## The Oklahoma Cooperative Extension Service

# WE ARE OKLAHOMA

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and research-based information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.



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# Banker Plants for Control of Greenhouse Pests

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Biological control is one of the pillars of IPM, or integrated pest management. Integrated pest management combines biological, cultural, mechanical, physical and chemical control in a manner that makes the crop environment unsuitable for arthropod pests, plant pathogens and weeds. In many cases, IPM methods are used prior to treating with pesticides. These methods may include altering the planting date of crops, removing diseased plants or plant parts, removing pests by hand, applying a biologically based pesticide, enhancing the crop habitat to attract beneficial insects or releasing parasitic or predatory insects and mites to target and control specific pests (i.e., augmentative biological control).

One strategy of IPM is biological control, which exploits the relationship between an arthropod pest and its natural enemies: predators, parasitoids or pathogens. Predators include, but are not limited to, lady beetles, lacewings and rove beetles, which attack and consume target pests. Parasitoids lay eggs in or on a target insect host. The eggs hatch into larvae that devour the host and ultimately kill it. Pathogens include specific fungi, viruses, bacteria or protozoa that infect and kill target pests. The success of a biological control program hinges on enhanced reproduction, survival and/or longevity of natural enemies.

Banker plants consist of a non-crop host plant harboring a natural enemy, and in most cases an alternate non-pest prey. Some banker plants only consist of a natural enemy and an alternative plant that may provide pollen, an egg-laying site or other required resource that enhances natural enemy survival and reproduction. Banker plant systems have been used mainly to target aphids, but they are also used against spider mites and thrips. In this unique system, pest populations may be reduced and maintained at densities below economic and/or aesthetic thresholds, the level at which plants would suffer significant damage from feeding and other pest activities. Banker plants provide a preemptive means of biological control via improved crop habitat, alternative food and/or alternate host insects to sustain natural enemies.

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## Banker Plant Systems for Greenhouses

Biological control works well in controlled environments because enclosed production spaces decrease the likelihood of natural enemies escaping and provide favorable climates that promote continuous reproduction of natural enemies. Banker plants are versatile and can be used in greenhouse production of vegetables, cut flowers and bedding plants. They can also be used in hydroponic operations.

If using grain aphids such as bird cherry-oat aphids as alternative prey, use banker plants with caution where greater than 10 percent of the greenhouse space consists of ornamental grasses, corn, Easter lily, spring flowering bulbs, onions, garlic, leeks and cole crops. In these growing situations, the alternative prey has the potential to become a pest. Scouting should still be performed regularly to maintain the quality and efficacy of biological control agents as well as detecting pest outbreaks as they occur.

## Benefits of Using Biological Control

Biological control can provide many benefits to growers as part of a comprehensive IPM program. First, traditional pesticide applications may be reduced, thereby minimizing the likelihood of pesticide resistance developing in a target pest population. Reduced reliance on pesticides can improve environmental quality and decrease operating costs. Biological control can be user friendly and more easily implemented than conventional control options, saving time and labor costs.

Banker plants provide a continuous source of natural enemies that are maintained in the crop, reducing the potential for insect outbreaks. Compared to augmentative biological control, banker plants can reduce costs by minimizing the need to purchase replacement biological control agents. Also, banker plants effectively maintain colonies of natural enemies on site, decreasing the lag time between pest detection and receiving shipments from the biological control supplier. Implementing biological control with or without banker plants poses no threat to employees and requires no pre- or post-harvest intervals nor re-entry intervals. This permits workers immediate access to plants following release of natural enemies, thereby facilitating maintenance, shipping and sale of plants. Lastly, growers have a chance to convey their choice to use more natural methods of pest control. With the demand for organic or more sustainable practices by consumers, biological control gives the grower a chance to market plants produced in an environmentally friendly manner.

## Types of Banker Plant Systems

Many types of banker plant systems can be implemented with commercially available biological control agents. A list of suppliers is provided in Table 1. Alternate prey are typically non-pests in the greenhouse, so risk of an outbreak is minimized. In addition, non-pest prey may be reared on banker plants that are not typically present in the greenhouse, such as cereal grains. This reduces or eliminates the risk of introducing an additional pest into the greenhouse.

### Parasitic Wasps

An example of a commercially available banker plant system includes a parasitoid and aphid prey for controlling the green peach aphid, *Myzus persicae* (Figure 1) and cotton melon aphids, *Aphis gossypii* (Figure 2). These are two of the most commonly encountered pest aphids in greenhouse production systems. The system targeting these pests consists of bird cherry-oat aphids, *Rhopalosiphum padi* (Figure 3) reared on winter wheat or barley, serving as alternative prey for the beneficial parasitoid, *Aphidius colemani* (Figure 4). This parasitic wasp seeks out and attacks individual aphids,

**Table 1. Canadian and U.S. biological control agent suppliers.**

| *Supplier* | *Location* | *Website* |
|---|---|---|
| A-1 Unique Insect Control | California | www.a-unique.com/ |
| American Insectaries | California | www.americaninsectaries.com/ |
| Applied Bio-Nomics | Canada | www.appliedbio-nomics.com/ |
| Arbico Orgainics | Arizona | www.arbico-organics.com/ |
| Associates Insectary | California | www.associatesinsectary.com/ |
| Beneficial Insectary | Canada; California | www.insectary.cm/ |
| Bio Ag Services | California | www.bioagservicescorp.com/ |
| BioBest | Canada | www.biobestgroup.com/ |
| Bio-Controle Inc. | Canada | www.agrobiocontrole.ca/home.php |
| Biofac Crop Care | Texas | www.biofac.com/ |
| Bioline AgroSciences | Canada; U.S. | www.biolineagrosciences.com/ |
| BioLogic Company | Pennsylvania | www.biologicco.com/ |
| Biotactics | California | www.benemite.com/ |
| Bio-Works | California | www.bioworksinc.com/ |
| BugLogical Control Systems | Arizona | www.buglogical.com/ |
| Crop Defenders | Canada | www.cropdefenders.ca/ |
| Entomology Solutions | Kentucky | www.idlewildbutterflyfarm.com/ |
| Evergreen Growers Supply | Oregon | www.evergreengrowers.com/ |
| Everwood Farm | Oregon | www.everwoodfar.com |
| Gardeners Supply Company | Vermont | www.gardeners.com/ |
| Gardens Alive! | Indiana | www.gardensalive.com/ |
| Green Methods | California | www.greenmethods.com |
| Hydro-Gardens | Colorado | www.hydro-gardens.com/ |
| IPM Laboratories | New York | www.ipmlabs.com/ |
| Koppert | Canada; U.S. | www.koppert.com/ |
| Kunafin "The Insectary" | Texas | www.kunafin.com/ |
| Natural Enemies | Oregon | www.naturalenemiesbiocontrol.com/ |
| Natural Insect Control | Canada | www..naturalinsectcontrol.com/index.php |
| Natural Pest Control | California | www.natpestco.com/ |
| Nature's Control | Oregon | www.naturescontrol.com/index.html |
| Peaceful Valley Farm Supply | California | www.groworganic.com/ |
| Plant Natural | Montana | www.planetnatural.com/ |
| Rincon-Vitova Insectaries | California | www.rinconvitova.com/ |
| Sound Horticulture | Washington | www.soundhorticulture.com/ |
| Territorial Seed Company | Oregon | www.territorialseed.com/ |
| Tip Top Biocontrol | California | www.tiptopbiocontrol.com/ |

**Table 3. Steps to implement the *A. colemani/R. padi* system.**

1. Purchase winter wheat see and *R. padi*, as well as two separate enclosures. Butterfly cages are ideal (Figure 6.).
2. Sow wheat seed in several 6- to 10-inch pots (two to three pots per 1,000 square feet of growing space).
3. Once the wheat is sprouted, infest the plants with purchased bird cherry-oat aphids. This can be done by placing three to four infested grass blades into each plant.
4. Keep the plants moderately moist and cool; 75 F or less.
5. After a few days, order *A. colemani* mummies from supplier (see Table 1).
6. Place half the *R. padi*-infested plants into a separate cage (heavily infested).
7. Make sure the plants have adequate moisture.
8. Add *A. colemani* mummies to one cage by sprinkling the mummies onto the soilless media of wheat plants.
9. The second cage should remain free of *A. colemani*, consisting of *R. padi* aphids only.
10. *Aphidius colemani* adults will emerge from the purchased mummies in 24 to 48 hours and parasitize the *R. padi* aphids on wheat. Do not water the plants for two days.
11. Seven to 10 days after placing the mummies, new mummies will be formed on the plant. These are your banker plants. (Leave at least one plant in the cage for future colonies.)
12. Place banker plants among the crop in the greenhouse.
13. Begin with one to two banker plants per 2,000 to 5,000 square feet, adding new plants weekly.
14. Allow dead banker plants to remain in the house for five to seven days. *A. colemani* will continue to emerge from mummies.
15. Inspect banker plants regularly for the presence of hyperparasitoids. These can be identified by their jagged exit holes from the mummy. If detected, destroy the plants and replace.
16. Continue to maintain the two colonies in separate cages by sowing wheat weekly.
17. If spraying is necessary, remove banker plants from the area before treatment. Plants may be reintroduced two to three days later.



**Figure 1. Green peach aphid, *Myzus persicae*, on ornamental pepper. (T.P. Miller)**

**Figure 2. Cotton melon aphid, *Aphis gossypii*, on ornamental pepper. (T.P. Miller)**

parasitizing them by laying an egg within their bodies. Upon hatching, the wasp larva consumes its aphid host from within and eventually completes its development. When the larva pupates, the aphid swells in size, hardens and turns brown, resulting in what is called a "mummy" (Figure 5). The adult wasp eventually emerges from the mummy through a smooth, round exit hole.

When pest aphids aren't present in the greenhouse, *A. colemani* is sustained on the bird cherry-oat aphid. However, the parasitoid has a preference for green peach and cotton/melon aphids over bird cherry-oat aphids. When populations of green peach aphid or melon aphid increase, *A. colemani* switches prey and begins attacking pest aphids within the crop. This system works best if established slightly before or at the start of the crop cycle. Different species of parasitic

**Figure 3. Bird cherry oat aphid, *Rhopalosiphum padi*, on winter wheat. (T.P. Miller)**


**Figure 4. *Aphidius colemani* parasitoid. (David Cappaert, Bugwood.org)**

wasps (Table 2) that use alternate aphid prey on cereal grains may be reared in the same fashion.

### Predatory Mites

Predatory mites can be reared on pollen plants in banker plant systems designed to control pest mites, thrips and other pests. Banker plants used in these systems include castor bean, corn and ornamental peppers. Because mites cannot fly, banker plant foliage must overlap or touch crop foliage to

**Table 2. Types of banker plant systems for greenhouse use.**

| *Type* | *Name* | *Alternative Prey* | *Food Source/ Alternative Plant* | *Pests Attacked* |
|---|---|---|---|---|
| Parasitic Wasps | *Aphidius colemani* | bird cherry-oat aphid, greenbug | winter wheat, barley, millet | green peach aphid, cotton melon aphid, tobacco aphid |
| | Aphidius matricariae | bird cherry-oat aphid | winter wheat, barley | green peach aphid |
| | *Aphidius ervi* | English grain aphid | winter wheat | potato aphid, foxglove aphid |
| | *Aphelius abdominalis* | bird cherry-oat aphid, English grain aphid | oat | potato aphid, green peach aphid |
| | *Lysiphlebus testaceipes* | bird cherry-oat aphid, greenbug | winter wheat, ryegrass, bluegrass, sorghum | cotton melon aphid |
| Predatory Mites | *Ambyseius andersoni* | pollen | castor bean, corn, ornamental pepper | spider mites and other mites, thrips larvae |
| | *Ambyseius cucumeris* | pollen | castor bean, corn, ornamental pepper | thrips |
| | *Ambyseius californicus* | pollen | corn | two-spotted spider mite, Carmine mite |
| | *Ambyseius degenerans* | pollen | castor bean | thrips |
| | *Ambyseius swirskii* | pollen | castor bean, corn, 'Red Missle' or 'Masquerade,' ornamental pepper | thrips, whitefly |
| | *Phytoseiulus persimilis* | pollen | corn | two-spotted spider mite |
| Predatory Bugs | *Orius insidiosus* | pollen | 'Purple Flash' or 'Black Pearl,' ornamental pepper, common mullein | thrips, two-spotted spider mites, moth eggs |
| | *Dicyphus hesperus* | pollen | common mullein | thrips, two-spotted spider mite, whitefly, moth eggs |
| Predatory Midges | *Aphidoletes aphidimyza* | bird cherry-oat aphid | winter wheat, barley | cotton melon aphid, green peach aphid, moth eggs |
| Predatory Beetles | *Scymus creperus* | bird cherry-oat aphid | winter wheat, barley | green peach aphid |




**Figure 5. Two aphid mummies next to two non-parasitized aphids. (Whitney Cranshaw, Colorado State University, Bugwood.org)**

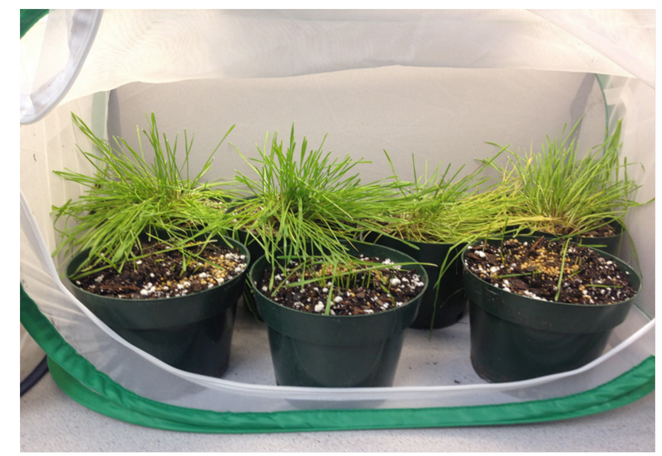

**Figure 6. Banker plant colonies in screen cages consisting of bird cherry oat aphid on immature winter wheat. (T.P. Miller)**

facilitate their movement among infested crop plants. Colonies of predatory mites can be maintained by the grower, and banker plants should be populated with mites a few days before or at the start of the crop cycle. This may mean infesting banker plants with mites weeks or months before moving the plants into the greenhouse alongside crop plants.

### Predatory Bugs

Other banker plant systems may use pollen as an alternate food source for a predatory insect or mite. Certain alternate plant cultivars have been identified that show improved reproductive benefits for natural enemies and are included in Table 2. For example, the minute pirate bug, *Orius insidiosus*, is a predator of western flower thrips and two-spotted spider mites. Predators provided with pollen from ornamental pepper, *Capsicum annuum* 'Purple Flash,' or common mullein, *Verbascum thapsus*, have increased predator longevity and reproduction compared to those that are simply purchased and released in an augmentation biological control program. Unlike the *A. colemani*-bird cherry oat aphid system, the minute pirate bug system must be started three to four weeks prior to the beginning of the crop cycle. The recommended density of banker plants is approximately one pepper plant per 500 square feet or one mullein plant per 1,000 square feet of production space.

Even when banker plants are successfully implemented, insecticide and fungicide applications may be necessary to control non-target pests and diseases. When spraying pesticides, it is best to choose narrow-spectrum products that target the specific pest and minimize impacts on natural enemies. The method of pesticide delivery, such as a spray, dip, or drench, should be considered in a way that will least impact biological control agents. Fortunately, new pesticide formulations and modes of action may be "softer" on predators and parasitoids. However, banker plants should be moved out of the greenhouse when using any pesticide until sufficient time has passed to reintroduce the natural enemies. Oklahoma Cooperative Extension Service publications HLA-6711, CR-6718, and E-1011 provide more information on chemical control in greenhouse production.

### Additional Reading


Frank, S. D. 2010. Biological Control of Arthropod Pests Using Banker Plant Systems: Past Progress and Future Directions. *Biological Control* 52: 8-16.

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Van Lenteren, J. C., and J. Woets. 1988. Biological and Integrated Pest Control in Greenhouses. *Annual Review of Entomology*: 239-269