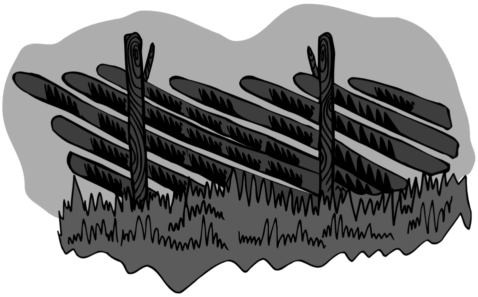

COLD TOLERANCE OF 'TIFTON 419' BERMUDAGRASS AS AFFECTED BY LATE-SEASON NITROGEN APPLICATIONS AND TRINEXAPAC-ETHYL (Primo)

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IMPACT STATEMENT

Hybrid bermudagrasses occasionally suffer significant damage when below-normal winter conditions occur. In an attempt to enhance cold tolerance of these grasses, a study was undertaken to assess the effects of late-season nitrogen (N) fertilization and applications of the growth regulator trinexapac-ethyl (Primo) on morphology and cold tolerance of 'Tifton 419' hybrid bermudagrass. Nitrogen applications after 15 August significantly enhanced the number of total rhizomes, the primary winter-survival organ in bermudagrass. Primo had no effect on the morphology of the grass but did enhance the freeze-tolerance of the rhizomes that were present. These studies suggest that applications of late-season N and Primo may impact winter-survival of hybrid bermudagrass in areas where winterkill is a problem.

BACKGROUND

The transition zone presents golf and sports turf managers with an array of problems relative to stress tolerance and survival. Although

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creeping bentgrass *(Agrostis stolonifera)* continues to be the grass of choice for putting greens in the region, warm-season grasses such as bermudagrass (*Cynodon* spp.) and zoysiagrass (*Zoysia* spp.) predominate on other intensively managed turf areas such as fairways, tees, and athletic fields. Zoysiagrass is generally more cold-tolerant than bermudagrass and is found more frequently in the northern extremes of the transition zone. The most extensively used bermudagrass cultivars are hybrids between *Cynodon dactylon* and *C. tranvaalensis*. These hybrids lack the cold tolerance of zoysiagrass, and severe loss of stand due to winter kill is routinely reported in the upper regions of the transition zone about 1 out of every 5 years (John King, University of Arkansas, personal communication). This winter injury is especially prevalent in intensively managed areas such as golf course fairways and tees, where high levels of fertilizer, low mowing heights, and intensive traffic predispose the grass to cold-induced injury.

Management of bermudagrass to enhance cold tolerance has often focused on avoiding late-season N applications and increasing potassium fertilization (Reeves, et al., 1970). Late-season applications of N are believed to promote excessive shoot growth, which prevents or reduces the accumulation of storage carbohydrates and other protective osmolytes. However, recent studies by Goatley et al. (1998) suggest that N fertilization may play less of a role in winter injury than previously believed.

Plant growth regulators are playing an ever-increasing role in turf management programs. These materials were originally used to reduce mowing and suppress seed-head development, but they have also been shown to affect turfgrass population dynamics and to precondition grasses to stress. Recent studies have shown that Primo can be effectively used to precondition both warm-season and cool-season grasses to various types of turfgrass stress. Some of the beneficial effects of Primo include increased root growth, reduced water use, and enhanced shade tolerance. Recent studies of shade tolerance by Qian and Engelke (1999) demonstrated that applications of Primo to ‘Diamond’ Zoysiagrass enhanced photosynthesis and increased carbohydrate levels relative to controls. These results suggest that reduced consumption of fixed carbohydrates (i.e., reduced leaf growth) allows photosynthate to be stored for later use.

The enhanced soluble carbohydrate levels observed in grasses treated with Primo suggest that plants treated with this material could better survive forms of desiccation stress, including drought, salinity, and freezing. To test this hypothesis, an experiment was conducted to assess the effects of Primo on morphology and cold tolerance of an established hybrid bermudagrass turf. The effects of late-season N applications on morphology and cold tolerance were also studied.

RESEARCH DESCRIPTION

A study was conducted at the University of Arkansas Agricultural Research and Extension Center, Fayetteville, on an established area of 'Tifton 419' bermudagrass. This area had not been used previously for experimental purposes but had been managed under moderate intensity with respect to fertilization, mowing, and weed control. Preemergent herbicide (Ronstar G) was applied on 6 March and 15 Sept. 1998 to control grassy weeds, and the fertilization program included monthly applications of agriculture-grade fertilizers at a rate equivalent to 1 lb of N/1000 ft^2. Irrigation was used as necessary to prevent drought, and plots were maintained at 0.75 in. mowing height prior to and throughout the experiment.

Experimental treatments were combined in a factorial arrangement and applied in a split-plot design, with N fertilization treatments as the whole plots and growth regulator (Primo) as the split-plot. Plots were arranged in a randomized complete block design with four replications. The three N treatments were: (1) no N fertilizer after 1 Aug., (2) 1 lb N/1000 ft^2 on 15 Aug., and (3) 1 lb N/1000 ft^2 on 15 Aug. and 15 Sept. Growth regulator splits were: (1) Primo at 0.38 oz/1000 ft^2 on 15 Aug., (2) Primo at 0.38 oz/1000 ft^2 on 15 Aug. and 15 Sept., and (3) no Primo. Fertilizer was applied in the form of urea, and Primo was applied with a carbon dioxide sprayer in the equivalent of 1.25 gal of water/1000 ft^2.

Plots were routinely rated for turf color and quality until turf was completely dormant. On 5 Jan. 1999, plots were sampled with a core sampler (7.4 x 6.4 cm) and morphological measurements were made for rhizome mass and number, shoot mass, root mass, crown and stolon density, and rhizome and stolon internode length. Additional plugs were taken on 10 Jan., and rhizomes were separated and either analyzed for total nonstructural carbohydrates (Smith, 1981) or assessed for freezing tolerance. Each experimental unit in the freeze test consisted of four to five rhizomes with a total of approximately 20 nodes. Each experimental unit was grouped, wrapped in moist cheesecloth, and maintained at 4 °C for 24 h prior to moving into the controlled freeze chamber (Tenney Jr., New Brunswick, N.J.). Samples were placed in the freeze chamber at 0 °C, and the temperature was decreased from 0 to –2 °C over a 2-h period. Samples were held at –2 °C for 2 h, at which time samples were removed and reacclimated in a refrigerator at 4 °C for 24 h. The remaining tissues were subjected to –4, –6, and –8 °C in 2-h increments, and samples were removed at each temperature and moved to the refrigerator. After the reacclimation period, rhizomes were potted in a commercial greenhouse mix and maintained under greenhouse conditions until regrowth occurred. Percent rhizome survival and recovery was assessed by counting the number of nodes that regrew from each treatment. Data were analyzed by general analysis of variance procedures using the split-plot model.

FINDINGS

Both N fertility and Primo had a significant effect on turf color, while turf quality was primarily affected by Primo applications (Table 1). In agreement with Goatley et al. (1998), late-season applications of N improved the quality and color of the turf in the fall period and prolonged the green period later into the fall. Two applications of Primo produced better color and higher quality than a single application at most observation dates. The overall effects of late-season applications of Primo were an improvement in turf color and a delay in dormancy as measured by turf color (Table 1). This is significant in that aesthetic properties of bermudagrass can be maintained longer into the winter. There was no significant interaction between N fertilization and Primo application in regard to turf aesthetic properties.

Primo did not affect the morphological characteristics of the bermudagrass turf (Table 2). It is noteworthy that Northwest Arkansas experienced a very mild fall in 1998 and the bermudagrass stayed green until early December. Assuming the grass was still metabolically active well into November, the growth-regulator effects may have subsided when dormancy was complete. Although it was expected that Primo would either increase crown, stolon, or rhizome density or shorten internode length, these results were not observed.

Late-season N fertilization affected both rhizome and crown density and stolon internode length of hybrid bermudagrass (Table 2). There were no interactions between N and Primo for any parameter.

Freeze tolerance data (Table 3) indicated that rhizomes had suffered some damage due to an early winter cold period, as noted by the >30% drop in survival of all rhizomes, even at –2 °C. Late-season N fertilization had no effect on the survival of bermudagrass rhizomes at any freezing temperature (Table 3). This contradicts the general belief that late-season N should be avoided to prevent winter damage. However, these results need to be repeated before general statements regarding N fertilization and cold tolerance can be assessed.

Primo applications had a significant effect on the freeze tolerance of bermudagrass rhizomes, and this effect was observed on rhizomes exposed to both –2 and –4 °C (Table 3). This is a significant finding in that a number of turf managers are using Primo to prepare bermudagrass turf for winter overseeding. Although the effects of Primo on freeze tolerance of rhizomes at –6 and –8 °C were not statistically significant, more rhizomes survived with both single and dual applications of Primo compared with the control. Dual applications of Primo were slightly better than a single application, but the effect on rhizome survival was significant only at –2 °C.

Although Primo enhanced freeze tolerance of bermudagrass rhizomes in this test, this finding could not be attributed to carbohydrate accumulation, as there was no significant difference in percent carbohydrates between treated and untreated rhizomes (Table 3). Nitrogen fertilization also had no effect on carbohydrate accumulation in bermudagrass rhizomes, suggesting that other mechanisms of freezing tolerance are active in Primo-treated plots; this needs further investigation.

In summary, late-season applications of N and Primo enhanced overall quality of bermudagrass turf compared with untreated plots. In addition, dormancy was delayed in the treated plots, which would extend the overall performance of the turf. Applications of Primo also had a significant effect on freeze tolerance of bermudagrass rhizomes, especially at modest freezing temperatures (–2 and –4 °C). Future investigations will evaluate repeated applications beginning earlier in the season and continuing later in the year.

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Table 1. Turf quality and turf color of 'Tifton 419' bermudagrass, as affected by late-season application of nitrogen and Primo.

	Turf quality[z]				Turf color[z]				
	Aug.	Sep.	Oct.	Avg.	Aug.	Sep.	Oct.	Nov.	Avg.
					Nitrogen fertilization				
None after 1 Aug.	7.2	6.7	6.3	6.7	6.5	6.2	5.8	4.5	5.8
1 lb N (15 Aug.)	6.9	6.7	6.1	6.6	6.9	6.4	6.1	4.9	6.1
1 lb (15 Aug.) + 1 lb (15 Sep.)	7.0	6.8	6.2	6.7	6.9	6.8	6.3	6.1	6.5
LSD (0.05)[y]	ns	ns	ns	ns	ns	0.5	0.4	0.6	0.5
					Primo (0.38 oz/1000)				
Control	7.1	6.2	5.0	6.1	6.3	5.4	4.5	4.5	5.2
15 Aug.	7.1	7.0	6.3	6.8	7.2	6.9	6.2	5.3	6.4
15 Aug. and 15 Sep.	7.0	7.1	7.3	7.1	6.9	7.0	7.6	5.7	6.8
LSD (0.05)	ns	0.4	0.6	0.2	0.6	0.5	0.6	0.6	0.3

[z] Turf quality and color are rated on a scale of 1 to 9, with 9 being highest quality or best color.

[y] LSD = least significant difference; ns = nonsignificant difference among the means.

Table 2. Morphological characteristics of 'Tifton 419' bermudagrass as affected by late-season application of N and Primo.[z]

	Rhizome	Root	Shoot	Root: shoot	Rhizome density rhizomes/ 10 cm³ soil	Stolon density stolons/ 10 cm²	Crown density crowns/ 10 cm²	Internode length rhizome	Internode length stolon
	wt./ plug (g)							mm	
Nitrogen Fertilization									
None after 1 Aug.	2.63	0.43	1.81	0.27	3.1	157.1	22.5	15.9	5.8
1 lb N (15 Aug.)	3.46	0.50	1.55	0.34	4.1	171.8	32.5	16.1	6.8
1 lb (15 Aug.) + 1 lb (15 Sep.)	3.31	0.47	1.70	0.31	4.3	167.1	36.3	14.9	7.3
LSD (0.05)[y]	ns	ns	ns	ns	0.8	ns	10.6	ns	1.2
Primo (0.38 oz/1000)									
Control	3.29	0.48	1.55	0.35	3.9	166.1	28.3	15.5	6.8
15 Aug.	3.29	0.50	1.62	0.32	4.2	176.4	33.5	15.5	6.8
15 Aug. and 15 Sep.	2.82	0.43	1.88	0.25	3.4	153.5	29.6	15.8	6.4
LSD (0.05)	ns	ns	ns	ns	ns	ns	ns	ns	ns

[z] All data were collected from replicated plugs 5 cm in diameter and 7.6 cm deep. Plugs were sampled on 5 Jan. 1999.

[y] LSD = least significant difference; ns = nonsignificant difference among the means.

Table 3. Total non-structural carbohydrate and percent freeze survival of 'Tifton 419' bermudagrass rhizomes as affected by late-season application of nitrogen and Primo. [z]

	Total non-structural carbohydrate (g kg^{-1})	–2 °C	–4 °C	–6 °C	–8 °C
		% rhizome survival			
Nitrogen Fertilization					
None after 1 Aug.	63.1	53.6	49.7	42.2	0.0
1 lb N (15 Aug.)	73.6	60.0	49.3	33.5	7.8
1 lb (15 Aug.) + 1 lb (15 Sep.)	70.8	53.4	44.4	38.5	0.0
LSD (0.05)[y]	ns	ns	ns	ns	ns
Primo (0.38 oz/1000)					
Control	67.7	46.0	36.6	32.4	0.0
15 Aug.	70.1	54.9	50.5	38.0	1.9
15 Aug. and 15 Sep.	69.7	68.4	57.6	43.7	6.0
LSD (0.05)[y]	ns	9.8	10.0	ns	ns

[z] Plugs were sampled on 5 Jan.

[y] LSD = least significant difference; ns = nonsignificant difference among the means.