Entomology

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Miscanthus Mealybug, *Miscanthicoccus miscanthi* (Takahashi): A New Pest of Ornamental Grasses in Tennessee

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Index Words: Miscanthus mealybug, *Miscanthicoccus miscanthi* (Takahashi), *Miscanthus* grasses

Nature of Work: Miscanthus mealybug is a pest of ornamental *Miscanthus* grasses. These sucking insect pests cause plant stress resulting in stunted, unthrifty plants that may exhibit reduced flower production and flower stem elongation (1, 2). The range of occurrence of this pest in Tennessee landscapes and nurseries is unknown, but are likely overlooked due to their preference for feeding within leaf sheaths in the plant crown where they are not readily visible. Purple spots on the plant stem are a good symptom that can help detect this pest. To confirm, pull back the leaf sheath to reveal the pinkish mealybugs, which are often tightly packed within a white waxy coating and surrounded by copious amounts of honeydew.

Results and Discussion: Adult females overwinter as egg-bearing individuals. Crawlers are expected to emerge by May in Tennessee. Three generations occur per year in the Central and Eastern United States and crawlers of each generation take three to four weeks to mature (2). Miscanthus mealybug can be spread by propagating infested plants or when emerging crawlers are blown onto nearby plants (4).

The recommended control option has been use of a soil/media drench of a systemic neonicotinoid insecticide containing imidacloprid (Merit, Marathon, Bayer Advanced Tree & Shrub Insect Control, Discus, Allectus), thiamethoxam (Flagship, Meridian), or dinotefuran (Safari). An alternative control option was demonstrated through research that suggested 99 percent control of Miscanthus mealybug achieved by immersing container-grown *Miscanthus* in water heated to 120˚ F for 15 minutes (3). Some plants are injured by such heat treatment so testing on a small portion of the crop is recommended. Crop injury can be ameliorated by misting heat-treated plants with warm water post-immersion. Early detection through scouting will allow for timely control options that will prevent plant stress and any resulting damage.

Significance to Industry: *Miscanthus* grasses are valued plants in Tennessee landscapes. They are easy to grow and provide color and texture to the landscape for all four seasons. Miscanthus mealybugs may be hidden within the leaf sheaths of the crown of these plants, which would cause them to be under-diagnosed in the landscape or nursery. These sucking insects can reduce plant vigor and attractiveness. Fortunately, this pest produces the symptom of purple spots on infested stems, which is a good indicator of a potential infestation. Examine symptomatic tissues to confirm pest presence and enable timely insecticide application, if needed.

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Imported Fire Ant Introductions by New Developments in Rutherford County, Tennessee

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Index Words: Imported fire ant, *Solenopsis* spp., hybrid

Significance to Industry: Imported fire ants are a serious pest in nursery industry and one mode of expansion is through introductions by ornamentals and sod from infested to non infested areas. USDA Federal Imported Fire Ant Quarantine only mandates treatment of articles destined for shipment outside but not within the quarantined areas. As a result, expansion of imported fire ants to areas not yet infested within a county is being aided by unrestricted movement of ornamentals in these areas.

Nature of Work: Imported fire ants are readily transported long distances when articles such as soil, nursery stock, and other items are shipped outside the infested area. In Tennessee, when new areas become infested the Tennessee Department of Agriculture or USDA-APHIS issue Emergency Action Notice (EAN) to producers and dealers in these areas and explain to them approved treatment methods that must be followed before a compliance stamp or limited movement permit is issued to ship restricted articles outside regulated areas. However, if articles are moved within the quarantined area, only a standard plant certificate (no compliance stamp) is used (3). Based on nursery trade estimates (1), approximately 84% of nursery stock from imported fire ant infested areas in Tennessee is shipped to locations outside quarantined areas.

Impact of human development has been shown to be one of the key modes of spread of imported fire ants in the United States (2). In middle Tennessee region, most areas where imported fire ant establishments have recently been found are in new developments. We collected samples of fire ant colonies from the compounds of three new developments in Murfreesboro, Rutherford County, and species identified as *Solenopsis invicta* Buren (red), *S. richteri* Forel (black) and *S. invicta* × *S. richteri* hybrids. Species identification was achieved by analysis of worker cuticular hydrocarbons and venom alkaloid profiles using gas chromatograph. Samples were collected by inserting a 50 ml centrifuge tube (Corning Inc., Corning, NY) into the mound to collect a minimum of 30 worker ants. Mounds were mapped with a LandMark Systems© Hemisphere Crescent A-100 sub-meter series with a Tripod Data Systems™ Nomad running SoloField™ CE (LandMark Systems, Tallahassee, FL). Other collection information including the date, location details, and collector were also obtained for each sample site. Samples were stored on ice before transporting to the lab for ant species identification. About 20-30 worker ants of mixed sizes from each colony was transferred to a 20 ml scintillation vial with just enough HPLC grade hexane (Sigma

Aldrich, Milwaukee, WI) to cover the ants. Ants were soaked in hexane for 24 h after which hexane was removed with a glass pipette, transferred to an empty 20-ml glass scintillation vial and then allowed to evaporate from the vial at room temperature. Five ml of neat hexane was then added to the test vial and processed for cuticular hydrocarbons and venom alkaloids using a Shimadzu 17-A gas chromatograph (Shimadzu Instruments Inc., Columbia, MD) equipped with a DB-1 capillary column (30 m × 0.25 mm i.d., 0.25 µm, J&W Scientific, Santa Clara, CA). The oven was programmed at 15 ^{o}C/min from 80 ^{o}C to 275 ^{o}C and then held for 7 min at the final temperature. Helium (25 cm/s) served as the carrier gas and nitrogen (10 cm/s) was used as the makeup gas.

Results and Discussion: A total of 110 fire ant colonies were sampled from the three facilities with correct global positioning (GPS) coordinates (Fig. 1). Among samples from the compound of facility # 1, 23 (47.0%), 13 (26.5%), and 13 (26.5%) were identified as red, black and hybrid imported fire ants, respectively. From both facility #2 and #3, 37 (60.7%) and 24 (39.3%) colonies were identifies as hybrid and black fire ant colonies, respectively. While black and hybrid colonies were present in all three facilities, hybrid fire ant colonies were the most abundant overall, comprising 45% of the total colonies sampled followed by black (33.6%) and red (20.9%). Red imported fire ants were present only in the compound of facility #1.

Most fire ant colonies were found at the bases of ornamental plants, at the edges of lawns next to the roadways as well as against the south-east and western sides of the building walls in these facilities. We did not find any fire ant colonies in open plots which have been cleared and ready for development just across the road from these facilities. The fact that very few ant colonies were found in the open lawns within the facilities and none at all in the open grounds across the road from these facilities, suggests that these colonies were established fairly recently and are likely to have been introduced to these sites with landscaping articles such as mulch or ornamental plants. We will continue to monitor fire ant establishment, distribution and inter-species competitions for several seasons at this location.

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Fig. 1 Map showing the geographic distribution of red, black and hybrid imported fire ants in the compounds of three facilities (new developments) in Rutherford County, TN.

Leafhopper Control in Field-grown Red Maples with Systemic Insecticides

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Index words: leafhopper, *Empoasca fabae*, *Acer rubrum*, neonicotinoid, insecticide, tree growth

Significance to Industry: Red maples are one of the most popular landscape trees. However, most cultivars of red maple are susceptible to foliar damage caused by potato leafhopper feeding. Typical potato leafhopper injury on red maple includes distorted leaf tissue and reduced shoot growth. This research identified systemic neonicotinoid insecticides that controlled leafhopper damage up to three years post-application on some cultivars. Most systemic insecticides have a higher application cost than contact sprays, such as pyrethroids; however, there are several advantages: fewer applications, control of leafhopper injury for longer periods, prevention of other pests like flatheaded borers, better plant aesthetics, and enhanced plant growth.

Nature or Work: Red maples (*Acer rubrum* L.) along with numerous cultivars developed for superior growth, fall color, insect resistance, and other plant qualities are popular ornamental trees in the U.S. nursery industry (1, 4, 7). However, many red maple cultivars are susceptible to damage caused by the potato leafhopper, *Empoasca fabae* (Harris) (Hemiptera: Cicadellidae) (1, 2, 5). Symptoms of leafhopper injury or burn include stunting and deformation of leaves, chlorosis of leaves and necrotic margins, cupping of leaf tissue, stunting of internodes (witches' broom), and death of apical tissues (1, 5). Leafhopper damage can prolong maple production time, decrease overall plant growth, reduce the aesthetic quality, increase pruning requirements, and lower the overall market value of red maples (3, 5, 6).

Although potato leafhopper activity can be monitored with yellow sticky cards, most nursery producers do not monitor for leafhoppers, and the uncertainty regarding their presence can result in as many as 10 cover sprays with contact insecticides per growing season (5). Contact insecticides have the disadvantage of requiring frequent applications to maintain leafhopper suppression. Few studies have examined systemic insecticides for long-term control of potato leafhopper damage in field-grown nursery trees. The objectives of this study were to 1) identify effective insecticides for potato leafhopper control on two red maple cultivars, 2) determine the duration of control provided by systemic insecticides, and 3) to determine effects on tree growth.

A field production nursery in middle Tennessee planted bare root liners of *Acer rubrum* L. 'Autumn Flame' and 'Franksred' in March 2005 in nursery blocks with in-row spacing of 1.5 m (5 ft) and 3.0 m (10 ft) between rows. Four insecticide treatments and an untreated control were randomly assigned to consecutive trees of each cultivar to constitute an experimental block. Each block was replicated 44 and 47 times in a randomized complete block design for 'Franksred' and 'Autumn Flame', respectively.

Treatments were applied May 24, 2005 using two application methods (Table 1). Three treatments were applied as drenches including Allectus SC (Allectus) (imidacloprid + bifenthrin) (5.6 ml product / tree [0.2 fl oz]) and Discus (imidacloprid + cyfluthrin) (22 or 44 ml product / tree [0.75 or 1.5 fl oz]). A 250-ml (8.5 fl oz) solution was poured into a 3.8-liter (1-gal) sprinkle can that was used to drench the lower trunk and the soil at the base of the tree (15 cm circle at tree base [6 in]). Small divots were made at the base of each tree when necessary to keep the solution from flowing away from the root zone. In addition to drench treatments, an experimental imidacloprid tablet formulation (0.5 g ai / tablet [0.02 oz ai / tablet]) was tested. Two imidacloprid tablets were inserted 7.6 cm (3 in) below the soil surface and 7.6 cm (3 in) from the trunk on opposite sides of the tree. A soil probe was used to open the hole, which was collapsed by hand following placement of the imidacloprid tablets.

Insecticide rates were determined by measuring trunk diameter on a subset of each cultivar (17 replications) at 15 cm (6 in) above the soil line. Trunks averaged 22.8 and 20.1 mm (0.9 and 0.8 in) for 'Franksred' and 'Autumn Flame', respectively. The Discus label recommends drench rates at 22 to 44 ml / 25 mm (0.75 to 1.5 fl oz / in) of trunk diameter at breast height (DBH) (137 cm above the soil surface [4.5 ft]). In this study, Discus was applied at a similar rate based on the trunk diameters at 15 cm (6 in); the height nursery trees are typically measured. The label rate of Allectus SC is 14 - 27 ml / 2.5 cm (0.5 - 0.9 fl oz / in) of trunk diameter, but Allectus was tested at a lower experimental rate of 5.6 ml / 2.5 cm (0.2 fl oz / in) of trunk diameter at 15 cm (6 in).

Trunk diameter (described above) and height were measured on all replicates on 23 August 2005, 21 December 2005, 3 November 2006 and 19 October 2007 (data not shown). Total growth was the difference between the August 2005 and October 2007 measurements (Table 2). For each cultivar, growth differences were compared among treatments by analysis of variance (ANOVA) and means separated using least significant difference test.

Trees were rated for hopperburn symptoms on August 23–26, 2005, August 29, 2006, and August 15, 2007. Leafhopper damage was rated on the entire canopy in 2005 and 2006. In 2007, only shoot tips were rated due to the size of the canopy and the concentration of leafhopper damage on the tips. A visual rating scale of 0–10 with 0 = no leafhopper damage and 10 = 100% leafhopper damage was used. Leafhopper data were transformed (arcsine square root [X]) before analysis to correct for unequal variance and means were compared as described previously.

Results and Discussion: *Potato Leafhopper Control*. There was some level of potato leafhopper damage in the study on both cultivars regardless of treatment. However, most insecticide treatments significantly reduced potato leafhopper damage for more than one season (Table 1). For instance, most imidacloprid treatments formulated as a drench (Allectus, Discus) had less leafhopper damage during the first year than imidacloprid treatments formulated as a tablet. Leafhopper damage on ‘Autumn Flame’ (2006 and 2007) and ‘Franksred’ (2005 and 2006) tended to decrease as the amount of imidacloprid active ingredient increased (Table 1). However, by the third year, the imidacloprid tablet treatment had significantly less leafhopper damage than some of the drench treatments, suggesting the tablets provided longer suppression than some of the drenches (Table 1) and that sufficient active ingredient may persist either in maple tissues or the soil from the initial tablet application.

The differences in leafhopper damage between insecticide treatments and the untreated plants became more apparent after the first year. During the first year following transplanting, the low leaf quality made it difficult to quantify potato leafhopper damage. This was particularly true for many of the ‘Autumn Flame’ trees, which had severe foliar burn unrelated to leafhopper damage. However, some differences in leafhopper damage were still detected during the first summer after transplanting. Because leafhopper damage was less distinct during the first growing season, some producers might question the need to apply insecticides in the first year. However, differences in cultivar susceptibility to leafhoppers may necessitate the need for insecticide application after transplanting. In addition, flatheaded borers were a significant problem during the first year and were controlled by these insecticides (J.B.O. and D.C.F., unpublished data).

Plant Response. Overall plant growth of the two cultivars was minimal during the first year (2005) due to transplant establishment (Table 2). However, trunk growth of ‘Autumn Flame’ was influenced by the insecticide treatments during year 1. Plants treated with Discus (44 ml) had greater trunk diameter increase compared to plants treated with imidacloprid tablets or the untreated plants. In the second year (2006), both maple cultivars treated with Allectus or Discus (22 or 44 ml) drenches or with imidacloprid tablets had greater trunk diameter growth than untreated plants. Likewise, total trunk growth during the 3-yr period was greater with plants treated with Allectus and Discus (22 and 44 ml) drenches and imidacloprid tablets compared to untreated trees, with the exception of ‘Franksred’ treated with Allectus.

Height growth was affected by insecticide treatments (Table 2). In the second year (2006), both ‘Autumn Flame’ and ‘Franksred’ treated with Discus (44 ml) and imidacloprid tablets had significantly greater increases in height compared to the untreated plants. Maples treated with Allectus and Discus (22 ml) had height growth similar to the untreated plants, and these treatments applied to ‘Franksred’ resulted in less height growth than the untreated plants. In general, total height growth with ‘Autumn Flame’ and ‘Franksred’ was greater for plants receiving the high rate of Discus (44 ml) or the imidacloprid tablets than untreated or trees treated with Discus (22 ml) or Allectus.

In conclusion, the insecticide treatments reduced leafhopper damage for more than one growing season while resulting in increased tree growth. The systemic insecticides also provided enhanced borer protection (J.B.O. and D.C.F., unpublished data). Therefore, treatments offer significant advantages to maple producers. The treatment effects in this study were often multi-year; and it is conceivable that treatment benefits may carry over into the landscape for a period of time either through continued uptake of insecticide residues in the original nursery soil or retention of imidacloprid in the tree tissues. Longevity of systemic treatments could offer producers significant cost savings over contact sprays like pyrethroids that require repeated applications.

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Table 1. Leafhopper damage on *Acer rubrum* 'Autumn Flame' and 'Franksred' treated on May 24, 2005 with imidacloprid-based insecticides and rated August 2005, 2006, and 2007.

			Active	Mean Leafhopper Damage Rating[b]					
	Treatment	Product /	Ingredient/	'Autumn Flame'			'Franksred'		
Treatment[a]	Method	Tree	Tree	2005	2006	2007	2005	2006	2007
Allectus	Drench	5.6 ml	0.30 g	1.6 a[c]	4.9 b	3.0 a	2.4 b	7.1 a	9.6 a
Discus	Drench	22 ml	0.69 g	1.8 a	2.0 cd	1.6 b	1.9 c	5.6 b	9.3 ab
Discus	Drench	44 ml	1.38 g	1.6 a	1.4 d	0.8 c	1.6 d	3.4 d	7.4 c
Imidacloprid Tablet	Soil Insertioı	2 Tablets	1.00 g	2.2 a	2.6 c	0.5 c	2.7 b	4.3 c	5.3 d
Untreated	----	----	----	2.0 a	9.0 a	2.7 a	3.6 a	6.7 a	9.1 b
LSD				0.08	0.11	0.07	0.04	0.06	0.10

[a]Allectus and Discus are combination products with imidacloprid as the systemic active ingredient. The imidacloprid tablets were experimental at the time of the study, but are now marketed as CoreTect.

[b] Leafhopper ratings were performed August 23-26, 2005, August 29, 2006 and August 15, 2007. Leafhopper damage was rated on a visual scale of 0-10 with 0 = no damage and 10 = 100% damage. Only 19 replicates (out of 47) of 'Autumn Flame' were evaluated in 2005. In other years, all 'Autumn Flame' replicates (n=47) and all 'Franksred' replicates (n=44) were evaluated.

[c] Means within a column followed by different letters are significantly different (a = 0.05).

Table 2. Height and trunk diameter growth on *Acer rubrum* 'Autumn Flame' and 'Franksred' treated on May 24, 2005 with imidacloprid based insecticides.

			Active						
	Treatment	Product /	Ingredient/	Trunk Diameter Increase, mm			Height Increase, cm		
Treatment[a]	Method	Tree	Tree	2005[bc]	2006	2005-2007	2005[b]	2006	2005-2007
				'Autumn Flame'					
Allectus	Drench	5.6 ml	0.30 g	1 ab[d]	10.2 b	13.7 c	1.6 a	33 c	53.0 b
Discus	Drench	22 ml	0.69 g	1 ab	11.1 ab	15.6 ab	1.7 a	37.6 bc	51.9 b
Discus	Drench	44 ml	1.38 g	1 a	11.6 a	16.5 a	1.8 a	44 a	65.8 a
Imidacloprid Tablet	Soil Insertion	2 Tablets	1.00 g	0 c	10.4 ab	14.5 bc	1.0 a	39.1 ab	59.9 ab
Untreated	----	----	----	0.3 bc	7.8 c	11.6 d	2.2 a	33 c	53.2 b
LSD				0.2	1.3	1.6	1.4	5.6	8.3
				'Franksred'					
Allectus	Drench	5.6 ml	0.30 g	1.8 a	10.8 c	17.2 c	4.1 a	35.5 c	62.5 c
Discus	Drench	22 ml	0.69 g	1.7 a	12.2 b	18.9 ab	6.0 a	40.0 c	67.6 c
Discus	Drench	44 ml	1.38 g	2.0 a	13.1 a	19.8 a	5.0 a	58.0 a	82.9 ab
Imidacloprid Tablet	Soil Insertion	2 Tablets	1.00 g	1.7 a	12.1 b	18.8 b	12 a	59.2 a	95.2 a
Untreated	----	----	----	1.7 a	10.1 d	16.5 c	4.5 a	47.9 b	70.4 bc
LSD				0	0.7	1.3	9.0	6.7	14.3

[a]Allectus and Discus are combination products with imidacloprid as the systemic active ingredient. The imidacloprid tablets were experimental at the time of the study, but are now marketed as CoreTect.

[b]Height and trunk diameter were measured on August 23, 2005, December 21, 2005, November 3, 2006 and October 19, 2007. The yearly growth increase for 2005 and 2006 was the difference between Dec. 2005 and Aug. 2005, Nov. 2006 and Dec. 2005, respectively. Total growth was the difference between the Oct. 2007 and Aug. 2005 measurements.

[c]Trunk diameter measured at 15 cm (6 inch) above soil line.

[d] Means within a column and tree variety followed by different letters are significantly different (a = 0.05).

Efficacy of Kontos Against Madeira Mealybug

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Index Words: *Phenacoccus madeirensis, Madeira Mealybug, Insecticides, Marathon, Kontos, Safari, TriStar*

Nature of Work: Historically, citrus mealybug was the primary mealybug species impacting floriculture and nursery production in the Southern United States. In the 1990s entomologists started to hear reports of growers having mealybug outbreaks that they could not manage. It turned out that the madeira mealybug, *Phenacoccus madeirensis,* had becomes established as a “new” ornamental pest. Although the madeira mealybug was historically known to occur in the United States, little was know about this species. The madeira mealybug is currently one of the most difficult ornamental pests to manage with pesticides. A greenhouse trial was conducted to evaluate Kontos (spirotetramat), a new systemic insecticide, and other systemic insecticide to determine their efficacy on madeira mealybugs.

The trial was conducted in a glasshouse at the Texas AgriLife Research and Extension Center at Overton, TX. Coleus plants ‘Giant Exhibition Palisandra’ were infested with all mealybug life stages at the initiation of the trial. Plants were set up in a randomized complete block design with five replicates. Foliar treatments were applied to coleus plant foliage using an R&D® CO_2 sprayer with an 8002VS tee-jet flat spray nozzle at 60 psi. All plants were sprayed until runoff. Foliar treatments also included CapSil Spray Adjuvant (Aquatrols, Paulsboro, NJ) at 6 fl oz /100 gal. Foliar applications were applied at 0 and 14 DAT. Drench applications were only applied at the start of the trial. To monitor the mealybug population, five leaves per plant were randomly selected every seven days and the number of live mealybugs was counted.

A logarithmic transformation [log10 (x+1)] of the data was used to make the variance independent of the means. Transformed data were subjected to analysis of variance (Randomized Complete Block AOV, Statistix 8). Means separation were performed using Tukey’s HSD test at the $P<0.05$ level.

Significance to the Industry: No statistical difference was observed between the untreated control and the insecticide treatments until 21 days after the first treatment (DAT).

<u>Foliar treatments.</u> There was no statistical difference among the three Kontos treatments and the Safari treatment. These four treatments resulted in statistically

lower populations compared to the Marathon II and TriStar treatments, and untreated controls.

Drench treatments. There was no statistical difference between the Safari treatment and the highest two rates of Kontos over the last four sample dates. These treatments were significantly different than control on the last four sample dates and Marathon II treatment on the last three sample dates.

Phenacoccus madeirensis is one of the most difficult greenhouse pests to manage with pesticides. Kontos and Safari both provided excellent control of this pest when applied as drenches or foliar sprays. Kontos will be a valuable tool for ornamental producers. Since these two products have different mode of actions they can be used in a mealybug rotation program.

Table 1. Mean number of *Phenacoccus madeirensis* per 5 coleus leaves

		Days after treatment (DAT)					
Treatment	Rate	0	7	14	21	28	35
Untreated		19.4	11.6	2.6 abc	57.2 a	133.8 a	77.0 ab
Kontos	0.85 fl oz/1000 6” pots	14.0	6.2	2.2 abc	0.6 c	1.0 b	18.8 bc
Kontos	1.7 fl oz/1000 6” pots	22.6	1.6	44.0 abc	14.8 abc	4.6 b	6.4 cd
Kontos	2.5 fl oz/1000 6” pots	20.6	15.8	5.8 abc	5.8 bc	0.8 b	0.6 cd
Kontos	3.4 fl oz/1000 6” pots	17.0	4.6	0.2 c	0.4 c	0.6 b	0.0 d
Marathon II	0.05 fl oz/1000 6” pots	18.6	20.4	0.8 bc	8.4 bc	35.2 a	103.2 ab
Safari 20SG	213 oz/1000 6” pots	18.8	0.2	0.0 c	0.0 c	0.0 b	0.0 d
Kontos	1.7 fl oz /100 gal	29.0	9.0	7.2 abc	1.4 c	2.6 b	2.6 cd
Kontos	2.5 fl oz /100 gal	34.8	16.6	2.6 bc	1.4 c	0.0 b	0.0 d
Kontos	3.4 fl oz /100 gal	46.0	1.8	7.4 abc	1.6 c	1.0 b	2.8 cd
Marathon II	1.7 fl oz /100 gal	33.8	9.4	26.2 a	30.8 ab	115.2 a	167.6 a
Safari 20SG	8 oz /100 gal	29.4	3.2	0.2 c	0.0 c	0.0 b	1.2 cd
TriStar 70WSP	2.3 oz /100 gal	43.4	6.4	23.0 ab	41.4 abc	80.0 a	155.2 ab

Within columns, means followed by the same letter are not significantly different (*P* > 0.05; Tukey’s HSD).