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TURFGRASS TRENDS

TURF TOLERANCE

What Makes Kentucky Bluegrass Wear-Tolerant?

By J. Scott Ebdon, James T. Brosnan and William M. Dest

Kentucky bluegrass (*Poa pratensis* L.) is the most widely used cool-season turfgrass in the United States (8). Along with perennial ryegrass (*Lolium perenne* L.), Kentucky bluegrass is commonly used on athletic fields grown in cool-season climates. Perennial ryegrass has been reported by Shearman and Beard (3, see references, page 58) to be the most wear-tolerant species and rough bluegrass (*Poa trivialis* L.) to be the least tolerant of the seven cool-season species they evaluated. Kentucky bluegrass ranked second to perennial ryegrass in terms of overall wear tolerance.

Wear evaluations in Kentucky bluegrass have been conducted (1, page 58). However, the number of studies investigating wear mechanisms important in this species (plant factors) is limited. This information would be valuable in selecting and breeding wear-tolerant genotypes. Various anatomical and morphological plant characteristics have been identified to be important in wear tolerance in evaluations conducted across species of cool-season turfgrass.

Wear tolerance in Kentucky bluegrass increased as leaf angle from horizontal increased and as shoot moisture content decreased.

Cool-season species with superior wear tolerance have been associated with plant characteristics, including greater total cell wall content (thicker cell walls), wide leaf width (coarse leaf texture), greater leaf tensile strength and high shoot density (4, page 58).

Increased shoot density provides more tissue (cushioning or resiliency) available to absorb the impact of the injury caused by wear. Greater total cell wall components enable plants to withstand pressure (bending and crushing) compared to thinner-walled plant cells. Furthermore, greater leaf cell wall content can lead to higher leaf tensile strength and decrease leaf elasticity (flexibility). Greater leaf blade tensile strength (leaf rigidity) and a coarser leaf appearance may provide plants with greater resistance to tearing under traffic.

Plant characteristics associated with superior wear tolerance vary greatly between and within species. In seashore paspalum (*Paspalum vaginatum* Swartz.), wear tolerance decreased as leaf total cell wall content increased (7, page 58). Greater leaf rigidity or lack of leaf elasticity in paspalum may lead to a reduction in wear tolerance rather than increase wear tolerance as observed with cool-season grasses (4, page 58).

Additionally, wear tolerance in warm-season grasses increased with plant water content (7, page 58) while in cool-season grasses no relationship between plant water content and wear tolerance was observed (5, page 58). Therefore, wear mechanisms are not consistent nor do they have universal application from species-to-species.

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TABLE 1

Mean wear tolerance ratings (1 to 9, 9=no injury or 100 percent grass cover) for 98 commercially available genotypes from the 2000 National Turfgrass Evaluation Program (NTEP) Kentucky bluegrass test.

Limousine	8.1	Excursion	6.8	Rambo	6.5	Monte Carlo	5.9
Markham	7.9	Boomerang	6.8	Washington	6.5	Rugby II	5.9
Misty	7.8	Apollo	6.8	Jefferson	6.4	Baron	5.8
Goldrush	7.6	Bartitia	6.8	Impact	6.4	Blacksburg II	5.8
Baronie	7.6	Glenmont	6.7	Award	6.4	Blue Ridge	5.8
Sonoma	7.4	Arrow	6.7	Chelsea	6.4	Chicago II	5.8
Champagne	7.3	Alpine	6.7	Barrister	6.4	NU Destiny	5.7
Baritone	7.3	Awesome	6.7	Coventry	6.3	Fairfax	5.6
Princeton 105	7.2	Bariris	6.7	Boutique	6.3	Cabernet	5.6
Brooklawn	7.2	Moonlight	6.7	Beyond	6.3	Shamrock	5.5
Bodacious	7.1	Bluemax	6.7	Eagleton	6.3	Wellington	5.5
Lakeshore	7.1	Raven	6.7	Wildwood	6.3	Jewel	5.3
Avalanche	7.1	Blue Knight	6.7	Bordeaux	6.3	Mercury	5.2
Midnight	7.0	Total Eclipse	6.7	Blackstone	6.3	Baronette	5.2
Bedazzled	7.0	Royale	6.6	EverGlade	6.2	Unique	5.2
Hallmark	7.0	Voyager II	6.6	Moon Shadow	6.2	Mallard	5.1
Abbey	7.0	Champlain	6.6	Liberator	6.2	Arcadia	5.1
Brilliant	6.9	Perfection	6.6	Bluestone	6.2	Rita	5.1
Midnight II	6.9	Freedom II	6.6	Barzan	6.2	York Harbor 4	5.0
Ascot	6.9	Royce	6.6	Odyssey	6.1	Goldstar	5.0
Julius	6.9	Ginney	6.6	Tsunami	6.1	Kenblue	4.8
North Star	6.9	Limerick	6.5	Serene	6.1	Langara	4.4
Quantum Leap	6.8	Envicta	6.5	Showcase	6.0	Allure	4.2
Chateau	6.8	Marquis	6.5	NuGlade	5.9	LSD (0.05)†	0.9
Julia	6.8	Everest	6.5	Lily	5.9		

†Any two genotypes are statistically different in wear (tolerance) rating if their mean difference exceeds the LSD value (Least Significant Difference).

Continued from page 53

These results suggest that wear mechanism and screening protocols need to be developed at the species-specific level in order to reliably predict and select for wear-tolerant genotypes. The objective of this research was to identify anatomical and morphological characteristics in Kentucky bluegrass, which then may serve as important selection criteria for breeding wear tolerance within this species.

Additionally, by understanding wear mechanisms, this may aid turf practitioners to develop better management strategies.

Genotype selection

Genotypes for evaluation were selected from the 2000 National Turfgrass Evaluation Program (NTEP) Kentucky bluegrass trial. The plots were established in October 2000 at the Joseph Troll Turf Research Center in South Deerfield, Mass. All plots received the same management practices (3 pounds of nitrogen per 1,000 square feet per year, 1.25-inch mowing height).

Wear treatments were applied to 173 genotypes of Kentucky bluegrass (including three replicates), using a differential slip-wear device fitted with metal football cleats.

The wear simulator was developed according to the design by the Sports Turf Research Institute (2, page 58). The wear simulator was designed to create a scuffing action while minimizing pressure to the soil, therefore limiting soil compaction. A cumulative total of 75 passes was applied, using the differential slip-wear device from Oct. 25-31, 2002.

Wear tolerance was visually rated as the percentage of the surface covered by the turfgrass foliage after wear was applied. The percent ground cover ratings were made by three evaluators (and then averaged) using a 1 to 9 scale (9=no injury or 100 percent ground cover) one day after wear applications were completed.

Kentucky bluegrass genotypes showed significant variation in wear tolerance. Wear ratings for 98 commercially available genotypes are presented in Table 1. The 10 most wear-

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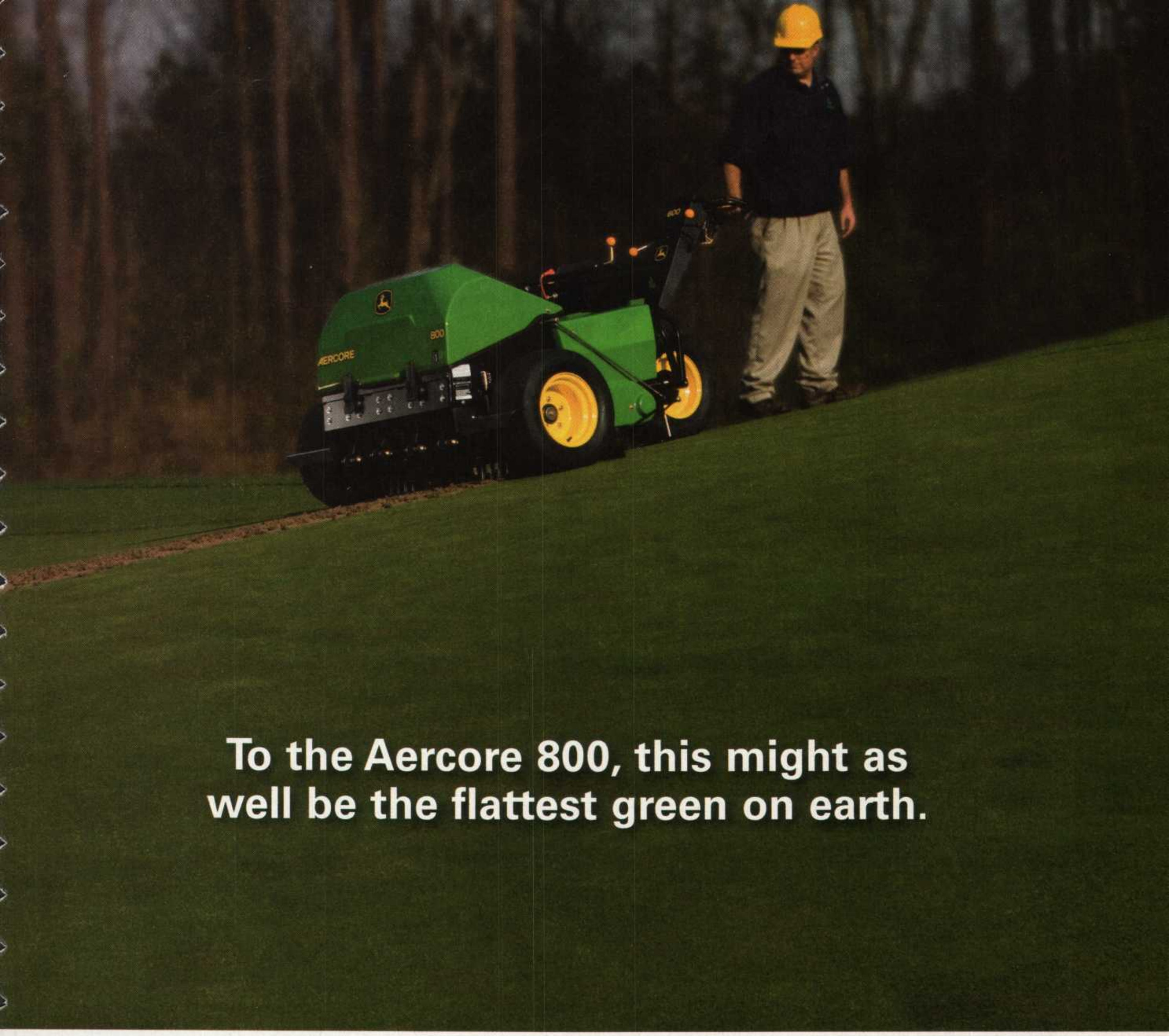
To the Aercore 800, this might as well be the flattest green on earth.

Continued from page 54

tolerant (TOL) genotypes and the 10 most wear-intolerant (INTOL) genotypes were selected from the complete roster of 173 entries, which included experimental and commercially available genotypes.

The 10 TOL genotypes ranged in wear tolerance (1 to 9 scale) from 7.4 to 8.1 while INTOL genotypes ranged from 4.4 to 5.2. These genotypes selected for further studies were distinctly different in percent ground cover because of the effects of wear (see photographs to the right that show wear TOL and INTOL genotypes, respectively).

Field measurements

A total of 10 plant characteristics was evaluated in field plots.

Leaf character measurements included leaf number per shoot, leaf width, leaf angle, leaf strength, leaf turgidity and leaf fiber analysis for cell wall constituents. Whole plant characteristics measured included shoot moisture content, tiller density and shoot fresh and dry weights. Field measurements were made from May 6-23, 2003, and May 1-11, 2004. The data reported here was averaged over the year.

Although genotype selections for wear tolerance was based on one year of wear assessment in 2002, successive annual wear treatments indicated that variation in wear tolerance was very consistent and repeatable from year to year. However, comparing wear tolerance results from this study with previous evaluations of Kentucky bluegrass (1, page 58), inconsistencies were detected in genotype performance. Studies conducted in New Jersey (1, page 58) ranked Limousine to be poor in wear tolerance. Limousine was a top-performing (wear TOL) genotype in our wear evaluations. Additionally, research conducted at Rutgers (1, page 58) found the genotype Unique to have superior wear tolerance while our study classified Unique as wear INTOL because of its poor tolerance to wear.

These inconsistencies in genotype performance between tests are due in part to (1), the differences that were present between the methods of imposing wear stress (machine specifications and features) (2), methods of evaluating wear tolerance (rating parameters and scale) and (3) differing levels of wear intensity involved in each. These differences in methodology, as well as in the effects of location and turf culture (mowing height, fertility and irrigation) on wear mechanisms, can contribute to the test-to-test variation in genotype performance that is observed. Standards for how wear is imposed and evaluated are needed. However, these standards have not been developed at this time.

Wear TOL and INTOL genotypes in our studies differed in leaf angle, total cell wall

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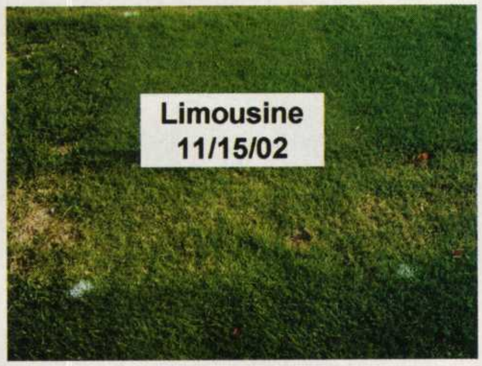
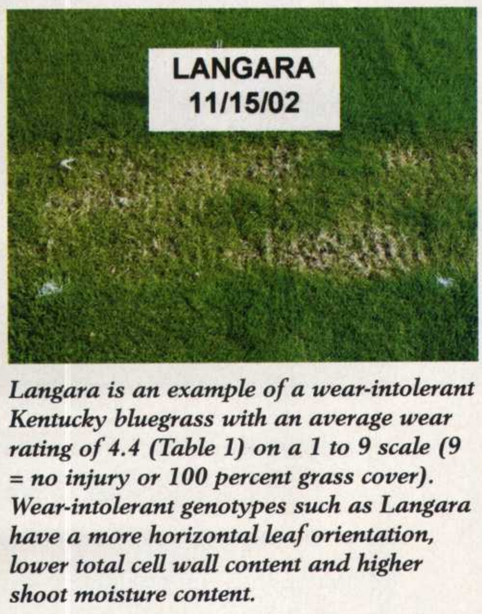


Limousine is an example of a wear-tolerant Kentucky bluegrass with an average wear rating of 8.1 (Table 1) on a 1 to 9 scale (9 = no injury or 100 percent grass cover). Wear-tolerant genotypes such as Limousine have a more upright leaf orientation, greater total cell wall content and lower shoot moisture content.



Langara is an example of a wear-intolerant Kentucky bluegrass with an average wear rating of 4.4 (Table 1) on a 1 to 9 scale (9 = no injury or 100 percent grass cover). Wear-intolerant genotypes such as Langara have a more horizontal leaf orientation, lower total cell wall content and higher shoot moisture content.

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Continued from page 56

content (TCW) and shoot moisture content. No difference in leaf width, leaf strength and shoot density was observed between wear TOL and INTOL genotypes. However, genotypes differed significantly in all leaf and shoot measurements.

Leaf angle and shoot moisture measurements sampled from mowed field plots were important predictors of wear tolerance. Leaf angle determined from mowed plots was correlated with wear tolerance ($r = 0.69$, $p \leq 0.001$), as was shoot moisture content ($r = -0.48$, $p \leq 0.05$).

So wear tolerance in Kentucky bluegrass increased as leaf angle from horizontal increased and as shoot moisture content decreased. Wear TOL genotypes had a 29 percent steeper leaf angle from horizontal than INTOL genotypes, 2.0 compared to 1.5, respectively. The wear TOL group also had significantly lower shoot moisture content than the INTOL genotypes, 80.7 percent to 81.9 percent. Tolerant and intolerant genotypes also exhibited differences in cell wall constituents. Wear TOL genotypes had significantly greater TCW than INTOL genotypes, 71.0 percent to 69.8 percent.

The biological significance of leaf angle in wear tolerance in genotypes with a more vertical leaf orientation will have less tissue on a horizontal plane exposed to the forces present in wear stress. Greater cell wall content in leaf tissues can provide superior mechanical strength and therefore can play a significant role in wear tolerance in Kentucky bluegrass. Lower moisture content will minimize crushing of tissues from the vertical forces involved in wear stress by increasing leaf blade elasticity (flexibility).

Any cultural practices that influence these mechanisms in a positive direction by increasing leaf angle and TCW while reducing shoot moisture can increase Kentucky bluegrass wear tolerance. To that end, avoiding excessive (lush) shoot growth by keeping nitrogen and irrigation to its lowest possible level needed to sustain moderate growth is critical. Also, avoiding excessively close mowing that promotes a more horizontal leaf orientation (6) while depleting carbohydrate reserves needed for recovery from wear is important.

In our studies, the worn portions of wear tolerant Kentucky bluegrasses reached cover ratings equal to their unworn check portions sooner than intolerant selections.

Grass cover in 30 percent of all wear-tolerant genotypes had fully recovered to a point that was statistically equivalent to their unworn checks by April 19 of the following year after wear was applied the previous fall and 90 percent was fully recovered by May 19. None of the wear intolerant genotypes had fully recovered by April while only 50 percent were fully recovered by May. So selecting wear tolerant grasses will permit sporting activities to be rescheduled sooner on trafficked surfaces.

By understanding wear mechanisms, selection criteria can be developed to aid breeders in developing improved turfgrass for use in the sports turf industry and help practitioners to develop better management strategies.

Further research is needed in other species such as Agrostis (bentgrass) to identify wear tolerant genotypes and associated plant factors (mechanisms) that lead to superior wear tolerance.

Acknowledgments

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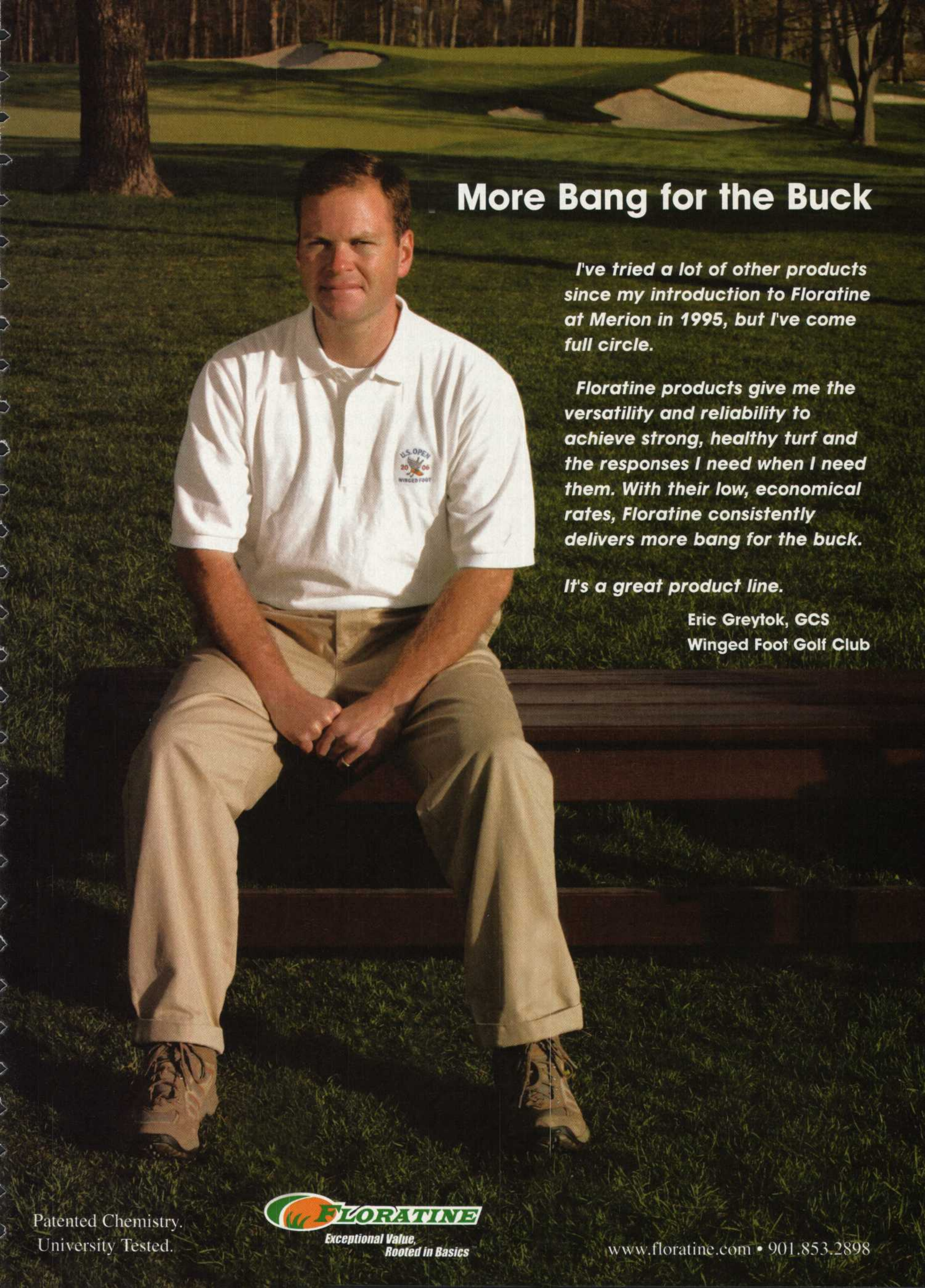
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Try These Tips on Pesticide Efficacy, Formulations, Equipment

By Eileen Buss and Grady Miller

Each year, some turfgrass managers call university specialists and/or regulators to discuss failures of certain insecticides against key pests. Build-up of insecticide resistance by the pests is often blamed, but poor control may be caused by any number of other factors. Understanding which factors can reduce pesticide effectiveness may help you avoid retreats, unnecessary exposure and lost revenues.

Pest identification. Proper identification of a pest is critical to knowing its life cycle, which then indicates when it is most vulnerable to control. Misidentifications often lead to poorly timed pesticide applications. For assistance, samples may be sent to your local cooperative extension office for identification.

Selection of pesticide and formulation. All insecticides are different, even within chemical classes. Products vary in formulation, length of residual, which and how many pests they target, their mode of action, ability to bind to organic matter and so on. Choice of formulation also matters, depending on which pest is targeted and where it lives and feeds. The primary formulations are liquids (e.g., flowables, emulsifiable concentrates or soluble or wettable powders) and dry formulations (e.g., granulars, dusts or baits).

Liquid applications usually leave a residue on grass blades, which insects may feed on and/or physically contact, and often provide faster knockdown of surface and thatch-feeding insects than dry formulations.

Granulars may be more useful if post-treatment irrigation must be delayed and may be safer to handle than sprayable formulations. Granulars are also less likely to drift on windy days than sprayable formulations, which is a major concern for turfgrass managers. Avoid spraying if wind velocity exceeds 5 mph. Superintendents in Florida identified in a recent survey that the most common formulations they used were flowables, wettable powders and granulars (Table 1).

Granulars may be more useful if posttreatment irrigation must be delayed and may be safer to handle than sprayable formulations.

TABLE 1

Percentage of superintendents who used these pesticide formulations on golf courses.

Pesticide Formulations	
Flowable	85.0
Granule	77.2
Wettable powder	77.2
Soluble powder	64.6
Emulsifiable concentrate	61.4
Bait	56.7
Fumigant	8.7
Dust	3.2

Research suggests that the efficacy of granular and sprayable formulations for turfgrass insect pests is actually similar. Baits tend to be more environmentally friendly because they are target specific and contain less active ingredient than other formulations.

Application equipment. Selecting the appropriate application equipment and calibrating the amount of pesticide delivered are key components of proper pesticide use.

Although which sprayer or spreader used may not directly affect pesticide efficacy, the choice may affect coverage and indicate adherence to an integrated pest management program. Properly calibrated equipment is essential for even coverage. If too little product is applied, only partial control may be achieved, or none at all. Similarly, if the distribution of product is not uniform, gaps in control may occur.

Application equipment comes in all shapes and sizes. Often, smaller pieces of equipment allow for more precise applications where pests are actually located, which is useful for spot treatments. Tractors or trucks are used for large-scale applications, but the pests may not be uniformly present throughout that area. It is useful when these larger sprayers are also equipped with a hose and handgun nozzle for applications in small or hard-to-reach areas.

Florida superintendents indicated in a recent survey that they used spray rigs/tractors or hand-held spray tanks either most of the time or always in their pest management (Table 2).

Broadcast spreaders were more popular than drop spreaders or hand-held granular spreaders ("belly grinders"). The main goal is to use equipment that can apply the pesticide close to where the insects are living and feeding while minimizing drift and non-target (e.g., people, animals, beneficial insects) exposure.

In addition, spray nozzles are an integral component of

Continued on page 62