

HAIRY CHINCH BUG SURVEY, DEMONSTRATION AND MONITORING IN NEW BRUNSWICK, 2002

ÉTUDE, DÉMONSTRATION ET DÉPISTAGE POUR LA PUNAISE VELUE AU NOUVEAU-BRUNSWICK EN 2002

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Abstract: Hairy chinch bug, *Blissus leucopterus hirtus*, populations were surveyed in 5 regions of New Brunswick (Bathurst, Grand Falls, Moncton, Fredericton, and Rothesay) in 2002 to establish monitoring, threshold and treatment guidelines. A total of 23 chinch-infested lawns were monitored. Floatation and quadrat monitoring techniques were compared. Monitoring was done weekly for 12 weeks (June to August) in all locations and continued for an additional 9 weeks at 2 locations to observe 2nd generation insect development. The quadrat monitoring method was as effective as the floatation method for guiding insect control decisions. The quadrat treatment threshold adopted was 10 chinch bugs per 0.1m² (Rocheffort *et al*, 1997), for a 60 second search while the 10-minute floatation threshold used was 22-32 chinch bugs per 0.1m² (Health Canada, 2000; Emmons, 2000). Treatments for chinch bug should be applied at the peak of the combined 2nd and 3rd instar populations. In 2002 the combined populations peaked in Bathurst, Fredericton, Moncton, and Rothesay between 423 and 877 degree-days (7°C base, air temperature). This indicates an optimum treatment window for hairy chinch bug between mid-July and mid-August in New Brunswick. Pest control intervention is not always necessary for above threshold populations of chinch bug. Treatment decisions must also consider the health of the lawn, history of previous insect damage, soil depth and quality, thatch levels, plant species mix (grass and broadleaf), and general turf maintenance practices (fertility, mowing height/frequency). It was found that lawns with high populations of broadleaf plants (≥10%) showed less visible damage from chinch bug feeding even with chinch bug populations that were well above treatment threshold levels.

Résumé : Une étude des populations de punaises velues (*Blissus leucopterus hirtus*) a été réalisée en 2002 dans cinq régions du Nouveau-Brunswick (Bathurst, Grand-Sault, Moncton, Fredericton et Rothesay) pour établir des lignes directrices en matière de dépistage, de seuil d'intervention et de traitement. Le dépistage a été effectué dans un total de 23 pelouses infestées de punaises velues, et l'on a comparé les techniques de dépistage par flottaison et par quadrat. Le dépistage hebdomadaire a duré douze semaines (de juin à août) à tous les endroits, et il s'est poursuivi pendant neuf autres semaines à deux endroits pour observer le développement de la deuxième génération de punaises velues. Le dépistage par quadrat a été aussi efficace que la méthode par flottaison pour orienter la prise de décisions dans la lutte contre l'insecte. Le seuil d'intervention utilisé pour un traitement avec le système par quadrat était 10 punaises par 0,1 m² (Rocheffort *et al*, 1997) pendant une inspection de 60 secondes, tandis que le seuil d'intervention dans le système par quadrat utilisé pendant 10 minutes variait de 22 à 32 punaises par 0,1 m² (Santé Canada, 2000; Emmons, 2000). Les traitements contre la punaise velue doivent être appliqués au point culminant des deuxième et troisième populations globales de larves. En 2002, le point culminant des populations globales se situait entre 423 et 877 degrés-jours (température de l'air de 7 °C) à Bathurst, Fredericton, Moncton et Rothesay. Ces observations indiquent que la période de traitement optimale contre la punaise velue se situe entre la mi-juillet et la mi-août au Nouveau-Brunswick. Une intervention phytosanitaire n'est pas toujours nécessaire quand les populations atteignent les seuils précités. La décision d'intervenir doit aussi tenir compte de divers facteurs comme la santé de la pelouse, les dommages précédents causés par les insectes, la profondeur et la qualité du sol, les taux de chaume excessifs, les mélanges d'espèces végétales (graminées et plantes à larges feuilles) et les pratiques générales d'entretien du gazon (fertilité, hauteur et fréquence de coupe). On a constaté que les pelouses renfermant beaucoup des mauvaises herbes à larges feuilles (≥10%) et ayant un aspect visuel acceptable présentaient moins de dégâts visibles causés par l'alimentation des punaises, même dans les cas où les populations étaient bien supérieures aux seuils d'intervention.

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Introduction

The hairy chinch bug, *Blissus leucopterus hirtus*, is a significant turfgrass insect in New Brunswick (Maund, 2002). Hairy chinch bugs (HCB's) feed on the crowns and stems of turfgrasses, and because they tend to aggregate in so-called hot-spots, this often results in localized injury. HCB damage usually presents as irregularly shaped patches of dead or dying grass (Tashiro, 1987). Other factors, such as moisture stress or fungal disease, may also produce these symptoms (Maund, 1992). Effective hairy chinch bug management involves the application of *integrated pest management* (IPM) principles such as monitoring, and understanding the chinch bug lifecycle. Monitoring for hairy chinch bug can be done using the floatation method (inserting a metal cylinder into the infested area and filling it with water, allowing the insects to float to the top) or the quadrat method (scanning through a 0.1m² quadrat at the thatch surface). The floatation method is an effective monitoring technique, but it requires considerable time and effort. The quadrat method is a more efficient approach to hairy chinch bug sampling. This is particularly true for geographic regions - like New Brunswick - where there is only one complete generation of hairy chinch bug; however, the two methods have not been previously tested in the New Brunswick region.

Climate, soil microorganisms and predatory insects influence hairy chinch bug populations. Heavy spring rains interfere with hatching and prevent females from ovipositing all their eggs (Maund, 1992). Extremely low temperatures and sudden temperature fluctuations can kill adults in the winter and spring. HCB's thrive in hot, dry weather, but can be killed in warm humid areas by the fungus, *Beauveria bassiana* (Bals). Other known predators of the hairy chinch bug include wasps (*Eumicrosoma beneficum* Gahem) that parasitize HCB eggs, and carabid beetles (*Amara* sp.) that feed on the eggs. Many common birds feed on HCB nymphs and adults. Other HCB predators include: bigeyed bugs (*Geocorus bullatus* Say and *Geocorus uliginosus* Say), the minute pirate bug (*Orius tristicolor* White), lacewings, and lady beetles.

In general a healthy turf is more resistant to insect damage. Ecological factors, such as thatch thickness, broadleaf weed cover and soil components may also affect hairy chinch bug population levels. A study by Kortier Davis and Smitley (1990), for example, positively correlates increased chinch bug populations with thatch thickness; however, subsequent studies have produced conflicting results, and question whether a causative relationship exists between the two parameters (Majeau *et al* 2000a). Broadleaf weed cover and its correlation to HCB populations has also been examined (Majeau *et al* 2000a) but warrants more attention. Various soil characteristics such as soil pH, soil organic matter, and soil P and K levels remain untested variables that also may or may not have an effect on HCB populations.

The hairy chinch bug adult overwinters in protected places in and around turfgrass. In early spring, as the temperatures warm, adults come out of hibernation and begin to feed. Shortly afterward, mating takes place and females begin laying eggs. The eggs hatch into first filial generation nymphs in early June. Unlike the adult, the HCB nymphs do not have wings. The first instar nymph (N1) is about half the size of a pinhead, 0.23 mm X

0.96 mm. It is a bright orange-red colour and has a white band across its back. As the nymph grows and feeds, it sheds its skin four times, progressing from the first instar stage to the fifth. Each instar is larger than the last and darker in colour. The bright orange-red 1st and 2nd instar nymphs turn to dark-red (3rd instar), then to brown (4th instar) and finally to black in the fifth instar stage (see the image in *Appendix C*). The fifth instar is almost as large as the adult at 0.96 x 2.97 mm, (Tashiro, 1987). In New Brunswick, first generation adults begin appearing in early to mid August. A partial second generation is produced from the mating of the first generation adults. A few second-generation nymphs appear in mid to late August however, the population strength of the second generation is weak and the nymphs appear not to reach the adult stage.

The hairy chinch bug life cycle for a given region can be characterized by collecting weekly samples from several infested sites and identifying the insects according to their developmental stage. The accumulated growing degree-days above 7°C and the insect's instar identification need to be considered, (Tashiro, 1987). Control decisions involving insecticide applications to above-threshold populations of the hairy chinch bug are timed to coincide with the peak of the second and third-instar nymph (N2-N3) population (Rochefort, 2002; Emmons, 2000; Tashiro, 1987). This specific period is selected for control for 2 reasons: a) the N2-N3 peak represents the point in the lifecycle when all the eggs have hatched (the eggs are not susceptible to treatment) and b) the early stage nymphs (present at this time) are more susceptible to treatment and are less mobile compared with adults and later instar nymphs, (Rochefort 2002, Tashiro 1987). Research by Rochefort *et al* (1997) and Liu and McEwen (1979) determined the date and degree-day timing for the peak of the second and third-instar HCB nymphs in Quebec and Ontario, Canada.

The research and reports by Rochfort *et al* (1997) has indicated that effective monitoring can demonstrate an 89% reduction in insecticide use for hairy chinch bug while maintaining customer appearance expectations. This study was initiated in New Brunswick to evaluate the efficacy of the Quebec monitoring method for hairy chinch bug and to verify the optimum insecticide application timing.

Materials and Methods

Selection of Experimental Lawns. Scouting potentially infested lawns in New Brunswick began on June 11, 2002 and continued until July 4, 2002. Five geographic regions were chosen in order to observe the variation in chinch bug development throughout the province. A total of 23 infested lawns in the regions of Bathurst (47.6N, 65.65W), Grand Falls (47.05N, 67.73W), Fredericton (45.97N, 66.65W), Rothesay (45.4N, 65.92W) and Moncton (46.1N, 64.78W) were selected for hairy chinch bug monitoring. The sites were monitored on a weekly basis, starting on June 17, 2002 and continuing until late August. Sampling was extended until the end of October in Fredericton and Rothesay to check for the presence of a second generation. Sites found to be infested with hairy chinch bug were selected.

Site. For each of the 23 selected sites, background information was obtained, including the property owner's name and phone number, the site address, and a sketched map of the property site. The quadrat samples were taken at the same ten locations on the lawn each week to monitor HCB distribution. A number that corresponded to a locator pin on the lawn indicated each quadrat location on the property site map. Each locator pin was made from a small plastic square (50 mm x 50 mm x 0.5 mm) and a 20-cm steel spike. The locator pins were numbered from one to ten and driven into the turf, leaving the coloured, plastic portion at thatch level. The locator pins remained in the lawn throughout the duration of the project. The history of the property maintenance (age of the turf, fertilizer, lime and pesticide use) and a description of the current maintenance regime (mowing height, mowing frequency and watering) were recorded.

Weekly Sampling Procedures. In order to gauge monitoring efficiency and understand the progression of the chinch bug lifecycle, many parameters were recorded during the weekly site visitations. The date, departure time from headquarters, weather conditions, air temperature, site address, time of arrival and departure at the site were all noted. On each site, ten quadrat samples were taken at the previously designated locations. The locations of the quadrat samples were randomly spread over an area of approximately 300 m². In selecting the quadrat locations preference was given to potential *hot spots* (full sun areas, slopes) where the potential for larger populations of HCB is greatest.

Quadrat Sampling. The weekly monitoring process at each site began with ten quadrat samples. A metal, 0.1m² quadrat was placed on the turf beside one of the ten locator pins and the enclosed area was inspected for approximately 60 seconds by searching for HCB at the base of the grass blades. In early July when the first and second instar (N1 and N2) nymphs began to appear, the time required to detect and count the nymphs increased to as much as 120 seconds because of the small size and abundant presence of the insects. Under normal monitoring conditions (i.e., non-experimental conditions), a 30 to 60 second search provides adequate time to inspect the quadrat area. The total number of chinch bugs (at any developmental stage) was recorded, taking note of the locator pin number at which the count took place. This process was repeated at each of the ten locator pins. The total time for the ten quadrat samples to be completed was recorded to help measure the efficiency of the quadrat monitoring technique.

Floatation Sampling. After the ten quadrat samples were completed, a single floatation sample was taken at the locator pin with the highest quadrat count. A sampling tool – a cylinder (20 cm diameter x 25 cm height x 2 mm wall) – made from a section of steel pipe and spray-painted white inside to facilitate the detection of the insects, was placed over the same turf area that was inspected during the earlier quadrat sample. One end of the cylinder was sharpened to ease its insertion into the ground. The sharpened end was placed in contact with the turf and, using a knife, the thatch around the perimeter of the can was cut. A thick, wooden board was placed over the top of the floatation can to disperse the force delivered by a mallet as the cylinder was driven 3 to 4 cm into the ground. A 20 to 30-L jug was used to transport water for the floatation sample. The cylinder was filled with water to a height within 5 cm of the top. The chinch bugs floated

to the surface of the water and were counted and collected at 2 min, 5 min and 10 min after the initial filling. This was done by skimming the insects from the surface of the water, using a small, fine-meshed strainer. The insects were then tapped out of the strainer, onto a piece of loose-leaf paper that was fastened to a clipboard. The paper was often folded up at the sides to prevent the insects from crawling away. When the paper began to get too full with debris and insects, it was folded a few times and placed inside a “Ziploc” bag. Several pieces of loose-leaf paper were used for each floatation sample. During the 10-min floatation sample, the water in the cylinder was replenished as needed to ensure that it never fell below $\frac{3}{4}$ the height of the can. At the 8-min point, a knife was used to scratch the inundated turf surface in order to extricate any insects clinging to the grass blades or remaining in the thatch. It is often recommended that this be done continually throughout the floatation sample. The completed floatation sample was labeled with the date, site address, and total hairy chinch bug count. The time needed to perform the floatation sample was recorded. Insect samples were frozen on the day of collection to preserve the insects at their developmental stage.

Laboratory Analysis. Frozen chinch bug samples were sent to a laboratory in Fredericton where the insects remained frozen until they were categorized according to developmental stage. This was done using a binocular microscope. The site address, date the sample was collected, and number of chinch bugs at each developmental stage were recorded for each sample. Using 2002 growing-degree day information for each of the five surveyed regions (obtained from Environment Canada), the growing degree-days were correlated to the observed HCB development. The degree-day accumulations above 7°C were calculated using minimum and maximum daily air temperatures from each of the five regions, finding the average between the two extremes, and subtracting 7. Accumulations were calculated from May 1, 2002 to August 31, 2002 (see *Appendix A* for more details). In order to make recommendations for HCB monitoring and treatment decisions, a 30-year average was used to determine the calendar dates when the specified number of GDD usually accumulate in each region. Assuming a climactically “normal” year, this revealed the calendar dates (in each of the five regions) at significant points during HCB development (see *Results and Discussion*, Table 2).

Site Evaluations. After the monitoring was completed in the fall, final site evaluations were carried out. Ten thatch samples were taken and averaged to give a thatch thickness value for each of the sites. Soil samples at a 15-cm depth were collected and analyzed. Weed and HCB damage evaluations were done at selected locations (mainly hot spots) on each of the sites. These evaluations described percent grass and weed cover, weed species, and percent damage within a 0.25 m² area. Photographic documentation was collected for each of the evaluations.

Data Processing. The collected data was analyzed to determine the average, longest and shortest times required to a) Perform ten quadrat samples, and b) Take one floatation sample. A comparison between the number of insects seen in a quadrat sample and a floatation sample taken at the same location was prepared. Using percent broadleaf plant cover and percent HCB damage information, the impact of broadleaf plants (weeds) on HCB populations was estimated by comparing percent broadleaf weed cover and average

quadrat counts. Average quadrat counts were compared with the average thatch thickness values (mm) for eleven of the monitored sites. An infestation index for the month of July, 2002 was calculated (using floatation count and quadrat count information) for 16 of the 23 sites and infestation was compared to soil organic matter (%), soil pH, soil phosphorus (ppm) and soil potassium (ppm).

Results and Discussion

Monitoring, Thresholds and Related Considerations. Comparison of the two principal HCB monitoring techniques - the quadrat method and the floatation method – revealed numerous findings. When monitoring to guide insect control decisions, the quadrat technique proved to be the easier and more efficient method, while the main advantage of the floatation method was that it facilitated the collection of the insect samples. Further comparisons between the two methods are noted in Table 1.

Table 1. Comparison of the quadrat and the floatation sampling methods for the hairy chinch bug in terms of efficiency, number of HCB per sample and recommended thresholds

	Quadrat	Floatation	Comments
Time for 1 person to take 1 sample	Efficiency (min)		The quadrat method was found to be 6x more efficient than the floatation method *
Average*	2.8	17.0	
High extreme	5.0	30.0	
Low extreme	1.2	11.0	
# HCB in sample	Number of Chinch Bugs per Sample **		A floatation sample taken at the same site as a quadrat sample, revealed 10 x more HCB per unit area.
Average	3.8 / 0.1 m ²	115 / 0.1 m ²	
High extreme	145 / 0.1 m ²	1250 / 0.1 m ²	
Low extreme	0 / 0.1 m ²	0 / 0.1 m ²	
	Recommended Thresholds ***		
# HCB at any stage / area	10 HCB / 0.1 m ²	22-32 HCB / 0.1 m ²	

* Outside experimental settings, an average quadrat sample would take ≤ 1 min. Therefore the quadrat method is actually at least 17x more efficient than the floatation method.

** All floatation samples were taken at hot spots while quadrat samples were taken at ten different on site locations.

*** See *Appendix B* for other HCB thresholds and their sources.

**** Metric-imperial conversions: $0.1\text{m}^2 = 1.076\text{ft}^2$; $1\text{ft}^2 = 0.0929\text{m}^2$

Population counts in this study showed a ratio of about 1:10 in counts obtained from quadrat and floatation sample techniques taken from the same location on a lawn. This is at variance with data from the University of Laval which reported a ratio of 1:4 (Rocheffort, 2001). The disparity may be due to the sampling procedures employed. In this study, weekly floatation samples were collected at only one location on each lawn – the spot with the highest quadrat count on the day of sampling – and this may have skewed the resulting data.

The 1:4 ratio between quadrat and floatation techniques supports the validity of the 10 count per quadrat when compared with the Pest Management Regulatory Agency (PMRA) recommendation of 22 to 32 per 0.1 m² (Health Canada, 2000). However, a

count of 10 per quadrat with a ratio of 1:10 suggests floatation threshold counts in the range of 100 per 0.1 m², much higher than the PMRA figure.

The validity of the higher threshold numbers is supported by data from this study and the OMAFRA HCB 1997 Fact Sheet, (see *Appendix B*) which suggest 100 HCB per 0.1m² in a floatation sample as a recommended threshold. Minimal damage was observed at 10 HCB per quadrat or 100 HCB per 0.1 m² in a floatation. Rochefort (2002) suggested that this could be due to favorable growing conditions for turf in this region that confer an added degree of resistance to HCB infestations.

In practical terms, the relative efficiency of the quadrat monitoring technique rules out floatation sampling in all but research applications. In field use, the time required for sampling can be reduced. With a short period of practice, the practitioner can determine in approximately 30 seconds whether HCB counts in the quadrat will approach or exceed the threshold figure of ten. If the figure of ten is reached in less than one minute, the location may be identified as a “hot spot” and marked for re-checking later. Hot spots should be re-evaluated weekly to check for early signs of HCB damage. If signs of damage are present, a spot control could be applied at the discretion of the lawn care technician or homeowner.

The recommended hairy chinch bug thresholds (Table 1) are meant to guide HCB control decisions; however, not all infested sites, reaching or exceeding the specified thresholds, require treatment. The turf’s resilience and general health, composite grass and weed species, history of chinch bug susceptibility, sustainability, and moisture levels should also be considered. Effective construction practice followed by proper management for mowing, fertilizing, topdressing, and moisture levels should be followed. These practices will reduce the severity of an existing hairy chinch bug infestation.

The prospect of using a biological control for hairy chinch bug has been investigated by Mailloux and Streu (1981). They found that although numerous natural enemies of the hairy chinch bug exist, no single parasite has been found that is capable of significantly reducing HCB populations. Thus, in dealing with severe HCB infestations, chemical treatment remains the primary control intervention. Three quadrat samples per 100 m² of lawn area are required to gain an accurate understanding of the hairy chinch bug population in the turf (Rochefort *et al*, 2002). In general, the samples should be randomly dispersed over the lawn unless problem areas are evident. Quadrat samples can be taken from areas where HCB problems would be expected (usually drier, full sun areas and slopes). After taking quadrat samples, an average count may be calculated to determine the overall severity of the infestation on the lawn. A summary of this control procedure (using the quadrat sampling technique) is shown in Figure 1.

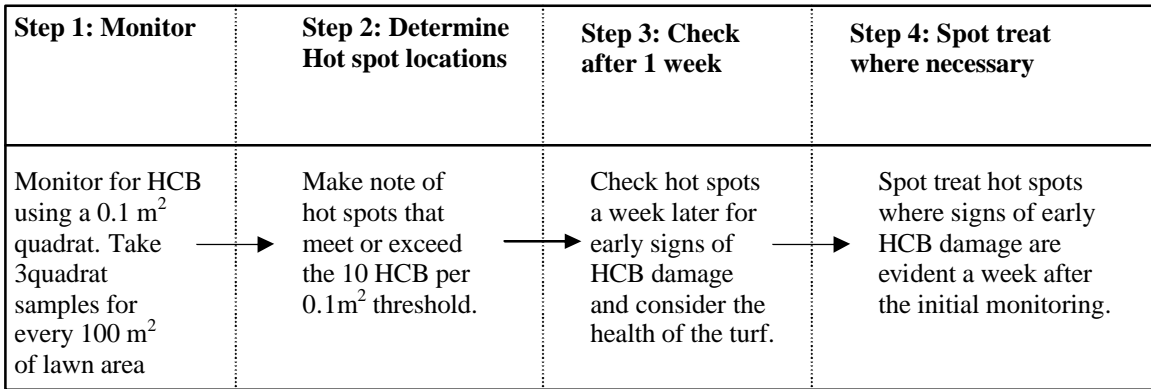


Fig. 1. Flow diagram of hairy chinch bug control decision-making process (part of the IPM process), using the quadrat monitoring technique.

Abiotic Factors. In observing the relationship between hairy chinch bug infestations and the turf’s population of grass and broadleaf plant species, it was found that increased broadleaf plant cover is strongly correlated to a reduction in visible HCB damage. Comparing equally infested hot spots on different lawns, it was found that hot spots with less than 10% broadleaf plants had an average of 27% HCB damage while sites with more than 10% broadleaf plants had an average of 9% HCB damage. These evaluations were done through visual estimations of percent coverage of broadleaf plant and HCB damage in a 0.25m² area. In general, as broadleaf plant cover decreases, hairy chinch bug damage increases (Fig. 2). Since hairy chinch bugs feed primarily on grasses, and not on broadleaf plants, this is to be expected. Figure 2 indicates the accepted percentage of broadleaf plant (weed) cover for class A, class B and class C turf. If customer acceptance permits, choosing a class B or C turf (over a class A) will be effective in reducing hairy chinch bug damage.

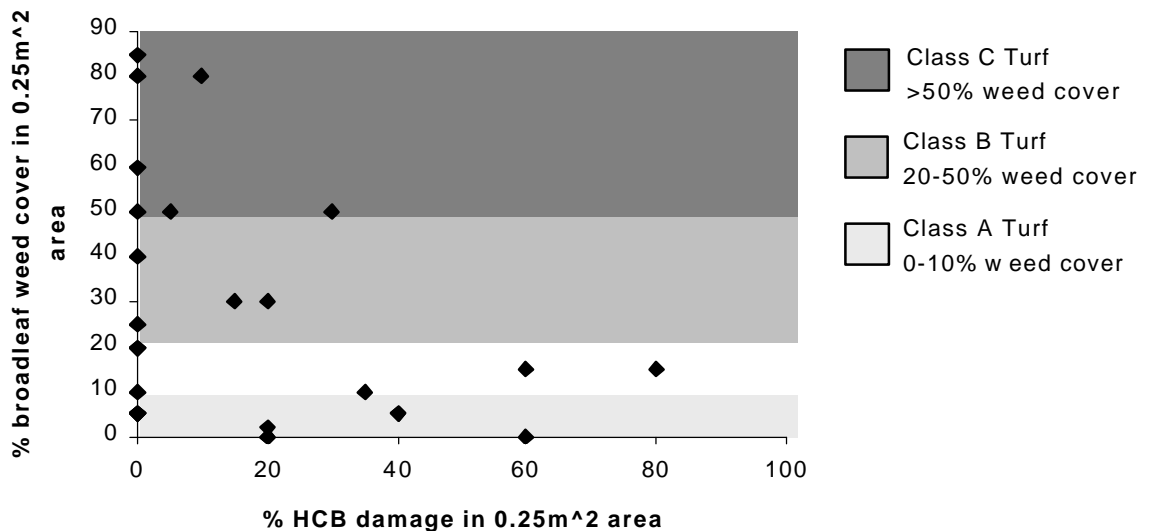


Fig. 2. Correlation between % broadleaf weed cover and % hairy chinch bug damage in 0.25 m² test square, as observed on lawns in New Brunswick in 2002. The weed cover ranges for class A, class B, and class C turf areas are shown by shading.

Although visible chinch bug damage was negatively correlated to broadleaf weed cover, this is not necessarily due to reduced HCB populations in areas with greater broadleaf weed cover. One lawn in particular was found to have the second highest HCB counts in the study, but – presumably due to its high broadleaf weed cover (>80%) – showed no visible HCB damage. Hairy chinch bug populations on this site remained considerably high throughout the summer with average HCB counts of 7 and 150 per 0.1 m² for the quadrat and floatation techniques, respectively. These findings differ from typical trends, observed by Majeau *et al* (2000a), that would predict a negative correlation between broadleaf weed cover and the number of hairy chinch bugs per unit area.

This study found no significant relationship relating average HCB infestation levels and thatch thickness (Fig. 3). These results are consistent with the findings of Majeau *et al* (2000a), who also found no significant relationship between the two variables; conversely, these results are in conflict with an earlier paper by Kortier Davis, and Smitley (1990) who found that HCB populations were positively associated with thatch thickness.

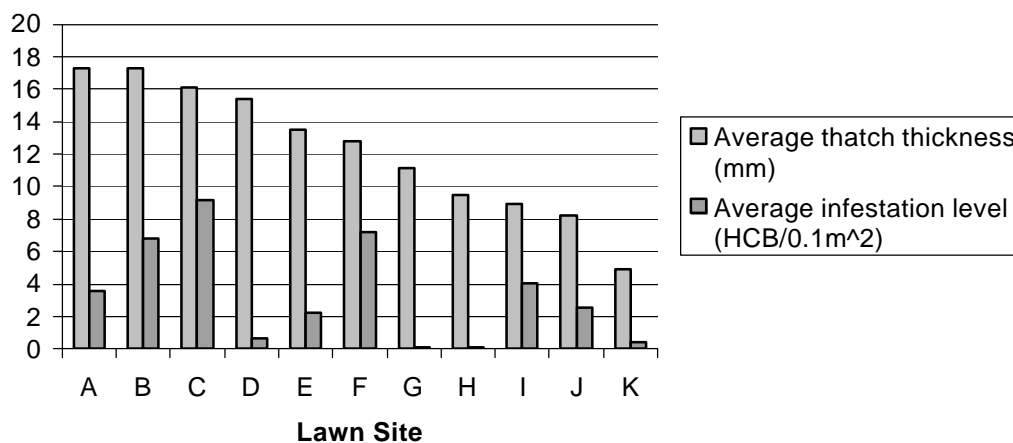


Fig. 3. Graph showing the relationship between average thatch thickness (calculated from ten thatch measurements on each lawn), and average HCB infestation level, (based on quadrat samples taken throughout the summer 2002 in New Brunswick.)

Soil content was examined to see if any relationship existed between a hairy chinch bug infestation index (calculated for the month of July 2002, using quadrat and floatation count information) and soil organic matter, soil pH, or soil phosphorus and potassium levels. The findings are displayed in Figures 4 and 5.

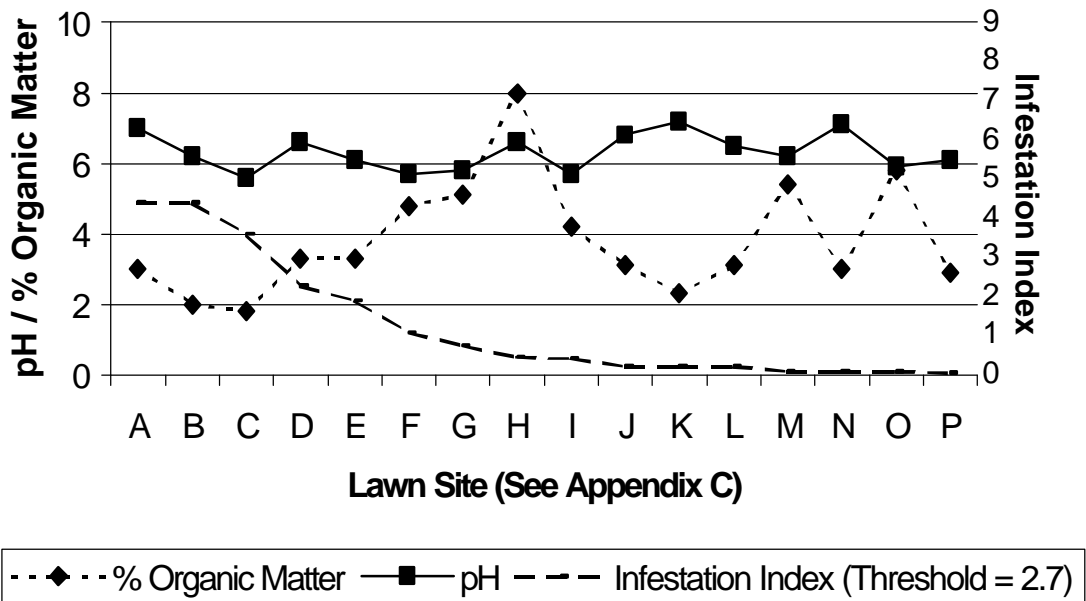


Fig. 4. Graph showing the independent relationship between % organic matter, soil pH and average HCB infestation level taken from numerous sites during July 2002, in New Brunswick

Neither the pH nor the organic content of the soil was found to be correlated to the hairy chinch bug infestation levels on the monitored sites (Fig. 4). As the infestation level decreases, the pH and the % organic matter increase and decrease erratically. This is also the case for the phosphorus and potassium levels in the soil, shown in Figure 5. No significant relationship was found, correlating any of these factors to the HCB infestation index in July 2002 in New Brunswick.

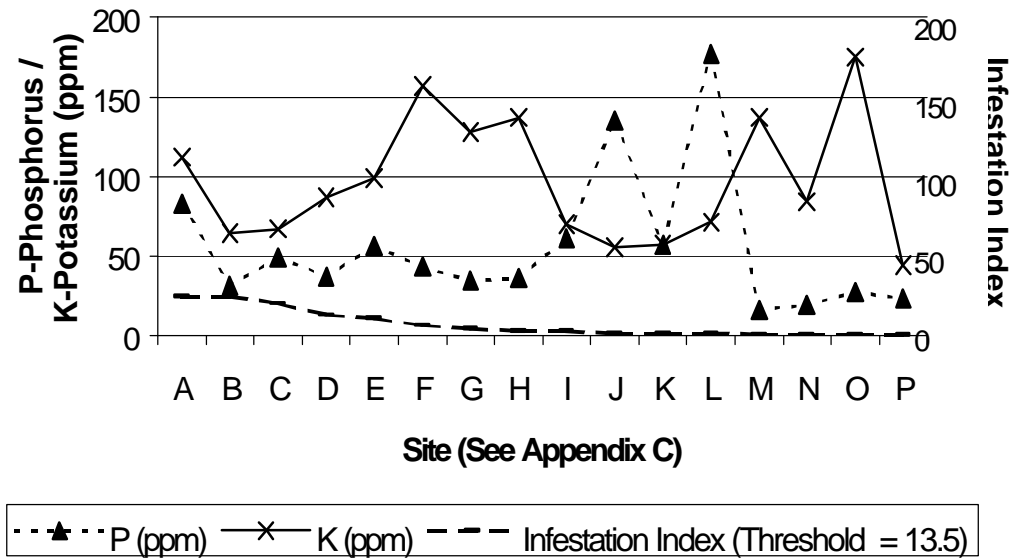


Fig. 5. Graph showing the independent relationship between phosphorus and potassium (ppm) and average HCB infestation level taken from numerous sites during July 2002, in New Brunswick

Development. The 2002 hairy chinch bug survey indicated that New Brunswick HCB populations complete only one single generation: the first filial (F1) generation (Fig. 6). This is also the case in other northeasterly regions including Quebec, Ontario and northern New York (Tashiro 1987). Evidence of an incomplete second filial (F2) generation was also observed in some New Brunswick regions. The presence of the F2 generation was also very weak. No more than five F2 nymphs were found in any one sample. There was also no substantial evidence of F2 development beyond the third-instar stage. The F2 nymphs appeared to have died off by mid-October. This is reasonable given that the colder temperatures prevent the more vulnerable nymphs from overwintering with the (F1) adults. Adults are better equipped to survive the cold winter temperatures, (Kennedy 1981, Leonard 1966).

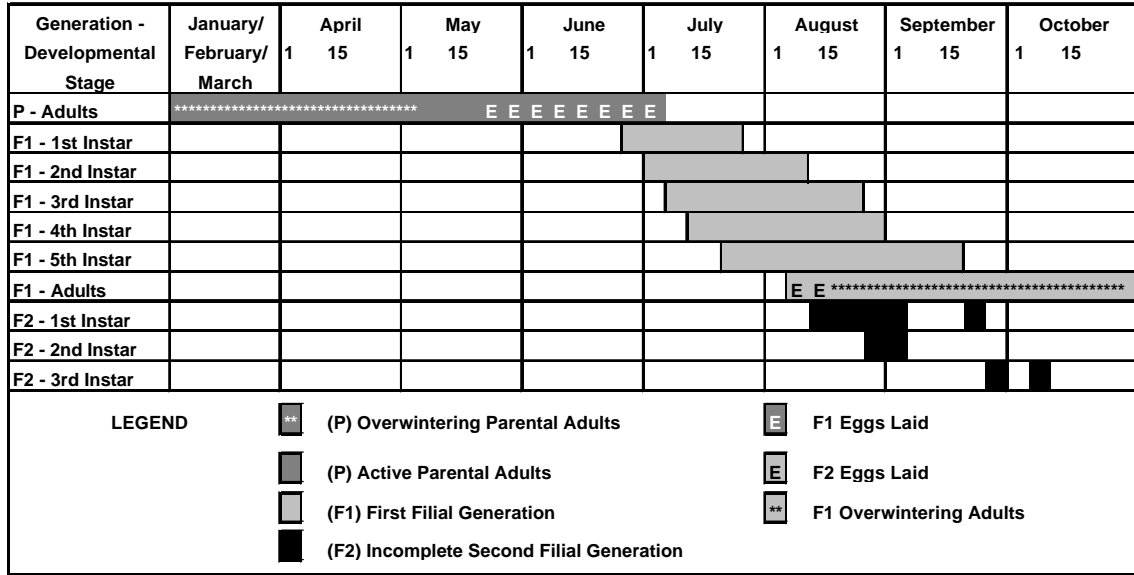


Fig. 6. Seasonal chronology of the hairy chinch bug. New Brunswick, 2002.

Using the Fredericton climate data as a model, the seasonal history of the hairy chinch bug can be shown both with the calendar dates and the corresponding accumulated growing degree-days (above 7°C, air temperature), Figure 6&7. The Fredericton climate data is consistent with the information from the other New Brunswick regions. The insect samples collected from Fredericton had an average of 32 to 77% more insects per sample than those collected from the other regions.

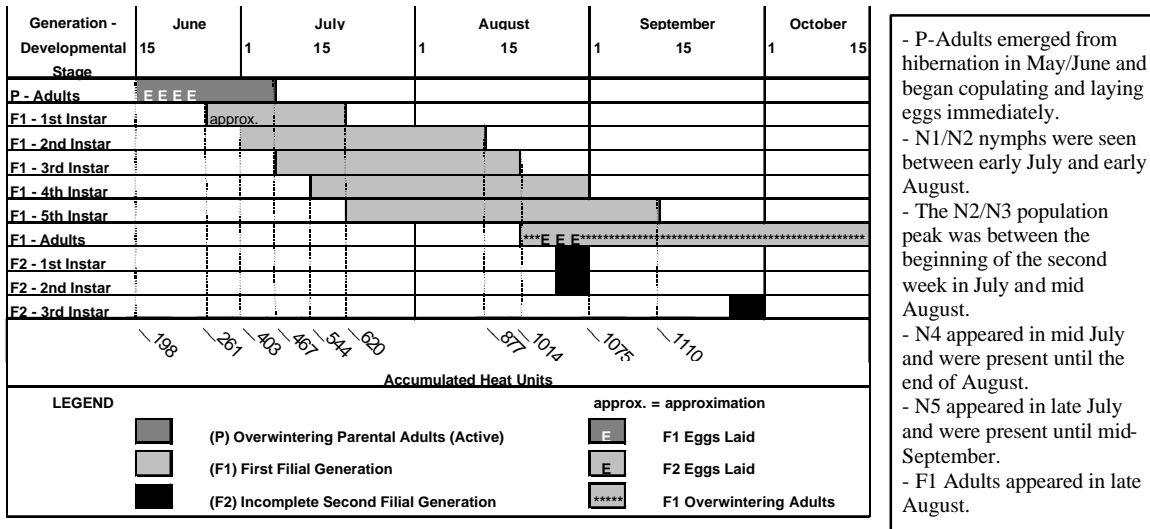


Fig. 7. Accumulated heat units (base 7°C, air temperature) and seasonal history of the hairy chinch bug infesting five lawns in Fredericton, New Brunswick between June and October, 2002

Continuing to use the Fredericton data as a model, the average number of HCB (at each of the six developmental stages) found in weekly floatation samples, taken on each of the five Fredericton sites is shown in Figure 8.

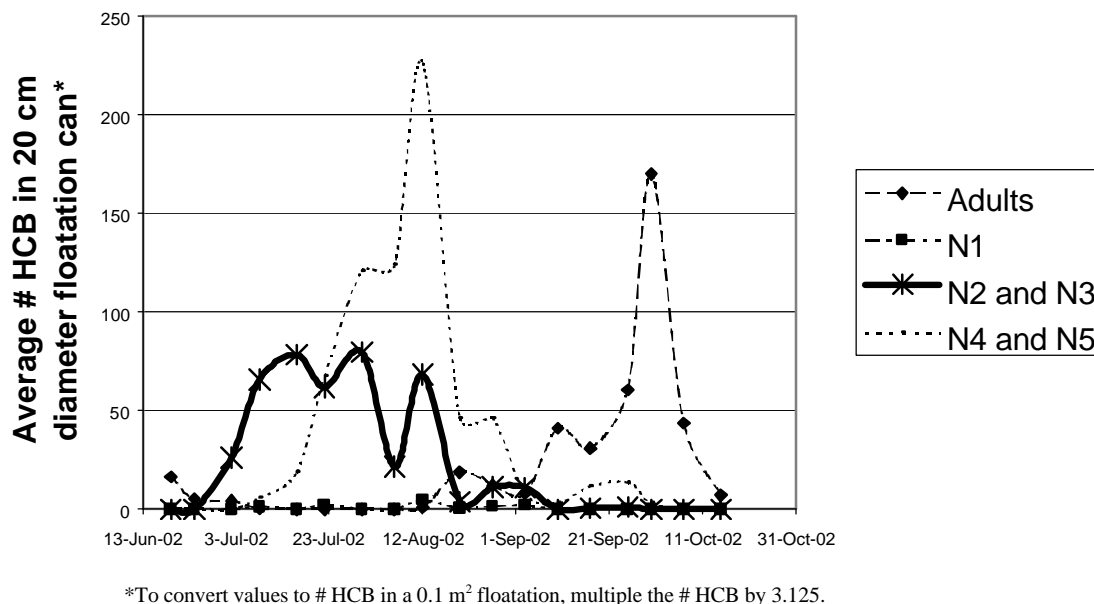


Fig. 8. Average number of hairy chinch bugs at each of the developmental stages, found in a ten-minute floatation sample on five lawns in Fredericton, New Brunswick, during weekly monitoring in the summer of 2002. All floatation samples were taken at hot spots on the lawn. (See *Materials and Methods: Floatation Sampling* for a description of how this location was determined).

Examining Figure 8, it is evident that the peak of the combined second and third-instar nymphs (shown by the heavy line) occurred between mid-July and mid-August in 2002. It is important to consider whether the accumulated heat units in 2002 were reflective of those seen in an average year in Fredericton. By comparing growing degree-day information for Fredericton in 2002 with average GDD data (compiled from a database that averaged climactic information for Fredericton between 1961 and 1990) it is evident that the 2002 HCB growing season was slightly below the 30 year average, i.e., it was slightly cooler. This is illustrated in Figure 9.

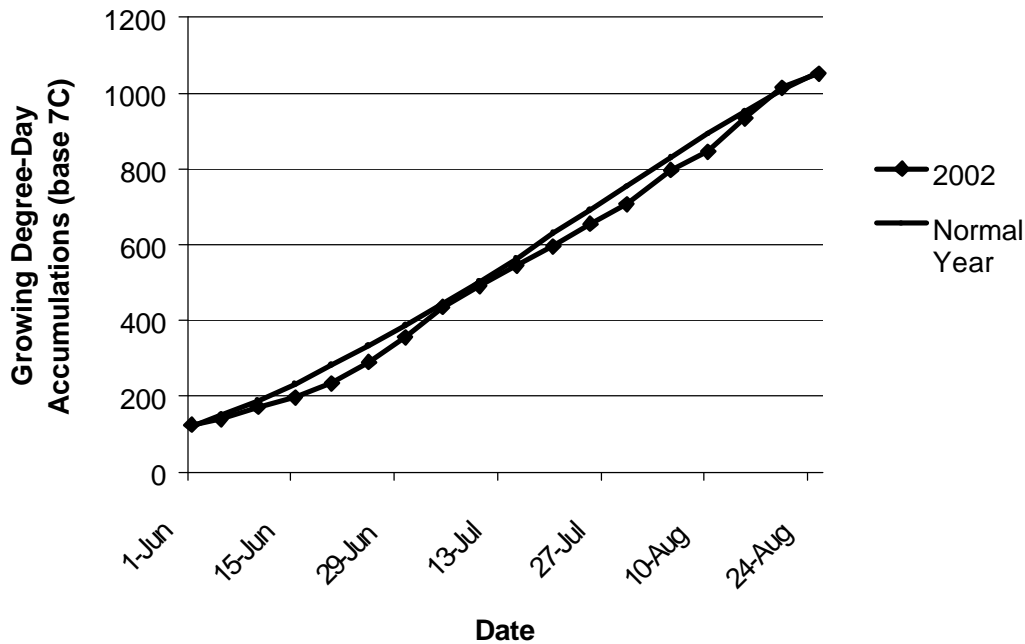


Fig. 9. Accumulated growing degree-days above 7°C (air temperature) in Fredericton New Brunswick in 2002, and on a normal year (based on average accumulated GDD >7°C, air temperature, between 1961 and 1990)

The information presented in Figure 9 suggests that during a climactically average year, the hairy chinch bug development would be accelerated by two to four days. This would shift the N2-N3 peak so that it would occur between earlier calendar dates, e.g. July 10th to August 10th (instead of July 15th to August 15th). The number of growing degree-days required to reach a particular stage in the HCB lifecycle, however, would remain constant. Thus hairy chinch bug development is dependent on accumulated growing degree-days. Calendar dates can give a rough prediction of the HCB lifecycle, but temperature aberrations will shift HCB development – slowing development during a cool period and accelerating it during a warmer period. Therefore different regions should experience peak HCB populations of a given stage after the same number of accumulated growing degree-days, but – due to climactic variation – this will not necessarily occur on the same calendar date.

Reasonable consistency in the growing degree-day accumulations (base 7°C, air temperature) required to reach the peak of the combined second and third-instar nymphs was found when comparing the five New Brunswick regions. In particular, three of the five regions, Fredericton, Moncton and Bathurst, all fell between 530 and 877 GDD > 7°C, air temperature (Fig. 10). The other two regions (Rothesay and Grand Falls)

required fewer accumulated heat units to reach the combined second and third-instar peak.

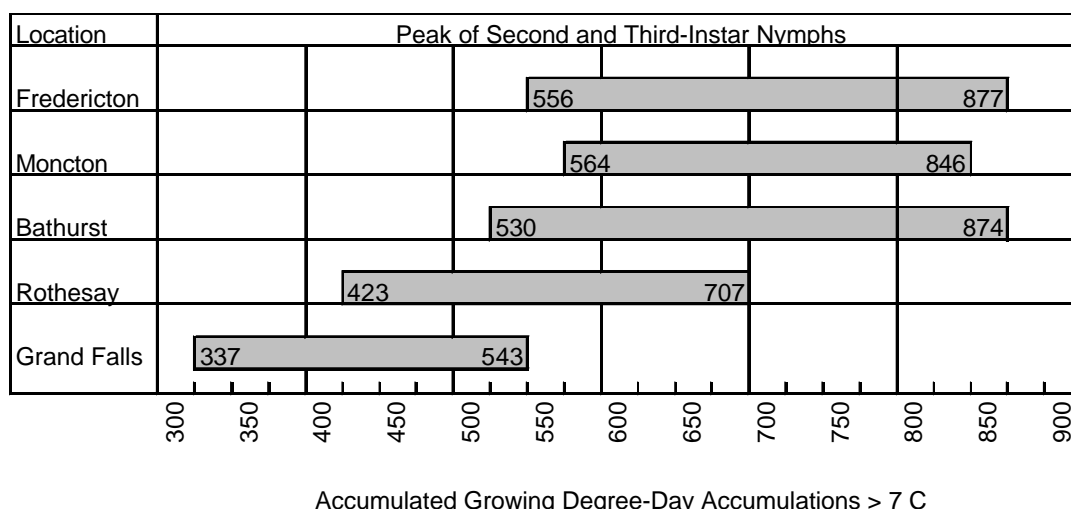


Fig. 10. Accumulated growing degree-days (heat units above 7°C) at the time of the combined peak of second and third-instar (N2-N3) populations, in five regions in New Brunswick, during the summer of 2002. For each region, the indicated GDD ranges correspond to the recommended treatment window for above threshold populations (>10 HCB /0.1m²) of hairy chinch bug

As discussed, above, it is expected that the number of accumulated growing degree-days required to reach a certain point in the HCB lifecycle would be consistent, regardless of location. The inconsistency of the Rothesay and Grand Falls growing degree-day N2-N3 peaks (Fig. 10) may have been caused by several factors. In Grand Falls the limited number of collected samples puts the results in question. Only seven floatation samples were collected from Grand Falls throughout the summer compared to 59, 32, 18 and 17 in Fredericton, Rothesay, Bathurst and Moncton, respectively. The growing degree-day data for Grand Falls may also be unreliable because the weather station used to collect heat unit information for that region is 20 km away from the HCB monitoring sites. Compared to the Grand Falls data, the Rothesay data deviated less from the ranges found in the other regions. The variance in the Rothesay data (Fig. 10) can be attributed to the reduced number of HCB in the insect samples. This was caused by the fact that the lawns monitored in Rothesay were less infested and produced fewer HCB's in the floatation samples than the lawns monitored in Fredericton, Moncton and Bathurst.

The N2-N3 peak determined for Fredericton, Bathurst and Moncton (between 530 and 877 GDD >7°C) is reasonable in comparison with the results of Liu and McEwen (1979) who found that third-instar nymphs peaked between 750 and 900 degree-day accumulations (7°C base) during July 4-8, 1977 in Ontario. Most of the discrepancy between our values and those of Liu and McEwen (1979) can be accounted for by the

difference between the peak of the combined second and third-instar nymphs (as determined for New Brunswick) and the third-instar peak (as determined for Ontario). Further disparity in these degree-day peaks can be explained by differences in air temperature (used to calculate degree-day accumulations in New Brunswick) and thatch temperature (used to calculate degree-day accumulations in Ontario). The accumulated GDD results for New Brunswick are also reasonable in comparison with the combined second and third-instar peaks determined by Rochefort, *et al*, (1997). Using a base of 7°C, Rochefort *et al* (1997) found that the N2-N3 peak in Quebec City, PQ in 1997 occurred between 557-649 growing degree-days and in 1998 the peak fell between 608-788 growing degree-days. In Montreal, PQ, peaks were found to occur between 632-823 and 637-740 in 1996 and 1997, respectively.

The timing for HCB monitoring and insect control decisions, shown in Table 2, is based on the 2002 HCB survey observations. The calendar dates recommended in Table 2 reflect the date when the appropriate number of accumulated GDD (base 7°C, air temperature) would be present in a climactically average year. Thirty years of data (collected from 1961 to 1990) was used to determine average (or “normal”) climate conditions for each New Brunswick region.

Table 2. Recommended periods for hairy chinch bug monitoring and control decisions during a climactically normal year in five regions of New Brunswick

Region	Observed accumulated growing degree-days (base 7 °C) at peak N2-N3 (2002) and normal year date	Normal year date corresponding to GDD at earliest 2002 siting of a N2 or N3 nymph	Recommended HCB monitoring period (2 weeks before beginning of N2-N3 peak, until end of peak)	Recommended HCB control decision period (from earliest siting of N2 or N3 to end of N2-N3 peak)
Bathurst	530 – 874; July 18 th -Aug. 16 th	Included in range	July 1 st - mid-August	July 18 th -Aug. 16 th
Fredericton	556 – 877; July 14 th -Aug. 9 th	July 7 th	June 23 rd - Aug. 9 th	July 7 th -Aug. 9 th
Moncton	564 – 846; July 22 nd -Aug. 15 th	July 18 th	July 1 st – mid-August	July 18 th -Aug. 15 th
Rochesay	423 – 707; July 17 th -Aug. 13 th	July 13 th	July 1 st – mid-August	July 13 th -Aug. 13 th
Grand Falls	337 – 543; July 1 st -July 21 st	Included in range	*	*

* Data is unreliable.

In general, the recommended monitoring period is set to begin two weeks prior to the beginning of the recommended control decision window. Control decisions should be based on observed quadrat counts (three quadrat counts per 100 m²) and should be guided by the recommended quadrat threshold of ten HCB per quadrat.

Conclusions

The quadrat monitoring method was equally effective and at least six times more efficient than the floatation method for guiding hairy chinch bug control decisions. The quadrat treatment threshold of ten chinch bugs per 0.1m² for a 60 second search appears to be suitable for guiding HCB management decisions. Treatments for hairy chinch bug should be applied at the peak of the combined 2nd and 3rd instar populations. In 2002 the

combined populations peaked in Bathurst, Fredericton, Moncton, and Rothesay between 423 and 877 degree-days (7°C base, air temperature). For an average year in New Brunswick (in terms of climate) this growing-degree day range corresponds to an optimum treatment window for hairy chinch bug between early/mid-July and mid-August. This treatment window can be narrowed for specific regions in the province (Table 2).

In practical terms, the relative efficiency of the quadrat monitoring technique rules out floatation sampling in all but research applications. In field use, the time required for sampling can be reduced. With a short period of practice, the practitioner can determine in approximately 30 seconds whether HCB counts in the quadrat will approach or exceed the threshold figure of ten. If the figure of ten is reached in less than one minute, the location may be identified as a “hot spot” and marked for re-checking later. Hot spots should be re-evaluated weekly to check for early signs of HCB damage. If signs of damage are present, a spot control could be applied at the discretion of the lawn care technician or homeowner.

The research and reports by Rochfort *et al* (1997) has indicated that effective monitoring can demonstrate an 89% reduction in insecticide use for hairy chinch bug while maintaining customer appearance expectations.

Pest control intervention is not always necessary for above threshold populations of chinch bug. If required, registered pesticide treatment is the most effective control intervention. Many alternative intervention products have been suggested but remain untested and without sufficient efficacy data. It was found that lawns with higher populations of broadleaf plants (weeds) $\geq 10\%$ showed less visible damage from chinch bug feeding than lawns with fewer weeds, despite above threshold HCB populations. The general health of the turf should always be included in the control decision-making process.

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Appendix A

Table 3. Method used to calculate growing degree-day (GDD) heat units above 7°C, done according to Environment Canada guidelines. For every day between May 1st, 2002 and August 31st 2002 the mean temperature was calculated by averaging the maximum and minimum daily temperatures in °C. The 7°C base temperature was then subtracted from the mean temperature to give the heat units (in °C) for that day. The daily heat units were calculated cumulatively, adding the heat units from each day to those accumulated in previous days.

Date	Max. T	Min. T	Mean T	DD>Threshold	Acc. Degree Days
1-May	10.3	-1.6	4.35	0	0
2-May	14.3	0.8	7.55	0.55	0.55
3-May	11.8	2.8	7.3	0.3	0.85
4-May	14.4	4.1	9.25	2.25	3.1
5-May	18.6	2.2	10.4	3.4	6.5
6-May	22.2	2.3	12.25	5.25	11.75
7-May	18.9	8.9	13.9	6.9	18.65
8-May	14.8	0.8	7.8	0.8	19.45
9-May	16.8	-1.2	7.8	0.8	20.25
10-May	22.4	8.5	15.45	8.45	28.7

Appendix B

HCB Threshold	Timing	Tips / Comments	Reference
20-30 / ft ² [22-32 / 0.1m ²]	1,650 DD (base = 45 ⁰ F) where there is one generation a year	- Monitor several times - thatch reduction, frequent irrigation, overseeding with endophytic varieties, use tall fescue and Kentucky bluegrass	Emmons, R.D. 2000. Turfgrass Science and Management. 3 rd edition. Delmar publishers Inc. pp. 301-302, 359-361. - Secondary source as original references not cited.
More than 20 HCB's per can of 200 cm area. Ten samples should be taken. (93/ ft ² = 100 / 0.1 m ²)	2 nd to 3 rd week in July for Guelph area (or when bird's foot trefoil is in full bloom).	Apply insecticides in 2 nd week of July, or later when damage is first observed.	Hairy chinch bugs in lawns. Fact Sheet. 09/1997. OMAFRA.
1) HIGH damage: >5% damaged area at end of season when more than ten 2 nd and 3 rd HCB nymphs per 0.1 m ² quadrat. (9/ ft ²) 2) MEDIUM damage: 1-5% damaged area at end of season with five to nine 2 nd and 3 rd HCB nymphs per quadrat. (5-8/ ft ²) 3) LOW damage: <1% damaged area at end of season with < five 2 nd and 3 rd HCB nymphs per quadrat. (5/ ft ²)	- last week in June to 3 rd week in July (Montreal and Quebec city) - (2 nd and 3 rd instars abundant in mid-July in Montreal and Quebec city)	- The sampling method with a can works but takes too long for use by industry personnel. Therefore, authors suggest visual inspection of 0.1 m ² quadrats, which takes 42 seconds / quadrat. - Sample when it is not raining - Authors state that the threshold they use is ten times higher than thresholds used in the USA because lawns in their study areas are more resistant to HCB infestations. - Threshold is equivalent to ten 2 nd and 3 rd HCB nymphs per 0.1m ² quadrat.	Brodeur, J., Y. Carrière, Y. Desjardins and S. Rochefort. March 2000. Lutte intégrée appliquée en milieu urbain. Projet – pilote sur les pelouses au Québec. Réseau des Partenaires en environnement. Association des Services en Horticulture Ornementale du Québec. (ASHOQ). Note: This information is referenced from the Journal of Economic Entomology article 93 : 834-839 (which was in press at that time).
# of 0.1 m ² quadrats and threshold for cumulative HCB counts: 30 99 : (3 / ft ² = 3.3 / 0.1m ²) 35 110 40 121 45 131 50 141 55 151 60 160	- July for Montreal and Quebec city	- Time required is 42 seconds per quadrat or 20 minutes per 30 quadrats - count all HCB's per 0.1m ² quadrat - threshold is 99 HCB's per 0.1m ² , based on 30 quadrats (= 3.3 HCB/ 0.1 m ²), and decreases as more quadrats are inspected. - Takes less time than the cylinder (can) method. - Method allows other insects and weeds to be monitored. - Potentially useful method where the HCB has less than 2 generations per year	Majeau, G., J. Brodeur and Y. Carrière. 2000. Sequential sampling plans for the hairy chinch bug (Hemiptera: Lygaeidae). J. Econ. Ent. 93 : 834-839.
HCB Threshold	Timing	Tips / Comments	Reference
Total of 30 third instar HCB's in <u>eleven</u> samples of 225 square cm. (11/ ft ² = 12/ 0.1 m ²)	From 750 – 950 DD >7 C. in thatch <u>and</u> when most HCB's are in the 3 rd instar.	Use 15 X 15 cm square samples. 86% of lawns can be sample in 30 minutes, 14% require 45 minutes. Minimum of 11 samples required to be taken. Maximum # of	H.J. Liu and F.L. McEwen. 1979. Environ. Entomol. 8 : 512-515.

		samples required was 26. MY COMMENT: If one samples too early, one may miss sampling potentially damaging HCB populations later on.	
15 to 20 HCB's per square foot [16-22 / 0.1 m ²]	No data given	Recommends flotation method. - use a "1 or 2 pound coffee can". - Mentions "in Canada, where the short-winged form is limited in numbers, adult HCB's frequently fly from lawn to lawn.	National Park Service IPM Manual, entitled "Turfgrass Insects" – from the internet.
5 to 10 HCB's in a "large coffee can" or 2 to 3 in a can if the lawn was in poor condition. Assume can has 6 inch diameter, then: High threshold: 25-51/ft ² (27-55 / 0.1m ²) Low: 10-15/ft ² (11-16 / 0.1m ²)	Last week of June, before hot dry weather develops.	- Sample 5 to 6 areas. - Sample where it is: sunny, dry, slopes, edges.	Two sources: 1) Nova Scotia fact sheet from the internet. 2) The PMRA fact sheet has the same information.

* Conversion rates: 1 ft sq = 0.0929 m sq; 1 m sq = 10.764 ft sq.

Fig. 11. Hairy chinch bug (HCB) threshold data from various literature sources, prepared by Christopher Maund in November, 2001.

Appendix C

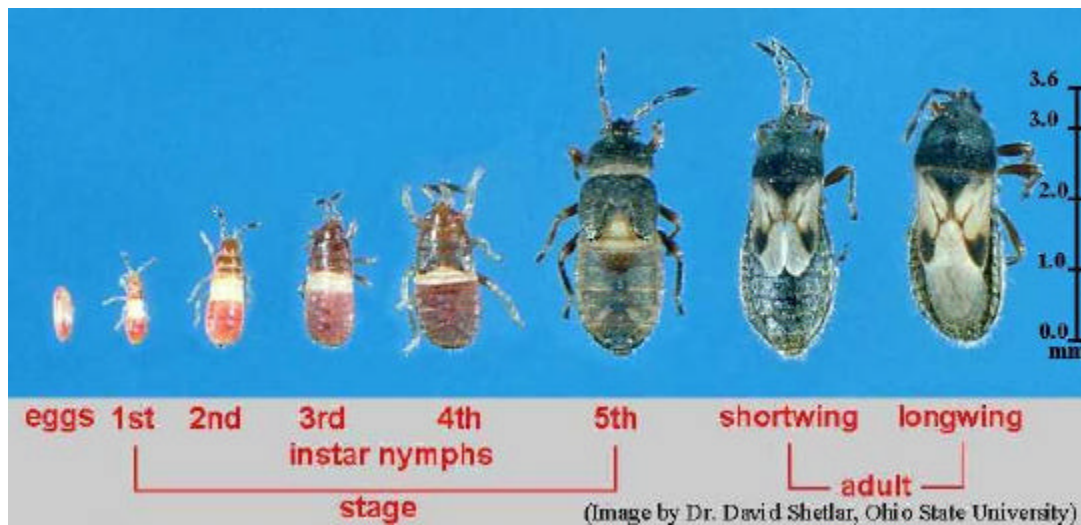


Fig. 12. Image of the hairy chinch bug egg, the five nymph instars, and both the shortwinged and longwinged adult. Image prepared by Dr. David Shetlar of Ohio State University: <http://bugs.osu.edu/~bugdoc/Shetlar/462/462InsectOrders/Orders05.htm>