

Insect Growth Regulators (IGRs) can be powerful new tools of pest management. Like plant growth regulators, they could revolutionize cotton production. IGRs, however, will not be sole solutions to our whitefly management problem, but instead, will be key selective agents which will figure prominently in our IPM and IRM (Integrated Resistance Management) systems. These compounds selectively target insect-specific growth processes, not nervous systems and therefore are usually not broadly toxic to wildlife and animals. Because of this specificity, IGRs can be applied in the environment with little potential for off-target effects—impacts on beneficial insects and aquatic arthropods must be considered in the development of these selective agents.

Juvenoids

Two major processes unique among insects and their relatives are metamorphosis and molting. These events are regulated by insect specific hormones, not found in higher animals. A class of hormones, which is called juvenoids or juvenile hormones, controls the “character” of metamorphosis. An immature insect such as a caterpillar or grub will normally molt several times into larger versions of itself as long as there are adequate levels of this hormone. As this juvenile hormone concentration declines, the young insect is “released” to change into an adult with the next molt. Scientists have exploited this relationship for pest management by manufacturing juvenile hormone look-alikes (mimics & analogs) which fool the insect’s endocrine systems into keeping the insect young. When the larval pests’ environment is flooded with these juvenoids, these insects are kept “forever” young until all metabolic reserves are depleted and the pest dies. Death may come slowly; however, many juvenoids have important and powerful secondary effects too. Many interfere with female oogenesis (fertility) and egg embryogenesis (hatching). Juvenoids even come in specific types which can affect only a few species or 1 or 2 groups of insects!

Chitin Synthesis Inhibitors

Molting is a process in insects dependent on the proper deposition of a new “skin” layer or exoskeleton and simultaneous peeling-off of the old, smaller covering (ecdysis). This process occurs between each larval instar and insect stage. Chitin is the principle polymer building-

block of the insect’s exoskeleton. Without the proper formation of chitin, the insect will rupture at the time of molting and die. Scientists have produced compounds which interfere with the biosynthesis of chitin in insects (chitin synthesis inhibitors). When these compounds are sprayed into the environment, they kill immature insects as they molt. Once an insect becomes an adult, they do not molt, so they are not susceptible to chitin synthesis inhibitors. Thus using chitin synthesis inhibitors requires proper timing and understanding of the insect’s life cycle.

Industry Development

For decades, several companies (e.g., AgrEvo, Ciba, Rhône-Poulenc, Valent, etc.) and scientists have been actively searching for IGRs useful to pest control. Some of the earliest breakthroughs were made by one of our own entomologists, Dr. William S. Bowers (Department of Entomology), who searches for these compounds in plants. Two companies have identified two different whitefly-effective products which are near the end of the registration process. Buprofezin, or Applaud® by AgrEvo is a chitin synthesis inhibitor which, in our cotton system, is specific against whiteflies. Pyriproxyfen or Knack® by Valent is a juvenoid which is equally selective in our system.

Section 18 Process

In times of crisis and when all other alternatives are failing, the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) has specific code which can exempt certain products from the normal registration process of the EPA. This code is known as Section 18. Arizona through the Arizona Department of Agriculture and the Arizona Cotton Growers Association has applied for this exemption in order to make available these two new products. Because these products do not yet have full registration, they need to meet several requirements of the EPA. Together with the two companies, all of the necessary documentation was submitted to the state on 12 February. This package was reviewed and submitted to EPA on 16 February. EPA typically requires 50 days to review such packages, ***so decisions on the potential use of these two products is not expected before 8 April.***

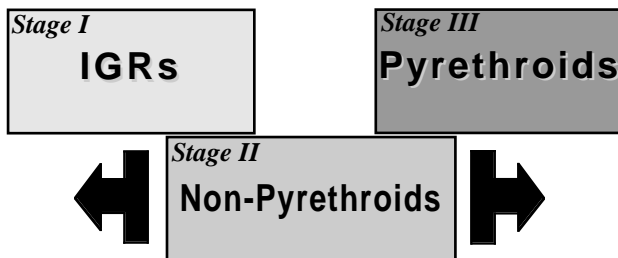
NOTE: Both IGRs were/are approved for use in Arizona cotton for 1996 and 1997. The use period expires 9/30/97. (pce 5/5/97).

Proposed Requirements

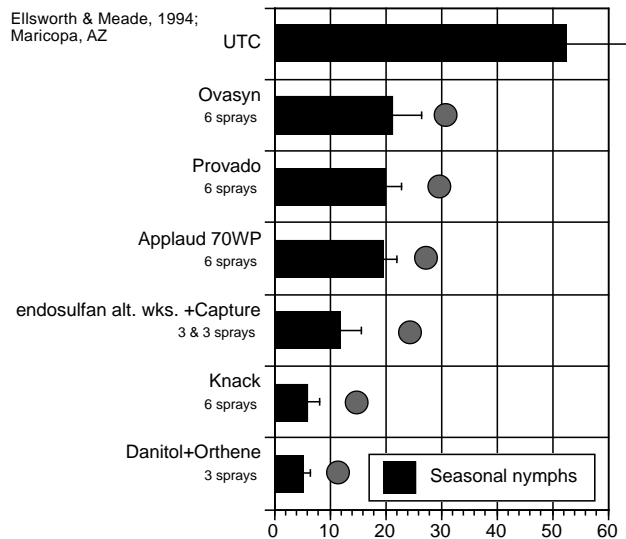
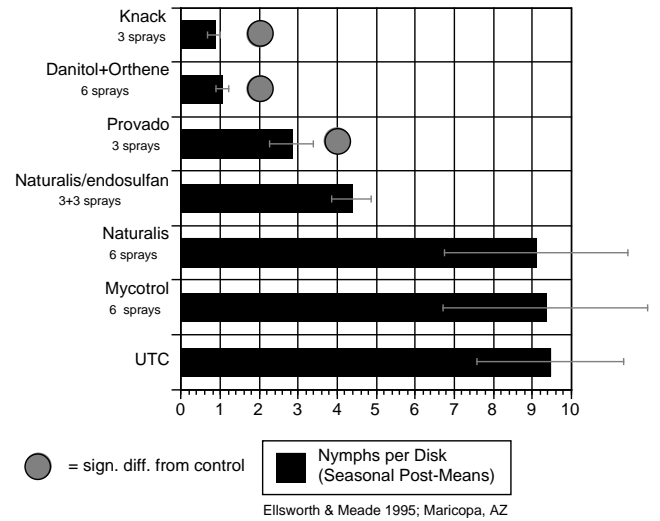
If granted, this Section 18 will carry very specific use restrictions (pending final changes by EPA). These restrictions were formulated and endorsed by ADA, ACGA, Arizona Cotton Research & Protection Council, and the Southwest Whitefly Resistance Management Working Group. *These restrictions are specifically designed to preserve these compounds for long-term use while still allowing flexibility for pest control.* A key conclusion of these groups was that premature loss of these new compounds to resistance would have devastating effects on the cotton industry. The recommendations are as follows:

- only one use per cotton season permitted for each IGR,
- Knack (8 fl. oz./A) may follow Applaud no sooner than 14 days,
- Applaud (8 oz./A) may follow Knack no sooner than 21 days,
- the grower or his agent must complete IGR educational training,
- the 1080 form for IGRs must be marked according to ACRPC,
- only whole fields should be treated,
- applications should be based on appropriate whitefly thresholds,
- neither compound should be mixed with any other pesticide,
- pyrethroids should not be used prior to either IGR application,
- users should subscribe to local IRM and IPM strategies.

Under the Section 18, Arizona proposes to limit use of the two IGRs to just one use each per season. These IGRs will be used towards the beginning of whitefly population development, usually in sequence when necessary, and before any pyrethroid use. Non-pyrethroids should be used whenever possible for other pests (e.g., Lygus, pink bollworm, beet armyworm, etc.) during the early season, before whiteflies are treated. Our IRM strategy will define three stages of insecticide use (see fig. below): I) IGRs, II) Non-pyrethroid combinations, and III) Pyrethroid combinations. Stage I will be initiated according to whitefly population levels of ca. 3–5 adults per leaf and/or equivalent levels of immatures. Sequential use of the alternate IGR will be governed first by a required interval, and second by the level of immature whiteflies present in the field. Stage II and III chemical uses will be initiated according to adult thresholds which have been established. Stage II chemicals may also be used as needed for adult whitefly suppression during Stage I and as rotational alternatives during Stage III.



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Performance

Although each IGR impacts different whitefly stages, neither kills adults and both are best measured by their impact on nymphal counts (see charts). Knack effects its primary lethal action via the developing egg (within the female), egg, or hatching crawler. Applaud kills nymphs during molts. There is no known cross-resistance between these IGRs and our current whitefly chemistry. Neither compound has significant adverse effects on beneficial organisms. Applaud has a significant vapor phase activity which may last up to 10 days in the field and affords some degree of protection to new cotton growth by reaching the leaf undersurface where whiteflies dwell. Knack has significant translaminar activity within cotton leaves and, when applied to the upper surface of the leaf, readily transports to the leaf underside. Both compounds have been successfully used in Israel as part of their IRM plan without adverse consequences for over five years. We hope to have the use of these IGRs in 1996 and to preserve their use well into the next century.

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