Crop Profile for Spinach in Virginia

Prepared June, 2001

General Production Information

- Approximately 1,500 acres of spinach were produced in Virginia in 1999 utilizing a double cropping system (1).
- A total of 195,000 cwt fresh market spinach was harvested in 1999, valued at $5,986,500 or $30.70/cwt (based on National Agricultural Statistics Service U.S. averages) (1).
- Most of Virginia spinach is grown for the fresh market.

Production Regions:
Spinach (90%) is produced primarily in Accomack and Northampton counties or what is otherwise known as the Eastern Shore of Virginia. Spinach (10%) has previously been grown in Suffolk, Chesapeake, and Virginia Beach although no acres were reported for the year 2000 growing season.

Cultural Practices

There are four planting-harvest cycles under which spinach can be produced in Virginia, although the majority of the production results from overwintering. They are as follows: plant early spring-harvest late spring, plant summer-harvest fall, plant summer-harvest fall-over-winter-harvest spring, and plant fall-harvest spring. Spinach typically prefers lower temperatures ranging from 50-60° F; therefore care is taken to avoid harvest during periods of hotter weather. If grown under the proper conditions, up to three cuttings can be harvested from one planting.

Hybrid varieties recommended for Virginia include the early maturing, Packer and Hybrid No. 7 and mid-maturing, Melody. Both Packer and Melody are resistant to the mosaic virus and Melody offers additional resistance against mildew. Seeding rates for clipped spinach are 18-25 pounds/acre and 10-14
pounds/acre for unclipped spinach. Prior to planting, seed should be treated with *Thiram 50WP* (thiram) applied at a rate of 5.33 ounces per 100 pounds. Spinach grown for fresh market production is often planted in narrow rows approximately 12 inches apart on 6- and 8-row beds. Processing spinach is planted on 12-inch centers. Populations generally average 8-10 plants per foot. Good air circulation between plants will help with the control of foliar diseases and will allow for greater light penetration.

Spinach grows well in soils with a pH between 6.5 and 6.8. The crop will not tolerate highly acidic conditions. This is important to remember when applying fertilizer, particularly nitrogen, which can decrease the pH. Ammonium nitrate as a source of nitrogen allows for better pH control. Lime may be required if the soil pH becomes too acidic. Approximately 150-200 lbs. of nitrogen are required for healthy, marketable spinach. Nitrogen applications are typically divided so that half is broadcast before planting, a quarter is side-dressed after the first cutting, and the remaining quarter is applied as a sidedress after subsequent cuttings, as needed.

Practices such as practicing crop rotation and using the lightest equipment may reduce the rate of soil compaction common in spinach production. Irrigation that utilizes a smaller droplet size and lower application rate may also help prevent compaction.

**Insect Pests**

*Insect descriptions found below were modified from information presented on the Virginia Tech Insect ID website* *(2).* *Control recommendations were taken from the 2000 Commercial Vegetable Production Recommendations—Virginia* *(3).*

Of the insects listed below, the green peach aphid (GPA) followed closely by the beet armyworm pose the greatest challenge for spinach producers in Virginia. In the case of the GPA, contamination of the harvested crop by these insects is the major problem, especially in processing spinach. The contamination issue also is of concern when beneficial insects such as parasitic wasps, ladybird beetles and syrphid fly larvae colonize fields because certain life stages of these insects are difficult to remove from the leaves before packaging. Damage caused by beet armyworms, on-the-other-hand, relates to the direct feeding of these insects on the spinach leaves. In addition to their feeding injury, beet armyworms have become more troublesome given their resistance to many commonly used insecticides. The importance of the remaining insects described in the following paragraphs depends on the environmental conditions. Rankings may vary from year to year.

**Beet Armyworm, Spodoptera exigua**

Beet armyworms feed primarily on the buds and terminal growth of the spinach plant. They may be
confused with garden webworms as a result of the webbing they produce on the leaf surface. Beet armyworm moths arrive in Virginia in early July, lay their eggs, and emerge as larvae in mid-August to feed on the fall crop.

**Monitoring:** Biweekly monitoring of ten random spinach plants from ten separate locations should be completed to assess potential beet armyworm problems. Treatment is recommended if one larva per ten plants is found on seedlings or one larva per two plants on established plants. The number of beet armyworm and cabbage looper larvae can be combined to make a control decision.

**Chemical Control:** See *Chemical Insect Control*.

**Biological Control:** No current recommendations for commercial production.

**Cultural Control:** No current recommendations for commercial production.

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*Cabbage Looper, Trichoplusia ni*

Cabbage loopers may be identified by their pale green color and thin white stripes down the back and sides and also by their doubling-up or looping as they move. 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 of the fall crop. Several generations can occur during a year.

**Monitoring:** Biweekly monitoring of ten random spinach plants from ten separate locations should be completed to assess potential cabbage looper problems. Treatment is recommended if one larva per ten plants is found on seedlings or one larva per two plants on established plants. The number of cabbage looper and beet armyworm larvae can be combined to make a control decision.

**Chemical Control:** See *Chemical Insect Control*.

**Biological Control:** No current recommendations for commercial production.

**Cultural Control:** No current recommendations for commercial production.

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*Cutworms*

*Black cutworm, Agrotis ipsilon*

*Variegated cutworm, Peridroma saucia*
Granulate cutworm, *Feltia subterranea*

Cutworms are dull gray, brown, or black, and may be striped or spotted. Another distinguishing quality is their act of rolling into a tight C-shape if disturbed. Cutworm larvae cause damage in spinach by severing the seedling off just below the soil, completely killing the plant.

**Monitoring:** Cutworms are not typically seen in the open during the day, however, digging the soil around injured plants may reveal their presence. If cutworm injury begins to noticeably reduce plant stands early in the season, control may be necessary.

**Chemical Control:** See *Chemical Insect Control*.

**Biological Control:** No current recommendations for commercial production.

**Cultural Control:** No current recommendations for commercial production.

**Flea Beetles, Various Species**

Many species of flea beetle attack spinach plants in Virginia causing severe damage to transplants and young plants, especially. Flea beetles are typically black, brown, or striped in appearance, active on the leaves and will hop away when disturbed. Both the adults and larvae feed directly on the leaves producing many tiny holes, which result in a reduced market value.

**Monitoring:** Currently no thresholds are available for flea beetles in Virginia. However, weekly scouting of newly emerged plants, especially those along the field borders, may help to reduce overall damage. If feeding seems to increase in the scouted areas, spot treatments can be made to stem further plant injury.

**Chemical Control:** *Sevin* (carbaryl) is the primary chemical labeled for control of flea beetles (see *Chemical Insect Control*). However, the use of *Admire* or *Provado* (imidacloprid) for aphids may also help to reduce infestations.

**Biological Control:** No current recommendations for commercial production.

**Cultural Control:** Plowing under weed and crop debris following harvest may help to disturb the flea beetle life cycle.
**Garden Webworms, Achyra rantalis**

Webworms are dark green caterpillars with two stripes and black spots on their backs. The larval stage feeds inside of webbed leaves, often tying the leaves together in the center of the plant. Feeding in this area results in stunted plants and distorted plant growth.

**Monitoring:** Leaves and buds of ten small plants should be monitored from ten locations for webbing or other signs of webworm infestation. Treatment should be applied when 5% of the plants are infested with small larvae.

**Chemical Control:** Chemical controls (see *Chemical Insect Control*) should be applied prior to the production of large amounts of webbing and/or before larvae have reached the plant meristem (growing point).

**Biological Control:** No current recommendations for commercial production.

**Cultural Control:** No current recommendations for commercial production.

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**Grasshoppers, Melanoplus spp.**

Grasshopper problems are mostly encountered during fall harvests. As other green crops are harvested or damaged by cold temperatures, grasshoppers move into spinach for protection. These insects are particularly troublesome in processing spinach as a result of their unshakable presence.

**Monitoring:** Currently no economic thresholds are available for grasshoppers in Virginia. However, weekly scouting to monitor population levels may allow for early detection and hence early treatment, which can help reduce the problem at harvest.

**Chemical Control:** Chemicals labeled for grasshopper control in Virginia are very limited. *Sevin* (carbaryl), the only pesticide registered provides fair control but requires a 14-day post-harvest interval. Given that most grasshopper damage occurs just prior to harvest, the use of *Sevin* (carbaryl) is not economically effective.

**Biological Control:** No current recommendations for commercial production.

**Cultural Control:** No current recommendations for commercial production.
**Green Peach Aphid, *Myzus persicae***

The green peach aphid attacks a number of economically valuable crops in Virginia. Green peach aphids typically feed on the underside of leaves causing severe curling and reduced photosynthate potential. Feeding of large GPA populations’ results in excretion of large amounts of honeydew that supports the growth of a black sooty mold fungus that causes leaf spotting. These aphids may also function as vectors of certain virus diseases of spinach. Populations in Virginia begin increasing in May through June and again in mid-September through October. In addition to the plant productivity problems, aphid presence may also contaminate processing spinach resulting in crop rejection.

**Monitoring:** Scout ten spinach plants in ten locations, paying particular attention to the underside of the leaves. Treatments should be applied if one aphid per plant on seedling plants or 4-10 aphids per plant on established plants is/are found. Scouting for natural predators such as ladybeetle, syrphid fly larvae, and lacewings, which can reduce aphid populations without contaminating the crop, should coincide with aphid monitoring.

**Chemical Control:** See *Chemical Insect Control*.

**Biological Control:** Natural predators available for control in commercial operations often result in additional contamination problems, which outweigh their benefits. For example, parasitized aphid mummies could remain attached to spinach leaves resulting in the reduced quality of both fresh and processing spinach.

**Cultural Control:** No current recommendations for commercial production.

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**Spinach Leafminer, *Pegomya hyoscyami***

Leafminers cause injury to leaves primarily as a result of their feeding. As the larvae hatch from eggs deposited within the leaf tissue, they mine long, 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. Severe infestations may result in discolored, and thus unmarketable leaves. Many generations occur annually in Virginia, but the first is usually the most damaging.

**Monitoring:** Weekly scouting for larvae and/or mines should begin once plants emerge and continue throughout the growing season. Treatment is recommended if half of the plants being monitored have eggs or mines or if one or more mine per leaf is found. Closer to harvest, the economic threshold increases to 4% of leaves with mines.

**Chemical Control:** See *Chemical Insect Control*. 
Seed Corn Maggot, *Hylemyia platura*

The seed corn maggot is most noted for its damage to sprouting seeds, particularly those planted early, which affects plant development. Adults emerge in the spring to feed and lay their eggs, preferably in moist, organically rich soils. 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 seed corn maggot damage has been observed treatments are ineffective. Therefore, management options must be applied to high-risk fields prior to planting. High-risk fields can be defined as those having previous seed corn maggot infestations.

**Chemical Control:** Control is best achieved by using seed treatments such as *Agrox D-L Plus*, *Agrox 2-Way*, *Kernel Guard*, *SeedMate*, or a seed protectant containing diazinon or chlorpyrifos. A broadcast application of *Diazinon AG500* made immediately before planting may also provide fair to good control (see Chemical Insect Control). However, if population pressure is heavy, a combination of a seed treatment and soil insecticide will be needed to reduce economic damage resulting from seed corn maggot infestations.

**Biological Control:** No current recommendations for commercial production.

**Cultural Control:** Several management practices can be used to reduce the potential for damage resulting from seed corn maggot infestations. These include plowing weeds or cover crops at least two weeks prior to planting, avoiding over-fertilization with manure, and plowing under crop debris immediately after harvest to prevent plant remnants. Planting transplants or pre-germinated seeds may also help avoid damage by seed corn maggots.

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**Chemical Insect Control**

- *Bacillus thuringiensis* (Agree) (Biobit) (Condor) (Crymax) (Cutlass) (DiPel) (Javelin) (Mattch) (XenTari)-PHI-0 days. For control of spinach leafminers, cabbage loopers, and garden webworms. Typically used in years where outbreaks occur. Consult the various labels for rates and restrictions. REI-4 hours.
- **carbaryl** (*Sevin*)-various formulations-PHI-14 days. Applied at a rate of 0.50-1.0 lbs. a.i./acre for control of flea beetles; a slightly higher rate is used for grasshoppers. REI-12 hours.
- **cyromazine** (*Trigard*)-PHI-7 days. Apply at a rate of 0.09-0.16 lbs. a.i./acre for control of spinach leafminers. Repeat applications at 7 day intervals or as necessary to maintain control. Do not exceed five applications per crop per season. REI-12 hours.
- **diazinon** (*Diazinon AG500*)-PHI-14 days. Apply at a rate of 2.0-4.0 lbs. a.i./acre just prior to planting and immediately incorporate into the soil for control of seed corn maggots. REI-24 hours.
- **dimethoate** (*Dimethoate 4EC*)-PHI-14 days. Apply at a rate of 0.25 lbs. a.i./acre for aphid control. Resistance has been documented in Virginia therefore, care should be taken to rotate with *Admire* or *Provado*. REI-48 hours.
- **imidacloprid** (*Admire* or *Provado*)-PHI-21 days (Provado)-PHI-7 days. Apply *Admire* at a rate of 0.16-0.38 lbs. a.i./acre to the soil at planting or broadcast *Provado* at a rate of 0.05 lbs. a.i./acre following planting for good control of aphids. The use of these chemicals for aphids may also reduce flea beetle infestations. REI-12 hours.
- **methomyl** (*Lannate*)-PHI-7 days. Apply at a rate of 0.45-0.90 lbs. a.i./acre for fair control of cabbage loopers and beet armyworms and at a rate of 0.45 lbs. a.i./acre for cutworm control. Use of this chemical will reduce garden webworm infestations if sprays are applied before webbing occurs. Continuous use of methomyl may result in leafminer outbreaks. Do not apply when minimum daily temperature is 32°F or lower. Do not apply to spinach seedlings less than 3 inches in diameter. REI-48 hours.
- **permethrin** (*Ambush 2EC*) (*Pounce 3.2EC*)-PHI-1 days. Apply at a rate of 0.10-0.20 lbs. a.i./acre for fair to good control of cutworms, spinach leafminers, cabbage loopers and beet armyworms (resistance problems). Of special note, the use of permethrin for worm control may reduce grasshopper populations. Do not exceed seven applications per acre per season. REI-24 hours.
- **thiodicarb** (*Larvin*)-PHI-14 days. Apply at a rate of 0.60-0.75 lbs. a.i./acre for good control of cabbage loopers and beet armyworms. Do not exceed 60 total fluid ounces per acre per season. REI-12 hours.
- **spinosad** (*SpinTor 2SC*)-PHI-1 days. Apply at a rate of 0.09-0.16 lbs. a.i./acre for good control of spinach leafminers and a rate of 0.06-0.13 lbs. a.i./acre for excellent control cabbage loopers and beet armyworms. Use of this chemical will reduce garden webworm infestations if sprays are applied before webbing occurs. Do not exceed 29 total fluid ounces per acre per season. REI-4 hours.
- **tebufenozide** (*Confirm*)-PHI-7 days. Apply at a rate of 0.13 lbs. a.i./acre for control of cabbage loopers, beet armyworms, and garden webworms. Do not exceed 56 total fluid ounces per acre per season. REI-12 hours.

**Diseases**
Disease control recommendations were taken from the 2000 Commercial Vegetable Production Recommendations—Virginia (3).

Rainy and humid weather conditions greatly increase the incidence of disease within spinach in Virginia. In an average growing season, however, disease is often held in check. Recently though, growers have expressed a concern for white rust, which is occurring more frequently on the Eastern Shore. To add to the difficulty, only one control option is currently available (see below) for use in Virginia.

**Anthracnose, Colletotrichum spp.**

Prominent in warm, wet weather, the anthracnose fungus produces yellow to brownish spots on the leaf surface, which help reduce plant productivity. Plant death may result in severe cases. Anthracnose is especially prevalent in over-wintered, second, and third cut fields.

**Monitoring:** Weekly sampling of ten random plants from ten different locations should be completed to monitor the occurrence of anthracnose in spinach. If found within the field, infected plants should be removed and destroyed immediately.

**Chemical Control:** The following preventative fungicides can be applied beginning 2-3 weeks after emergence on a 7-10 day schedule (do not use if temperature is 90°F or above). *Ridomil Gold 4E* applied at planting for damping-off control may also provide early season control.

- **fosetyl Al** (Aliette)-PHI-3 days. Apply at a rate of 2.4 lbs. a.i./acre. REI-12/24 hours.
- **copper, fixed** (Kocide DF) (Champ F)-PHI-0 days. Apply at a rate of 1.2 lbs. a.i./acre. REI-12/48 hours.
- **mefenoxam** (Ridomil Gold 4E) (Ridomil Gold/Copper) (Ultra Flourish)-PHI-21 days. Apply Ridomil Gold/Copper at a rate of 1.75 lbs. a.i./acre of (14-day schedule). For damping-off apply 0.50-1.0 lbs. a.i./acre as a soil surface spray after planting or as a preplant incorporated. REI-12/48 hours.

**Biological Control:** No current recommendations for commercial production.

**Cultural Control:** If anthracnose is detected, proper sanitation practices are essential to stop disease spread to additional plantings. Do not replant spinach into an infected site for 2 to 3 years.

**Blight (Cucumber Mosaic Virus)**

Blight resulting from the cucumber mosaic virus (CMV) can be devastating, however, it is typically only a problem in fall crops. Infected plants show severe mosaic symptoms, stunting, and are not well developed under average growing temperatures and may display veinal browning and necrosis during
low temperatures. CMV is transmitted by aphids which may feed on CMV infected weed species before moving into spinach. Therefore, proper control of both the aphids and weeds is an essential practice when managing the CMV.

**Monitoring:** No thresholds have been established for spinach.

**Chemical Control:** No current recommendations for commercial production.

**Biological Control:** No current recommendations for commercial production.

**Cultural Control:** Resistant varieties provide the only protection against CMV. Site selection and sanitation practices such as not locating plantings downwind from weedy border areas and weed elimination may help prevent CMV in spinach.

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**Damping-off, Pythium spp. and Rhizoctonia solani**

Damping-off is a fungal disease that attacks seedlings at the soil line, withering the stem and resulting in death, and which also induces seed rot. Although this disease may be caused by thirty or more species of fungi, the most common agents are *Pythium* spp. and *Rhizoctonia solani*.

** Monitoring:** No thresholds have been established for spinach.

**Chemical Control:** A preventative application of the fungicide listed below will help manage damping-off throughout the growing season.

- **mefenoxam** (Ridomil Gold 4E) (Ridomil Gold/Copper) (Ultra Flourish)-PHI-21 days. Apply at a rate of 0.50-1.0 lbs. a.i./acre as a soil surface spray after planting or incorporate as a pre-plant spray. REI-12/48 hours.

The use of seed treated with a fungicide (such as thiram or captan) may provide additional control.

**Biological Control:** No current recommendations for commercial production.

**Cultural Control:** Crop rotation may help to minimize buildup of fungi within the soil. Proper sanitation, site selection, and postharvest practices are not commercially viable management tools. No resistant varieties are available.
**Downy Mildew (Blue Mold), *P*eronospora effusa**

Downy mildew, sometimes referred to as blue mold, appears as pale yellow, irregular leaf spots on the upper surface, with corresponding grayish-violet rot on the lower leaf surface. Plant death may result in severe cases. As with other fungal diseases, downy mildew thrives under cool, moist conditions, but is not usually a problem when temperatures exceed 90°F.

**Monitoring:** Scouting should begin after plant emergence and continue on a weekly basis. Random samples of ten plants in ten different field locations should be used to determine downy mildew presence. If the disease is found, treatment should begin immediately.

**Chemical Control:** A preventative application of a copper containing fungicide (see Anthracnose) should be made as soon as plants begin growing in the spring or shortly after cutting, especially if over-wintered inoculum is present. Treatment should be repeated every 7-10 days as disease pressure warrants.

**Biological Control:** No current recommendations for commercial production.

**Cultural Control:** If downy mildew has been a problem in the previous planting, rotate away from spinach for at least two years. Avoid planting spring spinach near over-wintered fields and use resistant varieties if possible. Sanitation and postharvest practices are not commercially viable management tools.

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**Leaf Spot*, *Cercospora spp.***

Infection caused by the *Cercospora* spp. of fungi results in round, water soaked spots on the leaves and stems. These spots then enlarge, turn white at the center with dark margins. Long periods of 90-100% relative humidity, nighttime leaf wetting, and temperatures of 77-86°F favor leaf spot formation. The disease is especially prevalent in over-wintered, second, and third cut fields.

**Monitoring:** Weekly sampling of ten random plants from ten different locations should be completed to monitor the occurrence of leaf spots in spinach.

**Chemical Control:** An application of a copper containing fungicide (see Anthracnose) should be made as soon as plants begin growing in the spring or shortly after cutting. Treatment should be repeated every 7-10 days.

**Biological Control:** No current recommendations for commercial production.

**Cultural Control:** Proper sanitation practices are essential to stop disease spread once detected.
Other leaf spot diseases may be controlled using similar recommendations and techniques.

White Rust, *Albugo occidentalis*

White rust has become a major concern of spinach producers in Virginia. Plants infected with the white rust fungus are often weak and will collapse quickly if environmental conditions are favorable for disease development. When white rust does occur, losses may reach 100% in a very short period of time (1-2 weeks). Symptoms include the formation of white, blister-like pustules on the lower side of the leaf. Generally, the upper leaf surface will only be chlorotic, however, advanced stages will result in white lesions in this portion of the leaf. Initial outbreaks each season usually follow weather events such as hard rains that disperse the fungus on the young plants. The disease develops most rapidly during periods of cool, humid nights and mild day temperatures.

**Chemical Control:**

- **azoxystrobin** (Quadris)-PHI-1 day. Currently being used under section 18 registration. Recommended for application at a rate of 0.15-0.20 lbs. a.i./acre for control of white rust. Should be reapplied at 7-day intervals as needed. REI-12 hours.

**Biological Control:** No current recommendations for commercial production.

**Cultural Control:** White rust tolerant and resistant varieties are available, but are not adapted for growth in Virginia.

**Weeds**

*Control recommendations were taken from 2000 Commercial Vegetable Production Recommendations—Virginia (3).*

The two most troublesome weeds for spinach producers in Virginia are chickweed and henbit, both of which are winter annuals. Good overall weed control is essential, given the manner in which spinach is harvested and processed. Section 18 Emergency Labels are often requested to supplement the limited chemical weed control options available to spinach growers. *Dual Magnum*, not included in the list below, is currently being considered for emergency use as a preemergence herbicide in Virginia.

**Monitoring:** Identify the weeds in each field and select recommended herbicides for control of those weeds.

**Chemical Control:** See *Chemical Weed Control* section below.
**Biological Control:** No commercially effective controls are available.

**Cultural Control:** No commercially effective controls are available.

**Chemical Weed Control***

- cycloate (Ro-Neet)-Preplant herbicide used for both fresh and processing spinach. Apply 2.5-3.0 lbs. a.i./acre prior to seeding and incorporate 2-4 inches into the soil with disk. Used for good control of most summer annuals. REI-12 hours.

- **paraquat** (Gramoxone Extra 2.5SE)-A **Special Local-Needs 24c Label** has been approved in Virginia for postharvest desiccation of the spinach crop. Treatment with paraquat will also help control certain weed species for the next growing cycle. Apply at a rate of 0.50-0.60 lbs. a.i./acre. Provides good control of most summer annuals and also of yellow nutsedge. REI-12/48 hours.

- phenmedipham (Spin-Aid)-PHI-40 days. Postemergent labeled for **processing spinach only**. Apply during the fall months at a rate of 0.33-0.67 lbs. a.i./acre for moderate control of seedling broadleaf weeds. Reapply treatment if weeds germinate after the initial application. Do not exceed 6.0 pts./acre/year. REI-24 hours.

- sethoxydim (Poast)-PHI-15 days. Postemergence herbicide used on both fresh and processing spinach. Apply at a rate of 0.20-0.30 lbs. a.i./acre for control of annual grasses and certain perennial grasses. Repeat applications may be necessary for additional control of tough perennial grasses. Do not tank-mix with or apply within 2-3 days of any other pesticide unless labeled. Do not apply more than 3.0 pts./acre in one season. REI-12/24 hours.

*Section 18 Emergency Use Exemption label requests may be submitted to supplement the list above.

**On-line Resources**

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

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

**Prepared by:**  
Donna M. Tuckey  
Integrated Pest Management Coordinator  
Virginia Cooperative Extension  
Middlesex County Office  
P.O. Box 96  
Saluda, VA 23149
Contributors

**Diseases:**
Sam A. Alexander  
Associate Professor, Plant Pathology  
Eastern Shore Research and Extension Center (0512)  
33446 Research Drive  
Painter, VA 23420-2827  
Ph: (757)-414-0724  
Fax: (757)-414-0730  
e-mail: salex@vt.edu

**Insects:**
Brian A. Nault  
Assistant Professor, Entomology  
Eastern Shore Research and Extension Center (0512)  
33446 Research Drive  
Painter, VA 23420-2827  
Ph: (757)-414-0724  
Fax: (757)-414-0730  
e-mail: bnault@vt.edu

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

**Weeds:**
Henry P. Wilson  
Professor, Weed Science  
Eastern Shore Research and Extension Center (0512)  
33446 Research Drive  
Painter, VA 23420-2827
References