K-STATE
Research and Extension

Grub Management in Turfgrass Using Insecticides

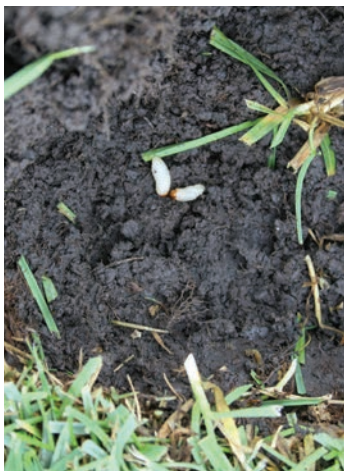
Turfgrass is susceptible to attack from a variety of insect pests located in the soil, in the crown and thatch, or leaves and stems. Insects that feed in the soil include grubs and billbug larvae (Figures 1 and 2). Chinch bugs, billbugs, cutworm, sod webworm, and armyworm feed on the crown and thatch, and billbug adults feed on leaves and stems.

Insect damage to turfgrass can be direct, affecting leaves, stems, and roots, or indirect. Indirect damage is not caused by insects, but rather by raccoons, skunks, armadillos, or other mammals searching for food. It is commonly assumed that moles feed on grubs, but in fact, moles feed on earthworms and do not consume grubs as a primary food source.

White grubs are the larval stage of many different species of beetles (Figure 3). The major white grubs found in Kansas are the Japanese beetle (*Popillia japonica*), Southern masked chafer (*Cyclocephala lurida*), May/June beetles (*Phyllophaga* spp.), and Green June beetle (*Cotinis nitida*), each with a different life cycle. The Japanese beetle and masked chafer have a one-year, or annual, life cycle; however, the May/June beetle has a three-year life cycle and grubs reside in the soil for two years.

Grub Damage in Turfgrass

Grub species with a one-year life cycle (annual white grubs) are more destructive than those with extended life cycles, possibly due to the amount of feeding during the season. Damage is more severe in late summer through early fall when grubs reach the third instar (stage between each molt) (Figure 4) and when turfgrass is exposed to dry



Figures 1-2. There are a number of grub (larva) types that feed on turfgrass. Bluegrass billbug grubs (larvae) feed on turfgrass roots.

Figure 3. White grubs are the larval stage of many species of beetles.

or drought conditions. Conversely, moist soils in August or September tend to mask grub feeding damage and encourage root growth. Grub densities associated with turfgrass damage are higher for irrigated turfgrass (more than 12 grubs per square foot) than for nonirrigated turfgrass (less than 12 grubs per square foot).

Figure 4. Third instar of white grubs.

Environmental Effects on Grub Behavior

Environmental conditions encourage grubs to migrate within the soil. For example, grubs migrate 2 or more inches into the soil to escape winter temperatures and even deeper under extremely dry or drought conditions. In both cases, grubs may escape exposure to insecticides. Environmental effects related to temperature and moisture can influence grub damage and insecticide efficacy. Soil moisture affects the distribution and abundance of grubs in turfgrass, and adult emergence is affected by rainfall or irrigation and soil temperature. Eggs and young grubs are sensitive to temperature and moisture extremes. Young grubs tend to migrate deeper into the soil profile where temperature and moisture levels are more stable. When soil conditions are hot and dry, grubs migrate to cooler and moister conditions. Grubs avoid insecticide exposure by moving deeper into the soil profile.

Control with Insecticides

Two types of insecticides—stomach poisons and those that work on contact — are used to manage grub populations. Grubs must consume stomach-poison insecticides to be negatively affected. Contact insectides kill grubs when they encounter residues in the soil. Preventive insecticide applications (those applied before grubs are present) are recommended for managing grubs in turfgrass. Insecticides should be applied at least four to six weeks before eggs hatch to ensure insecticide residues are present to kill young grubs. Curative insecticide applications (those applied when grubs are already present) typically are not effective. If applied too early, insecticide residues degrade before eggs hatch, so there is not enough active material remaining to kill grubs. In addition, if insecticides are applied too late, grubs may already be causing damage to turfgrass. Moreover, preventive insecticide treatments are not effective against third-instar grubs (Figure 5) late in the season. Insecticides with short residual activity should be applied as soon as eggs hatch as small, young grubs are more susceptible than older or larger grubs.

Figure 5. Large grubs (third instar) are difficult to kill with insecticides.

After an application, irrigate with at least ½ inch of water to move the insecticide into areas where grubs are feeding, thus increasing contact exposure and efficacy. Insecticides degrade due to photodecomposition or exposure to ultraviolet light (sunlight) when left on the turfgrass surface. In addition, a thick thatch layer (more than ½ inch) may inhibit insecticide movement into the root zone. Egg-hatch may be delayed when soil moisture content is less than 10 percent and is a consideration with calendar-timed applications of insecticides. Therefore, an insecticide should be present in the root zone where grubs feed. Irrigate with at least ½ inch of water one or two days before applying, especially when using curative grub treatments such as trichlorfon (Dylox) (Figure 6). Irrigation will encourage grubs to move up near the root zone, thus increasing exposure to insecticides.

Figure 6. Trichlorfon (Dylox) insecticide is a curative treatment for white grubs.

Problems with Spring Applications of Insecticides

Spring applications of curative insecticides are not recommended, partly because post-overwintering grubs are large and difficult to kill. In addition, turfgrass produces an abundant root mass and can outgrow feeding damage, although this depends on grub density. With spring applications, there is no protection against reinfestation when adults lay eggs during the summer. Inadequate grub control may occur when the insecticide and grubs are not present at the same time and location in the soil profile, thus preventing grubs from coming into contact with insecticide residues. Soil temperature and moisture levels influence grub behavior and the movement of insecticides through the soil profile. For example, cool temperatures decrease insecticide activity, which is why fall insecticide applications are not recommended.

Factors that Impact Insecticide Effectiveness

Factors that influence effectiveness of insecticides against grubs include improper timing due to grub size (more or less than ½ inch), improper calibration of equipment, volatilization (loss of insecticide from leaves and/or soil surface by evaporation), photodecomposition (breakdown of insecticide residues when exposed to direct sunlight), chemical degradation (breakdown in soils with a pH >7 or binding by soils with high organic matter or clay content), and microbial degradation (soil bacteria or fungi that consume insecticide).

Fate of Insecticides Associated with Turfgrass

Insecticides applied to grass blades and the soil surface are exposed to heat and ultraviolet radiation from the sun, resulting in rapid decomposition and deactivation of insecticides. However, this depends on the time of year (spring vs. summer). Liquid formulations must be washed off grass blades, stems, and crowns before drying occurs. Always irrigate immediately after applying granular formulations to wash the active ingredient off the carrier and allow it to move through the thatch layer and into the soil profile where grubs reside.

Two properties of insecticides affecting movement within the soil profile are adsorption to organic matter and water solubility. Water solubility determines how rapidly insecticides are washed from grassblades and stems or the carrier particles within granular formulations of insecticides. Insecticides applied to turfgrass can be absorbed by organic matter, thus preventing movement into the soil profile where grubs are located. Furthermore, insecticides that are less water soluble are more prone to binding by organic matter (thatch) as compared to insecticides that are more water soluble.

Cultural Practices

The best way to alleviate problems with grubs is to maintain a healthy turfgrass by implementing proper cultural practices such as watering or irrigation (Figure 7), aeration or dethatching (Figure 8), and adjusting the soil pH. Turfgrass should be irrigated deeply and infrequently to develop a well-established root system. Irrigate before applying an insecticide to lure or retain grubs within the target root zone. After applying insecticides, irrigate with ½ to ¾ inches of water to move the insecticide into the target root zone.

Rainfall and irrigation can also influence adult beetle behavior. For instance, adults may remain in the soil under dry conditions, which can delay emergence until irrigation or rainfall moistens the soil. Once beetles emerge and mate, females search for moist locations to lay eggs. In fact, irrigating turfgrass can increase egg-laying by adult females. For example, Japanese beetle adult females are

Figure 7. Watering turfgrass.

Figure 8. Regularly aerating turfgrass will increase the effectiveness of insecticides against white grubs.

attracted to moist (irrigated) turfgrass for egg-laying. Eggs are laid in moist soil 1 to 2 inches deep, which enhances egg survival. A soil moisture content less than 10 percent may result in high egg mortality.

A thatch layer greater than ½ inch thick (Figure 9) or more than 5 percent organic matter can restrict insecticide movement into the soil profile and reduce efficacy against grubs. A very thick thatch layer (more than 1 inch) can increase the breakdown of an insecticide due to chemical or microbial degradation. The level of thatch-binding depends on the insecticide. For example, trichlorfon (Dylox) is less sensitive to thatch-binding than most insecticides. Some insecticides have a greater affinity for organic matter, making them unsuitable for use against grubs in soils with high organic matter.

Figure 9. Thick thatch layer.

Another factor is pH, which is a measurement of the concentration of hydrogen ions (H^+) in a solution. The scale ranges from 0 to 14. A pH value below 7 is acidic and a pH value above 7 is basic or alkaline. A pH value of 7 is neutral. When the pH of the soil or spray solution is above 7, certain insecticides undergo a degradation process called alkaline hydrolysis in which insecticide molecules fragment. Insecticides in the chemical class, organophosphates such as trichlorfon (Dylox) are very sensitive to alkaline hydrolysis. In addition, as soil pH increases (>7) insecticides decompose more rapidly or the half-life (time required for ½ of the insecticide active ingredient to break down) is reduced. As soil pH increases, the efficacy against grubs decreases (based on percent mortality).

Summary

Proper application of insecticides results in higher mortality of grubs in turfgrass. Applying insecticides before egg hatch and watering in after application ensures residues are present when grubs hatch from eggs. In addition, implementing proper cultural practices such as irrigation, dethatching or aerating, and keeping the soil pH below 7 helps to maximize the performance of insecticides against grubs in turfgrass.

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