Crop Profile for Cucumbers in Virginia

Prepared: March 2005

General Production Facts[1]

- In 2002, 4,300 acres of cucumbers were planted, and 3,500 acres were harvested in Virginia.
- Cucumber production in Virginia averaged 90 cwt./acre or 9,000 lbs./acre in 2002.
- A total of 315,000 cwt. or 31,500,000 lbs. of fresh market cucumbers were produced in Virginia in 2002.
- The 2002 crop was valued at $5,040,000 or roughly $16.00/ cwt. ($0.16/lb.).
- Virginia ranked 9th of 11 cucumber-growing states, accounting for 3.95% of the national cucumber production in 2002.

Production Regions[2]

Accomack, Caroline, Northampton, and Westmoreland counties are the principal cucumber-producing counties in Virginia.

Cultural Practices[3], [4], [5], [6]

The cucumber, *Cucumis sativus*, is a warm-season annual with a prostrate vining growth habit. The plant produces stiff hairs on the leaves and stems that can be irritating to human skin when touched. Cucumbers are succulent and therefore sensitive to moisture stress. Ideal growing temperature is 82°F, with slower growth occurring at temperatures above 90°F and below 60°F.

In Virginia, both pickling and slicing varieties are grown. Variety selection often depends on such factors as market acceptability, yield, and horticultural characteristics. For early cucumber production and for higher, more concentrated yields, growers use gynoecious varieties. A gynoecious plant produces only female (fruit-producing) flowers. To produce pollen, 1% - 15% of the pollinator variety must be planted; seedsmen will add this seed to the gynoecious variety. Gyneocious varieties, used for slicing, include: *Dasher II*, *Raider*, *Speedway*, *Striker*, and *Thunder*. *Cyclone* is the only monoecious variety recommended, and *Lafayette* is the only pickling variety recommended. All of the varieties mentioned are hybrids. Environmental stress influences sex expressions, with high temperatures and long days promoting male flower development. Higher plant populations and low moisture will also promote production of male flowers.

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Cucumbers require well-drained soils. Best growth is obtained with soil pH in the range of 6.0-7.0. Fertility requirements depend upon soil type, with higher nitrogen requirements in light, sandy soils than in the heavier soils. To avoid periods of drought, irrigation is essential for production of market quality fruit in sandy soils.

For summer cucumbers, planting dates occur between April 1 and May 15; for fall cucumbers, planting begins mid-July to mid-August.

When mulching, clear plastic mulch is laid before field plantings. This conserves moisture, increases soil temperature, and increases early total yield. Fumigated soil helps control weeds and soilborne disease. Plastic and fumigant are applied on well-prepared planting beds 30 days before field planting. Plastic should be 4 ft. wide and is laid on 5- or 6- ft. centers immediately over the fumigated soil. The soil must be moist when laying the plastic. Fumigation alone may not provide satisfactory weed control under clear plastic. Herbicides labeled and recommended for use on cucumbers may not provide satisfactory weed control when used under clear plastic mulch on nonfumigated soil. You should consult your local county Extension agent for the latest recommendations. Black plastic or paper can be used without an herbicide. Fertilizer must be applied during bed preparation. At least 50% of its nitrogen should be in the nitrate form. Foils and highly reflective mulches can be used to repel aphids that transmit mosaic in fall-planted cucurbits. Direct seeding through the mulch is recommended for maximum virus protection. Transplants should not be used with foil mulches. Also, an herbicide is not necessary. Fumigation is necessary only when there is a history of soilborne diseases in the field.

The recommended spacing for slicing cucumbers is 3-6 ft. between rows with 7-12 inches between plants in the row.

Honeybees are important for proper set and pollination. Populations of pollinating insects may be harmed by insecticides applied to flowers or weeds in bloom. Apply insecticides are applied only in the evening hours or until after bloom is completed.

Harvest dates typically range from the middle of June through the end of August for summer cucumbers and from September to the beginning of November for fall cucumbers. When harvesting cucumbers for fresh market, the process is repetitive. They are usually picked by hand. If old fruit is allowed to remain on the vine, new fruit will not set. The fresh market cucumbers need to be less than 2-3/8 inches in diameter when harvested. The length should be at least 5.5 inches and can be up to 6-9 inches. Cucumbers grow very quickly, and in warm weather they can have a 40% increase in weight in 24 hours. Generally, fresh market cucumbers are harvested every two to three days. Pickles are harvested mechanically in once-over harvest. The crop is separated into sizes determined by the processor.

Worker Activities

During the growing season, worker activities in the field include planting (April-May and July-August), cultivating, irrigating, scouting, spraying, occasionally hand weeding and harvesting (June-August and September-November) fresh market cucumbers. Strictly following re-entry intervals (REIs) should minimize any risk of exposure to pesticides during these activities. If workers are required to go back in the field before the proper time limit has expired then personal protective equipment (PPE) is worn. Activities that bring workers in direct contact with the plants during the growing season are generally limited to periods of hand

harvesting.

Special Use Labels

Section 18 Emergency Use Exemption and Special Local Need 24(c) labels are used to supplement the pest controls available to producers. Once the problem or gap in pest control has been identified, specialists submit the proper documentation for the Emergency Use/Special Local Need label. Thus far, Extension specialists have been successful in obtaining these labels. Special Local Need (SLN) labels in Virginia are granted by the Virginia Department of Agriculture and Consumer Services (VDACS) and are usually only valid for limited time intervals. Section 18 Emergency Use labels are evaluated and granted by the Environmental Protection Agency (EPA) and can be renewed annually. Without these temporary use labels, pest control can be extremely difficult for producers.

Insect Pests

Control recommendations found below were modified from information presented in the 2004 Commercial Vegetable Production Recommendations-Virginia[7], unless otherwise noted.

INSECTS[8]

In general, cucumber beetles are the most economically important insect pests of cucumber in Virginia. Other important pests include: spider mites, which can be particularly devastating in hot, dry years, and aphids, especially after cool springs. Other minor pests include: seedcorn maggots, serpentine leafminers, pickleworms, cabbage loopers, and cutworms.

Aphids
Green Peach Aphid, *Myzus persicae*
Melon Aphid, *Aphis gossypii*

Both the green peach aphid and the melon aphid are pests on cucumber. However, the latter is the primary species infesting cucumber plants in Virginia. In general, aphids feed on plant sap, which may reduce plant vigor, size, and yield. Also, as they feed on the underside of the leaves, aphids excrete honeydew. This, in turn, leads to the growth of black, sooty mold, which may block out sunlight and thus reduce plant yield. In addition, aphids can vector certain plant viruses. In particular, the melon aphid is instrumental in transmitting the cucumber mosaic virus, which can be devastating to cucumber production.

Monitoring: If a systemic insecticide such as imidacloprid or thiamethoxam is not applied at planting, then aphid scouting is recommended. Scouting for melon aphids should begin as soon as plants form runners. Examine two runners at five sites in the field. Record the number of runners with live aphids present. Treatment is recommended if >20% of runners have aphids.

Chemical Control: Early infestations often occur in spots; therefore, spot treatments may be effective, or an at-planting, systemic insecticide such as imidacloprid or thiamethoxam. Thorough spray coverage beneath

leaves is important. Treat seedlings every five to seven days or as needed. See the *Chemical Insect Control* section for recommendations.

Biological Control: A number of natural enemies such as lady beetles (adults and larvae), lacewing larvae, syrphid larvae, parasitic wasps, and fungal pathogens will reduce aphid populations. Natural enemies will often keep aphid populations below damaging numbers and, therefore, should be considered before an insecticide application. However, if the spread of virus is of concern, chemical treatment will be necessary.

Cultural Control: Many cucumber varieties are resistant to plant viruses and should be considered in the pest management decision-making process for aphids. Plant disease-free certified seed. Avoid planting fields immediately downwind of a barrier such as hedgerows or woodlots, which reduce wind velocity and increase the number of dispersing aphids falling into fields. These barriers can also cause overfertilization with nitrogen, which results in lush growth attractive to aphids. Foil or highly reflective mulches may aid in repelling aphids.

Cabbage Looper, ***Trichoplusia ni***

Cabbage loopers may be identified by their pale green color, thin white stripes down the back and sides, and their doubling-up or looping movement. These insects feed on the underside of leaves, producing ragged holes of various sizes. Feeding begins in late July or early August and usually continues through harvest. Healthy plants can usually sustain feeding injury unless populations become exceedingly large. Several generations can occur during a year. Loopers are not usually serious pests of cucumber in Virginia.

Monitoring: Check leaf-feeding levels in the field at least weekly. Healthy and older plants can usually withstand moderate defoliation before economic yield loss to the fruit occurs. Monitored moth activity with blacklight traps may not be effective with this particular species. Pheromone traps might be a better option.

Chemical Control: See the *Chemical Insect Control* section for recommendations.

Biological Control: There are several parasitic wasps and predators that attack the cabbage looper. Also, a nuclear polyhedrosis virus (NPV) can substantially reduce population levels of larvae, especially after a period of precipitation.

Cultural Control: No current recommendations for commercial production.

Cucumber Beetles (Rindworms)
Spotted Cucumber Beetle, ***Diabrotica undecimpunctata howardi***
Striped Cucumber Beetle, ***Acalymma vittata***

Both the spotted and striped cucumber beetles (adults and larvae) may severely reduce cucumber productivity. These pests are the number one concern of growers in Virginia. The striped cucumber beetle has three black stripes along the length of its body, and the spotted cucumber beetle has 12 black spots on its back. Adults overwinter in wooded areas and fields, migrating in the spring to cucurbit crops. Adults mass on plants and feed voraciously on the foliage and stems, often causing girdling, which will greatly reduce plant stands.

Adults will also feed on the blossoms of developing plants, causing later scarring of the fruit[9]. Cucumber beetles also transmit bacterial wilt, although many cucumber varieties are resistant to this bacterium.

In addition to the damage adult cucumber beetles cause, the larval stage, otherwise known as a rindworm, feeds directly on the roots. Management of adult populations is necessary to reduce the number of rindworms (larvae) present. Direct control of rindworms can be difficult.

Monitoring: Begin weekly scouting for beetles following transplant or as soon as the plants emerge. Treat when an average of two beetles/plant are found.

Chemical Control: On farms with a history of bacterial wilt infections and where susceptible varieties are used, foliar insecticides should be used to control adult beetles before they feed extensively on the cotyledons and first true leaves. Began spraying shortly after plant emergence, and repeat applications at weekly intervals if new beetles continue to invade fields. Treatments may be required until vines begin to run (usually about three weeks after plant emergence). To provide additional pest control, a **Special Local Need 24(c) label** has been approved in Virginia for the use of carbofuran (*Furadan* 4F) at planting. See the *Chemical Insect Control* section for more information.

Biological Control: No current recommendations for commercial production.

Cultural Control: Plant varieties resistant to bacterial wilt. Always cultivate the soil thoroughly before planting. The use of plastic or straw as bedding for the developing fruit may deter rindworm feeding. In the fall, eliminating surrounding weeds will reduce the overwintering sites for the beetles.

Cutworms
Black Cutworm, *Agrotis ipsilon*
Variegated Cutworm, *Peridroma saucia*
Granulate Cutworm, *Feltia subterranea*

Cutworms are sporadic pests of numerous crops. Several species of cutworm may be found in Virginia. Most are night feeders that hide under plant and soil debris common in weedy or minimum-tillage fields. Another distinguishing quality is their habit of rolling into a tight C-shape if disturbed. Newly hatched cutworm larvae feed on young plants at the soil line, often severing the stems. Later generations of cutworms feed on developing fruit and in severe cases may tunnel completely through the fruit, greatly diminishing marketability.

Monitoring: Even if a preplant broadcast insecticide treatment is used, fields should be scouted for cutworm damage within a week of planting or plant emergence. Cutworms are not typically seen in the open during the day; however, digging the soil around injured plants may reveal their presence. If cutworms are actively cutting plants, a postplanting contact treatment may be used.

Chemical Control: See the *Chemical Insect Control* section for recommendations.

Biological Control: Cutworms are attacked by numerous ground-dwelling insect predators, especially carabid beetles. Also, pathogens such as *Beauveria bassiana* and entomopathenogenic nematodes often will infect

larvae.

Cultural Control: Proper tillage will help eliminate some species of cutworms that may move off of cover crops.

Leafminers
Serpentine Leafminer, *Liriomyza brassicae trifolii*

Leafminers cause injury primarily by their mining of leaves, which results in the destruction of leaf mesophyll tissue. As the larvae hatch from eggs deposited within the leaf tissue, they create slender, winding, white tunnels in their search for food. Mature larvae emerge from inside the leaf and drop to the soil, where they pupate in soil crevices or, in rare cases, the leaf. Leaf mining depresses the level of photosynthesis and may result in leaf droppage. Fewer leaves in the canopy can result in sunscalding of fruit. Many generations occur annually in Virginia, but the first is usually the most damaging.

Monitoring: The economic consequences of leaf mining are not well understood; thus, adequate scouting procedures have not been developed.

Chemical Control: See the *Chemical Insect Control* section for recommendations.

Biological Control: Parasitoids often provide excellent suppression of leafminers if broad-spectrum insecticides are not applied to the crop.

Cultural Control: No current recommendations for commercial production.

Pickleworm, *Diaphania nitidalis*
Melonworm, *Diaphania hyalinata*

The melonworm is generally a foliage feeder (unlike the pickleworm, which attacks the developing leaf and flower buds) but also damage the vines and fruit. The adults overwinter in the warmer southern regions of the United States and migrate north when temperatures warm. Females deposit eggs on the leaf surface. The larvae emerge several days later, feeding on the flowers, vines, and fruit for up to two weeks. Although several generations can occur during a year, pickleworm and melonworm are rarely serious pests of cucumbers in Virginia.

Monitoring: As soon as pickleworms or their damage appears, begin insecticide treatments.

Chemical Control: Make one treatment before fruit set, and then treat weekly. See the *Chemical Insect Control* section for recommendations.

Biological Control: No current recommendations for commercial production.

Cultural Control: After harvest, remove all debris from the field, destroy vines and unused fruit, and control adjoining weeds. Also, plowing early in the fall will bury the pupae. In the spring, planting early will help the

crop establish itself, thus preventing major damage. Resistant varieties are also available.

Seedcorn Maggot, *Hylemya platura*

The seedcorn maggot is most noted for its damage to seeds or seedlings in bedding trays and early-planted fields, especially during cool, wet growing seasons. Adults emerge in early spring to lay their eggs, preferably in moist, organically rich soils, such as freshly plowed fields or greenhouse flats. Larvae or maggots hatch from the eggs and bore into seeds, cotyledons, or rotting crop debris. The maggots feed for one to three weeks before tunneling into the soil, where they pupate for a period of about one to four weeks or for the duration of the winter. Multiple generations occur annually in Virginia.

Monitoring: Once seedcorn maggot damage has been observed, treatments are ineffective. Therefore, management options must be applied to high-risk fields before planting. High-risk fields can be defined as those having previous seedcorn maggot infestations or high soils high in organic matter.

Chemical Control: Seed treatments containing malathion or lindane or seed commercially treated at low rates for seed storage will **NOT** control seedcorn maggots. *It is prohibited to use treated seed for food or feed.* The use of imidacloprid (*Admire* 2F) at planting will reduce seedcorn maggot populations. See the *Chemical Insect Control* section for recommendations.

Biological Control: No current recommendations for commercial production.

Cultural Control: Several management practices can be used to reduce the potential for damage resulting from seedcorn maggot infestations. These include plowing weeds or cover crops at least two weeks before planting or transplanting, avoiding overfertilization with manure, and completely plowing under crop debris immediately after harvest to remove plant remnants.

Two-Spotted Spider Mites, *Tetranychus urticae*

Spider mites can be a very serious pest of cucumbers. Typically, they feed on the undersides of leaves, often causing them to turn brown and fall off. Severe infestations, especially of smaller, stressed plants, may result in death. Mite problems are often associated with hot, dry weather and, as such, have become a regular occurrence in Virginia during years with low rainfall.

Monitoring: Scout fields, especially areas that border roadsides or weedy edges or areas of the field that are sandy. Examine both the upper and lower sides of five crown leaves from 5 to 10 locations and look for white stippling. Also note the condition of terminal leaves. Treatment should be made when 10% -15% of the crown leaves are infested in the early season, or when 50% of the terminal leaves are infested later in the season.

Chemical Control: Spot treatment of "hot spots" and areas along the edges of fields is recommended to control mite populations when problems are first noticed. Use of dimethoate for leafminer control will reduce mite populations. The products *Agri-Mek, Capture, Danitol,* and *Kelthane* are excellent miticides. Continuous use of carbofuran (*Furadan*) and carbaryl (*Sevin*), or pyrethroids without miticidal activity for other pests, may result in mite outbreaks. See the *Chemical Insect Control* section for more information.

Biological Control: Natural predators and diseases of mites are present in fields, but rarely at levels high enough for adequate control during outbreaks.

Cultural Control: If possible, avoid mowing field margins and grassy areas until after midsummer since this forces mites into the crop.

Chemical Insect Control

The list below contains all of the products available to producers in Virginia for insect control in cucumbers along with the recommended application rates. Always consult the label before making an application. **PHI** = Pre-Harvest Interval. **REI** = Re-Entry Interval.

- **abamectin -** (*Agri-Mek* 0.15EC) - PHI - 7 days. Avermectin. For control of leafminers and mites, apply at a rate of 0.009-0.019 lb. a.i./A. Do **NOT** exceed 0.056 lb. a.i./A/season, and do not make more than two sequential applications. REI - 12 hours
- **azinophos-methyl** (*Guthion* 2L) - PHI - 1 day. Organophosphate. For the control of cucumber beetles, apply at a rate of 0.50 lb. a.i./A. Do **NOT** apply more than three times per season. REI - 5 days. *Registration will be discontinued by 2005*.
- ***Bacillus thuringiensis*** (various formulations) - PHI - 0 days. Microbial. For the control of cabbage looper, consult various labels for rates and restrictions. REI - 4 hours.
- **bifenthrin** (*Capture* 2EC) - PHI - 3 days. Pyrethroid. For control of cabbage loopers, cucumber beetles, cutworms, and rindworms, apply at a rate of 0.04-0.10 lb. a.i./A. For control of two-spotted spider mite, apply at a rate of 0.08-0.10 lb. a.i./A. Do **NOT** apply more than 0.30 lb. a.i./A per season. REI - 24 hours.
- **carbaryl** (*Sevin* 80S) - PHI - 3 days. Carbamate. For control of pickleworm and melonworm, apply at a rate of 0.5-1.0 lb. a.i./A. For control of cucumber beetle, apply at a rate of 1.0 lb. a.i./A. Do **NOT** apply more than 6.0 lb. a.i./A per crop. REI - 12 hours. *Carbaryl is not used as extensively now because of its high toxicity to bees.*
- **carbofuran** (*Furadan* 4F) - PHI - at plant. Carbamate. Apply 0.12 lb. a.i./1,000 linear ft. of row in-furrow at planting for control of cucumber beetle. *Furadan* may be mixed with water or liquid fertilizer. Do **NOT** use this product through any type of irritation system. Use of *Furadan* at planting frequently leads to spider mite outbreaks later in the season. Consult your local county Extension office for current restrictions - **Special Local Need 24(c) label**. REI - 48 hours.
- **cyromazine** (*Trigard* 75WSP) - PHI - 7 days. Triazine. For leafminer control, apply 0.12 lb. a.i./A as a foliar spray when leafminers first appear. Do **NOT** make more than six applications per season. REI - 12 hours.
- **dicofol** (*Kelthane* 50WP) - PHI - 2 days. Chlorinated hydrocarbon. For mite control, apply at a rate of 0.63 lb. a.i./A. Do **NOT** feed treated crops or crop residues to animals, and do **NOT** make more than two applications per season. REI - 12 hours.
- **endosulfan** (*Thionex* 3EC) - PHI - 2 days. Pyrethroid. For control of cucumber beetles, pickleworm, melonworm, green peach aphid, melon aphid, and rindworms, apply at a rate of 0.5-1.0 lb. a.i./A. Do **NOT** apply more than six times per season. Do **NOT** exceed more than 3.0 lb. .a.i./A/season. REI - 24 hours.
- **esfenvalerate** (*Asana* XL) - PHI - 3 days. Pyrethroid. For control of cucumber beetles, cutworms, pickleworms, melonworms, rindworms, and cabbage looper, apply at a rate of 0.03-0.05 lb. a.i./A. Do

NOT exceed 0.25 lb. a.i./A per season. REI - 12 hours.

- **fenpropathrin** (*Danitol* 2.4EC) - PHI - 7 days. Pyrethroid. For control of spider mites, apply at a rate of 0.20 lb. a.i./A. REI - 48 hours.
- **imidacloprid** (*Admire* 2F) - PHI - 21 days. Chloronicotinyl. For control of cucumber beetles, green peach aphid, melon aphid, and seedcorn maggot, apply at a rate of 0.25-0.38 lb a.i./A. Do **NOT** apply more than 0.5 lb. a.i./A/year. REI - 12 hours.
- **methomyl** (*Lannate* LV) - PHI - 3 days. Organophosphate. For control of cucumber beetles, cutworms, pickleworms, melonworms, green peach aphids, melon aphids, and cabbage loopers, apply at a rate of 0.45-0.90 lb. a.i./A. Do **NOT** apply more than 5.4 lb. a.i./A per crop, and do not make more than 12 applications. REI - 48 hours.
- **oxamyl** (*Vydate* L 2L) - PHI - 1 day. Carbamate. For the control of leafminers, apply at a rate of 0.50-1.00 lb. a.i./A. Do **NOT** apply more than 6 lb. a.i./A per season. REI - 48 hours.
- **oxydemeton-methyl** (*Metasystox*-R 2SC) - PHI - 3 days. Organophosphate. For control of aphids and mites, apply at a rate of 0.38-0.50 lb. a.i./A. Do **NOT** apply more than twice per season. REI - 48 hours.
- **permethrin** (*Ambush* 2EC) - PHI - 0 days. Pyrethroid. For the control of cucumber beetle, cabbage looper, pickleworms, and melonworms, apply at a rate of 0.10-0.20 lb. a.i./A. REI - 24 hours. (*Pounce* 3.2EC) - PHI - 0 days. Pyrethroid. For the control of cucumber beetle, cabbage looper, pickleworms, and melonworms, apply at a rate of 0.10-0.20 lb. a.i./A. REI - 12 hours.
- **pymetrozine** (*Fulfill* 50WP) - PHI - 14 days. Pyridine azomethine. For control of green peach aphids and melon aphids, apply at a rate of 0.09 lb. a.i./A. Do **NOT** exceed 0.20 lb. a.i./A per season. REI - 12 hours.
- **spinosad** (*SpinTor* 2SC) - PHI - 1 day. Spinosad. For control of leafminers, apply at a rate of 0.09-0.13 lb. a.i./A. For control of cabbage loopers, melonworms, pickleworms, and rindworms, apply at a rate of 0.06-0.13 lb. a.i./A. Do **NOT** exceed 0.45 lb. a.i./A per season. REI - 4 hours.
- **thiamethoxam** (*Actara* 25 WDG) - PHI - 0 days. Nicotinoid. For control of aphids, apply at a rate of 0.03-0.05 lb. a.i./A. Do **NOT** exceed 0.125 lb. a.i./A per season. REI - 12 hours. (*Platinum* 2SG) - PHI - 30 days. Nicotinoid. For control of aphids, apply at a rate of 0.078-0.125 lb. a.i./A. Do **NOT** exceed 0.125 lb. a.i./A per season or use less than 0.078 lb. a.i./A per season. REI - 12 hours.

Pesticide Use Date - % Acres Treated

Insecticide	1993	1997	2004	Growers' Needs
bifenthrin	N/A	N/A	70.0	*critical*
carbaryl	18.0	7.0	5.0	
carbofuran*	N/A	N/A	25.0	*critical*
diazinon	4.0	N/A	N/A	
endosulfan	18.0	18.0	18.0	
esfenvalerate	11.0	10.0	5.0	
imidacloprid	N/A	N/A	50.0	*critical*
kelthane	N/A	N/A	20.0	
methomyl	18.0	5.0	5.0	
permethrin	N/A	N/A	5.0	
thiamethoxam	N/A	N/A	50.0	*critical*

*24(c) label for *Furadan* 4F labeled at planting on bare ground in VA, some growers still use it.

Disease Pests

Control recommendations found below were modified from information presented in the 2004 Commercial Vegetable Production Recommendations-Virginia[10]

DISEASES

Disease in cucumbers can slow down development and injure the leaves and fruit, greatly reducing the yield and making the crop less profitable. Each of the diseases listed below occurs within Virginia and depends primarily on weather conditions but also on several other factors. These factors include site location, seed quality, and effective management procedures. Good sanitation and management practices are key to a successful disease-control program. Downy mildew and anthracnose are the most common foliar diseases in cucumber. Cottony leak, anthracnose, and belly rot are the most important fruit rots in Virginia.

Angular Leaf Spot, *Pseudomonas syringae* pv. *lachrymans*

This disease can attack the leaves, stems, and fruit of cucurbit plants. It causes minute, angular, water-soaked lesions on the leaves that later become sunken and brown. In humid conditions, a milky white exudate forms on the lesions and later dries to a chalky-white crust. Leaves that are heavily infected may eventually turn yellow. On the fruit, the bacterium causes circular spots that eventually crack open, turning white. This can leave the fruit vulnerable to secondary bacterial soft rot. However, most cultivars today possess good resistance to this disease, and the fruit rot phase is rarely seen. Angular leaf spot favors high humidity and is easily spread in the field by cultivation equipment, harvesters, and wind-blown rain. Angular leaf spot is an occasional problem for growers in Virginia.

Monitoring: Scout when weather conditions are hot and humid and daytime relative humidity remains high.

Check nonresistant cultivars more carefully. Send leaves with small, water-soaked, greenish-yellow to tan leaf spots should be sent to a disease identification laboratory for analysis.

Chemical Control: At the first sign of disease, add the labeled rate of fixed copper *plus* mancozeb. Repeat every seven days. See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Avoid overhead irrigation and working among plants when foliage is wet. Rotate infested fields out of cucurbits for at least two years. Also, use pathogen-free seed produced in arid regions where the disease is not a problem. Whenever possible, plant resistant cultivars.

Anthracnose, *Colletotrichum orbiculare*

An infection first appears on the leaves as a yellowish or water-soaked area that quickly enlarges, turns brown, and shatters to form a ragged hole. On the fruit, symptoms appear as sunken lesions colored by salmon or pink spore masses. They tend to only occur when anthracnose-susceptible cultivars are planted.

Monitoring: Frequent rains and humid weather promote the development and spread of the disease. Wind, raindrops, and anything moving from vine to vine can carry and spread the spores from plant to plant.

Chemical Control: Begin fungicide applications when vines run, or earlier if symptoms are detected. Alternate chlorothalonil or mancozeb with pyraclostrobin(*Cabrio*) or azoxystrobin (*Quadris*) every seven days. This is especially important to delay the development of resistant strains of the pathogen to pyraclostrobin (*Cabrio*) or azoxystrobin (*Quadris*). See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Some varieties offer excellent resistance, so use them whenever possible. For disease control in susceptible varieties, it is important to combine protectant fungicide applications with seed treatments and crop rotation with noncucurbits. If infection does occur, know that the disease overwinters in infected seeds, leaf litter, and plant debris and can remain in the soil for several years. After harvest, be sure to remove all plant debris to avoid a possible re-infection.

Bacterial Wilt, *Erwinia tracheiphila*

Bacterial wilt is a bacterial disease that affects the vascular system of the plant. The disease causes wilt in the infected branches and eventually spreads to the entire plant, killing it. The bacterium is transmitted by feeding of the overwintering generation of cucumber beetles. The disease is often seen in early- to mid-season cucumbers. Bacterial wilt can lead to serious yield loss for both small- and large-scale farm operations.

Monitoring: Weekly scouting for cucumber beetles should begin following transplant or as soon as the plants emerge. When an average of two beetles per plant is found, start a treatment plan. To confirm the presence of

bacterial wilt, cut a live, wilted runner off the plant near the crown. Cut the stem in two, hold the cut ends together, and squeeze them until the plant sap flows out from each cut edge and intermingles. Then, slowly pull the cut ends apart. If there is a strand of sticky sap between the cut ends, a bacterium is probably present and bacterial wilt is likely.

Chemical Control: The primary method for controlling the disease is to control the vector, the spotted and striped cucumber beetles. Control cucumber beetles early in the season before they feed on plants. Use the recommended insecticide when plants are one week old or as soon as the beetles appear in the spring. See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Remove and destroy wilted plants. Floating row covers can also be used to cover the plants until flowering begins. This physically prevents the cucumber beetles from feeding. However, for fruit to develop, they must be uncovered when blooming so that bees can pollinate the flowers.

Belly Rot, *Rhizoctonia solani*

Belly rot is one of the more common fruit rots and is caused by a soilborne fungus that appears when moisture collects on the "belly" of the fruit. It is most often a problem following periods of warm, wet weather. Sunken, dark brown, water-soaked spots occur where mature fruit comes in contact with the soil. Keeping the bottom side of the cucumber dry is important to prevent this fungus from forming.

Monitoring: This disease is first noted on the pale, light green underside of the fruit. Look for light tan water-soaked spots, especially in areas of the fruit that touch the soil. Mature fruit with very small infection spots may still be saleable since this disease dries up and does not produce a watery rot.

Chemical Control: Apply azoxystrobin (*Quadris*) at the one- to three-leaf stage. Make a second application just before vine tip-over or 10 to 14 days later. See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Crop rotation and well-drained soil.

Cottony Leak, *Pythium*

Cottony leak is a common fungal disease that first appears on the fruit as soft, dark green, water-soaked lesions or spots, usually appearing where the fruits touch the ground. These spots enlarge into raised, water-filled blisters about 1/4 inch in diameter. Subsequent disease development is very rapid. The blisters coalesce, and the entire infected area of the fruit becomes soft, watery, brown, and covered with a fluffy white mat. Transition from spot to spoilage may occur within 48 hours under conditions of high humidity and standing water. Symptoms are often confused with *Phytophthora* fruit rot.

Monitoring: Low areas of fields should be checked after rainfall. Plants at fruit-set that experience drought

stress become more vulnerable to this disease. It is especially important to check for diseased fruit after the first rainfall or irrigation on drought-stressed plants.

Chemical Control: See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Provide good soil drainage by using organic amendments, raising beds, etc. Lower the humidity and moisture in the field by keeping plant populations under control. A less-dense canopy increases air movement and lowers humidity. Rotate to noncucurbit crops. Apply less nitrogen to prevent excessive succulent vegetative growth. Keep fruit cool and dry immediately after harvest. Postharvest spread of this fungus is prompted by fruit-to-fruit contact.

Damping-Off, *Rhizoctonia solani*

This disease causes young seedlings to wilt and die, or to not emerge at all. Generally, this disease is most effective at low temperatures and when the weather is very wet or humid.

Monitoring: Monitoring your crop at crop emergence for disease will help you apply pesticides when needed.

Chemical Control: To protect against all damping-off pathogens, seeds are usually treated with broad-spectrum contact fungicides. See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Practices that promote healthy seedlings can prevent or reduce the disease. Because damping-off is so difficult to contain once it starts, it is best to avoid it all together.

Downy Mildew, *Pseudoperonospora cubensis*

Downy mildew is most prevalent during periods of cool night temperatures and when the weather is very wet or humid. Extended periods of dry, hot weather tend to suppress the spread of the disease. Spores are usually spread by air currents, rain, or equipment. They come up from the South where cucurbits are grown year round. Symptoms appear as irregular, yellowish spots on the upper leaf surface, eventually becoming more distinct on both sides of the leaves. During humid weather, the underside of the leaves may exhibit a brown to gray fungal growth. These spots grow rapidly. A general yellowing of the leaf occurs, eventually causing the leaf to wilt and die. The disease can progress quite rapidly leading to major defoliation and exposing fruit to sunscald. Downy mildew probably causes more damage to cucurbits than any other disease in Virginia.

Monitoring: Scout fields for disease incidence beginning in mid-July, even though generally this disease does not occur until mid-August. Check the website www.ces.ncsu.edu/depts/pp/cucurbit/ to see how close the disease has been sited to your location.

Chemical Control: Begin sprays when vines run or if disease occurrence is predicted for the region. See the

Chemical Disease Control section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Use resistant varieties when possible. Excellent resistance is available in some varieties. Crop rotation has little effect on prevention of downy mildew since the fungus does not overwinter in Virginia. It is important to promote healthy, vigorous growth and a good nutritional program in the crop, as plants under nutritional stress are more susceptible to the disease. Provide adequate plant spacing to reduce the density of the canopy and minimize humidity. Also, avoid overhead irrigation.

Gummy Stem Blight, *Didymella bryoniae*

This disease primarily occurs in late summer and can attack all parts of the plant except the roots. It also can occur at any growth stage, from seedlings to mature plants. The first symptoms appear as reddish-brown lesions on the main stems and dark, circular lesions on the leaf margins. If constant rain or high humidity occurs, these lesions can spread very quickly and cause curling, shriveling, and even leaf death.

Monitoring: Monitoring your crop on a regular basis for disease will help you apply pesticides when needed.

Chemical Control: Begin sprays when vines begin to run. Alternate chlorothalonil with azoxystrobin (*Quadris*) every seven days. This is especially important to delay the development of resistant strains of the pathogen to azoxystrobin (*Quadris*). See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: As there are no resistant varieties available, crop rotation with noncucurbits for three to four years is very important. To reduce survival of the fungus, plow any crop refuse deeply into the ground right after harvest is complete.

Phytophthora Fruit Rot, *Phytophthora capsici*

Fruit rot begins with a water-soaked or depressed spot, often on the underside of the fruit where it touches the soil. White, yeast-like growth is often seen in the spot. This growth is not thick. The rot progresses rapidly through the fruit until it is completely rotted and collapses. This disease can also occur postharvest. However, fruit rot is not all that common in cucumbers in Virginia.

Monitoring: Low areas of fields should be checked after rainfall. Fields planted after cucurbit, tomato, pepper, or eggplant crops are particularly vulnerable.

Chemical Control: See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Maintain a well-drained field, and do not over-irrigate. Select fields where *Phytophthora*

diseases have not occurred in the past. Clean equipment when moving between fields, as equipment is the main way the fungus is brought into a field. Use crop rotation, and avoid planting cucurbits, tomatoes, peppers, and eggplants for at least three years.

Powdery Mildew, *Erysiphe cichoracearum*

Powdery mildew appears on leaves, petioles, and young stems as a white, powdery mass composed of mycelium and countless numbers of spores. This generally occurs from mid-July until the end of the season. Under favorable environmental conditions, the entire top surface of the leaf may be covered with the powdery fungus and an entire field may appear to turn white within a few days. Badly infected leaves become yellow, turn brown, and shrivel. The resulting decrease in photosynthesis may cause significant reductions in the quality and yield of fruit. Although fruits are not directly attacked, they may be malformed or sunburned due to the loss of foliage cover. Powdery mildew is inhibited by free moisture on leaf surfaces, unlike downy mildew. However, high humidity is required for spore germination. Dense plant growth, low light intensity, and high fertility favor disease.

Monitoring: Examine older, shaded leaves on the upper and lower surfaces. The lower leaf surface may remain infected after contact fungicides have protected the top side of the leaves. The lower stems may also show infection. Plants are especially vulnerable at fruit-set.

Chemical Control: See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Avoid excess nitrogen fertilization and crowding plants. At the end of the season, remove plant debris to reduce overwintering fungus. Plant resistant cultivars when available. Excellent resistance is available in most recommended cucumber varieties.

Scab, *Cladosporium cucumerinum*

The first symptoms of scab look like many water-soaked areas on the leaves. As the disease progresses, the affected tissues turn brown, then white, and finally die. The dead tissue tears away from the healthy tissue, giving the leaf a ragged appearance. The disease can infect the fruit at any growth stage. It appears on the fruit as small, sunken, circular spots, exuding a sticky substance. As the disease progresses, the infected areas continue to enlarge and blacken. Scab is caused by a fungus that prefers cool, moist weather for development. This fungus overwinters in old, infected plant debris and on the seed. Fungal spores are spread by wind, insects, equipment, and during harvesting. Scab is not usually a problem today due to the resistant varieties available to growers in Virginia.

Monitoring: Check fruit on nonresistant varieties when fruit-set occurs during periods of cooler night temperatures and heavy dews or fog.

Chemical Control: Begin spraying as true leaves form. Repeat every five to seven days. See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Scab can be controlled best by planting resistant varieties. Also, remove old plant debris from field.

Viruses (CMV, WMV-2, PRSV-W, and ZYMV)

Viruses can be spread in the field by insect feeding, cuttings, and infected seeds. In the cucumber mosaic virus (CMV), the leaves show a distinctive yellow and green mosaic pattern on the youngest leaves near the growing tip. Over time, the leaves become malformed and curled, stunting of the vines occurs, and little fruit is produced. The watermelon mosaic virus - II (WMV-2) causes older leaves to become distorted and blistered and displays the same yellow and green mosaic pattern on the newest leaves. If plants are infected young, they can become stunted. The fruit can become misshapen, dwarfed, mottled, or spotted. Papaya ringspot virus (PRSV-W), formerly known as watermelon mosaic virus - I (WMV-1), causes severe plant stunting. A green mosaic pattern is visible on the leaves and is usually accompanied by malformations, leaf distortions, and narrowing leaf blades. The fruit can be malformed and present a break in color pattern. Zucchini yellow mosaic virus (ZYMV) also causes plant stunting and exhibits a yellow mosaic pattern, leaf malformations, and dead patches on the leaves. In the fruit, deep cracks can occur, allowing secondary bacteria to invade the flesh of the fruit.

Monitoring: Monitoring your crop for disease on a regular basis for disease will help you apply pesticides when needed.

Chemical Control: Soaps and oils can be used to control virus-transmitting aphids, but once the virus is established in the crop, there are no effective chemical controls available. Treating insect vectors with insecticides is an option. However, insecticides are not always effective in reducing virus spread because the virus may have been transmitted before the insecticide kills the insect.

Biological Control: No commercially effective controls are available.

Cultural Control: Always use virus-resistant cultivars whenever possible, and keep weeds mowed around fields that may harbor viruses over the winter. Plant crops early to escape peak aphid season, and plant as far away from existing cucurbit plantings as possible. This will prevent aphid transmission of viruses from existing fields to new fields.

Chemical Disease Control

The list below contains all of the products available to producers for disease control in cucumbers along with the recommended application rates of these chemicals. Always consult the label before making an application. **PHI** = Pre-Harvest Interval. **REI** = Re-Entry Interval.

- **azoxystrobin** (*Amistar* 80WDG, *Quadris* 2.1F) - PHI - 1 day. Strobilurin. Apply at a rate of 0.18-0.25 lb. a.i./A for control of anthracnose. For resistance management, do **NOT** make more than one application of *Amistar* or *Quadris* before alternating with a fungicide that has a different mode of

action. Do **NOT** make more than four applications per acre per crop per season or apply more than 1.0 lb. a.i./A per crop per season. REI - 4 hours.

- **chlorothalonil** (*Bravo* 6F) PHI - 0 days. Substituted aromatic. For control of anthracnose and downy mildew, apply at a rate of 1.20-1.40 lb. a.i./A. To control gummy stem blight, apply at a rate of 1.40-2.20 lb. a.i./A. REI - 48 hours.
  (*Echo* 6F) PHI - 0 days. Substituted aromatic. For control of anthracnose and downy mildew, apply at a rate of 1.10-1.50 lb. a.i./A. To control gummy stem blight, apply at a rate of 1.50-2.30 lb. a.i./A. Do **NOT** exceed 15.75 lb. a.i./A/season. REI - 12 hours.
  (*Equus* 6F) PHI - 0 days. Substituted aromatic. For control of anthracnose and downy mildew, apply at a rate of 1.20-1.50 lb. a.i./A. To control gummy stem blight, apply at a rate of 1.50-2.20 lb. a.i./A. REI - 12 hours.
  *When applying chlorothalonil, do **NOT** apply during intense heat, sunlight, or drought conditions and/ or if there is a poor vine canopy.*
- **cymoxanil *and* famoxadone** (*Tanos* 50WDG) - PHI - 3 days. Strobilurin. For control of downy mildew, apply at a rate of 0.25 lb. a.i./A. For resistance management, do **NOT** make more than one application of *Tanos* before alternating with a fungicide that has a different mode of action. Do **NOT** make more than four applications per season. *Tanos* must be tank-mixed with a contact fungicide that has a different mode of action. Do **NOT** use for control of gummy stem blight or powdery mildew. REI - 12 hours.
- **dimethomorph** (*Acrobat* 50WP) - PHI - 0 days. Morpholine. To control downy mildew and *Phytophthora* fruit rot, apply 0.2 lb. a.i./A. *Acrobat* must be tank mixed with another fungicide active against downy mildew and *Phytophthora* fruit rot. Do **NOT** make more than two sequential applications of *Acrobat* before alternating with another fungicide with a different mode of action. Do **NOT** make more than five applications per season. Do **NOT** exceed 1.0 lb. a.i./A/season. REI - 12 hours.
- **mancozeb** (*Dithane* 80WP) PHI - 5 days. Substituted aromatic. For control of anthracnose, downy mildew, and gummy stem blight, apply at a rate of 1.50-2.25 lb. a.i./A. REI - 24 hours.
  (*Manex II* 80WP) PHI - 5 days. Substituted aromatic. For control of anthracnose, downy mildew, and gummy stem blight, apply at a rate of 1.60-2.40 lb. a.i./A. REI - 24 hours.
  (*Manzate* 80WP) PHI - 5 days. Substituted aromatic. For control of anthracnose, downy mildew, and gummy stem blight, apply at a rate of 1.60-2.40 lb. a.i./A. REI - 24 hours.
  (*Penncozeb* 80WP) PHI - 5 days. Substituted aromatic. For control of anthracnose, downy mildew, and gummy stem blight, apply at a rate of 1.50-2.25 lb. a.i./A. Apply as soon as the vines begin to run or when disease threatens. REI - 24 hours.
- **mancozeb** (*Gavel* 75DF) - PHI - 5 days. Substituted aromatic. For control of downy mildew and *Phytophthora* fruit rot, apply at a rate of 1.13-1.5 lb. a.i./A. Start applications when plants are in the two-leaf stage and repeat at 7- to 10-day intervals or when environmental conditions are favorable for disease development. Do **NOT** apply more than 10.67 lb. a.i./A/crop. REI - 48 hours.
  (*Ridomil Gold* MZ 68WP) - PHI - 5 days. Substituted aromatic. For control of downy mildew, apply at a rate of 1.7 lb. a.i./A. Begin application when conditions are favorable for disease but before infection, and continue at 14-day intervals until threat of disease is over. Avoid late-season applications when plants reach full maturity or begin senescence. You may make up to four applications per crop. Use caution when applying other fungicides that contain similar active ingredients. Consult the label before application. REI - 48 hours.
- **mefenoxam** (*Ridomil Gold* 4E or *Ultra Flourish* 2E) - PHI - 5 days. Phenylamides. For control of damping-off, apply 0.5-1.0 lb. a.i./A in a 7-inch band at planting. REI - 24 hours.

- **mefenoxam *plus* chlorothalonil** (*Ridomil Gold/Bravo* 76WP)* - PHI - 0 days. Phenylamides. For control of downy mildew, apply at a rate of 1.52 lb. a.i./A. Begin applications before infection but when conditions are favorable. Continue at 14-day intervals until the threat of disease is over. Avoid late-season applications when plants reach full maturity and begin senescence. REI - 48 hours. (*Flouronil* 76WP)* - PHI - 14 days. Phenylamides. For control of downy mildew, apply at a rate of 1.52 lb. a.i./A. Begin applications before infection but when conditions are favorable. Continue at 14-day intervals until the threat of disease is over. Avoid late-season applications when plants reach full maturity and begin senescence. REI - 48 hours.
  ***** *Up to four applications can be made per crop.*
- **mefanoxam *plus* copper hydroxide** (*Ridomil Gold Copper* 65WP) - PHI - 5 days. Phenylamides. For control of downy mildew, apply at a rate of 1.3 lb. a.i./A. Begin applications when conditions are favorable for disease but before infection. Avoid late-season application when plants reach full maturity or begin senescence. REI - 48 hours.
- **pyraclostrobin** (*Cabrio* 20EG) - PHI - 0 days. Strobilurins. Apply 0.15-0.20 lb. a.i./A to control anthracnose, gummy stem blight, and powdery mildew. Do **NOT** apply more than 0.8 lb. a.i./A/ season or make more than four applications in a season. REI -12 hours.
- **thiophanate-methyl** (*Topsin* M 70WP) - PHI - 0 days. Benzimidazole. For anthracnose control, combine with chlorothalonil to improve the performance and apply at a rate of 0.18-0.35 lb. a.i./A. REI - 12 hours.
- **trifloxystrobin** (*Flint* 50WDG) - PHI - 0 days. Strobilurins. Apply 0.05-0.06 lb. a.i./A to control powdery mildew. Do **NOT** apply more than 0.25 lb. a.i./A/season. Do **NOT** exceed more than four total applications of *Flint* or other strobilurin fungicides per acre per season. To limit the potential for resistance to develop, do **NOT** apply more than one application before alternating with a nonstrobilurin fungicide. REI - 12 hours.
- **triflumizole** (*Procure* 50WS) - PHI - 0 days. Triazoles. To control powdery mildew, apply 0.13-0.25 lb. a.i./A. Applications should begin when vines start to run or at the first indication of disease. Do **NOT** apply more than 1.25 lb. a.i./A/season. REI - 12 hours.

Pesticide Use Date - % Acres Treated

Fungicide	1993	1997	2004	Growers' Needs
azoxystrobin	N/A	N/A	70	*critical*
benomyl	4.0	4.0	N/A	
boscalid	N/A	N/A	30	
chlorothalonil	32.0	32.0	70	*critical*
mancozeb	N/A	N/A	40	
metalaxyl	21.0	21.0	N/A	
mefenoxam	N/A	N/A	70	*critical*
myclobutanil	N/A	N/A	50	*critical*
propamocarb	N/A	N/A	10	*critical*
pyraclostrobin	N/A	N/A	50	*critical*
thiophanate-methyl	4.0	4.0	N/A	
triadimefon	4.0	4.0	N/A	
trifloxystrobin	N/A	N/A	20	*critical*
triflumizole	N/A	N/A	10	

Nematode Pests

Control recommendations were taken from 2004 Commercial Vegetable Production Recommendations-Virginia.[11]

NEMATODES

Root-knot nematodes (*Meloidogyne* spp.) are the most important species of nematode affecting cucumbers in Virginia.[12] Nematode problems can be magnified by hot, dry summers. The diagnostic feature of root-knot nematode infection is the presence of galls on roots of affected plants. Severely affected plants may have galls as large as one inch in diameter. Symptoms and damage can mimic other diseases and pests, making identification nearly impossible to determine on site. Soil and root samples should be collected and analyzed by an expert.

Monitoring: Both diagnostic and predictive nematode assay programs in Virginia provide data to producers on the numbers and kinds of nematodes in soil along with recommendations for control. Soil samples for diagnostic assays are processed without charge to determine the cause of production problems during the growing season. Predictive nematode assays are done on samples collected after harvest.

Chemical Control: When using soil fumigation, it is important that the fields be sufficiently prepared for planting. All crop debris and clods should be removed, and soil moisture should be adequate. Otherwise, soil fumigation will not be effective because the gaseous fumigant has not penetrated all soil particles. It is also necessary to allow an aeration period between fumigant applications and planting. Otherwise, crop injury will occur. For recommendations, see the *Chemical Nematode Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: Sanitation and good cultural practices are the best preventive measures against nematodes. Examples include obtaining nematode-free roots and washing soil from machinery and tools before using them at different locations. Crop rotation with nonhost crops to lower their population size is highly recommended in the event of nematode activity.

Chemical Nematode Control[13]

Several chemicals are currently available for nematode control, although this may change in the next few years. Currently, the multipurpose soil fumigants chloropicrin, chloropicrin and dichloropropene (*Telone C-17, Telone C-35)*, metam-potassium (*K-PAM* HL), metam-sodium (*Vapam* HL), and methyl bromide (*Terr-O-Gas 67, MC-33*) are recommended for use in Virginia. In addition, dichloropropene (*Telone II*) is a soil fumigant used only for nematodes. The nonfumigant nematicides, ethoprop (*Mocap* 10G or 6E) and oxamyl (*Vydate* L), are also recommended for use in cucumbers. Incorporate either one into the top 2-4 inches of soil two weeks after planting and repeat two to three weeks later. Typically, chemical controls are used only when cultural practices cannot provide adequate control. However, these chemicals are still important tools when other control methods have failed.

Weed Pests

Control recommendations were taken from 2004 Commercial Vegetable Production Recommendations-Virginia.[14]

WEEDS

In Virginia, the major weeds in cucumbers are annual and perennial grasses, common lambsquarters, and pigweed species. However, producers in Virginia are faced with a multitude of additional broadleaf weed problems, including common ragweed, common cocklebur, annual morningglory, and any of several annual grass species. Successful weed management is vital to the production of quality cucumbers. Weeds compete with the crop for light, space, nutrients, and, particularly water. Weed growth promotes disease problems and can harbor deleterious insects and diseases. If not controlled, weeds can greatly reduce root quality and may interfere with the harvest.

Monitoring: Proper weed identification is an important part of effective weed control. Weeds observed in previous crops within a given field should be noted to aid in future herbicide decisions. It is also important to monitor the effectiveness of preplant incorporated and preemergent herbicides once the crop emerges.

Chemical Control: To provide additional pest control, a **Special Local Need 24(c) label** has been approved in Virginia for the postemergence and postharvest use of paraquat (*Gramoxone Max* 3SC) and the preemergence and postemergence use of halosulfuron (*Sandea*). Recommended rates can be found in the *Chemical Weed Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: Cultivation is a very important part of weed control. Weeds will outcompete a crop for nutrients, water, and sunlight, reducing yield and making the crop less profitable. Mechanical cultivation provides very effective weed control but is limited to small weeds that can be easily uprooted or covered. Mechanical control also must be supplemented with chemicals or hand weeding to remove weeds in the rows. Hand weeding provides very effective weed control and is safe to the crop. Weed when the crop and weeds are small to reduce crop damage and to allow hoeing. Hand weeding, however, is labor-intensive. Incorporating cultivation with herbicides is the most cost-effective way to combat weeds and to produce a high yield. Crop rotation is also important to prevent domination of any one weed species year after year. Also, avoid fields with a history of severe infestations.

Chemical Weed Control

The list below contains all of the fully labeled products available to producers for weed control in cucumbers. Always consult the label before making an application. **PHI** = Pre-Harvest Interval. **REI** = Re-Entry Interval.

Preplant Incorporated

- **bensulide *plus* naptalam** (*Prefar* 4EC + *Alanap* 2SC) - PHI -N/A. Amide. Preplant incorporate 2 inches or less before seeding and transplanting. Apply at a rate of 4-6 lb. a.i./A *plus* 2 lb. a.i./A to control for annual and certain broadleaf grasses. Tank-mix is approved. REI - 48 hours.
- **naptalam** (*Alanap* 2SC) - PHI - N/A. Amide. Preplant incorporate 2 inches deep before seeding and transplanting. Apply at a rate of 2.0 lb. a.i./A to control annual and certain broadleaf grasses. Weed control may not be satisfactory on sandy soils with less than 1% organic matter. Do **NOT** use when growing conditions are adverse ¾ such as cold or wet weather or if rainfall is expected within 6 hours ¾ or mix with liquid fertilizer. REI - 48 hours.

Preplant Incorporated or Preemergence

- **bensulide** (*Prefar* 4E) - PHI - N/A. Amide. Preplant incorporate 1-2 inches deep before seeding and transplanting with power-driven rotary cultivators. Apply at a rate of 5-6 lb. a.i./A preplant or apply preemergent and activate with 1/2 inch of sprinkler irrigation within 36 hours primarily for grass control. Use the maximum rate preemergence followed by irrigation to suppress certain annual broadleaf weeds, including common lambsquarters, smooth pigweed, and common purslane. No unlabeled crop should be planted in the field for four months. Labeled crops include tomatoes, certain cole crops, lettuce, and certain other vegetables. REI - 12 hours.

Preemergence

- **clomazone** (*Command* 3ME) - PHI - N/A. Pyridazinones. To control annual grasses and certain broadleaf weeds, including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed, apply preemergence to direct-seeded cucumbers at a rate of 0.094-0.188 lb. a.i./A (based on soil texture). Mustards, morningglory species, and pigweed species will **NOT** be controlled. Combine with *Curbit*

3E to control pigweed species where *Curbit* is registered for use. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness. Banding the herbicide reduces the risk of crop injury and offsite movement due to vapor drift. Do **NOT** apply when wind or weather conditions favor herbicide drift. Do **NOT** apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). REI - 12 hours.
Warning: Herbicide residues may limit subsequent cropping options when Command is used for weed control in cucumbers. See planting restrictions on the label, or consult your local Cooperative Extension office for more information.

- **ethalfluralin** (*Curbit* 3E) - PHI - N/A. Nitroanilines. To control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed species, apply at a rate of 0.38-0.75 lb. a.i./A. Control of many other broadleaf weeds, including common lambsquarters, jimsonweed, morningglory species, ragweed species, and mustard species, may **NOT** be acceptable. Dry weather following application may reduce weed control. Cultivate to control tolerant weeds or if rainfall or irrigation does not occur before weed emergence. Do **NOT** preplant incorporate, apply under plastic mulch or tunnels, or use when soils are cold or wet. This could cause crop injury. REI - 24 hours.
- **halosulfuron** (*Sandea* 75WG) - PHI - N/A. Sulfonylurea. Apply 0.023-0.031 lb. a.i./A (based on soil texture) to suppress or control broadleaf weeds, including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed if used early in season before vines begin to run. Do **NOT** use if organophosphate (OP) insecticides have been applied to the crop or the risk of crop injury may increase. Consult your local county Extension office for current restrictions - **Special Local Need 24(c) label**. REI- 12 hours.

Postemergence

- **clethodim** (*Select* 2EC) - PHI - 14 days. Cyclohexanediones. Apply at a rate of 0.094-0.125 lb. a.i./A with oil concentrate to be 1% of the spray solution to control many annual and certain perennial grasses, including annual bluegrass. However, it will not consistently control goosegrass. *The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.* To reduce the risk of crop injury, omit additives or switch to a nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will **NOT** be controlled. Do **NOT** tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result. REI - 24 hours.
- **halosulfuron** (*Sandea* 75WG) - PHI - 2-5 true leaves. Sulfonylurea. Apply 0.023-0.031 lb. a.i./A to suppress or control yellow nutsedge and broadleaf weeds, including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga. Apply when the crop has two to four true leaves but has not yet begun to run. *Sandea* applied postemergence will **NOT** control common lambsquarters or eastern black nightshade. Add a nonionic surfactant according to the labeled instructions. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Occasionally, slight yellowing of the crop may be observed within a week of *Sandea* application. Recovery is rapid with no effect on yield or maturity. Integrate mechanical methods of

control, and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in rotation. Do **NOT** use if OP insecticides have been applied to the crop, or the risk of crop injury may increase. Do **NOT** exceed a total of 0.047 lb. a.i./A applied preemergence and postemergence to a single crop. Consult your local county Extension office for current restrictions - **Special Local Need 24(c) label**. REI - 12 hours.

- **naptalam** (*Alanap* 2SC) - PHI - N/A. Amide. Apply at a rate of 1-2 lb. a.i./A when the crop is ready to vine to extend residual weed control and to suppress or control smooth pigweed. Do **NOT** use when growing conditions are adverse ¾ such as cold or wet weather or if rainfall is expected within 6 hours ¾ or mix with liquid fertilizer. REI - 48 hours.
- **paraquat** (*Gramoxone Max* 3SC) - PHI - N/A. Bipyridyliums. Apply at a rate of 0.6 lb. a.i./A as a directed spray to control emerged weeds between the rows after the crop has been established. Add a nonionic surfactant according to the labeled instructions. Do **NOT** allow spray or spray drift to contact the crop or injury may result. See label for additional information and warnings. Consult your local county Extension office for current restrictions - **Special Local Need 24(c) label**. REI - 12 hours.
- **sethoxydim** (*Poast* 1.5EC) - PHI - 14 days. Cyclohexanediones. Apply at a rate of 0.2-0.3 lb. a.i./A with oil concentrate to be 1% of the spray solution to control annual grasses and certain perennial grasses. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do **NOT** tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result. Do **NOT** apply more than 0.6 lb. a.i./A in one season. REI - 12 hours.

Postharvest

- **paraquat** (*Gramoxone Max* 3SC) - PHI - N/A. Bipyridyliums. Apply at a rate of 0.6 lb. a.i./A as a broadcast spray after the last harvest. Add nonionic surfactant according to the label instructions. Use to prepare plastic mulch for replanting or to help remove the mulch. See the label for additional information and warnings. Consult your local county Extension office for current restrictions - **Special Local Need 24(c) label**. REI - 24 hours.

Pesticide Use Date - % Acres Treated

Herbicide	1993	1997	2004	Growers' Needs*
bensulide	N/A	N/A	12.0	
clomazone	7.0	55.0	70.0	*critical*
ethalfluralin	25.0	61.0	80.0	*critical*
glyphosate	4.0	N/A	N/A	
naptalam	N/A	20.0	5.0	
sethoxydim	11.0	11.0	18.0	*critical*

* Halosulfuron is currently used on an estimated 20% of acres PRE and especially POST. Growers need broader spectrum control PRE with safety to cucumbers with 6-8 weeks of control.

Table 1: Effectiveness of herbicides recommended for weed control in cucumbers.[15]

Herbicide	Barnyardgrass	Crabgrass, Large	Fall Panicum	Foxtail spp.	Goosegrass	Johnsongrass (Seedlings)	Yellow Nutsedge	Carpetweed	Cocklebur, Common	Cranesbill	Galinsoga, Hairy	Jimsonweed	Lambsquarterss, Common	Morningglory spp.	Shepherdspurse	Pigweed spp.	Purslane, Common	Ragweed, Common	Smartweed, Pennsylvania	Nightshade, Eastern Black	Velvetleaf
Preplant or Preplant Incorporated																					
Prefar	G	G	G	G	F/G	G	N	N	N	N	N	N	F/G	N	P/F	F	F	N	N	N	N
Preemergence or Preplant Incorporated																					
Alanap	P	P/F	P	F	P/F	-	N	F	P	N	F	F	F	F	N	F/G	F/G	F	P	P	F
Preemergence																					
Curbit	F	G	G	-	G	-	N	G	N	-	N	N	P/F	P	-	F	F/G	N	P	P	P
Sandea	N	N	N	N	N	N	G	P	G	-	G	G	N	F	-	G	P	G	F	N	G
Strategy	G	G	G	G	G	G	N	G	N/F	-	F	G	G	P	F	-	G	F	G	P	G
Postemergence																					
Gramoxone Max	F/G	F/G	F/G	G	F/G	-	G	G	G	-	G	G	F/G	F/G	-	G	F/G	G	P	-	-
Poast	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Sandea	N	N	N	N	N	N	G	P	G	-	G	G	N	F	-	G	P	G	F	N	G
Select	G	G	G	G	P	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Postharvest																					
Gramoxone Max	F/G	F/G	F/G	G	F/G	-	G	G	G	-	G	G	F/G	F/G	-	G	F/G	G	P	-	-

Herbicide performance is affected by weather, soil type, herbicide rates, weed pressure, and other factors. These ratings indicate ONLY relative effectiveness in tests conducted by the University of Delaware, University System of Maryland, The Pennsylvania State University, Rutgers (The State University of New Jersey), and Virginia Polytechnic Institute and State University. Actual performance may be better or worse than indicated in this chart.

G = good F = fair P = poor N = no control - = insufficient data

Contacts

Developed and Written by:

Therese N. Schooley
Project Manager
Virginia Polytechnic Institute and State University
Department of Entomology
Virginia Tech Pesticide Programs (0409)
34 Agnew Hall
Blacksburg, VA 24061
Ph: 540-231-2086
Fax: 540-231-3057
E-mail: tschooley@vt.edu

Contributing Authors:

Diseases:
Christine M. Waldenmaier
Research Specialist, Plant Pathology
Virginia Polytechnic Institute and State University
Eastern Shore Agricultural Research and Extension Center (0512)
33446 Research Drive
Painter, VA 23420-2827
Ph: 757-414-0724
Fax: 757-414-0730
E-mail: cwalden@vt.edu

Insects:
Thomas P. Kuhar
Assistant Professor, Entomology
Virginia Polytechnic Institute and State University
Eastern Shore Agricultural Research and Extension Center (0512)
33446 Research Drive
Painter, VA 23420-2827
Ph: 757-414-0724
Fax: 757-414-0730
E-mail: tkuhar@vt.edu

Jack Speese
Research Specialist, Entomology
Virginia Polytechnic Institute and State University
Eastern Shore Agricultural Research and Extension Center (0512)
33446 Research Drive
Painter, VA 23420-2827
Ph: 757-414-0724

Fax: 757-414-0730
E-mail: jspeese@vt.edu

Pesticides:
Michael J. Weaver
Professor and Extension Pesticide Coordinator
Virginia Polytechnic Institute and State University
Department of Entomology
Virginia Tech Pesticide Programs (0409)
34 Agnew Hall
Blacksburg, VA 24061
Ph: 540-231-6543
Fax: 540-231-3057
E-mail: mweaver@vt.edu

Weeds:
Henry P. Wilson
Professor, Weed Science
Virginia Polytechnic Institute and State University
Eastern Shore Agricultural Research and Extension Center (0512)
33446 Research Drive
Painter, VA 23420-2827
Ph: 757-414-0724
Fax: 757-414-0730
E-mail: hwilson@vt.edu

Cultural Practices:
Rikki Sterrett
Associate Professor, Horticulture
Virginia Polytechnic Institute and State University
Eastern Shore Agricultural Research and Extension Center (0512)
33446 Research Drive
Painter, VA 23420-2827
Ph: 757-414-0724
Fax: 757-414-0730
E-mail: vators@vt.edu

Reviewed by:
Association of Virginia Potato & Vegetable Growers
Butch Nottingham, VDACS Field Office Marketing Specialist
P.O. Box 26
Onley, VA 23418
Ph: 757-787-5867
Fax: 757-787-1041
E-mail: onleyva@shore.intercom.net

James N. Belote, III
Extension Agent, ANR
Virginia Cooperative Extension
Accomack County Unit
P.O. Box 60
Accomac, VA 23301-0060
Ph: 757-787-1361
Fax: 757-787-1044
E-mail: jbelote@vt.edu

Edited by:
Susan E. Nessler
Project Coordinator
Virginia Polytechnic Institute and State University
Department of Entomology
Virginia Tech Pesticide Programs (0409)
34 Agnew Hall
Blacksburg, VA 24061
Ph: 540-231-8956
Fax: 540-231-3057
E-mail: snessler@vt.edu

On-Line Resource

C&P Press Online Crop Protection Reference
http://www.greenbook.net/

Crop Data Management Systems - Pesticide Labels
http://www.cdms.net/pfa/LUpdateMsg.asp

Insects and Related Pests of Vegetables
http://ipm.ncsu.edu/AG295/html

Pests of Vegetables and Fruit Trees
http://everest.ento.vt.edu/~idlab/vegpests/vegfact.html

Virginia Agricultural Statistics Service
http://www.nass.usda.gov/va/

Virginia Tech Pesticide Programs
http://www.vtpp.ext.vt.edu/

Virginia Tech Weed Identification Guide
http://www.ppws.vt.edu/weedindex.htm

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