MAINTAINING AN IPM PROGRAM IN A SHIFTING PEST ENVIRONMENT

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Abstract

Insect pest management in San Joaquin Valley cotton can be characterized as lacking pests which dominate production decisions, such as bollworm, budworm, boll weevil, or silverleaf whitefly. Instead, key pests must be managed within an IPM system which relies on natural enemies and judicious use of disruptive broad spectrum insecticides. Insect pest management crises can arise for at least two reasons, introduction of a dominant new pest or upsetting the balance between pests and natural enemies through the use of broad spectrum insecticides. Maintaining an IPM program in shifting pest environments requires the development of management plans arrived through consensus of the community.

Background

The IPM program in cotton in the San Joaquin Valley (SJV) of California has developed over the past 60 years. The foundation of the program through the years has been 1) reliance on indigenous natural enemies, 2) close monitoring of insect populations, 3) rational and justified use of broad spectrum chemicals.

A unique feature of the insect pest complex in the SJV is the absence of a single dominant pest, such a cotton bollworm, budworm, boll weevil, or whitefly. The SJV has key pests which must be managed but whose annual severity depends on environmental factors. The arthropod pest complex requires management but over-correction through the frequent use of insecticides creates disruptions and secondary pest outbreaks.

Such a situation can be characterized by the experience of SJV growers during the 1960's when they faced the disastrous results of over managing Lygus *(Lygus hesperus*) with organochlorine and organophosphate insecticides. Secondary outbreaks of spider mites (*Tetranychus spp.),* cotton bollworm (*Helicoverpa zea*) and foliar worms (*Spodoptera exigua* and *Trichoplusia ni*) were common with the result being 8-10 applications of broad spectrum insecticides (Falcon et al, 1968).

Relief came as research improved Lygus management decisions by relating bug numbers to fruiting stage of the plant, resulting in the Lygus to square ratio of .03 bugs to 1 square. As a result, insecticide applications for Lygus were reduced in their frequency and general yield increases were achieved through the 1970's (Bassett and Kerby, 1996). Natural enemy populations increased and secondary problems diminished, including bollworm. At about the same time, area-wide, compulsory crop destruction and stubble burial were implemented to prevent the establishment of pink bollworm. This area-wide program may have played an important role in reducing overwinter survivorship of bollworm (Roach, 1981). During the 1970's and 1980's yields increased and insecticide/acaracide use was at all time lows (Bassett and Kerby, 1996, Phillips et al, 1986). Widespread cotton bollworm problems have not been experienced since the late 1960's.

Crisis Develops in the 1990's

During 1990's insect management has become much more problematic. In particular, Lygus became more difficult to manage with organophosphates resulting in multiple applications and a shift to pyrethoid insecticides (Figure 1). Bifenthrin, in particular became a popular means of providing general protection to early fruit development because of its residual protection and activity against spider mite nymphs and adults. At about the same time, cotton aphids became a mid-season pest and competed directly with the bolls for plant assimilates. Bifenthrin was very effective against cotton aphid and provided acceptable residual control. However, within two seasons, its effectiveness had diminished and high levels of resistance in aphids could be found throughout the SJV (Grafton-Cardwell and Goodell, 1996). Evidence is emerging which links pyrethoid use with aphid outbreaks (Kidd et al, 1996), suggesting these insecticides should be used with great caution.

Between 1985 and 1995, insecticide/miticide use increased from one and a half applications to six applications in some cases. The average season cost of applications rose from about $16.00/ac to $75.00/acre (Phillips et al, 1986; Hardee and Herzog, 1996) and yields decreased in 1995. Even though weather conditions could account for much of the yield depression, increasing use of insecticides and associated side effects sent a wake-up call through the industry.

Not since the last insect crisis of the 1960's had there been as much concern about insect pest management and profitability. Faced with diminishing profit caused by increased arthropod control costs and the grim prospect of stepping onto an insecticide treadmill, the industry requested a review of the situation.

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Annual Review of Arthropod Situation

In November 1995, a meeting was organized jointly by Cooperative Extension and the California Cotton Growers Association. The invitation list was limited to 60 participants composed equally of growers and pest control advisors (PCAs). Those invited were charged with acting as multipliers of the information to the larger industry. The meeting was developed around the format of a facilitated workshop with the specific goals being 1) what has changed in the cotton ecosystem to cause the increased arthropod pest problems; 2) how do we prepare for the following year?

The workshop was divided into two main sessions, the first to identify regional issues and highlight problems with emphasis placed on participation by individuals. The group was reformed and common elements of the various regions were identified and listed. The next break out session addressed the main issues identified with growers and PCAs working separately to identify possible solutions. The separate groups were asked to vote on the top five approaches for improving management. The groups were reconvened and the priority lists presented and combined (Table1). Both long and short term approaches emerged from the discussions including improve host plant resistance, a need to reexamine early Lygus management, and caution when "unholstering" broad spectrum insecticides, especially pyrethoids. A final list of guidelines was developed to specifically address problems faced in 1995 (Table 2).

In November 1996, a similar review was held with the goal of reviewing the 1995 guidelines and developing management plans for Lygus, silverleaf whitefly, aphid, and spider mites. Additional participants included agrichemical manufacturers, county agricultural commissioners, and representatives from California Department of Pesticide Regulation. In general, the guidelines suggested for 1996 worked well during 1996 but the rapid expansion of silverleaf whitefly in the SJV and early season spider mite outbreaks require new chemistries to manage resistance and limit early applications of broad spectrum insecticides. To approach CDPR and USEPA for emergency exemptions, well laid out management plans are required, similar to those developed by Arizona's Whitefly Management Program (Ellsworth et. al., 1996). A subcommittee met the day before and developed draft plans for Lygus, silverleaf whitefly, aphid, and spider mites as well as overarching guidelines. These were presented to the group and discussed in detail and accepted. Draft copies will be developed and circulated for comment. Final copies will be available by April 1997.

Results

In managing an ecosystem such as cotton and its associated arthropods, knowledge of the system will never be complete. It is unclear what has caused the shift in insect pests but a change of insecticide classes is certainly one of the contributing factors. Other factors could include variety shifts, changes in surrounding cropping patterns, changes in water and nutrition management, unique weather events, or changes in pest behavior and susceptibility to control measures. However, very few of these factors can be managed as directly as the choice of insecticides used in the field.

In 1996, pest management tactics were reconsidered in areas which had severe mite and aphid populations. Of key importance was understanding that pests cannot be managed individually, but actions toward one pest must be considered in the larger multiple pest complex. PCAs and growers reported changing attitudes about early Lygus management and holding off treatments until populations justified applications, based on established square retention thresholds. New approaches to managing Lygus, mites, aphids and whiteflies are being investigated including evaluation of action thresholds, insecticide/miticide resistance monitoring, and development of alternative management approaches.

The development of industry consensus for managing pests is essential for implementing and maintaining IPM programs. The process of issues identification and resolution develops commitment to the outcomes. A community is brought together to share the common elements of the crisis thus building stronger ties within it. Communication is improved between the various segments of the industry and results in stronger relationships. Questions are raised which provide direction for research and support for that research is garnered. Needs are identified for education and extension which can be addressed immediately.

The specific outcomes of the annual arthropod reviews establish valuable milestones against which the industry can measure progress. However, as important is the process itself which allows larger issues to be revealed, suggests actions to correct the situation, and develops a sense that the larger community is involved to finding solutions.

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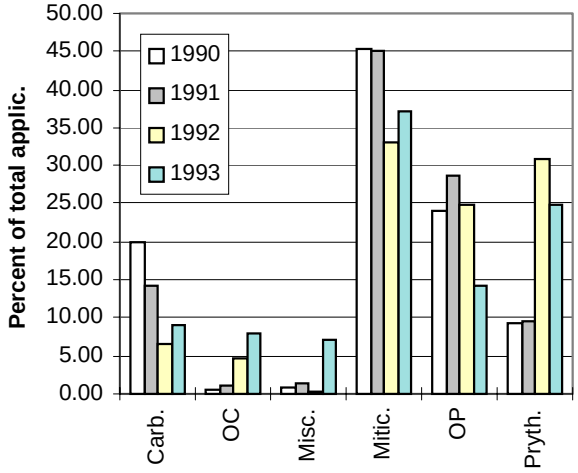

Figure 1. Proportional use of insecticides and miticides in the SJV by chemical "class". Axis titles: Carb. (carbamates), OC (organochlorines), Misc. (miscellaneous products, e.g. Bt, pyrethrins), Mitic. (miticides, dicofol, propargite, and avermectin), OP (organophosphates), Pyrth. (pyrethoids). Sulfur dust is not included. Data from CA Dept. of Pesticide Regulation

Table 1. Top five issues identified by SJV cotton growers and Pest Control Advisors, 1995 Insect Review Meeting.

Producers' List
1. Plant breeding to increase resistance or tolerance to arthropods
2. Improve understanding of why plants shed squares
3. Improve aphid action thresholds
4. Improve mite resistance management
5. Improve understanding of early Lygus thresholds and influence on early damage to yield
Pest Control Advisors' List
1. Avoid early applications of broad spectrum insecticides
2. Lygus thresholds need to be re-evaluated, especially early season
3. Use of broad spectrum insecticides will lead to mite outbreaks
4. Temik™ applied side dressed is less disruptive than other insecticides for Lygus
5. Breed host plant resistance for aphids

Table 2. General guidelines for arthropod management developed through a consensus of cotton producers and pest control advisors, 1995.

1. Anticipate aphid as number one pest
2. Early Lygus treatments lead to spider mites
Avoid using pyrethoids early in the fruiting period
Tolerate lower square retention, especially during a cool spring
Consider Temik™ as a side dress during high Lygus years or in areas prone to Lygus problems
3. Cool weather causes shed , increases thrips problems
4. Preventative mite control, especially if Lygus predicted to be a problem
5. Maximum profit rather than maximum production
6. Use selective insecticides/miticides - But where are they?