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ARTICLES

CONTROLLING WEEDS IN OLD ALFALFA STANDS

Tim Prather, U. C. Kearney Agricultural Center

Alfalfa stands thin as they get older, allowing weeds to invade. During the final year of production herbicide use is usually limited to paraquat to avoid carry-over problems in the next crop. Research done in Stockton and Santa Ynez evaluated the technique of planting grasses into old alfalfa stands to control weeds (Figure 1). Untreated alfalfa stands may have as much as 700 lbs of weeds per ton of hay. These weeds hurt hay quality and often increase weed problems for the next crop. Adding grasses has reduced the amount of weeds to about 200 lbs of weeds per ton of hay in some cases.

What about hay production?

Hay production actually goes up when grasses are used for interseeding (Figure 2), in addition to controlling weeds. The open spaces in the alfalfa stand are filled with forage grasses instead of weeds, yielding a higher

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quality hay. Nutritional quality was lower for the alfalfa-grass hay than for pure alfalfa. From the information collected so far, the alfalfa-grass hay ranged from 18.5 to 19.5 compared to 24.0 to 24.5 percent protein from the alfalfa hay in the same field. Acid detergent fiber ranged from 35 to 39 for the alfalfa-grass hay compared to 38 percent from the alfalfa hay in the same field.

What Does It Cost?

When figuring in all costs and the value of the hay produced, seeding grasses supply about the same return as applying herbicides (Figure 4). These figures assume that the same price is paid for hay with lots of weeds or for hay with few weeds. If the hay sells for a lower price because of the weeds then seeding grasses would yield higher profits.

What is different about growing this grass-alfalfa mixture?

The alfalfa stand should be harrowed or lightly disked in December or early January. Plant the grasses at rates of about 20 lbs per acre for Tetraploid annual ryegrass, Latar orchardgrass or Fawn tall fescue. If oats are used, a good variety is Montezuma seeded at 60 lbs per acre. When the grasses begin to tiller apply 30 lbs of nitrogen to get the grasses growing well so they out-compete the weeds. Cut the hay at the time you normally would but allow 1 to 2 days longer for drying. Try not to turn the hay too much because the grass leaves will break up and end up on the ground instead of in the bale.

[This information is from studies conducted by Tom Lanini, Tom Kearney and Michael Canevari]

(Figure not available)

Figure 1. Percentage of weeds in total yield (from the Stockton study).

(Figure not available)

Figure 2. Number of tons cut that was either weeds or hay from the Stockton study.

(Figure not available)

Figure 3. Costs and benefits of seeding grasses into alfalfa. Includes all labor, equipment and material costs. This information is from the Santa Ynez study.

BEMISIA TABACI (SILVERLEAF/SWEET-POTATO WHITEFLY) IN THE SAN JOAQUIN VALLEY

P.B. Goodell, C.G. Summers, L. Godfrey, R. Coviello, W.J. Bentley, and P. Elam, U. C. Kearney Agricultural Center, U. C. Davis, Kern and Fresno Counties

Field populations of *Bemisia tabaci* (silverleaf whitefly) were first noted in the San Joaquin Valley (SJV) in 1992. This pest has caused extensive damage in the southern desert valleys and Arizona to cotton, melons, alfalfa, tomatoes, and cole crops. In addition, it has become a major nuisance in urban settings in these areas. Loss estimates in Imperial County alone exceeded 111 million dollars for fall and winter 1991-92 and secondary effects on employment add to the regional loss (Gonzalez *et al*, 1992).

This insect has been called by many names and its taxonomy is currently under revision. It was considered to be *B. tabaci* but that is being revised by Bellows and colleagues who have a species description in press which includes behavioral and morphological differences from *B. tabaci*. It is commonly referred to as the Sweetpotato Whitefly Strain B but Perring *et al* (1993) make a persuasive case that it should be renamed the silverleaf whitefly.

Various whiteflies have been present in the SJV for a number of years, including greenhouse, iris, banded-wing, and sweetpotato whiteflies. In general these are not primary pests and only occasionally exceed treatable levels. However, the silverleaf whitefly poses a greater threat because of its wider host range and ability to build to much higher numbers than other whiteflies.

Host Range

The host range of silverleaf whitefly is wide and encompasses many of our agronomically important crops and common weeds. These plants include alfalfa, broccoli, cantaloupe, cauliflower, cotton, pumpkin, squash, and tomato. Arizona researchers (Ellsworth *et* *al*, 1993) suggest this loosely ranked host preference list: 1) cantaloupes, 2) watermelon, 3) peanuts, squash, cucumber, groundcherry, 4) broccoli, 5) cauliflower, 6) cotton, 7) alfalfa, 8) lettuce, tomato, and 9) corn, Johnsongrass.

Within the SJV, new host finds are being reported weekly. As of October, over 50 crop and weed plants have been found on which the life cycle of silverleaf whitefly can be completed. We have noted that host suitability will change through time. For example, from July until September no silverleaf whitefly was found on alfalfa in our survey zones. By mid September it could be found easily on alfalfa. What causes this shift in host "preference" is unclear at this time.

Of particular concern is the wide host range of ornamental plants this insect can utilize. This host range is based on previous reports and as well as limited inspections of greenhouses in the SJV. In one operation, 61 species were found capable of supporting the complete life cycle development. While not all plants are exceptionally good hosts, they could serve as refugia for overwintering populations.

Damage

Silverleaf whitefly causes damage by sucking the sap from plants and producing a sticky exudate called honeydew. There are several ways in which this pest can cause economic damage. First, it can cause **direct yield** reduction by removing nutrients from the plant, resulting in stunting, poor development, or even death. In some commercial ornamental plants, total defoliation has occurred in nurseries causing the plants to be unsalable. Second, the **quality of the produce** may be affected. Honeydew provides a substrate for sooty mold fungi and can reduce the marketability of fruit and vegetables. Honeydew falling directly on cotton lint can result in sticky cotton and reduced quality. If a region develops a reputation as a supplier of such cotton, serious economic impacts can result. Third, feeding is known to cause **physiological plant symptoms** such as silverleaf in squash, irregular ripening in tomato, white stalk in broccoli and cauliflower, and white petiole in sugar beets. Finally, silverleaf whitefly can act as a **disease vector** and has been associated with geminiviruses in Florida (tomato mottle geminivirus) where it caused tremendous yield reduction (Gilbertson, 1993). With the exception of cotton leaf crumple, these destructive viruses carried by silverleaf whitefly have not been detected in California.

Biology

It is suggested that silverleaf whitefly survives the colder, damper winters in the SJV in sheltered locations. These include greenhouses and landscape plants in protected and warmer locations. Overwintering populations in both the SJV and Imperial Valley are reduced to very low levels. The very high population levels which develop through summer are testament to the reproductive capacity of this pest.

Direct comparisons between the Imperial and San Joaquin Valleys are difficult since the pest has not been well studied in the SJV. However, there are important climatic and environmental differences between the two locations. First, the SJV is cooler and silverleaf whitefly should have fewer generations than in the Imperial Valley (see following discussion). Next, it warms up later in the SJV, thus pushing the critical growth phase further into the season. It cools off earlier in the SJV, assisting in reducing the number of generations at the end of the season. These temperature-based predictions are supported by limited observations made in 1993; populations increased much later in Merced County than in Kern County.

Population Development

The phenological research of Zalom and Natwick (1985) for sweetpotato whitefly in the Imperial Valley is a good starting point for silverleaf whitefly in the SJV. The developmental thresholds for this pest are: 50 F base, 90 F upper, and 582 D required per generation. Based on 30 year temperature averages, the following relative comparisons can be made:

Location	Total Day Degrees	Generations per year
El Centro	7654	13.2
Indio	8180	14.1
Bakersfield	5943	10.2
Visalia	5244	9.0
Merced	4876	8.4

Like the Imperial Valley, the most critical period will be mid to late summer when the populations reach critical numbers and undergo exponential growth. This year populations that were difficult to find one week increased dramatically several weeks later. Under normal July temperatures (30 D/day), a generation can be expected to occur within three weeks. Based on our limited experience, we expect the silverleaf whitefly will be a pest during August, September, and October. In years with warm spring temperatures, population development probably will increase earlier in the season.

Whitefly Management in the SJV

Management of this pest will be key to overall insect and mite pest management in the SJV. Silverleaf whitefly has the potential for disrupting 25 years of successful IPM programs in field and vegetable crops. Additionally, vines and trees are threatened indirectly from the pest from the disruption of millions of acres of surrounding crop land which provides indigenous biological control agents.

Other states and regions which have faced this pest have reached similar conclusions; it must be managed in an integrated fashion across a wide area. Discussions of regional pest management approaches include community efforts, cooperative host free periods, definitive crop termination dates, and widespread crop management approaches (Ellsworth, 1993; Natwick *et al* 1992). Multiple approaches are being suggested which include elements of cultural, biological, and chemical control. Of prime importance will be our understanding of host sequences and the role various hosts at different times play in the buildup and survival of this pest.

For cotton growers, silverleaf whitefly management is a numbers game. Because damage occurs primarily at high populations late in the season when the lint is exposed to honeydew, it will be a race between the cotton's maturity and the whitefly's reproductive capacity to build to damaging numbers. The cotton season in the SJV is 10-14 days shorter than it was 10 years ago, but the earliest feasible planting and crop termination dates will be the key in managing this pest. Later maturing varieties or late planted fields will be at greatest risk. Pima cotton will have to be managed for the shortest season possible. Organic cotton growers will have to strive for short season to avoid late season honeydew on undefoliated cotton. Cotton will act as the primary host in the seasonal buildup of the whitefly population and it will be important to limit its development in order to mitigate its eventual migration from cotton to fall vegetables and melons.

Recent reports indicate numerous problems due to whitefly in vegetable production on the east side of Tulare County, especially in truck farm settings. Fall crops will be especially susceptible because of the summer buildup on cotton and the removal of that host during September and October. As in the case of Imperial County, fall vegetable and melon production may be at most risk by this pest.

In addition to early planting and crop termination dates, other cultural control methods may be useful. Field sanitation to remove crop residues as soon as possible will help prevent unnecessary population development in crops like melons. Controlling weed hosts and volunteer crops also may help.

Chemical management is limited due to the potential for resistance developing quickly, the high populations, and the difficulty in getting the chemicals to the target. Already in the SJV, pyrethroid resistance is being detected in bioassay testing. For the latest chemical control and resistance management information, see the 1992 and 1993 Proceedings of the Beltwide Cotton Conferences and the annual report of the National Sweetpotato Whitefly Research and Action Plan (Henneberry *et al*, 1993). A dramatic increase in insecticide use will probably have severe secondary effects on other pest populations.

Surveys conducted in 1993 did not reveal parasitoid activity on silverleaf whitefly in the SJV. Generalist predators have been observed feeding on the pest in many areas. The role of such predators in slowing population growth for such a fecund insect is not known but is not expected to be great (Perring, pers. comm.). The biological control unit of CDFA in cooperation with entomologists at UCR are involved in statewide releases of *Delphastus* beetles. The classical approach of foreign exploration, identification and importation of natural enemies and establishment in California is essential. However, because the origin of this pest is in question, a full effort is not underway at present.

Since this insect appears to use urban ornamental plants as overwintering sites, there may be an opportunity for managing the pest during this period. For example, the selection of non-host species for landscaping may reduce the available sites for overwintering. Urban settings may provide biological control opportunities which agricultural settings would not. Finally, when speaking of urban settings, this should also refer to a single residence surrounded by thousands of acres of agricultural land. Such "urban" islands offer similar collections of ornamental plants in sheltered locations which could provide foci of outbreaks.

Research Activity

The research community has been actively seeking solutions to both sweetpotato and silverleaf whitefly since the early 1980's. Research is active nationally and coordinated at various levels by local management committees (Birdsall, 1993), the Governor's Whitefly Task Force (Lyons, 1993), and the National Five Year Plan (Henneberry *et al*, 1993). It is being supported by local assessments such as the Imperial County Whitefly Management Committee as well as by commodity groups.

Resources

There are a number of resources available for further information. Listed are useful references which will fill out this short discussion. They are available from P.B. Goodell. The Federal Extension Service is supporting efforts to develop an in-service training program for Farm Advisors and Specialists on the biology and management of this pest. The first session will be held at the Vegetable Production Conference at UC Davis on 12/16/93. Available from UCR and the Statewide IPM Program are leaflets and brochures which provide colored pictures and background information about this pest.

Current research information is available from the National Research and Action Plan (Henneberry *et al* 1993) in the form of short abstracts describing current research and extension efforts nationwide. This national group meets annually to review progress in all aspects of whitefly biology and management and in both basic and applied research.

Cooperative Extension is maintaining a regional hotline (800 880-0981) and a computer bulletin board (209 646-3958) which provide regular updates on the situation. The bulletin board also contains limited library files including Agricola literature searches. Information and situation updates are being held on the first Wednesday of the month, usually at Kearney Agricultural Center. Finally, in addition to the authors of this article, many UCCE and AES entomologists and plant pathologists can provide information and resources. These include Eric Natwick (Imperial County); Nick Toscano, Tom Perring, Tom Bellows, Rebecca Creamer (UCR); and Mike Parella, Frank Zalom, Robert Gilbertson (UCD).

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LEARNING ABOUT LEARNING THEORY

Tim Prather, U. C. Kearney Agricultural Center

Background

Introduction

In November of 1992, members of the Statewide IPM project met for an in-service training session that included learning theory. This topic was of interest to determine how it might be incorporated into extension activities to enhance adoption of IPM related methods and techniques. The information presented on learning theory and how our extension activities fit within that theory are discussed in this article.

Cognitive and Affective Domains

While extending knowledge is one of our primary objectives in Cooperative Extension, determining why some technologies or methodologies are readily adopted and others fail is often difficult. Adoption requires a change or modification in the behavior and/or techniques of the client. It is the human part of the equation that decides the success of an extension program. Part of this equation deals with how information is presented according to concepts of learning theory. One learning model is structured as a hierarchy with two domains, the cognitive and the affective (Table 1). The cognitive domain contains our analytic abilities and the affective domain contains our beliefs and values.

Analytic learning takes place at many levels of understanding within the cognitive domain (Bloom 1956). At the most basic level, **knowledge**, an individual can recall learned material. The person could define a term at this level. **Comprehension** is the second level of learning and at this level the person would be able to explain what a term means, as well as being able to recall the term. When the person can use the new material in new situations the next level has been attained, **application**. An example of the application level would be for an individual to be able to modify an insect threshold to account for environmental and crop conditions. Breaking material down into its component parts in order to understand its structure is an example of the **analysis** level in the cognitive domain. In the analysis level a person could deduce environmental conditions that would reduce the effectiveness of a herbicide from knowledge of the uptake, translocation and mechanism of action of the herbicide. The next level is the **synthesis** level. Here an individual can create a new whole from component parts. The person may see a weed control technique such as using a covercrop to provide a mulch in wine grapes, and fit this technique into another crop. By first dissecting the current practice to understand how the technique fits into the cropping system, the person then is able to adapt the technique to a new cropping system within the constraints of the new system. The highest level in the cognitive domain hierarchy is the **evaluation** level. The individual is able to judge the value of material. By reading all the known information about the effectiveness of a technique and understanding the cropping system, the person would determine if the technique was worth adopting or adapting. This level is considered the highest because it requires aspects of all other levels in the hierarchy.

The affective domain has five levels within its hierarchy (Krathwohl, 1964) that deal primarily with behavior, attitude and valuing (Table 1). At the **receiving** level an individual is listening to what is being taught, not sleeping or reading a newspaper during the presentation. The second level is where the person is **responding** to what is being taught. Here people may capture insects to identify them after taking an identification course, simply because they find them interesting and enjoyable. The next level is **valuing**, where an individual assesses the worth of an activity, possibly making a commitment to pursue the activity. A grower may have determined the effectiveness of a new production technique and now makes a commitment to make it work within the present production system. Bringing together several values, giving them **organization**, is the action that characterizes the next level in the affective domain. Considering a variety of pest control techniques that would fit in an IPM program, along with public and private pressures, a grower or PCA may adopt an IPM philosophy to controlling pests. The ultimate level is **characterization by value**. At this level, the adoption of an IPM philosophy has been in use as a modifier of behavior for a sufficient time period that the philosophy is part of a life style. Once a grower or PCA had adopted an IPM philosophy for an extended time period, the approach to a new pest problem would predictably be an IPM approach.

Some new methods or techniques may be adopted because of greater efficiency or cost saving that are easily recognizable. These adoptions predominately involve the cognitive domain. Methods or techniques that may be equivalent in cost saving or efficiency to current practices or that have less directly measurable benefits would require an extension effort that involved both the cognitive and affective domains, and may emphasize the affective domain.

Teaching as an intervention

As extension professionals, we are involved in education, but what are we really doing when teaching? We hope to achieve a modification in our clientele's behavior. We are intervening into our clientele's business and in some cases their personal behavior and value systems. There are a number of ways to intervene, but the methods fall into two categories; authoritative and facilitative interventions. The authoritative intervention is the most common and involves an expert imparting new knowledge. The facilitative intervention seeks to mimic the way people learn naturally. Here the learning is directed by the educator but the student is finding his/her own way through the process. The authoritative intervention dominates education currently and we need to consider balancing the authoritative with more facilitative interventions.

There are three categories of authoritative interventions, prescriptive, informative and confrontive. **Prescriptive** interventions direct the behavior of the client. An example would be offering a pesticide safety training program to promote safe use of pesticides but also to meet government regulation requirements. **Informative** interventions impart new knowledge to the client. This probably is the most common type of intervention used in extension. Demonstrations and recommendations on crop varieties are examples of the informative intervention. **Confrontive** interventions directly challenge a behavior or value of the client. This is common between lawyers and clients where the lawyer may argue with the client to avoid a potential legal battle.

There are three categories of facilitative interventions, cathartic, catalytic and supportive. **Cathartic** interventions deal with strong emotions such as those surrounding the widespread farm foreclosures of the midwest in the 1980's where farmers gathered together to protect their farms. Many learning experiences take place in association with strong feelings. **Catalytic** interventions help the client learn through self-directed study. A field meeting where the purpose is to discuss problems and possible solutions in an example of a cathartic intervention. **Supportive** interventions affirm the value of the client. This can be done through a certification process, an award or some other way to publicize the achievement of the client.

While there are cross-links between the hierarchical learning domains and intervention style, it seems that authoritative interventions are linked more strongly with the cognitive domain and the facilitative interventions are linked to the affective domain. Both domains and both intervention methods should be balanced to increase adoption of new methods and technologies.

Categorizing Educational Tools

At our training meeting, members of the Statewide IPM Project discussed current educational tools and their place within the learning theory hierarchies. Educational tools that were used in IPM extension programs were discussed and listed on sheets of newsprint (Table 2). The information on the cognitive and affective domains was then presented. After discussion, the educational tools were grouped into the various levels in both domains (Table 3). Tools could be listed in multiple categories if members of the group thought they could be used at various levels in either domain. The higher levels in the cognitive domain, synthesis and evaluation were not listed because the members of the group thought these levels were rarely reached through IPM extension efforts. In the affective domain the highest level, characterization by value was not listed for the same reason given for the cognitive domain.

After the table was completed interesting patterns were observed. There were more tools that were applicable at the lower levels of the cognitive domain. There were 12 tools at the knowledge level, 7 tools at the comprehensive level, 5 tools at the application level, and 2 at the analysis level. We seemed to do better in the affective domain with only 1 at the receiving level, 4 at the responding level, 6 at the valuing level and 3 at the organization level. However, fewer tools were categorized in the affective domain which may indicate that the affective domain is not as easy to address using traditional methods. This categorization reveals our strengths and weaknesses, and suggests that some techniques may not be adopted because of the way in which we attempt to teach our clientele.

The educational tools listed in Table 1 were also categorized according to the type of intervention they represented. Categorization according to intervention style was then compiled (Table 4). The tools we use tend to be authoritative styles of intervention. The tools were well distributed among the three types of authoritative styles but the informative style dominated. The informative style is something we are used to and were exposed to during our formal education. There were very few tools that were perceived as facilitative interventions. The lack of tools being used to address facilitative interventions demonstrates how little attention it receives. If the facilitative interventions are more strongly linked to the affective domain, our clientele may not have strong supportive feelings for many of our new methods and technologies. They may not place a high value on the material we are presenting nor is adoption of the material likely to modify behavior so that the new behavior is consistent and predictable.

Many of the educational tools we use could be adapted to emphasize the affective domain and facilitative intervention. As we address these issues through self-directed study and group discussions we should become more effective at conveying new methods and techniques to our clientele.

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FEASIBILITY OF SOIL FUMIGATION BY SEALING SOIL AMENDED WITH FERTILIZERS AND CROP RESIDUES CONTAINING BIOTOXIC VOLATILES

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Abstract: With increasing regulatory restrictions on soil fumigation chemicals, agricultural producers must find other strategies for combating soilborne pests and diseases. One emerging possibility is incorporation of fertilizers, composts, and crop residues containing biotoxic volatiles into infested soil. Previous work with fumigants has shown that activity normally increases when used in conjunction with a soil sealant such as polyethylene film. Recent studies showed that soil amended with certain organic and inorganic fertilizers and crop residues provided partial disinfestation of soil. The effect was increased when treated soil was sealed with polyethylene film or spray mulch. Soil heating further improved treatment. Similarly, concentrations of biotoxic volatiles were shown to increase in the soil atmosphere after sealing and heating.

Introduction

For the past 50 years, agricultural production and regulatory agencies have enjoyed the benefit using synthetic chemical fumigants to disinfest soil of pest and disease organisms. These materials have been effective and easy to apply. Cost of fumigant treatments has usually been recouped through dramatically higher yield and quality of produce, healthier and longer-lived permanent crops, certification of pathogen-free nursery stock, and reduced costs of other production practices such as weed control (2).

In the current climate of increasingly strict environmental and human safety regulations, however, it appears that the era of widespread disinfestation of agricultural soils by synthetic chemical fumigants is coming to a close. Alternative methods of soil disinfestation must be developed and implemented if current levels of crop production, quality, and phytosanitary certification are to be maintained. One such method is soil solarization, a passive hydrothermal process which occurs when moist soil is mulched by a heat-conducting barrier film under conditions of high air temperature and global radiation. Heat accumulation in solarized soil causes physical, biological, and chemical changes which normally result in greatly reduced pest and pathogen numbers and increased yield in subsequent crops. Disadvantages of solarization include dependence on favorable climatic and weather conditions, treating soil for several weeks during the growing season, lack of control of certain heat tolerant pests, and generally, decreased efficacy with increasing soil depth (2).

Another alternative method for soil disinfestation is incorporation into soil of fertilizers and plant residues which have pesticidal properties. This is a traditional practice which has recently received renewed attention, and numerous studies have shown that soil amendment with various cover crops, plant residues and extracts, animal manures and composts, and inorganic fertilizers can provide some degree of pesticidal activity (5).

Studies in which soil sealing and/or heating with plastic mulches was combined with soil amendments generally concluded that, like fumigants, levels of soil disinfestation were better than with either method alone (1, 3, 4, 6, 7). This paper summarizes recent experiments done with combinations of composts, inorganic fertilizers, or cruciferous residues and solarization with polyethylene film or liquid spray mulch to test improved pathogen control, and to determine relationships of soil heating and sealing on concentrations of biotoxic volatiles emanating from treated soil.

Recent Research

Solarization and fertilizers

Replicated laboratory and field experiments in different soil types were done in 1991 and 1992 near Fresno, CA, to determine effects of soil amendment with organic and inorganic ammonium-nitrogen sources (commercially formulated composted chicken manure and ammonium phosphate fertilizers at a rate of 80 kg NH_4-N/ha) with and without soil solarization with clear polyethylene film (4 wk treatment period; August 1991) on fungal (*Pythium ultimum*) and nematode (*Meloidogyne incognita*) pathogens in the rhizosphere and roots of lettuce (*Lactuca sativa* cv. Parris Island).

Solarization and crop residues or fertilizers

Another replicated field experiment was done in sandy loam soil near Fresno, CA, in 1993 to assay comparative effects of soil amendment with composted chicken manure (40 kg NH_4-N/ha) or dried cabbage harvest residues (500 kg/ha), with and without a 4 wk period (July 1992) of soil solarization with clear polyethylene film or black spray mulch on survival of *P. ultimum*.

Evolution of volatile compounds from amended and heated soil

Additional, controlled-environment experimentation was conducted in the laboratory to analyze evolution of volatile compounds by gas chromatography from soil amended with cabbage residues under various levels of soil heating, and to correlate the presence of these compounds with pathogen control.

Results and Discussion

Solarization and fertilizers

Preplant incorporation of ammonium phosphate fertilizer or composted chicken manure slightly reduced galling of lettuce roots by *M. incognita* (3-24%), while solarization was more effective (74%). Combination of ammonium phosphate and solarization was no better than solarization alone, but compost and solarization reduced nematode galling to undetectable levels (Fig. 1). In regard to *P. ultimum*, incorporation of fertilizer or compost alone reduced numbers in lettuce rhizosphere by 0-25% and solarization alone by 80-100%. Due to the high activity of solarization, combination with soil amendments did not give increased control (Fig. 1).

Solarization and crop residues or fertilizers

In this experiment, no fungicidal effect of either soil amendment without solarization was observed (Fig. 2). However, solarization with polyethylene film or spray mulch was very effective, resulting in reduction of fungal propagules ranging from 82-100%. No interaction was found between soil amendments and solarization.

Evolution of volatile compounds from amended and heated soil

Relative concentrations of several volatile compounds emanating from cabbage-amended soil, including several alcohols, aldehydes, isothiocyanates, and sulfides, were increased by soil heating. A few others, including CO_2, were generally higher in nonheated soil. Sealing of soil in jars was accomplished by both polyethylene film and spray mulch. Both soil heating and amendment with cabbage residue and chicken compost increased the lethal effect on *P. ultimum* (Fig. 3).

Results of these experiments indicate that sealing animal and plant residues containing biotoxic volatile compounds into soil and using materials such as polyethylene film and spray mulch can provide at least partial soil disinfestation, especially when combined with soil heating. Under present laws, use of these soil amendments, even when intended for pesticidal activity, do not carry regulatory requirements when the materials are produced on-farm. However, additional research will be necessary to develop guidelines for optimal usage. As interest and experimental results increase, it may be possible to develop "customized" soil amendments which will have greater activity on specific pest organisms found in particular fields. Crop managers will require more intensive soil sampling to identify and enumerate threshold levels of soilborne pests as the broad spectrum fumigants become unavailable.

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(Figure not available)

Figure 1. Field effect of soil solarization, chicken compost, and ammonium phosphate fertilizer on (A) galling of leaf lettuce (*Lactuca sativa* cv. Parris Island) by *Meloidogyne incognita*, and (B) numbers of *Pythium ultimum* in the rhizosphere of lettuce plants. Columns tended by different letters are different ($P \leq 0.05$) according to factorial ANOVA.

(Figure not available)

Figure 2. Field effect of solarization with clear polyethylene film or black spray mulch combined with soil amendment with chicken compost (10 t/ha) or cabbage residue (5 t/ha) on numbers of *Pythium ultimum*. Columns tended by different letters are different ($P \leq 0.05$) according to factorial ANOVA.

(Figure not available)

Figure 3. Effect of heating soil amended with chicken compost or cabbage residue and sealed with clear polyethylene film or black spray mulch on numbers of *Pythium ultimum* in a controlled environment experiment.

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ABSTRACTS

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<u>Performance of a portable device to control replant problems.</u> *M. V. McKenry, U. C. Kearney Agricultural Center*

A portable soil drenching device was used to apply metham sodium (MS) at 732 kg ai/ha rate to peach replant sites, each being 3 by 100 m in size. Plots were compared to a shanked 336 kg/ha methyl bromide (MB) and a nontreated check. Plots treated with MS exhibited dead peach roots and *Pratylenchus vulnus* throughout the surface 1.5 m of soil. MB treatments gave kill of old roots and nematodes throughout the surface 1.8 m of soil. Plant growth at 3 months after replanting was notably impaired in the nontreated check. After 5 months the growth and color of replants in sites receiving chemical treatments was identical. Weed control was best following the MS treatment. The MS at 366 kg ai/ha killed nematodes to the 1.5 m depth but live roots were found below 0.6 m depth. MS can be delivered uniformly and with consistency via a portable soil drenching device.

Table 1. Description of the Cognitive and Affective Domains.[1]

Category	Description
Cognitive	
Knowledge	Knowledge represents the lowest level of understanding and is defined as remembering previously learned material.
Comprehensive	Comprehension is the ability to grasp the meaning of material and represents the second level of understanding.
Application	Application is the ability to use learned material in new situations, for example applying rules, concepts or principles. This level requires knowledge and comprehension.
Analysis	Analysis is the ability to dissect material to understand its structure, usually by analyzing interactions among the component parts of the material.
Synthesis	Synthesis is the ability to assembly the dissected material into a new whole, for example develop a research proposal. This level emphasizes the formulation of new patterns.
Evaluation	Evaluation is the ability to judge the value of material for a given purpose, based on a set of criteria. This is the highest level in the cognitive domain because it uses all the other levels.
Affective	
Receiving	Receiving is the individual's willingness to devote their attention to the material, making the individual aware of the existence of the material. This is the lowest level of the affective domain.
Responding	Responding is the desire to participate in a learning activity.
Valuing	Valuing is the worth an individual attaches to the material learned. This ranges from acceptance of the value to commitment to what has been learned.
Organization	Organization brings different values together, resolves conflicts between values and then constructs a new whole.
Characterization	This level deals with a value system that by Value controls the individuals behavior. This deals with a broad range of activities but the behavior is now predictable and pervasive.

[1]Adapted from Gronlund 1981.

Table 2. Educational tools used in extension

TOOLS	
Newsletter	In-field meetings
Lecture	Displays
Quiz	Demonstrations
Small group meetings	Editorial
Hands-on-training	Mass media/Public service
UC IPM publications	Insect zoo
Train-the-trainer-programs	Slide sets
Slide sets	Symptomology
Databases	IMPACT
Games/Simulations	One-on-one discussion
Trade Journal	Drama
Demonstration-client involved	Video
Fungus garden	

Table 3. Educational tools grouped according to levels of the cognitive and affective domains.

Cognitive Domain		Affective Domain	
Level	Educational tool	Level	Educational tool
Knowledge	Newsletter Demonstration Lecture Trade Journal Demonstration Displays Mass media/ Public service Databases Slide sets Video Fungus garden IMPACT Insect zoo	Receiving	
Comprehension	In-field meeting Quiz UC IPM publications Train the trainer IMPACT Symptomology Slide sets	Responding	Editorial Mass media\ Public service Video Insect zoo
Application	Small group meeting Hands-on training One-on-one training Games/Simulation Drama	Valuing	In-field meeting One-on-one discussion Games/ Simulation Hands-on training Train the trainer Insect Zoo
Analysis	Demonstration- client involved Games/Simulation Demonstration-	Organization	Small group meetings Client involved Drama

Table 4. Categorization of educational tools into intervention style.

Authoritative		Facilitative	
Type	Educational tool	Type	Educational tool
Prescriptive	UC IPM publications Newsletter One-to-one discussion In-field meeting IMPACT Train the trainer	Cathartic	Drama
Informative	Newsletter Lecture Trade Journal Display Mass media/ Public service Slide sets Video IMPACT UC IPM publications Train the trainer Symptomology Small group meetings Insect zoo Games/Simulation	Catalytic	In-field meeting Small group meeting Hands-on-training Games/ Simulation IMPACT
Confrontive	One to one discussion Train the trainer Hands on training Games/Simulation Drama Editorial In-field meeting	Supportive	One-to-one discussion Train the trainer Hands-on training Games/ Simulation