GE 9819-127

# Executive Summary

**Third Year Annual Report -- November 1, 2000**

## Establish a Regional Center to Identify Genetic Insect & Mite Pest Resistance

**(Five Year Project)**

## (USGA Green Section Research & Texas Research Foundation Project 440291-0001)

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**Cooperators**: Dr. Charles Taliaferro, OK State Univ., Stillwater, OK; Dr. M. C. Engelke, Dr. James C. Read, TAMU, Dallas, TX; Dr. Richard White & Mr. Trent Hale (Ph.D. candidate), TAMU, College Station, TX; Dr. A. E. Dudeck, Univ. FL, Gainesville, FL; Dr. B. R. Wiseman, USDA, Tifton, GA.; Drs. Wayne Hanna & Glenn Burton, USDA, Tifton, GA; Dr. Terry Riordan, Univ. NB, Lincoln, NB; Dr. Ronnie Duncan, Univ. GA, Griffin, GA.

A Regional Center was established to screen and evaluate turfgrass germplasm for resistance to insect and mite pests. The primary goal for this Center has been to identify genetic lines of bermudagrass, zoysiagrass, buffalograss, seashore paspalum, bentgrass and bluegrass with resistance to the primary pests; caterpillars (fall armyworms, black cutworms, sod webworms), white grubs, billbugs and several host specific eriophyid mites, and to characterize the mechanisms of resistance. This process requires the development of efficient screening procedures to effectively identify genetic resistance to target pests. A secondary goal is for the cooperative grass breeders to incorporate the insect and mite pest resistance identified into agronomically acceptable cultivars for use in the landscape to help eliminate our dependency on pesticides in this multi-billion dollar turf industry.

Work has continued with elite germplasm of bermudagrass (*Cynodon* spp.) from the breeding program under Dr. Charles Taliaferro at Oklahoma State University, Stillwater and cultivars of bermudagrass from the NTEP bermudagrass trial under the supervision of Dr. Richard White at Texas A&M University, College Station. Additional work has continued with zoysiagrass hybrids (*Zoysia* spp.) and bluegrass hybrids (*Poa* spp.) from the breeding programs of Dr. Milt Engelke and Dr. James Read, respectively, at the Texas A&M University Research & Extension Center at Dallas.

The bermudagrass mite (*Eriophyes cynodoniensis*) has consistently been a major pest of many commonly used cultivars of bermudagrass used throughout the southern US. It is a pest in the

landscape, on golf courses and it causes considerable loss of production in the Arizona seed industry. An experiment with 83 bermudagrass cultivars and genotypes was established to characterize resistance or level of susceptibility to injury by the bermudagrass mite.

Bermudagrass genotypes can be grouped into five levels of mite infestation: 0.0 rosettes (9 lines); 0.1-0.4 (14 lines); 0.5-1.9 (16 lines); 2.0-9.9 (16 lines); 10.0-19.9 (12 lines) and 20.0+ (16 lines). **Any or all of the genotypes with 0.0 to 0.4 rosettes per plant (first two groups) could be resistant to the bermudagrass mite or they may have been missed** by the testing procedure. The level of confidence in these results increases the higher the number of rosettes. Plants with infestation levels of 0.5 to 1.9 rosettes per plant could be designated as moderately resistant. All plants with 2.0 or more rosettes per 7.5 x 7.5 cm plant should be considered as susceptible to the bermudagrass mite. Based upon this data, cultivars considered highly susceptible are Floradwarf, Champion, Lakewood, Tifdwarf, Baby, Majestic, Ormond, Tifgreen, Tif Eagle, Shangra La, MS Supreme, Blue-Muda and Southern Star.

The hunting billbugs (*Sphenophorus venatus vestitus*) causes some of the most commonly misdiagnosed damage associated with zoysiagrass and bermudagrass. Their damage in quite often identified as either drought, dormancy, chinch bug or white grub feeding, or even one of several disease infections. Increasingly higher populations of this billbug have been observed over the past 10 to 15 years and it is often responsible for extensive turf damage or loss of sod production in both zoysiagrass and bermudagrass.

An experiment was established to evaluate nine zoysiagrass (*Zoysia* spp.) cultivars for resistance to the hunting billbug. Cages (8 ft diam.) were used to confine adults of the hunting billbug on nine cultivars of zoysiagrass. A paired cage arrangement was used so treated plants could be directly compared with untreated paired plants. Plants were established and billbugs introduced in mid June 2000. Surface growth and damage was evaluated by ranking each test plant on a scale of 1 to 9 with 1=severe damage, 9= no damage. All plants were harvested and bagged in late Sept. 2000 by excavating the entire plant from the sand. Total rhizome and stolon length was measured and total plant biomass was collected to be oven dried and weighed. Stolons and rhizomes from each treated plant was also evaluated for feeding damage.

When plants from the treated cages (with billbugs) were ranked and compared with the untreated plants, Diamond exhibited the least leaf firing damage, followed by DALZ9601. Additionally, El Toro, Cavalier and Royal sustained less damage than Crowne, DeAnza Palisades and Meyer. Meyer sustained the most billbug feeding. Meyer has now been documented as highly susceptible to zoysiagrass mite, fall armyworm, tropical sod webworm, tawny mole cricket, differential grasshopper and hunting billbug. Data for the total plant biomass and total length of rhizome and stolon have not been processed yet, but visual evaluations during the harvesting process support these results. **This data provides the first documented report of resistance to the hunting billbug in zoysiagrass.**

# Third Year Annual Report -- November 1, 2000
# USGA Green Section Research Project
# Texas Research Foundation Project 440291-0001)

## Establish a Regional Center to Identify Genetic Insect & Mite Pest Resistance
### (Five Year Project)

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**Support Personnel:** Mr. Joe McCoy, Research Associate and Mr. Dennis Hays, Research Assistant.

**Purpose:** A Regional Center was established to screen and evaluate turfgrass germplasm for resistance to insect and mite pests. The primary goal for this Center has been to identify genetic lines of several turfgrass species (bermudagrass, zoysiagrass, buffalograss, seashore paspalum, bentgrass and bluegrass) with resistance to the primary pests; caterpillars (fall armyworms, black cutworms, sod webworms), white grubs, billbugs and several host specific eriophyid mites, and to characterize the mechanisms of resistance. This process requires the development of efficient screening procedures to effectively identify genetic resistance to target pests. A secondary goal is for the cooperative grass breeders to incorporate the insect and mite pest resistance identified into agronomically acceptable cultivars for use in the landscape to help eliminate our dependency on pesticides in this multi-billion dollar turf industry.

**Progress:** Work has continued with elite germplasm of bermudagrass (*Cynodon* spp.) from the breeding program under Dr. Charles Taliaferro at Oklahoma State University, Stillwater and cultivars of bermudagrass from the NTEP bermudagrass trial under the supervision of Dr. Richard White at Texas A&M University, College Station. Additional work has continued with zoysiagrass hybrids (*Zoysia* spp.) and bluegrass hybrids (*Poa* spp.) from the breeding programs of Dr. Milt Engelke and Dr. James Read, respectively at the Texas A&M University Research & Extension Center at Dallas.

**Bermudagrass cultivars and hybrids – evaluation for Bermudagrass Mite resistance:**

***Methods –***

The bermudagrass mite (*Eriophyes cynodoniensis*) has consistently been a major pest of many commonly used cultivars of Bermudagrass (*Cynodon* spp.) used throughout the southern US. It is a pest in the landscape and causes considerable loss of production in the seed industry in Arizona. Normally, damage from this pest is quite visible in mid to late July and August in the Dallas, TX area, but this year, populations were so high early in the season, that damage was very visible throughout the landscape in late April and May 2000. I attribute these early populations to our lack of a 'killer' Winter this year.

An experiment with 83 bermudagrass cultivars and genotypes was established to characterize resistance or the level of susceptibility to injury by the bermudagrass mite. Each bermudagrass genotypes (Table 1) was maintained in the greenhouse in two, 18-cell trays (each cell measuring 7.5 x 7.5 cm and 4 cm deep). Trays were arranged in a randomized complete design on greenhouse benches and allowed to be infested naturally by stock populations of bermudagrass mite from various infested plants placed throughout the greenhouse. To assay the level of susceptibility, six plants representing the highest bermudagrass mite infestation for each genotype were removed and infested terminals (rosettes) were counted. No attempt was made to count individual mites, since are so small and populations often exceed 200 mites under each leaf sheath.

***Results and Discussion –***

Bermudagrass mite infestations as expressed by symptoms (rosettes) for each of the 83 cultivars and genotypes are given in Table 1. Genotypes are grouped here as five levels of bermudagrass mite infestation; 0.0, 0.1-0.4, 0.5-1.9, 2.0-9.9, 10.0-19.9 and 20.0+. We did not detect rosettes on nine of the genotypes (1st group) and levels of less than 0.18 were detected on 13 of the genotypes with one selection having a mean of 0.33 (2nd group). **Any or all of these genotypes could be resistant to the bermudagrass mite or they may have been missed** by the testing procedure. In a previous experiment, I showed plants of Tifway to be infested 44% of the time, even though the individual plants did not have many rosettes. The level of confidence in these results increases as we move to the right within Table 1. Plants with infestation levels of 0.5 to 1.9 rosettes per plant could be designated as moderately resistant. All plants in the last three groups (greater than 2.0 rosettes per plant) should be considered as susceptible to the bermudagrass mite. Genotypes in the last two groups are extremely susceptible and many of the newer dwarf type cultivars that are widely used in the industry are listed here.

A second experiment with all the plants that had rosette levels of 0.0 to 0.4 has been established with six replicates in a randomized complete block design to confirm if these genotypes are resistant. Each plant in this experiment was also infested with a rosette removed from an infested plant. No results are available at this time.

**Zoysiagrass cultivars – evaluation for Hunting Billbug resistance:**

***Methods –***

Billbugs (*Sphenophorus* spp.) cause some of the most commonly misdiagnosed damage associated with turfgrass. Their damage in quite often identified as either drought, dormancy, chinch bug or white grub feeding, or even one of several disease infections. Several experiments by other scientists have identified resistance to the bluegrass billbug (*Sphenophorus parvulus*) in cultivars of Kentucky bluegrass. But no experiments have been conducted in either bermudagrass or zoysiagrass to identify resistance to the hunting billbug (*Sphenophorus venatus vestitus*). Increasingly higher populations of this billbug have been observed over the past 10 to 15 years and it is often responsible for extensive turf damage or loss of sod production in both zoysiagrass and bermudagrass.

An experiment was established to evaluate nine zoysiagrass (*Zoysia* spp.) cultivars for resistance to the hunting billbug. Metal livestock tanks 2.5 ft high by 8 ft diam. were used as cages. Each cage was fitted with four 1 $ft^2$ screened opening in the bottom before each tank was filled with ca. 18 inches of top dressing sand and the top of the tank was fitted with a screened lid to prevent migration into or out-of the cages. Nine zoysiagrass plants (Table 2) produced in the greenhouse in 18-cell trays (each cell measuring 7.5 x 7.5 cm and 4 cm deep) were planted in a separate randomized complete block design in both halves of each cage. A second cage was planted with exactly the same arrangement with plants that had been paired with the first set of plants. Three additional sets of paired cages were also established for a total of eight replicates of test plants. Plants were established in the cages on 23-24 June 2000. One cage of each pair was infested on 26 June 2000, with 30 female and 15 male hunting billbug adults. Cages were watered and fertilized as needed to provide good plant growth. On 21 Sept. 2000, surface growth and damage was evaluated by ranking each test plant on a scale of 1 to 9 with 1 = severe damage, 9 = no damage. Then all plants were harvested and bagged from 22-29 September 2000 by excavating the entire plant from the sand. Plants were held under refrigeration until they were processed. Total rhizome and stolon length was measured and total plant biomass was collected to be oven dried and weighed. Stolons and rhizomes from each treated plant was also evaluated for feeding damage.

***Results and Discussion –***

Nine cultivars of zoysiagrass were assayed for resistance to the hunting billbug. Results of the surface evaluation of leaf firing are presented in Table 2. When plants from the treated cages (with billbugs) were ranked, Diamond exhibited the least leaf firing damage, followed by DALZ9601. Meyer suffered the most damage and was in the lowest statistical grouping along with Palisades and DeAnza. When the difference in damage ranking for each of the paired plants was assayed, Diamond and DALZ9601 were again in the top statistical grouping and the same three grasses were most damaged. Data for the total plant biomass and total length of rhizome and stolon have not yet been processed. Visual evaluations during the harvesting process,

however support a high level of resistance in DALZ9601. The rest of the data from this experiment will be presented in the next annual report. **This data provides the first documented report of resistance to the hunting billbug in zoysiagrass.**

**Future Plans:**

**Bermudagrass cultivars – evaluate cultivars for resistance to the Hunting Billbug:**

Injury from the hunting billbug has been increasing annually across the southern states in bermudagrass. We intend to evaluate several cultivars of bermudagrass for potential resistance to this pest, now that we have an acceptable method for assaying the cultivars.

**Zoysiagrass hybrids – characterize the heritability of Fall Armyworm resistance among hybrids:**

Work has continued to identify the degree of heritability of fall armyworm resistance among hybrids between Cavalier and Diamond zoysiagrass. We successfully made ca. 250 hybrids between Cavalier (highly resistant) and Diamond (susceptible). We are in the process of evaluating each hybrid to determine the range of resistance among the hybrids and gain enough information to characterize the heritability of the resistance factor(s).

**Texas Bluegrass hybrids – characterize the heritability of Fall Armyworm resistance among hybrids:**

A selection of Texas bluegrass (*Poa arachnifera*) has been hybridized with Mystic Kentucky bluegrass (*Poa pratensis*) to produce ca. 60 interspecies hybrids. We are in the process of characterizing the levels of resistance to fall armyworm among these hybrids. We hope to gain enough information to characterize the heritability of the resistance factor(s).

**Kentucky Bluegrass cultivars – characterize resistance or susceptibility to Fall Armyworm:**

Approximately 50 cultivars of Kentucky bluegrass have been cultivated in the greenhouse so we can characterize their resistance or susceptibility to fall armyworm. This information will be valuable in choosing additional parents for future hybrids with Texas bluegrass genotypes.

**Publications, Papers & Posters presented by the Project Leader:**

***Peer Reviewed , Refereed Journal Articles:***

Engelke, M. C., P. F. Colbaugh, J. A. Reinert, K. Marcum, R. H. White, B. A. Ruemmelle & S. J. Morton. 2000. Registration of 'Diamond' zoysiagrass (Reg. No. CV- . Crop Sci. 40: (in review).

Engelke, M. C., J. A. Reinert, P. F. Colbaugh, R. H. White, B. A. Ruemmelle, K. Marcum & S. J. Morton. 2000. Registration of 'Cavalier' zoysiagrass (Reg. No. CV- . Crop Sci. 40: (in review).

Engelke, M. C., R. H. White, P. F. Colbaugh, J. A. Reinert, K. Marcum, B. A. Ruemmelle & S. J. Morton. 2000. Registration of 'Crown' zoysiagrass (Reg. No. CV- . Crop Sci. 40: (in review).

Engelke, M. C., R. H. White, P. F. Colbaugh, J. A. Reinert, K. Marcum, B. A. Ruemmelle & S. J. Morton. 2000. Registration of 'Palisades' zoysiagrass (Reg. No. CV- . Crop Sci. 40: (in review).

Reinert, J. A., S. George, W. A. Mackay, E. Smith & T. D. Davis. 2000. Resistance among *Lantana* cultivars to the lantana lace bug, *Teleonemial scrupulosa* Stal. J. Econ. Entomol. (peer review with journal editor).

Reinert, J. A. & S. J. Maranz. 2000. Residual control with insecticides of fall armyworm (*Spodoptera frugiperda*) on field treated *Cynodon dactylon*. Inter. Conf. Crop Protection, Brighton England, UK. (in press).

Reinert, J. A. Reinert, W. A. Mackay, S. W. George, J. Read, M. C. Engelke & S. J. Maranz. 2000. Residual chemical control for differential grasshopper, *Melanoplus differentialis*, in urban landscapes. Southwestern Entomol. 25: (peer review with journal editor).

Reinert, J. A. & P. Busey. 2001. Host resistance to tawny mole cricket, *Scapteriscus vicinus*, in bermudagrass, *Cynodon* spp. Int. Turfgrass Soc. Res. J. 9: (Submitted to editor).

Reinert, J. A. & M. C. Engelke. 2001. Resistance in zoysiagrass, *Zoysia* spp., to the tropical sod webworm, *Herpetogramma phaeopteralis* Guenee. Int. Turfgrass Soc. Res. J. 9: (Submitted to editor).

Reinert, J. A. & S. J. Maranz. 2001. Controlling the red imported fire ant, *Solenopsis invicta*, in urban landscapes. Int. Turfgrass Soc. Res. J. 9: (Submitted to editor).

Reinert, J. A. & J. C. Read. 2001. Host resistance to white grubs, *Phyllophaga* spp., among genotypes of *Poa arachnifera* X *P. pratensis* hybrids. Int. Turfgrass Soc. Res. J. 9: (Submitted to editor).

Engelke, M. C., J. A. Reinert, P. F. Colbaugh, R. H. White, B. A. Ruemmelle, K. Marcum & S. J. Morton. 2001. Registration of 'Royal' zoysiagrass (Reg. No. CV- . Crop Sci. 39: (in preparation).

***Nonreferred, Editor-Reviewed Journal Articles:***

Reinert, J. A., W. Mackay, S. George, J. C. Read, M. C. Engelke & S. Maranz. 1999. Chemical control of differential grasshoppers in urban landscape plants. Proc. SNA Res. Conf. 44: 148-152.

Reinert, J. A., W. Mackay, S. George, J. C. Read, M. C. Engelke & S. Maranz. 1999. Impact of differential grasshoppers, *Melanoplus differentialis*, on urban landscape plants. Proc. SNA Res. Conf. 44: 153-161.

***Abstracts:***

Reinert, J. A. and S. J. Maranz. 1999. Control of red imported fire ant, *Solenopsis invicta*, in Texas urban landscapes. (Abstr.). Inter. Sym. Crop Protection, Univ. Gent, Gent, Belgium p. 44.

Hale, T. C., R. H. White & J. A. Reinert. 2000. Resistance of six zoysiagrass cultivars to fall

armyworms. (Abstr. C5-108). Am. Soc. Agron. 2000: 131.

Reinert, J. A. & P. Busey. 2000. Host Resistance to Tawny Mole Cricket, *Scapteriscus vicinus*, in Bermudagrass, *Cynodon* spp. Annu. Plant Resistance Insects Newsl. 26: (Submitted to editor).

Reinert, J. A. & M. C. Engelke. 2000. Host resistance to insects and mites in *Zoysia* spp. for urban landscapes. (Abstr. #63). Proc. XXI International Congress Entomology 2000.

Reinert, J. A. & M. C. Engelke. 2000. Resistance in Zoysiagrass, *Zoysia spp.*, to the Tropical Sod Webworm, *Herpetogramma phaeopteralis*, Guenee. Annu. Plant Resistance Insects Newsl. 26: (Submitted to editor).

Reinert, J. A., S. George, W. A. Mackay, E. Smith & T. D. Davis. 2000. Lantana lace bug, *Teleonemial scrupulosa* Stal, resistance among *Lantana* cultivars for the landscape. *In* Items from the United States (Abstr.). Annu. Plant Resistance Insects Newsl. 26: (Submitted to editor).

Reinert, J. A. & J. C. Read. 2000. Host resistance to white grubs (*Phyllophaga* spp.) among genotypes of *Poa arachnifera* X *P. pratensis* hybrids. Annu. Plant Resistance Insects Newsl. 26: (Submitted to editor).

***Papers & Posters:***
***Invitational:***

Reinert, J. A. 2000. "Let Us Produce a Grass that Controls Insect Pests - 'Genetics and Management.'" Symposium talk for "Warm-Season Turfgrass Sod Production for 2000 and Beyond," at Midwinter Conference of Turfgrass Producers International. 8-12 Feb. 2000, San Antonio, TX.

Reinert, J. A. 2000. "Major Problems and Approaches in Turf Insect/Mite Pest Management." Talk presented at the SRIEG-16 (Turfgrass) Regional Project Meeting. 11-14 June 2000, Lexington, KY.

***Papers & Posters:***
***Volinteered:***

Reinert, J. A., W. Mackay, S. George, J. C. Read, M. C. Engelke. 2000. "Impact of Differential Grasshopper, *Melanoplus differentialis*, on Urban Landscape Plants." Display presentation presented at the International Plant Resistance to Insects Workshop - 14th Biennial Workshop, 28 Feb.- 2 Mar. 2000, Fort Collins, CO.

Reinert, J. A. & M. C. Engelke. 2000. "Host Resistance to Insects and Mites in Zoysia spp. for Urban Landscapes. Display presentation presented at the International Congress of Entomology, 20-26 August 2000, Iguassu Falls, Brazil.

Reinert, J. A. & S. J. Maranz. 2000. "Residual control with insecticides of fall armyworm (*Spodoptera frugiperda*) on field treated *Cynodon dactylon*. Display presentation to be presented at the International Conf. Crop Protection, 13-17 Nov. 2000, Brighton England, UK.

Reinert, J. A. & S. J. Maranz. 2000. "Residual Control with Insecticides of Fall Armyworm (*Spodoptera frugiperda*) on Field Treated *Cynodon dactylon*." Display presentation to be presented at the Joint

meeting of the Entomological Society of America and the Canadian Entomological Society, December 2000, Montreal, Canada.

Reinert, J. A. & M. C. Engelke. 1999. "Zoysiagrass Resistance to Insects, Mites." Talk presented at the American Society of Agronomy National Meeting. 31 Oct. - 4 Nov. 1999. Salt Lake City, UT.

Reinert, J. A., W. Mackay, S. George, J. C. Read, M. C. Engelke & S. J. Maranz. 1999. "Chemical Control of Differential Grasshopper, *Melanoplus differentialis*, on Urban Landscapes." Display presentation at the Southwestern Branch of Entomological Society of American Annual Meeting. 7-11 Feb 2000. Fort Worth, TX.

Reinert, J. A., S. George, W. A. Mackay, E. Smith & T. D. Davis. 2000. "Resistance among *Lantana* Cultivars to the Lantana Lace Bug, *Teleonemial scrupulosa* Stal." Talk to be presented at Twelfth Ornamental Workshop on Diseases and Insects. 16-20 Oct. 2000, Crossnore, NC.

Hale, T. C., R. H. White & J. A. Reinert. 2000. "Resistance of Six Zoysiagrass Cultivars to Fall Armyworms." Talk presented at the American Society of Agronomy National Meeting. 5-9 Nov. 2000. Minneapolis, MN.

Reinert, J. A. 1999. "Insect Resistance in Turfgrasses." Talk presented at Texas Turfgrass and Ornamentals Field Day. 15 Sep. 1999, Dallas, TX.

Reinert, J. A. 1999. "Impact and Management of Differential Grasshopper in the Urban Landscape" Poster presentation during the 1999 Texas Turfgrass Field Day. 15 Sep. 1999, Dallas, TX.

Reinert, J. A. & M. C. Engelke. 2000. "Host Resistance to Insects and Mites in Zoysia spp. for Urban Landscapes. Display presentation to be presented at the Texas Turfgrass and Ornamentals Field Day. 20 Sep. 2000, College Station, TX.

Reinert, J. A. 1999. "Insect Resistance in Turfgrasses." Talk presented at Texas Turfgrass and Ornamentals Field Day. 15 Sep. 1999, Dallas, TX.

Reinert, J. A. 1999. "Impact and Management of Differential Grasshopper in the Urban Landscape" Poster presentation during the 1999 Texas Turfgrass Field Day. 15 Sep. 1999, Dallas, TX.

Reinert, J. A. & M. C. Engelke. 2000. "Host Resistance to Insects and Mites in Zoysia spp. for Urban Landscapes. Display presentation to be presented at the Texas Turfgrass and Ornamentals Field Day. 20 Sep. 2000, College Station, TX.

Table 1. Bermudagrass mite resistance evaluations on cultivars and genotypes of Bermudagrass under greenhouse environment, Dallas, TX -- 21 March 2000.
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Total number of rosettes caused by Bermudagrass mites per 2 x 2 inch plant of Bermudagrass (6 reps.

| 0.0 | | | 0.1 - 0.4 | | | 0.5 - 1.9 | | | 2.0 - 9.0 | | | 10.0 - 20.0 | | | 20.0 + + | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotype | Mean | High count | Genotype | Mean | High count | Genotype | Mean | High count | Genotype | Mean | High count | Genotype | Mean | High count | Genotype | Mean | High count |
| 3200W 70-18 | 0 | 0 | 4200W 46-4 | 0.17 | 1 | CCB 10.9 | 0.50 | 2 | 4200 47-7 | 2.0 | 4 | Tif 99-16 | 10.0 | 25 | TXTD 67 | 22.5 | 43 |
| 4200W 20-6 | 0 | 0 | CN 2-9 | 0.17 | 1 | Mirage | 0.50 | 2 | 3200W 6-12 | 2.3 | 7 | 4200W 38-2 | 10.7 | 20 | Tifgreen | 22.8 | 36 |
| 4200W 52-15 | 0 | 0 | FHB-281 | 0.17 | 1 | Pyramid | 0.50 | 2 | 3200W 18-11 | 2.8 | 9 | 4200W 56-14 | 11.5 | 18 | Ormond | 22.8 | 76 |
| Cardinal | 0 | 0 | FHB-285 | 0.17 | 1 | AZ Common | 0.67 | 2 | FHB-227 | 2.8 | 12 | 4200W 68-9 | 11.7 | 15 | Majestic | 23.8 | 57 |
| ERS-Turf | 0 | 0 | Jackpot | 0.17 | 1 | 4200W 25-1 | 0.83 | 3 | Old Ranch | 3.2 | 7 | FHB 89 | 13.8 | 20 | 3200W 1-20 | 26.8 | 55 |
| GN-1 | 0 | 0 | NM Sahara | 0.17 | 1 | Sundevil II | 0.83 | 3 | 4200W 26-13 | 3.3 | 5 | MS Supreme | 14.0 | 44 | Baby | 27.7 | 50 |
| Midlawn | 0 | 0 | OKC 19-9 | 0.17 | 1 | 4200W 25-15 | 0.83 | 5 | 3200W 30-20 | 3.3 | 12 | 4200W 55-5 | 14.3 | 23 | Tifdwarf | 28.8 | 42 |
| Tifsport | 0 | 0 | OKS 95-1 | 0.17 | 1 | 4200W 22-10 | 1.17 | 4 | Tif 94-29 | 4.2 | 10 | Shangri La | 15.5 | 64 | Lakewood | 29 | 59 |
| Tifway | 0 | 0 | Princess | 0.17 | 1 | 4200W 74-3 | 1.17 | 5 | 3200W 94-2 | 4.7 | 7 | 3200E 9-4 | 15.7 | 37 | Tif 94-18 | 30.8 | 49 |
| | | | SWI-11 | 0.17 | 1 | OKC 18-4 | 1.17 | 5 | Southern Star | 4.8 | 15 | 3200W 78-10 | 17.7 | 32 | PST R69C | 33 | 74 |
| | | | Shanghai | 0.17 | 1 | CCB 25-6 | 1.50 | 3 | CCB 24-4 | 5.3 | 8 | 4200W 25-7 | 18.0 | 26 | 4200W 22-13 | 33.3 | 39 |
| | | | Savannah | 0.17 | 1 | Panama | 1.50 | 4 | J-540 | 5.8 | 13 | Tif Eagle | 19.0 | 36 | Champion | 37.2 | 65 |
| | | | Tif 94-21 | 0.17 | 1 | SWI-7 | 1.50 | 7 | FHB-272 | 6.5 | 15 | | | | 4200W 49-17 | 37.3 | 60 |
| | | | 4200W 53-1 | 0.33 | 1 | FHB-44 | 1.70 | 7 | Blue-Muda | 8.5 | 21 | | | | Floradwarf | 58.8 | 76 |
| | | | | | | Mobile | 1.67 | 3 | 4200W 51-14 | 8.7 | 24 | | | | 4200W 19-18 | 55.2 | 105 |
| | | | | | | FHB-240 | 1.67 | 4 | FHB-272 | 6.5 | 15 | | | | 4200W 47-1 | 159.5 | 265 |

Note: Plants with 3200 and 4200 ID numbers are from the breeding program of Dr. Charles Taliaferro, OK State Univ., Stillwater, OK; Plants with the FHB ID numbers are from the breeding program of Dr. A.E. Dudeck, Univ. FL, Gainesville, FL;

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Table 2. Resistance among Zoysiagrass cultivars to larval feeding by Hunting Billbug, Dallas, TX -- September 2000. James A. Reinert -Entomologist - Texas A&M University, Dallas,

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| Zoysiagrass | | Leaf firing rank of plants [2] | |
|---|---|---|---|
| Cultivars | spp.[1] | Rank with billbug feeding | Rank for plants with billbug feeding - plants without feeding |
| Diamond | Zm | 7.88 a | 0.50 a |
| DALZ 9601 | Zm | 6.17 b | 1.67 ab |
| El Toro | Zj | 5.63 bc | 1.88 bc |
| Cavalier | Zm | 5.88 bc | 2.25 bcd |
| Royal | Zm | 5.13 bcd | 2.38 bcd |
| Crowne | Zj | 4.25 de | 2.88 bcd |
| DeAnza | Zj | 4.83 cde | 3.00 cde |
| Palisades | Zj | 4.25 de | 3.50 de |
| Meyer | Zj | 3.57 e | 4.14 e |

[1] Zm = *Zoysia matrella*; Zj = *Z. japonica*.

[2] Leaf firing was considered as an above ground symptom expression of the root feeding damage by billbug larvae