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Biological control: Major emphasis in UC research

Public concern about pesticide residues in foods and degradation of the environment has stimulated increased interest in biological controls. A perception of pesticides as a threat to human health and the environment is leading to increasingly stringent laws limiting their use. It is likely that the number of chemicals available, and the number of uses allowable, will decline to the point where chemical control will not be available for some pest situations, particularly in California.

In addition to increased food safety and reduced pesticide load in the environment, biological controls have the advantage of reducing farm-worker exposure to pesticides. They also help avoid damage to nontarget crops and beneficial insect species, and they lessen the problem of pest resistance to chemicals. Once established, some biological control strategies can be relatively low in cost.

Thus the stage is set for increased research and extension programs in biological control. The University of California has a rich tradition in this area. California's interest in biological control began in 1888-89, when a few hundred vedalia beetles, *Rodolia cardinalis*, were imported from Australia and New Zealand to control cottony cushion scale, *Icerya purchasi*, which was decimating the state's citrus crops. Within two years, the pest was no longer an economic threat. To mark the centennial of this first successful biocontrol effort and to analyze its future, UC Riverside recently hosted "The International Vedalia Symposium on Biological Control: A Century of Success."

The University's first formal research unit in biological control was established in 1923 at what is now the UC Citrus Research Center and Agricultural Experiment Station in Riverside. A second unit was established in Berkeley in 1944. From an initial focus on insect natural enemies, biological control has expanded to encompass organisms such as pathogens, microbes, nematodes, and other antagonists or competitors of pests.

Today, more than 300 agricultural and urban insect pests worldwide are managed by biological control agents. UC scientists have developed many of them, pioneering biological control since its first scientific use with the vedalia beetle. Today the University of California spends more than $8 million a year on biological control research in eight departments on three campuses. More than 50 UC scientists work primarily in biological control. Within the Division of Agriculture and Natural Resources, a task force is examining the status of biological control and will recommend methods to help bring it into wider use.

In the real world of production agriculture today, biological control often provides a foundation for pest management, but frequently must be supplemented by the judicious use of cultural management practices and selective pesticides. Thus, biological control is a critical component of many integrated pest management programs. One example is the use of parasitic wasps to control red scale in citrus. This natural enemy is highly effective in southern California. But in the San Joaquin Valley, the cold winters limit its use. Although it must be supplemented with chemical control in the valley, use of the wasp has reduced the frequency of pesticide applications.

The goal is not to eradicate pests, but rather to keep pest populations below the threshold of economic injury. As biocontrol methods become more prevalent, reduced use of chemical pesticides will cause more pest damage to appear in foodstuffs. The public will need to learn to recognize that there are reasonable trade-offs between food appearance and increased environmental and human health safety.

Many exciting new frontiers exist for biological control. Genetics play a role in the choice of candidate target species, in the choice of a natural enemy for importation, in strategies for selection, collection, and handling of natural enemies before release, and in deliberate laboratory or field manipulation to improve the performance of natural enemies. Genetic engineering also has potential for development of more effective viral insecticides. Methods being considered include modification of natural virus functions to increase virulence or to alter host range.

The most widely used group of microbial insecticides is associated with the bacterium *Bacillus thuringiensis* (Bt). UC Riverside researchers already have isolated and cloned two genes for mosquito toxins from *Bacillus thuringiensis* var. *israelensis* (Bti). The impact has been significant. In 1983, the World Health Organization used more than 500,000 pounds of Bti to control disease-carrying blackflies in West Africa. Bt is effective against three major orders of insects, Coleoptera (beetles), Lepidoptera (moths), and Diptera (mosquitoes and blackflies). UC teams are investigating the molecular mode of action of each protein involved in toxicity and will eventually transform bacteria into more effective strains for insecticide use, or for use in endowing plants with insecticidal genes.

There are several other promising contenders for biological control. Mycopesticides are microbial agents used to control insects, nematodes, and weeds. Plant diseases are often controlled by cross-protection, or infection of plants with a mild, avirulent strain of virus to protect it against the effects of related, more virulent strains. In the future, it may be possible to genetically engineer selected viral genes responsible for cross-protection directly into the genes of the plant.

Another frontier is soil ecology, the development of modified ecosystems to suppress or alleviate some nematode problems and root diseases. Interest in this area is considerable, since many soil fumigants are being withdrawn from use or their registrations are not being renewed.

The use of some of these biocontrol strategies has been somewhat limited by competition from chemical pesticides, increasing costs of development, and cumbersome registration protocols. Progress has been slowed by major limitations relating to quality control, product stability, delivery, and environmental fate.

Despite these limits, the University of California intends to carry on a vigorous program in the development and introduction of biological controls. They can and will play a growing role in the future of agriculture as we continue our commitment to serving California agriculture and to protecting human health and the environment.

NOTE: Vice President Farrell has invited Interim Dean Van Gundy to write this guest editorial on the subject of biological control.