CULTURAL CONTROLS: Introduction

Pest problems are a major concern for both tomato and pepper producers in Florida and account for increasingly significant economic inputs. With the availability of pesticides always an issue as well as the concern of continued efficacy in the face of increasing resistance problems, cultural management has become an even more important component of a comprehensive pest management program. To fit the true definition of Integrated Pest Management, cultural controls must be included along with all other available and pertinent control tactics.

Figures 1 & 2. Cover crops are an important aspect of pre-season cultural control (left) and during the season there are many ways to manage tomatoes and peppers that reduce the incidence of diseases and keep harmful insect populations at a minimum (right). Photographs by: Phyllis Gilreath.

As both the cost of pesticides and pest pressure increases, growers and consultants are looking more closely at how cultural control options will fit into their cropping systems. The major cultural controls that are covered in this chapter include:

- **Mulches** – especially critical in light of the impending loss of methyl bromide and severe insect pressure in recent years
- **Transplanting Decisions** – including planting dates and times, use of resistant cultivars and planting depths
- **Field Sanitation** – this issue is becoming increasingly important in minimizing insect and virus problems across the state
- **Off-Season Management and Cover Crops** – cover crops should be chosen carefully to maximize benefits and avoid potential future problems
- **Double Cropping** – considerations must be made for the effect of both the primary and double crop on each other
- **Windbreaks** – a technique that is probably underutilized in terms of the potential benefit

Prepared by: Dr. Phyllis Gilreath

CULTURAL CONTROLS:
Mulches

INTRODUCTION:

Polyethylene mulch has been used in vegetable production for over 40 years and is currently used in virtually all pepper and tomato production in Florida. Mulches vary in thickness and color, with white being used in hot seasons and black in cool seasons. Colored mulches have been tried for insect control with varying success. More recently, use of virtually impermeable film (VIF) has gained in popularity. In addition to being an integral part of fumigation success, mulch can increase yield, inhibit weed growth, improve moisture retention, reduce crown fruit rot and reduce fertilizer leaching.

Figure 3. A variety of tests for mulches has been done to find the efficacy of the different colors on insect control. Photograph by: Milt Putnam.

BENEFITS OF MULCH:

- Silver, aluminized or metalized mulch reduce the population of thrips, aphids and silverleaf whitefly by deterring adult insects from landing on plants.
- Silver, aluminized or metalized mulch can delay tomato yellow leaf curl (TYLC) by at least 2 weeks and reduce tomato spotted wilt (TSW) significantly.
- VIF allows reduction of methyl bromide rates which saves money and helps increase the acreage which can be treated, maintaining effective pest control as alternatives continue to be developed.
- Some VIF products are also metalized, providing double the benefit.

Figure 4. Silver mulch for thrips/TSW control in North Florida. Photograph by: Steve Olson.

POTENTIAL PROBLEMS:

- Colored or reflective mulches are usually most effective early in the crop cycle before the crop canopy covers the mulch and before spray residues decrease the reflectivity.
- Silver and metalized mulch can affect soil temperature and plant growth; however, yield reductions due to temperature are often offset by the increase in yield as a result of reduced virus incidence.
- To reduce the cooling effect of silver mulch in cool seasons, mulch is available with a 5 to 6 inch strip of black down the middle **(Figure 4, pg. 70)**.
- Traditionally, VIF mulch has been hard to lay due to lack of elasticity, requiring equipment modifications. Newer films are being improved to lessen this problem.
- Reducing fumigant rates requires equipment modifications in order to achieve uniformity of delivery and effective pest control across the entire bed.

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SUCCESS STORY:

In the spring crop of 2000 in North Florida on a large scale grower trial (40 acres metalized and 100 acres black), use of metalized mulch reduced incidence of TSWV from 45% to 11%. In 2002 in another grower trial (100 acres metalized and 25 acres on black), the combination of Actigard® and metalized mulch reduced TSW from 23% to 3%. Other growers report reduction in virus of up to 75% with increased profits of up to $4000 per acre.

Figure 5. Metalized VIF mulch covering tomato beds in central Florida. Photograph by: Phyllis Gilreath.

Figure 6. TYLC symptoms on tomatoes in central Florida. Photograph by: Phyllis Gilreath.

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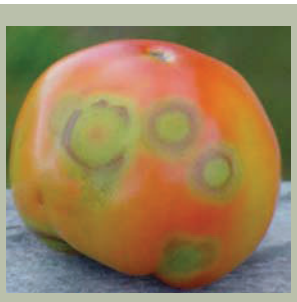

Figures 7 & 8. TSW damage on green and ripe fruit in north Florida. Photographs by: Steve Olson.

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INTRODUCTION:

Virtually all of the tomato and pepper acreage in Florida are planted using transplants or plug plants to promote earliness, uniformity and decrease disease problems. Planting dates are based primarily on marketing and economics. This decision is driven by anticipated "market windows" when crops are predicted to be of higher value for a given area. Within this general category there are also a number of other related factors which should also be taken into consideration to maximize production during any chosen planting period.

Figure 9. Healthy tomato transplants. Photograph by: Charles Vavrina.

TRANSPLANT DATE/TIME CONSIDERATIONS:

- Growers should be aware of cultivar/weather/pest interactions. Many diseases prefer cool, wet weather while some prefer warmer temperatures. Insects generally thrive under hot, dry conditions.
- Heat tolerant tomato cultivars are beneficial in early plantings in all Florida tomato production districts.
- In north Florida, *Tomato spotted wilt virus* (TSWV) resistant cultivars are especially important in spring plantings.
- In southwest Florida winter crops, resistance to *Fusarium* crown and root rot and tolerance to gray wall are important. In Dade County winter crops, gray wall tolerance is important.
- Avoiding transplanting during the heat of the day may minimize physiological drought which can cause 'heat girdling', especially prevalent in peppers. This is caused when temperatures just above the mulched bed are extremely hot and plants transpire faster than they can take up water from the small root ball, thus causing a collapse of the stem **(Figure 10).** If you must plant mid-day, keeping beds moist and using a water wagon soon after transplanting reduces the amount of resetting needed.

Figure 10. 'Heat girdling' or 'stem scalding' resulting in stem collapse of pepper. Transplanting at 11 am and 1 pm resulted in a 20-30% increase in heat girdling compared to 9 am and 3 pm. Photograph by: Charles Vavrina.

Prepared by: Dr. Phyllis Gilreath

OTHER TRANPLANTING DECISIONS:

- Setting tomato and pepper plants to the depth of the first true leaf results in earlier yields and larger fruit size. This is due in part to the more favorable environment, i.e. moist and cooler, a few inches below the bed surface, especially during hot weather **(Figure 11)**.
- If possible, locate early plantings away from neighboring fields which could be a source of insects and disease in the early part of the season.
- Mulch color is generally determined by time of transplanting. White mulch is used in warmer seasons since it reflects heat and results in a cooler bed. Black mulch is used during cool seasons because it absorbs heat 'into' the bed, providing a warmer environment for young plants.
- Silver or metalized mulches can be used in any season when insects such as whitefly or thrips are a problem.

Figure 11. Varying transplant depths (left to right): to first true leaf, to cotyledons and just covering the root ball. Photograph by: Phyllis Gilreath.

Effect of Tomato Transplant Depth On Yield

Transplant Depth	Yield (25 lb cartons/A) First Harvest	Extra-Large
Root Ball	658	536
Cotyledon	871	664
1st True Leaf	1081	912

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CULTURAL CONTROLS:
Field Sanitation

INTRODUCTION:

Good field sanitation practices are becoming more important pest management tools due to the loss of pesticides with fewer new products coming in, and the reduction in efficacy due to resistance problems. Field sanitation practices should be an important aspect of production from field preparation through harvest and beyond.

Figure 12. Good field sanitation, such as keeping the row middles free of weeds, can limit the number of pests and pathogens on your field. Photograph by: Phyllis Gilreath.

PREPLANT/PLANTING:

- Use only clean, pest free transplants, preferably grown in houses away from virus or disease infested production fields.
- As methyl bromide is phased out and herbicides are incorporated into alternative strategies, field histories of weeds present become important in choosing the correct herbicide.
- Field histories related to soil borne pathogens should also be considered in selecting the proper fumigant or alternative, mechanical operations such as deep disking or in decisions to avoid planting in certain blocks.
- Consider not only herbicide residue from previous crops but also think ahead to future crops and potential residue issues.

DURING THE SEASON:

- Maintain good weed control within the crop and field perimeters, paying particular attention to alternative pest hosts and volunteer crop plants.
- Spray a contact insecticide (oil may be a good choice due to the low REI) prior to rouging virus infected plants or doing any other activity that would disturb plants, including staking and tying. This will minimize insect movement to surrounding healthy plants.
- Avoid handling plants when wet to minimize disease spread (i.e. bacterial spot and speck). Clean hands and tools with disinfectant often when certain diseases are present (i.e. *Tobacco mosaic virus*).
- Avoid movement of equipment from infested fields (i.e. *Sclerotinia* and bacterial wilt). Work clean areas first, then move to diseased areas and then clean and/or disinfect. Decontaminate stakes that were used in disease infested fields prior to reuse.

Figure 13. Bacterial spot on tomato can easily be spread within the field when plants are wet when handled. Photograph by: Phyllis Gilreath.

Prepared by: Dr. Phyllis Gilreath

POST-SEASON:

- Maintain good sanitation procedures during harvest. Dirty buckets, bins and gondolas should be cleaned to reduce decay cross-contamination and those with rough surfaces, which can cause abrasion injuries, should be replaced. Plastic containers and bins can be readily cleaned and sanitized.
- Destroy crops immediately after harvest is complete. Do not wait until all blocks are harvested. Do not rely on "Mother Nature" for effective crop destruction.
- Include either oil (2-3%) or a contact insecticide with burn-down chemicals to reduce movement of insects such as whitefly out of fields.
- Make sure that tomato plants are completely killed, especially if double cropping is planned.

Figure 14. Make sure tomato plants are completely killed, especially if double-cropping is planned as shown in this photograph of cucumbers planted following tomatoes. The stakes and strings are left to provide support for the cucumber vines. Trellising improves fruit quality and reduces disease. Photograph by: Phyllis Gilreath.

Figure 15. A variety of weeds growing in tomato row middles can serve as hosts for crop pest problems. Knowing the weeds present in a field can help with selecting the best control materials for the future. Remember that weeds can also be hosts for nematodes. Photograph by: Phyllis Gilreath.

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INTRODUCTION:

While cover crops are often thought of in terms of their benefits for minimizing erosion and improving soil structure, composition and porosity, certain cover crops can either suppress or increase insect, nematode, weed and pathogen populations that may be pests to the primary tomato or pepper crop. Knowing this information can help growers make the best choice for their situation.

SELECTING A COVER CROP:

- Greatest benefits are from cover crops which grow fast and produce the maximum amount of biomass for shading out undesirable weeds and for adding green biomass back to the soil.
- Cover crops can help reduce the population of weeds which may be hosts for diseases such as *Phytophthora capsici, Alternaria solani* and others.
- Destruction of weeds prior to planting a cover crop is important because inoculum in weeds can survive for months on undecomposed plant material.
- Weeds can also be hosts for viruses such as *Tomato yellow Leaf curl virus* (TYLCV), *Tomato spotted wilt virus* (TSWV) and *Tobacco mosaic virus* (ToMV).
- Black nightshade can be a secondary host for pepper weevil, but can be reduced in numbers by a cover crop which will out-compete weed growth.
- Cover crops should be chosen which have adverse effects on pathogen populations either through competition, parasitism, predation or antagonism. Cover crops can also disrupt the life cycle of many destructive pests.
- Incorporation of Brassica cover crop residue has been shown to aid in soil-borne pest control by production of glucosinolates which further break down into isothiocyanates which have biofumigant properties.
- While sorghum-sudan grass hybrids make effective 'smother' crops, they also secrete allelopathic compounds (toxins) that suppress some weeds.
- Cover crops should be selected which are non-hosts for plant pathogens and nematodes, but which are adapted to the climate and production season.
- Some cover crops can either harbor beneficial insects or outcompete weeds that harbor pests; however, timing must be considered in terms of how long that crop will be in the field depending on season and climatic adaptation.
- Some cover crops can suppress weeds which can be an alternate host for nematodes. Certain sorghum-sudangrass cultivars suppress root-knot nematode populations, but can actually host sting nematodes. 'Iron-clay' pea **(Figure 16)** and Sunn hemp **(Figure 17)** are also nematode-suppressive.

Figure 16. 'Iron-Clay' pea cover crop. Photograph by: Carlene Chase.

Prepared by: Phyllis Gilreath and Carlene Chase

Table 1. Common weeds of Florida vegetables and their ability to support root-knot nematode galling and egg mass development. (Reproductive index scale consists of 0=no egg masses; 1=light or <10 per gram of root; 2=moderate or 10-50 per gram of root; 3=heavy or 50-100 per gram of root; and 4=very heavy or >100 per gram of root). Table by: Joe Nowling.

Weed Species	Reproductive Index
Pigweed	Heavy – Very heavy
Purslane	Very Heavy
Nightshade	Light – Very Heavy
Eclipta	None – Light
Ragweed	Moderate - Heavy
Sweet Clover	None – Light
Hemp Sesbania	Very Heavy
Sand Vetch	Very Heavy
Goosegrass	Very Heavy
Crabgrass	Light – Very Heavy
Carolina Geranium	None – Light
Cutleaf Evening Primrose	Moderate
Cudweed	None – Moderate
Yellow Nutsedge	Light

Figure 17. Sunn hemp has been shown to reduce root-knot nematode populations and enhance natural enemies. Seed may be expensive and difficult to obtain. Photograph by: Carlene Chase.

Table 2. Effect of cover crops on subsequent common weed populations.*

Cover Crop	Nutsedge	Pigweed	Crabgrass
Sorghum-sudan	Increase	Decrease	No effect to decrease
Cowpea	Decrease	Decrease	No effect to decrease
Millet	Increase	No effect	No effect to increase

** Gilreath, J. P., Personal communication*

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CULTURAL CONTROLS:
Off-Season Management and Double Cropping

INTRODUCTION:

Double cropping is the practice of planting successive crops on the same mulched bed to gain multiple use of production inputs from the first crop, thereby spreading the costs of these inputs over two or even three crops (triple cropping). The cultural management program practiced during double cropping can have a significant impact on pest management the following season. Crops planted as a second crop must be considered from a number of standpoints in terms of their effect on the primary crop.

PLAN AHEAD:

- Consider pest complexes for each crop in the rotation. Try not to use a second crop that is a host for pests that also affect the first or primary crop. In most cases, tomatoes or peppers are the primary crop and a cucurbit is the secondary crop and they are not hosts for the same diseases; however, they do have nematode and insect pests in common.
- When planting a second crop, make sure all first crop vegetation is completely killed in order to destroy potential hosts for primary crop insect, disease and nematode pests which could adversely impact successive crops **(Figure 18)**.

Figure 18. Tomato yellow leaf curl infected re-growth from tomatoes in a double-cropped field seeded to cucumber. Infected tomato re-growth can serve as a reservoir for virus which can then be carried to neighboring new fields. This grower resorted to hand-pulling the entire field of old tomato plants, a considerable labor expense. Photograph by: Phyllis Gilreath.

With the impending loss of methyl bromide, field histories of soil borne pests, pathogens and weeds become very important for both the first and the double crop.

DURING THE OFF-SEASON:

Keep a Field history:

- Know what pests are present. With the impending loss of methyl bromide, field histories of soil borne pests become very important for both the first and the double crop. Knowing what pests are present allows the grower to tailor the fumigant or herbicide program for best results.
- Ensure that pesticides used in the first crop or the double crop do not have plant back or other label restrictions that would affect the other crop.

Prepared by: Dr. Phyllis Gilreath

DURING THE OFF-SEASON:

- Practice good weed control in the double crop since weeds can increase the population of some insects, diseases and nematodes that must be controlled prior to the next primary crop season **(Figure 19)**.
- Destroy the second or double crop completely and in a timely manner to allow time for plant residue to break down prior to the next primary crop. Too much non- or partially decomposed organic debris can interfere with bed preparation and reduce efficacy of fumigant materials applied for the next primary crop.

Figure 19. Heavy weed infestation in a mulched double cropped cucumber planting along with re-growth of peppers from the first crop. This situation can increase nematodes and other pests which can be carried over to the next primary pepper crop. Photograph by: Phyllis Gilreath.

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Prepared by: Dr. Phyllis Gilreath

Notes:

INTRODUCTION:

Windbreaks are barriers used to reduce and/or redirect wind around and within crop production fields. They may be annual crops/grasses or perennial grasses, trees and shrubs. While windbreaks are typically thought of in terms of protecting crops from wind and cold, they may also increase plant diversity and provide an important habitat or reservoir for both pest and beneficial insects. The impact a windbreak has on the crop and the pests within that crop varies depending on the height, density, species and other factors.

BENEFITS OF WINDBREAKS:

- Windbreaks reduce wind speed, reducing wind erosion and abrasion to crops from wind-blown sand. This helps reduce disease by reducing entry points for pathogens **(Figure 20)**.
- Planted windbreaks create plant diversity, providing homes for a wider range of microbes, insects, plants and wildlife which can be beneficial for crop plants.
- Even large wild or native plants on field borders can serve both as windbreaks and as habitat as well as nectar and pollen sources for parasitoids and a source of alternate prey to sustain predators between seasons. These borders are usually not intensively managed and if left standing can increase the diversity of plants.
- Although rye windbreaks on irrigation ditch areas and roadways are the most common, sorghum can also be effective as can sugarcane in Central/South Florida.
- Windbreaks can serve as a physical barrier to movement of insects to, from and within a crop field. This is advantageous if entry of pests is blocked or outward movement of natural enemies is hindered.

Figure 20. Windbreaks are often planted on irrigation ditches in tomato fields to protect from 'sand blasting' and desiccation. This is especially true in spring; however, the windbreak must be planted early enough to be taller than the crop plants they are supposed to protect. Here a shorter growing rye species is planted between rows to reduce rain splashing of soil and pathogens onto plants. Photograph by: Phyllis Gilreath.

How a Windbreak Works

As wind approaches a windbreak, some moves through the barrier but most moves up and over. This results in a reduction in wind speed both windward (side toward the wind) and leeward (side away from wind). On the windward side, the protected zone extends 2-5 times the height of the windbreak. On the leeward side, the protected zone generally extends 10 to 20 times the height.

Prepared by: Dr. Phyllis Gilreath

POTENTIAL PROBLEMS:

- To provide year-round benefits, windbreaks must contain either a coniferous species or a dense shrub understory **(Figure 21)**.
- Some windbreaks may be alternate hosts to undesirable plants. For example, rye grass may harbor ahpids and thrips which may be pests or in some cases may only be a nuisance.
- Hurricane-force winds have been observed to actually increase damage to tomato plants on the windward side of a perennial windbreak due to the turbulence created. Windbreak densities of 60-80% are recommended to minimize this problem **(Figure 22)**.
- By changing temperature, shade and humidity levels, windbreaks can alter the microclimate, especially that of the cropped area in closest proximity. This can have either a positive or negative effect on pest pressure depending on the crop or pest.
- Weak flyers (aphids, thrips, whitefly, etc.) are carried further by wind and have been observed to utilize tall trees as obstructions, enabling them to settle and later move to crop fields.
- In some cases, crops closest to the windward side of boundary plantings are less likely to be infected by insect species that are carried by the wind, emphasizing the need for scouting interior plants to maintain control.

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Figure 21. Here, rye is planted as a temporary windbreak on ditch rows within the field and southern red cedar is planted on individual field borders as a permanent windbreak. Photograph by: Phyllis Gilreath.

Figure 22. Wind can desiccate plants and wind-blown sand can abrade young seedlings, causing loss of foliage and crop delay or even death. Tomato stakes can actually help protect young plants if wind is blowing down the row instead of across the row. Photograph by: Phyllis Gilreath.

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