BIOLOGICAL CONTROL
MAKING IT WORK

PART 5: SUPPORTING ADOPTION OF BIOLOGICAL CONTROL

If we divide the practice of biological control into two parts, microbes and macrobes, we find two very different states of development. The microbes, such as Bt, are well-known as commercial entities, although relatively few in number when compared to the number of chemical pesticides. Where most growers know what *Bacillus thuringiensis* is, growers are just becoming aware of the existence and use of macrobes that we call natural enemies such as crytolaemus, Encarsia formosa, lace wings, trichogramma, and beneficial insect-parasitic nematodes.

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This paper is based on the experience of members of the Association of Natural Biological Control Producers (ANBP). At this point, members of the ANBP are primarily producers of natural enemies. However, our challenges and needs are paralleled closely in the microbial industry. Since microbials are well-known in comparison to natural enemies, I will concentrate on examples from the lesser-known.

CURRENT STATUS

Commercial use of beneficial insects and mites almost disappeared after World War II, when biological control retrenched to classical exploration and importation of natural enemies of exotic pests. Production and releases of native natural enemies in the United States has made a gradual reappearance in mainstream agriculture over the last three decades. Today we find natural enemy production and demand accelerating out of the lag phase toward the log phase of the sigmoid curve that describes population growth. Major users include greenhouses, farms, and grower cooperatives. Public and research growing facilities nationwide are rapidly adopting parasites and predators as well.

In the United States today, planned releases of spider mite predators are made annually on approximately 75 percent of California's 20,000 acres of

strawberries. Releases of trichogramma egg parasites for worm control on cotton cover a conservatively estimated minimum of 50,000 acres. Release of predators and parasites against mealybug and scale are made on over 28,000 acres of California citrus. Lacewings are applied on over 10,000 acres both from the air and ground for control of aphids and other pests on many crops. Beneficial insects and beneficial mites are used in over 90 percent of British Columbia's vegetable greenhouses.

THE FUTURE FOR NATURAL ENEMIES

ANBP's goal (see p. 249), is to promote the production and supply of effective natural enemies of high quality for the management of pests. As regular witnesses of effective pest management through use of natural enemies, we envision the day when such biological controls are used regularly throughout all of agriculture. Just as pesticide users had to learn what type of nozzles to use, the most effective spray pressure, and the minimum effective spray volumes to get good chemical control, quite a lot of learning is ahead for the new biological control users. But it will be done. Pesticide use will also continue, but pesticides will be managed so that they have minimal impact on natural enemies. More careful pesticide management will grow together with pest managers growing awareness of natural enemies.

MAJOR HURDLES

Our major hurdles include general pest control habits, pesticide research techniques, regulatory habits, large information gaps, and the development of systems of massive quality production.

General Pest Control Habits—Essential for successful biological control are:

- -pest monitoring
- -creation of an environment friendly to beneficial pesticide management
- -releases of most natural enemies when the pest levels are still extremely low

These needs all come under a strategy familiar to us: Integrated Pest Management (IPM). Continued development of IPM and IPM professionals throughout agriculture will make it possible for biological controls to be effectively used.

The single greatest threat to continuous dedicated use of IPM is the silver bullet: the fantastic new pesticides or engineered plant that annihilates multiple pests with a single application for the entire season. Silver bullets encourage pest managers to stop monitoring because there is nothing to look for. Natural enemies are either killed or have nothing at all to eat (eventually resulting in secondary pest outbreaks). And massive pest resurgence resulting from pest resistance and absence of natural enemies almost always ensues in a few years.

• For these reasons, we recommend that public funds support research and development only for pest controls that are friendly to natural enemies. We need to be cautious in setting up barriers to new, broad-spectrum pesticides, however. For example, although the broad spectrum pesticide, Avid, is extremely effective against many types of pests, its permissiveness to natural enemy survival makes it an extremely useful IPM tool for knocking back outbreaks before applying natural enemies.

Pesticide Research Habits—The established routine for testing pesticides is to set out randomized treatments replicated over small plots to test for significant differences among treatments. The experience of ANBP producers is that small plot trials are often inadequate for evaluating natural enemy species. Some of the problems encountered are the natural enemies' movement and cross-contamination of the small plots, including their demise in the pesticide plots. One example is the very carefully done 1960s small plot trial that that demonstrated biological control of spider mites in strawberries (Oatman, *etal,* 1968). The trial clearly demonstrated that exorbitantly high numbers of predatory mites were needed for acceptable spider mite control. According to Glen Scriven, co-founder of BioTactics, this knowledge put a tremendous damper on this spider mite control technique. One pest control management consultant, Charles Wood from the Oxnard area persisted in predator releases for nearly twenty years until Driscoll's, a California strawberry growing cooperative, began to research predators in the early 1980s. By 1988, they faced a desperate situation: they expected the miticide Plictran® to be withdrawn from the market, and spider mites were exhibiting resistance to the remaining miticides. In 1988 Driscoll's began large scale trials with the predatory mites. Over a period of about three years, backed by Wood's and Driscoll's experience, growers turned en masse to predatory mite releases.

Today, large scale experience indicates that a release rate of 20,000 predatory mites per acres very early in the season is usually adequate for spider mite control.

The biological control experience in strawberries demonstrates the two most basic needs for biological control adoption.

1- a belief that biological controls can keep pests at acceptable levels.
2- a determination to figure out what is needed to make biological controls work.

The need for large scale trials rules out the possibility of generating rigorous statistical data. Instead, researchers need to rely more on experiential, unreplicated observation that is not generally accepted in the research community as "scientific."

Regulatory Habits—Regulations are impeding expansion of biological control by:

1- Setting up barriers to the movement of natural enemies from state to state. Natural enemy providers must deal with the individual regulations of each state to which they ship arthropods. For example, this month the Florida agriculture department sent us letters requesting that we ship them samples every six months of the natural enemies that we are sending over their borders. Such samples are a good idea, however, it will be expensive for us producers to replicate samples semi-annually for individual states.
2- Setting up barriers to the registration of new pesticides that are more compatible with natural enemies. For example, the plant extract neem has been registered as a pesticide in several states, but the registration process in New York state is so cumbersome that we will be extremely surprised if neem becomes commercially available in New York state in less than two years.

Information Gaps—The greatest initial need of every biological control practitioner is clear, concise fact sheets on individual natural enemy species, their life cycle, environmental tolerances (pH, temperature) and ranges in their developmental rates, feeding rates, and reproduction rates. Readily available facts would greatly reduce the guesswork in deciding when, where, and how to apply. Guidelines on application rates, methods, coverage, timing, and the reasoning behind these would greatly enhance

the rate of user success. Updated information on relative compatibility of individual natural enemies with different pesticides is badly needed.

Rather than have each state extension service publish individual fact sheets, it would be more efficient to do the fact sheets on a national level, with regional emphasis placed on regional demonstrations and field observations. Large scale trials are needed to test guidelines, recognize weak areas, and prioritize further study needs. Emphasis should be in the ultimate objective, the large-field laboratory with field observations feeding back to the scientific laboratory for refined testing on hypotheses of why given things are happening.

Massive Quality Production—All of the above depends upon the massive supply of healthy natural enemies at a reasonable cost. Constant improvements in production efficiency, quality controls, storage, and shipping will come both from the private and public sectors.

PARALLEL NEEDS STATED BY RESEARCHERS

Biological control researchers have stated similar and additional needs enumerated below:

In 1979, Ridgway, et al. (1981) identified trichogramma research needs general enough to apply to the entire realm of natural enemies. These are paraphrased below:

1- Identification and selection of most effective species of strains.
2- Efficiency improvements in production and release.
3- Quantitative observations and analysis of the impact of releases on pest populations and crop yields/quality.
4- Improved methods of pest monitoring and pest forecasting.
5- Management of pesticides to minimize impact on natural enemies.

During that same conference, Tauber and Helgesen (1981) identified the leading impediments to the use of biological controls in the United States greenhouses as: 1-lack of supply; 2-lack of experience and basic knowledge, and 3-lack of a sales and support system like that found for chemical or seed sales.

Private and public sectors need to cooperate in addressing these factors.

Oatman, E. R., J. A. McMurtry, and V. Voth. 1988. Suppression of the two-spotted spider mite on strawberry with mass releases of Phytoseiulus persimilis. /. *Ecott. Entomology* 61:1517-1521.

Ridgway, R. L., J. R. Abies, C. Goodpasture, and A. W. Hartstack. 1981. Trichogramma and its utilization for crop protection in the U.S.A. J. R. Coulson ed. In proceedings of the joint American-Soviet conference on use of beneficial organisms in the control of crop pests. Washington, D.C., August 13-14,1979. Entomological Society of America, College Park, MD.

Tauber, M. J. and R. G. Helgesen, 1981. Development of biological control systems for greenhouse crop production in the U.S.A. J. R. Coulson ed. In proceedings of the joint American-Soviet conference on use of beneficial organisms in the control of crop pests. Washington, D.C., August 13-14,1979. Entomological Society of America, College Park, MD.