USGA

Turfgrass and Environmental Research Online

...Using Science to Benefit Golf

Researchers at the University of Nebraska evaluated selected cool- and warm-season turfgrasses for resistance to chinch bugs in the *Blissus* complex, and documented the presence of multiple chinch bug resistance in these turfgrasses.

Volume 4, Number 19
October 1, 2005

PURPOSE

The purpose of *USGA Turfgrass and Environmental Research Online* is to effectively communicate the results of research projects funded under USGA's Turfgrass and Environmental Research Program to all who can benefit from such knowledge. Since 1983, the USGA has funded more than 290 projects at a cost of $25 million. The private, non-profit research program provides funding opportunities to university faculty interested in working on environmental and turf management problems affecting golf courses. The outstanding playing conditions of today's golf courses are a direct result of ***using science to benefit golf***.

Resistant Turfgrasses for Improved Chinch Bug Management

Tiffany M. Heng-Moss, Frederick P. Baxendale, Robert C. Shearman, and Thomas E. Eickhoff

SUMMARY

Researchers at the University of Nebraska evaluated selected cool- and warm-season turfgrasses for resistance to chinch bugs in the *Blissus* complex, and documented the presence of multiple chinch bug resistance in these turfgrasses.

- Greenhouse and field screening studies were initiated to search for cool- and warm-season turfgrasses with resistance to chinch bugs in the *Blissus* complex. Several warm-season turfgrasses (buffalograss, zoysiagrass, and bermudagrass) with resistance to the western chinch bug have been identified.
- Studies are currently underway to investigate the biochemical and physiological mechanisms underlying resistant turfgrasses. This information is fundamentally important for formulating plant breeding strategies, and subsequently developing chinch bug-resistant germplasm through conventional breeding and biotechnological techniques.
- This research project has also focused on documenting the presence of multiple chinch bug resistance among these cool- and warm-season turfgrasses. These studies have identified turfgrasses with resistance to multiple chinch bugs and suggest different feeding mechanisms among the chinch bug complex. The varying degrees of susceptibility and resistance exhibited among the turfgrasses evaluated underscores the importance of identifying turfgrasses that are not only resistant to one particular chinch bug species, but also resistant to other chinch bug species inhabiting nearby turf areas.
- Knowledge gained from this research will benefit golf course superintendents, sod producers, and other turfgrass managers by furnishing turfgrasses with improved resistance to chinch bugs.

Numerous arthropods are important pests of the cool-and warm-season turfgrasses commonly found on golf courses. With increasing restrictions on water use, golf courses superintendents in many U.S. communities are beginning to select alternative turfgrasses with reduced water requirements. These turfgrasses, like their traditional counterparts, are subject to injury by insect and mite pests, and several are known to have increased susceptibility to certain sap-feeding insects, including chinch bugs.

In the U.S. there are four chinch bug species that are of major economic importance: the common chinch bug, *Blissus leucopterus leucopterus*, the southern chinch bug, *Blissus insularis*, the hairy chinch bug, *Blissus leucopterus*, and the western chinch bug, *Blissus occiduus* (8). Chinch bugs are widely distributed throughout the United States, primarily east of the Rocky Mountains. Individual species often have overlapping geographic distributions. In particular, the geographic distribution of the western chinch bug, and its preferred host, buffalograss, are such that any of the other chinch bug species could be

The common chinch bug is widely distributed across the east coast and western plains of the United States and south in Mexico.

TIFFANY M. HENG-MOSS, Ph.D., Assistant Professor, Department of Entomology; FREDERICK P. BAXENDALE, Ph.D., Professor, Department of Entomology; ROBERT C. SHEARMAN, Ph.D., Professor, Department of Agronomy and Horticulture; and THOMAS E. EICKHOFF, Graduate Research Assistant, Department of Entomology, University of Nebraska, Lincoln.

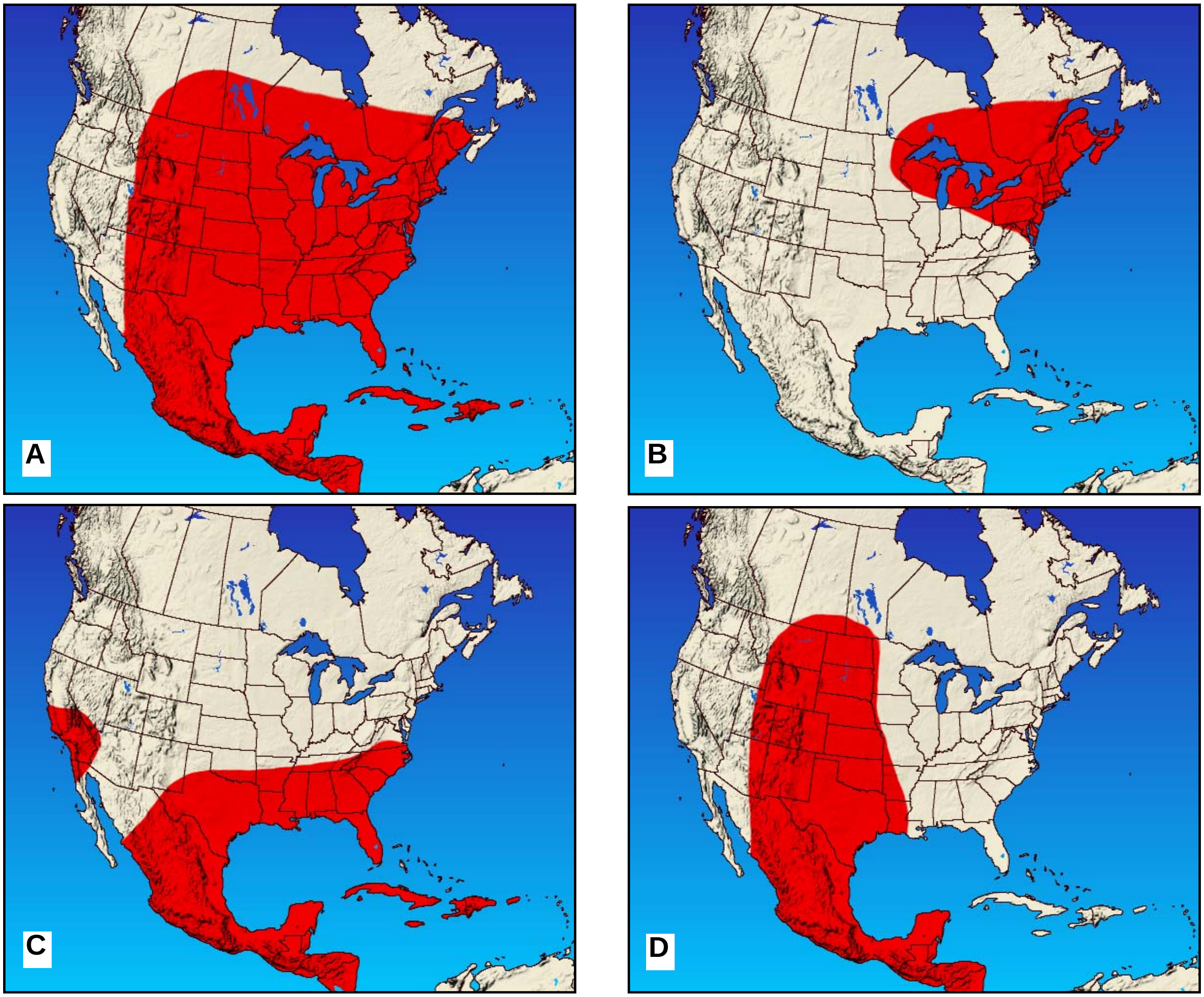

Figure 1. Chinch bugs are widely distributed throughout the United States, primarily east of the Rocky Mountains. Individual species often have overlapping geographic distributions. Shown above are the distribution of common chinch bugs (A), hairy chinch bugs (B), southern chinch bugs (C), and western chinch bugs (D).

present in adjacent turfgrasses. Furthermore, all four chinch bug species have extensive documented host ranges.

The common chinch bug is widely distributed across the east coast and western plains of the United States and south in Mexico (Figure 1A). The most common hosts of this chinch bug include sorghum, corn, wheat, and several turfgrasses (bermudagrass, Kentucky bluegrass, tall fescue, and zoysiagrass).

The hairy chinch bug is distributed throughout northeastern United States (Figure 1B). Its range includes southern regions of the eastern Canadian provinces, parts of the Midwest to Minnesota, and into the mid-Atlantic states as far south as Virginia. It is an important pest of most cool-season turfgrasses including creeping bentgrass, Kentucky bluegrass, perennial ryegrass, and fine-leaf fescues. The hairy chinch bug is also an occasional pest of zoysiagrass and St. Augustinegrass, and have been reported feeding on timothy grass.

The southern chinch bug ranges from southern North Carolina southward to the Florida Keys and into eastern and southeastern portions of Texas (Figure 1C). This chinch bug is considered the most destructive pest of St. Augustinegrass. It also occasionally infests bahiagrass, bermuda-

The immature stages of all chinch bug species are similar in appearance. Chinch bug eggs are elongate, whitish and average < 1/25 inch (1.0 mm) in length when first laid. As the embryo develops, the egg takes on an orange-red color with the nymphal chinch bug visible within the egg before hatching. First instars are tiny, < 1/25 inch (1.0 mm) long, bright red insects with a distinctive white band across the abdomen. As nymphs mature (there are five nymphal stages), their color gradually changes to orange-brown and finally to dark brown. Adults are black with reddish-yellow legs, and are about 1/10th to 3/16th inch (2.5 - 5 mm) depending on the sex and species. Females are typically larger and more robust than males.

grass, centipedegrass and zoysiagrass, and has been reported feeding on crabgrass, guineagrass, pangolagrass, torpedograss, and tropical carpetgrass.

The distribution of the western chinch bug includes much of the central United States, north into Canada and south into Mexico (Figure 1D). First detected infesting a heavily damaged buffalograss lawn in Lincoln, Nebraska in 1989, these chinch bugs have subsequently been found associated with buffalograss throughout Nebraska and surrounding areas (3). More recently, the western chinch bug has become a pest of zoysiagrass.

Recent studies at the University of Nebraska have shown that this chinch bug has an extensive host range which includes buffalograss, zoysiagrass, Kentucky bluegrass, tall fescue, bermudagrass, and perennial rye (4). Among the turfgrasses tested, offspring were produced on buffalograss, fine fescue, perennial rye, bentgrass, zoysiagrass, Kentucky bluegrass, and tall fescue, demonstrating that the western chinch bug can reproduce on a wide variety of hosts. These results have profound implications and provide new information which will facilitate improved monitoring and detection of chinch bug infestations before they build to damaging levels.

In the U.S. there are four chinch bug species that are of major economic importance: the common chinch bug, (A, *Blissus leucopterus leucopterus*), the hairy chinch bug (B, *B. leucopterus*), the southern chinch bug (C, *B. insularis*), and the western chinch bug, (D, *B. occiduus*).

Increased knowledge of the biology and host range of this chinch bug will aid in the development of more efficient management approaches.

Basic Chinch Bug Biology

The immature stages of all chinch bug species are similar in appearance. Chinch bug eggs are elongate, whitish and average < 1/25 inch (1.0 mm) in length when first laid. As the embryo develops, the egg takes on an orange-red color with the nymphal chinch bug visible within the egg before hatching. First instars are tiny, < 1/25 inch (1.0 mm) long, bright red insects with a distinctive white band across the abdomen. As nymphs mature (there are five nymphal stages), their color gradually changes to orange-brown and finally to dark brown. Adults are black with reddish-yellow legs, and are about 1/10th to 3/16th inch (2.5 - 5 mm) depending on the sex and species. Females are typically larger and more robust than males.

Most chinch bug adults have shiny white wings that extend back over the abdomen, but wing dimorphism is common with both macropterous (long-winged) and brachypterous (short-winged) forms present in certain species. Chinch bugs tend to feed in aggregations, and often produce a characteristic odor from scent glands when disturbed or crushed. Most chinch bug species have two generations per year and overwinter as adults.

Chinch bugs injure grasses by withdrawing sap from plant tissues in the crown area. While feeding, they also may inject a salivary toxin that damages plant tissues and inhibits the translocation of water and nutrients. Initially, this feeding results in reddish-purple discoloration of the leaves. In the turf stand, damage appears as patchy areas which turn yellow and dry to a straw-brown color as feeding progresses. At higher infestation levels, chinch bug feeding can result in severe thinning or death of the turfgrass stand.

Damage is usually the heaviest in sunny locations during hot, dry periods and is often mistaken for drought stress. Chinch bug infestations are more likely to develop in years when spring and summer rainfall and temperatures are near or below normal. This occurs in part because fungal diseases keep chinch bugs under control. These diseases are much less likely to develop during periods of drought, and following several dry seasons chinch bug numbers can build to damaging levels.

Plant Resistance

Historically, insecticides have been employed as the principle method to control chinch bugs. However, concern for reducing pesticide inputs has underscored the need for developing alternative approaches for controlling insect pests affecting turfgrasses. One such approach involves the use of integrated pest management (IPM). This strategy employs all suitable techniques in a complementary and environmentally compatible a manner to maintain pest populations below damaging levels. IPM tactics include cultural, mechanical, biological, and chemical controls, and the use of plant resistance to insects. The development of turfgrasses with resistance to chinch bugs offers an attractive approach for managing insect pests associated with turfgrasses because it is sustainable and environmentally responsible.

Of the buffalograsses studied, 'Prestige' exhibited minimal chinch bug damage although it became heavily infested with chinch bugs. This suggests that tolerance may be responsible for the resistance.

The idea behind plant resistance is to exploit natural plant defense systems. Turfgrasses possess a variety of natural defense mechanisms to overcome biotic stresses such as insect feeding. These defense mechanisms can be based on physical or chemical characteristics of the turfgrass. In some cases, the turfgrass is able to tolerate insect feeding through physiological and biochemical modifications.

Turfgrasses with resistance to the chinch bug species have been identified in both cool- and warm-season turfgrasses. However, few of the recently released cultivars have been evaluated for chinch bug resistance, and it remains unclear if turfgrasses with resistance to one chinch species may also be resistant to one or more of the other species. The USGA helped to fund a project that focused on evaluating selected cool- and warm-season turfgrasses for resistance to chinch bugs in the *Blissus* complex, and documenting any incidence of multiple resistance.

Resistance to the Western Chinch Bug

Greenhouse and field screening studies were initiated to search for buffalograsses, bermudagrasses, and zoysiagrasses with resistance to the western chinch bug. Forty-eight buffalograss genotypes from diverse geographical locations were evaluated in replicated studies under greenhouse conditions. Based on turfgrass damage ratings, four were categorized as highly resistant, 22 were moderately resistant, 19 were moderately susceptible, and three were highly susceptible to chinch bug feeding (5, 6).

Of the buffalograsses studied, 'Prestige' exhibited minimal chinch bug damage although it became heavily infested with chinch bugs. This suggests that tolerance may be responsible for the resistance (7). Plant tolerance has several advantages as a pest management tool from an ecological viewpoint: it raises economic/aesthetic injury levels preventing early pest management action and does not place selection pressure on pest populations, unlike other management approaches. In spite of its advantages, the use of tolerance for pest management is limited primarily because the mechanisms and the genetics of plant tolerance remain unknown.

Studies are currently underway to investigate the biochemical and physiological mechanisms imparting resistance in buffalograsses. This information is fundamentally important for formulating plant breeding strategies, and subsequently developing chinch bug-resistant turfgrasses through conventional breeding and biotechnological techniques. In addition, knowledge of specific resistance mechanisms would be valuable for identifying biochemical and physiological markers for use in germplasm enhancement programs and for characterizing plant defense strategies to insect feeding.

Several zoysiagrasses and bermudagrasses were also evaluated for resistance to the western chinch bug. The zoysiagrass 'Emerald' and bermudagrass 'Mini Verde' displayed the highest level of resistance, while the zoysiagrasses 'Myer', 'Zenith', 'DeAnza', and the bermudagrasses 'Jackpot' and 'Tifway 419' were moderately to highly susceptible to chinch bug injury.

Multiple Chinch Bug Resistance

Another component of this research was to document the presence of multiple chinch bug resistance among selected cool- and warm-season turfgrasses. Because of the extensive geographical overlap of the four economically important chinch bug species and their host plants, the potential exists for the western chinch bug and other chinch bug species to become associated with and damage non-traditional turfgrasses. The presence of turfgrasses with resistance to multiple chinch bug species would be highly desirable in these interfacing situations.

A series of studies were conducted under greenhouse conditions to evaluate selected buffalograsses, fine fescues, and St. Augustinegrass for resistance to multiple chinch bug species. These studies established that buffalograsses resistant to the western chinch bug were susceptible to southern and hairy chinch bugs. All St. Augustinegrasses (southern chinch bug-resistant 'Floratam' and -susceptible 'Raleigh' and 'Amerishade') were highly resistant to the western chinch bug. Furthermore, all endophyte-free and endophyte-enhanced fine fescues were moderately to highly susceptible to the hairy chinch bug, but moderately to highly resistant to the western chinch bug. This research clearly demonstrates multiple resistance among turfgrasses to chinch bugs and suggests different feeding mechanisms among the chinch bug complex (1).

The varying degrees of susceptibility and resistance exhibited by the grasses underscores the importance of identifying turfgrasses that are not only resistant to one particular chinch bug species, but also resistant to other chinch bug species inhabiting nearby turf areas. For example, as buffalograss is adapted to various regions throughout the United States, it is likely to be planted near areas of southern and hairy chinch bug infestations. Therefore, identifying turfgrasses that exhibit resistance to multiple chinch bug species will decrease the chances of an opportunistic infestation by southern and hairy chinch bugs.

The reason(s) for the differential responses of the grasses to the three chinch bugs remain unclear. Studies investigating chinch bug probing behaviors, feeding locations, and mouthpart morphology have documented differences in probing frequencies among the chinch bug species and identified the vascular tissues, bulliform cells, and bundle sheaths as primary chinch bug feeding sites (1). Scanning electron micrographs revealed no obvious differences in the mouthpart morphology among *Blissus* species and subspecies (2). Studies are currently underway to identify and characterize chinch bug salivary secretions, and document differences among the chinch bug species.

This research provides essential information for the development of chinch bug-resistant buffalograsses for use on golf courses and other turfgrass areas, and for the implementation of chinch bug management decisions. Commercial production of warm-season turfgrasses with resistance to chinch bugs will offer turfgrass professionals and homeowners with a high quality turfgrass with enhanced resistance to chinch bugs.

Acknowledgements

The United States Golf Association, the International Turfgrass Producers, and University of Nebraska Agriculture Experiment Station provided funding for this research. We thank Stacy Bonos (Rutgers University), John Reese (Kansas State University), and Turfgrass America for plant material, as well as David Shetlar (The Ohio State University) and Dennis Hoffman (Texas A&M University) for supplying chinch bugs not locally available.

Literature Cited

1. Anderson, W. G., T. M. Heng-Moss, and F. P. Baxendale. 2005. Evaluation of cool- and warm-season grasses for resistance to multiple chinch bug (Hemiptera: Blissidae) species. *J. Econ. Entomol.* (Accepted). (TGIF Record 107249)

2. Anderson, W. G., T. M. Heng-Moss, F. P. Baxendale, L. M. Baird, G. Sarath, and L. G. Higley. 2005. Chinch bug (Hemiptera: Blissidae) mouthpart morphology, probing frequencies, and locations on resistant and susceptible germplasm. *J. Econ. Entomol.* (Accepted). (TGIF Record 107250)

3. Baxendale, F. P., T. M. Heng-Moss, and T. P. Riordan. 1999. *Blissus occiduus* (Hemiptera: Lygaeidae): a chinch bug pest new to buffalograss turf. *J. Econ. Entomol.* 92:1172-1176. (TGIF Record 62473)

4. Eickhoff, T. E., F. P. Baxendale, T. M. Heng-Moss, and E. E. Blankenship 2004. Turfgrass, crop, and weed hosts of *Blissus occiduus* (Hemiptera: Lygaeidae). *J. Econ. Entomol.* 97:67-73. (TGIF Record 93375)

5. Gulsen, O., T. Heng-Moss, R. Shearman, P. Baenziger, D. Lee, and F. Baxendale. 2004. Buffalograss germplasm resistance to *Blissus occiduus* (Hemiptera: Lygaeidae). *J. Econ. Entomol.* 97: 2101-2105. (TGIF Record 107288)

6. Heng-Moss, T. M., F. P. Baxendale, T. P. Riordan and J. E. Foster. 2002. Evaluation of buffalograss germplasm for resistance to *B. occiduus* (Hemiptera: Lygaeidae). *J. Econ. Entomol.* 95:1054-1058. (TGIF Record 83300)

7. Heng-Moss, T. M., F. P. Baxendale, T. P. Riordan, L. Young, and K. Lee. 2003. Chinch bug resistant buffalograss: an investigation of tolerance, antixenosis, and antibiosis. *J. Econ. Entomol.* 96:1942-1951. (TGIF Record 92956)

8. Vittum, P. J., M. G. Villani, and H. Tashiro. 1999. Turfgrass Insects of the United States and Canada. Second edition. Cornell University Press. Ithaca, NY. (TGIF Record 64756)