INTEGRATED PEST MANAGEMENT ANALYSIS OF ALTERNATIVE TREATMENTMETHODS TO ERADICATE JAPANESE BEETLE
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The treatment program used by the California Department of Food and Agriculture (CDFA) for control of the Japanese beetle, *Popillia japonica* (Coleoptera: Scarabaeidae), primarily targets the larval stage. The program follows recommendations formulated by the Japanese Beetle Science Advisory Panel which met in December 2015 (please visit https://www.cdfa.ca.gov/plant/JB/index.html for more information). A systemic insecticide containing either chlorantraniliprole or imidacloprid is used to control developing larvae, and a contact insecticide containing cyfluthrin may be used if adult beetles are collected from the environment but not in a trap. These products have been shown to be effective against Japanese beetle during eradication projects in other uninfested states.

Below is an evaluation of alternative treatment methods for Japanese beetle which have been considered for eradication programs in California, including the methods chosen for the current program.

A. PHYSICAL CONTROL

Mass Trapping. This method involves placing a high density of traps in an area in an attempt to physically remove the adults before they can reproduce. It is not recommended as a general eradication measure against established populations because trap capture rates can be low, and studies indicate that there is only a 40 to 50% drop in population numbers at high trap densities (1 per acre, or 640 per square mile). It has been shown to reduce numbers significantly in isolated populations, but several years are required. Also, trapping as a small-scale eradication technique within a larger infested area is not recommended because it has been shown to encourage mating by drawing in males and females to nearby foliage, where they can more readily find each other and mate, and can actually increase the damage on plants around the traps.

Active Removal of Beetle Life Stages. Adult Japanese beetles are mobile day time fliers, and adults could theoretically be netted or collected off of foliage. However, due to their ability to fly when disturbed, and the laborious and time prohibitive task of collecting small insects from many properties by hand, it would be highly improbable that all of the adults could be captured and removed. Eggs, larvae, and pupae all occur in the soil in and around plant roots, so all potentially infested plant roots and associated soil in the entirety of the eradication area would have to be removed and disposed of in order to remove these life stages from the environment.

Host Plant Removal. Removal of host plants involves the large scale destruction of plants by either physical removal or phytotoxic herbicides. Host plant removal is not considered an economically efficient option for area-wide treatment because it is so labor intensive. It is also intrusive to residents, who may oppose losing their plants. Additionally, this method may possibly promote the dispersal of beetles in search of food and egg laying sites, thus spreading the infestation if other treatments are not used outside the host plant removal area.

B. CULTURAL CONTROL

Cultural Control. Cultural controls involve the manipulation of cultivation practices to reduce the prevalence of pest populations. These include crop rotation, using pest-resistant varieties, and intercropping with pest-repellent plants. None of these options are applicable for Japanese beetle eradication in an urban environment with multiple hosts, and may only serve to drive the beetles outside the treatment area, thus spreading the infestation. For these reasons, cultural control is not considered to be an effective alternative.

C. BIOLOGICAL CONTROL

Microorganisms. Milky spore is a soil bacterium, *Paenibacillus popilliae* (formerly *Bacillus*), which attacks the grubs. It can be effective in limiting the density of populations, but takes two to three years to build up sufficient numbers for control. The 1983-84 California Environmental Assessment of the Sacramento County Japanese beetle project noted that USDA had an extensive program that resulted in inoculation of the milky spore pathogen into large areas of the northeast U.S. However, results were variable and complete elimination of Japanese beetle was not achieved. In addition, pest resurgences were noted in a number of areas. Also, at very low Japanese beetle densities there are insufficient grubs to allow buildup of spores in the soil. The assessment concluded that milky spore was not an option for eradication. No milky spore products have been registered in California since 1987. Two other bacteria, namely *Bacillus thuringiensis japonensis* and *Ovavesicula popilliae*, have shown some effectiveness against Japanese beetle grubs. However, no products containing these microorganisms are registered for use in California.

Nematodes. *Heterorhabditis bacteriophora* and *Stenernema glaseri* appear to be the most widely used soil nematodes used against Japanese beetle grubs. The California Department of Pesticide Regulation does not regulate nematodes because they do not require pesticide registration for multicellular biocontrol organisms, so they can be used in California. However, success of nematodes is problematic because soil type, moisture, and temperature can greatly influence their effectiveness. Nematodes require a fairly loose textured soil (sand, loamy sand, or sandy loam) because they need to be able to move through the spaces between the soil particles. Nematodes work best in a moist soil (watered, but not to excess) and generally have a narrow soil temperature range in which they work best. Due to the practical challenges of maintaining optimal soil conditions for survival and distribution of Nematodes across a wide variety of public and private landscape conditions, Nematodes are not recommended as an effective means of eradication for JB relative to other available options.

Parasites and Predators. There have been 24 parasites released in the U.S. against Japanese beetle, but only five have become established and only three of these are considered somewhat successful. However, they are not available commercially. Parasites and predators in general are not considered an effective stand-alone eradication method because their success is density dependent, in that they are more effective against dense prey populations than against light populations, so their effectiveness decreases as the prey population declines.

Sterile Insect Technique (SIT). The sterile insect technique (SIT) involves the production and release of reproductively sterile insects, with the goal of preventing reproduction in a pest population via the mating of the sterile insects with the existing field population. Some research on the production and release of sterile Japanese beetle adults was done in the 1960’s and 1970’s, but it has never been developed as a control tactic.

D. CHEMICAL CONTROL

Soil Treatment. A number of systemic and contact insecticides have been researched for use against Japanese beetle grubs. The following products have been chosen for use by the CDFA, based on a combination of effectiveness against Japanese beetle, worker and environmental safety, and California registration status. One or the other will be used, depending on time of year.

- Acelepryn® is a formulation of chlorantraniliprole which is applied via hydraulic spray equipment or dispersal of solid granules to the soil surface. Chlorantraniliprole is most effective against young larvae and takes up to six weeks to be effective, so application of this compound is made during mid- to late-April. In the event that Acelepryn® cannot be used during this time period due to weather or other factors, then Merit® 2F, containing imidacloprid, will be used in mid- to late-June (see below). Chlorantraniliprole is a synthetic anthranilic diamide insecticide which controls a number of other root feeding pests, but is generally considered safe for beneficial biocontrol insects.

- Merit® 2F is a formulation of imidacloprid which is applied via hoses to the soil surface. Imidacloprid is most effective against young larvae, so application of this compound is made during the early summer in areas where Acelepryn® has not been used. Imidacloprid is a synthetic neonicotinoid insecticide which controls a number of other root feeding pests, but is generally considered safe for beneficial biocontrol insects.

Foliar Treatment. A number of contact insecticides have been researched for use against Japanese beetle adults elsewhere. The following product has been chosen for use by the CDFA, based on a combination of effectiveness against Japanese beetle, worker and environmental safety, and California registration status. Foliar treatment is warranted only if one or more live adult beetles are found in the environment (i.e., not in a trap).

- Acelepryn® is a formulation of chlorantraniliprole which may be applied to the foliage of host plants. Chlorantraniliprole is a synthetic anthranilic diamide insecticide that is generally considered safe for beneficial insects. The foliar spray application may be made using mechanically pressurized sprayers, hydraulic sprayers, hand sprayers, or backpack sprayers. Applications could be made to ornamental plants and trees (up to 30 ft. into the canopy), as well as landscaped areas including flowers and containerized plants. Up to four applications may be made per year at a 21-day re-treatment interval.

- Tempo® SC Ultra is a formulation of cyfluthrin which may be applied to the foliage of host plants. Tempo® SC Ultra is a wide-spectrum synthetic pyrethroid insecticide which controls hundreds of insect species. Tempo® SC Ultra is preferentially used over other contact insecticides by the CDFA because it has low mammalian toxicity and a relatively shorter half-life. However, it is not registered for use on a number of backyard fruit and vegetable crops which are attacked by Japanese beetle, so its usage is restricted primarily to ornamental plants. Tempo® SC Ultra is used in cases that fall outside of the Acelepryn® treatment label specifications.

E. RESOURCES

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