SUSTAINABLE COTTON PROJECT

BASIC Program Field Notes

The following articles were provided to cotton growers enrolled in the SCP cotton program from 2006 through 2009. Along with their weekly field scouting reports, the growers received a timely article once per month called "Field Notes." These were the articles sent to the growers during that time period. The cotton field program was then called BASIC (Biological Agriculture Systems in Cotton) and the information provided was designed to provide information and documentation on the best management practices being promoted by the program.

BASIC Program Components

The Sustainable Cotton Project's BASIC program (Biological Agriculture Systems In Cotton) has been actively meeting with cotton growers in the Firebaugh, Mendota and Dos Palos areas encouraging them to enroll a test block of cotton into the program. By agreeing to enroll, growers are helping to refine a system that will enable all cotton growers to reduce their dependence on pesticides.

The goal of BASIC is to develop a working knowledge of chemical reduction techniques that can be successfully and economically applied in California. BASIC offers strategies designed to save the grower money by reducing the need for insecticides, miticides, chemical fertilizers and water. To share this information with local growers, the program offers field days, demonstrations and on farm trials as well as highlighting new approaches to help cotton farmers save money and control pest outbreaks.

Growers enroll before planting, and team up with other growers to field test the effectiveness of the BASIC strategy. The main program components are:

1) an April planting date,
2) cotton fields located near alfalfa or planting beneficial habitat along field margins,
3) intensive scouting to monitor pests and beneficial insects,
4) early releases of natural enemies within cotton fields,
5) limiting or eliminating pesticide applications in the spring, and
6) soil fertility and nutrient monitoring.

These program elements can help cotton growers find a good balance by encouraging soil building, increasing beneficial habitat, and reducing the need for expensive chemical sprays.

Handling Mite Pressure

Injury to foliage reduces yield only if it is extensive enough to reduce the plant's ability to conduct photosynthesis and transfer energy to fruit. The foliage pests most damaging in the Northern San Joaquin Valley are spider mites. All spider mites cause essentially the same injury, leaves or parts of leaves turn yellow or red and may drop. Mites can cause heavily infested fields to defoliate.

Types Mites in Cotton. Spider mites in cotton include strawberry spider mite, twospotted spider mite, and the Pacific spider mite. Females of the strawberry, twospotted, and Pacific spider mites are green or straw yellow with dark blotches at the sides of the body.

Populations
Spider mites are present all year on perennial hosts such as alfalfa and almonds. Mite

populations thrive on annual crops and weeds as these become available during the year. A generation of mites can mature in as little as 5 days in hot weather. Cotton generally hosts about 10 generations of mites each season. Mite populations are regulated by temperature, condition of host plants, and the activity of predators, especially flower thrips, minute pirate bugs, bigeyed bugs, lace wings, predatory mites, and spider mite destroyer lady beetles. Early infestations can arise from mites that over winter on the soil or on weeds. Infestations can also start with adult females carried by the wind from perennial host crops. Mites are also associated with dusty or dirty cotton along frequently traveled dirt roads. Mites that are carried by the wind, often build up first along the edge of the up wind side of the field, then spread in a down wind direction. Infestations that arise from mites overwintering on the soil can occur anywhere in the field.

Early Season

Strawberry spider mite is the most dominant species on early season cotton. These mite colonies will be located on the lower leaf surfaces of cotyledons and first true leaves. Feeding injury appears as red patches on the upper side of leaves directly opposite the location of the colony. Early thrips often feed on these mites, therefore BASIC field scout's closely monitor this activity and encourage growers to resist spraying if at all possible.

Mid-Late Season

Twospotted spider mite and Pacific spider mite are the most common mid to late season mite species attacking cotton. Twospotted spider mite produce a diffuse pattern of yellow spots over much of the leaf surface. Pacific spider mite injury often spreads first along main leaf veins, although it may later cover most of the leaf. Twospotted spider mite and Pacific spider mite damage look very similar. However, Pacific spider mites produce more webbing and are the only mite commonly found on both surfaces of infested leaves.

Natural Controls

Insecticides often cause outbreaks of mites by destroying their predators. There is generally no significant natural control of mites for about a month following chemical treatment for lygus bugs, aphids, or other insect pests. Managing spider mites requires preserving natural controls as long as possible each season. Natural enemy populations can be increased or preserved in a variety of ways: establishment of beneficial habitat, augmented releases of beneficials, management of neighboring crops, and applications of beneficial friendly insecticides like sulfur. BASIC growers are encouraged to use these techniques in order to keep them off the pesticide treadmill and reduce overall pesticides applied.

Ask These Questions

Consider the following factors before making a decision to treat for mites. What percentage of leaves is infested with mites? How numerous are beneficials? How does the mite population compare with that of previous weeks? What is the previous history of mite outbreaks on the field? What growth stage is the crop in?

Why Soil Sample?

Each cotton grower with a block enrolled in the BASIC program will receive a soil sample as part of the project. The key objective in sampling is to determine if there are adequate, but not excessive levels of all necessary plant nutrients. Careful soil sampling is essential for accurate fertilizer application. It also can help growers develop and maintain more productive soil as well as to increase net returns per acre by providing information on the available nutrient content and fertility status of the soil. With this information, selection of the correct type and amount of fertilizer can be more accurate.

The Right Samples

Sampling needs to be done either after harvest or before planting. Collecting a representative sample is also very important. A minimum of 20 cores per field is suggested. The sample must reflect the overall or average fertility of a field so that analyses, interpretations and recommendations accurately represent the nutrient and/or mineral status of the field.

Soil sampling should exclude small areas within a field that are obviously unique. These can be sampled separately if they are large enough to warrant special treatment. Because nutrient availability is affected by moisture, avoid sampling areas that are either water stressed or excessively wet.

Efficiencies

With an accurate soil evaluation, growers can be more efficient with their fertilizer use, which can in turn increase yields, reduce costs and potentially reduce environmental pollution from excess nitrogen run off. Excessive nitrogen can pose problems in cotton. Studies in cotton and many other crops show a correlation between excessive nitrogen and pest outbreaks. Also high nitrogen levels at defoliation can make it difficult to completely desiccate the field.

BASIC grower's soil samples will be sent to labs for evaluation and interpretation of results.

Integrated Pest Management and BASIC

BASIC is a system that helps farmers save money by limiting or eliminating the need of pesticides. This is achieved by the use of Integrated Pest Management techniques, otherwise known as IPM. IPM is the selection, integration, and use of control methods based on scientific knowledge of the crop and the pest as well as associated pests and beneficials in order to achieve desirable economic, ecological, and sociological goals.

Natural Enemies

The suppression of pests below the economic threshold is achieved through biological control via natural enemies. Biological control is any activity of one species that reduces the adverse effects of other species. Natural enemies are organisms that kill, decrease the

reproductive potential, or otherwise reduce the numbers of another organism. The natural enemies that reduce pest populations in the BASIC program do so primarily through parasitism or predation. A predator is an organism that attacks, kills, and feeds on several or many other individuals (its prey) in its life time. A parasite is an organism that lives in or on a larger host.

Monitoring

An important component of the BASIC system is intensive monitoring, to establish pest and beneficial levels. Field monitoring provides information on the crop, pests, and biological control agents. Natural enemies sometimes provide sufficient control to completely manage a pest, but it is common for natural enemies to reduce pest populations, but not enough to prevent economic loss.

Beneficial habitats

Natural enemy populations can be increased through planting beneficial habitat adjacent to cotton fields, by planting cotton adjacent to alfalfa, or native habitat and augmented releases of beneficial insects. The ideal situation in cotton is to have the insects reared on site in either the field or beneficial habitat. Augmented releases should be reserved for treating hot spots, because without naturally occurring beneficials there is no way one could supply enough insects to treat the entire field. A hot spot is a place in the field where the pests are out numbering the beneficials and the damage is noticeable. This is where augmented releases of beneficials are used to suppress the pest population below the economic injury threshold. After the pest populations are suppressed, the hot spots serve as on site insectaries for beneficials.

Avoid early spring spraying

The key to rearing insects on farm is the avoidance of early spring sprays. This allows natural enemies to increase in population and control target pests which in turn can prevent secondary pest outbreaks. A secondary pest is an insect that in normal circumstances is controlled by natural enemies. The immediate effect of spraying is not only a reduction in the number of pests, but an even greater reduction of natural enemies. The resulting unfavorable ratio of pests to natural enemies permit's a rapid increase of target pest populations. This causes farmers to treat more often for insects which would normally be controlled by natural enemies. Chemicals kill good bugs as well as bad ones, this the root cause of the insecticide treadmill.

To help ensure farmers do not get on the insecticide treadmill, BASIC uses five methods of scouting the field and its associated beneficial habitat.

1. The first tool is soil and petiole sampling

A nutrient deficient plant is more susceptible to insect injury than a healthy one. For this reason, BASIC provides for one soil sample and two petiole samples each season. Aphids and white fly prefer plants that are high in nitrogen, so farmers should avoid excessive or poorly scheduled nitrogen applications.

2. Plant mapping is another tool utilized by the BASIC team
Plant mapping provides an indication of the cotton plant's growth and development. Plant mapping programs have been developed to aid growers in determining if their plants are growing at a normal pace for good yield. Plant mapping allows the farmer to make management decisions on when to pix, changes in irrigation practices, nitrogen fertilization, and defoliation. Plant mapping also allows the farmer to see what his/her square and boll retention is. Through the use of sweep net and D-Vac samples the farmer can decide if the square loss is due to lygus pressure or environmental conditions.

3. Sweep net and D-Vac are two sampling techniques used by BASIC to determine pest and beneficial levels. Sweep net sampling consists of 50 sweeps across a single row of cotton, using a standard net with a diameter of 15 inches. All pest and beneficials are recorded in their proper stage of development.

4. The D-Vac operates like a vacuum and it works a lot like the sweep net, except it is better at extracting extremely small insects and insects that are in their nymphal and larval stages of development.

5. The last sampling technique employed by BASIC is leaf sampling
Mites, aphids, thrips, and certain beneficials are sampled with this technique. 100 leaves are randomly selected throughout the field and checked for those insects.
Through the use of sweep net, D-Vac, and leaf sampling the BASIC management team is able to determine if biological control is working. It could be possible that all is needed is augmented releases of beneficials.

Green Lacewings: Are These Unpaid Workers In Your Cotton?

These green lacewings are common in much of North America. Adults feed only on nectar, pollen, and aphid honeydew, but their larvae are active predators. Adult green lacewings are pale green, about 12-20 mm long, with long antennae and bright, golden eyes. They have large, transparent, pale green wings and a delicate body.

Adults are active fliers, particularly during the evening and night and have a characteristic, fluttering flight. Oval shaped eggs are laid singly at the end of long silken stalks and are pale green, turning gray in several days. The larvae, which are very active, are gray or brownish and alligator-like with well-developed legs and large pincers with which they suck the body fluids from prey.

Prey
Cotton, sweet corn, potatoes, cole crops, tomatoes, peppers, eggplants, asparagus, leafy greens, apples, strawberries, and other crops infested by aphids. Several species of aphids,

spider mites (especially red mites), thrips, whiteflies, eggs of leafhoppers, moths, and leafminers, small caterpillars, beetle larvae, and the tobacco budworm are reported prey.

Life Cycle
Green lacewings overwinter as adults, usually in leaf litter at the edge of fields. During the spring and summer, females lay several hundred small (<1 mm) eggs on leaves or twigs in the vicinity of prey. Larvae emerge in 3-6 days.

The larval stage has three instars and lasts two to three weeks. Mature third instars spin round, parchment-like, silken cocoons usually in hidden places on plants. Emergence of the adults occurs in 10 to 14 days. The life cycle (under 4 weeks in summer conditions) is heavily influenced by temperature. There may be two to several generations per year. These lacewing larvae are considered generalist beneficials but are best known as aphid predators. The larvae are sometimes called aphid lions, and have been reported to eat between 100 and 600 aphids each, although they may have difficulty finding prey in crops with hairy or sticky leaves.

Habitats
Mass releases of C. carnea in a Texas cotton field trial reduced bollworm infestation by 96%, although more recent studies show that C. carnea predation on other predators can disrupt cotton aphid control. C. carnea is considered an important aphid predator in Russian and Egyptian cotton crops, German sugar beets, and European vineyards. Adult lacewings need nectar or honeydew as food before egg laying and they also feed on pollen. .
Therefore, plantings should include flowering plants, and a low level of aphids should be tolerated. Artificial foods and honeydew substitutes are available commercially and have been used to enhance the number and activity of adult lacewings

Dispersal
These products may provide sufficient nutrients to promote egg laying, but they cannot counter the dispersal behavior of newly emerged adult lacewings. These beneficial insects are shipped as eggs, young larvae, pupae, and adults. Larvae are likely to remain near the release site if aphids or other prey are available. Newly emerging adults, however, will disperse in search of food, often over great distances, before laying eggs.

SCP has made green lacewing releases in most all the project fields. They are available commercially and our field scouts can provide you with contact information if you would like to purchase additional larva for release in your cotton or other crops.

Why Is Biological Control Important?
Issues such as high chemical costs, pesticide resistance, environmental degradation, and water and worker safety have promoted researchers, growers, and policy makers to pursue alternative strategies to pest management. Biological control has emerged as one of the more successful, safe and sustainable strategies.

Experience at Work

Much of the information for this article is taken from the lifetime of experiences of Deke Dietrick, Board Certified Entomologist of the Dietrick Institute. Deke has been active in the biological control movement since 1955, and may be one of the first pest control advisors to market advice on biological control. In his work in the Coachella Valley, he learned that natural biological control was possible in cotton and that optimum yields and quality were produced using no pesticides. This article will discuss some of the basics of biological control in cotton which can be utilized to your economic advantage.

Natural Balances

Predators and parasites can often prevent a pest population from reaching treatable levels, and the control they provide is often cheaper, better, and longer lasting than that provided by insecticides. Scouts and growers should be aware of population levels of naturally occurring predators and parasites and should recognize that biological control can bring about a natural balance with out the use of expensive chemicals.

In Search of Food

Deke discovered in the decade of the fifties, that food drives all of the interactions of over one thousand species of potential plant feeding pests, predators, and parasites as well as all of the naturals processes affecting these insects including diseases and decomposition. Along with other researchers, he found cotton gown adjacent to alfalfa had a wider range and diversity of insect species. The insect pest Lygus develops in large numbers in alfalfa and then often moves in huge numbers into cotton when the alfalfa is mowed. Much work has been done to help show that strip mowing of alfalfa might prevent large scale migrations of lygus and thereby reduce the threat to cotton. When the entire alfalfa field is mowed all at once, a dense and lush plant cover is eliminated, leaving many arthropods without food and shelter and exposed to high temperatures and high humidity. Work as early as the 1960's showed that strip harvested fields prevent this mass migration and thus reduced damage in cotton.

Creating Balance

By developing a set of practices that includes strip cutting of alfalfa, habitat planting and enhancement, regular monitoring and proper pest identification, growers are well on their way to biological control. Pest identification is an important consideration in control of cotton insects, and before making control decisions, growers must correctly identify the pests or pest complex. This requires detailed study in pest characteristics and the type of damage associated with each pest species.

It is also essential that you develop a regular monitoring program that permits reasonably accurate population estimates of not just the pests, but beneficials as well. Cotton "scouting" involves taking systematic data on pests, beneficials, and plant characteristics from each field. Deke and his colleagues invented vacuum insect sampling equipment to monitor all of the insects and mites found in cotton and its adjacent alfalfa. Sampling each week of the growing season, they observed the full impact of biological control. Says Deke,

"We found that this diversity of migrating and resident insects and related organisms vacuumed from the plants provided sure, dependable resources that protected the cotton from predicted disasters. Producing top yields and quality cotton was free to those who would farm with this natural biological control."

Biological control should be encouraged and enhanced by adding additional food for insect populations. This is best done by having adjacent plants with lots of blossoms and encouraging all species of predators through habitat enhancement planting and mulches.

The avoidance of pesticides, reducing excessive road dust, and border plantings of Sudan grass, sunflowers, corn, sorghum are examples of how biological management practices can protect insect predators and help avoid damaging pest outbreaks.

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Petiole Analysis – An Important Tool in Cotton

Cotton growers enrolled in the BAISC program for 2002 were provided with two petiole nitrate samplings. The first sample was selected and tested in early July and the second in mid-August. Research has shown that petiole analysis can provide a way to monitor the nutritional status of your cotton.

The Right Amount?
For high yields, cotton must have the right amount of nitrogen during all phases of growth and fruit development. But the questions for farmers always remains what is the right amount of nitrogen to apply? Depending on the soil and climatic conditions it is easy to have too much or too little nitrogen available for cotton. Due to the nature of the soil nitrogen and the manner in which cotton responds to it, nitrogen has a greater potential for increasing or decreasing yield than any other nutrient.

Too little nitrogen leads to small stalks, pale green to yellow leaves, small bolls, fruit shed and low yields. If low nitrogen is detected early enough during the growing season, proper nitrogen application can mean sizeable yield increases.

Too much nitrogen delays maturity, causes rank growth, encourages diseases and increases the risk of boll rot and reduced lint quality. Also at critical periods, excessive nitrogen can cause cotton plants to shed pinhead-sized squares.

Seasonal Variations
Cotton response to nitrogen fertilization varies from one year to another, primarily due to climate changes. An optimum amount of preplant fertilizer nitrogen in a "normal" year may be excessive in a "wet" year and deficient in a "dry" year. Researchers have found that by monitoring the nitrate-nitrogen content of cotton peitioles (leaf stems), adjustments can be made in the nitrogen fertilization program during the growing season to compensate for seasonal variations. Such adjustments aid in achieving top yields by avoiding excess nitrogen in early and late season and insuring adequate nitrogen during crucial fruiting periods.

Monitoring
BASIC field scouts began about a week before the first bloom, just when the white tip of the first blooms were seen emerging from the oldest squares. They sampled only primary leaves on the main stem and avoided taking leaves from fruiting or vegetative branches. 25 to 35 leaf petioles (leaves are discarded) were taken from four different quadrants in the field. They were labeled and taken to Denele Agri-Link Laboratory for analysis. Analysis consists of chemically monitoring the nitrate-nitrogen and phosphorus content of cotton petioles. Growers then received a computer printout which graphically shows the nitrogen and phosphorus content along with any appropriate recommendations.
Petiole nitrate-nitrogen and phosphorus levels serve as indicators of the relative amounts of unused nitrogen and phosphorus in the plants. Both elements are potential components of amino acids and proteins. In densely fruiting cotton through about the fifth week of blooming, there is an inverse relationship between the nitrate and phosphorus levels. As nitrates increase, phosphorus tends to decrease. As phosphorus increases, nitrates tend to decrease. For example:

- When nitrates are decreasing and phosphorus in increasing, this is an indication of adequate moisture, heavy fruiting and rapid use of nitrogen.

- When both nitrates and phosphorus are decreasing, this is an indication of drought stress.
- When there is a sharp increase in both nitrates and phosphorus, this is a response to above normal moisture conditions. Fruiting may or may not be good. Conditions are conducive to insect damage.
- When nitrates are increasing and phosphorus is decreasing, this indicates that moisture is adequate, fruiting is poor, and fruit loss is possible.

Petiole analysis will indicate a need for nitrogen about two weeks prior to the appearance of plant symptoms. If petiole nitrate-nitrogen is low during the first three weeks of blooming, a soil application, foliar application or both would be recommended. Urea has been found to be an effective and safe source of nitrogen to apply to a developing cotton plant. Leaf and petiole analyses are most reliable when moisture and other stress-related factors are not influencing growth. Care should be taken to note recent growing conditions along with sampling
(BASIC does this)

This article was prepared by C. Owen Plank, Extension Agronomist, University of Georgia Extension Service.

Hedgerows and Herbaceous Plant Strips: They Promote and Conserve Predators, But Do They Promote Pest Control?

by Gail Langellotto, Post-doctoral Associate, UC Davis

It has been repeatedly shown that conserving edge habitat such as hedgerows and herbaceous strips in the vicinity of a cropping system promotes predator aggregations. However, how often predators venture into a cropping system to forage (versus foraging in the edge habitat) has yet to be determined.

Experimental Approach
Using a relatively novel ecological technique called stable isotope analysis, I am attempting to resolve the effectiveness of edge habitats for pest control. Isotopes are different forms of an element with the same number atomic number (e.g. they share the same number of protons), but with different atomic weights (e.g. they differ in their number of protons). Most elements of biological interest such as C, H, O, N, and S, have two or more isotopic forms that are stable (i.e., they do not decay). These stable isotopes are persistent in the ecosystem and are present in different ratios with lighter versions of atoms present in much greater abundance than the heavier isotope(s). Stable isotope-containing compounds are naturally present in the atmosphere, on earth, and in all living organisms.

How it works
In ecology, stable isotope analysis utilizes the carbon and the nitrogen 'signatures' of organisms to determine where and on what predators are feeding. Carbon signatures of C3 plants (such as cotton) v. C4 plants (such as corn and other grasses) are fairly distinct. Furthermore, the carbon signature of the plant remains relatively unchanged up the trophic chain (plant to herbivore to predator). Thus, by getting the carbon signal of a predator, we can determine where they were feeding, especially if the edge habitat has a distinct, C4 signature (cropping system versus edge habitat). Nitrogen signatures increase on average 3.4 parts per thousand up the trophic chain.

This is due to the retention of 'heavy' nitrogen 15 isotopes and loss of 'light' nitrogen 13 during excretion. Thus, by getting the nitrogen signature of a predator, we can determine whether they are feeding on an herbivorous pest (relatively low nitrogen signature) or whether they are feeding on other predators (relatively high nitrogen signature). Together, these two pieces of information can be combined to tell: (1) where the predators are feeding (hedgerow vs cropping system), (2) what the predators are eating (herbivorous pests v. predators), and (3) what proportion of a predators diet comes from the hedgerow insects versus insects in the cropping system.

The First Results
Last summer, with grower cooperation, I collected preliminary samples from 3 farms associated with the Sustainable Cotton Project. Cotton vegetation, edge vegetation, and arthropods (both predators and herbivores) were collected from each farm on a single occasion. Samples were brought back to the UC Davis lab for sorting and processing. While the data is still coming in (it takes time to make sure a sample is 'pure' for stable isotope analysis), initial data suggests that predators in general, and big-eyed bugs in particular, move between edge habitats and the cotton crop to forage. Data for herbivores is forthcoming. What remains to be seen, and what will be a major focus of my research in 2003, is the directionality and frequency of predator movement (e.g. do predators start out foraging in the edge habitat and move to the cotton crop, or vice versa). Additional work for the summer of 2003 will focus on verifying the strength and nature of the pattern of predator movement that was suggested by the preliminary 2002 data.

A New Look At An Old Pest: What Makes Lygus Hungry For Cotton Squares?

Andrew G. Zink and Jay A. Rosenheim
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Growers have repeatedly stressed an enigma that is familiar to cotton entomologists: sometimes there are lots of Lygus in the field, but little or no crop damage, whereas at other times even a few Lygus appear to generate heavy crop damage. Past work has shown that Lygus nymphs may inflict damage to squares that is equal to (or greater) than that of adults.

However Lygus nymphs are very hard to sample and may be "invisible" from a management perspective. It is possible that the patterns of square loss in cotton fields that appear enigmatic can be explained by more detailed analyses of nymph densities and the age structure of Lygus populations. We have found a broad range of age structure in Lygus populations where nymphs ranged from 18% to 71% of all individuals. This suggests that adult density alone cannot accurately reflect (or predict) Lygus presence in a particular field. We have also found that sweep nets are less successful at capturing nymphs relative to adults, which means that nymphs are often underestimated in populations. At the next BASIC meeting we will talk in more detail about these results and the implications for damage to cotton squares and square retention.

Why Try BASIC?

California cotton growers have traditionally been one of the biggest users of chemicals in the state's agriculture. The high cost of chemical control and the low price for ginned cotton point toward a new way of thinking about pest management—an areawide agroecology approach offered by the BASIC program.

BASIC uses techniques such as plant mapping, fertility measurements, and scouting methods that recognize the importance of assessing population numbers of both potential pest and natural enemy populations to predict future population trends. Scouting for natural enemies as well as pests makes it possible to determine pest control actions appropriate to their actual need. Natural enemy conservation and enhancement in a proactive program is the goal of Ecologically Based Pest Management (EBPM). Treatments are made with selective or soft chemicals only when necessary and when the action will help restore EBPM. Habitat enhancement and additional releases of beneficial insects are at the forefront of EBPM programs.

In the Chowchilla area of San Joaquin Valley, BASIC growers were able to reduce pesticide use by 83% while maintaining or improving yields and profitability. Growers in the central San Joaquin have been able to show similar results.

The Sustainable Cotton Project (non-profit organization) received a grant from the California State Water Resources Control Board to provide participant growers, and pest management consultants, an opportunity to apply BASIC methods in the Firebaugh area as well as in Kern County.

Senior entomologist, Everett "Deke" Dietrick, has spent his professional career researching applied techniques to eliminate pesticide sprays in cotton-growing regions. Most cotton spray programs were found to be unnecessary in the 1960's before the appearance of pink bollworm.
Combining the BASIC model from northern San Joaquin Valley and the unique experience of

the Dietrick Institute staff with EBPM in cotton, gives growers a chance to try farming with reduced chemicals creating a more sustainable future for cotton farming.

Five Features of Ecologically Based Pest Management (EBPM)

1:: Avoidance of disruptive pesticides
Spray only if there is a pest problem! Repeated use of all classes of chemical pesticides results in resistant pests. The natural enemies of pests generally do not reproduce as quickly as their hosts so when they are killed, they do not have an equal chance to develop resistance, as do the pests. Restoring biological control through EBPM allows beneficial populations to grow back into balance.

2:: Development of beneficial refuges
Strip or trap cover crops attract natural enemies that offer a field insectary and winter refuge for beneficial insects. These refuges provide the most economic way to establish biological control on your farm. Parasites live several times longer and destroy more pests when there are plants that provide pollen, nectar and refuge. Think of reserving 1% of your field for pest control by natural enemies. Much of the 1% can come from roadsides, borders, box ends and row ends.
Alfalfa borders can be used to trap lygus utilizing strip cutting to force beneficials to migrate into market crops. Roads or road borders may include limited amounts of other annuals, such as early radish, kale or fava beans, depending on the situation of each farm. Small scattered stands of corn (combining 90 and 120 day harvest) can be used to attract bollworm adults and their egg and larval parasites as well as to attract general predators of corn aphids, mites, and thrips.
For example, interplantings of a few hills of corn will act as a trap crop for corn earworm (cotton bollworm) which serve as food for a complex of 25 or more natural enemies.

3:: Monitoring of insect ecology
Effective pest management decisions can only be made if beneficial as well as pest populations are monitored regularly. Sampling with an insect vacuum net (D-Vac) provides a more complete sample of all life stages of pests and beneficials than conventional sweep net sampling. One can follow the progress of biological control interactions by observing the size and density distribution of pest populations. For example, samples of only eggs and adults without the larval stages suggest that when the adults die the pests will no longer be a problem. Rating the ratio of pests to beneficials makes it possible to predict damage thresholds more accurately and farther into the future in time to prevent yield losses.

4:: Development of cultural practices
Crop rotation, hedge rows and refuge enhancement management exploits the biology of both pests and beneficials to optimize the efficacy of the beneficials. For example, many more beneficials migrate into adjacent row crops sooner from strip cut alfalfa than from uniformly cut alfalfa.

5:: Release of beneficial organisms
Early releases of beneficials when the pest is first detected is the most cost effective way to establish beneficial populations that provide season long control.

Suggested Types of Beneficial Insect Refuges

The development of beneficial insect refuges is basic to the success of ecologically based pest management. Where habitat for natural enemies is too sparse or absent as in Kern County, participants will be assisted in choosing among three general insect habitat strategies for growing predators mainly of aphids, mites, lygus, whitefly and bollworm on the farm. Training will include how to plant, irrigate, cut, monitor and adjust the size and variety of these types of insect refuges.

A couple of BASIC growers will be planting perennial hedgerows designed to attract whitefly parasites in cooperation Dr. Charles Pickett, California Department of Food and Agriculture.

Habitat: What and How To Plant

The bottom line with habitat is that any habitat planted around your cotton is better than none. Most growers will agree that its best to grow cotton next to corn or alfalfa to provide a food source for beneficial insects.

With no corn or alfalfa, planting two rows of habitat along ditches or furrows (about 1% of the field) on the down wind side can be an effective tool. Remember, this habitat will require some water.

Suggested species
Corn—90, 120, 150-days. Alfalfa, Mustard, Sunflower, Yarrow, Fennel, Milo, Grains, Cilantro, Dill, Velvet Beans, Buckwheat, Black-eyed peas, Radish.
Planting Methods. There are many different planting scenarios that may be utilized. Three suggestions follow:

1:: Plant habitat before planting cotton
This may be difficult due to water considerations, but by having the habitat in ahead of the cotton, it will divert the attention of the aphids and other pests and help keep them from moving to the cotton.

2:: Plant with the cotton
This may be the easiest way to add habitat. You do lose the advantage of having the habitat up and growing and serving to attract the natural enemies of pests.

3:: Plant after the cotton
Growers can go back along the field margins after planting and add habitat. Another effective practice is to fill in the bare spot in the field with habitat. This will provide small pockets of beneficial plants that may lure pests from the cotton to the habitat. This can be done by hand.
Whichever planting scenario you choose, the habitat will need to watered along with your cotton during the season. There is no right way to plant. Growers have used many methods, for example, putting the seed all together in a planter, or planting the corn, sunflowers and sorghum in the outside row and the smaller seeded plants in the next row, planting by hand, what ever works for you.

Growers enrolled in the BASIC Program are encouraged to plant annual beneficial habitat on their field margins. This habitat serves as pollen and nectar sources for the beneficial insects that help keep your cotton clean.

What is Farmscaping?

By Rex Dufour
Appropriate Technology Transfer for Rural Areas

Farmscaping" is a whole-farm, ecological approach to pest management. It can be defined as the use of hedgerows, insectary plants, cover crops, and water reservoirs to attract and support populations of beneficial organisms such as insects, bats, and birds of prey.

Mini-Livestock
In some respects, beneficial organisms should be considered—and managed as—mini-livestock. The larger varieties of livestock are healthier and reproduce more readily when provided an adequate and nutritious diet. Likewise, "mini-livestock" require adequate supplies of nectar, pollen, and herbivorous insects and mites as food to sustain and increase their populations. The best source of these foods is flowering plants.

Habitat
Flowering plants are particularly important to adults of the wasp and fly families, which require nectar and pollen sources in order to reproduce the immature larval stages that parasitize or prey on insect pests. However, using a random selection of flowering plants to increase the biodiversity of a farm may favor pest populations over beneficial organisms. It is important to identify those plants, planting situations, and management practices that best support populations of beneficial organisms.

Benefits
Farmscaping, like other components of sustainable agriculture, requires more knowledge

and management skill on the part of the grower than conventional pest management. The investment in knowledge and management may yield such benefits as:

- A reduction in pesticide use
- Savings in pesticide costs
- Reduced risk of chemical residues on farm products
- A safer farm environment and more on-farm wildlife.

Integrated Approach
However, farmscaping is not a magical cure for pest problems. It is simply an ecological approach to pest management that can be an integral component of a biointensive integrated pest management (IPM) program.

Planting a mix of plants, particularly perennials, that bloom in succession and that meet the habitat needs of desired beneficials is another farmscaping option. The development of beneficial habitats with a mix of plants that flower throughout the year can help prevent such pests from migrating en masse from farmscaped plants to crop plants.

The use of farmscaping to increase beneficial organism habitat must be understood and practiced within the context of overall farm management goals. For example, when considering planting a perennial hedgerow the producer should evaluate the various costs and benefits likely to be associated with a hedgerow. Growers with farmscaping experience will likely be the best source for this kind of information.

Go to attrancat.org for more information.

Spider Mite Control Biologically

By Ramana G. Colfer, Jay A Rosenheim, and Larry D. Godfrey

Information for this article was taken from a paper presented by UC Davis Researchers, Ramana G. Colfer, Jay Rosenheim, and Larry D. Godfrey. Research for this project was conducted at UC Davis. The article was published in full in California-Arizona-Texas Cotton Magazine, Fall 2001.

Spider mites, Tetranychus spp. are foliar feeders in cotton which destroy photosynthetic cells as they feed on the plant. High populations of mites can lead to defoliation and are known to cause economic damage to cotton in the San Joaquin Valley. "While spider mites can be important primary pests, they are especially known as secondary pests. They display rapid rates of population growth following the application of broad spectrum insecticides (carbamates, organophosphates, and pyrethroids) for control of Lygus bugs or cotton aphids."

Cultural practices can also play a role in mite outbreaks as well. Dusty roadways and dry dusty fields can contribute to the problem. Watering roads or using ground covers will help reduce outbreaks. Plants stressed for water will be less tolerant of spider mite damage as well. Spider mite populations reproduce rapidly during hot weather and in most parts of California may feed and reproduce all year.

Natural Predators
Knowing that spider mites have many natural enemies, UC Davis Researchers, Ramana G. Colfer, Jay Rosenheim, and Larry D. Godfrey set out to look at controlling spider mites biologically. Their study was designed to evaluate the naturally occurring biological control of spider mites. The study focused on two groups: omnivorous western flower thrips, Frankliniella occidentalis and generalist predatory bugs, Big eyed bugs (Geocoris spp.), and (O. tristicolor) minute pirate bugs.

"Researchers found that western flower thrips were successful in substantially reducing spider mite population growth during the early season, and this, led to greater seed cotton yields at the end of the season." They also did not observe any yield losses from early-season plant feeding by the western flower thrips.

The generalist predators, especially big eyed bugs and minute pirate bugs were very effective at suppressing mites. "For three different field seasons, we found that predators suppressed spider mite populations to levels 76 to 99 percent below those observed where generalist predator abundance has been reduced."

The study observed that generalist predators suppressed mites over a wide range of initial mite densities. This again points out the importance of preserving natural enemies in controlling spider mites. Whenever possible, replace broad spectrum insecticides with more biological alternatives. Insecticides applied during hot weather usually appear to have the great effect on mites, causing dramatic outbreaks within a few days.

Releases of predatory mites can be very useful if naturally occurring predators are not abundant. Regular, careful monitoring can help growers keep track of field conditions . "Cotton is generally inhabited by a diverse and abundant complex of generalist predators. If the populations of these predators are conserved, there is the potential to partially or completely control many pests of cotton."

Assessing The Lygus Debate

By Stefan Long, Dietrick Institute

Lygus is probably the most feared pest in cotton because it can be a major cause of square loss. But does it make sense to base treatment decisions solely on Lygus counts? Let's

consider some other factors… First, not only the numbers of Lygus are important, but also the numbers in each lifestage should be counted since different ratios of adults to nymphs reflect different situations. High numbers of adult Lygus with no or few nymphs may indicate these are new immigrants or transients. Second, Lygus prefer alfalfa to cotton and will migrate from cut alfalfa through a cotton field to another alfalfa field.

Comparing Populations

The presence of nymphs tells a different story, however. Nymphs are of greater concern not only because they represent a breeding population in the cotton but also because this stage causes more damage per insect. Another important factor to consider is the number of each lifestage of natural enemies especially the Big-eyed bugs. Big-eyed bugs, damsel bugs, Assassin bugs and minute pirate bugs (the good bugs) prey on the eggs and nymphs of Lygus. Consistent samples taken over time that contain a few adults, but are lacking Lygus nymphs and contain many natural enemies are evidence that these good bugs have eaten the eggs and nymphs thus preventing the Lygus population from growing. The presence of "good bug" nymphs in the sample indicates that their populations are growing at the expense of Lygus. Thus, in order to get a complete picture of the potential threat Lygus poses, the number of each lifestage of both Lygus and at least one natural enemy (usually big-eyed bugs) need to be counted. To get a clearer picture of the Lygus situation, two samples taken two to three days apart should be compared.

Acceptable Boll Loss

The most important factor to consider is the number of squares on the plant that can actually produce bolls. Nearly 2/3 of the squares produced will fail to produce bolls with absolutely no pest pressure. In other words, cotton is 'programmed' to set 10 bales worth of squares but can physically only manage to support four bales worth of bolls. That means six bales can be 'lost' to Lygus without affecting the yield potential of the plant. Of course, a higher percentage of the early squares produce a majority of the bolls. Even on plants with only 3-5 fruiting branches, the treatment threshold is 73% retention implying that some of these first squares can be lost without decreasing yield.

Best Method

Counting square retention is the most unbiased way of making a treatment decision, because it is based solely on the yield potential of the plant. The number of Lygus and natural enemies are irrelevant. Unfortunately, different varieties have different square retention abilities which translates into different yield potentials. To complicate matters more, action thresholds for the same variety are different for different geographic regions. The best that can be done is to use the action threshold values as rules of thumb to support or oppose a treatment decision based on the assessment of both Lygus and its natural enemies.

Alfalfa Interplanted with Cotton: How does it work?

Lygus is a key insect pest in California cotton. They pierce the stems and suck plant juices, causing damage to flower buds, young bolls, and terminal buds.

Cotton is not the preferred host of lygus, but once the surrounding vegetation starts to dry up, they will move into irrigated cotton and feed on the plants. Through habitat manipulation it has been demonstrated that lygus can be kept away from the cotton during critical square formation. Alfalfa is a preferred host to lygus and can be grown in strip intercrops with cotton to assist in lygus control. (ATTRA Organic Cotton Production, 2003)

It is important to manage Lygus before they move into a cotton field and cause damage. Once they have migrated into the cotton, it often requires chemical treatment to control them, which results in the reduction of natural enemies and potential disruption by secondary pests.
In a paper written by UC Cooperative Extension Specialist Pete Goodell and J.W. Eckert* they found that "this disruption can lead to multiple pesticide applications, excessive production costs, and destabilization of the cotton ecosystem."

The use of alfalfa strips in cotton fields was introduced in the 1960's as an alternative method to broad spectrum insecticide applications. (Stern et al, 1969). Alfalfa is favored by lygus and can also serve as a refuge for natural enemies. Widespread adoption of the practice has not occurred, probably because of the difficulty in maintaining production practices for the two different crops.

How it's done
BASIC growers Frank Williams and Mark Fickett were intrigued by the idea and thought the benefits of interplanting alfalfa might outweigh the management aspects. They decided to give it a try. The following is a brief outline of the practices they used on their cotton in 2003:

Planting Scheme
Six rows of alfalfa and two rows of fava beans (on the outside of the alfalfa) were planted on December 10, 2002, at a rate of 5-6 pounds to the acre. The alfalfa was planted between two 80 acre cotton fields. The planting was done using standard equipment.

Irrigation
When the alfalfa was planted there was no pre-irrigation done, the rain took care of the germination process. However, during the season, the alfalfa habitat was irrigated four times. The first irrigation took place while pre-irrigating for cotton planting, on February 19; second irrigation took place with the first irrigation of cotton on June 10, third on July 10, and the final irrigation on August 4. Sprinkler irrigation was used for the alfalfa habitat trial.

Mowing
A mowing scheme was set-up to keep the alfalfa green and lush. This was done by using a

rotation system. Only a portion of the habitat was mowed at once, leaving a strip of alfalfa as a hosting zone. Every 30 days a portion of the habitat was mowed. When the alfalfa habitat was mowed, D-vac samples were taken, from the habitat as well as the cotton adjacent to the habitat. The volume and number of beneficial species were sizeable.

Monitoring
Throughout the season BASIC field staff monitored the WindFall alfalfa habitat along with the cotton. Using a D-vac, they took 17 samples during the season; starting from May 26th through September 12th. Each sample consisted 75 sucks from the D-Vac.
Pest Pressure. The cotton adjacent to the alfalfa strips had no significant changes in pest pressure from the rest of the field and most importantly there were no signs of pests moving out of the habitat.

Conclusions
The alfalfa habitat was considered a success since there were no significant changes in pest pressure coming into the cotton. The habitat provided a ready food source and refuge for the lygus which had no reason to move out of their preferred host. As the season progressed, we saw increasingly diverse species and large numbers of beneficial insects in the D-vac samples.

Using Trichogramma in Cotton IPM Programs

Research into the use of Trichogramma wasps in cotton is an ongoing topic of discussion world wide. Used in pest control since the 1900's, today, Trichogramma species are one of the most widely used insect natural enemies in the world. Secondary pest outbreaks, pesticide resistance, more stringent pesticide regulation, and concern about human health and environmental quality have renewed the interest in Integrated Pest Management programs that emphasize biological control. The commercially successful use of Trichogramma to control the European corn borer in Europe has demonstrated the potential of this approach.

Effectiveness
Trichogramma are among the smallest of insects, having a wingspread of about 1/50th of an inch. Despite its size, it is an efficient destroyer of the eggs of many moth and butterflies, which are the leaf-eaters in the larval stage. These insects disperse readily in their search for more than 200 species of eggs to parasitize. The Trichogramma seeks out eggs, but does not feed on or harm vegetation. It is an effective tool because it kills its host before the plant can be damaged.

Trichogramma activity enables reductions in chemical applications and reduces resistance pressures on those products. With a high reproductive rate, huge numbers of wasps develop

rapidly. The reliability and speed of this process can be increased by the mass release of Trichogramma.

Use
Trichogramma are released to control some 28 different caterpillar pests attacking corn, rice, sugarcane, cotton, vegetables, sugar beets, fruit trees and pine and spruce trees. Most releases are to control corn borers, sugarcane borers and cotton bollworm. Although widely used, a recent review of these programs worldwide concluded that "because of considerable variability in success of releases and little evidence of consistently successful application of Trichogramma, the usefulness of these parasitioids is currently being debated.

It is desirable to release the wasps into crops adjacent to cotton such as corn, or on field margins containing annual habitat. The wasp numbers will then increase and migrate into the cotton in high numbers. If spraying is then required in the cotton, wasp numbers are likely to be higher and the adjacent crops continue to act as a refuge and source of wasps.

Balance
According to Rincon-Vitova, a supplier of Trichogramma in California, "beneficial insects are small pest-fighting farm animals. Releases of Trichogramma can help tip the balance of nature towards more biological pest control. Creating sustainable biological control in cotton requires a change in thinking, as the rules are very different from chemical pest control. Even economic thresholds for pesticide treatments change when cotton fields are teeming with biological control organisms. When beneficials are on patrol in cotton fields, higher pest levels can be tolerated for longer periods of time without pesticide use, which translates into immediate bottom line pest control cost savings. The objective of adding new beneficials like Trichogramma to the cotton agroecosystem is strengthening the natural enemy complex, and creating an ecosystem where predator and prey (pest) are in better balance."

So, what does this mean to BASIC growers? BASIC field staff have made releases of Tricogramma in two of our enrolled fields where we have alfalfa interplanted with the cotton. It is hoped that the addition of the wasps will help to offset any increase in worm activity in these fields. We will be monitoring closely to see if the Trichogramma play a role in worm control.

Information for this article came from The Trichogramma Manual by Allen Knutson, Professor and Entomologist at Texas A&M University.

Now is the Time to Plant Annual Habitat

BASIC growers are being encouraged to plant annual habitat hedgerows along their field margins and the time to plant is now. Last season, 23 out of the 30 enrolled fields had at

least one field margin planted in annual habitat. Those remaining fields used strip cutting of alfalfa to increase and maintain the diversity of natural enemies in their cotton.

The planting of annual habitat can create a local ecosystem which more closely emulates natural ecosystems, and promotes the in-field production of millions (per acre) of voracious pest-eating beneficials at no additional cost to cotton growers. This free source of indigenous natural enemies, which would be prohibitively expensive to purchase, helps control the pest numbers in cotton.

Plant Variety

Cotton interplanted with or growing adjacent to unsprayed alfalfa hay, corn, cowpeas, sunflower borders, sorghum and mustard attracts a wide variety of natural enemies. These can include lady beetles, green lacewings, Tachinid flies, big-eyed bugs, spiders, pirate bugs, predacious beetles and many other predators that can effectively control sweet potato whitefly, bollworm, cotton aphids and other potential pests.

Risk?

It may seem risky or unnecessary to plant other crop species along field margins, but research continues to support the idea that increasing species diversity attracts and supports naturally occurring beneficials who work in your fields for free. Rachel Long, UCCE Farm Advisor notes in a publication about the use of hedgerows that "California farmers are interested in planting insectary hedgerows to attract beneficial insects for better biocontrol of pests in adjacent crops." She does acknowledge that some growers are concerned about attracting more pests to their farms with hedgerow plantings. Her work found that while some pests are found in the hedgerows, data show that insectary plants are not contributing to a build-up of pests on farms. Most pests were found mid-to-late in the season, and few were found to reproduce on the plants, especially early in the season. Instead, the insectary hedgerows in our study favored beneficial insects over pests, by a ratio of three to one. Her work was done with perennial plants, but the principles of additional habitat remain the same.

Integrated Methods

Rincon-Vitova producers of beneficial insects advises cotton growers to work closely with PCAs skilled in IPM methods such as beneficial insect releases, mating disruption, selective pesticides easy on beneficials, and spot spraying. If it is necessary to knock runaway pest populations down to levels that small populations of newly-introduced beneficials can easily mop up, use least-toxic, low-residual spray materials. The goal of spraying (selective use of pesticides least toxic to beneficials) is lowering pest populations to tolerable levels, not pest eradication. Low pest populations and innocuous alternate prey are necessary to feed biological control organisms.

For those using alfalfa as a border, strip cutting fields adjacent to cotton is a must. Strip cutting (harvesting alternate strips or fields) stabilizes the alfalfa agro-ecosystem, with different-aged hay growths occurring simultaneously in the same or nearby fields. When one

strip is cut, alternate strips or fields are half grown, and fields and farms are never completely bare or without an alfalfa breeding refuge for beneficials.

Harvesting alternate strips keeps plants producing predators and parasites throughout the season, sending a steady migration of beneficials into nearby cotton. This "battle of the bugs" takes place without damage to cotton. Alfalfa is also an excellent Lygus trap crop. Cutting an entire alfalfa field at one time forces Lygus bugs to fly into neighboring crops. Nearby uncut alfalfa as a trap crop eliminates the need to spray cotton for Lygus.

Weed Workshop Looks At Alternatives

On May 19th, about 20 participants gathered at Pikalok Farms in Firebaugh. The meeting focused on weed management alternatives to save growers both time and money.

First up on the agenda was UC IPM weed ecologist Anil Shrestha whose main message touts weed seed management as essential to healthy agriculture. Anil believes in the likelihood "that herbicide –resistant weeds will produce seeds who will in turn germinate and produce plants which are also herbicide-resistant. As we eliminate susceptible plants, the population of the resistant plants will increase. This may change the volume and diversity of the seed bank, and call for a change in our current weed-management strategies."

Even for growers who are not using chemical weed control, weed-seed banks are still a very important issue. "Most weeds start their life cycle from a single seed in the soil. If these weeds escape control, they will grow and produce thousands more seeds." Some seeds die within a few years or are eliminated from the seed bank for other reasons, such as by being eaten by insects or other vertebrates, by physical damage in agricultural processes, or getting buried too deep in the soil to germinate. However, some will germinate, grow and produce more seeds.

Different Methods
Preventing weeds from setting seeds will always pay off in the long run. Anil suggests several approaches in his article titled "Sowing Misfortunate." He promotes the implementation of measures that prevent existing weeds from producing seeds, which in turn will limit future weed populations and limit the addition of herbicide-resistant weed seeds to the seed bank. Some measures to minimize weed escapes in the field include: post harvest management to prevent seed set by weeds that continue to grow after crop harvest; cleaning equipment properly after use in a weedy field; crop and herbicide rotation to help change the composition of the seed bank from undesirable to desirable species.
For a copy of the complete article, contact Anil at anil@uckac.edu

Equipment
Steve Melanca and Jess Herrera from Thomason Tractor in Firebaugh demonstrated the

latest weed control equipment including the Weed Seeker sprayer. The Weed Seeker optically detects and sprays weeds. It does not spray bare ground. Use of the sprayer reduces chemical and spray volume. Steve and Jess would be happy to show you how it works.

Organic Products
Mike Woods from Bioganics presented information on their Matran 2 product. Matran 2 is a post-emergent, non-selective herbicide that is fast acting and provides effective control of grasses and broadleaf weeds. The product can be used in organic and IPM systems. It has zero restricted entry interval, so one can enter the field as soon as the spray has dried. Matran controls most weeds within hours of application. Mike supplied field trial data which showed the product's effectiveness on several different types of weeds.
For more information, contact Mike at 209-606-2737.

Natural Foam
Another interesting alternative to herbicides was the Waipuna Foamer. Originally developed in New Zealand, and demonstrated by Ian Webster, the Waipuna Systems does not use an herbicide and requires no registration as an herbicide. The foam produced is 100% natural, made from a non-toxic extract from corn and coconut sugar and is completely biodegradable. The heat from the system breaks down the cellular structure of the plant, immediately starting the decomposition process. The results can be clearly observed within hours of treatment.

Ian moved the Waipuna out to the field and demonstrated how the foam covered the area immediately. The treated area can be revegetated or used within minutes of treatment and the foam can be applied in windy conditions or even light rain. The Waipuna system has been used in California for many municipal uses, parks, schools, municipal areas and agricultural operations. For more information contact Ian Webster at 630-514-1501.

Looking at weed control options can provide growers with cost saving ideas. Using systems that reduce chemicals or don't involve registered chemicals can save time and help meet clean water regulations.

Whole Systems Thinking On the Farm

On June 1, 2004 several BASIC growers and UCCE Farm Advisors gathered at the Firebaugh-Mendota Methodist Church to meet with Ray William, an Extension Weed Ecologist from Oregon State University. Ray presented a workshop titled "Whole System Thinking – Getting a Handle on the Complexity of Farming." UC IPM Entomologist Pete Goodell with the statewide IPM Program was the main sponsor of the workshop.

Farmers and Farm Advisors worked together in groups and designed a system for growing cotton. Each group's work was unique and reflected the complexity of the farming enterprise.
By taking a closer look at the entire system, new insights and approaches can be discovered. Ray's goal as an educator has been to look at how people learn, how to increase the involvement by farmers and pest control advisors in the learning process and how to modify Extension programs to improve problem-solving in times of rapid change.

The group's differences and creativity became apparent when they drew out their systems on paper, analyzed the relationships involved and then looked for ways to leverage the system. Ray refers to leverage as those parts of the system that seem to create the greatest impact within the system, either positive or negative.

The meeting was positive and stimulating, encouraging new ways of looking at farming and marketing. It promoted new ideas and approaches among team members. Because the groups were looking at real life scenarios, the impacts, outcomes and consequences generated can go to work directly on the farm.
If you would like more information on Ray's work, please contact Pete Goodell at 559– 646-6515.

The Mighty Minute Pirate Bug

True to their name, the Minute Pirate Bug (Orius tristicolor) is a tiny, pinhead-sized, voracious insect predator whose beneficial impact is quite out of proportion with their minuscule size. They are important natural enemies of pests of many agronomic and horticultural crops including cotton, corn, sorghum and soybeans. Both the adults and nymphs are active predators and feed on thrips, spider mites, aphids and small caterpillars, exerting a predatory influence throughout the entire season. When there is an abundance of prey in one area, they are able to gather quickly and can consume 30 or more spider mites per day!

Life Cycle
Adult Minute Prate Bugs are oval-shaped, about 3 mm long (or 1/8"), very flat, and are black colored with white wing patches. Nymphs are small, wingless insects, yellow-orange to brown in color, teardrop-shaped and fast moving. Nymphs, like those of other true bugs, pass through five instars before becoming adult. Approximately 19 days are required to complete the nymphal stages and with each stage they increase in size and begin to look more like adults. Both adults and nymphs feed by sucking juices from their prey through a sharp needle-like beak, which is characteristic of all true bugs.

The Minute Pirate Bug overwinters as an adult in leaf litter both inside and outside orchards, under tree bark or boards, around homes and other buildings. They are most common

where there are spring and summer flowering shrubs and weeds, since they feed on pollen and plant juices when prey are not available. To encourage their presence year-round, field margin plantings in the carrot family such as fennel, dill, Queen Anne's lace, yarrow, sunflower, buckwheat, coyote brush, alfalfa, corn, clover and vetch are recommended.

Adults emerge in early spring and live for 3 - 4 weeks then lay their eggs in plant tissue. The nymphs emerge in 4 - 5 days and become adults in 7 - 10 days. Three to four generations may occur during the growing season. This predator does not injure crop plants to any significant degree. There are occasions when the adults will attempt to penetrate human skin with their proboscis causing a mild stinging sensation. Such instances are unusual and not severe.

Reduced Risk
Use of reduced risk pesticides such as Bts, applied only when and where needed, will conserve the existing population of flower bugs. Because these insects feed on plant sap when prey is not available, systemic insecticides should be avoided.

References: Berry, Ralph E., 1978. Insects & Mites of Economic Importance in the Northwest. O.S.U. Book Stores, Inc. Corvallis, Oregon.

Virginia Tech Entomology Department Website: www.ento.vt.edu/Fruitfiles/orius.html