1995 and 1996 Turf Insect Monitoring Studies

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Summary: An insect monitoring study was conducted in 1995 and 1996 to build on data generated in 1994 and to enable superintendents to predict the occurrence of key insect pests in advance of significant damage. Weekly black light trap counts of adult insect pests of turf were collected from April 17 - October 17, 1995. In 1996 the study period was lengthened to March 1 - December 1, 1996 to better characterize insect populations. Key results include:

Black turfgrass ataenius (BTA) continued to be the most damaging pest detected, particularly in the non-desert areas of Southern California. Cool-season greens, tees, fairways and roughs were infested, but insecticide applications were made primarily to greens. The proximity of golf courses to rivers, wooded areas and/or livestock operations seemed to increase the chances of a BTA infestation. Up to five generations of BTA were observed from March through November, with the highest populations occurring in July, August and September. Black light trap data on adult BTA was effectively used to predict the appearance of BTA grubs. During the summer months, grubs were most likely to be found 1 - 14 days after a peak adult population. Grubs were most commonly found at the thatch-soil interface.

Masked chafer grubs demonstrated different behaviors in Low Desert golf courses vs. inland courses vs. coastal courses. At coastal courses, chafer grubs have not been identified as causing serious problems during the three years of this study. Despite this fact, we have seen high numbers of chafer adults at coastal courses, with one large peak of activity seen very consistently in the last week of June. At inland courses, the adult population dynamics were similar to coastal locations, but the grub stages of the chafer actually caused damage on tees, fairways and roughs (but not on greens) at some inland locations during July and August. In the Low Desert, chafer grubs caused severe damage on greens and tees at many golf courses during July and August, and may have been mis-identified as black turfgrass ataenius grubs in some cases. Two peaks of adult chafer activity were observed in the desert -- one in late May/early June, and another in late August/early September. It is likely that a different species of chafer is responsible for each peak.

Black cutworm and common armyworm adults had 4 -5 key peaks between June and October, but were constantly present at low levels at all

other times. The highest populations occurred in June and in October, with several superintendents reporting the season's worst worm infestations as late as November. Larval infestations were worst 2 weeks after adult moth peaks. Damage was worst following aerification. 1996 populations were substantially lower than 1995 populations at almost all test locations.

Overall damage from insects was worst in July, August and September when turf is most stressed and therefore least likely to resist feeding.

Monitoring programs for BTA, chafers, cutworms and armyworms were developed to help avoid serious insect damage, and are described below.

Background: The turf insect monitoring study was first conducted in 1994, and among its conclusions was that the populations models currently available for predicting BTA and cutworm development were not useful in our sub-tropical climate, where air temperatures rarely dip below 32° F. As a result, the reliance on black light traps to predict the occurrence of insect populations and to effectively time management practices is even higher. The objective of the 1995 and 1996 turf insect monitoring studies was to continue to determine timing and occurrence of key turf insect pests including cutworms, armyworms and BTA, to develop better monitoring techniques for these pests and to more effectively time management practices.

Materials and Methods: In 1995, the first samples were shipped to PACE on April 17, 1995 and last samples shipped on October 17, 1995. In 1996, the first samples were shipped on March 1, 1996 and the last samples on December 1, 1996. Black light traps (Bioquip [Gardena, CA] Model 2851 A) with 22 watt black lights (Bioquip Model 2851 L) and with 120 volt AC photoelectric switches (Bioquip Model 2833A) were installed by each cooperator at a convenient site with electrical power (usually from irrigation control box or weather station) and within clear eye-shot of the turfgrass area under study. A 2-inch section of Vapona pest strip was placed in each bucket. The strip was changed monthly or sooner if live insects were found in the trap.

Insects were collected from traps by golf course personnel each Monday or Tuesday and were placed in mailing envelopes which were in turn placed in cardboard boxes for shipment to PACE Consulting. Weekly reports identifying the presence and abundance of the pest insects in Table 1 were provided to each cooperator via FAX by PACE Consulting.

At 3 courses in 1995 and 4 courses in 1996, incomplete data sets were generated due to vandalism or malfunctioning of insect light traps. Pest insects detected in the studies are listed in Table 1 and non-pest insects detected are listed in Table 2.

Results and Discussion:

BLACK TURFGRASS ATAENIUS:

The black turfgrass ataenius (BTA), *Ataenius spretulus,* was the most damaging and most difficult to control insect detected, particularly on stressed cool season turf (bentgrass, ryegrass, bluegrass and mixtures). Although adult BTA populations were highest in the Low Desert, infestations from BTA grubs were more common at coastal and inland courses. Exactly where BTA grub populations are located in the Desert is at this point unknown, but it is likely that they are developing on Bermudagrass fairways and roughs or in non-turfgrass areas, without causing any visible damage.

BTA Appearance: The white to gray, “C” shaped grubs are difficult to detect due to their small size (1/10” - 1/3” long) and their occurrence underneath the turf at the thatch/soil interface. To distinguish BTA grubs from other grubs, you must use a 10X hand lens to examine the **raster,** which is the underside of the grub's hind segment. BTA grubs are unique in having two pad like structures at the end of the raster, while other grubs (June beetles, chafers, etc) do not.
The adult BTA is a small (1/5” long) black beetle with longitudinal ridges on its wings. The adult causes no damage to turf, but is the most commonly encountered stage due to its habit of walking across greens and tees during the daytime, and flying short distances, particularly around lights, during warm summer evenings.

BTA Damage: The presence of BTA caused two types of damage. The first resulted from

presence of the BTA adult beetle, a small black beetle which is frequently found walking on the surface of turf. Although this beetle does not cause any direct damage to turf by feeding, birds such as crows and starlings find the beetles very attractive. As a result, birds often cause damage to turf in their search for BTA adults to feed upon. The second type of damage caused by the BTA is through the feeding of the small white BTA grubs on the roots of turfgrass. These immature stages of the BTA live their entire existence underground, usually feeding at the thatch-soil interface (in fact, the commonly held belief that BTA grubs migrate downwards when soil temperatures are hot did not appear to hold up; we found grubs present 1/2" below the soil surface even when soil temperatures exceeded 100°F). In the early stages of infestation, BTA grub feeding results in small, irregularly shaped yellowing or browning patches of thinning or wilted turf that looks similar to symptoms of root diseases such as summer patch. As the infestation progresses, large areas of turf become yellow to brown, and are easily scalped during mowing.

Although present on Bermudagrass, BTA grubs rarely cause damage there due to the fibrous and deep root system which can withstand significant feeding damage. Cool season turf, with it's shorter and less extensive root system (especially in the summer) is more susceptible to root feeding by grubs. Sparse populations of BTA grubs rarely cause damage and are in fact rarely detected. However, the presence of BTA grubs in 50% or more of the soil samples taken (as described below) should trigger treatment in most cases.

BTA Life cycle: Adult trap count data indicated that at least 3, and up to 5 generations of BTA adults occur in California from March through November. This is in contrast to the 1 - 2 generations recorded for BTA in the eastern U.S., where it has been most widely studied. Although significant numbers of BTA adults were captured at almost all golf courses, their presence did not necessarily always result in serious grub infestations. This is because grubs may be developing on fairways, roughs or even in non-turfgrass areas where their impact is not significant.

BTA Risk Factors: BTA populations appeared to be worst in areas characterized by one or more of the factors below. When monitoring for BTA, use these risk factors to locate areas where BTA are most likely to occur.

Turf Risk Factors for the BTA

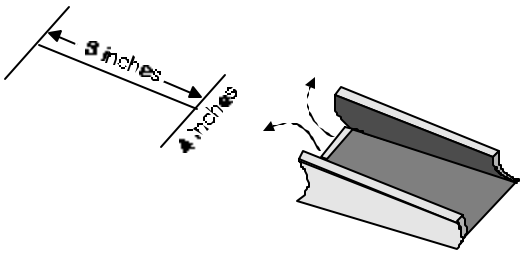
1. Wet spots (particularly where black layer occurs) in low areas, near sprinkler heads, or in poorly draining soil
2. Stressed turf/short roots due to:

- prolonged periods of high temperature
- high soil salinity
- heavy traffic, particularly around collars
- low mowing height

3. Cool season turf varieties, particularly bentgrass and bluegrass
4. Golf courses near river bottoms and/or livestock operations
5. Signs of bird damage
6. Presence of adult BTAs on greens or in black light traps
7. Areas previously infested with BTA grubs

Monitoring for BTA: Monitoring for BTA grubs is problematic because it involves sampling underneath the turf where grubs feed. As a result, some damage to turf cannot be avoided. Most textbooks recommend the use of cup cutter samples (2 -3 locations per green), but this is highly destructive to turf. We have developed a somewhat less destructive method which is illustrated below. However, stressed turf on greens will still show some signs of damage following use of this method as well.

Sampling for black turfgrass ataenius grubs: Using a knife, make a six inch long straight line through the damaged turf, cutting deeply enough to go just beyond the thatch. Cut perpendicular lines about 4 inches long to form a "T" at either end (diagram on left). Peel back the turf as illustrated below, and examine soil for grubs.



To minimize damage from sampling while still insuring that BTA infestations are detected BEFORE they cause damage, the following monitoring program is recommended:

- beginning in May, sample for grubs in 2 - 3 locations per green or fairway every 2 - 3 weeks using the method illustrated above.
- to narrow down the number of areas that need to be sampled, concentrate sampling efforts in the high risk areas identified above, as well as in areas that show signs of BTA feeding damage.
- consider treatment when grubs are found in 50% of samples taken or when signs of BTA feeding damage are seen
- continue monitoring through September

Control of BTA: **The target of BTA control measures should be the grub, or larval stage of this insect.** Although there are several effective products for control of adult BTA, the problem is rarely solved by insecticide applications targeted against adults. This is because there are large reservoirs of adult BTAs from fairways, roughs and non-turf areas around your course, and it is impossible to kill them all. In addition, because BTA adults have been found in several cases where grub infestations never developed, targeting the adult could result in unnecessary insecticide applications.

Products labeled for control of BTA larvae include **trichlorfon (e.g. Dylox or Proxol)** and **imidacloprid (Merit)**. In PTRI tests conducted in 1995 and 1996, these products showed good to excellent results against BTA larvae. All products should be watered in with at least 1/10" water.

MASKED CHAFERS:

High numbers of masked chafer adults were observed at almost all courses. The predominant species was the Pasadena masked chafer, *Cyclocephala pasadenae.* In most cases, a single peak of adults was observed very consistently each year in late June and early July. However, in the Low Desert, two peaks of adult activity were observed -- one in late May/early June, and another in late August/early September. It is likely that a different species of chafer was responsible for each peak.

Masked chafer appearance: The large (1 - $1^{1}/_{2}$ inches long) white, "C" shaped larvae (grubs) of these beetles are readily identifiable once they have reached their full size, but when newly hatched they are indistinguishable from BTA grubs, other than by examination of the raster (see above). Adult masked chafers are heavy-bodied beetles that are light brown in color, and about 1 inch long.

Masked chafer damage: Damage is caused exclusively by the immature, or grub stage of the masked chafer which feeds on turf roots. Grub feeding results in characteristic patterns of large (1 square foot or more) areas of dead and dying turf, with long, fingerlike areas of damaged turf radiating out from the center. The adults do not cause any damage to turf. In the Low Desert, grub damage was observed on cool-season and warm-season greens in July and August, while in the inland areas, grub damage was observed only on tees, fairways and roughs, also in July and August. Although high numbers of chafer adults occurred at coastal courses as well, there were no reports of chafer grub damage at these locations.

Masked chafer life cycle: Unlike BTA, which have multiple, but brief (6 - 8 weeks) life cycles, masked chafers have a one year life cycle, spending approximately 11 months as larvae

and about 1 month as adults. Thus, the chafer larvae that hatch in July of each year are present on the golf course until May or June of the following year. In most of the state, one generation of masked chafer adults was identified, with a peak of activity during the last week of June. In the Low Desert, however, two peaks of adult activity were observed -- one in late May/early June, and another in late August/early September. It is likely that a different species of chafer is responsible for each peak. The result of two species existing, with different time niches for adult activity, may mean that chafer grubs will be more difficult to control in the Low Desert than in other California locations (see below).

Monitoring for masked chafer: Chafer and BTA monitoring efforts can be combined because the same methods, and roughly the same time frames are involved. To minimize damage from sampling while still insuring that chafer grub infestations are detected BEFORE they cause damage, the following monitoring program is recommended:

- beginning in July, sample for grubs in 2 - 3 locations per green or fairway every 2 - 3 weeks using the method illustrated above in "Monitoring for BTA".

- to narrow down the number of areas that need to be sampled, concentrate sampling efforts in the higher risk areas (locations of previous chafer infestations, cool season turf, areas showing signs of turf damage)

- treat if grubs are present at all (the threshold is low for chafer grubs because one large grub can do a considerable amount of damage).

- In non-desert locations, continue sampling through August. In Low Desert locations, continue sampling through October.

Control of masked chafers: The target of chafer control measures is the soil-inhabiting grub -- not the adult.

Products labeled for control of BTA larvae include **trichlorfon (e.g. Dylox or Proxol)** and **imidacloprid (Merit)**. In PTRI tests conducted in 1995 and 1996, these products showed good to excellent results against chafer larvae. All products should be watered in with at least 1/10" water.

BLACK CUTWORMS AND COMMON ARMYWORMS

Adult moths of the black cutworm, *Agrotis ipsilon,* and common armyworm, *Pseudalatia unipuncta,* had 4 -5 key peaks between June and October, but were constantly present at low levels at all other times. The highest populations occurred in June and in October, with several superintendents reporting the season's worst worm infestations as late as November. Larval infestations were worst 2 weeks after adult moth peaks. 1996 populations were substantially lower than 1995 populations at almost all test locations.

Damage: Adult moths are non-feeding and cause no damage to turf. Larvae (caterpillars or worms) of these insects caused some damage at several courses, but populations were easily controlled through insecticide applications. Damage caused by these pests was a combination of direct feeding by insect larvae on blades of turfgrass, and damage caused by birds searching for larvae. However, it is important to note that bird activity does not necessarily indicate the presence of cutworms and armyworms, as is commonly believed. Instead (see above), BTA beetles and grubs are also preferred food sources for many birds such as starlings. Therefore, when bird activity is observed, do not immediately assume that cutworms or armyworms are the source. Always monitor for the insect (see below) before making treatment decisions.

Direct feeding by cutworm and armyworm larvae occurs on all species of turfgrass,.causing small patches of browning turf if feeding is heavy. Damage was worst following aerification, primarily because black cutworm caterpillars appear to prefer to feed from a shelter, such as a small hole in the turf. Without the presence of aerification holes, larvae graze the surface of a green, feeding on random blades of turf; under these conditions, their feeding damage is difficult to see. However, when larvae feed around an aerification hole, damage is concentrated in the area around the hole, and damage is easier to see. Although many believe that aerification holes "attract" cutworms and armyworms, the reality is that the caterpillars are always present, but that aerification holes make their damage more obvious.

Life Cycle: Unlike the temperate areas of the Northeast where cutworms and armyworms have only three generations per year, our Southern California data from 1994 - 1996 indicates that these insects were present continuously throughout the year. Insect counts during the cooler winter months were much lower, however.

Monitoring for Larvae: Because cutworms and armyworms feed on the surface of the turf, it is easier to detect their presence than it is for soil-borne insects such as chafers and BTA. To monitor for cutworms and armyworms, two methods can be used: 1) examine greens or tees immediately (within 5 minutes) following irrigation. Larvae will come to the surface or 2) apply a soap drench (2 tbsp liquid detergent/2 gallons water spread over a square yard of turf) to 1 -2 areas per green or tee. Larvae will come to the surface. A suggested monitoring program is outlined below:

- using one or both of the methods above, look for presence of worms and/or of worm damage every two to three weeks between April and November.
- intensify sampling efforts after aeration, since this is when damage is most likely to show up
- if worm damage is confirmed, consider treatment (see below)

Control of Cutworms and Armyworms: Many effective conventional insecticide treatments are available for worm control (**chlorpyrifos**: e.g. Dursban or Pageant; **trichlorfon:** e.g. Dylox or Proxol). In addition, biological products such as **beneficial nematodes**,(Cruiser, Savior) and the insect disease ***Bacillus thuringiensis*** (Condor, Dipel, Mattch, MVP) are labeled for control of cutworms and armyworms, although we haven't yet had a chance to evaluate these products. If possible, insecticide applications should be made late in the day, since larvae are most active at night. In addition, treatments should be applied to surrounds as well as to greens or tees, since we now know that many caterpillars are migrating onto greens and tees from higher mown turf. This is because caterpillar eggs are laid on the tips of grass blades. On low mown turf, these eggs are removed by frequent mowing. However, in higher mown turf, more eggs survive and hatch into caterpillars, thus creating a constant reservoir or pest caterpillars. By treating this reservoir, additional control should result.

Other caterpillar pests such as sod webworm and variegated cutworm adults were identified in black light trap samples, but only in very low numbers. Larvae (caterpillars) from these species did not appear to cause damage at any of the participating courses. However, if present in higher numbers, these species can cause significant damage.

Other (Non-Pest) Insects Detected: Ground beetles, lacewings and ladybird beetles, beneficial insects that feed on other insect species, were observed at almost all courses. This indicates that superintendents have been making progress towards managing their use of broad spectrum insecticides. It should be noted that ground beetle adults can easily be mistaken for BTA adults. Consult your technical information or an expert to help distinguish between these two insects, and to avoid an unnecessary insecticide application against a beneficial insect. Other non-pest insects identified in black light trap samples are listed in Table 2.

Table 1. Pest insects detected in 1995 96 study.

COMMON NAME	SCIENTIFIC NAME
Black cutworm	*Agrotis ipsilon*
Black turfgrass ataenius	*Ataenius spretulus*
Common armyworm	*Pseudalatia unipuncta*
Granulate cutworm	*Agrotis subterrane*
Masked chafers	*Cyclocephala* spp.
Variegated cutowrm	*Peridroma saucia*
Yellow striped armyworm	*Spodoptera ornithogalli*

Table 2. Non-Pest Insects Detected in 1995-1996 Study

COMMON NAME	SCIENTIFIC NAME
Ants**	Family Formicidae
Aphodius beetles**	*Aphodius lividus*
Beet armyworm	*Spodoptera exigua*
Cabbage looper	*Trichoplusia ni*
Caddis flies*	Family Trichoptera
California praying mantid	*Stagmomantis californica*
Carrion beetle	Family Silphidae
Click beetle (wireworms)**	Family Elateridae
Crane fly**	*Tipula* spp.
Dragonflies	Family Odonata
False blister beetle	Family Oedemeridae
False darkling beetle	Family Melandryidae
Giant silkworm	Family Saturniidae
Granulate cutworm**	*Feltia subterranea*
Ground beetle*	Family Carabidae spp.
Lacewings*	Family Chrysopidae
Ladybird beetles*	Family Coccinellidae
Long horned beetle	Family Cerambycidae spp.
May and June beetles**	*Phyllophaga* spp.
Mosquitoes	Family Culicidae spp.
Phorid flies	Family Phoridae
Rove beetles*	Family Staphylinidae
Saltmarsh caterpillar	*Estigmene acrea*
Sphinx moth	Family Sphingidae
Stink bugs	Family Pentatomidae
Ten lined June beetle**	*Polyphylla decemlineata*
Tiger moth	Family Arctiidae
Variegated mud loving beetle	Family Heteroceridae

***** beneficial insect
****** may be turf pests in other locations

