Tennessee’s Pest Management Strategic Plan for Cucurbits

List of workgroup participants

June 14, 2002 participants of the Tennessee Pest Management Information Network

Dr. Steve Bost, Professor, Entomology and Plant Pathology (Extension Pathology, Nematology) scbost@utk.edu 615-832-6802

Dr. Jerome Grant, Professor, Entomology and Plant Pathology (Research, Entomology) jfgrant@agmail.ag.utk.edu 865-974-7135

Dr. Frank Hale, Professor, Entomology and Plant Pathology (Extension Entomology) fahale@utk.edu 615-832-6802

Mr. Gray Haun, Tennessee Department of Agriculture, Division of Regulatory Services (Plant Certification Administrator) walker.haun@state.tn.us 615-837-5338

Mr. Darrell Hensley, Entomology and Plant Pathology, (Assistant Extension Specialist) dhensley@utk.edu 865-974-7958

Mr. Robert Moncier, Extension Agent, Hawkins County Extension Service rmoncier@utk.edu 423-272-7241

Dr. Melvin Newman, Professor, Entomology and Plant Pathology (Extension Pathology, Virology) manewman@utk.edu 731-425-4718

Dr. Pat Parkman, Assistant Professor, Entomology and Plant Pathology (IPM coordinator) jparkman@utk.edu 865-974-7135

Dr. Darren Robinson, Assistant Professor, Plant Sciences and Landscape Systems (Extension Weeds) drobins5@utk.edu 865-974-7999.

Ms. Sharon Shelton (grower, former county extension agent and area IPM specialist) shelton1@planetc.com 865-475-9856

Dr. Scott Stewart, Assistant Professor, Entomology and Plant Pathology (Extension IPM, Cotton, Soybeans) sdstewart@mail.ag.utk.edu 731-425-4718

Dr. Alan Straw, Assistant Professor, Plant Sciences and Landscape Systems (Extension Agronomist) astraw@utk.edu 865-974-7422

Listed on the following page are individuals that were asked to attend however, indicated they could not attend this meeting due to conflicts, however participated in advisory capacity. These include:

Ms. Robin Thomas - Syngenta Crop Protection (Sales), Committee Advisor
Robin.thomas@syngenta.com 865-984-3930

Mr. Bill Draper - The Tennessee Farmers Cooperative (Pesticide inventory, state sales), Committee Advisor, bdraper@ourcoop.com 615-793-8311

Mr. Jimmy Fluker* - Bayer Corp. (Sales), Committee Advisor. Forwarding information not available.

Mr. John Mitchell - TN-producer of vegetables, corn, cattle, and milk production. Committee Advisor mitchdairy@aol.com 865-933-2357

Dr. Fitzroy Bullock** - Tennessee State University, Small Farms and Integrated Pest Management. fbullock@tnstate.edu 615-963-5449

---

* Mr. Fluker has recently been relocated to Alabama and will no longer be able to assist with the Tennessee Pest Management Network as of 11/02.

** Dr. Fitzroy Bullock was not able to attend the June 14, 2002 meeting due to medical problems.

Tennessee's Pest Management Strategic Plan for Cucurbits

Executive summary:

The USDA's Office of Pest Management Policy (OPMP) developed the Pest Management Strategic Plan (PMSP) as a planning and priority setting process for states and regions to follow as a guideline. This process facilitates transitions of alternative pest management practices when one or more pesticides used to manage pests on a crop are lost as a result of regulatory review conducted by the Environmental Protection Agency (EPA) and the United States Department of Agriculture (USDA). The University of Tennessee, research and extension specialists and other stakeholders, assisted in development of Tennessee's cucurbit PMSPs. The development of this Pest Management Strategic Plan (PMSP) is a method of setting pest management priorities for cucurbits grown in Tennessee. This plan included stakeholder's involvement within the developmental process. This PMSP outlines the current state of pest management for cucurbits in Tennessee and presents a prioritized list of needs for research, regulatory activity, and extension educational programs needed to facilitate the transition to alternative pest management practices. This plan includes information concerning crop phenology and pest-by-pest approach to identifying and assessing the current management practices (chemical and non-chemical). Listed below includes research, regulatory and educational priorities that were identified by the work group.

Tennessee's Pest Management Strategic Plan for Cucurbits

Priorities:

Research

- Cucumber beetle management
- Plant breeding and control programs for yellow vine, aphids, powdery mildew, Phytophthora blight, downy mildew and improved control of bacterial wilt in pumpkin and cantaloupes.
- Lack of weed control products – investigate herbicide products for efficacy and/or cultural control methods of broadleaf weeds
- Develop improvements in spider mite management
- Determine economic threshold for pests of cucurbits
- Post harvest disease control (*Fusarium* spp., *Phytophthora*, *Xanthamonas* spp. and other diseases)
- Methyl bromide replacements and cost-effective alternatives

Regulatory

- Registrations for seed treatments with the insecticides imidacloprid (Admire) and thiomethoxam (Platinum). Since the meeting, imidacloprid was approved for application to direct seed. Thiomethoxam (Platinum) is only labeled for soil or trickle irrigation applications.
- Streamlined Section-18 Process
- When new chemistries are developed and determined to be effective and environmentally sound, provisions should be made to quickly expedite registrations in manner that is beneficial for all concerned.
- Limited modes of action may increase the chance of resistance developing within the pest population. New pesticide chemistries are needed to replace the loss of diazinon (an organophosphate) and benomyl (a carbamate).

Education

- Increase knowledge of growers so they may properly and most effectively control cucumber beetles. This may be accomplished by reviewing current practices that are available.
- Increase skills and understanding of pest identification, life cycles, monitoring and scouting. Hold training sessions for pest management of cucurbits and review these techniques.
- Increase access and availability of information concerning integrated pest management (IPM) to growers and public. Development of production guides in hard bound format and make available in electronic format.
- Increase access to information and release information concerning GMOs to the public and growers. Develop informational seminars held in county and regional meetings. Write newspaper articles concerning these issues.
- On-farm demonstrations which include methods, research and replication

- Loss of Diazinon and Benomyl will increase dependency on other expensive products. Inform growers of available alternatives and proper methods of application.
- Inform growers how to use available products to maintain economic stability.
- Inform growers how to find markets for marketing fresh market products.

Background:

Due to the enactment of the Food Quality Protection Act, the EPA is reassessing many pesticides currently utilized in agricultural production and in other areas for pest control. There are several pesticides listed in EPA's Phase 1 list for tolerance reassessment. These pesticides are called high risk pesticides which include the classes known as organophosphates, carbamates and B/2 carcinogens. These pesticide chemistries are extremely important to agricultural production. Many may only require a single application to simultaneously control two or more primary pests observed in a particular crop. Most of these pesticides have been in use in agricultural production for many years and have proven performance. Growers have become familiar with many of these pesticides and their ability to control. These pesticides are generally economically priced and often fit into many IPM programs. However some have their drawbacks. Several are highly toxic and pose exposure risks to applicators, workers and/or the environment. Due to the requirements of FQPA, the EPA is examining all aspects of possible exposure from the listed classes of pesticides. The EPA is reviewing dietary, ecological, occupational risks posed by these pesticides. Information contained in developed PMSPs helps EPA determine most critical needs of pesticides and possible risks.

During the meeting, a discussion concerning genetically altered crops for control of pests was brought up. Attendees of the meeting agreed that until growers and consumers accepted genetically modified organisms (GMOs) in the market place, there was no reason to extend much emphasis to growing these modified genotypes on a commercial scale at this time. In Tennessee, consumer acceptance will take many years until consumer consumption of GMOs will occur. Consumer education programs informing the public that GMOs are safe to consume will be needed in all educational programs (food nutrition and agriculture).

Production information:

Background of cucurbits as a commodity in Tennessee:

Cucurbits are an important commodity in Tennessee's agricultural system. In Tennessee, commercial cucurbit production consists of cantaloupes, cucumbers, pumpkins, squash, and water melons. Approximately 7,000 acres of commercially produced cucurbits are harvested each year in Tennessee. Harvested acreage often fluctuates from season to season. There are many factors for these acreage fluctuations, such as weather, past pest pressures and past marketing trends. Tennessee is not ranked highly in national production in any one of the cucurbit crops grown, however Tennessee has been listed in USDA's statistics and varied in ranking from 3rd to 7th of states

producing pumpkins. The majority of pumpkins grown in Tennessee are produced for decorative purposes only. Cucurbit production is a very important component in Tennessee's economy and during favorable growing seasons may provide excellent returns to growers. Due to the reduction of tobacco quotas in Middle and East Tennessee, farmers have been seeking viable alternatives. Vegetable production is one alternative that Tennessee farmers have selected. Over the last few years cucurbit production has increased in all areas of Tennessee. Cucurbits could continue to fill the void in areas where tobacco production occurs and if tobacco acreage continues to decrease. During the 2002 production season, cucurbits had an approximate value of $14 million dollars.

Pumpkin production

- Tennessee's national ranking in pumpkin production fluctuates annually often competing for third place with other states and falling as low as seventh place. States producing similar acreage as Tennessee include Illinois, New York, and California. Tennessee's contribution to the national pumpkin production is approximately thirteen percent of total national production.
- Pumpkins generate approximately $5 million dollars in Tennessee's economy. Approximately 4,000 acres were planted in Tennessee during 2001 and approximately 3,500 acres were harvested.
- A typical yield per acre averages from 800 to 1,200 marketable pumpkins per acre and varies, depending on type planted. Pumpkins are the most popular vegetable in the cucurbit group (mostly *Cucurbita argyrosperma*), which includes gourds, summer and winter squashes.
- The majority of pumpkins grown in Tennessee are grown for ornamental purposes. Varieties grown vary depending on local needs and previously requested orders. Production costs of pumpkin average around $1500 per acre.
- Pumpkin production on plastic is increasing in Tennessee, since this production method results in better early weed control, and improved moisture conditions. Also, use of plastic is being done by growers who have the potential for double crop systems. Strawberry growers who produce crops on plastic are beginning to double crop with pumpkins behind strawberries.
- For additional information concerning pumpkin production see: http://www.pmcenters.org/Southern/

Cantaloupe production

- The melon referred to as "cantaloupe" is actually named muskmelon (*Cucumis melo*, var. *reticulatus*). The term "cantaloupe" is a misnomer that has been used widely in the vegetable industry as a synonym for muskmelon. True cantaloupe (*C. melo*, var. *cantalupensis*) is grown in Europe and is a small fruit with a hard, scaly, or warty skin.

- The national reported harvested acreage in 1997 for cantaloupe was 113,770 acres. Tennessee ranks low in national production of cantaloupes and contributes to approximately 1 percent of U.S. production.
- In 2001, Tennessee cantaloupe production included approximately 1,500 acres.
- Hybrid cantaloupes commonly available for Tennessee planting include Burpee Hybrid, Athena, Eclipse, Minerva, Canadian Gem, Cordele, Gold Star, Legend, Primo, Star Headliner, and Superstar. Approximately, 75% of all Tennessee cantaloupe acreage is Athena.
- While the state average is 80 hundredweight (cwt.) per acre, new hybrids that are selected by farmers provide approximately 150 cwt. per acre, and 300 cwt. per acre has been achieved in some trials. Similarly, gross returns for wholesale melons average $1,500 per acre, but could reach as high as $3,000 per acre. Estimated cost of production is $2,500 an acre ($4,000 with the use of plastic mulch and drip irrigation). Break-even price ranges from less than $3.00 per cwt. to over $9.00 per cwt. depending on expected yield and method of production selected.
- Plastic-culture cantaloupe production occurs in Greene, Hawkins Jefferson, and Washington counties in Tennessee where bare-ground production is spread across the state. Approximately 50% of plastic-culture grown cantaloupes were irrigated.
- The majority of pesticides used in cantaloupe production are ground applied.
- Cantaloupes are produced across the state of Tennessee, but the majority is planted in the Western and East area of the state. In 2001, 25 percent of Tennessee's cantaloupe farms and 50 percent of the cantaloupe acreage was located in East Tennessee (Jefferson, Hawkins, Greene and Washington counties). Western Tennessee (Henderson and adjacent counties) accounted for 25 percent of the state's cantaloupe producing farms. The remainder of cantaloupe production was distributed throughout the state.
- For more information concerning Tennessee cantaloupe production see: http://www.pmcenters.org/Southern/

Squash Production

- Summer squash (*Cucurbita pepo*) production in Tennessee during 2002 includes both fresh market and processed squash. Tennessee was ranked 12 of 12 states producing squash, harvesting approximately 900 acres during 2002.

- The Tennessee Department of Agriculture Statistics Service reported that acreage averaged approximately 9,400 lbs of squash per acre, valued at $25.10 per cwt. The 2002 crop was valued at $2,136,000 to Tennessee's economy. Tennessee produces just above 1.5 % of squash produced in the U.S.

- State Extension Specialists believe that acreage reported by the Tennessee Department of Agriculture is short by 600 acres and the 2002 value of squash was under estimated. State Extension Specialists believe that 2002 production consisted of 900 acres for fresh market and 600 acres for processing. They believe the value of squash produced during 2002 should have been estimated at $2.8 million dollars.

- For more information concerning Tennessee squash production see: http://www.pmcenters.org/Southern/

Watermelon Production

- Watermelon (*Citrullus lanatus*) production in Tennessee during 2002 was approximately 750 acres harvested acres. Yields averaged approximately 2,000 melons per acre.

- The average wholesale price was $0.06 to 0.10 per pound. Assuming an average melon was 20 lbs in weight and a producer received approximately $0.08 per lb., the value would be $1.60 per melon. Wholesale prices ranged from $1.50 to $2.00 per melon during 2002.

- Watermelon production is valued at approximately $2.4 million dollars for Tennessee's economy.

- Cost of production varies depending on production method selected. Direct seeded production costs approximately $2,500 per acre and transplanted plants would cost around $4,000 per acre.

- Tennessee is not national ranked for watermelon production. However, Tennessee produces approximately 0.5% of watermelons produced in the US.

Cucumber Production

- The 2002 cucumber (*Cucumis sativus*) production information for Tennessee includes acreage for both slicers and pickles.

- The harvested acreage was between 250 and 300 acres, yielding an average of approximately 3.5 tons per acre. This acreage was valued at $220 per ton and total production value ranged from $192,500 to $231,000 to Tennessee's economy. Production costs average around $1,700 per acre.

- Tennessee is not nationally ranked for production of cucumbers.

- Tennessee produces approximately 0.5 % of the total cucumbers grown in the US.

Critical Pest Information:

There are several insects that are observed and may cause damage in cucurbit production. Cucumber beetles, squash bugs and aphids are three of the major pests capable of causing severe problems in cucurbit production. Not only do these pests cause damage by feeding on plants, but they are also capable of transmitting viruses and wilts. Cucumber beetles are capable of spreading bacterial wilt. Squash bugs are capable of damaging vines and spreading a virus known as yellow vine disease. Aphids feed on succulent plants reducing photosynthates, therefore reducing yield. Aphids are also capable of spreading several viruses such as; cucumber mosaic virus, zucchini yellow mosaic virus, papaya ringspot and watermelon mosaic virus. If plants become infected early in the season, yields may be severely reduced. Also, weeds may serve as reservoirs for plant viruses.

Broad leaf weeds and yellow nutsedge are some of the most troublesome weeds in cucurbit production. More efficacious herbicides need to be added to the arsenal of currently available products. Weed control can be an important factor for control of viruses and other diseases.

There are several diseases which affect cucurbits. Bacterial wilt is one of the most common diseases observed in Tennessee cucurbit production. Effective products used to control cucumber beetles are needed to reduce losses from disease transmission by this pest. Downy mildew can be devastating to a crop, if not controlled. Products containing different chemistries should be rotated to achieve long term control of this pest. Yellow vine is another disease that has recently been spreading across the state. This disease is spread by the squash bug. Control of squash bugs will reduce spread of this disease. The disease is easily confused with other diseases and proper identification is critical to engage proper control tactics and reduce spread.

Critical Pesticide Information:

Pest control products are seriously needed for control of cucumber beetles and other pests in cucurbit production. Products containing thiomethoxam, imidacloprid and pyrometrozine are essential in controlling many pests observed in cucurbits. These products fit well in integrated pest management systems due to their selectiveness in controlling certain pests. However, if thiomethoxam or imidacloprid are sprayed near bloom they may have potentially harmful affects on honeybees. The availability of several pesticide chemistries are needed in cucurbit production to reduce the possibilities of developing strains that are resistant. Rotation of pesticide chemistries is one method to reduce development of resistance.

Short post harvest intervals listed on many pesticide labels are critical for cucurbits produced primarily for processing purposes. Pesticide residues may be detected if crops are harvested prior to PHI. Growers of vegetables for processing purposes must adhere to label directions. Occasionally, products that are less affective, often have shorter PHIs. Products with shorter PHIs are often utilized by producers for control of pests to reduce residues. Table 1 lists the re-entry and post harvest interval of commonly used pesticides in cucurbit production.

Integrated Pest Management Issues:

Pesticides that provide selective control rather than broad spectrum control fit well into an integrated pest management plan. Several products utilized in Tennessee cucurbit production have been incorporated into farm IPM programs. IPM programs are sometimes difficult to manage due to regulations of the Worker Protection Standards (WPS). In many instances fields should be scouted twice a week and due to REIs listed on pesticide labels entry may be limited. However, producers follow label recommendations to avoid possible poisoning, accumulation of pesticide residues and possible harmful effects to workers.

More research is needed in cucurbit production concerning economic thresholds. Economic thresholds have been determined for several pests of cucurbits, however these thresholds were developed for other areas and are often not valid for Tennessee. Tennessee researchers should develop economic thresholds for pests that infest cucurbits.

Resistance Management Issues:

Glyphosate resistance

- The weed marestail has developed a resistance to the herbicide glyphosate, the active ingredient in Roundup and several other commercial weed killers. This has been observed in several counties in Western Tennessee. Marestail, which is also known as horseweed, is an annual weed that grows up to 6 feet tall and is commonly found in undisturbed no-till or fallow fields. Resistant weeds have appeared in fields that have been planted exclusively in herbicide-resistant soybeans. A major concern is this weed grows tall and its seeds are light and easily carried by wind. Worse yet, if the weeds are resistant, they could spread even more quickly. Tennessee's recommendation to growers is to be diligent in rotating herbicide chemistries no matter what crop they are planting.

Spidermite resistance

- Products continuously used to control spider mites must be rotated to reduce possible resistance. Multiple foliar applications of products containing carbaryl, permethrin, pyrethrin or diazinon may lead to increased populations of spidermites. These products must be rotated with other chemistries to prevent resistance.

Consumer education issues:

Genetically modified Organisms (GMO) or transgenic crops are becoming more important in agriculture. Crop specialists see GMO crops as a logical method of improving the quality of products as well as protecting the environment by reducing chemical inputs. Growers are becoming more familiar with GMOs and are utilizing these pest management tools in cotton, corn and soybean production. Consumer acceptance is

the major factor keeping vegetable producers from using GMOs. With proper educational programs, consumers may soon become more knowledgeable of the science behind the product. With knowledge, fear is reduced and hopefully acceptance will soon follow. Several transgenic varieties are being developed in other states with virus resistance.

Pest Management Strategic Plan
Cucurbit Pests

Insect and Mite Pests:

- Due to the nature of insect and mite pests, fields must be observed frequently to reduce damage due to infestation. Spraying pesticides on a regular schedule increases production costs as well as pollutes the environment. Growers are continually adapting and utilizing scouting and following recommended control practices stressed by county extension personnel. Extension plays an important role in relaying best management practices to growers. Re-entry intervals (REIs) and pre-harvest intervals (PHIs) are becoming more important due to the restrictions and guidelines set by the Environmental Protection Agency (EPA) and local regulatory officials. Table 1 lists the re-entry interval, and post harvest intervals of commonly used insecticides. Tables 3 and 4 lists alternative pest management tools available to growers.

- Several of the new chemistries of pesticides being evaluated in the Interregional Project #4 (IR-4) are specie specific rather than broad spectrum as past developed insecticide/miticides. Table 2 lists the relative effectiveness of insecticides, miticides and other pest management tools available for use in cucurbit production. Products being investigated by IR-4 provide superior control and should be investigated for use in cucurbit production.

Aphids:

Aphids infest all cucurbits and can become a severe pest if not controlled during early infestations. Due to the nature of aphids and their ability to rapidly reproduce, pesticide resistance may occur. Rotation of active ingredients used to control this pest is recommended. Damage may occur soon after plants have been set or emerged. Aphids pierce the stems and leaves of plants and feed on plant sap reducing photosynthates within the plant. Honey dew is a waste product of aphids which appears on leaf surfaces during heavy infestations. Honey dew soon becomes covered with a saprophytic fungus known as sooty mold. The presence of sooty mold reduces photosynthesis of the plant therefore reducing plant vigor and reducing fruit size. Aphids may also serve as reservoirs of many viruses which may affect yields more than direct feeding by aphids themselves. Aphids may be observed feeding at planting and thorough out the season. Aphid control is most critical during early season to reduce aphid populations and reduce spread of viruses.

<u>OPs available for aphid control</u>

All organophoshate insecticides are subject to resistance management. These products should be rotated with non-OPs when making more than two consecutive applications per crop per season.

- Diazinon (diazinon): no longer available for use in squash and cucumber production due to manufacturer changes in labeling. Diazinon does provide fair

control of this and other pests in cucurbit production. This product has a 24 hour re-entry interval (REI) and a 7 day pre-harvest interval (PHI).

- Dimethoate (dimethoate, Cygon): provides good control of aphids. It is not recommended for use in cucumber, pumpkin or squash. This product has a 48 hour REI and a 3-day PHI.
- Naled (Dibrom): provides good control of aphids. Dibrom is not recommended for watermelons. Depending on the formulation of Naled, it has both 48 and 72 hour REIs listed on the label. REI depends on application. It also has a 1 day PHI.
- Malathion (malathion): provides fair control of aphids. Malathion is no longer recommended for use in cantaloupe, pumpkins, winter squash or watermelons. Malathion has 12 hr REI and a 3 day PHI.

Carbamate insecticides available for aphid control

- Methomyl (Lannate): provides fair control of aphids. Is not recommended for use in pumpkin or winter squash production. Methomyl has a 48 hour REI and a 1-3 day PHI depending on formulation used.
- Oxamyl (Vydate): provides fair control of aphids and aids in the control of nematodes. Oxamyl is a restricted use pesticide and is highly toxic. Oxamyl has a 48 hour REI and 1-day PHI. Other products are normally selected for use due to their greater effectiveness.

Other Insecticides available for aphid control

- Thiomethoxam (Platinum, Actara): recently registered products have excellent control of aphids with a long residual. These have a 12 hour REI and 0-day PHI for Actara and 30-day PHI for Platinum. Selective for aphids and flea beetles. Normally, safe on beneficials. Foliar applications should not be made just prior to bloom to reduce harmful effects to honeybees. Soil treatment is extremely expensive.
- Pymetrozine (Fullfill): recently registered and provides excellent control of aphids, and has a long residual. This product has a 12 hour REI and a 14-day PHI. Easy on beneficials.
- Imidacloprid (Admire, Provado): excellent control with long residual. Has a 12 hour REI and a 0-day PHI for Provado and 21-day PHI for Admire. Selective for aphids, slight control of flea beetles. Foliar applications should not be made just prior to bloom to reduce harmful effects to honeybees. Safe on beneficials. Soil treatment is extremely expensive.
- Bifenthrin (Capture): provides good control of aphids. Recommended for use in all cucurbits. Continuous use may result in mite outbreaks. 24 hours EIA and 3-day PHI.
- Endosulfan (Thiodan): provides good control of aphids. Recommended for use on all cucurbits. 24 hour REI and a 2-day PHI.

Insecticidal soap and oil

- Insecticidal soap (M-Pede): fair control, no residual therefore must be repeated often. Frequent repeated sprays are needed for control, which increases production costs. This product has a 4 hour REI and a 0-day PHI.

- Insecticidal oil (Saf-t-cid oil): fair control, must be reapplied on a frequent schedule for control to be maintained. Rarely used in commercial production. 4 hour REI and a 0-day PHI.

Non-chemical pest management methods available for use

- Lady beetles, lacewings, midges, parasitic wasps and stink bug predators. These provide slight control of aphids. Not used in commercial production. Cost of these beneficials outweighs the benefits.
- Foliar applications of water may aid in control of this pest, however may provide an environment conducive for disease development. Not used in commercial production.

Unregistered pest management tools

- Acetamiprid: good control in IR-4 preliminary tests
- Canola oil: no data, has not been tested
- Cinnamaldehyde: fair control in IR-4 preliminary tests
- Fenpropathrin: good control in IR-4 preliminary tests, is registered in other commodities
- Flonicamid: no data
- Pyriproxyfen: fair control in IR-4 preliminary tests
- Thiacloprid: fair control in IR-4 preliminary tests
- Tolfepyrad: no data

"TO DO" list for Aphids:

Research:

- Resistant varieties or non-attractive varieties
- Determine what species is currently infesting the cucurbits grown in Tennessee

Regulatory:

- Expedite labeling of seed treatments of imidacloprid and thiomethoxam

Education/Training:

- Importance of scouting regularly
- Increase knowledge of viruses spread by aphids

Armyworms

There are several types of armyworms that have been observed in cucurbit production. These include; yellowstriped armyworm, (*Spodoptera ornithogalli*), southern armyworm (*Spodoptera eridania*), fall armyworm (*Spodoptera frugiperda*), and beet armyworm (*Spodoptera exigua*). Larvae of this pest cause damage by feeding on foliage. Depending on which armyworm occurs within the field, infestation may be observed from early to late season.

OPs available for use

- Naled (Dibrom): provides good control against armyworms. Not recommended for use in watermelon production. 48-72 hour REI depending on rate and 1-day PHI.

Carbamate insecticides available for use

- Methomyl (Lannate): provides good control against armyworms. Not recommended for use in pumpkin or winter squash production. 48 hour REI and 1-3 days PHI depending on rate used.

Non-OPs and non-carbamate insecticides available for use

- Spinosad (SpinTor): provides good control against armyworms. 4 hours REI and 3 day PHI.
- *Bacillus thuringiensis* (various): provides fair control against armyworms. 4 hour REI and 0-day PHI.

Non-chemical pest management methods available for use

- Planting early maturing varieties may help with some armyworm species.
- Pheromone use for disruption may aid in control of various species.

Unregistered pest management tools

- Methoxyfenozide: may provide good control of this pest according to IR-4 preliminary testing.
- Zeta-cypermethrin: may provide fair control of this pest according to IR-4 preliminary testing. Labeled for use in other crops.
- Azadrichitin: may provide fair control of cutworms, labeled in other crops. Labeled for use in other crops.
- Bistrifluron: may provide fair control according to preliminary research.
- Canola oil: no data however, may provide fair control
- Chromafenozide: may provide control according to IR-4 profiles.
- Deltamethrin: may provide control according to IR-4 profiles.
- Emamectin benzoate: may provide fair control according to preliminary research
- Fenpropathrin: may provide good control according to preliminary research. Continuous use may result in mite outbreaks.
- Inodoxacarb: may provide good control according to preliminary research
- Lufenuron: may provide fair control according to preliminary research
- Methoxyfenozide: may provide good control according to preliminary research
- Thiacloprid: may provide fair control according to preliminary research
- Tolfepyrad: may provide control according to IR-4 profiles.

"TO DO" list for Armyworms:

Research:

- Determine economic thresholds
- Determine effectiveness of phermones

Regulatory:

- Expedite registration of zeta-cypermethrin and methoxyfenozide

Education/Training:

- Stress the importance of scouting regularly
- Provide training for proper identification of the species of cutworm

Cabbage looper (*Trichoplusia ni*)

Cabbage loopers are primarily leaf feeders and occasionally they may feed on the surface of fruit, leaving fruit unmarketable. They are more often observed in cantaloupes, cucumbers, squash and watermelons. These pests are observed in early spring migrating as adults into the area laying eggs on host plants.

OPs available for use

- Naled (Dibrom): provides good control. High acute toxicity "Danger" is listed on the label. Not recommended for watermelon production. 48 – 72 hours REI depending on rate used and a 1-day PHI.

Carbamate insecticides available for use

- Methomyl (Lannate): provides good control. Not recommended for pumpkin or winter squash production. 48 hour REI and a 1 – 3 days PHI depending on rate used.

Non-OPs and non-carbamates available for use

- Bacillus thuringiensis (various): Provides good control if product is fresh and proper placement is practiced. Product must be fresh (within 10 months manufacture) to be effective. 4 hour REI and a 0-day PHI.
- Esfenvalerate (Asana): Provides excellent control. Continuous use may result in mite outbreaks. 12 hour REI and a 3-day PHI.
- Permethrin (Ambush, Pounce): provides excellent control. Continuous use may result in mite outbreaks. 12 hour REI and a 0-day PHI.
- Spinosad (SpinTor): provides good control. Fairly safe to use. 4 hours REI and a 3-day PHI.
- Insecticidal oil: provides poor control. 4 hr REI and 0-day PHI.
- Insecticidal soap: provides poor to fair control. 4 hour REI and a 0-day PHI.
- Neem: provides fair control, however expensive. 4 hour REI and a 0-day PHI.

Non-chemical pest management methods available for use

- Trichogramma wasps, Encyrtidae, lacewing, Pteromalidae and *Bacillus thuringiensis* kurtsaki.
- Hand picking may aid in reducing yield losses. This is not economically feasible in commercial production.
- Nuclear polyhedrosis virus (NPV). Row covers used in early season may prevent adults from laying eggs in early season. This product is difficult to find for commercial growers.

Unregistered pest management tools

- Emamectin benzoate: no data available

"TO DO" list for Cabbage looper:

Research:

- Determine economic thresholds
- Determine effectiveness of pheromone traps or disrupting pheromones
- Evaluate emamectin benzoate

- Evaluate insecticidal oils for control of this pest

Regulatory:

- Expedite registration of zeta-cypermethrin and methoxyfenozide

Education/Training:

- Stress the importance of scouting regularly

Corn earworm (*Helicoverpa zea*)

Feeds on foliage and fruit. They overwinter in soil as pupae and adults emerge in early May. Adults may be observed from May until the end of season.

OPs available for use

- Malathion (various): provides fair control of this pest. May no longer be available on many cucurbits. Recommended for cucumber and summer squash production. 12 hours REI and 3-day PHI.

Carbamate insecticides available for use

- Carbaryl (Sevin): provides fair control of this pest. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.

Non-OPs and non-carbamates available for use

- Esfenvalerate (Asana): provides good control of this pest. Continuous use may result in mite outbreaks. 12 hour REI and 3-day PHI.
- Permethrin: (Ambush, Pounce): provides good control of this pest. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.

Pesticides considered to be organic

- *Bacillus thuringiensis* (various): provides fair control of this pest. 4 hour REI and 0-day PHI.
- Insecticidal soap: provides fair control, must be re-applied within short intervals. 4 hour REI and 0-day PHI.
- Insecticidal oil: provides fair control. 4 hour REI and 0-day PHI.
- Neem: provides fair to good control. 4 hour REI and 0-day PHI.
- Rotenone: provides fair control

Non-chemical pest management methods available for use

- Early planting may reduce infestations.

Unregistered pest management tools

- Emamectin benzoate: no available data, may provide control according to IR-4 research.

"TO DO" list for Corn earworm:

Research:

- Determine economic thresholds
- Determine effectiveness of pheromone traps
- Evaluate new insecticidal oils for control of this pest

Regulatory:

- Expedite registration of emamectin benzoate, if found to be effective

Education/Training:

- Importance of scouting regularly
- Proper identification

Cucumber beetle (*Diabrotica undecimpunctata, Acalymma vittata***)**

As larvae, cucumber beetles feed on roots of host plants causing minimal injury, however, injury allows entry for soilborne diseases. Second generation larvae may be found feeding on developing fruit if fruit is lying on moist ground. Adults feed on foliage and developing fruits and are vectors of bacterial wilt. Adults usually leave overwintering sites by late March, however may be seen during overly warm periods in January - February.

OP insecticides available for use

- Azinphos-methyl (Guthion): labeled for cucumbers only, very effective on cucumber beetles. 48 hour REI and 7-day PHI for all cucurbits except cucumbers which have a 4-day PHI.

Carbamate insecticides available for use

- Carbaryl (Sevin): Provides good control for cucumber beetles. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.
- Methomyl (Lannate): provides fair control. Not recommended for use in pumpkin or winter squash production. 48 hour REI and 1-3 days PHI depending on rate used.
- N-Methyl carbamate / carbaryl bait (Adios): provides good control.

Non-OPs and non-carbamates available for use

- Bifenthrin (Capture): provides good control. Continuous use may result in mite outbreaks. 24 hour REI and 3-day PHI.
- Imidacloprid (Admire, Provado): provides excellent control. 12 hour REI and 0 day PHI for Provado and 21-day PHI for Admire. This product is extremely expensive.
- Permethrin (Ambush, Pounce): provides good control. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.
- Esfenvalerate (Asana): provides excellent control. Continuous use may result in mite outbreaks. 12 hour REI and 3-day PHI.
- Endosulfan (Thiodan): provides good control. 24 hour REI and 2-day PHI.
- Pyrethrins (various): provides fair control. 12 hour REI and 0-day PHI.

Products considered as organic

- Insecticidal soap: provides poor control of this pest. 4 hour REI and 0-day PHI.
- Neem: provides fair control. 4 hour REI and 0-day PHI.

Non-chemical pest management methods available for use

- Soldier beetle, braconid wasps, and parasitic nematodes

Unregistered pest management tools

- Kaolin: may provide control according to IR-4's website.

"TO DO" list for Cucumber beetles:
Research

- Determine economic thresholds for adults
- Determine economic thresholds for root feeding larvae
- Develop resistant varieties
- Determine what other sources that may harbor the bacterial wilt and eliminate spread

Regulatory

- Expedite labels for seed treatments using imidacloprid and thiomethoxam

Education

- Scouting is a must for this pest
- On-farm demonstrations of tolerant cultivars

Flea beetle (*Systena blanda***)**

Flea beetles feed on newly developed leaves. They riddle the foliage with holes in which the edges turn brown. Older leaves may withstand heavy infestations, however younger leaves may die. Larvae of the flea beetle feed on roots of susceptible plants. Adults normally overwinter in and around surrounding areas and in old crop residue. They may act as vectors of several plant diseases.

<u>OP insecticides available for use</u>

- Oxamyl (Vydate): provides fair control. 48 hour REI and 1-day PHI.

<u>Carbamate insecticides available for use</u>

- Carbaryl (Sevin): provides fair control. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.

<u>Non-OPs or non-carbamates available for use</u>

- Bifenthrin (Capture): provides excellent control. Continuous use may result in mite outbreaks. 24 hour REI and 3-day PHI.
- Imidacloprid (Admire, Provado) provides poor to fair control. 12 hour REI and 0-day PHI for Provado and 21-day PHI for Admire. Soil applications of this product can be extremely expensive.
- Thiomethoxam (Platinum / Actara) provides good control. 12 hour REI and 30 day PHI for Platinum and 0-day PHI for Actara. Soil applications of this product can be extremely expensive.
- Pyrethrin (various): provides fair control. 12 hour REI and 0-day PHI.

<u>Non-chemical pest management methods available for use</u>

- Braconid wasps, and parasitic nematodes
- Delaying planting favors establishment of these pests in other areas.

<u>Unregistered pest management tools</u>

- Kaolin: may provide control according to IR-4's website.

"TO DO" list for Flea beetles:
Research

- Determine economic thresholds

- Resistant varieties
- Review effectiveness of planting dates
- Identify primary flea beetles occurring in Tennessee cucurbit production

Regulatory

- Labeling of seed treatments with the active ingredient thiomethoxam

Education

- Scouting for this pest should be emphasized

Cutworms, Black cutworm (*Agrotis ipsilon*), spotted cutworm (*Amathes c-nigrum*), Varigated cutworm (*Peridroma saucia*)

More often occurs in cucumber, watermelon, squash and pumpkin production. Larvae cut main stems of plants soon after plants emerge or after transplanting. Usually feeding is observed on edges of fields near weedy areas. Cut worms are early season pests, observed at planting or soon after.

OPs available for use

- Diazinon (various): provides good control and is fairly inexpensive. 24 hours REI and 7-day PHI.
- Dimethoate (Cygon): provide good control of cutworms. 48 hour REI and 3-day PHI.
- Azinophos-methyl (Guthion): provides excellent control of cutworms.

Carbamate insecticides available for use

- Methomyl (Lannate): Provides good control of cutworms. Not recommended for use in pumpkin or winter squash production. 48 hour REI and 1 – 3 day PHI depending on rate used.
- Carbaryl (Sevin, Adios): provides good to fair control of cutworms. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.

Non-OP and non-carbamate insecticides available for use

- Bifenthrin (Capture): provides good control of cutworms. Continuous use may result in mite outbreaks. 24 hour REI and 3-day PHI.
- Esfenvalerate (Asana): Provides excellent control of cutworms. Continuous use may result in mite outbreaks. 12 hour REI and 3-day PHI.
- Permethrin (Ambush): Provides excellent control of cutworms. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.
- Bacillus thuringiensis (various): Provides fair to good control depending on application coverage. 4 hour REI and 0-day PHI.
- Spinosad (Spintor): Provides excellent control of cutworms. 4 hour REI and 3-day PHI.

Non-chemical pest management methods available for use

- Protective collars around main stems, which is not cost effective
- Cultivation provides fair to poor control of cutworms. Plastic or reflective mulches provide fair control of cutworms.

Unregistered pest management tools

- Zeta-cypermethrin: may provide good control of cutworms, labeled in other crops
- Azadrichitin: may provide fair control of cutworms, labeled in other crops
- Bistrifluron: may provide fair control according to preliminary research.
- Canola oil: no data however, may provide fair control
- Chromafenozide: may provide control according to IR-4 profiles.
- Deltamethrin: may provide control according to IR-4 profiles.
- Emamectin benzoate: may provide fair control according to preliminary research
- Fenpropathrin: may provide good control according to preliminary research. Continuous use may result in mite outbreaks.
- Inodoxacarb: may provide good control according to preliminary research
- Lufenuron: may provide fair control according to preliminary research
- Methoxyfenozide: may provide good control according to preliminary research
- Thiacloprid: may provide fair control according to preliminary research
- Tolfepyrad: may provide control according to IR-4 profiles.

"TO DO" list for Cutworms:

Research

- Determine which species are most prevalent in varieties currently grown in Tennessee.
- Determine efficacy of applying insecticides on the perimeter of the field
- Establish economic thresholds
- Test unregistered products and determine efficacy

Regulatory

- Expedite state registrations on Zeta-cypermethrin, Deltamethrin and Fenpropathrin. These products are already registered for other uses.

Education

- On-farm demonstrations using *Bacillus thuringiensis* for pest control.

Leafhoppers (*Empoasca fabae* and others)

Leafhoppers feed on many different host plants including beans and Irish potatoes. Saliva injected by potato leafhopper into Irish potato plants causes a deadening and upcurling of the tissues known as hopperburn. Sap feeding on beans causes leaves to be stunted, crinkled, and curled downward. Many adult leafhoppers are pale green, wedge-shaped, and about 1/8 inch long. Eggs inserted into plant tissues produce green nymphs that resemble adults but are smaller and wingless. Adults and nymphs suck plant juices. Potato leafhoppers are a problem primarily in western Tennessee. At least three generations of this pest occur each year. The potato leafhopper is one of several leafhopper species found on vegetables.

OP insecticides available for use

- Dimethoate (Cygon): provides good control. Only recommended for use in cantaloupe and watermelon production. 48 hours REI and 3-day PHI.

- Naled (Dibrom): provides good control. Not recommended for use in watermelon production. 48-72 hour REI depending on rate used and 1-day PHI.
- Azinphos-methyl (Guthion): provides good control. 48 hour REI and 7-day PHI on all cucurbits except for cucumbers which have a 4-day PHI.

Carbamate insecticides available for use

- Carbaryl (Sevin): provides good control. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.

Non-OP and non-carbamate insecticides available for use

- Abamectin (Agri-Mek): provides good control. 12 hour REI and 7-day PHI.
- Bifenthrin (Capture): provides good control. Continuous use may result in mite outbreaks. 24 hour REI and 3-day PHI.
- Cyromazine (Trigard): provides good control. 12 hour REI and 0-day PHI.
- Spinosad (SpinTor): provides good control. 4 hour REI and 3-day PHI.
- Insecticidal soap: provides slight control of this pest. 4 hour REI and 0-day PHI.
- Neem: provides fair control and is rarely used due to expense vs. control. 4 hour REI and 0-day PHI.
- Rotenone: rarely used due to efficacy

Non-chemical pest management methods available for use

- Lacewing or flower bug. Purchasing quantities of these beneficial insects is not economically feasible for commercial purposes.

Unregistered pest management tools

- Buprofezin: may provide fair control according to University research.
- Canola oil: no data available
- Flonicamid: no data available
- Thiacloprid: may only provide slight control according to University research.
- Thiamethoxam: may only provide slight control according to University research.

"TO DO" list for Leafhoppers:

Research

- Determine economic thresholds
- Determine what species infests Tennessee cucurbit production areas
- Determine if resistance is present in cultivars currently used.
- Determine populations of beneficial insects needed to receive adequate control

Education

- Provide training for proper identification of pest

Leafminers (*Liriomyza sativae* and others)

Leafminers infest a wide variety of plants. These insects mine areas in leaves leaving an S-shaped pattern. Infested leaves are generally where one would find these pests. Damage caused by these pests reduces photosynthetic efficiency of the plant and also makes the plant more susceptible to bacterial and fungal pathogens. Females insert eggs into leaf tissue from the underside of the leaf. Soon after hatch, young larvae begin feeding by mining the leaf. A new generation is produced every 23 days. Approximately 5 generations may be produced per year. Economical losses rarely

occur in cucurbit production.

OPs insecticides available for use

- Diazinon (Diazinon): provides good control. 24 hour REI and 7-day PHI.
- Dimethoate (various): provides good control. Only recommended in cantaloupe and watermelon production. 48 hour REI and 3-day PHI.
- Naled (Dibrom): provides good control. Not recommended in watermelon production. 48 or 72 hour REI depending on rate used and 1-day PHI.
- Azinphos-methyl (Guthion): provides good control. 48 hour REI and 7-day PHI on all cucurbits except cucumbers which have a 4-day PHI.

Carbamate insecticides available for use

- Carbaryl (Sevin): provides fair control. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.

Non-Ops and non-carbamates available for use

- Abamectin (Agri-Mek): provides excellent control. 12 hour REI and 7-day PHI.
- Cyromazine (Trigard): provides excellent control. 12 hour REI and 0-day PHI.
- Spinosad (SpinTor): provides excellent control. 4 hour REI and 3-day PHI.
- Neem: provides fair control, however expensive. 4 hour REI and 0-day PHI.

Non-chemical pest management methods available for use

- Eulophidae, lacewing and apply materials to attract parasitic wasps. These beneficials are extremely expensive for use in commercial production.

Unregistered pest management tools

- Azadrichitin: may provide fair control according to preliminary research.
- Canola oil: no data
- Clothianidin: no data
- Cyromazine: no data
- Emamectin benzoate: no data
- Methoxyfenozide: may provide good control according to preliminary research
- Thiacloprid: may only provide slight control according to preliminary testing conducted on this product.

"TO DO" list for Leafminers:

Research

- Determine resistance levels in current varieties used
- Determine economic thresholds

Education

- Proper identification of damage and when to spray

Pickleworms *(Diaphania nitidalis)* and melonworms *(Diaphania hyalinata)*

These two caterpillars infest only cucurbits. The pickleworm prefers summer squash, however it may severely damage other cucurbits. The melonworm prefers muskmelon, cucumber, squash and pumpkin. Pickleworms normally bore into sides of fruits and continue to feed there causing internal damage and producing soft excrement. Both young and old fruits may be attacked, however they prefer young fruits before the rind has hardened. As the infestation increases, young fruits and

flowers are damaged. Growing vines are sometimes riddled with holes and cease to grow. These pests normally migrant from warmer areas into Tennessee. Pickleworms and melonworms generally do not overwinter in Tennessee, however, if sanitation is not practiced in greenhouses, they may infest areas sooner than normally observed. Generally, the pickleworm is observed in mid to late season (July) in Tennessee. Pickleworm can complete a life cycle in approximately 30 days, and up to four generations per season have been documented in Georgia. Although pickleworm larvae often attack cucurbit fruit, cantaloupe is not a preferred host. However, pickleworm larvae sometimes burrow into the melon but more often feed on the surface, causing "rindworm" damage.

OP insecticides available for use

- Naled (Dibrom): provides fair control. Not recommended for watermelon production. 48 or 72 hour REI depending on rate used and 1-day PHI.

Carbamate insecticides available for use

- Carbaryl (Sevin): provides fair control. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.
- Methomyl (Lannate): provides good control. Not recommended for use in pumpkin or winter squash production. 48 hour REI and 1 – 3 day PHI depending on rate used.

Non-OP and non-carbamate insecticides available for use

- Bifenthrin (Capture): provides good control. Continuous use may result in mite outbreaks. 24 hour REI and 3-day PHI.
- Endosulfan (Thiodan): provides good control. 24 hour REI and 2-day PHI.
- Esfenvalerate (Asana): provides excellent control. Continuous use may result in mite outbreaks. 12 hour REI and 3-day PHI.
- Permethrin (Ambush, Pounce): provides good control. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.
- Spinosad (SpinTor): provides excellent control. 4 hour REI and 3-day PHI.

Non-chemical pest management methods available for use

- Eucoilidae, and parasitic nematodes, some tolerant cultivars are available.

Unregistered pest management tools

- None listed

"TO DO" list for Pickleworms and melonworms:

Research

- Determine tolerance in cultivars currently used
- Determine economic thresholds
- Determine best time to spray

Regulatory

Education

- On-farm demonstrations of pesticide efficacy

Seedcorn maggot

Seedcorn maggots feed on newly planted seeds usually leaving the entire contents of the seed empty. This feeding results in poor or reduced germination. Occasionally seedcorn maggots will tunnel into seedling stems. Primary damage occurs a few days after seeding. Using transplants can reduce losses from this pest.

OP insecticides available for use

- Diazinon (Diazinon): product is very effective, must be applied as a furrow application. 24 hour REI and 7-day PHI.

Non-OP and non-carbamate insecticides available for use

- Imidacloprid (Admire): may be effect however no data available. 12 hour REI and 21 day PHI. Soil application is extremely expensive.
- Thiomethoxam (Platinum): may be effect, however no data available. 12 hour REI and 30-day PHI. Soil application is extremely expensive.

Non-chemical pest management methods available for use

- Cultivation may aid in control.
- An early planting date may aid in control and cultivation after harvest and prior to planting will aid in control.

Unregistered pest management tools

- None listed

"TO DO" list for Seedcorn maggot:

Research

- Determine if any predators or parasites present
- Compare tillage vs. no-till with infestations

Regulatory

- Expedite regulations to allow seed treatments with imidacloprid and/or thimethoxam

Education

- Training for proper identification of pest problem

Spider mite (*Tetranychus urticae*)

Spider mites pierce the epidermis and extract sap from the undersides of leaves. The surface of infested foliage soon becomes whitish to bronze in appearance. If heavy infestations occur, the undersides of leaves often have a silken webbing. Spider mite larvae initiate the damage observed on leaves. Development of spider mites is extremely rapid during hot dry weather with many generations being produced through the summer months. Spider mites may be spread by females migrating into other portions of the field or by wind, man, and/or mammals. Spider mites are most often observed from mid to late season and are more severe during drought conditions.

OPs available for use

- Naled (Dibrom): provides good control. Not recommended in watermelon production. 48 hour or 72 hour REI depending on rate used and 1-day PHI.

- Dimethoate (Cygon): provides good control. Only recommended in cantaloupe and watermelon production. 48 hour REI and 3-day PHI.

Non-OP and non-carbamate insecticides available for use

- Abamectin (Agri-Mek): provides excellent control. 12 hour REI and 7-day PHI.
- Bifenthrin (Capture): provides good control. Continuous use may result in mite outbreaks. 24 hour REI and 3-day PHI.
- Dicofol (Kelthane): provides good control. Continuous use may result in mite outbreaks. 48 hour REI and 2-day PHI.
- Fenpropathrin (Danitol): provides good control. Continuous use may result in mite outbreaks. 24 hour REI and 7-day PHI.

Non-chemical pest management methods available for use

- Lady beetles – expensive, movement of beneficials, not used
- Predatory mites – expensive, not used in commercial production
- Lace wings – expensive, not used in commercial production

Unregistered pest management tools

- Bifenazate: may provide good control according to IR-4 preliminary data
- Cinnamaldehyde: may provide fair control according to IR-4 preliminary data
- Etoxazole: may provide fair control according to IR-4 preliminary data
- Flufenzin: may provide fair control according to IR-4 preliminary data
- Kaolin: may provide slight control according to IR-4 preliminary data
- Lufeuron: may provide slight control according to IR-4 preliminary data
- *Metarhizium anisopliae*: may provide fair control according to IR-4 preliminary data

"TO DO" list for Spider mites:

Research

- Dry days vs. probability of infestation

Regulatory

Education

- Emphasize scouting during hot dry periods
- Emphasize mowing weedy areas early in the season to prevent migration of this pest

Squash bug (*Anasa tristis*)

Squash bugs are a key pest of nearly 100% of the fields each year and cause more losses than all other insect pests. Adult squash bugs are large and suck sap from vines, leaves, stems, and the base of the plant. Squash bug causes wilting of vines, reduced yields, poor quality, and possibly death. Squash bugs are also responsible for the spread of yellow vine a bacterial disease.

Carbamate insecticides available for use

- Carbaryl (Sevin): provides good control. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.

- Bifenthrin (Capture): provides excellent control. Continuous use may result in mite outbreaks. 24 hour REI and 3-day PHI.

Non-OP and Non-carbamate insecticides available for use

- Esfenvalerate (Asana): provides excellent control. Continuous use may result in mite outbreaks. 12 hour REI and 3-day PHI.
- Permethrin (Ambush / Pounce): provides good control. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.
- Pyrethrin (various): provides fair control. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.
- Insecticidal soap: may only provide slight control. 4 hour REI and 0-day PHI.
- Insecticidal oil: provides fair control. 4 hour REI and 0-day PHI.

Non-chemical pest management methods available for use

- Some tolerant cultivars are available; these may not be acceptable to growers
- Cultivation – increases erosion
- Sanitation - Removal of past crop debris where overwintering adults are may not always be practiced due to time restrictions other critical items must be completed.
- Hand picking adults, labor intensive and costly.
- Early planting may aid in control of yellow vine. Early planting may be susceptible to late frosts. Cantaloupe yield may be reduced by temperatures lower than 50F.

Unregistered pest management tools

- Cinnamaldehyde: may be effective according to IR-4's preliminary data

"TO DO" list for Squash bug:

Research

- Resistant varieties
- Economic threshold
- Evaluate the efficacy of the removal of previous years crop residue on reducing pest populations

Regulatory

Education

- Training for proper identification and scouting prior to spraying
- Stressing cultivation and sanitation
- Stress early planting to avoid yellow vine disease

Squash vine borer (*Melittia satyriniformis*)

Primarily squash and gourds are the primary hosts of squash vine borers, however cucumbers and melons are often infested. Squash vine borers are the larvae of a clearwinged moth. Their size, shape and flying habits are somewhat similar to wasps for which they are often mistaken. Squash vine borers overwinter as larvae or pupae in cocoons buried in the soil. Adult moths emerge in the late spring (normally mid-June) at a time coinciding with the establishment of pumpkins. Eggs are deposited

singly on the underside of the vines and are often concentrated at the base of the plants. Larvae bore into the stems where they tunnel and feed. Matured larvae exit stems and then burrow into the soil, where most prepare their overwintering cocoons (there may be a partial second generation in depending upon yearly weather conditions).

OP available for use

- Malathion (various): provides fair control. Only recommended in cucumber and summer squash production. 12 hour REI and 3-day PHI.

Non-OP and non-carbamate insecticides

- Bifenthrin (Capture): provides excellent control. Continuous use may result in mite outbreaks. 24 hour REI and 3-day PHI.
- Endosulfan (Thiodan/Phaser): provides excellent control. 24 hour REI and 2-day PHI.
- Esfenvalerate (Asana): provides excellent control. Continuous use may result in mite outbreaks. 12 hour REI and 3-day PHI.
- Permethrin (Ambush / Pounce): provides excellent control. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.
- Pyrethrin (various): provides good control. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.

Non-chemical pest management methods available for use

- Some tolerant varieties are available
- Remove and destroy borer, if found in infested stems. This method is too time consuming for large scale control

Unregistered pest management tools

- None have been listed

"TO DO" list for Squash vine borer:

Research

- Develop tolerant or resistant varieties
- Determine or estimate economic thresholds

Regulatory

Education

- Importance of scouting, observing wilting plants
- Proper identification
- Importance of repeat insecticide applications

Thrips (*Frankliniella tritici*, and others**)**

Thrips rasp the tender parts of center leaves and or terminal buds with their sharp mouthparts and feed on escaping plant juices. Occasionally leaves develop a silvery blotched, scratched like appearance. Heavy infestation may cause leave to distort and curl upward. Infestations tend to delay plant growth and retard maturity.

OPs available for use

- Oxamyl (Vydate): provides good control. 48 hour REI and 1-day PHI.

- Naled (Dibrom): provides good control. Not recommended in watermelon production. 48 or 72 hour REI depending on rate and 1-day PHI.

Carbamate insecticides available for use

- Carbaryl (Sevin): provides fair control. Continuous use may result in mite outbreaks. 12 hour REI and 0-day PHI.
- Methomyl (Lannate): provides fair control. 48 hour REI and 1 – 3 day PHI depending on rate used.

Non-OP and non-carbamate insecticides available for use

- Spinosad (SpinTor): provides good control. 48 hour REI and 3-day PHI.
- Insecticidal soap: provides slight control. Expensive for the amount of control received. 4 hour REI and 0-day PHI.
- Insecticidal oil: provides fair control. Expensive for the amount of control received. 4 hour REI and 0-day PHI.

Non-chemical controls available for use

- Some tolerant cultivars are available
- Plastic reflective mulches

"TO DO" list for Thrips:

Research

- Determine what species is most frequent in Tennessee cucurbit production
- Determine effectiveness of mowing weedy field perimeters
- Review weather data to compare dry vs wet springs to gauge future infestation levels
- Evaluate effects of weekly overhead watering

Regulatory

Education

- Inform growers of damage that occurs due to infestations

Wireworm (*Conoderus falli* and others)

Wireworms chew ragged holes on the roots occasionally preventing germination, causing seedlings to wilt or stunting of growth.. Wireworms usually attack plants in mid-to-late season. Heavy infestation can make the plant more susceptible to other soil inhabiting pathogens. Wireworms can overwinter in Tennessee's climate. The wireworm is the larval form of the adult click beetle; however, the click beetle adult is not considered a pest.

OPs currently used

- Diazinon (various): applied to the soil, provides good control. 24 hour REI and 7-day PHI.
- Oxamyl (Vydate): applied to the soil, provides good control. 48 hour REI and 1-day PHI.

Non-OP and non-carbamate insecticides

- Imidacloprid (Admire): applied to the soil, provides fair control. 12 hour REI and 21-day PHI.

Non-chemical controls:

- Cultivation provides fair control
- Crop rotation provides good control

"TO DO" list for Wireworms:

Research:

- Resistance management research
- Develop resistant varieties
- Determine efficacy of newer chemistries
- Determine efficacy of biocontrols

Regulatory:

- Expedite registration of seed and transplant treatments with imidacloprid

Education / Training:

- Suggest rotation with other non-susceptible crops

Whiteflies (*Bemisia tabaci, B. argentifolii, Trialeurodes vaporariorum***)**

Whiteflies cause damage to cucurbits in various ways. Damage may occur due to direct feeding damage, by contamination with excrement (also known as honeydew), as vectors of several plant viruses and causing phytotoxic disorders. Whiteflies have needle-like stylets allowing them to feed on plant sap reducing photosynthates. Heavy infestations may cause premature defoliation and build up of honeydew which results in reduced photosynthesis due to build up of sooty mold growing on the honeydew. Whiteflies feed on the lower surface, making chemical control by conventional foliar application difficult. Monitoring should begin at the time of planting and continue throughout the season. Pesticide applications should be made at the first sign of whiteflies due their nature of rapid reproduction. Fields should be regularly scouted for possible infestations. There are several natural enemies, including predators, parasites and pathogens of whiteflies. Greenhouses can be a source of whiteflies.

OP insecticides currently available for use:

- Malathion: no longer recommended, provides poor to fair control. No longer labeled for use on most cucurbits. 12 hour REI and 3-day PHI.

Non-OP insecticides currently available for use:

- Endosulfan (Thiodan): provides excellent control. 24 hour REI and 2-day PHI.
- Imidacloprid (Admire / Provado): provides excellent control. 12 hour REI and 21 day PHI for Admire and 0-day PHI for Provado.
- Pymetrozine (Fulfill): provides excellent control. 12 hour REI and 14-day PHI.
- Insecticidal oil: provides slight control. 4 hour REI and 0-day PHI.

Non-chemical pest management methods available for use:

- Lace wings and *Encarsia formosa*

Unregistered pest management tools:

- Acetamiprid: according to IR-4's preliminary data, this product may provide good control
- Azadrichitin: according to IR-4's preliminary data, this product may perform poorly
- Buprofezin: according to IR-4's preliminary data, this product may perform poorly
- Canola oil: efficacy information needed
- Fenpropathrin: provides good control in other crops according to IR-4's data
- Lufenuron: according to IR-4's preliminary data, this product may perform poorly
- Pymetrozine: according to IR-4's preliminary data, this product may perform poorly
- Pyriproxyfen: according to IR-4's preliminary data, this product may provide good control
- Thiacloprid: according to IR-4's preliminary data, this product may perform poorly
- Thiamethoxam: according to IR-4's preliminary data, this product may perform poorly
- Tolfepyrad: no data on this product
- *Metarhizium anisopliae*: according to IR-4's preliminary data, this product may perform poorly

NOTES: efficacy has not been established for all these pesticides in cucurbit production, however information from research on other crops suggests possible efficacy against these pests.

"TO DO" list for Whiteflies:

Research:

- Resistance management research
- Develop resistant varieties
- Efficacy of newer chemistries
- Efficacy and application methods of biocontrols; *Beauvaria bassianna*

Regulatory:

- Expedite registration of seed treatments with imidacloprid or thiomethoxam

Education / Training:

- Monitoring or scouting are very essential for control. Emphasize these methods of control.
- Suggest using newly developed selective tools when they become available

DISEASES OF CUCURBITS

Disease pressure changes from year to year and field to field. Several materials are used for disease control in Tennessee. Table 5 indicates the relative effectiveness of disease-control products used in cucurbit production. Table 6 list the relative efficacy of controls used for disease control in cucurbit production. Table 7 lists several alternative pest management tools available for cucurbit production.

Downy mildew (*Pseudoperonospora cubensis*)

Downy mildew is one of the most important yet devastating diseases of cucurbits. This disease is severe during hot wet and humid conditions. The infection is generally confined to the leaves of infected plants. Occasionally, fruit and flowers may become infected. Heavy infections cause premature defoliation resulting in scalded fruit. If infections are slight to severe, fruit size can be affected.

Fungicides classified as B2 - Carcinogens available for use

- Mancozeb (Dithane DF): provides good control, inexpensive. 24 hour REI and 5-day PHI.
- Maneb (Maneb): provides good control. 24 hour REI and 5-day PHI.

Other Fungicides available for use

- Azoxystrobin (Quadris): provides fair control. Chlorothalonil (Bravo and others): provides excellent control. 4 hour REI and 1-day PHI.
- Fixed copper (Various): provides slight control, inexpensive. 12 hour REI and 0-day PHI.
- Fosetyl-AL (Aliette): provides fair control. 12 hour REI and 1-day PHI.
- Trifloxystrobin (Flint): provides slight control. 12 hour REI and 0-day PHI.
- Mefenoxam (Ridomil Gold): provides fair control, however must be combined with a protectant for effective control. Over use of this product may lead to resistance within the pathogen population. 48 hour REI and 0-day PHI.
- Pyraclostrobin (Cabrio): available for use in 2003. A strobulin fungicide. This product provides excellent control. 12 hour REI and 0-day PHI.
- Zoxium (Gavel): provides excellent control. Newly registered. Is a combination of zoxamide and mancozeb. Not labeled for pumpkin. 48 hour REI and 5-day PHI.

Notes: Strobulin fungicides should be rotated with non-strobulin fungicides to avoid build up of resistance within the population.

Non-chemical pest management methods available for use

- Some commercial cultivars of cucumber are available
- Increasing plant spacing
- Reducing canopy density
- Do not irrigate overhead

Unregistered pest management tools

- Acibenzolar: may provide control according to preliminary testing by IR-4.
- BAS516 may provide control good according to preliminary testing by IR-4.
- Benthiavalicarb may provide control according to preliminary testing by IR-4.
- Chitosan may provide control according to preliminary testing by IR-4.

- Cinnamaldehyde may provide control according to preliminary testing by IR-4.
- Dimethomorph: provides excellent control. Has a section 18 in NJ and NY.
- Cyazofamid may provide control according to preliminary testing by IR-4.
- Cyprodil / Fludioxonil may provide fair control according to preliminary testing by IR-4.
- Ethaboxam may provide control according to preliminary testing by IR-4.
- SYPL190 may provide control according to preliminary testing by IR-4.
- *Bacillus pumilus* strain 2808 may provide control according to preliminary testing by IR-4.
- *Bacillus subtilus* QST 713 may provide control according to preliminary testing by IR-4.
- Phosphonic acid: may provide control according to preliminary testing by IR-4.
- Potassium phosphate: may provide slight control according to preliminary testing by IR-4

"TO DO LIST for Downy Mildew"
Research

- Review effects of phosphonic acid, cinnamaldehyde and potassium phosphate
- Develop resistant varieties
- Review the Benefits of the Downy Mildew Forecast System for Tennessee production

Regulatory

Education

- On-farm demonstrations with reduced density planting.
- On-farm demonstrations with multiple varieties.

Yellow Vine Disease (*Serratia marcescens*)

Cucurbit yellow vine disease causes a slow decline of cucurbit plants. The causal bacterium is spread is by squash bugs. It is most severe on pumpkin and squash, followed by watermelon and cantaloupe. Leaves on an infected plant become dull yellow to bright yellow, gradually becoming necrotic. Many of the leaves may die, producing a blighted appearance. The leaves of some plants will wilt. A consistent symptom is a light brown discoloration of the phloem tissue inside the stem in the crown area. Cucurbit yellow vine disease can be confused with other problems such as bacterial wilt and Fusarium wilt. Control consists of insecticides that are effective against the squash bug vector.

"TO DO LIST" for Yellow Vine Disease
Research

- Development of resistant varieties

Education

- Develop a training program for growers to correctly identify the disease.

- On-farm demonstrations comparing spray programs to control the squash bug.
- On-farm demonstrations to evaluate tolerances between varieties currently used.

Anthracnose (*Colletotrichum orbiculare***)**

This is a fairly common disease of watermelon, melons and cucumbers. Squash and pumpkins are less susceptible. Lesions form on seedlings, leaves, petioles stems and fruits of susceptible plants. Diseased fruit reduce marketability of the fruit, therefore minimizing returns.

Fungicides classified as Carbamate available for use

- Benomyl (Benomyl): provides fair control, however will no longer be available. 24 hour REI and 1-day PHI.
- Thiophanate-methyl (Topsin-M): provides fair control. 12 hour REI. Pumpkins not listed on label.

Fungicides classified as B2 - Carcinogens available for use

- Maneb (Maneb): provides good control. 24 hour REI and 5-day PHI.
- Mancozeb (Dithane DF): provides good control, fairly inexpensive. 24 hour REI and 5-day PHI.

Non-OP and non-carbamate fungicides available for use

- Azoxystrobin (Quadris): provides excellent control. 4 hour REI and 1-day PHI.
- Chlorothalonil (Bravo and others): provides excellent control. 48 hour REI and 0-day PHI.
- Fixed copper (various): provides slight control, generally mixed with mancozeb or chlorothalonil for extra control. Inexpensive. 12 hour REI and 0-day PHI.
- Trifloxystrobin (Flint): provides excellent control. 12 hour REI and 0-day PHI.
- Pyraclostrobin (Cabrio): recently registered for 2003. Strobulin fungicide that provides good control. 12 hour REI and 0-day PHI.

Non-chemical pest management methods available for use

- Deep plowing provides good control
- Rotation provides good control
- Resistant varieties provides good control
- Solarization provides fair control
- Sanitation provides fair control
- Use of clean seed
- Fields should not be entered on wet days

Unregistered pest management tools

- BAS 516: according to preliminary research, IR-4 data indicates good control may be achieved with this product
- Fludioxonil: according to preliminary research, IR-4 data indicates good control may be achieved with use of this product.

"TO DO LIST" for Anthracnose
Research

Regulatory

- Expedite registration of fludioxonil, it is registered for other crops

Education

- Develop a training program for growers to utilize all non-chemical management techniques for this disease
- On-farm demonstrations with Cabrio also known as BAS 500.

Alternaria leaf blight (*Alternaria cucumerina*)

Normally causes lesions on the leaves of cantaloupes and watermelons, however may be observed on the fruit. Yellow to brown lesions with light green halo are observed on lower leaves first. The lesions enlarge then coalesce and leaves develop a cupped appearance then die. Fruit is then exposed to sunscald which reduces quality and quantity of marketable fruit.

Fungicides classified as B2 - Carcinogens available for use

- Maneb: provides good control. 24 hour REI and 5-day PHI.
- Mancozeb: provides good control, inexpensive. 24 hour REI and 5-day PHI.

Other Fungicides available for use

- Chlorothalonil: provides good control of this pathogen. 48 hour REI and 0-day PHI.
- Azoxystrobin: provides excellent control of this pest. Fairly expensive compared to others products. 4 hour REI and 1-day PHI.
- Pyraclostrobin (Cabrio): provides good control. Registered for use in 2003. 12 hour REI and 0-day PHI.
- Fosetyl-AL: according to IR-4's preliminary data slight control may be achieved. 12 hour REI and 1-day PHI.

Non-chemical pest management methods available for use

- Rotation with a non-host for 2 years provides good control of this pest.
- Reducing foliar wetness by not using overhead irrigation provides fair control of this pest.
- There are several watermelon varieties being developed with slight resistance.

Unregistered pest management tools

- BAS 516: according to IR-4's preliminary data, good control may be achieved.
- Cyprodil / Fludioxnil: according to IR-4's preliminary data, good control may be achieved
- Fenamidone: according to IR-4's preliminary data, control may be achieved
- Nicobifen-BAS10: according to IR-4's preliminary data, good control may be achieved
- Prochloraz: according to IR-4's preliminary data, control may be achieved
- Triflumizole: according to IR-4's preliminary data, control may be achieved

"TO DO LIST" for Alternaria Leaf Blight

Research

- Enhance resistance in cantaloupes and watermelon

- Develop resistance in other cucurbits

Regulatory

Education

- Stress rotation of products to reduce possible resistance within pathogen population
- Stress control of leafminers since feeding has shown increase in disease

Gummy stem blight (*Didymella bryoniae***)**

This disease affects leaves, stems and fruits of all cucurbits. Infected leaves have circular, tan to dark brown spots which eventually cover the entire leaf. Infected stems appear to be water soaked and infected fruits turn black. Infected vines usually wilt and generally no marketable fruit is produced.

Carbamate Fungicides available for use

- Thiophanate-methyl: provides fair control. 12 hour REI. Pumpkins not listed on label.
- Benomyl: provides good control, however is no longer available and resistance may occur with repeated uses. 24 hour REI and 1-day PHI.

B2 Carcinogens available for use

- Mancozeb: provides good control, inexpensive. 24 hour REI and 5-day PHI.
- Maneb: provides good control. 24 hour REI and 5-day PHI.

Other fungicides available for use

- Azoxystrobin: provides excellent control, should be rotated with other non-strobulin fungicides to reduce possibilities of resistance. 4 hour REI and 1-day PHI.
- Chlorothalonil: provides excellent control. 48 hour REI and 0-day PHI.
- Fixed copper: provides slight control. 12 hour REI and 0-day PHI.
- Trifloxystrobin: provides excellent control. 12 hour REI and 0-day PHI.
- Fumigation: should provide good control of this pest

Non-chemical pest management methods available for use

- Water management may provide fair control of this pest, reduce foliage moisture
- Crop rotation should provide good control of the pest
- Use of treated seed

Unregistered pest management tools

- None

"TO DO" LIST for Gummy Stem Blight

Research

- Identify resistant cultivars or level of resistance
- Plant breeding programs to develop resistance
- Conduct research with new chemistries when available

Regulatory

Education

- Demonstrate methods of field identification of infected plants

Microdochium blight / Plectosporium blight (*Microdochium tabacinum* **or** *Plectosporium tabacinum***)**

Plectosporium blight (formerly called Microdochium blight) is a disease of pumpkins and squash that was first reported in Tennessee in 1988. It is caused by the fungus *Plectosporium tabacinum* (formerly *Microdochium tabacinum*). The disease has appeared in both pumpkins and squash, causing severe blighting of the vines before fruit maturity.

Plectosporium tabacinum infects stems, leaf veins, and fruit. Symptoms of Plectosporium blight are very distinctive and easily distinguished from other cucurbit diseases. Initially, lesions on stems and leaf veins are small, white, and diamond-shaped. Lesions quickly coalesce, causing the entire surface of the vine or leaf vein to turn white. Because leaf lesions are restricted to the veins and do not spread to the interveinal tissue, they may be overlooked in the early stages of disease development. Leaves on severely affected vines die and complete defoliation may occur in severe cases.

On fruit the white lesions are more circular and less diamond-shaped. Spots on the flesh remain small and scattered; however the handle or stem stub on the pumpkin may be completely white at harvest. Reducing foliar infection and fruit infections are very important to obtain economic returns. Infections on pumpkin and squash reduces value at market.

<u>Carbamate fungicides available for use</u>

- Benomyl (Benlate): provides fair control, however is no longer available. 24 hour REI and 1-day PHI.
- Thiophanate-methyl (Topsin-M): provides fair control. 12 hour REI. Pumpkins are not listed on label.

<u>Fungicides classified as B2 - Carcinogens</u>

- Maneb (Maneb): provides good control. 24 hour REI and 5-day PHI.
- Mancozeb (Dithane DF): provides good control, inexpensive. 24 hour REI and 5-day PHI.

<u>Other fungicides available for use</u>

- Chlorothalonil (Bravo and others): provides good control. 48 hour REI and 0-day PHI.
- Fixed copper: provides fair control. 12 hour REI and 0-day PHI.
- Azoxystrobin (Quadris): provides fair control. 4 hour REI and 1-day PHI.
- Trifloxystrobin (Flint): provides excellent control. 12 hour REI and 0-day PHI.
- Pyraclstrobin (Cabrio): provides excellent control.

<u>Non-chemical pest management methods available for use</u>

- Rotation may aid in control but not confirmed

Unregistered pest management tools

- none

"TO DO" LIST for Microdochium blight

Research

- Develop resistant varieties
- Identify methods to reduce infection

Regulatory

Education

- Stress the importance of scouting to detect presence of fungus
- Stress the importance of rotation of fungicides with different modes of action

Powdery mildew (*Sphaerotheca fuliginea* and *Erysiphe cichoracearum***)**

All cucurbits are susceptible to powdery mildew, however symptoms may not be as obvious in cucumbers due to resistant cultivars that are available. Powdery mildew reduces yield of fruit by decreasing size and number of fruit produced. Sun scald is another symptom that generally occurs due to leaves falling from premature defoliation. In melons, powdery mildew may cause poor flavor and/or incomplete ripening. In winter squash, infections from powdery mildew may reduce storage life of the fruit. In pumpkin production, handles may become shriveled or discolored. The spores may be blown into the area from other infected cucurbits. Hot humid conditions are conducive for the development of this disease.

Carbamate Fungicides available for use

- Benomyl (Benlate): provides slight control, however is no longer available. 24 hour REI and 1-day PHI.
- Thiophanate-methyl (Topsin-M): Because of widespread resistance within the fungal population this product is no longer effective. If used, must be rotated with other products to reduce risk of resistance within pathogen population. 12 hour REI. Pumpkins are not listed on the label.

Fungicides classified as B2 carcinogens

- Mancozeb (Dithane DF): provides slight control. 24 hour REI and 5-day PHI.
- Maneb (Maneb): provides slight control. 24 hour REI and 5-day PHI.

Other fungicides available for use

- Azoxystrobin (Quadris): provides excellent control. 4 hour REI and 1-day PHI.
- Chlorothalonil (Bravo and others): provides fair control. 48 hour REI and 0-day PHI.
- Fixed copper: provides slight control. 12 hour REI and 0-day PHI.
- Myclobutanil (Nova): provides excellent control, must be rotated with other products to reduce chances of resistance buildup in pathogen population. 24 hour REI and 0-day PHI.
- Sulfur (various): provides excellent control. This product can be phytotoxic to sensitive varieties of cantaloupe and cucumbers at high temperatures. 24 hour REI and 0-day PHI.

- Trifloxystrobin (Flint): provides excellent control. 12 hour REI and 0-day PHI.
- Harpin protein (Messenger): provides slight control. 4 hour REI and 0-day PHI.
- Pyraclostrobin (Cabrio): provides excellent control, New product registered for 2003. 12 hour REI and 0-day PHI.
- Triflumizole (Procure): provides excellent control. 12 hour REI and 0-day PHI.

Non-chemical pest management methods available for use

- Resistant cultivars

Unregistered pest management tools

- BAS 516: may provide good control according to preliminary testing conducted by IR-4.
- Chitosan: may provide control according to preliminary testing conducted by IR-4.
- Cinnamaldehyde: may provide control according to preliminary testing conducted by IR-4.
- Cyprodil / Fludioxonil: may provide good control according to preliminary testing by IR-4.
- Kresoxim-methyl: may provide control according to preliminary testing by IR-4.
- Nocobifen-BAS 510: may provide good control according to preliminary testing by IR-4.
- Prochloraz: may provide control according to preliminary testing by IR-4.
- Quinoxyfen / DE795: may provide control according to preliminary testing by IR-4.
- *Ampelomyces quisqualis* isolate M-10: may provide control according to preliminary testing by IR-4.
- *Bacillus pumilus* strain 2808: may provide control according to preliminary testing by IR-4.
- Milsana: may provide fair control according to IR-4 preliminary testing.
- Potassium dihydrogen phosphate: may provide control according to IR-4 preliminary testing.

"TO DO" List for Powdery Mildew

Research

- Develop a breeding program to develop resistant varieties

Regulatory

Education

- Stress importance of scouting for this disease so fungicide applications may be applied at the onset of this disease.

Bacterial wilt (*Erwinia tracheiphila*)

This disease has traditionally been a problem in cucumber and cantaloupe but is becoming a problem in pumpkin. It is not as severe in squash or watermelon. Portions of the plant (individual runners or entire plant) wilt and die. Symptoms may

appear at any stage of plant development, however is most severe when plants are young. This disease is spread by cucumber beetles and other insects that are capable of wounding the upper portion of the plant. It is normally observed as soon as runners begin until fruits mature.

Chemical pest management methods available for use

- Insecticides used to control cucumber beetles is currently the best method of control.
- Pyraclostrobin (BAS 500, Cabrio): according to IR-4's preliminary data this product may provide fair control. 12 hour REI and 0-day PHI.

Unregistered pest management tools

- Acibenzolar: according to IR-4's preliminary data this product may provide slight control
- *Bacillus subtilis* QST 713: according to IR-4's preliminary data this product may provide control.

"TO DO LIST" for Bacterial wilt

Research

- Develop resistant varieties

Regulatory

- Expedite registration on *Bacillus subtilis* QST713

Education

- Educating growers on conducting field diagnostic tests to determine infection from this disease.
- Stress the fact that if cucumber beetles are present, an insecticide application must be made to reduce insect populations.

Viruses of cucurbits

There are several viruses that occur in cucurbit production. Five that are commonly observed in Tennessee cucumber mosaic virus (CMV), squash mosaic virus (SMV), zucchini yellow mosaic virus (ZYMV), papaya ringspot virus (PRV) and watermelon mosaic virus (WMV). Each virus differs in their host range, method of transmission and means of overwintering. CMV, ZYMV, PVR and WMV are spread by aphids and SMV is spread by cucumber beetles.

Insecticides available for use

- See insecticides listed in insect section for aphid and cucumber beetle control

Non-chemical pest management methods available for use

- Precocious yellow-stemmed varieties mask the fruit-greening effects.
- Eradicate weeds
- Apply insecticides to prevent the build up in aphid and cucumber beetle
- Plant virus free certified seed
- Isolate late plantings far from early plantings
- Remove infected plants soon after symptoms are observed

- Resistant and/or tolerant squash varieties

Unregistered pest management tools

- See insecticides section listed above for aphid and cucumber beetle control

"TO DO" LIST for Viruses

Research

- A breeding program is severely needed for these viruses

Regulatory

- Expedite registration of seed treatments with imidacloprid and thiomethoxam

Education

- Train growers how to identify virus infections
- On-farm demonstrations using resistant or tolerant varieties

Fusarium fruit rot (*Fusarium* spp.**)**

Fusarium fruit rot occurs in the field prior to harvest and during harvest. Post harvest applications of fungicides have been reported to control this pest.

Non-chemical pest management methods available for use

- Avoiding wounding during harvest or handling and proper storage temperatures reduce infections by this pest.
- Maintain adequate calcium levels in fruit
- Use drip irrigation
- Use resistant pumpkin varieties (hard shell types)

Unregistered pest management tools

- *Gliocladium cateulatum* J1446: no data
- Prochloraz: no data
- Fludioxonil: according to preliminary data obtained through IR-4, this product should provide control of seedling Fusarium root and stem rot.

"TO DO" LIST for Fusarium rot

Research

- Develop varieties that can tolerate this pest
- Determine efficacy of *Gliocladium cateulatum* J1446
- Determine efficacy of Prochloraz

Regulatory

Education

- On-farm demonstrations with different planting, production and harvesting techniques to determine which methods have lowest incidence of disease.
- On-farm demonstrations drip irrigation vs. non drip irrigation

Belly rot (*Rhizoctonia solani*)

Belly rot begins on the underside of developing fruit. It usually begins on the blossom end of the fruit. Tan to brown lesions usually form which are sunken and irregular in shape. This can be a serious disease in cucumbers and they are most susceptible of the cucurbits. This disease is normally observed during mid to late fruit development.

Carbamate Fungicides available for use

- Thiophanate-methyl: provides fair control of this disease. 12 hour REI. Pumpkins are not listed on the label.

Other Fungicide available for use

- Azoxystrobin (Quadris): provides good control of this disease. 4 hour REI and 1-day PHI.
- Fumigation
- Chlorothalonil (Bravo): provides fair control. 48 hour REI and 0-day PHI.
- Pyraclostrobin (Cabrio): a new product labeled for 2003 provides good control. 12 hour REI and 0-day PHI.

Non-chemical pest management methods available for use

- Plastic mulch, however may promote soft rots if plastic becomes depressed by weight of fruit.
- A barrier between soil and fruit, such as wood planks, this would not be feasible on large scale production.
- Deep plowing prior to planting may be effective in controlling this pest.

Unregistered pest management tools

- Fludioxonil: may provide fair control according to preliminary data obtained from IR-4 research.
- Kresoxim-methyl: may provide control according to preliminary research conducted by IR-4
- Tebucoazole: may provide good control according to preliminary data conducted by IR-4.
- Triflumizole: may provide control according to preliminary data obtained by IR-4.
- *Gliocladium cateulatum* J1446: may provide fair control according to preliminary data obtained by IR-4.
- *Streptomyces lydicus* WYEC 108: may provide control according to preliminary data obtained by IR-4.

"TO DO" LIST for Belly rot

Research

- Compare broadcast soil applications of Azoxystrobin, Trioxystrobin and Pyraclostrobin with a control to determine efficacy.

Regulatory

Education

- On-farm demonstration involving deep plowing to reduce disease

- On-farm demonstrations to compare plastic mulch with conventional planting

Pythium rot, Phytophthora root rot, Damping-Off Fungi and Phytophthora blight.

Damping off pathogens usually occur early in the season, usually several days to a few weeks after planting. Pythium spp. or Phytophthora spp. are both water loving fungi, they are generally worse during wet conditions. Phytophthora capsici causes root, crown and fruit rot and shoot blight. Rhizoctonia and Fusarium are generally a problem when soil temperatures warm. Fungicides with different modes of action are recommended for control of these pests.

Fungicides available for use

- Mefenoxam (Ridomil Gold): applied at planting, provides good control of seedling stage of Pythium and Phytophthora root and crown rot. Possible build up of resistance within the pest population, if use continues in same location year after year. Mefenoxam applied foliarly as Ridomil Gold Bravo, Ridomil Gold MZ, or Ridomil Gold Copper provides fair control of Phytophthora blight. 48 hour REI and 0-day PHI.
- Zoxium (Gavel): applied foliarly provides fair control of Phytophthora blight. 48 hour REI and 5-day PHI.
- Dimethomorph (Acrobat): applied foliarly provides fair control of Phytophthora blight. 0-day PHI.
- Fosetyl-AL (Aliette): may provide slight control of Phytophthora blight according to preliminary data obtained by IR-4. 12 hour REI and 1-day PHI.

Non-chemical pest management methods available for use

- Rotation
- Plant on raised beds
- Water management

Unregistered pest management tools

- AE C638206: may provide control of the pathogens according to preliminary data obtained by IR-4.
- Fenamidone: may provide control of these pests according to preliminary data obtained by IR-4.
- Ipconazole: may provide control of both organisms according to preliminary data obtained from IR-4.
- Propamocarb hydrochloride: may provide control of both organisms according to preliminary data obtained from IR-4.
- Pyraclostrobin: may provide slight control of both organisms according to preliminary data obtained from IR-4.
- SYP-L190: may provide control of both organisms according to preliminary data obtained from IR-4.
- *Gliocladium cateulatum* J1446 may provide slight to fair control according to preliminary data obtained by IR-4.
- *Streptomyces lydicus* WYEC 108 may provide control according to preliminary data obtained by IR-4.

"TO DO" List for Damping-off fungi
Research

- Determine efficacy of both *Gliocladium cateulatum* J1446 and *Streptomyces lydicus* WYEC 108 separately and in combinations and with labeled and non labeled fungicides

Regulatory

- Expedite registration of dimethomorph and zoxamide

Education

- On-farm demonstrations with varied planting dates and rotations

Angular leaf spot (*Pseudomonas syringae*)
This disease first appears on leaves and later moves to fruit and eventually seed may become infected. Leaf symptoms are small water soaked spots and in humid weather a clear to milky exudate may appear. Infected fruit may a white crusty exudate present.

Pesticides classified as B2 Carcinogens

- Mancozeb: provides slight control, copper is needed to see any benefits. 24 hour REI and 5-day PHI.

Non-OP and non-carbamate fungicides available for use

- Fixed copper: provides fair to good control, inexpensive. 12 hour REI and 0-day PHI.
- Harpin protein: no data
- Pyraclostrobin (Cabrio): newly registered for 2003, may provide fair control according to preliminary data obtained through IR-4. 12 hour REI and 0-day PHI.
- Seed treatments: provide fair control
- Fumigants: excellent control, however expensive

Non-chemical pest management methods available for use

- Use disease free seed
- Deep plowing may provide fair control
- Rotation may provide good control
- Resistant varieties may provide good control
- Sanitation may provide fair control
- Solarization may provide fair control
- Mulching may provide good control
- Water management may provide good control

Unregistered pest management tools

- Acibenzolar: according to IR-4's preliminary data this product may control
- *Bacillus subtilis* QST 713: according to IR-4's preliminary data this product may provide control.

"TO DO" List for Angular leaf spot
Research

- Determine economic threshold of this pest

- Determine efficacy of Harpin Protein (Messenger)
- Determine efficacy of Pyraclostrobin

Regulatory

- Expedite registration of *Bacillus subtilis* QST 713

Education

- Inform growers importance of water management
- On-farm demonstrations with solarization
- On-farm demonstrations with resistant varieties

Bacterial Fruit Blotch (unknown)

This disease only causes minor losses in watermelon production, however it does occur in other cucurbits. Plants infected with bacterial fruit blotch usually have a dark olive green stain or blotch on the upper surface of the melon. Small spots first appear water soaked rapidly increasing in size and may cover the entire surface within 7-10 days. The rot rarely extends into the flesh, however if infection does reach the flesh, seeds may become infected. Secondary invading organisms are normally responsible for the collapse of the melon.

<u>Non-OP and non-carbamate insecticides available for use</u>

- Copper sprays may be effective, if applied prior to fruit set. 12 hour REI and 0-day PHI.
- Pyraclostrobin (Cabrio) may provide fair control according to preliminary data obtained through IR-4. 12 hour REI and 0-day PHI.

<u>Non-chemical pest management methods available for use</u>

- Use disease free seed to reduce spread
- Partial genetic resistance may occur in some watermelon cultivars
- Rotation: should provide good control of this pest
- Destroy volunteer melons the following year

<u>Unregistered pest management tools</u>

- Acibenzolar: according to IR-4's preliminary data, this product may control
- *Bacillus subtilis* QST 713: according to IR-4's preliminary data, this product may provide control.

Research

- Determine pathogen
- Explore resistance observed in watermelon
- Develop resistance in other cucurbits
- Determine efficacy of Pyraclostrobin

Regulatory

- Expedite registration of *Bacillus subtilis* QST 713.

Education

- Stress rotation and destruction of volunteer plants

Bacterial rind necrosis (*Erwinia* spp. suspected**)**

Bacterial rind necrosis is a disease of watermelon. In watermelon, the disease causes a brown, corky, dry necrosis of the interior of the rind. The necrosis rarely extends into the flesh. The affected area may vary from a small single spot to encompassing the entire rind in cases of systemic necrosis. Mis-shapened fruit may be observed when fruit has systemic infections.

Non-chemical pest management methods available for use

- Selecting cultivars that are less susceptible to this disease is the only form of control, however no known tolerances have been reported.

Research

- Develop resistant varieties

Extension

- On-farm demonstrations to observe any resistance

Cercospora leaf spot (*Cercospora citrullina*)

This disease is most severe in watermelon production, however it is observed in other cucurbits. Typically spots are only found on the foliage of cucurbits. Defoliation may occur in heavily infected plants resulting in reduced fruit size and quality.

Carbamate fungicides available for use

- Benomyl (Benlate): provides fair control, however is no longer available. 24 hour REI and 1-day PHI.
- Thiophanate-methyl (Topsin-M and others): provides fair control. 12 hour REI and no-PHI listed.

Fungicides classified as B2 carcinogens available for use

- Mancozeb (Dithane DF): provides excellent control, inexpensive. 24 hour REI and 5-day PHI.
- Maneb (various): provides excellent control. 24 hour REI and 5-day PHI.

Other Fungicides available for use

- Azoxystrobin (Quadris): provides excellent control. 4 hour REI and 1-day PHI.
- Chlorothalonil (Bravo, others): provides excellent control. 48 hour REI and 0-day PHI.
- Fixed Copper (various): provides fair control, inexpensive. 12 hour REI and 0-day PHI.
- Pyraclostrobin (Cabrio): no efficacy data. 12 hour REI and 0-day PHI.

Non-chemical pest management methods available for use

- Destroy old crop residue
- Crop rotation for 2 – 3 years

Unregistered pest management tools

- Tebuconazole: no data

Research

- Determine efficacy of pyraclostrobin and tebuconazole

Education

- Educational programs stressing the importance of crop rotations

Scab (*Cladosporium cucumerinum***)**

Scab is also known as gummosis, but is rarely a problem in cucumber production due to resistant varieties. However, summer and winter squash, pumpkin, melons and watermelons can be affected by this disease, which can cause severe problems. The fungus attacks all above ground parts, however it causes greatest concern when fruit become infected reducing marketability of the fruit. It also has a foul smelling odor.

Fungicides classified as B2 carcinogens available for use

- Mancozeb (Dithane DF): provides good control. 24 hour REI and 5-day PHI.
- Maneb (Maneb): provides good control. 24 hour REI and 5-day PHI.

Fungicides available for use

- Myclobutanil (Nova): provides good control. 24 hour REI and 0-day PHI.
- Trifloxystrobin (Flint): provides good control. 12 hour REI and 0-day PHI.
- Chlorothalonil (Bravo): provides good control. 48 hour REI and 0-day PHI.

Non-chemical pest management methods available for use

- Resistant varieties of cucumber, some tolerance in other cucurbits
- Rotation with non-host crops
- Use disease free seed
- Grow plants in well drained soil

Unregistered pest management tools

- Copper octanoate: no data
- Kresoxim-methyl: no data
- Phosphonic acid: no data
- Tebuconazole: no data
- Triflumizole: no data

"TO DO" List for Scab

Research

- Identify varieties with disease tolerance or resistance
- Develop resistant varieties in other cucurbit crops
- Evaluate efficacy of unregistered pest management tools

Education

- On-farm demonstrations with different varieties to determine tolerance
- Stress the importance of rotation with non-host crops

Weed Management in Cucurbit Production

Cucurbits are extremely sensitive to competition by many different weeds. Yield and quality may be severely restricted because of weed competition. Weeds compete for water and nutrients as well as light and space. Weeds that restrict crop growth,

eventually effect yields, reducing returns to growers. Weeds may also reduce the ability of other products to penetrate the plant canopy, therefore reducing efficacy of fungicides and insecticides use to control other pests. Weeds developing late within the season may hinder harvesting. Weeds may also harbor diseases or attract or harbor insects that may cause damage to the crop. Tables 8 and 9, list the relative efficacy of preemergent and post emergent herbicides used in cucurbit production.

Normally cucurbits are placed on a wide row and plant spacings to allow for vine growth and development. This form of production allows weeds to better compete with the cucurbit crop for many essentials needed for optimum growth. There are many weed species that compete with cucurbits. They are normally categorized into groups which include; broadleaf weeds, weedy grasses and sedges. And for each group, they may be divided into annual and perennial species.

Early weed control in cucurbits is extremely important. This is also true when plastic mulches are being used. The major thrust in cucurbit weed management must be placed for early season weed control allowing the cucurbit to develop and hopefully shading out any weeds. Weed control in cucurbits typically includes combinations of two or more of the following means of control: mechanical, cultural, or chemical.

Mechanical weed control

Mechanical control involves plowing the field to prepare the field for planting and removes many of the weeds that are present at the time of plowing. However, this method also stimulates germination of many other weed seeds.

Cultural weed control

Polyethylene sheeting also called plastic mulching helps warm the soil as well as retain moisture and inhibits weed growth. One major drawback if using polyethylene is if yellow nutsedge is present, it often pierces the plastic. Clear plastic is normally used for solarization of soils. Solarization is a method of pest reduction that utilizes clear plastic. This method helps reduce weed, disease and insect populations. Solarization is normally practiced the year previous to planting a cucurbit crop. It allows soil temperatures to rise high enough to kill most living organisms. Clear plastic is not recommended for use as a plastic mulch due to the high temperatures observed during the growing season, however is very effective for solarization.

Cultural Methods of Weed Control Available for Use:

- Select land that lacks a history of intense weed pressure (especially large seeded broadleaf weed and difficult to control perennial broadleaf weeds)
- Control perennial broadleaf and grass weeds at least one year prior to growing cucurbits
- Produce the least competitive crop on land with a history of the least intensive weed pressure.
- Rotate with vegetable or field crops which have herbicide options that provide broad-spectrum or more complete control.

- Focus on timely planting into a well-prepared seed-bed to reduce early weed problems.
- Cultivate (shallow) as close to the row as possible without damage to crop and crop roots
- As a barrier to weed establishment, use mulches either natural or synthetic, where applicable.

Chemical weed control

Pre-emergence herbicides are applied before the crop is planted. In many cases they are incorporated into the soil and called pre-plant incorporated (PPI) treatments. This method helps place the material closer to the germinating weed seeds. Other materials may be applied as pre-emergence, which means applied prior to the target weed emerging. In many cases the seed of the crop may be planted and the pre-emergent herbicide applied. Irrigation or rain may be required to activate the pre-emergent herbicide.

Post-emergence herbicides are applied after the crop seed or transplants have been planted.

Fumigation

At the present time, use of fumigation can be economically justified in crops grown with plastic row covers. Fumigation is extremely costly and should only be used for crops which offer a high per acre potential return in order to justify the cost. Plant back intervals from the time the fumigant is applied to the time of planting must be strictly followed to avoid loss of trans-plants. This production system is often combined with directed or hooded sprays. Herbicide application is made between the rows to control weeds emerging in the non-fumigated area of the field. Fumigation is very effective in controlling most diseases (including nematodes), soil inhabiting insects and weeds. Rotation can be fairly effective also, however due to limited acreage, rotation may not always be an alternative. Due to increased production costs only about 3% of all cucurbit production utilizes fumigation. Methyl bromide containing fumigants were the standard fumigants, however with the expected phase-out of methyl bromide, alternatives are being evaluated by researchers.

Annual Grasses

Biology and Life Cycle:

Grass weeds germinate at soil depths of $1/8^{th}$ of an inch to 2 to 3 inches. Seed size and dormancy are the controlling factors for when these seeds emerge. Large seeded weeds have greater seed food reserves and can emerge from greater soil depths where moisture is less variable than near the soil surface.

Annual grasses germinate at various times throughout the season depending on environmental conditions such as soil moisture and temperature.

Annual grasses produce great numbers of seed which often lie dormant for brief periods to long periods before germination occurs.

Annual grass seeds are distributed by wind, rain, birds, other vertebrates and machinery.

Pest Distribution and Importance:
Annual grasses are present in most fields across Tennessee. Many of these are controlled with applications of preemergent herbicide applications and tillage. Occasionally, an application of a post directed herbicide is used to control grasses.

Grasses are usually not as competitive as broadleaf weeds, however they may reduce crop yields when significant populations are present. Grasses compete for moisture which is critical during fruit development.

Barnyardgrass (*Echinochloa crus-galli*)
This grass may germinate as deep as 4 inches in depth. Seed may remain viable for several years. Barnyardgrass is a summer annual which has tillers which lie flat and form secondary roots resulting in a fibrous mat formation. Barnyardgrass spreads by seed which germinate in late spring and early summer.

Crabgrass (*Digitaria* spp.)
Crabgrass is a troublesome grass that is present in almost all situations in Tennessee. It has a waxy coating making it difficult for herbicides to penetrate it after it has emerged. The best method of control is with preemergent herbicide applications.

Fall panicum (*Panicum dichlotomiflorum*)
This annual grass can become a serious pest during warm wet seasons. This plant tillers profusely in late July through August competing for soil moisture.

Wild prosomillet (*Panicum miliaceum*)
Stems of wild prosomillet are erect, stout, nearly smooth, with numerous tillers usually near the first stem. The leaves very long (45 cm), ciliate at base and hairy on both sides, with stiff- and long-haired sheath. Total height may reach 120cm. Wild prosomillet is a summer annual.

Foxtails (*Setaria* spp)
Foxtails are erect summer annuals which reach 1 - 2 m tall depending on species. Low populations of this weed exist across Tennessee. Little crop competition generally occurs with this pest. However, it may become a serious threat if growers do not control this weed. This weed is a heavy seed producer and if unmanaged may reduce available moisture for cucurbits during hot dry weather, therefore possibly reducing yield.

Goosegrass (*Eleusine indica*)
Goosegrass is a prostrate-growing summer annual. Goosegrass grows in a clump with the base of the leaves being distinctively white to silver in color. Goosegrass spreads by seeds that germinate later in the season than other annual grasses.

Signalgrass, Broadleaf (*Brachiaria platyphylla*)
Broadleaf signalgrass is a summer annual which may reach 90cm in height. It has a fibrous root system capable of reducing soil moisture needed for fruit development.

Perennial Grasses
Biology and Life cycle:
Perennial grasses may survive 3 or more years. The foliage of some perennial grasses may die during the winter months and then reappear during the spring and summer (examples include; bermuda, johnsongrass). Other perennial grasses may be observed throughout the year. Perennial grasses survive by regenerating back from rhizomes or nutlets.
Pest Distribution and Importance:
Perennial grasses can become serious pests if not controlled. Usually these weeds reoccur from season to season and normally in greater numbers the following season. Grasses may compete for available moisture and if larger in size may reduce the penetration of insecticides and fungicides used in the field.

Johnsongrass, rhizome (*Sorghum halepense*)
Johnsongrass is present in most agricultural cropping areas and may reach 3.5 m in height. It is a perennial grass which produces rhizomes. The rhizome portion of the plant must be killed to avoid regrowth. Products such as glyphosate, sethoxydim and clethodim are translocated and move down towards the root system and are capable of killing the rhizome. Seedling Johnsongrass may be controlled with any of the above herbicides as well as some preemergent herbicides that inhibit germination of weed seeds such as bensulide, naptalam and ethalfluralin. Paraquat directly applied to seedling johnsongrass is also effective.

Bermudagrass (*Cynodon dactylon*)
Bermudagrass is creeping perennial warm-season grass. Bermudagrass spreads by both rhizomes and stolons. The roots of bermudagrass are deep and fibrous allowing it to be highly drought tolerant. The stolons root at the nodes forming a thick dense mat. Seedheads are present during the summer months which will help spread this pesky weed the next season. Bermudagrass is normally found on open sunny areas. Bermudagrass does not grow well in the shade.

Dallisgrass (*Paspalum dilatatum*)
Dallisgrass is a warm season coarse perennial which is light green in color. Dallisgrass can from short thick rhizomes, but spreads upright in clumps. This highly invasive plant germinates in soil temperatures of 60 to 65 degrees F and thrives in the hot humid conditions of the southern states. A preemergent herbicide is recommended to control this weed.

Fescue, tall (*Fescuta* spp.)
A long-lived, high producing, cool-season bunchgrass found under a wide range of soil and climatic conditions. This grass produces a highly fibrous root system.

Fall panicum (*Panicum dichotoniflorum*)
Fall panicum is a warm-season, vigorous perennial bunchgrass. It has an extensive root system and forms tough crowns of short rhizomes. The early vigor of this grass makes it important to be controlled in cucurbit production.

Sedges:

Sedges have triangular stems with waxy grass-like leaves which alternate. Sedges are not grass plants, but seedlings may be mistaken for grass. The leaves on both sedges are waxy and have an up right growth habit and a prominent midrib. The waxy coating may make it difficult for herbicides to penetrate. Both sedges have underground root systems containing rhizomes and underground tubers which accomplish most of the reproduction. Both spread mainly by germinating underground tubers, which are the only part of the plant that over-winters. A yellow nutsedge tuber can produce 1,900 plants and 7,000 new tubers in a single growing season. Sedges grow extremely well in soil that has poor drainage. Post-emergent herbicides are the best method of control

Yellow nutsedge (*Cyperus esculentus*): normally seeds germinate from June to July. Yellow nutsedge is one of the worst weeds a grower can have if raising cucurbits. This weed often emerges from under plastic mulches. Yellow nutsedge is more common than purple nutsedge. Seeds of purple nutsedge (*Cyperus rotundus*) usually germinate from May to June.

Broadleaf weeds
Biology and Life Cycle:
Most broadleaf weeds observed in cucurbit production are summer annual weeds. However, there are some perennials such as honeyvine milkweed. Many of the broadleaf weeds may produce seeds in great numbers increasing spread throughout the field. Several produce large seeds that may survive in the soil for several years where others produce mass amounts of seeds at maturity.
Pest Distribution and Importance:
There are many broadleaf weeds that may be observed in cucurbit production. They may compete for water, if they are growing near the root system of cucurbit plants. In most instances broadleaf weeds are competing for sunlight reducing growth of cucurbits. Broadleaf weeds may also reduce the efficacy of many pesticides used by reducing ability of the pesticides to reach the plant.

Pigweed (*Amarantus* spp., especially *A. retroflexus* and *A. spinosus*)
Most troublesome pigweeds are erect summer annuals that may reach 6 1/2 feet in height. Redroot pigweed is one of the more an abundant seed producers. It can spread across the field within a few years.

Honeyvine milkweed (*Ampelamus albidus*)
Honeyvine milkweed is a perennial broadleaf weed that occurs in fields and fencerows throughout Tennessee. Its leaves are heart-shaped and oppositely arranged on a viney stem. The viney growth of this plant makes it difficult to enter fields with heavy populations and workers may become entangled within the vines. This weed grows around developing vines of cucurbits resulting in shading of the crop. The foliage of the weed reduces photosynthesis of the crop and reduces penetration of applied insecticides and fungicides. The long spreading roots make it possible for honeyvine milkweed to persist in a field for several years if not controlled.

Nightshades (*Solanum* spp.)
Silverleaf nightshade is an erect perennial which has creeping roots. This weed may reach height of ~ 1 m tall.

Hairy Galinsoga (*Galinsoga ciliate*)
Hairy galinsoga is a summer annual that abundantly produces seed in the summer. It has hairy leaves and stems, reaching 2 feet in height. This weed produces much foliage shading the developing cucurbits. Weeds which have large amounts of foliage, reduce penetration of fungicide and insecticide sprays through the canopy. Also, reducing photosynthesis of the plant.

Lambsquarter (*Chenopodium* spp)
Lambsquarter is an erect summer annual. The root of lambsquarter is a branched taproot. Lambsquarter spreads by black seeds that germinate in the late spring to early summer. This plant may become large later in the season overshadowing cucurbits. Preemergent herbicides are fairly effective in controlling this weed. Germination begins around March.

Evening Primrose (*Oenothera* spp.)
Common evening-primrose is included in most weed manuals since it coexists readily with forage crops in pastures and meadows. It may grow 3 to 5 foot in height and has a long flowering season.

Horseweed (*Conyza canadensis*)
Horseweed is a summer annual weed. Horseweed is an upright growing plant and can reach 4 - 5 feet if not mowed. Horseweed grows in a basal rosette. Horseweed has a taproot and spreads by seed produced in the summer. Germination of seeds usually begins around April. There have been several reports that horseweed has become resistant to glyphosate in West Tennessee.

Jimsonweed (*Dactura stramonium*)
Jimsonweed, belongs to the nightshade-family (*Solanaceae*), and is an annual herbaceous plant with a disagreeable odor. Growing several feet tall, it is characterized by irregularly toothed leaves and funnel-shaped purplish or white flowers. Jimsonweed produce prickly fruits about 2 inches long with small kidney-shaped seeds, brownish or black in color. The weed seed can be very irritating to the skin of harvesting workers.

Smartweed (*Polygonum* spp.)
Pennsylvania smartweed (P. pensylvanicum) is a summer annual. The growth habit is erect with multiple branching and may reach 2 m tall. Germination begins around March through April.

Morningglories (*Ipomea* spp.)
There are several morningglory species found in cucurbit production. Most are spread by seed and are fast growing after germination occurs which normally begins in May. *Ipomea* species have a viney, climbing growth habit. Workers easily become entangled in vines of morning glory making harvest difficult.

Common ragweed (*Ambrosia artemissifolia*)
Common ragweed is as summer annual. Heavy infestations may make it difficult to determine where developing fruit are located within the field. This weed may reach 2.5 m in height. Foliage from this plant may reduce penetration of insecticides and fungicides that are applied throughout the season.

Cocklebur (*Xanthium strumarium*)
Xanthium strumarium is a common annual weed spread by water, humans, or other animals. It reproduces from seeds that are viable for up to several years. Seeds have sharp spiny ends that can attach to clothing and animal making it easy for transport. Heavy populations make harvest miserable due to the physical characteristics of the spiny seeds. The plant reaches a height up to 4 feet and has large leaves which may shade developing plants reducing photosynthesis.

Chemical Controls for Cucurbits:
Products containing glyphosate or paraquat are used as burn downs prior to seeding or transplant. They may be used after seeding or transplant but must be directed towards outsides of the row. Products containing naptalam, clethodim, and sethoxydim may be applied as postemergence herbicides. Products containing ethalfluralin, clomazone, bensulide and naptalam may be applied as preemergence herbicides. Tables 8 and 9, list the relative efficacy of products used in cucurbit production.

<u>Growth Regulator</u>
Naptalam (Alanap): applied as a preemergent
- Provides good control of most annual grasses
- Provides fair control of fall panicum and signalgrass
- Provides poor control of sedges and perennial grasses
- Inexpensive
- Crop oil should not be added when applied as a postemergent
- Not labeled for pumpkins or squash
- 48 hour REI and 0-day PHI

<u>Chlorophyll/Carotenoid Pigment Inhibitors</u>
Clomazome (Command): applied as a preemergent

- Provides excellent control of most annual grasses
- Provides poor control of seedling johnsongrass
- Must be soil incorporated within listed areas
- Cover crops may be planted anytime but stand reduction may occur
- Roots of transplants must be placed below chemical barrier.
- 12 hour REI and 0-day PHI.

Shoot and Root Inhibitors (Carbamothioates):

Bensulide (Prefar): applied as a preemergent

- Applied with naptalam for control of broadleaf weeds
- Must be incorporated into soil at least 1" depth followed by rainfall or irrigation
- Provides excellent control of barnyardgrass, crabgrass, fall panicum, foxtails and goosegrass.
- Provides good control of johnsongrass and broadleaf signalgrass.
- Poor control of perennial grasses and sedges
- Excellent control of smartweed and jimsonweed
- Good control of lambsquarter and pigweeds
- Poor control of most other broadleaf weeds
- 12 hour REI and 0-day PHI.

Ethalfluralin (Curbit): applied as a preemergent

- Provides excellent control on most annual grasses
- Poor control of sedges
- Poor control of perennial grasses
- Good control of nightshades, lambsquater and pigweed
- Fair control of smartweed
- Crop tolerance is variety dependent in Pumpkins
- Crop injury may occur in cool wet conditions in cantaloupes.
- 24 hour REI and 0-day PHI

Lipid Biosynthesis Inhibitors (Cyclohexanediones):

Sethoxydim (Poast): applied as a postemergent

- Selective for grasses
- Provides good control for barnyardgrass and signalgrass
- Provides excellent control for most other annual grasses
- 12 hour REI and 14 days PHI

Clethodim (Select): applied as a postemergent

- Selective for grasses
- Provides good control for barnyardgrass and signalgrass
- Provides excellent control for most other annual grasses
- 30 days after application no other crops may be planted unless on label
- 24 hour REI and 14 day PHI.

Bipyridyliums

Paraquat (Gramoxone, BOA): applied to stale seed bed or directed

- May be used prior to planting as a burn down
- Must be shielded if applied after emergence of crop
- Inexpensive

- Broad spectrum
- Does not kill below ground portions of plant, contact kill
- May be used during cooler days
- 12 hour REI and 0-day PHI

Amino Acid Synthesis Inhibitors (EPSP synthase):

Glyphosate (Roundup): applied to stale seed bed or directed

- Broad spectrum
- Low to moderate cost
- Tolerance has been developed in other crop systems
- Potential for weed resistance development (low probability, if properly managed)
- Highly systemic during weed growth
- Not effective if colder than 70 degrees
- Not as effective if weeds are not actively growing
- 12 hour REI and 0-day PHI

Alternative Chemical Controls:

- Dimethenamid-P: may provide good control of broadleaf weeds, grasses and sedges according to preliminary data obtained through IR-4
- Flumioxazin: may provide fair control of broadleaf weeds according to preliminary data obtained through IR-4.
- Carfentrazone-ethyl: may provide fair control of broadleaf weeds according to preliminary data obtained through IR-4.
- Halsulfuron: may provide fair control of broadleaf weeds and sedges according to preliminary data obtained through IR-4.
- Sulfentrazone: may provide good control of broadleaf weeds and grasses according to preliminary data obtained through IR-4.

Cultural Weed Control Methods:

Tillage

- Can be effective in control of several weeds
- Soil erosion results from tillage
- Must be performed just prior to seeding or transplanting
- Can be repeated before runners extend through field
- Not always an option if equipment is wider than row spacing
- Inexpensive

Stale Seedbed Weed Control:

The stale seed bed system is another system used to control weeds prior to planting. It is very effective for control of most weed species. Most weed seed germination takes place within the first upper two inches of soil. Weed seeds will germinate within the first two to four weeks after initial soil preparation, provided that moisture and temperatures are favorable. The idea of this method is to allow weeds to emerge after initial field preparation and then kill emerged weeds prior to planting. Weeds may be killed mechanically with tillage equipment or by use of products containing a contact herbicide such as paraquat or product containing materials that are

moved to the root system such as glyphosate. Glyphosate is the best choice if perennial weeds exist, however it may not be effective if temperatures are below 70 degrees.

TO DO for Weed control

Research

- Find effective controls for glyphosate resistant horseweed.
- Find effective controls for evening primrose.
- Find more control products for weeds encountered in cucurbit production.

Regulatory

- expedite registration on all materials that are not harmful to cucurbits when research determines efficacy of a product.

Extension

- Proper identification of weeds
- Proper selection of herbicides available for use
- Stress the importance of keeping records of past herbicide uses in the field to reduce possible injury of following crops.

References

National Agricultural Statistics Service Vg 1-2 (03)
Southern Region Pest Management Center "http://www.pmcenters.org/Southern/"
Tennessee Agricultural Statistics Service. 2003. Farm Facts. Vol. 3. no. 3.
Tennessee Agricultural Statistics Service. 2003. Farm Facts. Vol. 3. no. 4.
Tennessee Agricultural Statistics Service. 2003. Farm Facts. Vol. 3. no. 5.

Table 1. Re-entry Interval, and Post Harvest Interval of Commonly Used Pesticides in Cucurbit Production

Pesticide Class	Common name (Active Ingredient)	Trade name	Signal word	REI	PHI	Crop				
						Cantaloupe	Cucumber	Pumpkin / winter squash	Summer Squash	Watermelon
Insecticide / Miticide										
aliphatic amide organothiophosphate	Dimethoate	Dimethoate	Warning	48 hrs	3 days	x	-	-	-	x
cyclodiene	Endosulfan	Thiodan	Danger	24 hrs	2 days	x	x	x	x	x
pyrethroid ester	Bifenthrin	Capture	Warning	24 hrs	3 days	x	x	x	x	x
pyridylmethylamine	Imidacloprid	Admire / Provado*	Caution	12 hrs	0 -21 days	x	x	x	x	x
carbamate	Carbaryl	Sevin	Caution	12 hrs	0-day	x	x	x	x	x
pyrethroid ester	Esfenvalerate	Asana	Warning	12 hrs	3 days	x	x	x	x	x
pyrimidine organothiophosphate	Diazinon	Diazinon	Caution	24 hrs	7 days	x	x	-	x	x
oxime carbamate	Methomyl	Lannate*	Danger	48 hrs	1 - 3 days	x	x	-	x	x
organochlorine	Dicofol	Kelthane	Danger	48 hrs	2 days	x	x	-	x	x
antibiotic	Abamectin	AGRI-MEK (RUP)	Warning	12 hrs	7 days	x	x	x	x	x
organophosphorus	Naled	Dibrom*	Danger	48 - 72 hrs	1 day	x	x	x	x	-
antibiotic	Spinosad	SpinTor*	Caution	4 hrs	3 days	x	x	x	x	x
pyrethroid ester	Fenpropathrin	Danitol	Warning	24 hrs	7 days	x	x	x	x	x
pyrethroid ester	Permethrin	Ambush / Pounce (RUP)	Warning	12 hrs	0-day	x	x	x	x	x

Table 2. Relative effectiveness of insecticides / miticides and other management tools used in cucurbit production.

	PESTS																	
Pest Management Tools:	aphids	armyworms	cabbage looper	cabbage webworm	corn earworm	cucumber beetles	cutworm(s)	flea beetles	leaf hopper	leaf miner	pickleworm /	seedcorn maggot	spider mite	squash bug	squash vine borer	thrips	wireworm	whitefly
Registered materials																		
abamectin (Agri-mek)									G	E			E					
azinophos-methyl (Guthion)						E	E											
Bacillus thuringiensis (various)		F	G	G	F													
bifenthrin (Capture)	G					G	G	E	G		G		G	E	E			
carbaryl (Sevin)					F	G	F	F	G	F	F			G	G	F		
carbaryl bait (Adios)					F	G	G	G										
cyromazine (Trigard)									G	E								
diazinon (Diazinon)	F*						G			G		G					G	
dicofol (Kelthane)													G					
dimethoate (Digon)	G						G		G	G			G					
endosulfan (Thiodan / Phaser)	G					G					G			E	E			E
esfenvalerate (Asana XL)			E	E	G	E	E		E		E			E	E			
fenpropathrin (Danitol)													G					
imidacloprid (Admire / Provado)	E					E											F	E
malathion (malathion)	F				F	G									F			F
methomyl (Lannate)	F	G	G	G		F	G				G					F		
naled (Dibrom)	G	G	G	G					G	G	F		G			G		
permethrin (Ambush, Pounce)	G		E	E	G	G	G		G	G	G			G	E			
spinosad (Spintor)		G	G	G			E		G	E	E					G		
oxamyl (Vydate)	F							F								G	G	
New products																		
Pymetrozine (Fulfill)	E																	E
Thiomethoxam (Platinum / Actara)	E					E		G										
Cultural controls																		
planting date												G						
cultivation							F					G		F			F	
mowing													F					
crop rotation																	G	
sanitation														F				
weed control	P												F					
resistant varieties																		
Plastic mulches, reflective	P						F									F		
Insecticidal soap	F												F			P		
Insecticidal oils	F												F			F		

Rating scale: E = excellent; G = good; F = fair; P = poor, * when applied as an EC formulation.

Table 1. Re-entry Interval, and Post Harvest Interval of Commonly Used Pesticides in Cucurbit Production

Pesticide Class	Common name (Active Ingredient)	Trade name	Signal word	REI	PHI	Crop				
						Cantaloupe	Cucumber	Pumpkin / winter squash	Summer Squash	Watermelon
aliphatic organothiophosphate	malathion	malathion and others	Caution	12 hrs	3 days	-	x	-	x	-
oxime carbamate	Oxamyl	Vydate (RUP)	Danger	48 hrs	1 day	x	x	x	x	x
organothiophosphate	Azinphos-methyl	Guthion (RUP)	Danger	48 hrs	7 day	x	x	-	-	x
aliphatic organothiophosphate	oxydemeton-methyl	Metasystox-R (RUP)*	Warning	various	3-14 day	x	x	x	x	x
biological	Bacillus Thuringiensis	various	Caution	4 hr	0-day	x	x	x	x	x
inhibits chitin biosynthesis	Cyromazine	Trigard	Caution	12 hrs	0-day	x	x	x	x	x
nitroguanidine	Thiamethoxam	Platinum Actara	Caution	12 hrs	30-days 0-day	x	x	x	x	x
Feeding blocker	Pymetrozine	Fulfill	Caution	12 hrs	14 days	x	x	x	x	x
potassium salt	Insecticidal soap	M-pede	Warning	12 hrs	0-day	x	x	x	x	x
botanical	Neem Oil	Trilogy	Caution	4 hrs	0-day	x	x	x	x	x
Herbicide										
Organophosphorus	Bensulide	Prefar	Caution	12 hrs	0-day	x	x	x	x	x
Cyclohexene oxime	Clethodim	Select	Warning	24 hrs	14 days	x	x	x	x	x
NA	Clomazone	Command*	Warning	12 hrs	0-day	x	x	x	x	x
Dinitroaniline	Ethalfluralin	Curbit	Danger	24 hrs	0-day	x	x	x	x	x
Organophosphorus	Glyphosate	Roundup	Warning	12 hrs	0-day	x	x	x	x	x
Amide	Naptalam	Alanap	Warning	48 hrs	0-day	x	x	--	--	x

Pesticide Class	Common name (Active Ingredient)	Trade name	Signal word	REI	PHI	Crop				
						Cantaloupe	Cucumber	Pumpkin / winter squash	Summer Squash	Watermelon
Quaternary ammonium	Paraquat (RUP)	Gramoxone / Boa	Danger	12 hrs	0-day	x	x	x	x	x
Cyclohexene oxime	Sethoxydim	Poast	Warning	12 hrs	14 days	x	x	x	x	x
Fungicide										
nitrile	Chlorothalonil	Bravo	Warn - Danger	48 hrs	0-day	x	x	x	x	x
ethylenebisdithiocarbamate	Mancozeb	Dithane	Caution	24 hrs	5 days	x	x	--	x	x
ethylenebisdithiocarbamate	Maneb	Maneb	Caution	24 hrs	5 days	x	x	--	x	x
acylalanine	Mefenoxam	Ridomil Gold	Caution	48 hrs	0-day	x	x	x	x	x
strobilurin	Aoxystrobin	Quadris	Caution	4 hrs	1 day	x	x	x	x	x
conazole	Myclobutanil	Nova	Caution	24 hrs	0-day	x	x	x	x	x
strobilurin	Trifloxystrobin	Flint	Caution	12 hrs	0-day	x	x	x	x	x
strobilurin	Pyraclostrobin	Cabrio	Caution	12 hrs	0-day	x	x	x	x	x
sterol-inhibitor	Triflumizole	Procure	Caution	12 hrs	0-day	x	x	x	x	x
benzamide and EBDC	Zoxamide and mancozeb	Gavel	Caution	48 hrs	5 day	x	x	x	x	x
inorganic	Sulfur	various names	Caution	24 hrs	0-day	x	x	--	x	--
copper	Copper	various	Caution	12 hrs	0-day	x	x	x	x	x
organophosphorus	Fosetyl-Aluminum	Aliette*	Caution	12 hrs	1 day	x	x	x	x	x
benzimidazolylcarbamate	Benomyl	Benlate*	Caution	24 hrs	1 day	x	x	x	x	x

x = Indicates product labeled for use.

* Spinosad: cucumber has a 1-day PHI, benomyl: cantaloupe has 0day PHI, oxydemeton-methyl: Pumpkins, winter squash, cantaloupe, have 14-day PHIs, watermelon has 7-day PHI, summer squash and cucumbers have 3-day PHI. Dibrom/naled: 0-day PHI for cucumber, 1-day for others, Aliette 80WDG: Blount and Lincoln counties have endangered species act restrictions. Clomazone not to be used on Jack-o-lantern pumpkins, NK530, NK580, Turks Turban, Golden Delicious, all banana types and all other *Cucurbita maxima* types that have a pink or burnt orange coloration at harvest. Unacceptable whiting may occur in these types. Foliar applications of imidacloprid have a 0-day PHI.

Cucurbit Insect Management

Table 3, ALTERNATIVE MANAGEMENT TOOLS AVAILABLE

FOR CUCURBIT PRODUCTION

Pest	Naturally Occurring Biological Control Organisms	Commodity				
		Cantaloupe	Cucumber	Pumpkin / winter squash	Summer squash	Watermelon
Aphid	Lady beetles, lacewings, midges, Aphidiid wasps and stink bug predators	X	X	X	X	X
Cabbage lopper	Trichogramma wasps, Encyrtidae, lacewing, Pteromalidae, and BTK	X	X			X
Cucumber beetle	Soldier beetle, braconid wasps, and parastic nemotodes. Drench soil with parastic nematodes weekly to control larvae.	X	X	X	X	X
Flea beetle	Braconids, and soil drench with parastic nematodes.		X			
Cutworm	Moist bran mixed with BTK and molasses on soil surface.	X	X	X	X	X
Leafminer	Eulophidae, lacewing and attract parastic wasps. Spray plants with neem	X	X		X	X
Pickleworm	Eucoilidae and parastic nematodes	X	X			
	Tolerant cultivars				X	
Spider mite	Lady beetle, predator mites, and lacewings		X			X
Thrips	Flower bug, lacewings, and predatory mites.	X	X			X
Whitefliy	Lace wings, and *Encarsia formosa*.		X			
Leafhoppers	Lace wings and flower bug	X				X
Corn earworm	Flower bug, Trichogramma wasps, lacewing, Ichneumonid wasps and Preomalidae			X		
Squash bug	Tolerant cultivars			X		
Squash Vine borer	Tolerant cultivars			X	X	

Cucurbit Insect Management

Table 4, ALTERNATIVE MANAGEMENT TOOLS

Pest	Alternative Control Procedures	Commodity				
		Cantaloupe	Cucumber	Pumpkin / winter squash	Summer squash	Watermelon
Aphid	Wash with strong spray of water, or spray with insecticidal soap, neem or insecticidal oil.	X	X	X	X	X
Cabbage looper	Hand pick or spray with insecticidal soap, neem, pyrethrins, rotenone, BTK or insecticidal oil.	X				X
Corn earworm	Spray with insecticidal soaps, neem, pyrethrin, rotenone, BTK or insecticidal oil	X	X	X	X	
Cucumber beetle	Spray with insecticidal soap, pyrethrins, neem, drench soil with parastic nematodes weekly to control larvae.	X	X	X	X	X
Flea beetle	Drench soil with parastic nematodes. Spray with insecticidal soap, neem pyrethrins, rotenone, or insecticidal oil.	X				
Cutworm	Scatter bran mixed with BTK and molasses on bed surface or use protective collars.	X	X	X	X	X
Leaf hopper	Spray with insecticidal soap, neem, pyrethrins, rotenone, BTSD or insecticidal oil.	X				X
Leafminer	Hand pick and destroy mined leaves and remove egg clusters. Spray plants with neem.	X	X		X	X
Spider mite	Insecticidal oil	X	X			X
Squash bug	Hand pick adults, provide a board for them to hide under and then collect bugs. Insecticidal soap or oil.			X	X	
Squash vine borer	Choose borer tolerant cultivars. Cover plants with floating row covers until female flowers appear then use sprays containing insecticidal soap, pyrethrins, rotenone or BTK. Inject parasitic nematodes every 4” along infested stems.			X	X	
Thrips	Spray with insecticidal soap, or insecticidal oil.	X	X			X
Whitefly	Insecticidal oil	X				

Table 5, Relative effectiveness of disease-control products used in cucurbit production

	Disease					
Fungicide	**Alternaria Leaf Spot**	**Anthracnose**	**Downy Mildew**	**Gummy Stem Blight**	**Microdochium Blight**	**Powdery Mildew**
Benomyl	0	2	0	2	2	0 - 4[a]
Chlorothalonil	3	4	3	4	3	3
Copper, fixed	0	1	2	1	2	2
Thiophanate-methyl	0	2	0	2	2	0 - 4[a]
Trifloxystrobin	--	--	--	--	4	5
Maneb, Mancozeb	3	3	3	3	3	0
Mefenoxam	0	0	3	0	0	0
Metalaxyl	0	0	3	0	0	0
Myclobutanil	0	0	0	0	0	4
Azoxystrobin	4	4	3	4	2	4
Sulfur	0	0	0	0	0	4

Rated on a scale of 0 to 5, 0= no control, 1 = slight control, 2 = fair control (adequate only when conditions are unfavorable for the disease), 3 = moderate control (adequate in most seasons), 4 = very good control, 5 = excellent control. Modified from Table 5, in the "2002 Commercial Vegetable Disease, Insect and Weed Control" Publication 1282.

[a] The occurrence of resistance to benomyl and thiophanate-methyl in cucurbit powdery mildew populations results in unpredictable control by these materials.

Table 6, Relative efficacy of controls used for disease control in cucurbit production.

Method		Soilborne Diseases								Foliar Diseases														
		Charcoal rot	Fusarium wilt	Phytophthora	Pink root	Damping-off	Verticillium wilt	Nematodes		Alternaria leaf blight	Anthracnose	Cercospora leaf spot	Downy mildew	Gummy stem blight	Microdochium blight	Powdery mildew	Scab	Target leaf spot	Angular leaf spot	Bacterial fruit blotch*	Bacterial leaf spot	Bacterial rind necrosis*	Bacterial wilt	Viruses
Chemical applications																								
Soil applied fungicides	Protectants			P		G	F							F										
	Systemic			F		G	F						F	G										
Foliar applied fungicides	Protectants			P		P					G-E	E	G	G	E	E	G	E		F	G			
	Systemic			F		P						E	E	G		G								
Seed Treatments		P	P	P	P	G	P	P						F					G		G		F	
Nematocides								G																
Fumigants		P	G	G	G	E	G	E						G	P				E-G		G			
Cultural Methods																								
Deep Plowing					P	P				F	G								F	P	F			
Rotation		P	P	F		F	F	G		G	G	G		G			G		G	G	G			F
Resistant Varieties		F	G	P		P	G	G		P	G		F			G	G	G	G	F		G	F	G
Solarization		P	F	F	F	F	F	F			F						F		F		F			
Sanitation/residue management		G	P	P	F	P		P			G	G					F	G	F		F		F	P
Planting date						F	F						P			F								F
Plant spacing													F			0								
Mulching								P								0			G		G			
pH adjustment			F													0								
Water management				F	F	P							F	F		F	F		G		G			F
Raised beds				F		F											F							

Cucurbit Disease Management

Table 7, ALTERNATIVE MANAGEMENT TOOLS

Disease	Non-chemical Controls	Availability of Resistance Varieties				
		Cantaloupe	Cucumber	Pumkin / Winter squash	Summer squash	Watermelon
Alternaria leaf blight	Crop rotation	Yes	Yes			
Alternaria	Crop rotation		Yes			
Angular leaf spot (wilt suppression)	Disease free seed.		Yes		Yes	
Anthracnose	Spray with copper or bordeaux mix do not handle when leaves are wet and crop rotation.		Yes		No	Yes
Bacterial rind necrosis		N/A	Yes	N/A	N/A	N/A
Bacterial wilt	Control cucumber beetles and use copper sprays.	No	Yes			Yes
Belly rot	Plastic mulch		No			
Pythium (plant bed)	Increase aeration.	--	--	--	--	--
Downy mildew	Copper spray at first appearance; Remove and destroy severely infected plants, rotate and destroy residue.	No	Yes			No
Altemaria leaf spot	Crop rotation and spray with copper or bordeaux mix; do not handle wet leaves.		Yes			
Cercospora leaf spot	Two to three year rotation, copper spray at first appearance, remove and destroy severely infected plants, rotate and destroy crop residue		Yes		No	No
Cucumber mosaic			Yes		Yes	
Downy mildew	Use resistant or tolerant cultivars, copper spray at first appearance; Remove or destroy severely infected plants, rotate and destroy residue.	--	Yes		No	--
Fusarium root and stem rot	Clean seed, resistant cultivars and solarize soil before planting, three year rotation.	No	Yes		No	No
Fusarium wilt	Clean seed, resistant cultivars and solarize soil before planting, three year rotation, adjust pH to 6.5 and use all nitrate nitrogen.		No		No	
Gummy stem blight	Solarization, rotation, destroy crop residue	No	No		No	No
Scab			Yes		No	
Southern blight	Use deep plowing to bury sclerotia.		Yes		No	No
Target Spot			Yes			
Postharvest rots	Reduce storage temperatures	--	--	--	--	--
Powdery mildew	Spray with sulfur at first appearance of disease. Spray with copper or bordeaux mix. Do not handle when leaves are wet.	Yes	Yes		Yes	
Pythium Damping-off & fruit rot	Use raised beds to dry soil surface.	No	No		No	
Squash mosaic	Insecticidal oil and reflective mulch				Yes	
Watermelon mosaic II	Reflective mulch, row covers		Yes			
Zucchini yellows mosaic II	Reflective mulch, row covers		Yes			
Fusarium root and stem rot	Clean seed, resistant cultivars and solarize soil before planting. Three year rotation.	No				Yes
Fusarium wilt	Clean seed and solarize soil before planting, use three year rotation, adjust pH to 6.5, and use all nitrate nitrogen.		Yes			
Verticillium wilt	Solarize soil before planting. Use three year rotation.	Yes	Yes		Yes	Yes

Columns marked yes = available, columns marked no = not available at this time.
Columns marked N/A = not applicable, columns marked -- = may work, and blank columns = no information available.

Method		Soilborne Diseases								Foliar Diseases															
		Charcoal rot	Fusarium wilt	Phytophthora	Pink root	Damping-off	Verticillium wilt	Nematodes		Alternaria leaf blight	Anthracnose	Cercospora leaf spot	Downy mildew	Gummy stem blight	Microdochium blight	Powdery mildew	Scab	Target leaf spot	Angular leaf spot	Bacterial fruit blotch*	Bacterial leaf spot	Bacterial rind necrosis*	Bacterial wilt	Viruses
Insect Control								P		F													E	F
Nematode Control								G																
Weed management										F			P			P	F							P
Pathogen free seed																	G		G	G	G			

E = excellent, G = good, F = fair, P = poor, 0 = no control

*Bacterial fruit blotch and bacterial rind necrosis are diseases of watermelon

Table 8, PREEMERGENCE HERBICIDES: WEED RESPONSE IN CUCURBITS

Key to Weed Response Ratings: E = Excellent or 90% control or better; G = Good or 75 - 90% control; F = Fair or 50 - 75% control; P = Poor or control less than 50%; N = No activity; – = Lack of information. For a specific target weed(s), choose an appropriate herbicide or herbicide combination that provides excellent (E) to good control (G). Fair (F) to poor (P) control of additional weeds should be considered as added benefits to control of specific weeds. Ratings are based on application of labeled rates of each herbicide, applied at the optimum timing for each weed.

Weed Type and Species	ALANAP	COMMAND	CURBIT	PREFAR	POAST	SELECT	GRAMOXONE	ROUNDUP
Annual grasses								
barnyardgrass	G	E	E	E	G	G	G	G
crabgrasses	G	E	E	E	E	E	G	G
fall panicum	F	E	E	E	E	E	G	G
foxtails	G	E	E	E	E	E	G	G
goosegrass	G	E	E	E	E	E	G	G
johnsongrass (seedling)	G	P	E	G	E	E	G	G
signalgrass, broadleaf	F	E	G	G	G	G	G	G
Perennial Grasses								
bermudagrass (from seed)	P	P	P	P	F	G	P	G
dallisgrass (from seed)	P	P	P	P	G	G	P	G
fescue, tall (from seed)	P	P	P	P	G	E	P	G
johnsongrass (rhizome)	P	P	P	P	G	E	P	G
Sedges								
nutsedge, yellow	P	P	P	P	N	N	F	F
nutsedge, purple	P	P	P	P	N	N	F	F
Annual Broadleaf Weeds								
nightshades	P	-	G	P	N	N	G	G
chickweed, common	E	-	G	P	N	N	E	E
cocklebur	G	F	P	P	N	N	E	E
galinsoga	G	-	P	P	N	N	G	E
horseweed	-	-	-	-	N	N	G	G
jimsonweed	G	E	P	E	N	N	G	G
lambsquarters	E	G	G	G	N	N	G	G
morninglories (annual)	P	N	P	P	N	N	G	F
pigweeds	G	P	G	G	N	N	E	E
prickly sida (teaweed)	P	-	P	P	N	N	G	G
primrose, evening	-	G	-	-	N	N	F	F
smartweed	G	G	F	E	N	N	G	G
ragweed, common	G	-	P	P	N	N	G	E
wild mustards/radishes	-	-	-	-	N	N	G	G

Table 9, POST-EMERGENT HERBICIDES: WEED RESPONSE IN VEGETABLES

Key to Weed Response Ratings: E = Excellent or 90% control or better; G = Good or 75 - 90% control; F = Fair or 50 - 75% control; P = Poor or control less than 50%; N = No activity; - - = Lack of information. For a specific target weed(s), choose an appropriate herbicide that provides excellent (E) to good control (G). Fair (F) to poor (P) control of additional minor weeds should be considered as added benefits to control of specific weeds. Ratings are based on application of labeled rates of each herbicide, applied at the optimum timing for each weed.

	Herbicides					
	Non-residual					
	Grasses Only				Grasses and Broadleaf weeds	
	Systemic				Non-systemic	Systemic
Weed Type and Species	ASSURE	FUSILADE	POAST	SELECT	BOA GRAMOXONE	ROUNDUP
Annual grasses						
barnyardgrass	G	G	G	G	G	G
crabgrasses	G	E	E	E	G	G
fall panicum	G	E	E	E	G	G
foxtails	G	G	E	E	G	G
goosegrass	G	G	E	E	G	G
johnsongrass (seedling)	E	E	E	E	G	G
signalgrass, broadleaf	G	G	G	G	G	G
Perennial Grasses						
bermudagrass	G	G	F	G	P	G
dallisgrass	G	G	G	G	P	G
fescue, tall	G	E	G	E	P	G
johnsongrass (rhizome)	E	F	G	E	P	G
Sedges						
nutsedge, yellow	N	N	N	N	F	F
nutsedge, purple	N	N	N	N	F	F
Annual Broadleaf Weeds						
nightshades	N	N	N	N	G	G
chickweed, common	N	N	N	N	E	E
cocklebur	N	N	N	N	E	E
galinsoga	N	N	N	N	G	E

Weed Type and Species	ASSURE	FUSILADE	POAST	SELECT	BOA GRAMOXONE	ROUNDUP
horseweed	N	N	N	N	G	G
jimsonweed	N	N	N	N	G	G
lambsquarters	N	N	N	N	E	G
morninglories (annual)	N	N	N	N	G	F
pigweeds	N	N	N	N	E	E
prickly sida (teaweed)	N	N	N	N	G	G
primrose, evening	N	N	N	N	F	F
smartweed	N	N	N	N	G	G
ragweed, common	N	N	N	N	G	E
wild mustards/radishes	N	N	N	N	G	G