New Source of Southern Chinch Bug (Hemiptera: Lygaeidae) Resistance in a Diploid Selection of St. Augustinegrass[1]

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Abstract Over 400,000 ha of St. Augustinegrass, *Stenotaphrum secundatum* (Walt.) Kuntze, are managed as a turfgrass in the southern United States, and the southern chinch bug, *Blissus insularis* Barber, is its most important insect pest. New sources of host plant resistance to southern chinch bugs became necessary due to the development of virulent populations of chinch bugs which were able to feed on the only acceptable resistant cultivar, Floratam. Initial testing evaluated 14 lines for chinch bug resistance using insects collected from five locations from Palm Beach Co., FL. Host plant resistance was determined by mortality of adult chinch bugs held on a turfgrass for 14 d. A second study was conducted with five lines from the first test with southern chinch bugs collected from nine locations throughout Florida. Tests showed a high level of southern chinch bug resistance in NUF 76, NUF 216 and FX-10. Leaf blades of NUF-76 are significantly shorter and narrower than other tested St. Augustinegrass lines when evaluated 2 wks after mowing. NUF-76 is unique because for the first time, resistance to the southern chinch bug has been identified within a diploid line of St. Augustinegrass. Prior to this, southern chinch bug resistance was only associated with polyploid lines which generally have large leaves and reduced or no seed set due to sterility problems. This discovery will allow chinch bug resistance to be more easily bred into other St. Augustinegrass lines.

Key Words *Stenotaphrum secundatum, Blissus insularis,* turfgrass, turfgrass breeding, host plant resistance, chinch bug

St. Augustinegrass, *Stenotaphrum secundatum* (Walt.) Kuntze, is used for lawns throughout the southern United States due to its wide adaptation to varying environmental conditions. The southern chinch bug, *Blissus insularis* Barber, is the plant's most damaging insect pest (Crocker 1993). Prior to the release of resistant Floratam St. Augustinegrass in 1973 (Horn et al. 1973), control of southern chinch bug was primarily through insecticidal applications. Host plant resistance in Floratam lasted until 1985 when southern chinch bug damage on Floratam was reported in Florida (Busey and Center 1987) and later confirmed by Cherry and Nagata (1997). This new southern chinch bug biotype was labeled the polyploid damaging population (PDP) due to the polyploid genomic character of Floratam.

Busey (1990) identified several new lines in polyploid St. Augustinegrass of African origins and their hybrid progeny resistant to the PDP population. This led to the

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development of the variety FX-10 St. Augustinegrass (Busey 1993) which was resistant to the PDP-population of chinch bugs. However, FX-10 was never extensively grown due to several overriding negative characteristics including a very coarse appearance and tough texture (Busey 1993). Floratam is also considered to be a coarse turfgrass. However, Floratam has considerably more positive agronomic characters and was accepted as a suitable turfgrass mainly due to resistance to southern chinch bug and panicum mosaic virus, drought tolerance, and its rapid growth rate.

Despite the high level of southern chinch bug resistance in polyploid FX-10, transfer of this character to other desirable lines has been impeded due to poor seed fertility which results in non-viable seeds. Diploid lines (2n = 18) of St. Augustinegrass are known and make up the majority of St. Augustinegrass cultivars. In part, this is due to the production of viable seeds which allows recombination of characters and selection of new cultivars. Many of these diploid cultivars have narrow leaf blades, giving these lines a finer texture than the coarser polyploid lines. Historically, the lack of southern chinch bug resistance limited the wide acceptance of diploid lines. Thus far, southern chinch bug resistance limited the wide acceptance of diploid lines. Thus far, southern chinch bug resistance has been identified only in polyploid lines, those lines that have 27 or more chromosomes. Floratam and its relatives have 32 chromosomes, while FX-10 and its relatives have 30 chromosomes (Busey 1995). A major characteristic of polyploid lines is the increased size of plant organs, i.e., roots, stems, leaves, and reproductive parts. In St. Augustinegrass, this resulted in lines with wider, larger leaves that contribute to the coarse appearance of Floratam, Floralawn, FX-10 and other polyploid lines. In this paper we report on southern chinch bug resistance in lines NUF-76, a diploid St. Augustinegrass selection with fine leaf blade characteristics and NUF 216.

Materials and Methods

Preliminary survey. Five tests were conducted from August to October 2001 for host plant resistance of St. Augustinegrass against southern chinch bugs. Because the response of southern chinch bugs to host plant resistance in St. Augustinegrass can vary among different populations of the insect (Busey and Center 1987), chinch bug adults from five different locations were used in these tests and each location of collection was considered a single replication. Chinch bugs were collected from five different locations in Palm Beach Co., FL, by vacuuming St. Augustinegrass lawns and then sorting through debris for adults in a laboratory.

Fourteen St. Augustinegrass lines were evaluated for resistance to southern chinch bug including checks Floratine (susceptible), Floratam (variable susceptible) and FX-10 (resistant). Evaluations were conducted using potted St. Augustinegrass plants grown in 11-cm diam. azalea pots filled with 1:1 (v/v) mixture of sand and Fafard #2 potting mix (Conrad Fafard, Agawam, MA). All test plants were 8 to 12 wks old and were started from a single node cutting. Stolon runners 30 to 40 cm in length with a minimum of 3 nodes within an evaluation box were used for testing.

Evaluation boxes were constructed from polypropylene food storage containers 28 × 16 × 11 cm (l × w × h) (Rubbermaid #3901, Wooster, OH) that were modified in the following manner. The inner portion of each lid was removed leaving approximately 3 cm around the sealing edge. A 6-mm diam hole was drilled halfway up on one of the 16-cm sides. A channel was then cut from the top of the box to the hole drilled in the side. This slot was used to pass the stolon into the box. A potted plant was positioned next to the box and shoots at the node(s) closest to the point entering the box were

removed as necessary. Strips of parafilm (American National Can, Greenwich, CT) were wrapped around the stolon where it would pass through the channel to prevent southern chinch bugs from escaping and to protect the stolon from damage as it was passed through the channel cut in the box. The flap on either side of the channel was bent to aid the passing and positioning of the stolon within the hole. Once the stolon was positioned within the hole, additional strips of parafilm were used to secure the stolon to the box. Cellophane tape was used to cover the channel to prevent chinch bugs from escaping. Chinch bug adults from each location collected on the previous day were put into each of 14 containers (10 adults per container) with each container containing the stolon of one St. Augustinegrass line. A fine mesh fabric was placed on top of the box and held in place by the lid to keep chinch bugs from escaping. All evaluations were conducted within an insectary room maintained at 31°C and 14 L/10 D photoperiod. Plants were watered as needed.

After 14 d, boxes were opened, stolons were dissected, and dead and living chinch bugs were counted. Each collection location was considered a replication of the experiment, and data from the five locations were pooled and analyzed for differences in mean chinch bug mortality for the 14 cultivars using a protected LSD test (SAS 1996).

State-wide survey. Based upon results of the preliminary survey, two newly-identified chinch bug resistant lines were selected for further evaluation along with the three check lines. The objective of the state-wide survey was to evaluate host plant resistance to different chinch bug populations throughout the state of Florida. Chinch bugs were collected by vacuuming lawns in nine cities or their suburbs in nine counties in Florida. These cities were Cocoa Beach, Fort Lauderdale, Fort Myers, Gainesville, Jacksonville, Miami, Orlando, Tampa, and West Palm Beach. These cities represent most large urban areas of Florida. After collection, chinch bugs were tested as previously described except that 20 unsexed adults were used per box.

Nine tests, each using chinch bugs from a different location, were conducted from November 2001 to February 2002. Each collection location was considered a replication, and data from the nine locations were pooled. Differences in mean chinch bug mortality for the five cultivars were determined using a protected LSD test (SAS 1996).

Leaf measurements. Leaf length, width, and area were measured from field plots of turf maintained at the University of Florida, IFAS, Everglades Research and Education Center, Belle Glade, FL. St. Augustinegrass lines used were Floratam, FX-10, NUF-76, NUF-216 and Seville. the plots were not mowed for 2 wks prior to measurements. Five leaves were randomly selected from each plot for measurements. Only matured leaves with intact leaf tips were measured. Leaf length was measured from the collar to leaf tip. Width was measured across the midpoint of the length. Leaf area was determined by passing the leaves through a leaf area meter (LiCor, Lincoln, NE). Plots were arranged as a randomized complete block and replicated five times. Differences in mean leaf length, width, and area for the five lines were determined using a protected LSD test (SAS 1996).

Results and Discussion

Preliminary survey. Mortality of southern chinch bugs was significantly ($t = 2.01$; $df = 52$; $P < 0.05$) higher when held on FX-10 than on Floratam (Table 1). this corroborates earlier studies by Busey (1993) and Cherry and Nagata (1997). Mean mortality of southern chinch bugs was not significantly different between Floratam and

Table 1. Mean percent mortality of adult southern chinch bugs held two weeks on 14 St. Augustinegrass cultivars. Chinch bugs collected in Palm Beach County, Florida

Cultivar	Mean ± SD	Range
FX-10	92.0 ± 17.8a	60-100
NUF-216	86.0 ± 20.7a	50-100
NUF-76	84.6 ± 10.9a	72-100
NUF-241	53.4 ± 28.6b	27-100
NUF-224	52.0 ± 27.6b	20-90
NUF-206	51.0 ± 21.3b	30-75
NUF-175	48.8 ± 35.4b	10-100
NUF-222	44.0 ± 35.1b	10-100
Floratam	43.8 ± 32.9b	20-100
NUF-237	37.4 ± 15.1b	22-60
Floratine	35.8 ± 37.4b	9-100
NUF-238	35.6 ± 21.1b	10-64
NUF-240	34.2 ± 33.8b	0-89
NUF-239	28.4 ± 30.0b	0-67

Means followed by the same letter are not significantly different (alpha = 0.05) using a protected LSD test (SAS 1996).

10 other lines. However, mortality on the NUF-216 and NUF-76 lines was significantly higher than that observed on all lines except FX-10. Of the 14 lines evaluated, the three lines, FX-10, NUF-216 and NUF-76 clearly caused the most mortality to southern chinch bugs. Mortality did not differ significantly among these three lines.

Large variations in chinch bug mortality were observed between locations for some St. Augustinegrass lines. Some of this variation may be attributed to localized insect biotypes at these locations, since southern chinch bugs have been reported to exhibit differential population responses within Florida to both host plant resistance (Busey and Center 1987) and insecticide resistance (Reinert and Portier 1983). These populations may be a mixture of avirulent and virulent chinch bugs when tested on a specific host line.

Statewide survey. In the statewide survey, chinch bug mortality in FX-10, NUF-216 and NUF-76 did not differ significantly ($t = 2.02$; $df = 38$; $P < 0.05$), but was significantly greater than that observed with Floratine or Floratam (Table 2). Chinch bug mortality in Floratam and Floratine were not significantly different. These data from the statewide survey are essentially the same as the chinch bug mortality data observed in populations from Palm Beach Co., FL (Table 1).

Leaf measurements. The mean leaf length, leaf width, and leaf blade area of NUF-76 were all significantly ($t = 2.09$; $df = 24$; $P < 0.05$) less than the other four lines, thus producing a desirable fine textured grass (Table 3). Floratam, the most widely

Table 2. Mean percent mortality of adult southern chinch bugs held two weeks on St. Augustinegrass cultivars. Chinch bugs collected from nine cities or their suburbs in different areas of Florida

Cultivar	Mean ± SD	Range
FX-10	94.9 ± 10.3a	69-100
NUF-216	94.6 ± 9.6a	71-100
NUF-76	91.3 ± 12.1a	63-100
Floratine	60.6 ± 23.8b	14-95
Floratam	47.2 ± 27.9b	0-71

Means followed by the same letter are not significantly different (alpha = 0.05) using a protected LSD test (SAS 1996).

Table 3. Leaf morphological characteristics of five St. Augustinegrass lines two wks after mowing

Cultivar	Ploidy	Leaf length (mm)	Leaf width (mm)	Leaf area (cm^2)
Floratam	polyploid	204.4 ± 24.4a	9.0 ± 0.2a	15.5 ± 1.2a
FX-10	polyploid	153.2 ± 13.8b	9.2 ± 0.4a	12.2 ± 1.4b
NUF-216	polyploid	170.2 ± 18.4b	8.0 ± 0.4b	11.7 ± 1.0b
Seville	diploid	130.2 ± 11.9c	8.0 ± 0.4b	9.2 ± 0.9c
NUF-76	diploid	106.5 ± 14.4d	6.7 ± 0.5c	6.3 ± 0.9d

Means ± SD in a column followed by the same letter are not significantly different (alpha = 0.05) using a protected LSD test (SAS 1996).

used St. Augustinegrass, is a much coarser textured grass than NUF-76 as shown by its significantly greater leaf length, leaf width, and blade area. FX-10 and NUF-216 were similar in every category except leaf width in which NUF-216 was significantly narrower.

The development of resistant cultivars depends on the plant breeders' ability to efficiently combine desirable characters together, creating a population from which superior cultivars can be selected. Reinert et al. (1986) and Busey and Zaenker (1993) discussed the need to identify diploid lines with southern chinch bug resistance to aid in the breeding of superior lines of St. Augustinegrass. They also discussed the possible use of tissue culture to rescue embryos from unreduced gametes because, until now, all known sources of southern chinch bug resistance were in lines that were polyploids (Horn et al. 1973, Busey 1993). The once resistant lines, Floratam, Floralawn, and currently resistant FX-10, are characterized by very low number of viable seeds when crossed to diploid lines, both under natural conditions and in controlled hybridizations, due to unstable chromosome pairing associated with different ploidy levels (Long and Bashaw 1961, Horn et al. 1973, Busey 1993, 1995). NUF-76 is a diploid with 2n = 18 chromosomes, and seed viability in this and other diploids are

good (Long and Bashaw 1961). With the identification of southern chinch bug resistance in NUF-76, hybridization to transfer chinch bug resistance to lines with other desirable characters can now be accomplished more easily.

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