farm to sod production. The farm in Hammonton was purchased primarily for its soil conditions, water access and prime location for its tri-state sales. In 1980, the business was purchased by Walter's sons, Tom and George, who continue to operate it today with their sons, John (turf production), James (office management and sales), Philip (farm manager), and David (dispatcher). The farm produces mainly bluegrass sod and tall fescue sod. Approximately 83,000 pounds of seed are planted each year.

This farm is big! The Hammonton farm is approximately 6 miles in perimeter. As the busses drove through the verdant sod fields in varying stages of growth development, over the remarkably smooth dirt roads, I admired the irrigation system that the farm uses. This irrigation system uses a number of large above ground irrigation machines on wheels that can roll over the field on a big circle from a central vertical water pivot. The large horizontal pipe with sprinkler heads is called a lateral. The size of these water pivots and laterals range from 1,100-2,000 feet in length, and deliver a water volume of 700-1,000 gallons per minute. The water is supplied from 120'-150' deep wells (10-18" wide) on the farm. George Betts said that it takes 2 days to water the entire farm.

The first stop was a demonstration of how they harvest big roll sod. I was expecting to see a mammoth harvesting machine. Instead, I was amazed that a 30 hp tractor with a 3 pt. hitch mounted harvesting implement not much larger than an aeravator was capable of harvesting a 4'x50' roll on sod in less than a minute. Fork lifts load the big rolls on a flat bed semi in record time. George said that they can harvest an acre of big rolls in about 2 hours. And as easy as it appeared to harvest the big roll, the crew gave a demonstration on how to install big roll sod using a tractor equipped with a tool mounted on the 3 pt. hitch that holds the big roll. Tuckahoe will install the sod for you or the attachment is available for you to do it yourself.

Next stop was across the farm to another field where a crew was harvesting the more common slabs of sod that are loaded on pallets. The harvesting machine is configured around a tractor, the pieces are cut, and a conveyor moves the slab from the ground up to a couple of workers who stack the sod on a pallet. The entire work area is under a canopy protecting the workers from the elements. When the pallet is full, the machine drops the pallet on the ground where the fork lifts load it a flatbed. There are about 500 square feet. of sod on a pallet. 1 acre of pallets can be harvested in about 4 hours. The farm's eight delivery tractor trailers each hold about 11,000 square feet per truck. This fall, 2 new auto stackers will replace the older harvesters.

In addition to growing sod, Tuckahoe Turf Farm does specialty work such as golf course restoration and installation, athletic fields and major off site seeding projects. They also operate a supply store, selling seed, fertilizer, tools and more. The day concluded with the awarding of pesticide credits.

Our sincere thanks go out to Frank LaSasso and his Team, the Hammonton Board of Education, the Betts family, John Doyle, Dr. Henry Indyk, our featured speakers, members of the Board of Directors and all who helped and who attended for making our Spring Field Day a success. ◆

White Grub Management in Athletic Field Turf

Biology of the white grub complex **by Dr. Albrecht M. Koppenhöfer***

In the northeastern USA, a complex of primarily introduced white grub species are the most widespread and destructive turfgrass insect pests. Until recently, the Japanese beetle (Popillia japonica) was regarded as the key species, but surveys have indicated that the oriental beetle, [Exomala (=Anomala) orientalis] has become the most important white grub species in New Jersey and some neighboring areas. Thus, the average white grub species composition in New Jersey home lawns in fall 2001 (5 counties, 61 sites, primarily central NJ) was 63% oriental beetle, 14% Asiatic garden beetle (Maladera castanea), 9% northern masked chafer (Cyclocephala borealis), 8% Japanese beetle, 4% May/June beetle (Phyllophaga spp.), and 2% green June beetle (Cotinis nitida) (Koppenhöfer et al. unpublished data). Another species, the European chafer (Rhizotrogus majalis) is the major low maintenance turfgrass pest north and west of New Jersey and may be more common in northwestern counties of New Jersey. However, it is important to keep in mind that species composition can vary considerably among sites.

Different white grub species can vary significantly in susceptibility to different control agents. Therefore proper species identification can be critical. The safest way to identify white grub species in the larval stage is to examine the raster pattern just in front of the anal slit on the grub's underside (Figure 1, see insert). Identification is the easiest when the grubs are 3rd instar larvae but at this point, the damage is often already done or impending. Therefore, identification should be done when grub populations are being monitored to determine whether curative treatments are necessary, i.e., in mid August.

Although the general life cycle of the important white grub species is very similar, the egg-laying period (major target for preventive treatments) and accordingly the occurrence of the voracious 3rd larval stage can vary by a few weeks among species; another reason for obtaining knowledge about the prevalent species in a turf site. Adult beetles emerge between June and August, mate, and the females return into the soil to lay eggs (total of about 20-60) in several batches over a period of 2-4 weeks. The egg stage, 1st larval stage, and 2nd larval stage each last about 3 weeks so that through September most of the grubs will molt to the 3rd and last larval stage. As the soil temperatures cool down in October, the grubs move to deeper soil layers to stay below the frost line to overwinter. During this time most species are more or less inactive. As the soil temperatures warm up in spring, the grubs come up to the root zone to feed for another 4-6 weeks in April and May before they pupate in the soil.

Signs of infestation

White grubs damage turf by chewing

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off roots close to the soil surface. The voracious feeding of the larger late 2nd stage and 3rd stage grubs, when combined with hot and dry conditions, can result in quick and extensive loss of turf from late August through mid-October. All cool-season and many warm-season grasses are susceptible to white grubs. Being alert to the signs and symptoms of white grub infestations will help avoid unexpected loss. Early signs of a white grub infestation include gradual thinning, yellowing, wilting in spite of adequate soil moisture, and the appearance of scattered, irregular dead patches. The patches grow and may join together until large turf areas are affected. Due to the grubs' tunneling activity, infested turf feels spongy underfoot and can be pulled up easily, exposing the C-shaped white grubs. Secondary, often more severe, damage can be caused by vertebrate predators (e.g., crows, skunks, raccoons), that tear up the turf to feed on the grubs.

Early detection, sampling and monitoring, damage thresholds

Mid- to late August, when the grubs are primarily 2nd instars, is the time to monitor for potentially damaging white grub populations. The only way to accurately determine the presence of white grubs is through examining the upper 3-4" of soil under the turf. Most conveniently turf/soil plugs are sampled with a standard golf course hole cutter (4.25" diam ~ 0.1 ft2). More tedious is the use of an oversized hole cutter (6" diam ~ 0.2 ft2; "turf mender") or cutting a square-foot sample with a flat-blade spade. The plugs can be broken up and examined on the spot (preferably on a tray). To improve sample survival, split the soil end of the sample first into halves and then quarters and smaller pieces to reveal the grubs that typically will occur near the thatch-soil interface. Record the number, species (check raster pattern with a hand lens), and life stages on a data sheet or map. Place the soil back in the hole and replace the sod cap. Irrigate to promote turf recovery especially when dry. Because white grub populations have a patchy distribution, several samples should be taken in a grid pattern. Rarely does an entire turf area require treatment.

To save time and effort, sampling can be concentrated on suspected infestation areas, high risk or low tolerance areas, or areas with a history of grub infestations. If historical information is not available and/or a more accurate idea of grub distributions is necessary, mapping and surveying is the thing to do. Using graph paper, prepare a general map of the turf area including landmarks. Mark sampling spots at 6-10 feet (lawns) or 10-20 feet (sports fields) apart in a grid pattern. At each spot take a sample and record number, species, and stage of grubs found (also record 0s!). Experienced samplers can process about 20 samples per hour.

To determine whether treatment is required, transform the grub numbers into 'per ft2'-values and compare to damage thresholds. Most published damage thresholds lie in the range of 6-10 (Japanese beetle, oriental beetle, European chafer) and 15-20 (Asiatic garden beetle) grubs per ft2. However, damage thresholds vary considerably with grass species, management type, and climatic conditions. In well-maintained tall fescue plots I have repeatedly observed grub densities in the range of 30 to 60 grubs per ft2 without any signs of turf damage. With experience, turf managers should develop their own range of thresholds for the various turf

areas they are responsible for.

Preventative white grub control

The arrival of new insecticide chemistry with long residual activity in the soil in the last few years has added preventative applications as an option in the management of white grubs. The 2 insecticides presently on the market, Merit, a neonicotinoid, and Mach2, an insect growth regulator, can be applied as early as late May and June, respectively, to provide season-long white grub control. If applied that early, various other insect pest can also be controlled (Merit and Mach2: billbugs, annual bluegrass weevil, greenbugs; Mach2: cutworms, sod webworms) or at least suppressed (Merit: chinch bugs). If white grubs are the primary targets, the optimal application time for Merit and Mach2 is June/July when the female beetles are laying eggs. At this time, control efficacy against many white grub species is typically in excess of 90%. As the larvae hatch and go through their 3 larval stages, they become less susceptible to these insecticides (and other insecticides). Applications against the 3rd larval stage in September are not recommended.

Oriental beetle is very susceptible to Merit but MACH2 has only provided 50-60% control on average and should be applied right around peak egg-laying activity. Japanese beetle is very susceptible to Merit and Mach2, and even mid-September applications can still provide around 70% control. Applications after mid-August, however, may not kill the grubs quickly enough to avoid impending damage. Masked chafers are less susceptible to Merit, and where this species prevails, applications should be done during egg laying (June-July) and at the highest label rate. The European chafer appears to be less susceptible to Mach2 and Merit, and applications should be done during the egg laying period (June) and at the highest label rate. The Asiatic garden beetle appears to be immune to Mach2 and Merit.

The obvious disadvantage of preventative applications is that they have to be done before white grub populations can be estimated through soil sampling. Thus, preventative applications are often applied to areas that would need only partial or no control at all. This increases the cost of grub management, resistance development, and may in the long-term dramatically reduce populations of natural enemies by depriving them of prey or hosts. Smart turfgrass manager will restrict preventative applications to high-risk areas, i.e., areas with extremely low damage threshold and tolerance, areas with a history of white grub infestations, and areas with high beetle activity (egg-laying) in June-July.

Curative white grub control

If soil sampling has revealed white grub populations, areas with densities above treatment thresholds or ongoing damage may need to be treated. This curative control approach works best if applied while the grubs are still smaller (i.e., mid August to early September). Monitoring and sampling helps optimize application timing and restrict treatments to areas that actually have high grub populations. Once the grubs have reached the 3rd instar, they are much harder to control. Spring applications (late April through May) are generally the least effective and rarely justified because the grass can outgrow most grub populations. Only extremely high grub populations, unduly stressed turf, or digging grub predators can cause damage at this time. Any necessary treatments need to be applied before the grubs pupate. Due to the annual life cycle of the grubs, areas that had no damaging infestation or were successfully treated in the previous late summer/fall, will not need treatment in the following spring.

For best results with any insecticide, mow the turf and rake out dead grass and thatch before treatment. This will reduce the amount of insecticide bound up by surface debris. Irrigate with 0.5-1" water immediately after treatment (or timely rainfall) to leach the insecticide into the root zone where the grubs are feeding. Irrigation also increases insecticide contact by drawing the grubs closer to the surface. If the soil is very dry, pre-treatment irrigation 1 day before treatment will also increase efficacy by bringing grubs closer to surface and reducing thatch binding and evaporation of liquid treatments. However, do not apply soil insecticides to saturated soil. Also, granular formulations need to be applied to dry grass to allow the granules to sift down into the thatch. Liquid and granular applications are usually equally effective, however, granular formulations may be more forgiving if post-treatment irrigation is delayed.

Successful treatments typically kill 75-90% of the grubs but product performance varies with soil type, thatch thickness, and grub species. Therefore, evaluate treatments and keep record of product performance. While speed

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of kills varies with insecticides, soil insecticide applications never work overnight. Affected grubs usually turn yellow or brown within a week of treatment. Wait at least 1-2 weeks before evaluating. But don't wait longer than 3 weeks to allow for a follow-up treatment if the 1st treatment was ineffective. In the latter case, don't apply the same product again at a rate exceeding the label rate. Rather try a different compound. While development of grub resistance to insecticides is unlikely with the presently used short-residual insecticides, some grub control failures can be caused by enhanced microbial degradation of the insecticide, especially after repeated insecticide use. Avoid unnecessary applications and alternate insecticides.

The range of insecticides available for curative white grub control has already and will continue being effected by the implementation of the Food Quality Protection Act of 1996. Among the organophosphates, only trichlorfon (Dylox) and diazinon (Diazinon) are still available. However, Diazinon production and retail sale is supposed to stop in August 2003. Diazinon may also not be very effective against Japanese beetle grubs. Of the carbamates, only carbaryl (Sevin) is still available but generally does not seem to provide good white grub control. Presently available nematode products for grub control contain the species Heterorhabditis bacteriophora, Heterorhabditis megidis, or Steinernema glaseri. These nematodes can be very effective against Japanese beetle and masked chafer grubs, but are not effective against grubs of oriental beetle, Asiatic garden beetle, or European chafer. While these nematode products have to be handled and stored with more care than chemical insecticides (you are dealing with living organisms!), they have the advantage of no reentry interval due to their non-toxicity. Use of the halofenozide (Mach2) and imidacloprid (Merit) is generally not recommended for curative control. While they

may still provide good overall curative control depending on grub species (see above), their speed of kill is too slow to prevent impending turf damage.

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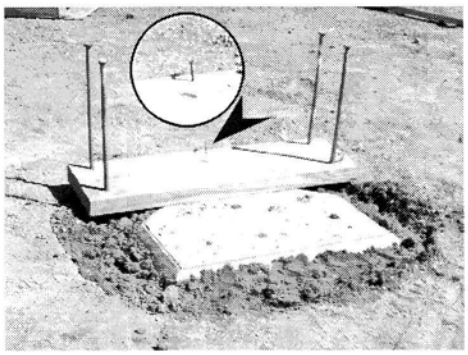
Drive a nail 1" or 2" from the edge, centered on the board from end to end. Allow the nail to protrude through the bottom of the board ¼" or so. File or round the point of the nail to eliminate danger of being stuck by the point of



the nail. Position the board with the nail contacting the home plate at the apex and stabilize the board utilizing landscape spikes. The nail can then be used as a connecting point for your string or tape measure, which can be pulled in any direction from that point.

If you have a solution to a common problem we would like to hear about it. Fax it to (908) 730-7770 or email it to hq@sfmanj.org ◆