bamate insecticides, systematic sampling of vulnerable areas for targeting control is still a very viable alternative to blanket "wall-to-wall" applications of grub control.

This technique, along with information developed in our earlier research (see "The Economics of Scouting") can provide managers with the accurate information about grub populations, species and growth stages needed to make more precise control decisions. Systematic sampling can also provide additional information regarding the condition, size and health of turf root systems; thatch depth and density; soil texture, compaction and moisture levels; and many other valuable inputs in the overall management process.

For managers who have embraced the newest grub control materials, knowing the site conditions of vulnerable areas, combined with specific information about scarab grub activity tendencies, can help ensure the efficacious use of these materials.

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Keep the following basic information regarding scarab beetle grubs in mind even if you don't have the resources to carry out sampling and mapping practices:

- Well managed, irrigated locations near vulnerable vegetation will tend to harbor Japanese beetle grubs, often at very high populations.
- Dryer, low-maintenance locations near vertical surfaces or sources of nightime illumination will tend to harbor European chafer populations.
- High organic content or heavily thatched soils will tend to harbor populations of black turfgrass ataenius.

LITERATURE REVIEW

Spring Transition of Bermudagrass

A Review of Information

By Robert Green[1], Grant Klein[1], F. Merino[1], J. Evans[1], Mike Henry[2] and Steve Cockerham[1].

The spring transition of overseeded bermudagrass back to a monostand of bermudagrass can be a concern and a challenge for golf course superintendents and turfgrass managers of sports fields, parks and other turfgrass areas in southern California. Spring transition is a common concern of turfgrass managers across the southern regions of the United States.

Numerous articles concerning the overseeding of warm-season turfgrasses have been published in technical and trade journals. A review of selected reports, organized by topic and including a brief description of the work and the findings is presented below.

Importance of Healthy Bermudagrass

A strong, healthy bermudagrass is essential for a rapid spring transition. Healthy rhizomes, roots and bud tissue associated with the crown are characteristic of a healthy bermudagrass prior to spring growth. Freezing, traffic and extremely low mowing heights are examples of the many factors attributed to plant stress which can result in weak bermudagrass prior to spring growth. (It should be noted that freezing stress may not be a dominant plant stress factor in southern California.)

Maintaining a strong, healthy bermudagrass in late summer and fall is recommended to help provide for a strong, healthy bermudagrass in the following spring. Recommendations for maintaining a strong, healthy bermudagrass in the fall normally involve good nutrition, higher heights of cut and the least disruptive renovation practices.

Horgan B. and F. Yelverton (North Carolina State Univ.) 1997. Removal of Perennial Ryegrass From Overseeded Bermudagrass. Agron. Abstr. 89:123.

Description: Bermudagrass plots maintained at a 0.75-inch mowing height were overseeded with perennial ryegrass. Spring-applied cultural and chemical treatments were evaluated for the removal of overseeded perennial ryegrass.

Findings: Cultural treatments (which included vertical mowing, scalping, vertical mowing plus scalping, and core cultivation) did not affect bermudagrass transition. Environmental conditions (high air temperatures and high relative humidity) were the determining factors in removing the overseeded turfgrass. Results from the chemical treatments indicated that Kerb applied in mid-spring or early summer provided excellent perennial ryegrass removal and transition.

Bruneau, A., J. DiPaola, W. Lewis, W. Gilbert, and L. Lucas (North Carolina State Univ.) 1985. Overseeding Bermudagrass Turf. North Carolina Extension Serv. AG-352.

Description: General article concerning the overseeding of bermudagrass.

Findings: Recommends the spring management practices of reducing mowing height, delaying fertilization, and reducing soil moisture to hasten the transition of cool-season grass to bermudagrass. However, response from vertical mowing and coring have not been consistent. In a second article, authors recommended that when night temperatures approach 60°F, begin mowing the overseeded turfgrass lower. This will stress the ryegrass, reduce its ability to compete with the bermudagrass and help the soil warm up faster.

Influence of Air and Soil Temperatures

Spring transition occurs when air and soil temperatures favor the growth of bermudagrass and discourage the growth of the cool-season overseeded turfgrass. One paper reported that spring transition naturally occurs when soil and air temperatures are above 80°F, when ryegrass roots begin to decline. A second paper recommended that mowing heights should be lowered when night temperatures approach 60°F. Cultural practices designed to hasten the bermudagrass transition could be timed when air and soil temperatures favor the growth of bermudagrass and discourage growth of cool-season overseed turfgrasses. It should be noted that several weeks of threshold temperatures are probably needed to maintain substantial warm-season turfgrass growth in the spring.

DiPaola, J. and J. Beard (North Carolina State Univ. and Texas A&M Univ.) 1992. Physiological Effects of Temperature Stress. Chapter 7. In D.V. Waddington, R.N. Carrow and R.C. Shearman (ed.) Turfgrass Agron. Monogr. 32, ASA, CSSA,SSSA, Madison, WI.

Description: Literature review concerning temperature stress of turfgrass.

Findings: Optimum temperature range for cool-season shoot growth is 59° to 75°F. Optimum temperature range for warm-season shoot growth is 80° to 95°F. Optimum temperature range for cool-season root growth is 50° to 64°F. Optimum temperature range for warm-season root growth is 75° to 84°F. Lethal temperature (LT50) for freezing stress of Tifgreen and Tifdwarf bermudagrasses is 17.6° to 23°F.

Beard, J. and W. Menn (Texas A&M Univ.) 1988. The Texas System of Winter

Overseeding. Grounds Maintenance, Sept. pg. 14, 16.

Description: The Texas System of Winter Overseeding described. Recommends minimal renovation for a strong bermudagrass in the fall. Annual bluegrass control. Seed when four-inch soil depth is 72° to 78°F with 80% perennial ryegrass plus 20% *Poa trivialis* (by weight). For best spring transition, mow closely, maintain a high N fertility level and lightly vertical cut weekly.

Findings: These recommendations are based on ten years of research. It should be noted that other investigators have reported that water and fertilizer have been shown to extend the competitiveness of the overseeded grasses. Also, other investigators have reported that high intensity vertical mowing slowed bermudagrass emergence. The success of management programs often depends on weather conditions and timing of practices to hasten the spring transition period. Other investigators suggest that the condition of the bermudagrass roots and rhizomes before spring growth will predict the transition. Those years when they found dead, small or off-white rhizomes were followed by poor spring transition. This type of inspection will aid in decisions concerning the timing of transition or the need to hold the overseed grass while the bermudagrass recovers.

Batten, S. (Texas A&M Univ.) 1985. The Hidden Connection. Weeds Trees & Turf. July: 32,34,37,38.

Description: General article concerning overseeding with selected data from the Texas System of Winter Overseeding.

Findings: Reported that spring transition natural occurs when spring soil and air temperatures above 80°F cause the ryegrass roots to decline in active growth. Other investigators indicate that bermudagrass initiates growth as soil temperatures approach 60°F.

However, competitive, vigorous bermudagrass growth is associated with air and soil temperatures in the 90°F range. Also, when temperatures are consistently in the 80° to 90°F range, there is a rapid decline of perennial ryegrass from stress and disease pressure. Other reports suggest that mowing heights should be lowered when night temperatures approach 60°F.

Mazur, A. and D. Wagner (Clemson Univ.) 1987. Influence of Aeration, Topdressing, and Vertical Mowing on Overseeded Bermudagrass Putting Green Turf. Hort Science. 22:1276-1278.

Description: Studied the effect of spring-applied core cultivation, vertical mowing and topdressing on the rate of bermudagrass emergence and quality of putting green turf during spring transition.

Findings: All practices were shown to have no effect on bermudagrass transition. It should be noted that other investigators have reported that vertical mowing and aeration hasten bermudagrass emergence.

Spring-Applied Treatments to Hasten Transition

There have been numerous studies employing spring-applied treatments to hasten the bermudagrass transition. Unfortunately, the majority of the findings from these studies are not consistent. The treatments that have been tested include: core cultivation, vertical mowing, topdressing, scalping, vertical mowing and scalping, nitrogen applications, herbicide applications and plant growth regulator applications. No doubt, successful and consistent adoption of spring-applied treatments to hasten the bermudagrass transition will require timing based on soil and air temperatures.

Johnson, B. (Univ. of Georgia) 1990. Effects of Pronamide on Spring Transition of a Bermudagrass (*Cynodon dactylon*) green overseeded with perennial ryegrass (*Lolium perenne*). Weed Technology. 4:322-326.

Description: Studied the influence of Kerb applications on spring transition of bermudagrass greens overseeded with perennial ryegrass.

Findings: Found that applications of Kerb hastened bermudagrass transition. However, there was some injury to the bermudagrass and correct rate and timing of application were essential. It should be noted that Johnson has published other papers concerning the testing of other herbicides.

Johnson, B. (Univ. of Georgia) 1990. Influence of Plant Growth Regulators on Transition of a Bermudagrass Golf Green Overseeded with Perennial Ryegrass. Georgia Agr. Expt. Sta. Res. Report 580.

Description: Studied the influence of plant growth regulators on the transition of a bermudagrass golf green overseeded with perennial ryegrass.

Findings: Found that some PGR applications did not severely injure the turf. However, the transition was not acceptable. It should be noted that other investigators have reported more positive results.

Menn, W. and R. White (Texas A&M Univ.). 1995. Effects of Primo on perennial ryegrass overseeding establishment. Progress Report, Novartis Crop Protection, Inc., p. 7.

Description: Tifway bermudagrass, overseeded with perennial ryegrass, 0.625-inch mowing height, Primo 1EC applied at 0 to 0.75 oz. per 1,000 sq. ft, minimal bermudagrass renovation.

Findings: Fall applications of Primo did not appreciably affect spring transition of bermudagrass.

Genetic Variation

Genetic variation for spring/summer persistence among overseed turfgrass species has been reported by a number of researchers.

Dudeck, A. and B. McCarty (Univ. of Florida) 1989. Comparison of Overseeded Grasses for Putting Greens. Proc. Fla. State Hort. Soc. 102: 127-133.

Description: Studied differences among 27 cool-season turfgrass treatments for overseeding bermudagrass putting greens.

Findings: Noted differences in germination rate, rate of ground cover and visual ratings of turfgrass color and quality for seeding rates of cultivars, mixtures and blends of: perennial ryegrass; Chewings fescue; tall fescue; roughstalk bluegrass (*Poa trivialis*); Kentucky bluegrass; redtop; and creeping, colonial and velvet bentgrass.

Goatley, J., J. Krans, V. Maddox, H. Philley, J. Osteen and M. Atkin (Mississippi State University) 1997. Seeding Rate by Date Comparisons of Roughstalk Bluegrass Overseedings. Agron. Abstr. 89:132.

Description: Studied various seeding methods for applying 12 lb. of *Poa trivialis* per 1,000 sq. ft. Total of 12 pounds of seed applied in one application; two applications (9 lb. + 3 lb. or 6 lb. + 6 lb.); or three applications (6 lb. + 3 lb. + 3 lb.).

Findings: Split seeding treatments 6 lb. + 3 Lb. + 3 lb. (every two weeks) and 6 lb. + 6 lbs. (four week interval) and 9 lb. + 3 lb. (four week interval) tended to perform better than one seeding at 12 lb./1,000 sq. ft.

DiPaola, J. (North Carolina State Univ.) 1987. Spring Transition of Warm-Season Grasses. Grounds Maintenance. February: 34,38,40,42.

Description: Evaluated 60 different cool-season overseedings in Tifgreen bermudagrass under putting green conditions for spring/summer persistence.

Findings: Differences for persistence among perennial ryegrass cultivars was large. Intermediate ryegrass, *Poa trivialis*, and several perennial ryegrass cultivars were least persistent. Plots overseeded with the least persistent grasses had the greatest amount of bermudagrass regrowth.

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