CHAPTER 2

Influence of Thatch Layer on Populations of Chinch Bugs (*Blissus leucopterus* Hemiptera:Lygaeidae) in Turfgrass
INTRODUCTION

Thatch is defined as a layer of living and dead roots, stems, and grass blades that develops between the green vegetation and soil surface in turfgrass. Excessive accumulation of thatch, such as 1.2 cm or more on a Kentucky bluegrass turf, is considered to be undesirable. In addition to increasing disease problems and decreasing drought stress and effectiveness of pesticides, thick thatch can contribute to insect problems (Beard, 1973). The hairy chinch bug (*Blissus leucopterus* Montandon Hemiptera:Lygaeidae) is a major pest of turfgrass in eastern North America (Tashiro, 1987), especially on home lawns. It has been suggested that chinch bugs are more likely to be found in turfgrass with thick thatch (Niemczyk, 1981). However, there are no experimental data to support this. What benefit heavy thatch may give chinch bugs is not clear. Kennedy (1981) suggests that heavy thatch may provide protection for nymphs and overwintering adults. The insects are known to seek thatch or debris in which to overwinter, suggesting that this type of environment is beneficial to survival through the cold months. The thick spongy thatch produced by St. Augustine grass provides a refuge for the southern chinch bug (*Blissus insularis* (Say), Reinert and Kerr, 1973), perhaps imparting protection from predators or from desiccation.

We investigated the relationship of thatch to chinch bug abundance by: (1) artificially inducing thatch in the field to determine the effect on chinch bug populations; (2) collecting and releasing chinch bugs into thatched and dethatched areas to observed short term habitat preferences; (3) investigating the effect of thatch on predation of the chinch bug by the big-eyed bug in the laboratory; and (4) surveying lawns in the Lansing, MI, area.
MATERIALS AND METHODS

Induced Thatch Experiment

A population of chinch bugs in the lawn of the Botany and Plant Pathology Field Research Center (Michigan State University, East Lansing, MI) was studied during 1986 and 1987. In 1986, eight 36.6 m² plots were established in a chinch bug infested area of the lawn. All plots received full sun. Four of the plots were designated as controls and the other four were treated biweekly with the fungicide mancozeb ("Dithane M-45", Rohm and Haas) at 2.35 oz Al/1000 ft² in 4 gal. water per 1000 ft², approximately 60% of the lowest recommended rate for this product. Mancozeb is known to increase thatch accumulation (Smiley et. al, 1985). Chinch bugs were sampled by visually searching a 930 cm² area for 3 min. Numbers of instars one and two were lumped together, as were numbers of instars three and four, due to difficulty in differentiating between these instars in the field. Four counts were made per plot. Plots were sampled approximately biweekly for a total of eight counts. Notes were made as to the presence of dead insects sporulating with fungi. Dead chinch bugs that were sporulating with a white powdery fungus were noted. The first count was taken on May 28 and the last on October 10. Peak population sizes of instars were interpolated as the value at the 50% point of the cumulative total chinch bugs observed in each instar group.

In 1987, fourteen 36.6 m² plots were established in a different area of the same lawn used in the 1986 experiments. Seven were treated biweekly with mancozeb, the other seven were designated as controls. Because the distribution of chinch bugs is known to be clumped (Liu and McEwen,
1979), a transect method was used to sample in 1987. Transects were defined by a loop of string stretched between two 2.5 cm wide wooden row markers placed 1.5 m apart. Chinch bugs were sampled weekly using six randomly placed transects per plot. Instars one and two or three and four were grouped together in counts. A total of 19 counts were made; the first on May 4 and the last on September 17. Degree days were calculated using the Baskerville-Emin (1969) method with a base of 15°C (rounded up from 14.6°C, Mailloux and Streu 1981).

One hundred and sixty insects (twenty from each plot) were collected on Sept. 22, 1986, and brought back to the lab. They were individually placed in tissue culture wells filled with a thin layer of plaster of Paris. Each mini-sporulation chamber was kept moist by introducing water through a small needle hole in the lid over each well. Mortality and incidence of fungus sporulation for the bugs was recorded. Fungi were identified as Beauveria bassiana by microscopic examination (Barnett and Hunter, 1972).

Dethatching Experiment

Eight 3.7 m² plots, were dethatched using a "Mataway" dethatching machine in a mature stand of "Jamestown" fine fescue at the Hancock Turfgrass Research Center (Michigan State University, East Lansing, MI) during August of 1988. Thatch thickness ranged from 10 to 50 mm. Two 3.7 m² non-dethatched plots and two 3.7 m² dethatched plots were arranged inside a 14.8 m² block such that the dethatched plots were diagonal to each other and adjacent to non-dethatched plots on two sides. Each block was surrounded by aluminum lawn edging sunk to a height of 12.7 cm to discourage chinch bug migration out of blocks. Four such blocks were used. On August 10, 100 adult chinch bugs were released into the center of each of
the four plots in each block, for a total of 1600 bugs used. These bugs had been recently collected from an East Lansing lawn that was 94% Kentucky bluegrass and 6% fine fescue. Three-minute visual counts of a 930 cm² area in the center of each plot were made at 1, 3, and 5 days post-release.

Predation Experiment

Thatched and non-thatched chambers were set up in the lab during July and August of 1988. Slabs of turf were taken from a mature stand of "Jamestown" fine fescue at the Hancock Turfgrass Research Center. Thatch thickness in this turf ranged from 10 to 50 mm. A small section of the turf slab containing approximately twelve 30 mm tall grass plants was placed on top of moist silica sand in a 2 oz. clear plastic diet cup. Thatch material removed from the same slab was added to the chamber, surrounding the plug of turf to a depth of 10 mm. A hole covered with mosquito-netting in the lid of the chamber provided ventilation. Non-thatched cups were prepared using slabs of turf from a dethatched section of the same area. No thatch was added to these cups, leaving the area around the plug of turf as exposed silica sand. On August 5, twenty adult chinch bugs collected from five different lawns were added to each of 10 thatched and 10 non-thatched cups. After a 10 minute acclimation period, 0, 2, 4, 8, or 16 adult big-eyed bugs (Geocoris bullatus (Say); identified to species at The Center for Insect Identification, Lansing, Michigan) collected from three lawns were added to the chambers. There were two replicates of each treatment type, for a total of 20 chambers. Chambers were maintained for seven days in an air-conditioned room with temperatures between 25 and 27 °C and relative humidity between 72 and 80%. The chambers were then dismantled and live and dead bugs counted. The experiment was repeated August 26 to September 1. Then, numbers of
big-eyed bugs that were added were changed to 0, 10, 20, and 30 per chamber, for a total of eight thatched and eight non-thatched chambers.

Survey

One hundred and eight lawns were surveyed in the Lansing Michigan area in 1986 and 1987 as part of a larger study on relationships of lawn parameters to chinch bug abundance (see Chapter 1). A subset of 25 infested and nine non-infested lawns were sampled for the two consecutive years. Numbers of insects in five transects per lawn were counted to estimate chinch bug abundance. Transects were sampled as described under the induced thatch experiment. Thatch was measured to the nearest mm at five randomly selected points in each lawn and an average thatch thickness was calculated.

RESULTS

Induced Thatch Experiment.

In both years the fungicide treated plots supported larger average populations of chinch bugs than did the control plots (Figures 5 and 6). Chinch bug population densities in fungicide treated plots were compared to that in control plots by fitting linear regression models (SAS Institute, 1985) to fungicide and control data and determining if the slopes were different. In 1986, the linear model of chinch bug population density in control plots had a slope of 0.067 whereas the slope for chinch bug population model in fungicide treated plots was 0.137. The two slopes were significantly different (t=2.514, df=10, 0.02<P<0.05). In 1987, the slope of the chinch bug population development model for control plots was 0.093 and the slope for fungicide treated plots was 0.187 (t=7.40, df=26, P<0.001).
Figure 5. Cumulative number of chinch bugs in control and mancozeb treated plots in 1986. Data are sums of average number of bugs observed in 3720 cm$^2$ in each of 4 plots. Slopes of lines are significantly different (control: m=.0665, mancozeb: m=.137, $t=2.51$, df=10, .02<$P<$0.05).
Figure 6. Cumulative number of chinch bugs in control and dithane treated plots in 1987. Data are sums of average number of bugs observed in 6 transects in each of 7 plots. Slopes of lines are significantly different (Control: m=.094, mancozeb: m=.186, t=7.40, df=26, P<0.001). Vertical bars represent peak density of instar groups, determined as the 50% point in the cumulative instar group count. N1+2 means the group of nymphal instars 1 and 2, etc, and A stands for adult.
Chinch bug development rate was determined in 1987 by plotting the 50% point of the cumulative count of each of the instar groups for the control and fungicide treated groups. The chinch bugs in the fungicide treated and control plots had similar rates of development in 1987 as evidenced by the similar timing of instar population peaks (Figure 6). The group composed of instars one and two peaked at 186 degree days in the control plots, whereas it peaked at 212 degree days in the fungicide treated plots. The third and fourth instar combined group peaked at 346 degree days days in the control, and 366 degree days in the fungicide treatment. Fifth instars and adults reached maximum population levels at 451 degree days and 724 degree days, respectively, in control plots and 450 degree days and 724 degree days, respectively, in the fungicide treatments.

Symptoms of phytotoxicity were noticed in the treated turf during the middle of July in 1987. This may have been caused by drought conditions. Treated turf was noticeably more yellow than the non-treated turf. Thatch was significantly thicker in treated plots than in the control plots in 1987 (10.32 mm and 3.54 mm, respectively, t=6.2, P<0.001). Thatch was not measured in 1986.

Sporulation of chinch bugs collected in September of 1986 with the insect pathogenic fungus *Beauveria bassiana* did not differ between fungicide treated plots and controls. Of insects from fungicide treated plots an average of 8.6% sporulated with *Beauveria*, compared to 9.2% in control plots. These infection rates are not significantly different (t= 0.07, P>0.50). No other fungal pathogens were found to sporulate from chinch bugs collected from the field plots. Over the course of the field season, ten out of 228 bugs (4.4%) observed in the control plots sporulated with an undetermined
powdery white fungus, compared to 12 out of 356 (3.4%) in the fungicide treated plots.

Dethatching Experiment

There were significantly more chinch bugs found in plots with thatch compared to dethatched plots 24 hrs after release (Table 6, $t=2.47$, $0.02<P<0.05$). The trend remained the same at 72 and 120 hrs after release, although the counts were no longer statistically significantly different (for 72 hrs; $t=1.77$, $0.10<P<0.2$ and for 120 hrs; $t=1.76$, $0.10<P<0.20$).

Predation Experiment

Chinch bug mortality was not correlated with changing densities of big-eyed bugs (Figures 7 and 8). There was 50% mortality of big-eyed bugs during the first experiment, and 90% during the second. Therefore, data are graphed using mean number of live big-eyed bugs during each experiment, determined by adding the number of live bugs at the beginning to the number of live bugs at the end and dividing by two. Mortality of chinch bugs did not increase with increasing big-eyed bug densities in the first experiment (Figure 7). It appeared as though chinch bugs may have had increased survivorship in the thatch treatment as compared to the no thatch treatment; however, neither the slopes nor the intercepts of the lines were significantly different. There was little chinch bug mortality during the second experiment (Figure 8). Big-eyed bugs were observed to feed on chinch bugs in the laboratory, sometimes with more than one big-eyed bug feeding on a single chinch bug. Big-eyed bugs also fed on each other.
Table 6. Mean number of chinch bugs observed in thatched and dethatched turfgrass plots. Variance is reported in parentheses.

<table>
<thead>
<tr>
<th>Days after release</th>
<th>With thatch</th>
<th>Without thatch</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>6.88 (28.64)</td>
<td>2.12 (0.98)</td>
</tr>
<tr>
<td>3</td>
<td>4.88 (6.70)</td>
<td>3.00 (2.29)</td>
</tr>
<tr>
<td>5</td>
<td>1.71 (1.71)</td>
<td>0.86 (0.86)</td>
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</tbody>
</table>
Figure 7. Number of chinch bugs surviving one week confinement with different numbers of big-eyed bugs (BEB), first experiment. Due to mortality of BEB during the experiment, BEB numbers are reported as the average live BEB. Slopes and intercepts of lines are not significantly different (slope of non-thatch treatment = 1.41, thatch treatment = 1.56, t = 1.195, P > .05; for test of intercepts, t = 0.322, P > .05)
Figure 8. Number of chinch bugs surviving one week confinement with different numbers of big-eyed bugs (BEB), second experiment. Due to mortality of BEB during the experiment, BEB numbers are reported as the average live BEB. Slopes and intercepts are not significantly different.
Survey

Thatch thickness and chinch bug density were significantly positively correlated \( (r=0.325, n=108, P<0.0006) \). On lawns for which there were two years of data, I used a paired t-test to compare thatch accumulation for the two years in both infested and non-infested lawns. Thatch significantly increased from 1986 to 1987 in infested lawns (from a mean of 6.5 mm to a mean of 10 mm, \( d=-3.55, n=25, t=-2.73, 0.01<P<0.02 \)) but did not significantly change in lawns without chinch bugs (4.0 mm to 5.3 mm, \( d=-1.29, n=9, t=-0.667, P>0.5 \)).

DISCUSSION

Accumulation of thatch is caused by an imbalance in the rate of production and decay of organic matter (Beard, 1973). Many cultural factors are known to contribute to the accumulation of thatch. Some of these are the growth characteristics of the turfgrass cultivar (Shearman et al., 1980), high nitrogen levels (Potter et al., 1985), acidic conditions of the soil, infrequent or excessively high cutting levels (Beard, 1973; Shearman et al., 1980), failure to remove clippings (Soper, et al., 1988), and treatment with certain herbicides (Turgeon, et al., 1975), insecticides (Streu, 1973) and fungicides (Smiley et al., 1985). Thatched turf is also generally shallow-rooted, making it more susceptible to temperature stress (Dunn et al., 1981).

Chinch bugs were found in larger numbers in lawns that had thick thatch. However, the significant correlation implies only a mathematical relationship, not causality. Chinch bugs may be responding to, or, alternatively, influencing thatch thickness of a lawn. Damage caused to vascular tissues by chinch bug feeding activity may prevent water and nutrients from reaching
leaves and shoots, thus killing the plant (Painter, 1928). Baker et al. (1981) found a higher percent dry matter content in turf of chinch bug infested lawns. A significant increase in thatch thickness from 1986 to 1987 was found in chinch bug infested lawns in this study. No such increase was observed in non-infested lawns. One hypothesis worthy of future investigation is that chinch bug feeding injury contributes to accumulation of thatch.

Alternatively, chinch bug populations may be responding to the increase in thatch, not causing it. The fungicide mancozeb is known to increase thatch accumulation by decreasing the degradation of organic material (Smiley et al., 1985). The thick thatch induced by fungicide treatment did not affect the rate of development of chinch bugs in those plots as evidenced by the similar timing of instar population peaks for fungicide and control plots (Figure 6). These peaks differed by a maximum of 87 degree days (base 15°C) from those determined by Mailloux and Streu (1981). Experimentally increasing thatch thickness with low rate mancozeb treatments did, however, increase chinch bug abundance as compared to controls (Figures 5 and 6). *Beauveria bassiana* activity was monitored in these plots because *Beauveria* has been observed to infect large numbers of chinch bugs in turfgrass (Bartlett and Lefebvre, 1934; Kennedy, 1981). Although mancozeb is known to be active against *Beauveria bassiana* (Loria et al., 1983), no differences among treatments were found in the number of dead chinch bugs sporulating with fungus in field plots or in moist chambers in the laboratory. No other fungal pathogens were found to sporulate from chinch bugs collected from field plots. It is possible that mancozeb treatment suppressed predator or parasitoid activity. However, no differences were detected in the number of predators observed in mancozeb compared to control plots, and no
parasitoids emerged from field collected bugs. The difference in chinch bug abundance between mancozeb and control treatments may be owing to either a higher oviposition rate or a lower mortality rate in the mancozeb plots. Direct effects of mancozeb on predators or indirect effects such as protection from predators and/or protection from extremes in temperature and humidity afforded by the thicker thatch may have contributed to reduced chinch bug mortality in these plots.

Chinch bugs are also attracted to thatchy areas. There were significantly more bugs in the thatched compared to the dethatched plots 24 hrs after release of the bugs (Table 6). Because chinch bugs were not confined to our study plots it is possible that the bugs were mostly moving out of all plots into surrounding turf, and the observed differences were due ascribable to longer residence times by chinch bugs in thatched plots.

Possible benefits for chinch bugs living in a thickly thatched environment are not clear. Probabilities of survival may increase in thick thatch by reduced predator efficiency. The big-eyed bug (Geocoris bullatus) is known to be a predator of the chinch bug, and is often found in large numbers in chinch bug infested lawns (Mailloux and Streu, 1981). The large eyes possessed by the big-eyed bug suggest that it relies heavily on vision to find its prey. In a thatchy environment, it may be more difficult for big-eyed bugs to locate chinch bugs because chinch bugs tend to hide in the thatch. The impact that the big-eyed bug has on chinch bug populations has not been determined. Mailloux and Streu (1981) did not find a correlation between chinch bugs and big-eyed bug populations. In our laboratory studies, we observed the big-eyed bug to feed upon the chinch bug, but we did not see a significant effect on adult chinch bug mortality (Figures 7 and 8). Immature chinch bugs were not offered as prey but actually may be the preferred food source. The high
source. The high mortality rate of the big-eyed bug during the second run of the experiment (90% over a one-week period) may have eliminated any potential predation effect on the chinch bugs. More experiments are required to determine whether big-eyed bugs have a significant impact on chinch bug populations in turfgrass.

The results of this study indicate that chinch bug abundance is closely linked to the thatch thickness of home lawns. I have presented and tested several hypotheses for why thatch thickness is related to chinch bug abundance. It may be hypothesized that grass species composition is the driving force affecting chinch bug abundance and that thatch thickness is merely correlated to species composition. However, in Chapter 1 I showed that thatch thickness was not related to species composition of home lawns. Three hypotheses that deserve attention are: 1) thatch helps chinch bugs escape predation; 2) thatch reduces mortality from environmental stress; and 3) chinch bug feeding injury induces thatch.
LITERATURE CITED


Bartlett, K. A. and C. L. Lefebvre. 1934. Field experiments with Beauveria bassiana (Bals.) Vuill., a fungus attacking the European corn borer. J. Econ Ent. 27:1147-1157.


