INTEGRATED PEST MANAGEMENT ANALYSIS OF ALTERNATIVE TREATMENT METHODS 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), targets multiple life stages. A contact insecticide is used for an immediate control of adults in order to prevent spread, and a systemic insecticide is used to control developing larvae. The contact insecticides preferentially used contains either the synthetic pyrethroid cyfluthrin or the synthetic organophosphate carbaryl, while the systemic insecticide contains the synthetic neonicotinoid imidacloprid. These products have been shown to be effective against Japanese beetle during eradication projects in other uninfested states such as Colorado, Oregon, and Utah.

Below is an evaluation of alternative treatment methods for Japanese beetle which have been considered for eradication programs in California.

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 more readily can find each other and mate, and can actually increase the damage on plants around the traps.

Active Beetle Removal. 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. Grubs live 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 the larvae 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 inefficient 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 had never been 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.

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 not been pursued further and has never been developed as a control tactic.

D. CHEMICAL CONTROL

Foliar Treatment. A number of contact insecticides have been researched for use against Japanese beetle adults elsewhere. The following products have been considered for use by the CDFA, based on a combination of effectiveness against Japanese beetle, worker and environmental safety, and California registration status.

Tempo® SC Ultra is a formulation of cyfluthrin which may be applied to the foliage of host plants. Tempo® SC Ultra is effective against Japanese beetle. Tempo® SC Ultra is a wide-spectrum synthetic pyrethroid insecticide which controls hundreds of insect species, including beneficial insects. 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.

Sevin® SL is a formulation of carbaryl which may be applied to the foliage of host plants. Sevin® SL is effective against Japanese beetle. Sevin® SL is a wide-spectrum carbamate insecticide which controls hundreds of insect species, including beneficial insects. Sevin® SL is registered for use on various backyard fruit and vegetable crops. Therefore, it is used in situations where the preferred insecticide for foliar treatment, namely Tempo® SC Ultra, cannot be used because of label restrictions on the application to fruits and vegetables.

Soil Treatment. A number of systemic and contact insecticides have been researched for use against Japanese beetle grubs. The following product has been considered for use by the CDFA, based on a combination of effectiveness against Japanese beetle, worker and environmental safety, and California registration status.

Merit® 2F is a liquid containing 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 summer. Imidacloprid is a synthetic neonicotinoid insecticide which controls a number of other root feeding pests, but is generally considered safe for beneficial insects.

E. RESOURCES

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