

# **Pest Management Strategic Plan for Spinach in Delaware, Eastern Shore Maryland and New Jersey**

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## **Executive Summary**

Numbers after items = priority rank on scale of 0 (lowest) – 15 (highest)

## Critical Priorities

### *Regulatory:*

- White rust: reregistration of maneb or Mancozeb to be used in rotation with Quadris even if they were registered with limited usage (once per season) and with preferred 7 day PHI. It is important not just for White rust – these products are superior to any current chemistry for leaf spot (15).
- Stinger: change PHI to closer to harvest (now 21 days) (15).
- Spinaid needs label for fresh market and processing with shorter PHI for all (15).
- Keep diazinon as a soil applied treatment (14).
- Use of Capture to control grasshoppers – reduced PHI (12). (Grasshopper currently not on Capture label.)
- Some formulations of Captan are registered for application pre-plant incorporated, but there are some that are not. Do we need to change? Captan, even though a B2 Carcinogen, is a critical use (12).

### *Research:*

- Need something to control winter annuals, especially chick weed (15).
- Research is needed on prediction and detection of white rust for timing of fungicide application, especially initial infection (15).
- A product is needed for white rust (in addition to copper) to alternate with strobilurans, Acrobat, Etc (14).
- IR-4 residue trials to reduce PHI for Provado and dimethoate on Green Peach Aphid (13).
- Damping off and root rot need more materials for control (12)
- Etiology of Cucumber Mosaic Virus (10).

### *Education/Extension*

- List spinach in plant-back restrictions tables: when can you plant spinach after you have used various herbicides on other crops (15).

## Other identified needs

### *Regulatory*

- Keep dimethoate for aphids (0).
- Actigard – get a 24C for MD and DE (0).
- Paraquat as post plant, pre-emergent burn down (0).

### *Research*

- Need new seed treatments for seed corn maggot (9).
- Question seed treatment long term effectiveness with aphids. This will need to be addressed through IR-4 (6).
- White rust transmission – is it really soil borne? How important is soil borne inoculum (4)?
- Biologicals research for white rust, damping off or root rot. For example, Serenade or Trichoderma (3)
- In furrow treatments for root rots: Cabrio and Quadris (1).

- ID races of Downy mildew in region (0).

### Production Information

- Approximately 1,000 acres are planted and harvested in Delaware each year (1). Most spinach in the state is grown in Sussex County (2).
- Both Maryland and New Jersey grow approximately 2000 acres annually each (1).
- From 1995 to 1997, Delaware production averaged 62 Cwt./A for a total of 27,666 Cwt. (2)
- The cash farm income to spinach producers in Delaware in the years 1995 to 1997 was \$1,260,000, \$253,000, and \$288,000 respectively (2).
- In Delaware most spinach is grown for freezing, although some is clipped, washed and packed in plastic-film bags for fresh market shipment (2).

### Cultural Practices

Spinach (*Spinacia oleracea*) is grown in the region for both fresh-market and processing. It is classified as a very hardy cool-season crop and grows best at a mean temperature of 50 to 60 degrees Fahrenheit. Spinach for processing can be planted for 3 different harvest periods. Spring crops are planted between March 12 and April 20 and are harvested between May 20 and June 7. Fall Crops are planted between August 10 and September 2 and are harvested between September 15 and December 24. Overwinter crops are planted between October 1 and October 15 and are harvested in the Spring.

#### ESTIMATED COSTS RETURNS AT SELECTED PRICES PER ACRE FOR FRESH MARKETING AND PROCESSING SPINACH (FALL, 1996)

ITEM, DIRECT EXPENSES	FRESH MARKET SPINACH	PROCESSING SPINACH
Fertilizers	\$111.50	\$111.50
Fungicides	94.41	94.41
Herbicides	18.75	18.75
Insecticides	2.76	2.76
Hired Labor	61.50	60.00
Pack & Harvest Items	430.80	
Seed	56.25	56.25
Custom (Water)	75.00	50.00
Harvest Labor	7.80	
Operator Labor	92.10	77.10
Diesel Fuel	4.98	3.13
Repair & Maintenance	26.82	19.37
Interest on Operating Capital	26.01	18.32
<b>Total Direct Expenses</b>	<b>1008.68</b>	<b>511.59</b>

<b>Returns above Direct Expenses</b>	<b>825.32</b>	<b>608.41</b>
<b>Total Fixed Expenses</b>	<b>65.61</b>	<b>50.08</b>
<b>Total Specified Expenses</b>	<b>1074.29</b>	<b>561.67</b>
<b>Returns above total Specified Expenses</b>	<b>759.71</b>	<b>558.33</b>
<b>Hauling</b>	<b>65.00</b>	<b>65.00</b>
<b>Residual Return</b>	<b>694.71</b>	<b>493.33</b>
<b>Selling Charges</b>	<b>55.02</b>	
<b>Residual returns</b>	<b>639.69</b>	

## **Critical Pest Information**

### **Insects**

In the Mid-Atlantic Region, there are several insect pests known to attack spinach including seed corn maggot, spinach flea beetle, green peach aphid, leafminers, grasshoppers, beet armyworm, garden and Hawaiian beet webworm. All of these pests can attack both fresh market and processing spinach.

### **Diseases**

White Rust is the most common and economically damaging disease of spinach in the region. Other spinach diseases that are considered primary pests are leaf spots and damping off. Diseases with secondary pest status are: downy mildew (blue mold), root disease complex, cucumber mosaic virus (CMV), and the nematode diseases, root knot, and lesion.

### **Weeds**

Late summer, fall and spring spinach have the same weed problems (for the most part). There are several species of winter annual broadleaf and grass weeds and there are several species of summer annual broadleaf and grass weeds.

## **Critical Pesticide Information**

### **Insecticides:**

Of the insecticides labeled for use in spinach, two are organophosphates (Diazinon and Dimethoate) and three are carbamates [Sevin (carbaryl), Lannate (methomyl), and Larvin (thiodicarb)]. At this time, US-EPA is considering canceling the registration of Dimethoate in spinach. In addition, there is a question about the long-term future use of diazinon for seed corn maggot control.

IPM issues – The ability to rely on beneficial organisms (parasitic wasps, predators and fungal pathogens) to control aphids is limited because they are considered a contaminant when present in high enough numbers to control aphids. Consumers who will not accept any level of insect contaminated product drive this issue. As a result, additional sprays are needed to prevent aphids from building to the levels necessary for beneficial organisms to provide control.

Resistance management issues - Since Green peach aphids can develop tolerance to insecticides, there is always a need for multiple products to prevent the development of resistance. Although dimethoate resistance has been observed in Virginia, it can be an important management tool in the Delaware/Maryland area.

Consumer education issues – As stated above, the IPM issue is also a consumer driven issue.

Export/Import issues - None

### **Fungicides:**

There are no organophosphate or carbamate fungicides used in spinach. The only B2 carcinogen used is captan to control Damping off. Other fungicides are fosetyl-aluminum (Aliette), copper hydroxide (Kocide DF), azoxystrobin (Quadris), Ridomil Gold Copper, and mefenozam (Ultra Flourish). This report discusses several non-registered (pipeline materials) pest management tools.

### **Herbicides**

Herbicides used in spinach include: S-metolachlor (Dual Magnum 7.62E), cycloate (Ro-Neet 6E), phenmedipham (Spin-aid 1.3E), clopyralid (Stinger 3A), sethoxydim (Poast 1.5EC), clethodim (Select 2EC), and paraquat (Gramoxone Max 3SC).

## **Diseases**

### **White Rust**

White rust is the most common and economically damaging disease in Delaware, Maryland and New Jersey. Losses are due primarily to reduction in quality and increased costs resulting from increased sorting time, and rejection of loads when the level of white rust is too high. Processing spinach has specific threshold levels of disease, when a load exceeds the threshold the entire load will be rejected.

Crop rotation is used on most of the spinach acreage in the U.S.; however, rotation alone is not adequate to control white rust. Recently cultivars that have moderate levels of resistance to white rust, and with fair agronomic characteristics, have been developed. A cultivar with moderate resistance to white rust (Vancouver) is now grown on 30% of processing acreage in region, and other moderately resistant cultivars are currently in University trials. In addition, fungicide applications are necessary on moderately resistant cultivars to limit the incidence of white rust lesions that reduce leaf quality. Despite widespread crop rotation and limited use of host resistance, fungicide usage is very high on spinach in order to control white rust. Azoxystrobin (Quadris), copper, mfenoxam (Ultra Flourish) and fosetyl-aluminum (Aliette) are used to control foliar diseases on U.S. acreage. Acibenzolar-S-methyl is registered for use in some counties in Texas and California and is available through a Special Local Needs label (24c) in New Jersey and Virginia. Despite high fungicide

usage, losses due to white rust persist due to lack of information on pathogen detection, prediction and timing of initial fungicide applications. In addition, copper fungicides and acibenzolar-S-methyl have caused phytotoxicity in some environments.

White rust appears as a small yellowish spot on the upper surface of the leaves. As these lesions develop, glassy white pustules form which eventually release spores. Tissue next to pustules may turn brown. An entire leaf may become infected and die. Ideal conditions for disease spread are cool nights with heavy dew alternating with warm, dry, sunny days. This disease is the most troublesome for processing spinach in the region. It is the most abundant in the spring and fall crops. Twenty-five to seventy-five per-cent of acreage is treated. Fall spinach is almost always treated. Spring spinach is usually treated. Moderately resistant cultivars are available, however the leaf type is not as desirable as the leaf type of the sensitive cultivars.

**Threshold**

Random sample weekly 10 plants in 10 locations looking for white blister-like pustules on underside of leaves. Threshold is “presence” within the area.

**Organo-phosphates currently used to manage this pest:** none

**Carbamates currently used to manage this pest:**none

**B2 carcinogens currently used to manage this pest:** None

**Other pesticides currently used to manage/ control this pest:**

FUNGICIDE	Use Category	REI	PHI	
Aliette	G	12,24	3	Less than 2% acreage Frequently after cutting –25%; Rotation with Quadris 90% at planting
Kocide DF	G	12,48	0	
mefenoxam/Ultra Flourish	G	12	21	Not used
Quadris	G	4	0	
Ridomil Gold Copper	G	48	21	
Ultra Flourish	G	12	21	

Fosetyl-aluminum (Aliette) is not widely used because it does not provide control for an adequate time period. It is expensive, and not as effective. Copper products (Kocide DF; Ridomil Gold Copper) cause phytotoxicity under certain environmental conditions, and do not give good control. Azoxystrobin (Quadris) applications are limited due to concerns about resistance development. Actigard is registered in a limited geographic region. In addition, it has caused phytotoxicity in some environments.

**Non-chemical methods currently used to help manage this pest:**

**Biological:** Limited reports that Serenade (*Bacillus subtilis*) has activity on white

rust when used in combination with reduced rates of conventional chemicals. **Cultural:** Rotation is widely practiced, however disease can infest even fields that have not been planted to spinach for many years.

**Non-registered (Pipeline materials) pest management tools:**

Pristine, a combination of boscalid and pyraclostrobin, is currently an IR-4 project and a petition to EPA for food residue tolerance limits (Maximum Residue Limits, MLR) has been submitted. Cabrio is a strobilurin with good efficacy on white rust. In a study in Oklahoma, Cabrio had superior ability to control white rust, after infection by *A. occidentalis*, compared to Quadris (i.e. better “back-action”). Tanos is also an IR-4 project currently under research, and the manufacture supports registration. Preliminary results on Tanos efficacy on white rust look good, when it is used on a weekly schedule. Fenamidone is also in the IR-4 program through a request from two states. The manufacturer is requiring more efficacy data prior to continuing the registration process. Zoxium, an IR-4 project, has a petition to EPA (MRL) in preparation. Efficacy reports on Zoxium, when sprayed weekly, are promising. Serenade is a biological fungicide that has reported efficacy on white rust. Control was best when applied with a reduced rate of copper. The combination of the biofungicide with copper at a reduced rate would likely reduce the risk of phytotoxicity from copper.

**Leaf Spots**

Leaf spots are primary pests. Cercospora leaf spot and Cladosporium have been encountered on overwintered spinach as minor problems but Cladosporium can be a primary pest in some circumstances. Anthracnose is probably the major leaf spotting disease-afflicting spinach. Initial symptoms are small, water-soaked areas on both old and young leaves. These areas develop into yellow or necrotic lesions. The older lesions are tan and appear papery. Eventually lesions may coalesce causing the leaf to be wilted. Anthracnose is also a secondary infection often infecting leaves with other diseases, especially white rust. Wet conditions, dense plantings, poor air circulation, and low soil fertility favor the disease. The disease is favored by long periods of 90-100% relative humidity, night time leaf wetting & temperature of 77-86°F. Controls should be applied when the disease is first noticed.

***Threshold***

Random sample weekly 10 plants in 10 locations. Threshold is “presence” or favorable weather conditions.

**Organo-phosphates currently used to manage this pest:** none

**Carbamates currently used to manage this pest:** none

**B2 carcinogens currently used to manage this pest:** None

**Other pesticides currently used to manage/ control this pest:**

FUNGICIDE	Use Category	REI	PHI	
Kocide DF	G	12,48	0	
Quadris	G	4	0	
Ridomil Gold Copper	G	48	21	Not used do to PHI
Copper hydroxide (Kocide DF)				
Azoxystrobin (Quadris)				

**Non-chemical methods currently used to help manage this pest:**

**Biological:** none

**Cultural:** Rotation

**Non-registered (Pipeline materials) pest management tools:**

It is likely that some products being registered for white rust (such as Pristine) would provide control of leaf spots.

**Damping off**

Seedling damping off, a primary pest of spinach, is caused by soil-borne fungi and is the most serious in the fall planted crop. After germination, the seedling becomes infected, withers and dies.

**Organo-phosphates currently used to manage this pest:** none

**Carbamates currently used to manage this pest:** none

**B2 carcinogens currently used to manage this pest:** Captan soil applied, widely used; pre-plant.

**Other pesticides currently used to manage/ control this pest:**

Mefenoxam (Ultra Flourish), though it is not effective on Rhizoctonia. 90% acreage treated

**Non-chemical methods currently used to help manage this pest:**

**Biological:** Possibly Trichoderma products such as T-22 planter box.

**Cultural:** Rotation is only moderately effective because the organisms that cause damping off have wide host ranges.

**Non-registered (Pipeline materials) pest management tools:** None

**Downy mildew (blue mold)**

Downy mildew is not common in Delaware or Maryland, possibly due to the use of fungicides and resistant cultivars. Predominant cultivars grown have resistance to several races of *Peronospora farinose*. The varieties Seven R, Vancouver, Melody, Tyee, Olympia, Samish, Vienna, Marathon, and Kent have some resistance to specific races of downy mildew. Because new races could occur, this disease has the potential to result in significant yield loss. Fungicides used for white rust management, such as mefenoxam Ridomil, copper and

axoxystrobin have some efficacy on downy mildew. Ninety per-cent of spinach acreage is treated with Ridomil Gold or Ultra Flourish.

Downy mildew is the most troublesome in cool, wet weather (temperatures of 2 to 25 degrees C), which are frequently the conditions experienced in this region in fall, winter and spring. Under ideal conditions the disease can spread rapidly and significant yield loss can result. Lesions occur primarily on the undersurface of leaves and when sporangia develop they have a bluish hue, giving rise to the name blue mold. There are several races of the disease, which makes it more difficult for selecting disease resistance varieties.

**Threshold**

Begin scouting weekly after emergence. Random sample 10 plants in 10 locations. Threshold is “presence.” Downy mildew is not a problem when temperatures exceed 90°F.

**Organo-phosphates currently used to manage this pest:** none

**Carbamates currently used to manage this pest:** none

**B2 carcinogens currently used to manage this pest:** None

**Other pesticides currently used to manage/ control this pest:**

Less than 2% of acreage is treated for downy mildew.

FUNGICIDE	Use Category	REI	PHI
Aliette	G	12,24	3
Kocide DF	G	12,48	0
mefenoxam	G	12	21
Quadris	G	4	0
Ridomil Gold Copper	G	48	21
Ultra Flourish	G	12	21

Copper hydroxide (Kocide DF)

Azoxystrobin (Quadris)

Fosetyl-aluminum (Aliette)

Mefenozam (Ultra Flourish)

**Non-chemical methods currently used to help manage this pest:**

**Biological:** none

**Cultural:** Widespread use of cultivars with resistance to some races of *P. farinosa*. Three year rotation away from spinach is widely practiced.

**Non-registered (Pipeline materials) pest management tools:**

IR-4 has a petition in preparation on Zoxamide (Gavel) and BAS 516 (Pristine). Research is being conducted on Tanos (famoxadone and cymoxanil).

### **Root disease complex**

Root disease complex is of secondary importance in spinach, but when it occurs, it causes 100% yield loss. Several diseases combine to create root problems, including Pythium, Rhizoctonia, Phytophthora, and Fusarium. These soil-borne fungal pathogens typically persist in fields for years and infect susceptible plants when conditions are optimal. Rhizoctonia can cause an eyespot symptom on leaf petioles resulting in loss of entire leaves. The growing points may not be harmed and plants can recover and produce some yield. Fusarium wilt in Delaware can cause considerable damage. Crop rotation, planting fields with good drainage and using resistant varieties whenever possible are probably the best ways to manage these diseases.

**Organo-phosphates currently used to manage this pest:** none

**Carbamates currently used to manage this pest:** none

**B2 carcinogens currently used to manage this pest:** Captan soil applied, widely used; pre-plant.

**Other pesticides currently used to manage/ control this pest:**

Mefenoxam, though it is not effective on Rhizoctonia. 90% acreage treated

**Non-chemical methods currently used to help manage this pest:**

**Biological:** Possibly Trichoderma products such as T-22 planter box.

**Cultural:** Rotation is not always effective because root disease complex pathogens have a wide host range (Pythium, Rhizoctonia, Phytophthora) or survive for long periods of time in soil. Vancouver and some other varieties have tolerance to Fusarium wilt.

**Non-registered (Pipeline materials) pest management tools:** None

### **Cucumber Mosaic Virus**

Cucumber mosaic virus (CMV) is a minor disease in spinach. Extension Specialists in Delaware report one grower with a problem on Vancouver in 2003. Aphids which vector the virus must be controlled. Using resistant varieties is the only control for CMV.

### **Nematodes (Root Knot and Lesion)**

Nematodes are not usually a major problem in spinach, but can sometimes be severe. They are controlled by soil sampling and survey in advance. They are primarily a fall crop issue and a rotation issue (their damage is worse behind specific crops)

### **Chemical Controls**

*Fungicides used in 2000* – last year of available data, NJ Pesticide Control Program

**Azoxystrobin** –

- Azoxystrobin, applied as Quadris, 167.21 lbs ai or about 14.7 % of all fungicides.

**Copper –**

- In 2000, 121.25 lbs ai of copper or about 10.7 % of all fungicides used.
- Copper was used in the control of leaf spots, anthracnose, downy mildew or white rust.

**Copper hydroxide –**

- In 2000, 42.05 lbs of copper hydroxide, Kocide, or about 3.7 % of all fungicides applied on spinach, was used.
- Copper hydroxide was used in the control of leaf spots, anthracnose, downy mildew or white rust.

**Fosetyl-aluminum –**

- In 2000, 316 lbs ai of fosetyl-aluminum, Aliette, or about 27.9 % of all fungicides applied on spinach, was used.
- Fosetyl-aluminum was used primarily for the control of blue mold and white rust.

**Mefenoxam –**

- In 2000, 72.67 lbs ai of mefenoxam, Ridomil Gold (UltraFlourish), or about 6.4 % of all fungicides applied on spinach, was used.
- Mefenoxam was used for the control of damping-off, blue mold and white rust.

**Metalaxyl –** Note: This is no longer available

- In 2000, 414.87 lbs of metalaxyl, Ridomil, or about 36.6 % of all fungicides applied on spinach, was used.

***Current (2000) Pesticide Recommendations for Disease Pests, Product Rates Per Acre and Use (G=general, R=restricted) (4)***

*Damping Off*

**Mefenoxam** 1 - 2 pt /A (Ridomil Gold) G

2 - 4 pt /A (Ultra Flourish) G

*Downy mildew (Blue mold), white rust, leaf spots, anthracnose*

**Azoxystrobin** 6.2 – 15.4 fl oz 2.1F/A G

**Fosetyl AL** 3 lb 80WDG/A G

**Fixed copper** 2 lb 61 DF/A G

**Mefenoxam and copper hydroxide** 2.5 lb 70WP G

**Efficacy Table**

	Downy Mildew (Blue Mold)	White Rust	Leaf Spots	Damping off	Root disease Complex
<b>Registered Materials</b>					
Fosetyl-aluminum (Aliette)	G	P	NU	NU	NU
Copper hydroxide (Kocide DF)	F	P	P	NU	NU

Azoxystrobin (Quadris)	F	G	G	NU	NU
Ridomil Gold Copper	F	P	P	NU	NU
Mefenoxam (Ultra Flourish)	GE	GE	NU		
Actigard	NU	G	NU	NU	NU
Captan	NU	NU	NU		
<b>New Chemistries</b>					
Zoxamide (Gavel)	?	? NU	NU	NU	NU
BAS 516 (Pristine)	?	?	?	NU	NU
Tanos (famoxadone & cymoxanil)	?	G	?	NU	NU
Cabrio	?	G	?	NU	NU
fenamidone	?	?	?	NU	NU
zoxium	?	F	?	NU	NU
<b>Cultural/ non-chemical</b>					
Serenade (B. subtilis)	?	?	NU	NU	NU
Tricoderma	NU	NU	NU	?	?
Crop rotation		P		F	
host plant resist.	F	F	NU	NU	
Good drainage	NU	NU	NU	NU	

Rating Scale:

E = excellent; G = good; F = fair; P = poor; ? = more research needed; NU = not used; \* = used but not necessarily a stand alone management tool; GE = good control for 4 weeks after planting when applied at planting.

## INSECT PESTS

### **Seed Corn Maggot**

This insect is a primary pest and one of the major pests of spinach in the region. It can be a problem in overwintered, spring and fall planted spinach. In the spring crop, it is primarily a problem during cool, wet growing seasons. Only a few maggots per seed or plant can significantly reduce stands. Maggots overwinter as puparia in the soil with flies emerging as early as late February. Eggs are laid in freshly plowed fields as well as at the base of overwintered spinach plants. Maggots may feed on roots in soil, or feed in the heart of the plant above ground during wet conditions, causing foliage damage as well. Outbreaks are favored by planting into freshly plowed ground that is high in organic matter; freshly manured fields; and/or heavy crop residues (e.g. small grain covers) where tillage is delayed and/or surface residue is visible after tillage operations.

**Monitoring:** Scouting and applying rescue treatments after the damage is observed are ineffective. Management options must be applied to high-risk fields prior to planting. There are no resistance problems or pest related export/import issues.

**Organo-phosphates currently used to manage this pest:** The only available option for control is a broadcast application of diazinon incorporated just prior to planting or transplanting. Control with diazinon has been good, but it must be incorporated 3-4 inches immediately before planting to achieve the best control.

Diazinon AG500: At planting; 2 qt/A; Labeled for crop but not pest. Must be broadcast and shallow incorporated in top 3-4 inches immediately before planting to be effective. One application per crop. Used on 50 – 60%% of the acreage. There are no resistance problems or pest related export/import issues.

**IPM issues** – There are no other available chemical control options, cultivation helps but is not a complete control strategy, especially if organic matter is high. REI.- 24 hours; PHI – 14 days

**Carbamates currently used to manage this pest:** None.

**B2 carcinogens currently used to manage this pest:** None

**Other pesticides currently used to manage/ control this pest:** None

**Non-chemical methods currently used to help manage this pest:**

**Biological:** None Available

**Cultural:** The use of cultural management practices before planting is critical to reduce the potential for economic problems; however, cultural controls alone may not eliminate the problem. A combination of the following cultural strategies can be used: (1) plow down cover crops at least 3-4 weeks before planting or transplanting, (2) completely bury cover crops or previous crop residue to reduce fly attraction to rotting organic matter on the soil surface, and (3) avoid the use of heavy manure applications close to planting. Many of these strategies are not practical due to weather conditions.

**Non-registered (Pipeline materials) pest management tools:** None we are aware of at this time for spinach.

### **Green Peach Aphid**

Green Peach Aphid is a primary pest of spinach and one of the major pests in the region. This insect is known to infest a wide variety of crops in addition to spinach. Adults overwinter on cultivated greens and weeds. Eggs overwinter on fruit trees such as peach, plum and cherries. In the Mid-Atlantic region, multiple generations occur throughout the season with peak populations occurring in May through June and again in mid-September through October. Aphids remove sap from the undersides of the leaves resulting in curled leaves and stunted plants. In addition to plant damage, they can also vector viruses including lettuce and spinach mosaic. Aphids as well as beneficial insects can be considered contamination problems in spinach grown for fresh market and processing resulting in rejection of an entire crop.

**Monitoring:** Sampling for aphids should begin in the spring, by checking the undersurface of leaves on 5 to 10 plants in 10 locations throughout the field. Treatments should be applied if you find one aphid per plant on seedling plants or 4 -10 aphids per plant on established plants. However, current thresholds are difficult to use because labeled products have long pre-harvest interval restrictions. When making a treatment decision, beneficial insects such as ladybeetles, syrphid fly larvae, and lacewings should also be taken into consideration. However, they can also be a contaminant problem.

**Resistance Problems** – In the Mid-Atlantic region, Green peach aphids are known to be resistant to methomyl (Lannate). In Virginia, resistance has been documented to dimethoate. Variable results are found in Delaware, Maryland, and New Jersey. It appears that control is better in the spring than in fall.

**Pest Related Export/Import Issues** – None

**Organo-phosphates currently used to manage this pest:** Dimethoate 4EC - 0.5 pt/acre; does not provide control of exploded green peach aphid populations. Generally used in fresh market spinach to reduce populations. Resistance has been documented in Virginia. Two applications per season are used to suppress populations for fresh market. At least 50% of acreage for fresh market; 30% for processing.

IPM issues - None

REI - 48 hours

PHI. - 14 days

Export/import issues - None

**Carbamates currently used to manage this pest:** Methomyl (Lannate), although labeled on spinach, it is not used to control GPA due to resistance issues.

**B2 carcinogens currently used to manage this pest:** None

**Other pesticides currently used to manage/ control this pest:**

Imidacloprid (Admire 2FS) - 10-24 oz/acre; Applied at planting; Not practical to apply at planting and does not provide long enough control, so currently used on 0% of the acreage , PHI - 21 days; REI - 12 hours

Acetmiprid (Assail 70WP) - 0.8 - 1.2 oz/acre; New label in 2003, so not used as of this writing; from available data provides good aphid control on spinach; PHI - 7 days; REI - 12 hours

Pymetrozine (Fulfill 50W) - 2.75 oz/acre; One application due to cost; used on 10% of the acreage; provides very good control but a penetrating surfactant should be used to provide the best control; PHI - 0 days; REI - 12 hours. Some reports that has not worked well.

Imidacloprid (Provado 1.6FS) - 3.75 oz/acre; One to two applications per season; New Jersey does not get the pressure that Delaware does. New Jersey is rarely using Provado. 90% of acreage in Delaware is treated; providing fair to good control; have seen reduced control in outbreak years; PHI 7 days; REI - 12 hours

**Resistance Problems:** Yes -- Since GPA can develop resistance to insecticides, new chemistry with different modes of action is critical. With the exception of Fulfill, all new labeled chemistry belongs to the neonicotinoid class. New modes of action are necessary to avoid the development of resistance. .

**Export/import issues:** None with any products

**Non-chemical methods currently used to help manage this pest:**

**Biological:** Although biological controls may eventually help to reduce populations, it often does not happen soon enough to prevent contamination problems in both fresh market or processing crop. Diseased or parasitized aphids will turn brown and remain stuck to leaves resulting in rejection of crop.

**Cultural:** None

**Non-registered (Pipeline materials) pest management tools:** Flonicamid from FMC; thiamethoxam (Platinum, Actara) from Syngenta.

### **Beet Armyworm**

Beet Armyworm is a primary pest in spinach. It is a migratory pest arriving in the Mid-Atlantic region in mid-July and is generally a problem in fall plantings. Female moths lay their eggs in the hearts of the plants, with larvae feeding on the buds and terminal growth of the plants. In spinach, webbing may be produced on the leaf surface but should not be confused with garden webworm, which generally feeds in the heart of the plant. Feeding damage generally peaks in late August to early September.

**Monitoring:** Fields should be sampled twice a week to determine the number of larvae per plant. Randomly sample 10 plants in 10 locations throughout a field.. Once larvae are detected, treatment is needed.

**Resistance Problems** - Although labeled for BAW control in spinach, methomyl (Lannate), thiodicarb (Larvin) and the pyrethroids have not provided effective BAW control.

**Pest Related Export/Import Issues** - None

**Organo-phosphates currently used to manage this pest:** None

**Carbamates currently used to manage this pest:** Methomyl (Lannate); thiodicarb (Larvin)

Lannate LV - 1.5 - 3 pt/acre; Can not be used until spinach plants are at least 3 inches in diameter. Poor to fair control of beet armyworm, especially in outbreak years; One - two applications used on 10% of the acreage Due to resistance problems. PHI - 7 day; REI - 48 hours. Useful for rotation.

Larvin 3.2F - 24 - 30 oz/acre; Poor to fair control of BAW. One application applied in out break years; Used on less than 2 % of the acreage due to variable control. PHI 14 days; REI - 12 hours.

**Resistance problems.** - This insect has developed resistance to currently labeled carbamates and pyrethroids. Since it is a migratory pest, resistance issues in the south affect control ability in our area, especially in outbreak years.

**IPM issues.** - None

**Export/import issues** - None

**B2 carcinogens currently used to manage this pest:** None

**Other pesticides currently used to manage/ control this pest:**

Tebufenozide (Confirm 2F) - 8 oz/acre; Fair to good control of beet armyworm; Used on 50% of the acreage; One - three applications per season; PHI - 7 days; REI - 4 hours. Good for rotation with Spintor. Lower cost option.

Methoxyfenozide (Intrepid 2F) - 4-8 oz/acre; Good beet armyworm control; Labeled in fall of 2002 so only used on 20% acreage so far this season (due to price); PHI- 1 day; REI - 4 hours

Permethrin 3.2EC - 8 oz/acre; Poor control of resistant beet armyworm; used on less than 2% of the acreage for this insect due to resistance issues.

Spinosad (SpinTor 2SC) - 6-8 fl oz/acre; good beet armyworm control; One - two applications; used on 50% of the fall spinach crop. PHI - 1 day; REI - 4 hours . most effective currently use Beet Army Worm treatment, but most expensive.

Bt Insecticides - multiple formulations; Agree, Match and Xentari most commonly used; Good control on small larvae only; used on less than 5% of the acreage treated; PHI - 0 days; REI - 4 hours.

**Resistance problems** - Yes, methomyl (Lannate), thiodicarb (Larvin) and pyrethroids

**IPM issues** - None

**Export/import issues** - None

**Non-chemical methods currently used to help manage this pest:** None

**Biological:** None

**Cultural:** None

**Non-registered (Pipeline materials) pest management tools:** None aware of except Diamond (novaluron) tested in 2002 with only fair results ; S-1812 from Valent

**Garden and Hawaiian Beet Webworm**

These webworms are primary pests of spinach. Overwintering moths begin laying eggs in fall planted spinach soon after plant emergence in mid-August. Garden Web worm Larvae immediately move into the growing point ("heart") of the plants resulting in stunted plants and distorted plant growth. As their name implies, webworms quickly produce silk often tying all of the "heart" leaves together. These pests are difficult to control once the web has formed. Also, the web helps keep the pest tight to the leaves. Thus both the web and the insect become contaminants.

**Monitoring:** Examine 10 plants in 10 locations and look for infested leaves and buds on small plants. Treatment should be applied when 5% of the plants are infested with small larvae. Controls must be applied before larvae are found deep in the growing point and before significant amounts of webbing are produced.

**Resistance Problems** - None

**Pest Related Export/Import Issues** - None

**Organo-phosphates currently used to manage this pest:** None

**Carbamates currently used to manage this pest:** Lannate (methomyl)  
Lannate LV - 1.5 - 3 pt/acre; Can not be used until spinach plants are at least 3 inches in diameter; Poor control. One application on 5% of the acreage. Weather related.

**Resistance problems** - None

**IPM issues** - None.

**REI** - 48 hours **PHI.**- 7 days

**Export/import issues** - None

**B2 carcinogens currently used to manage this pest:** None

**Other pesticides currently used to manage/ control this pest:** Permethrin (Ambush, Pounce), spinosad (Spintor); Bt insecticides, tebufenozide (Confirm), methoxyfenozide (Intrepid).

Tebufenozide (Confirm 2F) - 8 oz/acre; Fair to good control of webworms; Used on 50% of the acreage due to lower cost; One - three applications per season; PHI - 7 days; REI - 4 hours

Methoxyfenozide (Intrepid 2F) -4-8 oz/acre; Good webworm control; Labeled in fall of 2002 so only used on 20% acreage so far this season; PHI- 1 day; REI - 4 hours

Permethrin 3.2EC - 4 - 8 oz/acre; Fair-good control; used on 10% of the acreage; PHI - 1 day; REI - 24 hours

Spinosad (SpinTor 2SC) - 4-8 fl oz/acre; good webworm control; One - two applications; used on 30% of the fall spinach crop. PHI - 1 day; REI - 4 hours

Bt Insecticides - multiple formulations; Agree, Mattech and Xentari most commonly used; Good control on small larvae only; used on 10-20% of the acreage for this pest ; PHI - 0 days; REI 4 hours

**Resistance problems** - none

**IPM issues** - none

**Export/import issues** - none

**Non-chemical methods currently used to help manage this pest:** None

**Biological:** None

**Cultural:** None

**Non-registered (Pipeline materials) pest management tools:** none aware of

### **Grasshoppers**

Grasshoppers are a primary pest in processing spinach grown in the fall. Although grasshoppers do not cause feeding damage on the leaves, they are a major contamination problem during harvest of fall spinach. Grasshoppers are a major problem especially when spinach is harvested at night or in cold weather (which it usually is) because the grasshoppers hold on and won't shake off. In the fall, spinach is often the only green crop left and it can get full of grasshoppers in a bad year. Movement from surrounding grassy areas and soybeans can result in high population levels.

**Monitoring:** No precise sampling methods or treatment thresholds have been developed for grasshoppers in spinach. In fall planted spinach, fields should be watched within a month from harvest for movement of grasshoppers into the main field. Early controls in surrounding crops can help to reduce the problem at harvest. In addition, treatment around field edges to reduce movement into the main field has helped reduce the problem. Unfortunately, even with the use of these methods, economic levels can often occur.

**Resistance Problems** - None

**Pest Related Export/Import Issues** - None

**Organo-phosphates currently used to manage this pest:** Dimethoate provides fair control of small grasshopper control; however, it is only labeled for the crop and not the pest. In addition, it also has a 14-day wait until harvest; 5 % acres treated

**Resistance problems** None

**IPM issues-** None.

**REI.** 48 hours; **PHI** - 14 days

**Export/import issues** none

**Carbamates currently used to manage this pest:** Carbaryl (Sevin)

The use of labeled insecticides has provided poor control. Materials like Sevin are labeled for grasshopper control in spinach but it has a 14-day wait until harvest; 0 % acres treated PHI - 14 days; REI - 12 hours

Zeta-cypermethrin (MustangMax); high rate; 50% acres treated; variable control

**B2 carcinogens currently used to manage this pest:** None

**Other pesticides currently used to manage/ control this pest:** None

**Non-chemical methods currently used to help manage this pest:**

**Biological:** None available

**Cultural:** None

**Non-registered (Pipeline materials) pest management tools:** Bifenthrin (Capture) - IR4 is working to reduced the PHI.

### **Spinach Flea Beetle**

This beetle is a secondary occasional pest of spinach. It eats small holes in spinach leaves resulting in reduced market value. Unlike other flea beetles, larvae can also cause leaf-feeding damage by skeletonizing the undersides of the leaves. When disturbed, larvae and adults drop to the ground and play dead.

**Monitoring:** Monitor newly emerged plants two to three times per week for adults and larval damage including pitting or irregularly shaped holes. Pay particular attention to outside rows. Although no thresholds are available, spot treatment of outside rows may be needed if damage increases at each sampling date. There are no resistance problems or pest related export/import issues.

**Organo-phosphates currently used to manage this pest:** None

**Carbamates currently used to manage this pest:** Carbaryl (Sevin).

Sevin 80S - 0.67 - 1.25 lb/acre; One application per season; Applied to less than 2% of the acreage and provides good control.

REI - 12 hours; PHI - 14 days

**Pyrethroids currently used to manage this pest:**

Zeta-cypermethrin (Mustang MAX) - 2.4-4.3 oz/acre; One application per season; Applied to less than 2% of the acreage; provides good flea beetle control.

REI - 12 hours; PHI - 1 day. There are no resistance problems, IPM issues, or pest related export/import issues.

**B2 carcinogens currently used to manage this pest:** None

**Other pesticides currently used to manage/ control this pest:** None

**Non-chemical methods currently used to help manage this pest:** None

**Biological:** None

**Cultural:** None

**Non-registered (Pipeline materials) pest management tools:** Not aware of any

### **Spinach and Vegetable Leafminers**

Leaf miners are sporadic secondary pests in spinach. This insect emerges from April through May depositing eggs on the undersides of leaves. Initially, larvae produce light colored, irregularly winding mines. As the maggots increase in size, the mine widens at one end to form an irregular blotch. Severe infestations cause the foliage to turn brown or white. Infested spinach becomes unmarketable. Four to five generations can occur each year; however, the first generation causes the most damage.

**Monitoring:** As soon as plants emerge, fields should be sampled on a weekly basis for the presence of mines and larvae. Randomly examine 10 plants in 10 locations for larval damage. Treatment is recommended if the plants have eggs or mines.

**Resistance Problems** - None

**Pest Related Export/Import Issues** - None

**Organo-phosphates currently used to manage this pest:** None

**Carbamates currently used to manage this pest:** None

**B2 carcinogens currently used to manage this pest:** None

**Other pesticides currently used to manage/ control this pest:**

Permethrin (Ambush 2EC) - 6.4 - 12.8 oz/acre; One application per season; poor control; Less than 2 % of the acreage treated in outbreak years. PHI - 1 day; REI - 24 hours

Permethrin (Pounce 3.2EC) - 4 - 8 oz/acre; One application per season; poor control; Less than 2 % of the acreage treated in outbreak years. PHI - 1 day; REI - 24 hours -- not readily available

Spinosad (Spintor 2SC) - 6 - 10 oz/acre; One applications per season; Data shows it will provide good control, however in field experience shows that it gives poor control. less than 2% of acreage treated. PHI - 1 day; REI - 4 hours

Cyromazine (Trigard 75WSP) - 0.167 lb/acre; One application per season; Data shows Good control; however it has not been used in this region. PHI - 7 days; REI - 12 hours

**Non-chemical methods currently used to help manage this pest:** None

**Biological:** None

**Cultural:** None

**Non-registered (Pipeline materials) pest management tools:** Not aware of any

**Efficacy Table**

	Seed Corn Maggot	Green Peach Aphid	Beet Armyworm	Garden and Hawaiian Beet Webworm	Grasshoppers	Spinach Flea Beetle	Spinach & Vegetable Leafminers
<b>Registered Materials</b>							
diiazinon	G	NU	NU	NU	NU	NU	NU
dimethoate	NU	Var*	NU	NU	F	NU	NU
methomyl	NU	P to F	P to F	F	NU	NU	NU
imidacloprid (Admire)	NU	NU	NU	NU	NU	NU	NU
acetamiprid	NU	G	NU	NU	NU	NU	NU
pymetrozine	NU	G	NU	NU	NU	NU	NU
imidacloprid (Provado)	NU	F to G	NU	NU	NU	NU	NU
thiodicarb	NU	NU	P to F	NU	NU	NU	NU
tebufenozide	NU	NU	F to G	F to G	NU	NU	NU
methoxyfenozide	NU	NU	G	G	NU	NU	NU
permethrin	NU	NU	P	F to G	P to F	NU	P
Spinosad	NU	NU	G	G	NU	NU	P to F
Bt insecticides	NU	NU	G	G	NU	NU	NU
carbaryl	NU	NU	NU	NU	P	G	NU
zeta-cypermethrin	NU	NU	P to F	F to G	Var	G	NU
cyromazine	NU	NU	NU	NU	NU	NU	F to G
<b>New Chemistries</b>							
Fonicamid	NU	G to E	NU	NU	NU	NU	NU
Novaluron	NU	NU	?	?	NU	NU	NU
Bifenthrin	NU	NU	P	?	?	NU	NU
Thiamethoxam	NU	F to G	NU	NU	NU	NU	NU
<b>Cultural/ non-chemical</b>							
Plow down cover	F	NU	NU	NU	NU	NU	NU
Bury Cover	F	NU	NU	NU	NU	NU	NU
Avoid heavy manure	F	NU	NU	NU	NU	NU	NU

Biologicals	NU	P	NU	NU	NU	NU	NU
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Rating Scale:

E = excellent; G = good; F = fair; P = poor; ? = more research needed; Var = variable; NU = not used; \* = used but not necessarily a stand alone management tool

## WEEDS

Spinach is planted in early to mid spring for mid to late spring harvest, in late summer for fall harvest, or early fall to be overwintered for early spring harvest. Some late summer fields can be cut twice in the fall, and some late fall harvested fields may be overwintered for a second cut in the early spring. Weed problems are not the same in all planting seasons. For example common ragweed, a summer annual, is a severe problem in spring seeded spinach, but not a problem in spinach seeded for fall harvest or to be overwintered. Chickweed species, winter annuals, are a severe problem in late summer and early fall seeded spinach, but much less of a problem in early spring plantings and often not present in later plantings in the spring.

### Herbicides Registered for use in Spinach

	Common Trade names	Use rates (lbs ai/A)	Maximum rate/A allowed	REI hr	PHI days
<b>Preplant incorporated</b>					
Cycloate	Ro-neet	2.5 – 3	3	12	--
<b>Preemergence</b>					
s-metolachlor	Dual Magnum	0.32 – 0.64	0.64	12	40
<b>Postemergence</b>					
phenmedipham	Spin-Aid	** 0.33 – 0.67 0.48 – 0.98	0.975	24	40
clopyralid	Stinger	0.09 – 0.187	0.187/crop/yr	12	21
clethodim	Select	0.094 – 0.125	0.5/season	24	14
sethoxydim	Poast	0.188 – 0.28	0.56/season	12	15

\*\*extension specialists in the mid-Atlantic region recommend use rates of 0.33 to 0.67 lbs ai/A due to potential injury. The label recommends 0.488 to 0.975 lbs ai/A

### Efficacy table for herbicides in spinach

	Dual	Roneet	Spinaid	Stinger	Poast	Select
<b>Winter annual broadleaves</b>						
Wild mustard	P	--	G/F/P *	P	N	N
Wild radish	P	--	G/F/P *	P	N	N
Redstem filaree	--	G	F	P	N	N
Carolina geranium	--	--	F	P	N	N
Common	F	P	P/F/G *	P	N	N

chickweed						
Knalweed	--	--	P	P	N	N
Primrose species	F	P/F	G	P	N	N
Field pansy	N	N	P	P	N	N
Deadnettle/henbit	--	G	F/P *	P	N	N
Yellow rocket	--	P	G	P	N	N
Shepard's purse	--	G	F	P	N	N
Common groundsel	F	--	G	G	N	N
Vetch	N	N	P	E	N	N
Mayweed (chamomile)	--	--	G	G	N	N
Prickly lettuce	--	--	G	G	N	N
<b>Winter annual grasses</b>						
Annual blue grass	G	G	N	N	P	E
Brome species	--	G	N	N		
Volunteer small grains	P	G	N	N	F	E
<b>Perennial</b>						
Mouseear chickweed	--	P	F	P	N	N
Canada thistle	N	N	--	F	N	N
Dock species	N	--	--	G	N	N
Pokeweed	N	N	--	P	N	N
Yellow nutsedge	F-G	F-G	N	N	N	N
<b>Summer annual broadleaves</b>						
Common cocklebur	N	N	P	E	N	N
Jimsonweed	N	N	G	**	N	N
Eastern black nightshade	F-G	F-G	G	G/E	N	N
Common ragweed	N	N	F/G	E	N	N
Common lambsquarters	P	F	F	P	N	N
Pigweed species	G	G	P	P	N	N
Morningglory species	N	--	P/F *	N	N	N
Galinsoga	G	N	F/G	G	N	N
<b>Summer annual grasses</b>						
Fall panicum	G	G	N	N	E	E
Foxtail species	G	G	N	N	E	E

Crabgrass species	G	G	N	N	E	E
Volunteer corn	N	P	N	N	G	E

\* depending on size and rates

-- No data available to rate these species.

### Pre-plant incorporated

Cycloate--2.5-3 lb/A. Apply 2 to 4 pints per acre Ro-Neet 6E. Apply before seeding and incorporate into soil 2 to 4 inches with disk. Delay of planting for 7 to 10 days may help reduce potential injury. 90% on Delmarva acreage treated; 50% on New Jersey acreage treated; general broadleaf control some grass suppression; lower rate if followed by Dual Magnum 7.62E

### Preemergence

S-metolachlor--0.31-0.63 lb/A. A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in spinach in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia. The use of this product is legal ONLY if a waiver of liability provided by the local growers association has been signed by the grower, all fees have been paid, and a label has been provided by the association. Apply 0.33 to 0.66 pints per acre Dual Magnum 7.62E to control annual grasses, yellow nutsedge, galinsoga, and certain other broadleaf weeds. Use the lower rate on fields with coarse-textured soils low in organic matter. Use higher rates on fields with fine-textured soils and those with high organic matter. Apply as a surface-applied preemergence spray. Do NOT exceed the rates recommended for use on spinach, or crop injury may result. DO NOT preplant incorporate Dual Magnum in spinach. DO NOT apply within 40 days of harvest. 95% acreage treated.

### Postemergence

Clethodim—0.094--0.125 lb./A. Apply 6 to 8 fluid ounces per acre of Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select 2EC 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 nonionic surfactant when grasses are small, and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather 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, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days. 20% acreage treated on Delmarva and New Jersey.

Clopyralid—0.047-0.188 lb/A. Apply 2 to 8 fluid ounces of Stinger 3A per

acre in a single application to control certain annual and perennial broadleaf weeds. Stinger controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineapple weed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2 to 4 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fluid ounces to control larger annual weeds. Apply the maximum rate of 8 fluid ounces to suppress or control perennial weeds. Spray additives are not needed or required by the label, and are not recommended. Application of higher recommended rates, 0.094 to 0.188 lb/A (4 to 8 fluid ounces), may cause a crop response that appears as a more upright leaf development. Yield and maturity are not affected. Observe a minimum preharvest interval (PHI) of 21 days. Stinger is a postemergence herbicide with residual soil activity. Observe follow crop restrictions or injury may occur from herbicide carryover. 10% acreage treated (increase with more experience). Stinger use is currently primarily for common ragweed, thistle and vetch control.

Phenmedipham--0.33-0.67 lb/A. Apply 2 to 4 pints per acre Spin-aid 1.3E. For use on spinach for processing only. Spin-aid will control seedling broadleaf weeds. Only chickweed less than (one) inch long or tall can be controlled consistently. Scout fields regularly and reapply if weeds germinate after the initial application, but do NOT exceed 6 pints per acre per year and maintain a 40-day preharvest interval. Apply to spinach with a minimum of four true leaves. Apply in a spray volume of 10 to 18 gallons of water per acre (sometimes less volume is used). The use of an 8002 flat fan nozzle or a comparable nozzle is suggested. See label for application restrictions, mixing instructions, and weather restrictions to prevent crop injury or herbicide failure. 75% acreage treated. Application during increased temperatures can lead to phytotoxicity. Reduce rates with increased temperatures (above 80 do not apply). High cost per acre may limit use.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. Choose Poast 1.5EC to control large crabgrass. 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 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. Annual bluegrass, 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, as the risk of crop injury may be increased, or

reduced control of grasses may result. Observe a minimum preharvest interval of 15 days and apply no more than 3 pints per acre in one season. 5% acreage treated, current recommendation favor Select.

Postemergence herbicides are usually effective on small weeds, but then in some situations suppression may be adequate for additional 1 or 2 cuttings when the field will be finished. Also good crop vigor is essential for tolerance to phenmedipham and other herbicides which often may cause undesirable stunting, chlorosis etc.

### **Postharvest**

Paraquat--0.6 lb/A. A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Max 3SC for postharvest desiccation of the crop in Maryland and Virginia. Apply 1.5 pints per acre Gramoxone Max 3SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings. Less than 2% acreage treated. Used prior to preparing soil for next crop after final harvest of spinach.

There are no export/impost issues.

Currently there are no known reported instances of herbicide resistant weeds that plague spinach. Growers are urged to use different herbicide mode of actions to avoid resistance problems.

### **Non-chemical methods currently used to help manage this pest:**

**Biological:** None

**Cultural:** Depending upon circumstances and the weeds involved, expensive hand weeding options are often done to make sure that the weeds are removed. This practice is done to increase yield and decrease the possibility of quality rejections; due to lack of herbicide choices and effectiveness. Crop rotation is recommended to assist in weed management. Tillage immediately after harvest is encouraged to reduce pest populations. After the spring crop, any weeds in the field when the spinach is harvested, especially for processing, would remain as a cut stem. By tilling the field the weeds would be destroyed before they have a chance to regrow and go to seed. 80-90% of the spinach acreage is cultivated at least once; some is cultivated twice; fresh market spinach may be cultivated more than twice. Many growers are reluctant to cultivate because they believe it spreads white rust, etc. Disease spread is believed to occur from equipment contact on the foliage and/or from dust developed by cultivation. Cultivation is certainly beneficial for weeds in spinach, but not really essential for most typical weed problems and implementing a good herbicide program.

### **Growth Regulators**

Gibberellic acid: 20-25% fall crop; not used on spring or winter crops; rates follow label; applied once 10-14 days preharvest (aids harvest ability).

Non-registered (Pipeline materials) pest management tools: None.