Southern Chinch Bugs (Hemiptera: Blissidae) Increase Severity of Plant Disease in St. Augustinegrass[1]

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Abstract The southern chinch bug, *Blissus insularis* Barber, is the most damaging insect pest of St. Augustinegrass. Numerous studies have shown direct damage to the plant by chinch bugs. However, these studies did not determine if the insect may be causing indirect damage to the plant by making it more susceptible to disease. The study reported herein demonstrates that the fungal plant disease, gray leaf spot (*Magnaporthe grisea* [T.T. Hebert]), significantly increased in St. Augustinegrass after being infested with chinch bugs. Damage by the insect to other morphological and growth traits is also reported. This study emphasizes the complexity of southern chinch bug damage to St. Augustinegrass by direct damage and by indirect damage making the plant more susceptible to disease.

Key Words St. Augustinegrass, *Blissus insularis*, *Stenotaphrum secundatum*, plant disease

St. Augustinegrass, *Stenotaphrum secundatum* (Walt.) Kuntze, is used as lawn grass throughout the southern United States for its adaptation to varying environmental conditions. The southern chinch bug, *Blissus insularis* Barber, is the plant's most damaging insect pest. Insecticidal application was the primary control for southern chinch bugs before the release of resistant Floratam St. Augustinegrass in 1973 (Horn et al. 1973). Southern chinch bug damage on Floratam was first reported in Florida in 1985 (Busey and Center 1987), showing its loss of host plant resistance which was later confirmed by Cherry and Nagata (1997).

Earlier studies such as Beyer (1924), Wilson (1929), and Kerr (1966) described southern chinch bug damage to St. Augustinegrass in general terms, but did not present data. Reinert and Dudeck (1974) first quantified visual damage by the chinch bugs to St. Augustingrass and also measured chlorophyll in leaf tissue of terminal nodes. Busey and Snyder (1993) used visual damage to measure a population outbreak of the chinch bugs affected by fertilization. Later, Busey (1995) again used visual damage to determine resistance of St. Augustinegrass germplasm to the chinch bugs. Cherry (2001) determined the spatial distribution of the chinch bugs and used this to explain visual color changes in damaged St. Augustinegrass during an infestation. Most recently, nutrient changes in St.

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Augustinegrass caused by southern chinch bug feeding damage has been reported by Cherry et al. (2013).

These previous studies have shown direct damage to the plant by the chinch bugs. However, these studies did not determine if the insect may be causing indirect damage to the plant by making it more susceptible to disease. Several studies such as Reinert et al. (1980), Bruton et al. (1983), and Crocker et al. (1989) have tested St. Augustinegrass varieties for combined resistance to southern chinch bugs and the plant disease St. Augustine decline caused by the Panicum mosaic virus. The effect of fertilization (Cherry et al. 2011) and silicon (Cherry et al. 2012) on resistance of St. Augustinegrass varieties to southern chinch bugs and gray leaf spot disease caused by the fungal pathogen *Magnaporthe grisea* (T.T. Hebert) has been reported. Yet, these latter disease studies, like the previous damage studies, did not determine if southern chinch bug feeding may increase a disease problem. Our objective was to determine if southern chinch bug damage increases plant disease in St. Augustinegrass. Morphological damage on different varieties is also noted.

Materials and Methods

Insects and plants. Chinch bugs were collected by vacuuming from natural chinch bug infestations in St. Augustinegrass lawns in Palm Beach County, Florida. Chinch bugs and debris were stored in buckets with fresh St. Augustinegrass clippings at 18°C until used in testing. Three St. Augustinegrass cultivars (Floratam, Roselawn, and Seville) were used in this study. All are susceptible to southern chinch bug (Busey and Center 1987, McCarty and Cisar 1995, Polomski 1999). Individual nodes of stolons of each cultivar were cut from the mother plants and plugged in the wells of a 50-well flat (52 cm $\times$ 27 cm with wells of 4.7-cm diam. and 7-cm depth) filled with soil mix and fertilizer. The soil in each well was watered, and the flats were placed on a bench in the greenhouse to allow the nodes to develop roots. The plugs were kept under a mist system in the greenhouse. The mist system was automatically turned on for 5 min/d. After 40 d, 12 plugs of each cultivar were transplanted into plastic pots (20-cm diam. and 15-cm depth) with 1 plant/pot filled with potting soil, and 5 g fertilizer (Scotts 14–14–14) was applied to a pot. Plants were kept on an outside bench to receive full sunlight under an automatic mist system. After 45 d, 12 plants of each cultivar were placed into buckets and flooded to remove predators and chinch bug adults and nymphs. No chinch bugs were observed in the plants at this time. The same day, water was poured out and plants allowed to drain for 24 h. Thereafter, the plants in each variety were randomly selected to be placed into two groups, the control (no chinch bugs) and treatment (chinch bugs). Each pair of the groups was considered one replication, and six replications were made for each of the three varieties. Plants were placed into 30-cm-diam. by 35-cm-high buckets (1 plant/bucket) that had sand 3 cm deep on the bottom to absorb excess water. Twenty randomly selected chinch bug adults were placed into each treatment bucket, and all buckets were covered with fine mesh cloth held in place with rubber bands on 21 June 2013. This cloth prevented emigration of the bugs from the buckets or immigration into buckets. Buckets were maintained on benches in a completely random design in a greenhouse at the

Everglades Research and Education Center. More chinch bugs were added to buckets as previously described after 14 d and 28 d to increase damage to plants. Buckets were opened each 3–4 d to water plants and to use a fan to blow fresh air into buckets. By 13 August 2013, plants with chinch bugs were severely damaged and the test was terminated. Plants were brushed to remove adult and nymphal chinch bugs, which fell into the bucket with other chinch bugs present in the bucket. Thereafter, plants were taken for disease and morphological assessments and chinch bugs in all buckets were counted.

Disease assessments. Disease assessments were made on the terminal node of an arbitrarily selected runner from each of the six pots per treatment. Disease assessments were made monthly on 18 June, 26 July, and 13 August. The first assessment on 18 June was made before the addition of chinch bugs and used only one runner per plant, but two runners were used in later disease assessments. The number of leaflets with lesions of gray leaf spot divided by the total number of leaflets counted for the length of the runner and disease incidence was calculated as the percentage of leaflets exhibiting gray leaf spot. Disease severity, the percentage of symptomatic plant tissue for the entire plant, was visually estimated rated on a modified Horsfall–Barratt (Horsfall and Barratt 1945) scale of 0 to 9, where 0 = no disease; 1 = <1% of plant with lesions of gray leaf spot; 2 = 1–5% symptomatic with leaf spots and slight yellowing of infected tissue; 3 = 6–10% symptomatic with yellowing and some necrotic leaflets; 4 = 11–25% tissue symptomatic with both yellowing and necrosis; 5 = 26–50% of plant symptomatic including more necrosis of leaflets; 6 = 51–75% tissue symptomatic with majority of leaflets necrotic; 7 = 75–90% tissue symptomatic and necrotic; 8 = 91–99% very little to no green tissue; and 9 = all tissue dead. The least significant difference (LSD) test was used for comparison of the differences of treatment means at the 5% level of significance (SAS Institute 2013).

Morphology assessments. At the end of the test, the plant leaf color was recorded using the scale 1–9 as described in Carrow (1996), with 1 = dead leaves with brown color, 2 = dying leaves with yellow color, 3 = yellowish leaves but not dying, 4 = light green, 6 = green, and 9 = dark green color. Then, morphological measurements were made to determine stolon numbers per pot and length of the longest stolon. After color recording and morphological measurement, plants were cut from above soil, placed into paper bags, dried at 70°C for 3 d, and then weighed for determination of dry weight. The LSD test was used for comparison of the differences of means at the 5% level of significance (SAS Institute 2013).

Results and Discussion

Insects and plants. At the termination of the test, no live or dead chinch bugs were found in any of the control buckets. Buckets with chinch bug treatments all contained >50 live chinch bugs and numerous dead chinch bugs/bucket. Clearly, plants in chinch bug treatments had been exposed to numerous chinch bugs during the test, and controls had none or at most very few not seen.

Disease assessments. Gray leaf spot severity and incidence was significantly increased on plants after being infested with chinch bugs (Tables 1, 2). At the conclusion of the trial, many of the Floratam and Seville plants infested with chinch

Table 1. Gray leaf spot severity* on St. Augustinegrass damaged by southern chinch bugs.

Cultivar	Chinch Bug	Severity**		
		18 June	26 July	13 August
Floratam	+	2.2 ± 0.2a	5.7 ± 0.5a	8.8 ± 0.2a
Floratam	–	1.4 ± 0.1ab	3.5 ± 0.6b	3.0 ± 0.4c
Roselawn	+	0.6 ± 0.1b	5.7 ± 0.8a	6.8 ± 0.6b
Roselawn	–	0.6 ± 0.1b	3.2 ± 0.6b	3.3 ± 0.7c
Seville	+	0.7 ± 0.7b	6.5 ± 0.7a	8 ± 0.5ab
Seville	–	0.9 ± 0.1b	2.5 ± 1.0b	2.5 ± 0.6c

* Disease severity on a 0-to-9 scale, with 0 = no symptoms of gray leaf spot and 9 = plant dead.
** Means ± SD in a column followed by the same letter are not significantly different ($\alpha = 0.05$) using the LSD test (SAS Institute 2013).

bugs were nearly dead, with a disease severity rating mean of 8.8 and 8.0, respectively. Roselawn with chinch bugs was also significantly higher than the plants with no insects but was not significantly different from Seville with insects. Disease incidence in all three cultivars plus chinch bugs was >90% and not significantly different from each other. Despite all cultivars having nearly 100% with gray leaf spot, Roselawn appeared only better than Floratam at withstanding both disease and insects.

In contrast, all the cultivars without insects had a disease severity rating of <4 at the final rating date which was not statistically different from each other, but all were

Table 2. Gray leaf spot incidence* on St. Augustinegrass damaged by southern chinch bugs.

Cultivar	Chinch Bug	Incidence**		
		18 June	26 July	13 August
Floratam	+	33.8 ± 3.5a	89.4 ± 4.0bc	99.9 ± 1.1a
Floratam	–	19.8 ± 4.6a	77.8 ± 3.9c	40.8 ± 3.2bc
Roselawn	+	4.3 ± 4.7b	99.4 ± 2.3a	92.9 ± 3.2a
Roselawn	–	2.6 ± 3.1b	84.4 ± 2.5bc	50.6 ± 6.3b
Seville	+	1.9 ± 5.7b	95.6 ± 3.3ab	96.1 ± 5.0a
Seville	–	5.7 ± 3.2b	41.4 ± 6.2d	23.3 ± 3.7c

* Disease incidence measured as a percentage on leaflets on a runner exhibiting symptoms of gray leaf spot.
** Means ± SD in a column followed by the same letter are not significantly different ($\alpha = 0.05$) using the LSD test (SAS Institute 2013).

Table 3. Morphology* and growth of St. Augustinegrass damaged by southern chinch bugs.

Cultivar	Chinch Bug	Leaf Color**	No. of Stolons	Stolon Length (cm)	Dry Matter (g)
Floratam	+	1.2 ± 0.8c	6.5 ± 0.3d	106.6 ± 6.0b	20.1 ± 2.4c
Floratam	–	7.5 ± 0.4a	8.0 ± 0.7cd	126.7 ± 5.3a	36.8 ± 3.5a
Roselawn	+	4.2 ± 1.0b	13.5 ± 1.7b	68.3 ± 4.5e	16.7 ± 2.5c
Roselawn	–	7.7 ± 0.2a	18.3 ± 1.2a	90.5 ± 3.6c	24.0 ± 1.0bc
Seville	+	1.5 ± 0.8c	8.5 ± 1.1cd	73.0 ± 2.1de	19.8 ± 3.2c
Seville	–	7.7 ± 0.2a	9.8 ± 0.7c	86.0 ± 4.9cd	30.2 ± 2.0ab

* Means within each column followed by the same letter are not significantly different ($\alpha = 0.05$) determined with an LSD test (SAS Institute 2013).

** Color rating based on 1-to-9 scale, with 1 = dead leaves with brown color to 9 = dark green (Carrow 1996).

significantly less than those with insects (Table 1). Similarly, cultivars without insects had significantly less disease incidence than those with disease (Table 2). Although the incidence was reduced nearly 50% on Seville compared to Floratam or Roselawn, it was not significantly lower. Interestingly, disease incidence in all the cultivars without insects was highest at the second rating but was lower by nearly 50% at the final rating. The reduction in the number of lesions of gray leaf spot might have been due to plant growth which resulted in new, uninfected tissue. Floratam and Seville with insects showed increased disease incidence at each date, and Roselawn only was slightly decreased (99.4 versus 92.9%); therefore, the insects appear to mitigate the ability of the plants to "grow out" of the foliar disease.

Insects are vectors of various plant diseases. However, beyond this direct relationship, the insect–plant–plant disease relationship is less simple. For example, Zhang et al. (2014) reported that southern rice black-streaked dwarf virus infection improves host suitability for its insect vector, *Sogatella furcifera* (Horvath). In contrast, infectious plant diseases may reduce host suitability to insects by increasing plant resistance to insects (Smith 1989). And, insect attacks on plants may increase the resistance of the plants to subsequent invasions by plant pathogens (Norris 1988). In this study, southern chinch bug infestation increased the gray leaf spot infestation in St. Augustinegrass. Because it had not been reported that the southern chinch bug is a vector of this disease (Harmon et al. 2011), it is most likely that the disease increase was due directly to damage to the plants by the chinch bugs.

Morphology assessments. Plants of the three cultivars with no chinch bugs had similar leaf color readings (7.5 for Floratam, 7.7 for Roselawn, and 7.7 for Seville) (Table 3). These readings were close to 9, which is dark green and the best color of a turf (Carrow 1996). When the plants were exposed to chinch bugs, the leaf color reading was decreased to 1.2 for Floratam, 4.2 for Roselawn, and 1.5 for Seville. Stolon numbers per pot were significantly lower in the chinch bug–exposed plants than in untreated controls in Roselawn, though the insect treatment also tended to reduce stolon numbers in the other two cultivars. The chinch bug–exposed plants had much shorter stolons than the untreated controls in two of the three cultivars, with a 16% reduction in Floratam and a 25% reduction in Roselawn. Chinch bugs also retarded stolon elongation of plants in Seville as evidenced by a 15% reduction in stolon length in insect-infested plants, but the difference between insect-treated plants and untreated controls was not significant. Chinch bug exposure reduced aboveground dry matter accumulation in plants by 45% in Floratam, 30% in Roselawn, and 34% in Seville. Our results are in agreement with those in a previous report of Cherry et al. (2013) indicating that southern chinch bug is a highly destructive insect and can cause significant damage to many morphological and growth traits in St. Augustinegrass.

In most insect studies, damage to plants has been measured by morphological changes in plants such as growth, biomass, yield, and other factors. This study shows various morphological changes in St. Augustinegrass caused by chinch bug damage. However, chinch bug damage to St. Augustinegrass is more complex than simply direct damage to the plant. For example, Rainbolt et al. (2006) reported that southern chinch bug damage to St. Augustinegrass provides an opportunity for weeds to become established in lawns. Hence, even after chinch bug infestations are reduced through insecticidal and/or natural controls, the weed problem at infestation sites remains. In this study, we have shown that gray leaf spot disease increased in St. Augustinegrass with southern chinch bug damage. Similarly to the previous study, even after chinch bug infestations are reduced through insecticidal and/or natural control, the disease problem remains at infestation sites. These latter two studies emphasize the complexity of southern chinch bug damage to St. Augustinegrass.

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