

Morphological and Nutrient Changes in St. Augustinegrass Caused by Southern Chinch Bug (Hemiptera: Blissidae) Feeding Damage¹

Ron Cherry², Alan Wright, Huangjun Lu, Yigang Luo, and Steven Arthurs³

Everglades Research and Education Center, University of Florida, 3200 E. Palm Beach Road, Belle Glade, Florida 33430 USA

J. Entomol. Sci. 48(4): 327-331 (October 2013)

Abstract The southern chinch bug, *Blissus insularis* Barber, is the most damaging insect pest of St. Augustinegrass, *Stenotaphrum secundatum* (Walt.) Kuntze. However, there is little understanding of the impact of the insect feeding on the plant biomass or nutrient flux in tissues. The objective of this study was to measure biomass and nutrient change in St. Augustinegrass caused by feeding of southern chinch bugs. Chinch bugs were collected by vacuuming infestations in commercial and residential lawns in southern Florida. After collection, chinch bugs were placed in buckets containing St. Augustinegrass potted plants whereas controls were plants with no chinch bugs. Nutrient concentrations were measured for nine elements (N, P, K, Ca, Mg, Mn, Fe, Cu, Zn) in leaf and stolon tissue. At the termination of the test, chinch bug treated buckets had >100 chinch bugs/bucket in them and controls had none. Stolons were 31% shorter in chinch bug exposed plants than controls with no chinch bugs. Above-ground dry matter was reduced by 37% by chinch bug feeding. Plant leaf color was also significantly changed by chinch bug feeding from dark green to yellow. In general, chinch bug feeding decreased all nutrient concentrations, suggesting that the damage was broad in scale and reduced the plant's ability to maintain nutrients.

Key Words St. Augustinegrass, southern chinch bug, turf, *Blissus insularis*

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. Augustinegrass and also measured chlorophyll in leaf tissue of terminal nodes. Busey and Snyder (1993) used visual damage to measure a population outbreak of

¹Received 07 January 2013; accepted for publication 24 March 2013.

²Corresponding author (rcherry@ufl.edu).

³Mid-Florida Research and Education Center, Apopka, FL 32703.

the chinch bugs affected by fertilization. Later, Busey (1995) again used visual damage to determine resistance of St. Augustinegrass germplasm to the chinch bugs. More recently, Cherry (2001) determined the spatial distribution of the chinch bugs and used this to explain visual color changes in St. Augustinegrass during an infestation.

These previous studies have attempted to measure southern chinch bug damage to St. Augustinegrass primarily by visual damage through color change in plants. However, there is little understanding of the impact of insect feeding on plant biomass or nutrient flux in tissues. Moreover, although there are numerous studies showing insect damage to plants in general, there are very few measuring changes in nutrient concentrations in plant tissues due to insect feeding. The objective of this study was to measure biomass and nutrient changes in St. Augustinegrass caused by feeding of southern chinch bugs.

Materials and Methods

Chinch bugs were collected by vacuuming from natural chinch bug infestations in St. Augustinegrass lawns in Palm Beach Co., FL. Chinch bugs and debris were stored in buckets with fresh St. Augustinegrass clippings at 18°C until used in testing. St. Augustinegrass plants of the variety Floratam were grown in 15-cm diam pots. Floratam is the most widely used variety of St. Augustinegrass in Florida. Fertilizer was added to pots to provide nitrogen, phosphorus, and potassium prior to the addition of chinch bugs. On 14 June 2011, 20 plants 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 were randomly selected to be placed into 2 groups being the control (no chinch bugs) and treatment (chinch bugs). Plants were placed into 30-cm diam by 30-cm high buckets (1 plant/bucket). One hundred randomly-selected chinch bugs (adults and nymphs) were placed into each treatment bucket, and all buckets were covered with fine mesh cloth held in place with rubber bands. This cloth prevented emigration of the bugs from the buckets or immigration into buckets. Buckets were maintained 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 days to water plants and to use a fan to blow fresh air into buckets. By 24 July, 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 morphological and tissue analysis, and live chinch bugs in all buckets were counted.

At the end of the test, measurements were made to determine stolon numbers per pot and length of the longest stolon. The plant leaf color was recorded using the scales 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. After morphological measurement and color recording, plants were cut from above soil, placed in paper bags, dried at 70°C for 3 d, and then weighed on a scale for determination of dry weight. Student's *t*-test (SAS 2012) was used to detect significant differences among means between the chinch bug treatment and the untreated control.

At the end of the test, leaf and stolon tissue samples also were collected and analyzed for total N, P, K, Ca, Mg, Mn, Fe, Cu, and Zn. Leaves and stolons were separated at

collection, rinsed in distilled water to remove surface residues and contaminants, and dried at 70°C for 3 d. The tissue was then ground and subjected to high-temperature acid digestion for analysis of all nutrients. Tissue (0.3 g) was digested with 2 mL H₂SO₄ and 2 mL 30% H₂O₂ for 2 h at 350°C, then digestates were diluted to 50 mL final volume, and analyzed colorimetrically for N and P as described in Wright (2009), and for other nutrients using methods described in Wright and Mylavarapu (2010). Student's *t*-test (CoStat 2012) was used to detect significant differences among means between the chinch bug treatment and the untreated control.

Results and Discussion

At the termination of the test, no live chinch bugs were found in any of the 10 control buckets. Nine of the 10 buckets with chinch bug treatments contained +100 live chinch bugs and one contained 75. Clearly, chinch bug treatments had numerous live chinch bugs in them and controls had none or at most very few not seen.

Plants exposed to chinch bugs did not differ significantly from control plants for stolon numbers per plant, but the chinch bug exposed plants had much shorter stolons than the untreated controls, with a 31% reduction (Table 1), indicating that chinch bugs significantly retarded stolon elongation of plants. Chinch bug exposure reduced above-ground dry matter accumulation in plants by 37%. The average color scales were 2.0 (dying leaves with yellow color) for the chinch bug exposed plants and 8.2 (close to dark green color which is the best color) for the controls being significantly different. The color reading was low in the chinch bug exposed plants because many of the plants had dried and were nearly dead.

After exposure to chinch bugs during the test, there were significant changes in leaf and stolon tissue nutrient concentrations (Table 2). In leaf tissue, the Zn concentration was significantly decreased by chinch bug exposure. Interestingly, zinc proteins have been implicated in leaf senescence (Kong et al. 2006) although we do not know how the zinc reduction affected damaged plants in this study. Moreover, 8 of the 9 nutrients tested in leaf tissue were higher for the unexposed control than for chinch bug treatments. On average, unexposed leaf tissue had 19% higher nutrient concentrations compared with leaves exposed to chinch bugs. Chinch bug exposure had a greater influence on nutrient concentrations for stolons than for leaf tissue. Four of the

Table 1. Morphology and growth of St. Augustinegrass damaged by southern chinch bugs.

Trait	Chinch bugs*		t-value	P
	-	+		
Color**	8.2 ± 0.8	2.0 ± 1.5	24.9	< 0.01
Dry weight (g)	23.9 ± 2.6	15.1 ± 2.0	10.8	< 0.01
# Stolons	9.9 ± 1.1	9.4 ± 1.1	1.4	0.18
Stolon length (cm)	87.0 ± 15.0	60.1 ± 8.9	5.7	< 0.01

* Means ± SD's in columns. Statistical analysis by *t*-tests (SAS 2012).

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

Table 2. Nutrient concentrations of St. Augustinegrass damaged by southern chinch bugs.

Nutrient	Units	Leaf*		Stolon*	
		-CB	+CB	-CB	+CB
N	g/kg	23.4 ± 2.5	22.0 ± 4.5	24.3 ± 6.6	23.7 ± 9.2
P	g/kg	3.0 ± 0.7	2.6 ± 0.6	2.1 ± 0.8	2.0 ± 0.5
K	g/kg	28.3 ± 6.0	26.5 ± 6.0	24.2 ± 0.5**	20.8 ± 0.3**
Ca	g/kg	3.8 ± 1.0	3.3 ± 0.8	1.7 ± 0.4**	1.1 ± 0.1**
Mg	g/kg	5.0 ± 1.5	3.9 ± 1.5	4.0 ± 0.8**	2.4 ± 0.7**
Mn	mg/kg	25.7 ± 11.8	27.6 ± 14.2	18.5 ± 10.9	12.8 ± 9.8
Fe	mg/kg	58.0 ± 24.4	50.6 ± 14.8	42.4 ± 13.8**	25.3 ± 9.4**
Cu	mg/kg	7.7 ± 1.7	6.1 ± 1.0	11.8 ± 4.5	10.0 ± 1.8
Zn	mg/kg	11.5 ± 0.7**	6.8 ± 0.3**	10.1 ± 10.1	7.4 ± 5.1

* Means ± SD in a column. Statistical analysis by *t*-tests (CoStat 2012).

** Means significantly different (alpha = 0.05) in the tissue (leaf or stolon) between two treatments (- or + CB).

nutrients were at significantly higher concentrations for the unexposed control than for chinch bug treatments. Similarly to leaf tissue though, all nutrient concentrations in stolons were higher in stolons not exposed the chinch bugs. On average, unexposed stolon tissue had 35% higher nutrient concentrations compared with stolons exposed to chinch bugs. As a group, the macronutrients N, P, and K were the least sensitive to chinch bug exposure and damage, with concentrations averaging 9.5% (leaves) and 8.0% (stolons) higher for the unexposed treatment. In contrast, Ca, Mg, and the micro-nutrients were much more sensitive to chinch bugs, with concentrations averaging 24% (leaves) and 49% (stolons) higher for the unexposed treatment. Thus, in general, exposure of the turfgrass to chinch bugs tended to decrease all nutrient concentrations, suggesting that the damage was broad in scale and reduced the plant's ability to maintain nutrients.

As noted previously, there are no reports of changes in plant nutrient composition following southern chinch bug damage. However, studies have documented changes in photosynthetic response of monocots following infestation with different species of chinch bugs. In laboratory studies, Reinert and Dudeck (1974) reported chlorophyll loss in St. Augustinegrass presumably due to southern chinch bug feeding. Ni et al. (2009) showed millet infested with *B. leucopterus* (Say) had reduced chlorophyll and photosynthetic rates compared with uninfested plants, although there were differences among genotypes. Heng-Moss et al. (2006) documented reduced carbon assimilation rates 20 d after infestation on a susceptible variety but not a resistant variety of buffalograss infested with *B. occidus*, suggesting that the resistant variety can better allocate energy for recovery from chinch bug injury. However, both resistant and susceptible varieties showed increased levels of nonstructural carbohydrates in response to *B. occidus* feeding (Heng-Moss et al. 2006). In addition to decreased plant biomass, Overholt et al. (2004) reported that CO₂ assimilation (as a function of photosynthetic activity) was reduced by 35% by feeding of *Ischnodemus variegatus*

Signoret adults and nymphs on the invasive West Indian Marsh grass *Hymenachne amplexicaulis* Rudge (Nees).

In summary, studies on southern chinch bug damage to St. Augustinegrass have focused on visual damage through color change and not the direct damage to the plant by biomass changes and nutrient flux in damaged plant tissues. Moreover, there are very few studies measuring nutrient flux in plants damaged by insects. Our data show that, besides the more obvious visual damage, chinch bug feeding reduces the plant's biomass and, moreover, decreases many nutrient concentrations in plant tissues. Our study suggests more future research on the effect of insect feeding on nutrient flux in plants.

References Cited

- Beyer, A. 1924.** Chinch bug control on St. Augustine Grass. Proc. Florida State Hort. Soc. 37: 216-219.
- Busey, P. 1995.** Field and laboratory resistance of St. Augustinegrass germplasm to the southern chinch bug. HortScience 30: 1253-1255.
- Busey, P. and B. Center. 1987.** Southern chinch bug overcomes resistance in St. Augustinegrass. J. Econ. Entomol. 80: 608-611.
- Busey, P. and G. Snyder. 1993.** Population outbreak of southern chinch bug is regulated by fertilization. Inter. Turfgrass Soc. Res. J. 7: 353-357.
- Carrow, R. 1996.** Drought resistance aspects of turfgrasses in the Southeast: root-shoot responses. Crop Sci. 36: 687-694.
- Cherry, R. 2001.** Spatial distribution of southern chinch bugs (Hemiptera:Lygaeidae) in St. Augustinegrass. Fla. Entomol. 84: 151-153.
- Cherry, R. and R. Nagata. 1997.** Ovipositional preference and survival of southern chinch bugs on different grasses. Int. Turfgrass Soc. Res. J. 8: 981-986.
- CoStat. 2012.** Cohort Software, Inc. Monterrey, CA.
- Heng-Moss, T., T. Macedo, L. Franzen, F. Baxendale, L. Higley and S. Sarath. 2006.** Physiological responses of resistant and susceptible buffalograsses to *Blissus occiduus* (Hemiptera: Blissidae) feeding. J. Econ. Entomol. 99: 222-228.
- Horn, G., A. Dudeck and T. Toler. 1973.** Floratam St. Augustinegrass: a fast growing new variety for ornamental turf resistant to St. Augustinegrass decline and chinch bugs. Florida Agric. Exp. Stn. Circ. S-224.
- Kerr, S. 1966.** Biology of the lawn chinch bug, *Blissus insularis*. Fla. Entomol. 49: 9-18.
- Kong, Z., M. Li, W. Yang, W. Xu and Y. Xue. 2006.** A novel nuclear-localized CCCH-type zinc finger protein, OsDOS, is involved in delaying leaf senescence in rice (*Oryza sativa* L.). Plant Physiol. 141: 1376-1388.
- Ni, X., J. Wilson and G. Buntin. 2009.** Differential response of forage pearl millet genotypes to chinch bug (Heteroptera: Blissidae) feeding. J. Econ. Entomol. 102: 1960-1969.
- Overholt, W., S. Ewe, R. Diaz, E. Morgan and O. Moeri. 2004.** Feeding effects of *Ischnodemus variegatus* (Hemiptera: Blissidae) on photosynthesis and growth of *Hymenachne amplexicaulis* (Poaceae). Fla. Entomol. 87: 312-316.
- Reinert, J. and A. Dudeck. 1974.** Southern chinch bug resistance in St. Augustine-grass. J. Econ. Entomol. 67: 275-277.
- SAS. 2012.** SAS Institute Inc., Cary, NC.
- Wilson, R. 1929.** The chinch bug in relation to St. Augustinegrass. USDA Circ. 51.
- Wright, A. 2009.** Soil phosphorus stocks and distribution in chemical fractions for long-term cropping, pasture, turfgrass, and forest systems in Florida. Nutr. Cycl. Agroecosyst. 83: 223-231.
- Wright, A. and R. Mylavarapu. 2010.** Nutrient stratification in uncultivated and sugarcane-cultivated peatlands. Commun. Soil Sci. Plant Anal. 41: 2633-2643.