Does Milky Spore Disease Work?

IPM Corner

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Many factors have led to the current interest and increased demand for environmentally benign alternatives to traditional pesticides. Industry has responded with an ever-growing list of "new" materials. One category of products experiencing this upsurge in the marketplace is microbials: products based on fungi, bacteria or viruses. In general, successful use of these materials requires greater attention to environmental conditions (temperature, moisture, structure, pH, etc.) and determining results can be problematic, as they may not be obvious or immediate. Managers accustomed to the relative simplicity and convenience of synthetic pesticides can avoid frustration by becoming familiar with the limitations and performance of microbial products.

Many microbial products have only recently appeared commercially, while some have been around for quite some time. Foremost among these is *Paenibacillus (Bacillus) popillae*, milky disease (commonly referred to as milky spore disease and sold commercially as Milky Spore), the first microbial product ever registered in the US. First detected in New Jersey in 1933, USDA trials of milky spore began back in 1937. The commercial registration followed in 1948.

How Milky Spore Works

The basic mode of action is that Japanese beetle grubs ingest the bacterial spores as they are feeding and, provided they ingest a sufficient amount (5-10,000 spores) and the soil temperature is high enough, the spores reproduce within the grub. This results in the hemolymph (internal insect fluids) turning an opaque white—hence the name milky disease. Infested grubs eventually die and the spores, several billion, are dispersed into the surrounding soil. Persistence in the soil is from 2-10 years though persistence in a treated area may be as long as 30 years due to recycling through grub populations.

Commercial production of milky disease remains dependent on obtaining it from infected grubs (*in vivo* production). Several years ago a technique for producing it on artificial media (*in vitro* production) was registered and the products were widely marketed. Unfortunately it turned out that a different but related bacteria was actually being produced which did not have any activity against the grubs. Disappointing results naturally followed and the products were withdrawn from the market. Current production, by a different company, is back to using the earlier method.

Temperature-Related Limitations

While spore reproduction can occur at temperatures of 16℃ (61℉), ideal soil temperatures are between 19℃ and 21℃ (approximately 66℉ to 70℉). As soil temperatures are often below this in the north during the primary grub feeding period (third instar grubs in the fall and spring), many question the efficacy of the disease in these colder areas. This question remains unresolved, partially because the nature of the organism makes determining efficacy difficult. You can check infectivity in the course of fall grub sampling by examining third instars. The normally opaque area on the rear of infected grubs will be the characteristic milky white. You can also clip off a leg from the grub and examine the droplet of hemolymph that forms at the cut for this same coloration.

Dividing the number of infected grubs by the total number of third instar Japanese beetle grubs examined will give you a rough percentage. As only a portion of the grub population will be third instar in the fall and some may have already decayed, a more accurate measure would be to sample periodically from late summer through the fall and into the spring just before pupation. However, the inconvenience of adding more tasks to the already crowded schedule most turf managers follow far outweighs the small increase in precision gained.

Application Procedure

The application procedure involves "seeding" the spores into the soil and relying on infected grubs to eventually spread it throughout the soil profile. This has several implications.

A white grub infected with milky spore disease. Regular infection can serve to increase bacteria populations and continue to suppress grubs under optimum conditions.

Results, if any, will take several seasons (3-5 years in cooler climates according to manufacturer's literature) to manifest themselves—a far different situation than the relatively "instant" results managers, and researchers, are accustomed to. The higher the Japanese beetle population in the first few seasons following application, the faster the soil will become thoroughly inoculated with spores. Milky disease is compatible with traditional grub insecticides so they can be used on turf treated with the bacteria. However, controlling grubs with an insecticide runs counter to the reliance on infected grubs for spread of the disease and may slow its dispersal.

How Effective Is It?

Where it works, the overall effect of milky disease is as a population suppressant, not as a direct control. Hopefully it keeps Japanese beetle levels below a damage threshold. If you are considering using milky disease you may want to check before applying to observe the ambient level of disease activity. In areas conducive to spore reproduction it's not unusual to find some incidence of the disease. While it is technically possible to bioassay the soil for the presence of the disease the complexity of doing so makes it impractical for field use.

Another concern is that milky spore only affects one species of "white grub" and in areas where Japanese beetle is neither the sole nor the predominant species this can be a serious issue. Knowing or checking the species composition of your grub population allows you to better gauge any possible benefit. Likewise, knowing the typical soil temperature profile during the fall and early spring will help you determine the likelihood of success. Post-application sampling in the following seasons can confirm or deny the anticipated results.

While more attention to detail is usually involved in successfully using organism-based products, the attraction, pressure and, in some instances, necessity of incorporating alternatives into your pest management program may warrant the time spent determining their viability and potential usage on your turf. More than ever, basic agronomic practices will prove their importance in raising the tolerance level of the turf as fewer products are available to compensate for deficiencies in this area. Hopefully, the ever-growing pressure to rely on materials such as milky disease will spur the research needed to advance their usefulness in pest management programs.

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