**TITLE:** Damage Thresholds, Risk Assessment, and Environmentally Compatible Management Tactics for White Grub Pests of Turfgrass

**INVESTIGATORS:**

Daniel Potter, Dept. of Entomology, Univ. of Kentucky
Andrew Powell, Dept. of Agronomy, Univ. of Kentucky

**1991 Funding:** $ 20,000

**CLIMATIC REGION:** Warm Humid
**USGA REGION:** Mid-Atlantic

**PROGRESS REPORT**
USGA TURFGRASS RESEARCH FOUNDATION
MIS# 9010101045- 1991

# DAMAGE THRESHOLDS, RISK ASSESSMENT, AND ENVIRONMENTALLY COMPATIBLE MANAGEMENT TACTICS FOR WHITE GRUB PESTS OF TURFGRASS

Daniel A. Potter, Kenneth F. Haynes, and A.J. Powell
Departments of Entomology and Agronomy
University of Kentucky
Lexington, Kentucky 40546-0091

## 1A. Field testing a pheromone-based risk assessment system for predicting white grub densities in turf.

The goal of this part of the project is to develop the first practical system by which turfgrass managers could assess the risk of white grub damage at a particular site by monitoring the abundance of adult masked chafer beetles during their flight period. This system could be used for identifying high-risk lawns or golf fairways, and for eliminating unnecessary preventative treatments at sites that are unlikely to have a damaging grub infestation. Our initial objective was to develop and field-test an inexpensive trap system such as could be easily used by homeowners or golf superintendents.

Female masked chafers produce a volatile sex pheromone that is highly attractive to night-flying males. During 1990 and 1991 we collected hundreds of virgin masked chafer females from golf course fairways at night. Crude female sex pheromone extract was prepared by rinsing with hexane glass flasks in which females had been confined for 24 hours. For these initial tests, we used a trap constructed from a styrofoam lunch tray, coated on the upper surface with stickum.

*Procedures*. In 1990 we placed sticky traps at 30 sites in the roughs surrounding three fairways at the Lexington Country Club, Lexington. The traps were baited with 3 female-equivalents of the pheromone extract, and set out on the turf surface about 8:30 P.M. The number of beetles captured on each trap was evaluated at 11 P.M. We repeated this procedure on two nights, July 3 and July 9. In early August, we returned to the golf course and took 12 turf core samples at each site within a 2 meter radius of each trap site. Grubs were returned to the laboratory where they were identified and counted. We plotted and analyzed the data to determine if there was a predictive relationship between the trap captures of adults and subsequent grub populations.

This basic experiment was repeated in home lawn settings in 1991. We solicited cooperation from 30 homeowners who were also faculty or staff of the U.K. College of Agriculture. Traps, bait and other supplies sufficient for two nights of trapping were distributed to each cooperator. Trapping was conducted on two nights, June 19 and 24. Cooperators were given detailed written instructions concerning experimental procedures, and were reminded by personal contacts and telephone on the nights of the study. The cooperators baited their traps between 8:30 and 9:00 P.M. and recovered and returned their trap to us the following morning. The number of male masked chafer beetles caught was determined for each site. We visited each home lawn site in early August and sampled the grub population as described for the golf course test.

*Results*. While we had hoped for a strong correlation between the number of adult beetles caught and the subsequent grub density, no such relationship was evident in the golf course test. We could not predict the local grub population based on pheromone trap captures. These results suggest that on golf courses, movement of male and female beetles between roughs and fairways will complicate risk assessment at particular localized sites. The predictive system might work better on a larger spatial scale, i.e., the level of whole fairways, rather than at individual locations within a rough.

The results of the home lawn test were more encouraging. Although the correlation was not a strong one, we found that the number of beetles captured was a statistically significant indicator of the subsequent masked chafer grub population in a particular lawn. This relationship would no doubt have been much tighter if we had been able to trap the beetles on more than two nights during the 4-5 week flight period. Because beetle flight on a given lawn is affected by such factors as irrigation, it can be quite variable from night to night. Extended trapping would give a more reliable indication of the overall beetle population at that site.

Our efforts on this project will now be mainly directed at identifying the chemical sex pheromone. This would enable large quantities of synthetic pheromone to be produced at relatively low cost. The pheromone could be formulated in dispensers which discharge it slowly over a period of several weeks, making extended trapping more practical. Used in combination with a cheap, cardboard, milk-carton style trap, we propose that this system could eventually provide a useful tool for lawn care specialists, homeowners, and possibly golf superintendents who seek to decrease unnecessary applications and to more efficiently target insecticide treatments made to turf.

**1B. Attraction of adult southern masked chafer beetles to grubs.**

While conducting night research with masked chafers on golf courses, we observed an unexpected phenomenon. In late June, when active grubs would not normally be present, we found a small number of grubs infected with milky disease on the turf surface. We speculate that the development of these larvae had been delayed by the disease, although we do not know why they had surfaced. We were surprised to observe that adult male masked chafer beetles were strongly attracted to these immature grubs and repeatedly attempted to mate with them. Sexual attraction of adult male insects to the larval stage has not been previously reported for any insect species.

*Procedures.* In 1991 we conducted experiments to confirm these observations and to more fully document this phenomenon. Grubs were collected earlier in the spring and held in a cooler to delay their development until the adult flight period had begun. Metal Japanese beetle traps were baited with male or female grubs or grub extracts, or adult virgin female beetles. All experiments were conducted on golf course fairways during June and July.

*Results*. As expected, large numbers of male beetles were captured in female-baited traps. This response is a part of the beetles' functional communication system. However, we found that adult males were also highly attracted to both male *and* female grubs and to grub extracts. This response is non-functional, because the grubs are not normally accessible to mate-seeking males. This discovery may provide new insight on the mechanism of evolution of chemical communication systems in insects. It is generally assumed that sex pheromones are evolutionarily "gained" by adult females; this discovery suggests that they could be present in the immature stages of both sexes and subsequently

"lost" in the adult male. To our knowledge, this is the first confirmation of this phenomenon for any insect species.

From the practical standpoint, this finding will help us in our ongoing efforts to identify the sex pheromone of this species. Adult beetles are only available for a few short weeks during the summer, but grubs are available for our chemical analyses for most of the year. The identification of a potent attractant for masked chafers may aid our efforts to develop a risk assessment system based on pheromone trapping.

**2. Compatibility of Turfgrass Insecticides with Beneficial Predators.**

The goal of this part of the project is to determine the importance of predators in reducing populations of pest insects in turf, and to identify those turfgrass insecticides that are least disruptive to this process. Research is needed to identify insecticides that provide good control of pests with minimum impact on beneficials. This is particularly important in light of renewed interest in low input, sustainable management tactics for golf courses that seek to minimize pesticide usage and negative side-effects to the environment. We speculated that improper timing of insecticide applications or use of certain insecticides that are particularly harsh on predators could result in pest resurgences because of interference with natural predation on eggs and other life stages of pest species.

*Procedures.* Large plots (1000 $m^2$) of Kentucky bluegrass were treated in June 1991 with either carbaryl (Sevinmol, Rhone-Poulenc Corp.), isazophos (Triumph, Ciba-Geigy Corp.), or cyfluthrin (Tempo, Mobay Corp.) or were left untreated. These insecticides are representative of the three main chemical classes presently registered for use on turf. Impact of the insecticides on predators was monitored with pitfall traps for up to 10 weeks post-treatment. Eggs of the Japanese beetle were implanted into the treated plots at 1 week and 3 weeks after treatment, and the incidence of natural predation that occurred in 48 hours was determined. Similarly, we implanted 240 pupae of the fall armyworm into treated and untreated plots after 1 and 3 weeks, and monitored losses to natural predation. Additional predators were live-trapped from the study site and returned to the laboratory, where they were use in experiments to determine those species that feed upon Japanese beetle and fall armyworm eggs and larvae. Grub populations were sampled in treated and untreated plots in the fall to determine if the June treatments could indirectly affect grub populations by eliminating predators.

*Results.* Preliminary counts suggest that all of the insecticides resulted in significant reductions in predator abundance. However, their effects were not equally severe, and analysis of the full data set is expected to reveal significant differences in impact on beneficials. Sorting and counting of samples is expected to be completed by late December 1991.

There was significantly less natural predation on Japanese beetle eggs implanted into turf previously treated with Triumph than occurred in untreated turf. The other insecticides were intermediate in their effects. The high rate of predation documented in the control plots (more than 50%) is the first experimental verification that predators are important in natural regulation of this pest. There were high rates of predation on fall armyworm pupae in all plots, including those treated with insecticides. Many of the predators recovered from the turf were found to consume large numbers of Japanese beetle and/or fall armyworm immatures in the laboratory tests. For example, individuals of one very abundant predatory beetle were observed to consume as many as 24 fall armyworm caterpillars in one hour!

Perhaps the most striking and significant result from these 1991 studies was the finding that fall grub populations were significantly higher in some treated plots than in untreated control plots. This is the first experimental evidence that destruction of turfgrass predators by improperly-timed insecticide treatments during the Japanese beetle egg-laying period can result in pest resurgences due to increased survival of eggs and young white grubs.

**3. Damage Thresholds for White Grubs on Cool-season Turfgrasses.**

The objective of these experiments is to quantify relationships between grub density, root damage, foliar growth, and aesthetic quality of different cool-season turfgrasses so as to establish damage thresholds for use in making management decisions. Interactions between grass species, grub species, and management tactics on the expression of grub feeding injury will be measured.

*Procedures*. Large, replicated plots of Kentucky bluegrass, creeping bentgrass, hard fescue, perennial ryegrass, and endophyte-infected and endophyte-free tall fescue were established in 1989. In spring 1991 we implanted 12 galvanized steel enclosures (0.1 $m^2$) into each plot. In addition, 204 wooden rooting boxes, each consisting of a 0.1 $m^2$ wooden frame with a nylon screen bottom, were implanted into a Kentucky bluegrass turf. These were divided among two studies, one to measure effects of irrigation and fertilization on expression of grub damage, and the other to consider grass species effects. In the first rooting box test, slabs of Kentucky bluegrass or tall fescue sod were planted in the boxes and allowed to establish for the whole growing season. There were two fertilization regimes: 3 lbs N/1000 $ft^2$ applied in the spring, or no supplemental fertilization, and two watering regimes: 1" per week or no supplemental irrigation. In the grass species study, slabs of sod of the different turfgrass species were rooted within the boxes. There were five replicates of each combination of treatments.

Grubs were dug from local golf courses and sod farms and implanted into the steel enclosures and rooting boxes in late August. In the former test, we used densities of 0, 15, 30, 45, or 60 masked chafer or Japanese beetle grubs per enclosure. Damage ratings were recorded weekly, and surface temperatures were measured with an infrared thermometer. Beginning in mid- October (8 weeks after implantation), the rings were harvested by clipping and bagging all above-ground tissues. The soil was them broken apart and examined, and surviving grubs were counted. The rooting boxes were harvested by pulling them from the soil with a custom-built hydraulic device that measured and recorded relative rooting strength electronically via a load cell and a strip chart recorder. Clippings were then harvested, and grubs counted as before. The hundreds of samples from both cylinders and rooting boxes were oven dried and stored in envelopes.

*Results*. Because white grubs do the most damage during late summer and fall, the above experiments were run until mid-October, and harvesting was completed just one week before this report was written. We have begun the time-consuming task of separating the formerly living (green) and dead (brown) grass tissue before weighing the hundreds of samples. This will be followed by data analysis. Results from the damage ratings, temperature readings, and rooting strength measurements are scheduled to be discussed in a paper to be presented in the Formal Conference on Arthropod Pests of Turf and Ornamentals at the National Conference of the Entomological Society of America in early December. Our goal is to have those samples processed and analyzed by that time.

Although specific conclusions must await sample processing and data analysis,

certain patterns were apparent during the test period. It appears that masked chafer grubs are more damaging than equal densities of Japanese beetle grubs, a result contrary to common belief. Aesthetic damage thresholds for grubs in tall fescue appear to be considerably higher than for Kentucky bluegrass. The rooting box technique, which has not previously been exploited for studies of white grubs, appears to be a useful tactic for evaluating damage from these pests. This part of the overall funded project was by far the most difficult and labor-intensive, and it appears to have yielded a very large quantity of useful information.