds on putting greens is the combination of oxadiazon with bensulide. Dernoeden et al. (1984) found oxadiazon plus bensulide at 1.7 kg active ingredient (ai) ha^1 and 6.7 kg a.i. ha^1, respectively, provided effective control of *Eleusine indica* and *Digitaria spp.* Bensulide applied at 14 kg a.i. ha^1 and 28 kg a.i. ha^1 on dormant Tifgreen bermudagrass has shown minimal to no foliar injury during spring transition and summer growth (Callahan, 1976). Additionally, Johnson (1980) reported that oxadiazon at 4.5 kg ha^1 and 13.4 kg ha^1 did not affect Tifdwarf or Tifway bermudagrass rooting.

Based on these findings, it is believed oxadiazon will be a suitable pre-emergent herbicide for ultradwarf bermudagrass cultivars. However, the combination of oxadiazon plus bensulide is the only oxadiazon-containing product that is labeled for bermudagrass putting greens. Furthermore, the combination with bensulide, a potential root inhibitor, may reduce the safety of oxadiazon on the new ultradwarf bermudagrass cultivars relative to exclusive oxadiazon applications. Therefore, information is currently warranted on the safety of this herbicide combination for use on the ultradwarfs. The objective of this research was to evaluate the response of five ultradwarf bermudagrass cultivars to oxadiazon plus bensulide during active growth.

Turfgrass rooting is strongly influenced by shoot growth competition for stored root carbohydrates.

Materials and methods

Two studies were conducted at the Clemson (S.C.) University Greenhouse Research Complex from October to November 2003 (Study 1) and January to February 2004 (Study 2).

Greenhouse day/night temperatures were set for approximately 78/68 degrees Fahrenheit (F). TifEagle and Champion bermudagrass plugs, established in July 2002 and 2003, respectively, were collected from experimental greens located at the Turf Service Center in Clemson. Tifdwarf and MiniVerde bermudagrass sod was obtained from American Turf in Duluth, Ga. FloraDwarf bermudagrass sod was obtained from the University of Florida.

Sod was established in 10-centimeter (cm) pots in the greenhouse for approximately four weeks. Turf was washed free of soil and roots were cut to approximately 2.5 cm from the thatch layer. To help mimic growing conditions in the field, sod was transplanted to polyvinyl chloride lysimeters (photograph to right) with 40-cm depths and 177-square-cm surface areas, built to United States Golf Association specification (USGA Green Section Staff, 1993) with an 85:15 volume-to-volume (v/v) of sand and peat moss soil medium. Starting fertilizer, 9-18-18, was mixed into the soil at 48 kg nitrogen (N) ha^{1}.

After transplanting sod to lysimeters, a two-week establishment period was chosen before herbicide applications to encourage root regeneration similar to spring and early summer bermudagrass growth. Oxadiazon plus bensulide (6.6 granular [G], 1.3 percent oxadiazon plus 5.3 percent bensulide) was applied from a prepackaged combination at 1.6 kg ha^{1} plus 6.8 kg ha^{1} (130 kg ha^{1} of product) to initiate the eight-week studies. Lysimeters were irrigated and mowed at 4 millimeters (mm) five days per week. Ammonium nitrate solution was applied weekly at 12 kg N ha^{1}.

Turf quality was rated weekly on a 1 to 9 scale with 9 being dark green turf and 1 completely dormant turf. Ratings below 7 were considered unacceptable. Turf injury was evaluated on a percent-scale basis, with 0 equaling no injury, 1 to 15 percent equaling minor discoloration, 16 to 30 percent equaling moderate injury, greater than 30 percent equaling unacceptable injury, and 100 percent equaling completely dead turf. Clippings were harvested four and eight weeks after treatment (WAT). Roots were sampled at the 0-cm to 15-cm and 15-cm to 30-cm depths eight WAT and were cut approximately 2.5 cm from the thatch layer. After harvestings, clippings and roots were oven-dried at 176 degrees F for 48 hours, then weighed. Data were subjected to an analysis of variance with Statistical Analysis System (SAS) General Linear Model procedure. Mean separations were based on Fishers Protected least statistical difference (LSD) test (P = .05).

Lysimeters built to USGA specifications are used for greenhouse experimental units.

Results and discussion

Since herbicide interactions did not occur in either study, results were pooled over the two studies. Herbicide treatment caused no visible injury symptoms and had no effect on turf visual quality.

Oxadiazon plus bensulide did not affect root length or dry root mass after eight weeks on any of the ultradwarf bermudagrass cultivars. However, there was highly significant variation among the cultivars for final dry root mass. Therefore, results are presented among cultivars for root length and root mass.

TifEagle bermudagrass averaged 15-percent reduced root length compared with the other bermudagrass cultivars and had the least amount of root mass at both sampling depths (Figure 1). Tifdwarf, FloraDwarf, and MiniVerde had similar total root mass after eight weeks. Compared to these three cultivars, Champion and TifEagle had 36 percent and 88 percent less root mass, respectively (Figure 2). TifEagle bermudagrass, however, had 81-percent less root mass than Champion.

White (1998) observed similar results with TifEagle bermudagrass four months after sprigging the same five bermudagrass cultivars. TifEagle had 63-percent and 56-percent reduced root mass compared to Tifdwarf and

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Champion bermudagrasses, respectively, four months after establishment.

Genetic and morphological variations among dwarf-type bermudagrasses may affect root and shoot growth characteristics of these grasses. Turfgrass rooting is strongly influenced by shoot growth competition for stored root carbohydrates (Younger, 1969). In this experiment, root growth restrictions of Champion and TifEagle bermudagrass may have occurred from higher shoot growth, exemplified by higher clipping yields.

Comparing untreated turf, Champion and TifEagle had 39-percent and 52-percent higher total clipping yield, respectively, from two sampling dates compared to Tifdwarf, FloraDwarf and MiniVerde. Herbicide treatment had no effect on clipping yield four weeks after treatment. However, TifEagle and FloraDwarf bermudagrass receiving oxadiazon plus bensulide had 32-percent and 25-percent reduced clipping yield eight weeks after treatment, respectively.

Tifdwarf, Champion, and MiniVerde bermudagrass had similar clipping yield to untreated turf eight weeks after treatment.

Reductions from the herbicide may have resulted after eight weeks from overall increased growth of untreated turf relative to samples taken four weeks later. Tifdwarf, Champion and MiniVerde bermudagrass had similar clipping yield to untreated turf eight weeks after treatment.

From this research, it appears the ultradwarf bermudagrass cultivars, FloraDwarf and MiniVerde, may have similar rooting characteristics comparable with the traditional bermudagrass putting green cultivar Tifdwarf. TifEagle bermudagrass was the only cultivar to have reduced root length and root mass relative to all other cultivars. Reduced root growth may be a major limitation to this cultivar, although, because of TifEagle's putting green quality and popularity among Southern golf courses, future research in promoting root growth of this grass will be warranted.

Oxadiazon in combination with bensulide, at 1.6 kg ha^{1} plus 6.8 kg ha^{1}, appears to be safe for pre-emergent weed control on actively growing dwarf bermudagrass under consistent growing conditions. However, ultradwarfs will likely be more vulnerable to pre-emergent herbicide

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FIGURE 1

Root length of five dwarf-type bermudagrasses after eight weeks in combined greenhouse experiments. Different letters indicate a significant difference (P = .05), according to Fischer's Protected LSD test.

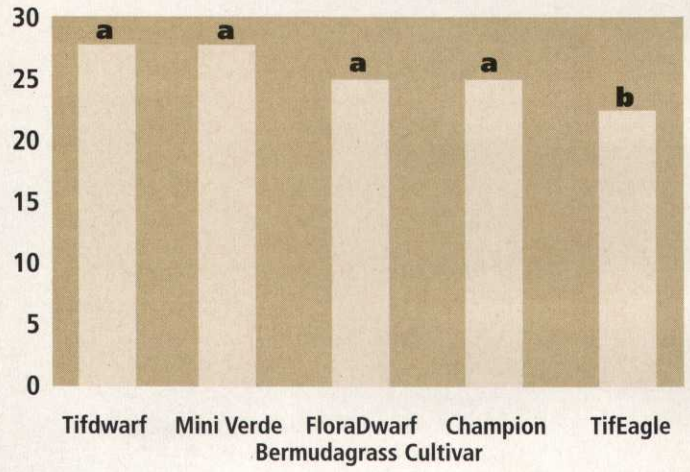
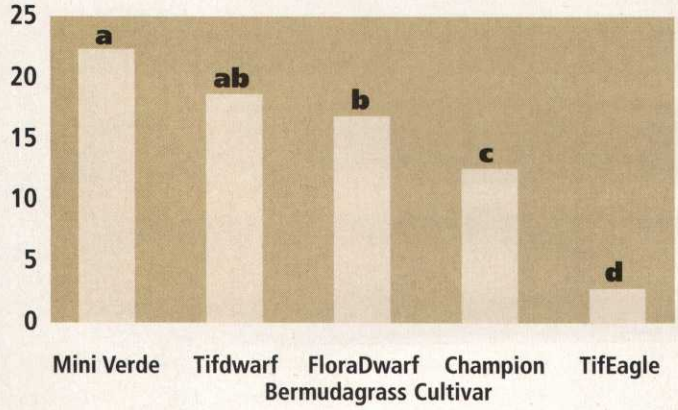


FIGURE 2

Dry root mass of five dwarf-type bermudagrasses after eight weeks in combined greenhouse experiments. Different letters indicate a significant difference (P = .05), according to Fischer's Protected LSD test.



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injury during root regeneration in the spring as bermudagrass breaks dormancy. Further field research is needed with different nitrogen levels, soil types and environmental conditions to which dwarf bermudagrass turf may be subjected during spring and early summer months when applying pre-emergent herbicides.

Our current research at Clemson University is evaluating the effects of six pre-emergent herbicides on seasonal root growth of field grown TifEagle bermudagrass. Because there are no herbicides currently labeled for the ultradwarfs, information from this research will be valuable for golf courses converting their greens to these new cultivars.

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