Spinach Crop Profile for New Jersey

Production Facts

- **State rank**: New Jersey ranks 5th nationally in fresh market spinach production
- **New Jersey's contribution to total US production:** fresh market = 3.2%; processing = 8%
- **Yearly fresh market production**:
  - 2002 = 157,000 lbs.
  - 2001 = 204,000 lbs
  - 2000 = 170,000 lbs.
  - 1998 = 180,000 lbs.
  - 2000 = 238,000 lbs.
- **Annual production costs**
  - **spring crop**, including growing ($749.89), and harvesting and marketing ($1464.47) = $2214.89/acre (1986 figures)
  - **fall crop**, including growing ($879.70), and harvesting and marketing ($1674.94) = $2554.64/acre (1986 figures)
- **Percent of crop for processing and fresh market**: 67% processing; 33% fresh market

Production Regions

Southern New Jersey (area south of Trenton)
Nearly all spinach, *Spinacia oleracea* L., is grown in the southern half of southern New Jersey. The soils in this area are coastal plain, generally light soils ranging from sand to sandy loams, but areas of heavier, clay and silt loam soil do exist. Elevations are low with most of the area less than 200 feet in elevation. The warmest, seasonal temperatures occur in the extreme southern part of the state with the Salem County area being the warmest.

Cultural Practices

In New Jersey, spinach is a cool season crop that is raised in the spring, fall, and overwinter. Fields are planted as a series of beds, each comprised of several narrow-width rows to enhance machine harvesting. Planting dates of beds are staggered so that not all of the spinach in a field is ready for harvest at the same time.

The **spring** seeding typically occurs from March 12th to April 20th, placing harvest between May 20th and June 7th. This represents about 30% of the total acreage. The **fall** seeding typically occurs from August 10th to August 31st with harvest from September 25th to October 10th. This represents about 50% of the total crop acreage. The **overwinter** seeding typically occurs from October 1st to 15th, with harvest in the spring. This represents about 20% of the total crop acreage.

The method of harvest and relative size of fields planted depends upon how the crop will be marketed. For processing spinach, the leaves are clipped so that two harvests are made from the same planting. Fresh market plantings are harvested once, because the plants are cut and bunched for fresh market. As a result in the difference in marketing, processing fields range from 25 to 300 acres, whereas fresh market

fields range from 1 to 10 acres. Usually farmers that raise processing spinach will not also raise fresh market spinach and the reverse is generally true.

Spring seeding Planting is recommended from March 12 to April 20 placing harvest between May 20 and June 7. This represents about 30% of the total acreage.

Fall seeding Planting is recommended from August 10 to August 31 with harvest from September 25 to October 10. This represents about 50% of the total crop acreage.

Overwinter seeding Planting is from October 1 to 15 with harvest in the spring. This represents about 20% of the total crop acreage.

Fall planting of processing spinach, Elmer, New Jersey.

Insect and Mite Control

In New Jersey, the primary insect pests of spinach are: seed corn maggot, spinach flea beetle, aphids, leafminers, cabbage looper, beet armyworm, garden webworms, grasshoppers

Seed corn maggot – Seed corn maggot is a small fly that is attracted to rotting organic material and is a frequent pest of planted crop seeds, especially in cool, wet weather where seed germination is delayed. Eggs are laid at the soil surface where they hatch and the larvae (maggots) migrate to the food source. Destruction of seed and young seedlings can be severe requiring replanting of a crop. The most severe damage occurs in the spring particularly in fields that have had large amounts of plant matter incorporated during tilling. There are multiple generations a year.

Spinach Flea beetle – Flea beetles frequently attack leafy green vegetables. Eggs are laid on the soil surface and larvae feed on plant rootlets, seldom causing significant damage. The adults cause the shot-hole feeding damage in leaves, which sometimes becomes extensive. Usually, only the smaller seedling plants are at risk from flea beetles and the most severe damage occurs on field borders or at the edge of plantings. Depending upon the species of flea beetle there may be multiple generations each year.

Threshold. Several damaged rows.

Aphids – Aphids, usually green peach aphid, feed on the plant sap and may cause plant stunting if large numbers exist. Feeding damage results in curled leaves and stunted plants. Aphids may further transmit viral diseases such as spinach mosaic. In New Jersey, peak aphid populations occur in May and June, and again in mid-September through October. Since cooler weather generally favors aphid populations they may increase problems with insect contamination near harvest by drawing in predators and parasites that would normally feed on the aphids. Adult aphids overwinter on cultivated greens and weeds.

Threshold Seedlings – 1 aphid per plant
Established plants – 4 to10 aphids/plant

Leafminers – These are small flies of two species, spinach leafminer and vegetable leafminer that attack the leaves. Eggs are laid in the leaf tissue where they hatch and the larvae begin to feed between the upper and lower leaf cuticle. As the larvae grow they produce a larger mine that snakes it way across the leaf. Mature larvae cut through the leaf cuticle and fall to the ground to pupate. Adult flies emerge from the soil and reproduce. There are multiple generations. Leafminers not only damage the leaf reducing photosynthesis but also contaminate the leaves. Generally these are minor pests but can be significant pests in some years.

Threshold

50 % of plants have eggs or mines, or more than one mine/leaf on average.
Near harvest – 4% of leaves with mines.

Cabbage looper – Like other caterpillars these insects feed on the foliage and should be considered one of the major pests of spinach. Damage occurs mostly in late summer and early fall. Cabbage loopers may be present at harvest and therefore be a contaminant as well as their feces.

Beet armyworm – This is a migratory pest from the southern states that is found from mid to late summer in several vegetable crops in New Jersey. The armyworm caterpillar is a foliage feeder capable of consuming large amounts of foliage. The fall planting of spinach is the most susceptible to beet armyworm. The moths lay their eggs in the hearts of the plants, with larvae feeding on the buds and terminal growth. Webbing may be produced on the leaf surface. Until the advent of newer insecticides a few years ago, beet armyworm was a serious pest, but is now considered a minor pest.

Threshold

treatment thresholds: seedling plants = one larva per 10 plants,
established plants = one larvae per 2 plants

Garden Webworms - Moths begin laying eggs in fall planted spinach soon after plant emergence in mid-August. Larvae move into the growing point ("heart") of the plants, producing silk, often tying all of the

"heart" leaves together. The caterpillars consume leaf tissue causing stunted plants and distorted plant growth.

Threshold

Treatment should be applied before 5% of the plants are infested with small larvae, AND larvae are found deep in the growing point AND before significant amounts of webbing are produced

Grasshoppers – Several species occur in field borders and primarily a problem with processing spinach grown in the fall; do not cause feeding damage on the leaves, but they are a major contamination problem during harvest of fall spinach.

Petiole maggot – This is a newly observed, unidentified pest that is related to the seed corn maggot and root maggots. A single larva, maggot, is found per plant. The maggot feeds on the meristematic tissue and bores into the base of the petioles. Damaged plants are smaller and maturing leaves are contorted and misshapen. Up to 10% of the plants in the field were found infested. Found in the fall on 2000, it is unknown whether this fly attacks spinach in the spring and summer.

According to local spinach processors, any insect contamination in harvested plants is unwanted, regardless of whether the contaminating insect is a pest or beneficial. Insects such as lacewings and others that produce webbing (either at pupation or otherwise) are especially difficult because the webbing adheres to the foliage. Parasitized aphids also cause problems in that they adhere to the foliage and remain even after the parasite has left.

Chemical Controls Used in New Jersey Spinach

Insect Pests in New Jersey Spinach (4)

General Use Insecticides

Insecticides used in 2000 – last year of available data

Imidacloprid –

- Imidacloprid use was 0.48 lbs ai or about .2 % of all insecticides used in 2000.
- This material is not registered use in spinach.

Spinosad –

- Spinosad (Spintor) use was 25.7 lbs ai or about 1.5 % of all insecticides used in 2000.
- Spinosad is used primarily for controlling imported cabbageworm, cabbage looper, beet armyworm, armyworms, leafminers and thrips.

Restricted Use Insecticides

Insecticides used in 2000 – last year of available data

Cyhalothrin –

- Cyhalothrin (Warrior) use was 0.48 lbs ai or about 0.03 % of all insecticides used in 2000.
- Usually only one application for managing aphids is needed per season.

Dimethoate –

- Dimethoate use was 32.69 or about 1.9% of all insecticides used in 2000.
- Usually only one application for managing aphids is needed per season.

Diazinon –

- Currently diazinon is not a recommended material for use on spinach except as a pre-plant incorporated soil insecticide for controlling cutworms.
- Diazinon use was 1,197.19 lbs ai or about 70.3 % of all insecticides used.
- The targeted pests were probably lepidopterous pests such as cutworms.

Methomyl –

- Methomyl use was 28.04 lbs ai lbs or about 1.6 % of all insecticides used in 2000.
- Methomyl is used primarily for controlling cabbage looper, beet armyworm, and armyworms, however, it is recommended that methomyl not be used too frequently or leafminer populations will increase and it is not recommended for use when the minimum daily air temperature is 32 degrees F or cooler. The garden webworm populations may be reduced when methomyl is used.

Permethrin –

- Permethrin use was 369.85 lbs or about 21.7 % of all insecticides used in 2000.
- Used as either the products Pounce or Ambush, permethrin is used for controlling leafminers and lepidopterous pests. When treating for leafminers, multiple applications may be necessary for control. Grasshopper populations may also be reduced when permethrin is used.

Phosmet –

- Phosmet (Phosdrin) use was 16.8 lbs ai or about 0.99 % of all insecticides used in 2000.

Tebufenizide –

- Tebufenizide (Confirm) use was 29.38 lbs ai or about 1.7 % of all insecticides used in 2000

Current (2002) Pesticide Recommendations for Insect Pests, Product Rates Per Acre and Use (G=general, R=restricted) (4)

Cutworms		
Methomyl	1.5 pt LV/A	R
Mustang	2.4 - 4.3 fl oz/A	R
Permethrin	6.4 - 12.8 oz/A (Ambush)	R
	4 - 8 oz/A (Pounce)	R
Flea Beetle		
Carbaryl	.67 - 1.25 lb 80 S/A	G
Mustang	2.4 - 4.3 fl oz/A	R
Aphids		
Acetamiprid	29.38 fl oz 80S/A	G
Dimethoate	0.5 pt 4 EC/A	
Imidacloprid	10 - 24 fl oz 2FS/A (soil)	G

Imidacloprid	3.75 fl oz 1.65FS/A (foliar)	G
Pymetrozine	2.75 50W/A	G
Leafminers		
Permethhrin	6.4 - 12.8 oz/A (Ambush)	R
	4 - 8 oz/A (Pounce)	R
Spinosad	6 - 10 oz 2SC/A	G
Cyromazine	0.167 lb 75 WP/A	
Mustang	3.4 - 4.3 fl oz/A	R
Cabbage Looper and *Beet Armyworm*		
Bacillus thuringiensis	see labeled rate on specific products	G
Tebufenozide	8 fl oz 2F/A	G
Methomyl	1.5 - 3 pt LV/A	R
Thiodicarb	24 - 30 oz 3.2F/A	G
Permethhrin	6.4 - 12.8 oz (Ambush)	R
	4 to 8 oz (Pounce)	R
Spinosad	6 - 10 oz 2SC/A	G
Grasshoppers		
Carbaryl	0.6 - 1.8 lb 80S/A	G
Garden Webworms		
Bacillus thuringiensis	see labeled rate on specific products	G
Tebufenozide	8 fl oz 2F/A	G

Chemical Use in IPM Programs

Processing spinach is largely sold to one processor and, while the individual farmer is responsible for maintaining the quality of the crop, the main emphasis is acceptable, marketable produce.

Chemical Use in Resistance Management

Producers are always encouraged to rotate chemical classes of pesticides.

Alternatives

There is no current alternative to insecticide use.

Cultural Control Practices

Cultural controls focus largely on maintaining a well-fertilized, healthy crop. Since spinach is a cool season crop there is little latitude in planting dates being shifted to avoid pest problems. Harvest is completed as quickly as plants are ready.

A combination of the following cultural strategies can be used to reduce problems with seed corn maggot (4):

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.

Biological Controls

No current intentional uses of biological control. Parasites have been recovered from the petiole maggot so that it appears that damage from this insect could be worse than is currently found.

Post Harvest Control Practices

Growers are encouraged to till under crop residues immediately after harvest. This enhances rapid breakdown of residues and mechanically induces mortality to remaining insect crop pests.

Weed Pests in New Jersey Spinach (4)

All weeds are pests in spinach, because they will compete with spinach for nutrients, water, and space. Generally, weeds are considered to be at threshold when they are distributed at the rate of 1 weed per square yard. Weeds have a zero tolerance threshold at harvest because of the extreme difficulty of separating weeds from spinach for processing. Weeds still cause problems for fresh market spinach because workers must separate the weeds by hand before bunching.

Spring crop

Summer Annuals

All annuals and especially zero tolerance weeds including nightshades, morningglory, jimson weed, common cocklebur, and chickweed.

Perennials

Zero tolerance weeds including Horsenettle, yellow nutsedge, Canada thistle, common milkweed, help dogbane, field bindweed, johnsongrass, bermudagrass, and quackgrass. These weeds especially should not be allowed to become established because of either intense competition with the crop or increasing difficulty of harvest.

Fall planted and Over-wintered crop

Winter Annuals

All winter annuals.

Summer Annuals

All summer annuals, and especially zero tolerance weeds including nightshades, morningglory, jimsonweed, and common cocklebur.

Perennials

Zero tolerance weeds including Horsenettle, yellow nutsedge, Canada thistle, common milkweed, help dogbane, field bindweed, johnsongrass, bermudagrass, and quackgrass. These weeds especially should not be allowed to become established, because of either intense competition with the crop or increasing difficulty of harvest.

Chemical Controls

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

General use herbicides

Cycloate –

- Cycloate (Ro-Neet) is a pre-plant incorporated herbicide that has activity on several grass and broadleaved species.
- Cycloate use was 953.13 lbs ai or about 31.3 % of all herbicides used in 2000.
- It is recommended to be used at half the labeled rate.

Chlorpropham –

- This material (Sprout Nip) currently is not labeled for use on spinach in New Jersey.
- Chlorpropham use was 463.32 lbs ai or about 15.2 % of all herbicides used in 2000.

Metolachlor –

- This material (Dual) is currently recommended for use on spinach under a section 18 emergency exemption.
- Metolachlor use was 1,000 lbs ai or about 32.9 % of all herbicides used in 2000.
- Most of this material was applied under section 18 exemptions, or 24 C exemptions. Metolachlor is primarily a grass herbicide with activity on some broadleaved weeds.

Phenmediphan –

- Phenmediphan use was 538.96 lbs ai or about 17.7 % of all herbicides used in 2000.
- Phenmediphan (Spin-aid) is used only for fall and over-wintered, processing spinach, controlling broadleaved weed seedlings, especially chickweed. It has a 40 day pre-harvest interval

Sethoxydim –

- Sethoxydim (Poast) use was 10.9 lbs ai or about 0.06 % of all herbicides used in 2000.
- Usually only one application is made.

Glyphosate –

- Glyphosate use was 76.41 lbs ai or about 2.5 % of all herbicides used in 2000.

Current (2001) Pesticide Recommendations for Weed Pests, Product Rates Per Acre and Use (G=general, R=restricted) (4)

Preplant Incorporated		
Cycloate	2.5 - 3 lb/A	G
Postemergent		
Clethodim	0.094 – 0.125 lb ai/A	
Phenmedipham	0.33 - 0.67 lb/A	G
Sethoxydim	0.2 - 0.3 lb/A	
Postharvest		
Paraquat	0.5 - 0.6 lb/A	R

Chemical Use in IPM Programs
None

Chemical Use in Resistance Management
Growers are urged to use different chemical classes for spraying for weeds.

Alternatives
Depending upon circumstances and the weeds involved, hand weeding may be done to make sure that the weeds are removed.

Cultural Control Practices
Crop rotation is recommended to assist in weed management.

Biological Controls
None

Post Harvest Control Practices
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.

Disease Pests of Spinach in New Jersey (1, 4)

Damping off – Seedling damping off 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.

Downy mildew (blue mold) – Downy mildew is probably the most important spinach disease, being the most troublesome in cool, wet weather (temperatures of 2 to 25 degrees C), which are frequently the conditions experienced in New Jersey in fall, winter and spring. However the disease in New Jersey is relatively rare due to the use of the fungicide, Ridomil. 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

Presence of the disease.

White rust – Another foliar disease, 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. 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 New Jersey being the most abundant in the spring and winter crops. Resistant varieties are available.

Threshold

Presence of the disease.

Anthracnose – 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. Anthracnose is most troublesome in the fall plantings, especially with susceptible varieties, such as, Seven R. There are several other foliar diseases that will also reduce marketability but these are minor pests and are seldom sprayed for.

Threshold

Presence of the disease.

Root disease complex - 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. Crop rotation, planting fields with good drainage and using resistant varieties whenever possible are probably the best ways to manage these diseases.

Chemical Controls

Insecticides 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, 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 –

- 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 (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

Chemical Use in IPM Programs

Chemical Use in Resistance Management
Growers are urged to use different chemical classes for spraying for diseases.

Alternatives
There are resistant varieties available for downy mildew, depending upon the race of the fungus.

Cultural Control Practices
None

Biological Controls
None

Post Harvest Control Practices
Farmers are encouraged to till under crop residues as soon as harvest is completed to help break disease cycles.

Worker Activities

Post-emergent pesticides would be applied by ground sprayers from tractors or terragators (large 3 wheeled tractors often equipped with boom sprayer arms) both with enclosed cabs. Thus, exposure to pesticides to applicators is minimal. Seabrook (processor) fieldmen visit fields about twice a week starting at plant emergence and make recommendations for pest control up until harvest. More distant fields may be visited once a week and there the field men have to confer with the grower before entering the field because the grower may have made a pesticide application on their own. Currently the longest REIs exist for methomyl and dimethoate at 48 hours; permethrin at 24 hours; and spinosad and tebufenizide at 4 hours; these REIs do not negatively impact the activities of field men. It is roughly estimated that REIs greater than 7 days would negatively inspection by field men.

Processing spinach is machine harvested so that there is little or no risk of pesticide residue exposure to the harvesters. Lengthy preharvest intervals exist for several of the organophosphate and carbamate pesticides: 7 days for methomyl, 14 days for dimethoate, 14 days for carbaryl, 14 days for thiodicarb and 21 days for mefenoxam and Ultra Flourish, fungicides. Depending upon the pests present near harvest, increasing days to harvest restrictions could become a problem since an insecticide application is always made just prior to harvest to ensure that there is no insect contamination in the harvested crop. So, preharvest intervals of greater than 7 days would negatively impact spinach harvest and overall crop production. If the pesticide's effectiveness extends as long as the pre-harvest interval then the phi is no longer a concern.

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