# Biological and cultural control of Japanese beetle in Michigan

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***Significance***

Japanese beetle (*Popillia japonica*) is one of the most destructive agricultural and landscape pests in Michigan. The larvae feed on grass, shrub and tree roots, while the adults feed on many types of trees and shrubs. The nursery industry is the most vulnerable. Losses in nursery sales are estimated at 10 percent per year ($100 million) because nursery stock cannot be shipped to other states unless it is certified free of Japanese beetle. The Japanese beetle is also a destructive pest of golf courses, recreational turf and landscape trees. Lindens, crabapple, purple-leaf plums and roses are some of the trees and shrubs frequently damaged by the adult beetles.

***Project goal***

Reduce the pest status of Japanese beetle in Michigan and, ultimately, in the North Central United States through the introduction of parasites and pathogens. Develop cultural strategies to minimize damage.

***Project description***

**Biological control**

Japanese beetle populations have been intensively sampled at ten sites in southern Michigan for three years. Adults and larvae were dissected to determine the proportion of individuals infected with pathogens or parasites. Two pathogens and two parasites of Japanese beetle were collected from the Eastern United States and introduced to our research sites in Michigan.

**Cultural control**

Two field experiments were conducted to determine how irrigation and soil moisture in the summer and fall affect egg laying and survival of Japanese beetle and European chafer larvae.

***Research update for 2001***

The Japanese beetle parasites *Tiphia vernalis* (a parasitic wasp) and *Istocheta* sp. (a parasitic fly) have not yet been recovered from any of the four golf course locations where they were introduced. We will continue looking for parasitized beetles at introduction sites over the next two years.

- Ovavesicula, a protozoan pathogen, has been recovered from all three locations where it was introduced. At one site, 100 percent of the Japanese beetle larvae collected from introduction plots this fall were infected with Ovavesicula, and the grub density is decreasing. Ovavesicula-infected grubs are now being found in the turf in the area surrounding our plots. We hope to use these areas as "Ovavesicula nurseries" to collect and introduce infested grubs to other parts of the state. We were not able to do so this fall because the grub density was too low in the plots with a high level of Ovavesicula infection.
- A Eugregarine (protozoan) parasite found in the digestive system of Japanese beetle larvae has not yet spread to some of the "leading edge" infestations of Japanese beetle in Michigan. In the first laboratory experiment with the gregarine pathogen, infected larvae grew slower and more died (20 percent) than in the control treatment (zero percent). Another experiment is in progress at this time (November, 2001).
- In irrigation experiments in field plots, Japanese beetle larvae did not survive well when soil became dry in July and August. Just the opposite was true for European chafer larvae: they survived well in dry plots and poorly in irrigated plots. See the section on the irrigation experiment for more details of this experiment.

***Irrigation experiment with Japanese beetle and European chafer***

**Methods**

Experimental plots (10' x 10') in the rough (non-irrigated turf) at Jackson Country Club received one of the following irrigation treatments:

1. **Dry** (non-irrigated) throughout summer

2. **Early** irrigation: 1 to 2 inches per week, July 3 - July 23
3. **Late** irrigation: 1 to 2 inches per week, July 31 - Sept 13
4. **Total** (irrigated throughout summer): 1 to 2 inches per week, July 3 - September 13

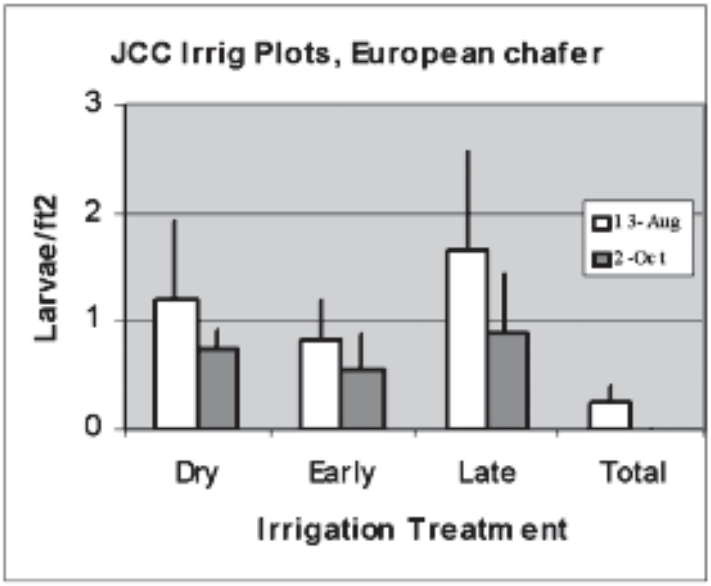
European chafer and Japanese beetle are both active at this location. Our plots became infested naturally without introducing beetles or grubs. All plots were sampled on August 13 and October 2 to determine the density of both grub species.

### *Results*

The density of Japanese beetle larvae was reduced by 80 percent in plots that were dry in July and August compared with irrigated plots (Figure 1). In contrast, European chafer larvae were reduced by 100 percent (no survival) in irrigated plots compared with dry plots.

### *Conclusions*

1. Japanese beetle are 5-fold more abundant in irrigated plots than dry ones.
2. Japanese beetle appears to benefit from irrigation both July and August.
3. European chafer larvae do not survive well in irrigated turf (zero EC larvae in irrigated plots on October 2).
4. Japanese beetle larvae may not survive well in nursery fields if it is dry in July or August. European chafer larvae survive well in dry conditions.



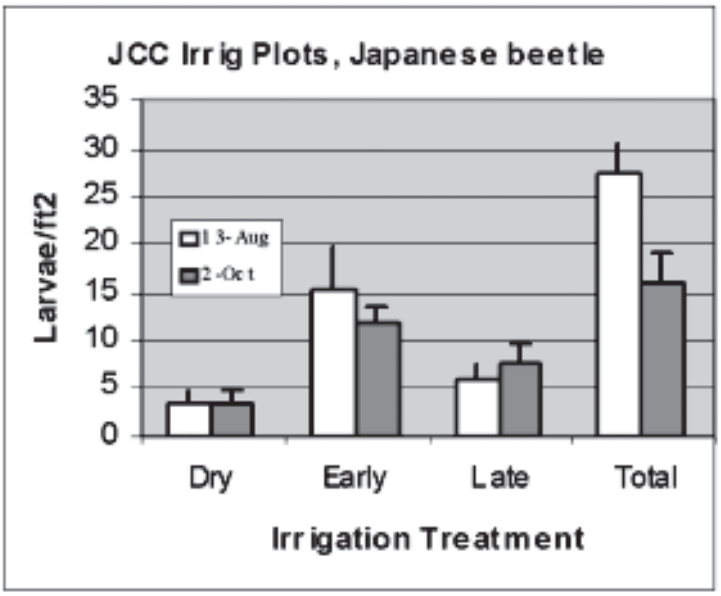




**Figure 1.** Egg laying and survival of European chafer and Japanese beetle larvae in irrigation plots. Grubs were sampled on Aug 13 (white bars) and Oct 2 (green bars).

# Responding to the white grub invasion: A survey and management study of Japanese beetle and European chafer in mid-Michigan

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***Significance to turfgrass, landscape, and nursery industries***

The larvae of Japanese beetle and European chafer ("white grubs") are the primary pests of turfgrass in Michigan. The Japanese beetle is also a destructive pest of landscape plants and a quarantine concern for nursery plant exporters. Both species are invasive exotics that arrived in the state during the last 20 to 30 years. The range of these species has only recently begun to expand into to Midland, Saginaw, Bay and Genesee counties. Thus, we are presented with a unique opportunity to monitor the development of a likely pest outbreak. In our study, we will assess the density and distribution of white grubs at representative sites in the four-county area. Findings will serve three objectives:

1. Provide early information on population trends, assist turf and nursery managers, extension staff, and the general public in making proactive management decisions.
2. Contribute to a wider study conducted by Michigan State University in which we are evaluating the potential of natural enemies to reduce white grub densities.
3. Define study sites at which we can experiment with novel management techniques. The first such experiment will evaluate the impact of Japanese beetle pathogens imported from another site in Michigan.

***Methods***

**Survey.** Working with extension and landscape industry contacts, we selected a minimum of two pairs of monitoring sites in each of the four counties. Pairs of sites included an area of irrigated turf (favorable to Japanese beetle) and a nearby area of unirrigated turf (favorable to European chafer). At each site, twenty one square-foot turf plots were sampled. Larvae were sampled and identified to species in spring and fall of 2001. Adult Japanese beetles were collected with standard pheromone traps at each of the larval sampling sites. Samples of larvae and adults from each site were dissected to determine prevalence of pathogens and parasites.

**Pathogen experiments.** Based on MSU studies, we are hypothesizing that protozoan pathogens (*Ovavesicula popilliae* and *Gregarina* sp.), abundant where Japanese beetle has been long established, suppress population growth as they become abundant in an area of recent invasion. In a preliminary laboratory experiment we compared the growth rates of larvae infected with protozoans (from southern Michigan and New York) and "clean" larvae collected in Genesee County. We then set up a field experiment to evaluate protozoan impact: larval density was determined for five pairs of 10x10 foot plots at Currie Golf Course in Midland, and 180 infected grubs were introduced to each study plot in November, 2001.

***Results to date***

**Survey.** We found that the mid-Michigan area exhibits two features of early invasion by white grubs; low insect density and low pathogen prevalence. (For a color photo comparing grubs of Japanese beetle, European chafer and June beetle, see color insert on page A-4). Population densities are low (with local exceptions), generally less than one-tenth of the densities typical of comparable sites in southern Michigan. In fact, *Phyllophaga* spp. (commonly referred to as May or June beetles), a third white grub species not usually a significant pest, was nearly as abundant as Japanese beetle (Table 1). The relatively low density of Japanese beetle is also evident in a comparison of central and southern Michigan adult trap catches. The highest individual trap catches in Genesee, Midland, Saginaw and Bay counties were 433, 157, 6 and 0 beetles per day. Maximum trap catches at golf course sites in Macomb, Oakland, Wayne, Battle Creek and

Kalamazoo counties all exceeded trap capacity of 1200 beetles per day.

Although regional population pressure appears low in mid-Michigan, individual locations with ten or more Japanese beetle or European chafer larvae per square foot were detected in fall 2001 samples. We predict a significant likelihood of "outbreak" densities in the near future.

Natural enemies of Japanese beetle were essentially absent in mid-Michigan. Gregarines were detected in one percent of Japanese beetle larvae (compared to 36 percent in southern Michigan), and entomopathogenic nematodes in one and one-half percent of larvae. Approximately five percent of European chafer larvae were gregarine-infected (about half the rate in southern Michigan).

### *Pathogen experiments.*

Our laboratory experiment indicated a significantly lower growth rate for Japanese beetle infected with protozoan parasites (Table 2). A color photo of *Gregarina* sp., one of the protozoan parasites infecting Japanese beetles, can be found on page A-4.

### *Future directions*

Follow-up experiments in winter 2002 will further evaluate the pathogenicity of protozoan parasites in the laboratory. Larval density in the field trial will be evaluated in spring and fall, 2002. We will also continue monitoring grub populations in the mid-Michigan area and use this data to support relevant management and research strategies.

**Table 1**. White grub density (larvae/ft$^2$), mid-Michigan sites, spring 2001.

| County | No. sites | Type* | Japanese beetle | European chafer | *Phyllophaga* spp |
|---|---|---|---|---|---|
| Bay | 2 | I | 0 | 0 | 0 |
| Genesee | 2 | I | 0.05 | 0.08 | 0 |
| Midland | 3 | I | 0.77 | 0 | 0.02 |
| Saginaw | 3 | I | 0 | 0 | 0 |
| Bay | 2 | N | 0 | 0 | 0.05 |
| Genesee | 2 | N | 0.2 | 0.95 | 0.08 |
| Midland | 3 | N | 0.12 | 0 | 0.15 |
| Saginaw | 3 | N | 0 | 0 | 0.27 |

* I=irrigated, N=non-irrigated

**Table 2**. Growth rate (mg/larva/day) of Japanese beetle larvae, infected vs. uninfected populations. Midland larvae had a significantly higher growth rate.

| Larval source | Parasite infection | Mean (SE) growth rate |
|---|---|---|
| Midland, MI | None | 2.04 (0.22) a[1] |
| Monroe, MI | *Gregarina* sp. | 1.03 (0.16) b |
| Geneva, NY | *Gregarina* sp. + Ovavesicula | 1.50 (0.16) b |

[1]means followed by the same letter are not statistically significant