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PURDUE UNIVERSITY

Turfgrass Insects

Department of Entomology

MANAGING BILLBUGS IN TURFGRASS

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HOW TO USE THIS PUBLICATION

This publication provides turfgrass management professionals and property owners with information to help them 1) properly identify the most common billbug species associated with turfgrass in Indiana and adjacent states, 2) understand billbug biology, 3) recognize billbug damage and 4) formulate safe and effective billbug management strategies. For information on turfgrass identification, weed, disease and fertility management, visit the Purdue Turfgrass Science and Management Website (http://www.turf.purdue.edu/) or call Purdue Extension (765-494-8491).

BILLBUG SPECIES ASSOCIATED WITH TURFGRASS IN THE MIDWEST

Billbugs represent a complex of weevils in the genus *Sphenophorus* that are increasingly being recognized as major pests of managed turfgrass around the world. The larvae of these insects damage a variety of warm- and cool-season grasses by feeding on or inside the stems, crowns, roots, stolons, and rhizomes. There are at least 4 species of billbugs associated with turfgrass in the Midwest. These include the bluegrass billbug *Sphenophorus parvulus* Gyllenhal (Fig. 1A), the hunting billbug *Spenophorus venatus* Say (Fig. 1B), the lesser billbug *Sphenophorus minimus* Hart (Fig. 1C) and the unequal billbug *Sphenophorus inaequalis* Say (Fig. 1D). The distribution of these four species overlaps significantly. It is not uncommon to find mixed populations of two or more species at a single location. In the Midwest, bluegrass billbug is the most prevalent species infesting cool-season turfgrasses such as Kentucky bluegrass, perennial ryegrass, fine fescue, and tall fescue. However, bluegrass billbugs have also been identified damaging warm-season grasses, such as zoysiagrass, in Indiana. Hunting billbug is the most frequently encountered billbug pest of warm-season turfgrasses such as zoysiagrass and Bermudagrass. Lesser and unequal billbugs may infest warm-or cool-season turfgrasses, but infestations of these two species usually occur at comparatively low densities and damage attributable to these species has rarely been reported.

IDENTIFICATION AND SEASONAL BIOLOGY

Bluegrass Billbug

Like all billbug species, bluegrass billbug adults can be easily recognized by the presence of a long snout on the front of the head. They are 7-8 mm long and gray to black in color, but they are sometimes coated with soil making them appear brown or beige. Upon closer examination, the region directly behind the head (pronotum) is adorned with small, evenly spaced punctures of uniform size. The rest of the body

Figure 1. Adults of four billbug species associated with turfgrass in the Midwest. (A) bluegrass billbug, (B) hunting billbug, (C) lesser billbug, and (D) unequal billbug.

Figure 2. Bluegrass billbug larva and damaged crown of a Kentucky bluegrass plant.

is covered with alternating rows of small and large punctures that give them a striped appearance. The larvae are white, legless, soil- and crown-inhabiting insects with a chestnut colored head (Fig. 2).

Adult bluegrass billbugs spend the winter in the thatch, cracks and crevices in the soil, plant debris or around structures such as sidewalks, driveways and buildings. They become active in April or May as soil temperatures at the surface warm to about 65°F (Fig 3.). Adults feed by chewing holes in grass stems, but cause no significant damage to the turf. Adult females insert eggs into the feeding holes they create (Fig. 4) and these eggs hatch into small larvae. Larvae bore inside the stems until they deplete the resources within (Fig. 5). By mid-June, larger larvae begin feeding on plant crowns just below the soil surface. Feeding by these larger larvae causes significant damage and may kill plants. By mid-July, larvae start to pupate. New adults begin to appear by August. These adults generally feed for a short time and find a suitable place to overwinter, but some may lay eggs resulting in a partial second generation of larvae. Larvae of this second

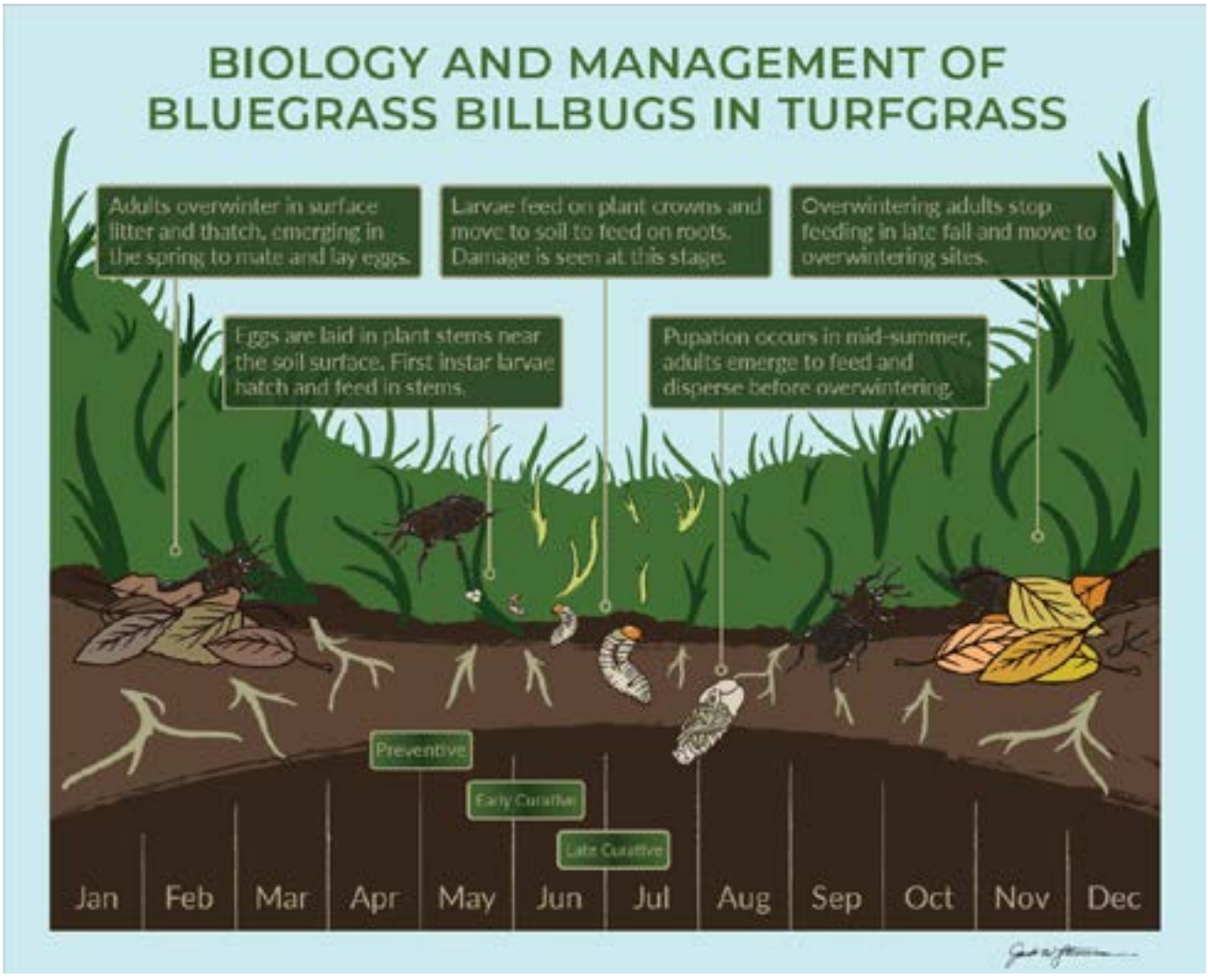

Figure 3. Seasonal biology of the bluegrass billbug and windows of opportunity for three different management strategies using chemical or biological insecticides: (1) preventive targeting adults, (2) early curative targeting larvae inside plant stems, and (3) late curative targeting larvae in the soil. *(Artwork by Jack Stevens)*

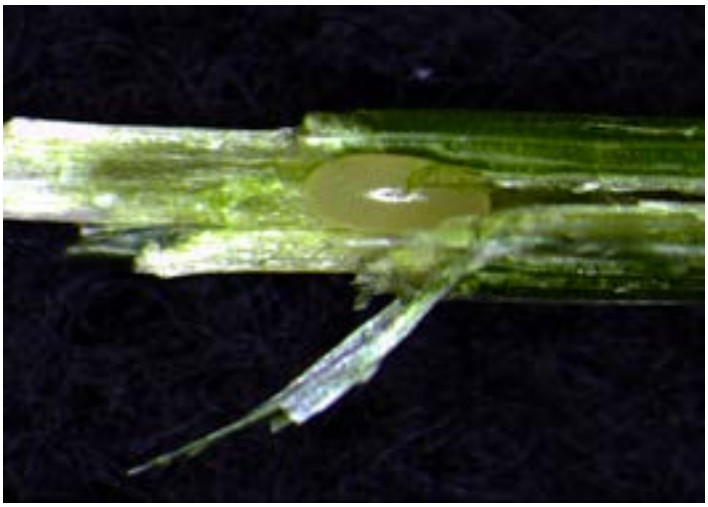

Figure 4. Bluegrass billbug egg inside the stem of a Kentucky bluegrass plant.

Figure 5. Bluegrass billbug larva inside stem of a Kentucky bluegrass plant. *(Photo/video Credit: John Obermeyer)*

generation do not survive the winter. Activity and development of bluegrass billbug can be tracked online using the Growing Degree-Day Tracker: <http://gddtracker.msu.edu/>.

Hunting Billbug

Although adult hunting billbugs are also easy to recognize by their characteristic snout, they differ somewhat from bluegrass billbug in both appearance and biology. Hunting billbug adults vary in size from about 8-11 mm and are usually dark reddish-brown in color although they may also be coated with soil giving them a dirty appearance. In contrast to the bluegrass billbug, the area behind the head (pronotum) is covered with unevenly spaced punctures that are not uniformly sized. The area behind the head also exhibits a raised Y-shape that is surrounded on each side with a parenthesis (Y). Like other billbugs, hunting billbug larvae are white and legless, with a chestnut colored head (Fig. 6).

Both adults and larvae of this species overwinter at least as far north as West Lafayette, IN (40.5°N). Overwintering adults become active in April and immediately begin laying

Figure 6. Hunting billbug larva in the root zone of zoysiagrass.

eggs in leaf sheaths and near the crowns of plants (Figure 7). Larvae resulting from overwintering adults may be present in the soil from early-June through July. Overwintering larvae resume feeding on plant crowns, roots, stolons, and rhizomes as soil temperatures increase in the spring. These overwintering larvae may be present in the top 2-3" of soil as early as mid-March. Overwintering larvae pupate and emerge as adults by June, joining the overwintering adults and resulting in a prolonged period of adult activity during the spring and summer months. As a result, all stages of hunting billbug may be present in the turf and soil across most of the growing season. A second cohort of larvae may be present in the soil by September and many of these larvae move deeper into the soil profile where they spend the winter. Larval activity may be accompanied by significant damage to turfgrass whenever they are present, but particularly from July through September.

Other Billbug Species Associated with Turfgrass

Although not uncommon, much less is known about the biology of two additional billbug species associated with turfgrass in the Midwest; the lesser and unequal billbugs. These species often occur in mixed populations with the bluegrass and hunting billbugs and probably have a seasonal biology similar to the bluegrass billbug (one generation of larvae each year). The unequal billbug is a bit broader than the bluegrass billbug, but about the same length (7-8 mm). The area behind the head is covered with unevenly spaced punctures that are not uniformly sized, as well as a smooth, raised area resembling an elongated diamond shape. It apparently feeds on both warm- and cool-season grasses, but its status as a pest has not been confirmed.

The lesser billbug is a bit smaller than the bluegrass billbug (6-7 mm). The area behind the head is more sparsely punctured and the punctures are very obviously not uniform in size. Otherwise, there are few other distinguishing marks.

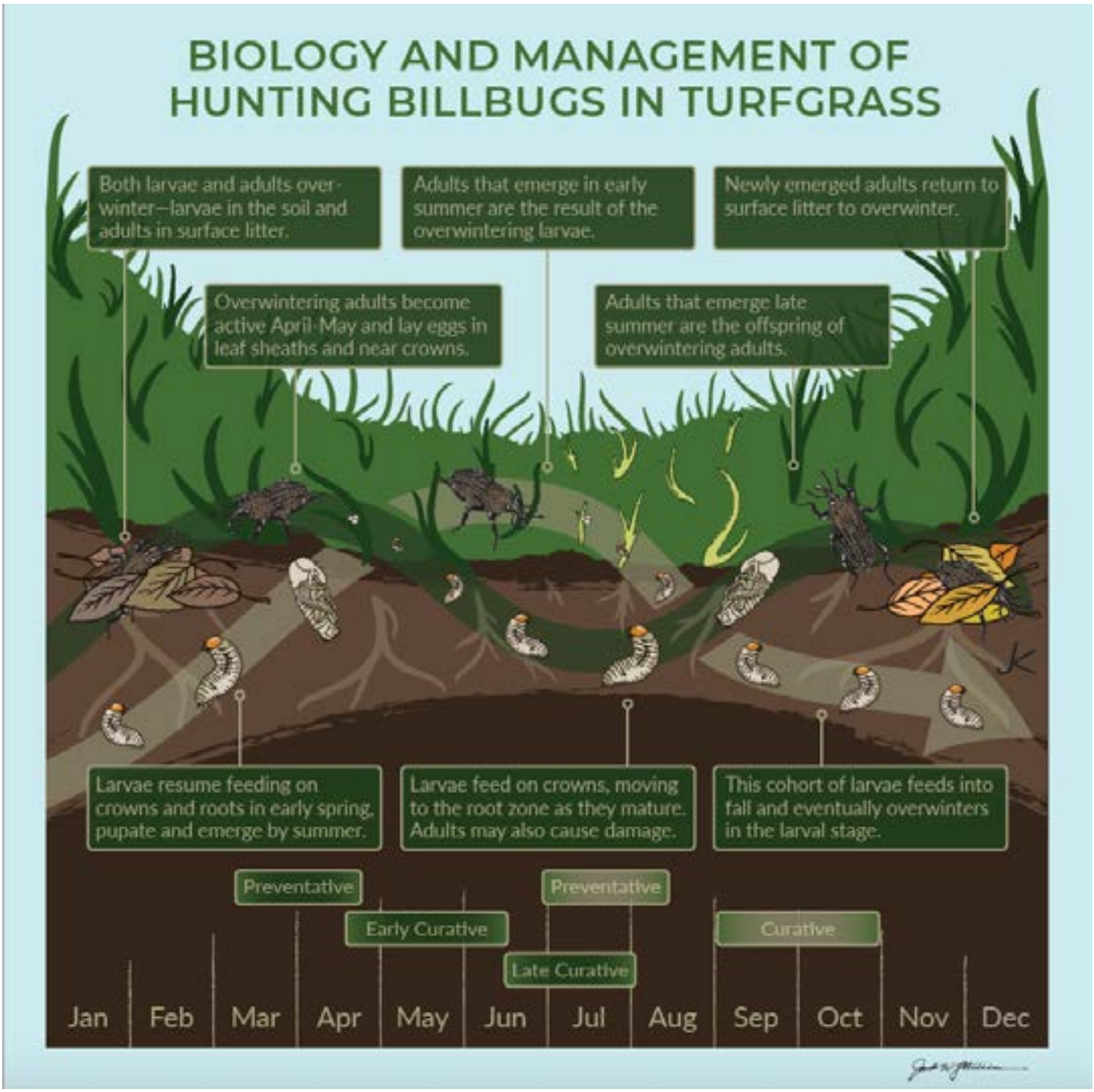

Figure 7. Seasonal biology of the hunting billbug and windows of opportunity for three different management strategies using chemical or biological insecticides: (1) preventive targeting adults, (2) early curative targeting larvae inside plant stems, and (3) late curative targeting larvae in the soil. *(Artwork by J. Stevens)*

Like the uneven billbug, it apparently feeds on both warm- and cool-season grasses and its status as a pest has not been confirmed.

DAMAGE AND DIAGNOSIS

Billbugs are the most commonly misdiagnosed insect-related turfgrass disorder in North America. The list of ailments for which billbug damage is confused includes compacted soil, drought or summer dormancy, nematode damage, spring dead spot and dollar spot disease. Damage caused by billbugs is often incorrectly attributed to other insects such as white grubs. As a result, these insects can become a perennial problem leading to seriously degraded stands of turfgrass that are easily overrun by weeds. Billbugs affect roughly half of all home lawns in Indiana making them the most common turfgrass-infesting insect in our region.

Billbug larvae primarily damage turfgrass by feeding on plant crowns and roots, and damage is similar regardless of

billbug species. The first indications of billbug feeding are usually visible by mid-June when individual plants start to decline as a result of crown-feeding by the larvae. This early phase of damage appears as dead spots about 2-3" in diameter. As damage progresses, these spots may coalesce to form large, irregular patches of dead and damaged turf (Fig. 8). In areas where hunting billbug is present, patches of turf may exhibit delayed green-up during the spring as a result of feeding by overwintered larvae. Unlike bluegrass billbug, visible damage from adult hunting billbugs feeding on stems and leaves has been reported where populations densities are high.

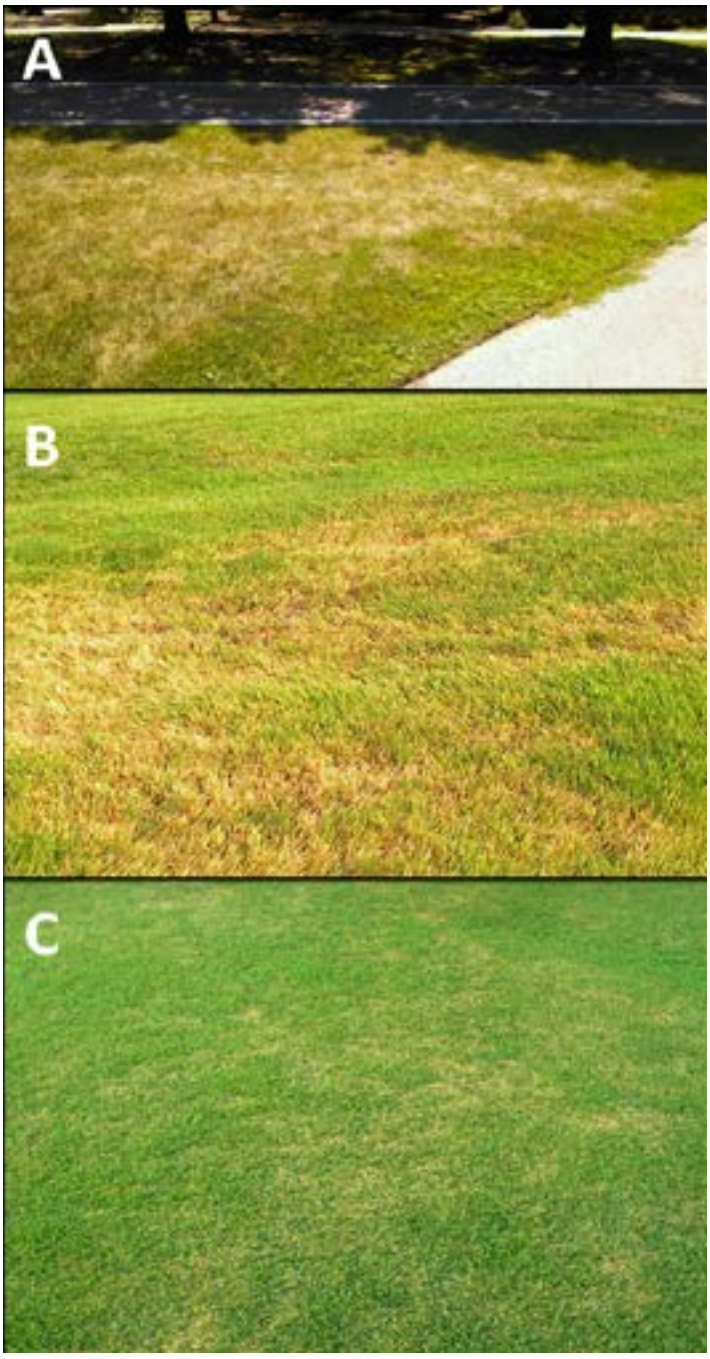

Figure 8. Kentucky bluegrass (A) high-cut zoysiagrass (B) and short-cut zoysiagrass (C) showing typical symptoms of billbug damage.

Detection and Monitoring

Diagnosing billbug damage is a relatively straight-forward process. In areas where damage is suspected, plant crowns can be examined during June, July and August by pulling on dead or damaged stems. If stems easily dislodge or break-off at the soil surface, the bottom ends should be examined for the presence of fine, powdery, sawdust-like material (frass). The presence of this material is diagnostic for billbug larval feeding (Fig. 9). In warm-season turfgrasses such as zoysia or Bermudagrass, a similar technique can be employed, but inspection of plant stolons and rhizomes may also be useful (Fig. 10). Larvae can be detected directly using of a golf course cup cutter or a sturdy knife to cut a core or wedge into the sod about 3 inches deep. The soil can then be broken apart and carefully examined for the presence of larvae in the crowns and roots.

Figure 9. A tug-test can be used to examine the bottom-ends of Kentucky bluegrass tillers that pull easily from the sod and are filled with fine sawdust-like frass indicating billbug damage.

Scouting for adult billbugs can provide an early indication of a potential billbug infestation. Since adults are not capable of sustained flight, they often use driveways, sidewalks, cart paths and curbs to disperse in the spring and late summer (Fig. 11). Experienced turfgrass managers will keep an eye on these areas for adult billbug activity as this can serve as an early indicator of billbug presence. Pitfall trapping can also be used to monitor adult activity and linear pitfall traps can be particularly effective for this purpose (Fig. 12). However, adult activity only indicates that billbugs are present and does not necessarily predict damage by larvae. Unless billbug damage has been previously diagnosed, control may not be warranted.

BILLBUG MANAGEMENT

Billbug management relies on a combination of cultural, biological and chemical tools aimed at keeping populations

Figure 10. Zoysiagrass shoots hollowed-out by hunting billbug larvae. *(Photo Credit: A. J. Patton).*

Figure 11. Billbugs often used sidewalks and curbs to disperse. Observing these areas can serve as a simple monitoring tool. *(Photo Credit: H.D. Niemczyk)*.

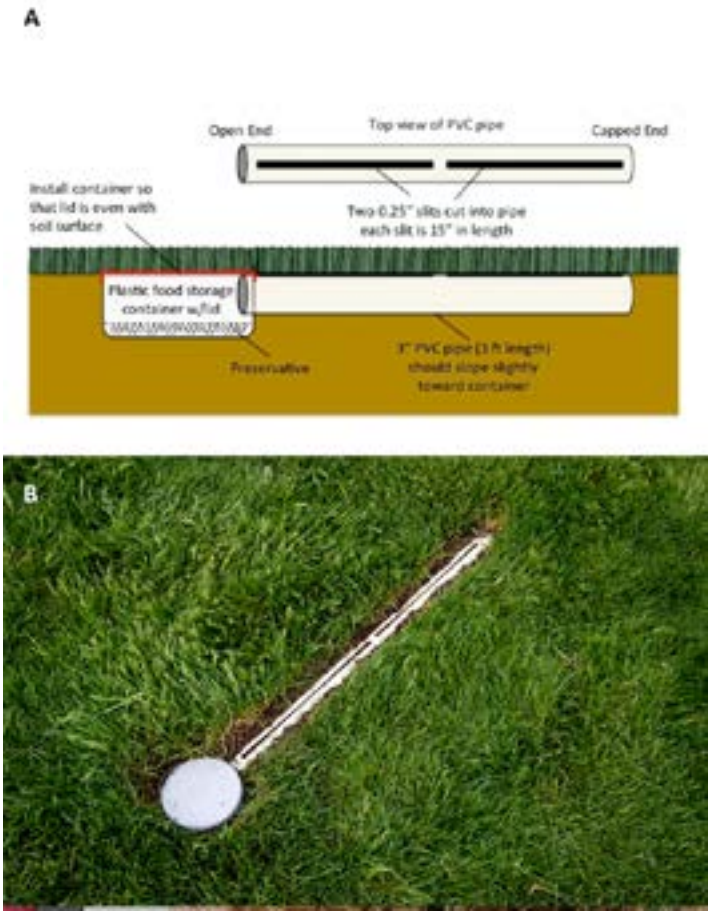

Figure 12. Plans for constructing a linear pitfall trap used to monitor adult billbug activity (A). Installed trap (B).

below damaging levels. Although detection of adults can be an indication of a potential problem, it is usually the larvae that damage plants. Larval populations densities of 10/ft^2 are not uncommon and most healthy turfgrasses may tolerate such densities without suffering significant damage.

Cultural Tools

The primary challenge for turfgrass managers is striking a balance between the functional and aesthetic requirements of the turf and maintaining an environment that is suitable for beneficial organisms and the services they provide. Sound cultural practices that include, 1) selection of turfgrass species and cultivars that are well adapted for a specific site or use and 2) proper mowing, fertilization, irrigation, thatch management and cultivation to promote healthy, vigorous turf. Such turf is capable of tolerating or quickly recovering from insect feeding and serves as the foundation of "integrated pest management" (IPM).

Resistant Turfgrasses

Resistant turfgrass varieties play an important role in integrated pest management because they are less likely to suffer damage and quicker to recover if damage should occur. When complimented by proper mowing, irrigation and fertilization, planting resistant varieties can reduce or eliminate the need for chemical insecticides.

Endophyte-Enhanced Varieties

Endophyte-enhanced (E+) turfgrasses, including many cultivars of perennial ryegrass, tall fescue and creeping red fescue provide resistance to billbug adults and larvae. These grasses harbor symbiotic fungi (*Epichloë spp.*) (Fig. 13) that deter feeding and development of above-ground insects and provide improved tolerance to environmental stresses such as heat and drought. A stand of turfgrass composed of at least 40% E+ plants is generally recommended for providing billbug resistance and overseeding E+ grasses into an otherwise susceptible stand can achieve excellent results. However, reliable estimates of endophyte infection must be assessed in living plants. Infection rates measured in the seed only provide an estimate of initial infection and viable infection may actually be much lower. Low infection rates limit the utility of endophyte-enhanced turfgrasses in IPM. For a list of E+ turfgrass cultivars and initial endophyte infection rates measured in the seed, see <http://www.ntep.org/endophyte.htm>. Endophyte infection rates in living stands of turfgrass can be

assed using a commercial endophyte detection service available from Agrinostics Ltd. Co. <http://www.agrinostics.com>.

Resistant Kentucky Bluegrasses

Several varieties of Kentucky bluegrass exhibit resistance or tolerance to bluegrass billbug, probably due to their finer texture and narrower leaves and stems that are not preferred for egg-laying. Among these varieties are *Arista, Barvette HGT, Delta, Eagleton, Kenblue, Midnight, NuDwarf, Park, Prosperity, Ram I, South Dakota certified, Unique, Wabash, Washington, Wildwood* and *4-Season*. Susceptible varieties include *Broadway, Canterbury, Classic, Georgetown* and *Nassau*. Ongoing efforts to identify additional Kentucky bluegrass varieties that resist or tolerate bluegrass billbug are presently underway at Purdue University.

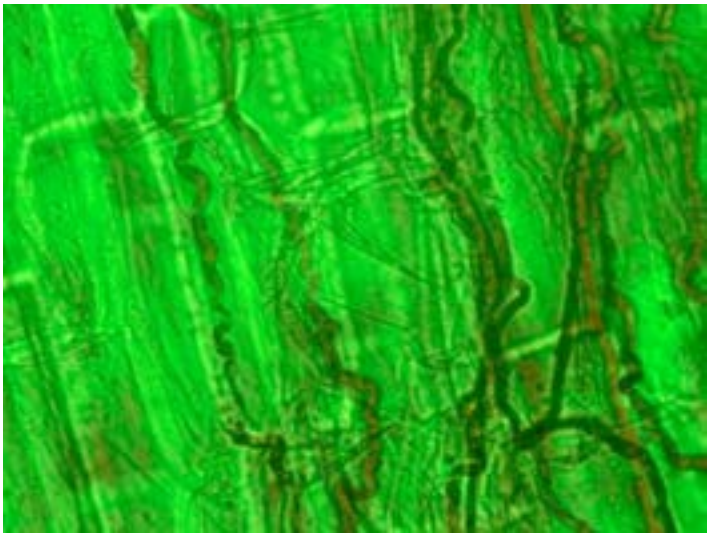

Figure 13. The fungal endophyte *Epichloë festucae* in tall fescue. Note the darker stained fungal hyphae growing between the plant cells.

Resistant Warm-Season Turfgrasses

Several varieties of Kentucky bluegrass exhibit resistance or tolerance to bluegrass billbug, probably due to their finer texture and narrower leaves and stems that are not preferred for egg-laying. Among these varieties are *Arista, Barvette HGT, Delta, Eagleton, Kenblue, Midnight, NuDwarf, Park, Prosperity, Ram I, South Dakota certified, Unique, Wabash, Washington, Wildwood* and *4-Season*. Susceptible varieties include *Broadway, Canterbury, Classic, Georgetown* and *Nassau*. Ongoing efforts to identify additional Kentucky bluegrass varieties that resist or tolerate bluegrass billbug are presently underway at Purdue University.

Biological Controls

Although a host of pathogens predators and parasites will attack and kill billbug adults and larvae, commercially available, effective biological controls are limited primarily to the insect-parasitic nematodes *Heterorhabditis bacteriophora* and *Steinernema carpocapsae* (Fig. 14). *H. bacteriophora* is effective against billbug larvae once they have entered the root zone, whereas *S. carpocapsae* is more effective against adult billbugs. When used properly, these products can provide adequate control and are generally safer than chemical insecticides. However, special considerations must be made when using insect parasitic nematodes.

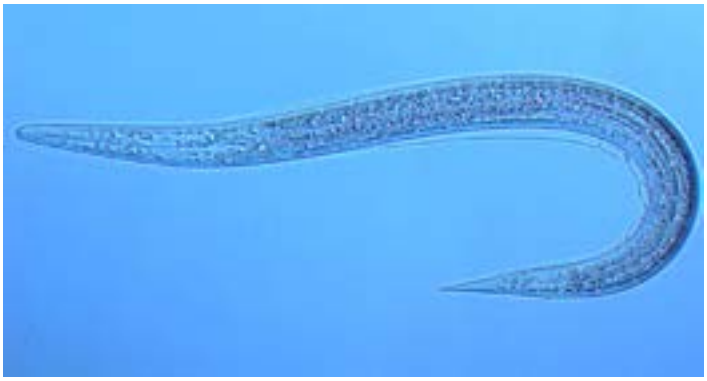

Figure 14. Infective juvenile of the insect-parasitic nematode *Steinernema carpocapsae*; a biological control for billbug adults.

Nematode products should be refrigerated upon arrival and stored as briefly as possible. Nematode viability should be checked prior to application by examining a small amount of the spray solutions with a magnifying glass to ensure the nematodes are active and moving about. After mixing, nematodes should be applied immediately and not allowed to sit in the tank for more than a few hours without agitation. Applications should be made in the early morning or evening to limit exposure to UV radiation and irrigation should immediately follow application in order to wash the nematodes off of the turf canopy and into the soil. Screens should be removed from the spray nozzles and spray equipment should be pressurized to a maximum of 50 psi. CO_2 should not be used to pressurize spray equipment as nematodes may be asphyxiated.

Chemical and Biological Insecticides

There are three basic strategies for using chemical or biological insecticides to target billbugs. Tables 1 and 2 provide lists of active ingredients recommended for each of these strategies. These recommendations are based on knowledge of insecticide efficacy and billbug seasonal biology, and should be implemented with the target species (bluegrass billbug or hunting billbug) in mind.

Strategy 1: Preventive Control of Adults

This approach relies on the use of a surface applied, contact insecticide to target adults as they emerge from overwintering and before they have a chance to deposit eggs. This is also the most effective time for using the insect-parasitic nematode *Steinernema carpocapsae*. Because adult activity during this

time of year can fluctuate with unpredictable spring weather patterns, the primary challenge for using this approach is timing of application. This is especially true when using products with moderate- to short-term residual activity like pyrethroids, carbamates organophosphates or nematodes. However, as a rule of thumb, bluegrass billbugs historically become active by late-April (southern Indiana) or early May (northern Indiana) with hunting billbug activity beginning about 1-2 weeks earlier. Activity of adult bluegrass and hunting billbugs can also be predicted using degree-day (DD) models. With this approach, heat units can be tracked using average daily temperatures starting on March 1 or January 1 for bluegrass billbug or hunting billbug, respectively. A developmental threshold of 50°F is appropriate for bluegrass billbug whereas a developmental threshold of 7.8°C should be used for hunting billbug. Adult bluegrass billbugs first become active around 280 $DD_{50°F}$ whereas overwintering adult hunting billbugs first become active around 75 $DD_{7.8°C}$. A second cohort of hunting billbug adults, those resulting from overwintering larvae, first become active around 400 $DD_{7.8°C}$. After making an application targeting adult billbugs, liquid materials should be left on the surface or only lightly irrigated in order to achieve maximum contact activity. Granular materials should always be lightly irrigated in order to wash the active ingredient from the granule.

Strategy 2: Early Curative Control of Larvae

This approach targets the larvae inside the plant after adults have begun depositing eggs, but before damage is visible. It is a somewhat more flexible approach since it relies on the use of systemic insecticides (neonicotinoids or diamides) that are taken up by the plant and distributed throughout the plant tissues over an extended period of time. In this way, the active ingredients are able to reach the larvae inside plant stems. The neonicotinoids in particular also have good contact activity against adult billbugs so they can be used to target adults while providing residual, plant-systemic activity against the larvae inside the stems. Optimal timing for using this approach is roughly the same as for the adult preventive strategy with efficacy decreasing by mid-June. Post-application irrigation is recommended to wash material into the root zone where it can be taken up by the plants. Bluegrass billbug larvae usually begin tunneling inside stems at 650 $DD_{50°F}$.

Strategy 3: Late Curative Control of Larvae

This strategy targets larvae in the crowns and soil after damage has become apparent. In this regard, it is a reactive strategy aimed at mitigating damage that is ongoing. Most soil insecticides labeled for use in turfgrass can be used in this manner, including neonicotinoids, carbamates, organophosphates, and the insect growth regulator novaluron. The insect-parasitic nematode *Heterorhabditis bacteriophora* is also most effective when used in this capacity. The window for using the larval curative approach is fairly narrow since the appearance of damage is highly dependent on weather conditions (especially rainfall) and can manifest quickly. Larvae of bluegrass billbug start to appear in the soil at 926 $DD_{50°F}$ whereas first generation hunting billbug larvae first appear in the soil around 500 $DD_{7.8°C}$. In order to reach soil dwelling larvae, curative insecticide applications targeting billbug larvae in the soil should be followed with rainfall or irrigation within 24 hours for best results.

Special Considerations for Hunting Billbug in Warm-Season Turf

Because hunting billbugs overwinter as larvae and adults, a prolonged period of adult activity may result during spring and early summer. Overwintering larvae will develop into adults that emerge during this late spring/summer time frame. These two separate, but overlapping cohorts of adults can make proper timing of insecticide applications difficult to achieve. In practice, a combination of the strategies outlined above, with the second application of insecticide 6-8 weeks after the first application may sometimes be required to prevent damage to turf. Please refer to figure 7 for additional timing and targeting information.

Table 1. Active ingredients and management strategies for synthetic (chemical) insecticide products recommended for use against billbugs in turfgrass.

Insecticide Active Ingredient*	Insecticide Class	Management Strategy (Target Stage)[b]		
		Adults (Preventive)	Larvae in Stems (Early Curative)	Larvae in Soil (Late Curative)
Beta-cyfluthrin	Pyrethroid	X		
Bifenthrin	Pyrethroid	X		
Carbaryl	Carbamate	X		X
Chlopyrifos[a]	Organophosphate	X		
Chlorantraniliprole	Diamide	X	X	
Cyantraniliprole	Diamide	X	X	
Clothianidin	Neonicotinoid	X	X	X
Deltamethrin	Pyrethroid	X		
Dinotefuran	Neonicotinoid	X	X	
Imidacloprid	Neonicotinoid	X	X	X
Lambda-cyhalothrin	Pyrethroid	X		
Novaluron	Insect growth regulator			X
Tetraniliprole	Diamide	X	X	
Thiamethoxam	Neonicotinoid	X	X	X
Trichlorfon	Organophosphate	X		X
Zeta-cypermethrin	Pyrethroid	X		

*Always consult label directions for specific timing and application recommendations.
[a]Labeled only for use on turfgrass grown for sod or seed.
[b]See figures 3 and 7 for details about management strategy, timing, and targeting.

Table 2. Active ingredients and management strategies for biological insecticide products recommended for use against billbugs in turfgrass.

Insecticide Active Ingredient*	Insecticide Class	Management Strategy (Target Stage)[a]		
		Adults (Preventive)	Larvae in Stems (Early Curative)	Larvae in Soil (Late Curative)
Heterorhabditis bacteriphora	Parasitic nematode			X
Steinernema carpocapsae	Parasitic nematode	X		
Steinernema riobrave	Parasitic nematode	X		X

*Always consult label directions for specific timing and application recommendations.
[a]See figures 3 and 7 for details about management strategy, timing, and targeting.

READ AND FOLLOW ALL LABEL INSTRUCTIONS. THIS INCLUDES DIRECTIONS FOR USE, PRECAUTIONARY STATEMENTS (HAZARDS TO HUMANS, DOMESTIC ANIMALS, AND ENDANGERED SPECIES), ENVIRONMENTAL HAZARDS, RATES OF APPLICATION, NUMBER OF APPLICATIONS, REENTRY INTERVALS, HARVEST RESTRICTIONS, STORAGE AND DISPOSAL, AND ANY SPECIFIC WARNINGS AND/OR PRECAUTIONS FOR SAFE HANDLING OF THE PESTICIDE.

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