CHAPTER 3

REDUCING POPULATIONS OF ANNUAL BLUEGRASS AND ROUGH BLUEGRASS IN CREEPING BENTGRASS FAIRWAYS: A NUTRITIONAL APPROACH

ABSTRACT

Creeping bentgrass (*Agrostis palustris* Huds.) is often the turfgrass selected for golf course fairways in temperate regions and must compete for dominance with two invasive weed species, annual bluegrass *(Poa annua* L.) and rough bluegrass (*Poa trivialis* L.). Although little research has been designed to study control of rough bluegrass in these situations, many projects have been devoted to the control of annual bluegrass. Creeping bentgrass has a competitive advantage in relation to annual bluegrass under certain irrigation regimes and under specific nutritional programs. Chemicals such as preemergent herbicides, selective herbicides, and plant growth regulators have indicated potential for controlling annual bluegrass in creeping bentgrass turf.

Although considerable research and development has been devoted to the control of one or both of these weeds, both species remain major weed concerns for golf course managers. The physiology of these weeds in relation to creeping bentgrass suggests that a simple, inexpensive, nutritional control program could be effective. The objective of this study was to compare creeping bentgrass, annual bluegrass, and rough bluegrass competition when subjected to common weed control practices and foliar applications of iron and magnesium. A research site was selected from a section of Kentucky bluegrass rough on an intensively managed golf course. The area was stripped of sod and seeded to a mixture of creeping bentgrass, annual bluegrass, and rough bluegrass. The site was divided into main plots receiving one of two irrigation regimes. Each main plot was further divided into sublplots receiving one of seven treatments: 1) preemergent herbicide, 2) selective herbicide, 3) plant growth regulator, 4) foliar magnesium, 5) foliar iron, 6) foliar magnesium plus foliar iron, 7) no additional input. With the exception of experimental treatments, the site was maintained by the golf course green crew in a manner consistent with the existing fairways. The site was seeded in September, 1995, and treatments begun in March, 1996. Most treatments, although not statistically significant, resulted in a reduction of both annual bluegrass and rough bluegrass compared to controls in November, 1996. A significant reduction in annual bluegrass occurred on plots treated with foliar iron and an even greater reduction on plots treated with foliar iron plus foliar magnesium. Rough bluegrass was reduced significantly on plots treated with foliar iron, plant growth regulator, and foliar iron plus foliar magnesium. This study demonstrated that annual bluegrass and rough bluegrass populations can be reduced simply and economically. The process described here can be used by golf course superintendents to enhance turf color, uniformity, and playability providing consistent surfaces that make the game of golf more aesthetic and more enjoyable.

INTRODUCTION

Annual bluegrass and rough bluegrass are important grassy weeds on golf course fairways in temperate regions. Creeping bentgrass, a common turfgrass chosen for fairways, must compete for dominance with these grassy weeds. Attempts to control annual bluegrass and rough bluegrass in creeping bentgrass fairways have met with limited success. It is believed that applications of plant growth regulators such as flurprimidol and trinexapac-ethyl tend to favor the competitive ability of creeping bentgrass over these weed species (Shoop, et al. 1986). Selective herbicides such as ethofumesate have been somewhat successful for controlling annual bluegrass in fairway situations (Branham 1990). Used correctly, preemergent herbicides can be used to control annual varieties of annual bluegrass but have no effect on rough bluegrass (Callahan and Shepard 1991; Callahan and McDonald 1997). It is also believed that regulating irrigation can affect annual bluegrass and rough bluegrass less favorably than creeping bentgrass (Sprague and Burton 1937).

Little research has been attempted with rough bluegrass in fairway conditions, but several studies have tested the ecology of mixed stands of creeping bentgrass and annual bluegrass treated with various nutritional inputs (Waddington, et al. 1978; Eggens and Wright 1985; Dest and Guillard 1987). Annual bluegrass and rough bluegrass are more yellow than creeping bentgrass. This suggests either a higher concentration of accessory pigments in these two weeds or a lower concentration of chlorophyll. Annual bluegrass is more photosynthetically efficient than creeping bentgrass (Vargas 1996) and rough bluegrass, because of its propensity to proliferate in shaded environments may also be more photosynthetically efficient. These variations in photosynthetic efficiency could provide a means for controlling these weed species in creeping bentgrass turf. Increases in iron stimulate pigment synthesis (Walker and Weinstein 1997) and result in increased chlorophyll content when combined with increases in magnesium (Averina et al. 1992; Parekh and Puranik 1992). Increasing pigment concentrations above normal levels in plants with efficient photosynthetic potential can increase light energy consumption to critical levels. These high energy levels may result in photoinhibition (Barenyi and Krause 1985; Critchley 1988; Long, et al. 1994), increased photorespiration during periods less than light saturating (Ogren 1984; Watschke, et al. 1972), or lipid peroxidation (Fuerst 1991). Annual bluegrass and rough bluegrass decline rapidly during summer periods. Although this decline has been linked to poor heat tolerance or disease (Vargas and Detweiler 1985), some decline may be due to photodegradation. By increasing leaf concentrations of magnesium and iron, this decline may be accelerated. Creeping bentgrass, because it already contains high concentrations of chlorophyll, is unlikely to be severely affected by additional pigment increases. The objective of this study was to compare creeping bentgrass, annual bluegrass, and rough bluegrass competition when subjected to common weed control practices and foliar applications of iron and magnesium.

MATERIALS AND METHODS

A research site was selected in an area of Kentucky bluegrass rough at The Country Club at Muirfield Village, Dublin, OH. The site was stripped of Kentucky bluegrass sod, cultivated with a rototiller, raked, and seeded with a mixture of creeping bentgrass ('Crenshaw'; 'Pro Cup'; 'Providence'; 'Penncross'; 'Southshore'; 'SR 1020'), annual bluegrass (a 1990 seed source and a 1994 seed source collected as weed seed in Oregon), and rough bluegrass ('Laser' and 'Polder') in September, 1995. Creeping bentgrass was sown at 97.6 kg ha^{-1} (2.0 lb / 1000 sq ft), annual bluegrass at 16.6 kg ha^{-1} (0.34 lb / 1000 sq ft), and rough bluegrass at 16.6 kg ha^{-1} (0.34 lb / 1000 sq ft). The soil at the site was clay loam and slope at the site was adequate to provide drainage. The research site was maintained by the golf course green crew and provided the same level of care as the golf course fairways. Nitrogen was applied at 220 kg ha^{-1} (4.5 lb / 1000 sq ft) and pesticides were applied as needed. The site was mowed at 12.7 mm (1/2 in) three times each week. Preemergent herbicides, plant growth regulators, and irrigation were applied only as treatments.

The site was divided into 10 main plots, five randomly selected to receive deficit irrigation at 50% evapotranspiration (ET) and five randomly selected for deficit irrigation at 100% ET. Irrigation was applied three times each week (Mon., Wed., Fri.) and adjusted for natural rainfall. No irrigation was applied unless ET exceeded natural rainfall for the week preceding the date of irrigation. This resulted in plots occasionally being required to survive for up to one week without irrigation.

Each main plot was randomly divided into seven subplots, including a control. Subplots measured 2.16 m^2 (3 x 8 ft). Each subplot received one of the following treatments: 1) trinexapac-ethyl [4-(cyclopropyl-α-hydroxy-methylene)-3,5-dioxo-cyclohexanecarboxylic acid ethyl ester; Primo formulation] at 0.26 L ha^{-1} (0.5 oz / 1000 sq ft) applied monthly, 2) ethofumesate (2-ethoxy-2,3-dihydro-3,3-dimethyl-5-benzofuranol methanesulfonate; Prograss formulation) applied in mid-March, early-May, early September and early-October at 0.78 L ha^{-1} (1.5 oz / 1000 sq ft), 3) bensulide [S-(O,O-diisopropyl phosphorodithioate) ester of N-(2-mercaptoethyl) benzenesulfonamide; Bensumec 4E formulation] applied at 3.13 L ha^{-1} (6.0 oz / 1000 sq ft) in mid-March, early-May, and early-September of each year, 4) foliar magnesium ($MgSO_4 \cdot 7H_2O$) at 1.68 kg ha^{-1} (1.5 lb / A) applied monthly, 5) foliar iron ($FeSO_4 \cdot 2H_2O$) at 1.68 kg ha^{-1} (1.5 lb / A) applied monthly, 6), or a mixture of foliar magnesium and foliar iron (foliar Mg/Fe) applied at previous rates monthly.

Monthly applications were made on the first of each month beginning in April and ending in October. Subplots treated with trinexapac-ethyl also received a single treatment of bensulide at 3.13 L ha^{-1} (6.0 oz / 1000 sq ft) in mid-March to help control crabgrass and other grass weeds. Foliar treatments (magnesium, iron, Mg/Fe, Primo) were applied using SS8002 spray nozzles. Remaining treatments were applied using SS8010 nozzles. Visual ratings for color on a 1 through 9 scale (1 = brown; 5 = yellow-green; 9 = blue-green) and density by percentage (density = % of maximum potential density) were taken on the 15th day of each month during the same period.

Data were analyzed using analysis of variance for a split plot design and multiple comparisons were made using LSD (least significant difference). Results were considered significant if probability of a type I error was less than 0.05.

RESULTS AND DISCUSSION

The three species (creeping bentgrass, annual bluegrass, and rough bluegrass) exhibited differential seedling survival. The fall seeding in 1995 produced a dense stand of young turf by spring, 1996. All three species were present, and other species comprised less than 1% of the turfgrass stand. Species survival was not rated at this time because segregation had not occurred and individual ratings were difficult. In November, 1996 subplots receiving no additional input (control) averaged 62.2% creeping bentgrass, 33.9% annual bluegrass and 3.9% rough bluegrass. Laboratory germination tests using AOSA (Association of Official Seed Analysts) protocol revealed 95% germination for creeping bentgrass and annual bluegrass and 65% germination for rough bluegrass, accounting for the poor representation of rough bluegrass at the site.

Annual bluegrass increased in plots irrigated at 100% ET but these results did not vary significantly. Surprisingly, rough bluegrass increased significantly in plots treated at 50% ET irrigation compared to plots treated at 100% ET irrigation. All subplot treatments resulted in an average decrease in annual bluegrass compared to control subplots but only foliar Fe treatments and foliar Mg/Fe treatments indicated significant reductions (Figure 3.1). Foliar Fe (30.0% reduction for annual bluegrass; 51.4% reduction for rough bluegrass) and foliar Mg/Fe (63.7% reduction for annual bluegrass; 91.9% reduction for rough bluegrass) resulted in significant reductions in annual bluegrass and rough bluegrass and trinexapac-ethyl treatments (81.3% reduction for rough bluegrass) reduced rough bluegrass proportion significantly (Figure 3.1). Soil tests prior to seeding detected sufficient levels of Fe (86.2 kg ha^{-1}) and Mg (827.7 kg ha^{-1}), consequently additional applications were excessive for normal plant metabolism. Sulfur applications may reduce the competitive ability of annual bluegrass under some circumstances (Varco and Sartain 1966). The apparent control of annual bluegrass in subplots treated with $FeSO_4 \cdot 2H_2O$, however, was not attributed to the application of sulfur because subplots receiving $MgSO_4 \cdot 7H_2O$ treatments did not differ significantly from controls. The application of $FeSO_4 \cdot 2H_2O$ and the possible creation of a more acidic soil may also favor the growth of creeping bentgrass in comparison with annual bluegrass (Kuo et al. 1992). Because $FeSO_4 \cdot 2H_2O$ applications were made with a foliar spray and because foliar Mg/Fe was significantly more effective for controlling annual bluegrass than foliar Fe alone, the acidic effect was believed to be minimal.

Color was significantly enhanced by foliar Mg/Fe, foliar Fe alone, and by trinexapac-ethyl (Table 3.1) compared to plots receiving no additional input (control). These results support those of Johnson and Carrow (1995) who found color enhancements with applications of Fe in creeping bentgrass and those of Blalok, et al. (1996) who observed a darker green color in turf treated with trinexapac ethyl. Although color ratings were higher for plots receiving deficit irrigation at 100% ET than those receiving irrigation at 50% ET in 1996, the difference was not significant. Although color was acceptable (poorest rating = 5.78), the research area, in general, consistently rated lower than the adjacent fairway for quality of color suggesting that the plots did not receive enough water or that the frequency of irrigation was insufficient.

Density throughout the stand remained consistent with the exception of a significant enhancement in the trinexapac-ethyl subplots (3.2% improvement) and a significant reduction in the subplots treated with foliar Mg/Fe (3.3% reduction)(Table 1). Trinexapac-ethyl shortens stolon internodes resulting in increased turf density. Foliar Mg/Fe is not known to reduce stand density and this result can be attributed to the severe reduction of annual bluegrass and rough bluegrass within these subplots. The general density of this first-year turf was acceptable for fairway conditions with a minimal average rating of 82.8% of potential for foliar Mg/Fe treatments and a maximum average rating of 88.3% for trinexapac-ethyl treatments (Figure 1). Subplots treated with foliar Mg/Fe retained acceptable density throughout the season in spite of losing 25.0% of the stand to the death of weed species. Density observations were higher for plots treated to 100% ET compared to 50% ET but the difference was insignificant.

It is possible that foliar applications of Fe reduce turfgrass root growth (Glinski et al. 1992). There were no visible signs of water or nutrient stress within subplots treated with foliar Fe or foliar Mg/Fe in relation to control subplots.

These results demonstrated that applications of foliar Mg/Fe, foliar Fe, and trinexapac-ethyl on a monthly basis reduce annual bluegrass and rough bluegrass weed encroachment and enhance turf quality on creeping bentgrass maintained as golf course fairway. These treatments enhance the competitive ability of creeping bentgrass in relation to annual bluegrass and rough bluegrass resulting in a reduction of existing weeds over time. Foliar Fe and foliar Mg/Fe were more successful for this purpose than any pesticide tested and the combination of foliar Mg/Fe was more successful than any other treatment. Proper application of these nutrients enhanced the beauty and playability of golf course turf and limited the use of pesticides.

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	Color		Density
Treatment	Mean	Treatment	Mean
Fe	7.02 a	TGR	88.28 a
Mg\Fe	6.95 a	Pre	87.57 ab
TGR	6.81 a	Fe	87.12 ab
NAI	5.98 b	Mg	86.58 ab
Pre	5.92 b	SH	86.51 ab
Mg	5.87 b	NAI	85.55 b
SH	5.78 b	Mg\Fe	82.75 b
LSD =	0.29	LSD =	2.65

Table 3.1. Means for turf color rated on a 1 - 9 scale (1 = brown; 5 = yellow-green; 9 = blue-green) and turf density (% potential density) in plots treated to foliar iron (Fe), foliar magnesium (Mg), foliar iron plus foliar magnesium (Mg/Fe), trinexapac-ethyl (TGR), bensulide (Pre), ethofumesate (SH), and control plots (NAI). Means are averaged over monthly ratings from May 1, 1996 through November 1, 1996. Letters following means indicate significance (P = 0.05).

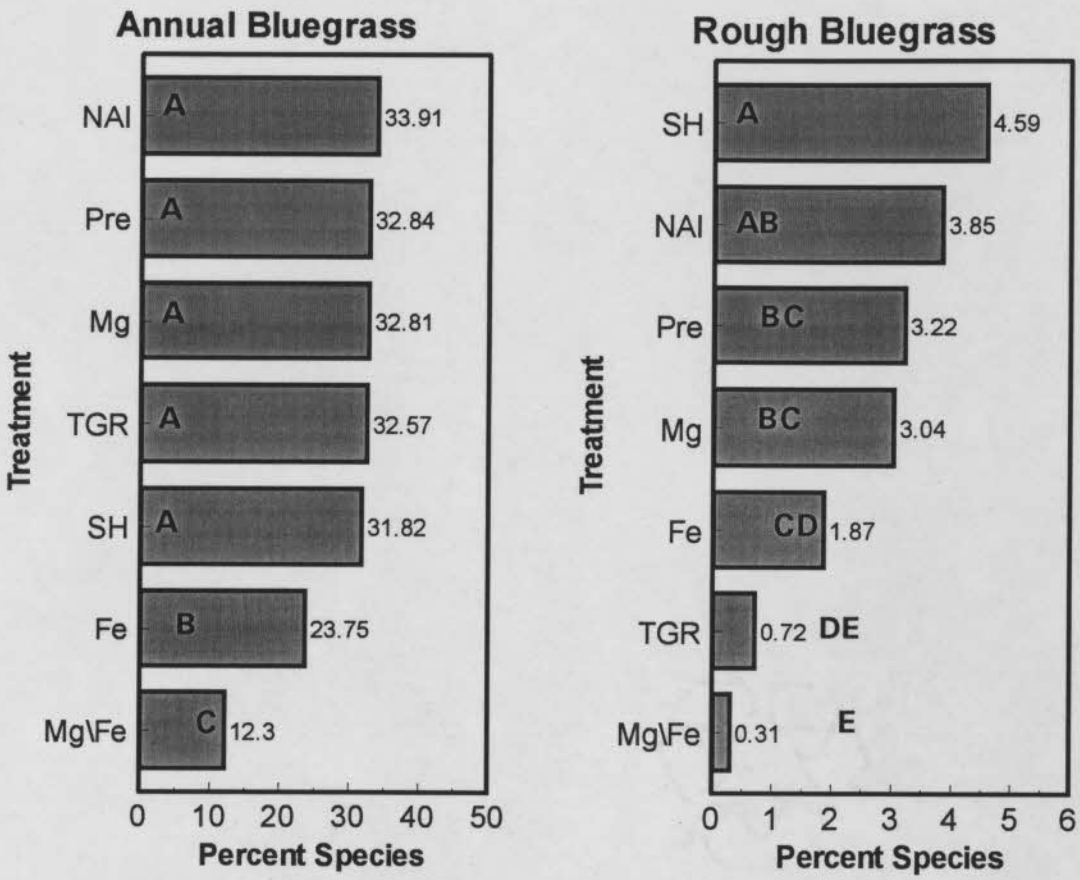

Figure 3.1. Percent creeping bentgrass, annual bluegrass, and rough bluegrass contained in treatment subplots and averaged over 10 replications of a control receiving no additional input (NAI), a preemergent herbicide, bensulide (Ben), a plant growth regulator, trinexapac-ethyl (TE), foliar magnesium (Mg), foliar iron (Fe), and foliar magnesium plus foliar iron (Mg/Fe). Letters indicate significance.

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