Crop Profile for Basil in New Jersey

***Ocimum basilicum* (L.)**
O. tenuiflorum
O. americanum
Lamiales: Lamiaceae

Prepared: 2008

General Production Information

Yearly production: Approximately 450 acres
% of crop for fresh market: 100%
% of crop grown for retail market: 10 %
% of crop grown for wholesale market: 90 %

Production Regions

The majority of basil production occurs in the southern New Jersey counties of Atlantic (100 acres), Cumberland (225 acres), and Gloucester (50 acres). There is some basil production in the central counties of Monmouth, Ocean, and Burlington, amounting to less than 50 acres. Soils in southern and much of central New Jersey are light, ranging from sand to sandy loam with some areas of silt loam. Basil production in the southern region extends from early April to October. In this region, basil is predominantly grown for the wholesale market, with plant stems generally cut or pulled, washed and bundled in 12-15 plant or stem bunches. Wholesale units are 15-count (bunch) crates. Some basil in this region is produced for the retail market and sold at farm stands or directly to restaurants. In this case, basil is generally sold by the bunch.

In the northern counties of Hunterdon, Mercer, Morris, Warren, and Sussex, many growers produce basil, but on minimal acreage. Soils in the northern region are typically Piedmont (heavy silt loams) and Appalachian (shaley) soils. The field season begins in mid-May here, and continues until cold weather terminates production. In the north, basil is grown exclusively for retail at farm stands and at community-sponsored farmers markets. Typical growers in this region produce less than one half acre of basil. Total acreage in the northern region is approximately 10 acres.

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Cultural Practices

Sweet basil is a tender annual herb native to Asia. Related cultivated species are native to Africa as well. Basil is an extremely popular culinary herb in the United States, particularly in the affluent coastal regions, and is a key ingredient in Mediterranean, Middle Eastern, and Indian cuisines.

Basil requires well-drained soils, with a pH ranging from 6.0-7.5. It is not drought tolerant and must have adequate moisture to prevent wilting and yield loss. Warm conditions are necessary for basil production, as temperatures in the upper 30°F range can result in foliar necrosis. Basil grows quickly, and harvests of stems may begin approximately 40-60 days after seedling emergence. Stems may be clipped off, leaving several sets of leaves on the below the cut. Stems are bunched and sold individually at farm markets, or placed in 15 bunch crates and sold wholesale. Regular harvesting of stems encourages lateral growth and limits the production of flowers, which are not marketable. The crop may be harvested multiple times during the season if stems are cut. Some growers prefer to sell entire plants. In this case, plants are pulled prior to flowering, rinsed, and taken to market in buckets of water. They are then sold as individual rooted plants, or bunched and placed in 15-count crates for wholesale. Retail prices range from $1-2 for bunched stems (described as a “handful” of 8-12” stems); or whole, rooted plants, with $2 being more common. Wholesale prices range from $6-8 per crate.

In the northern New Jersey growing region, production consists almost exclusively of the variety ‘Genovese’ a sweet basil type. Basil is typically seeded in the greenhouse in April and transplanted into the field in late May to early June after the risk of frost has passed. Beds, raised or flat, are prepared and covered with black plastic. Irrigation is applied through drip tape laid under the plastic. Transplants are placed in beds in single or double rows. Fertility programs here are variable, with the basil crop typically receiving the same initial fertilizer application as the major crop in closest proximity, i.e. tomato or cucumber. Northern growers indicate that a 200-300 lb./acre broadcast application of nitrogen is fairly standard prior to bed-making, with phosphorous and potassium applied according to soil test results for the closest dominant crop. Two additional applications of water soluble nitrogen may be added via drip irrigation through the life of the crop.

The basil crop in the southern areas of New Jersey is direct seeded into bare ground beds. The rows per bed vary, but a 4-row bed is common. Basil here requires more fertilizer input, owing to the lighter soils. Fertility programs may include 500 lbs/acre of 10-10-10 or 14-7-14, broadcast and plowed in prior to bed making. This application is followed by a side-dress application of 14-7-14, or 16-8-8 when plants are approximately 6” at cultivation. On light, sandy soils, the total pounds of fertilizer applied at side-dress may exceed that of the initial plow down application. Common varieties include ‘Genovese’, ‘Martina Genovese’, and ‘Nufar’ (*Fusarium* resistant).

Insect Pests of Basil in New Jersey

Insect pests of basil include aphids, leaf miners, and Japanese and oriental beetles. Growers in New Jersey indicate that Japanese beetle is the most serious and common insect pest, with grasshoppers occasionally a problem in the southern growing areas. Leaf miner and caterpillar pests are not typically encountered.

Japanese Beetles *Popillia japonica* (Newman)

Occurrence: Annual. Introduced into Connecticut in the 1920's, and having no natural enemies, the Japanese beetle has become well established in New Jersey and states beyond. Adults emerge from pupal cases in the soil around the end of June, and begin feeding on crops, including basil foliage. Adult activity peaks in late July. At this time, eggs are laid in the soil, and the resulting grubs feed on the roots of turf and other plants. Adult activity ceases by early September. The grub is the overwintering stage.

Damage: Japanese beetle adult feeding on basil foliage results in heavily skeletonized leaves. Often, numerous adults are present in an area, which can lead to significant injury to an entire planting of basil in a short period of time. No level of feeding is considered acceptable due to significant decrease in marketability.

Alternative management strategies used in combination with chemical control:
In areas where Japanese beetles are common, there are few non-chemical options for preventing damage from adult feeding, other than a physical barrier. In this case, a net-like material such as Reemay® or similar floating row cover would be deployed to block the beetles from landing on the crop. This would need to be removed and replaced for harvests.

Chemical Control:

Soil Applied Materials

Imidacloprid (Admire Pro) (Generics available)
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 7.0 -10.5 fl oz./A of Admire Pro at planting.
Method: Banded spray over row, at- or prior to planting.
REI: 12 hr.
PHI: 14 days.
Efficacy: Good
Notes: 10.5 fl. oz./A/crop is maximum allowable. This material also effectively controls aphids, although growers indicate that it is not used, likely due to the long PHI. Due to application method, there is little potential for worker exposure to this material. The dermal LD-50 is extremely high (>5000), making it quite safe for handlers as well. Imidacloprid is toxic to bees, but due to the application method and harvests being prior to flower production, exposure is unlikely.

Foliar Applied Materials

Azadirachtin (Aza-Direct, Neemix)
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 1-2 pt. of Aza-Direct/A
Method: 2-3 foliar sprays at 7-10 day intervals when beetles are present and damage is occurring.
REI: 4 hr.
PHI: 0 days.
Efficacy: Fair to poor.
Notes: 3.5 pt./A/crop is maximum allowable. This product also has fair to good efficacy against aphids. High dermal LD-50 (>2000) makes the product quite safe for workers, but growers indicate that it is not used, likely because as a molting inhibitor, it is not effective against adult beetles. Azadirachtin is not toxic to bees.

Pyrethrin + PBO (Evergreen EC 60-6)
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 2-16 fl. oz. of Evergreen EC 60-6/A.
Method: Foliar sprays when aphids are present.
REI: 12 hr.
PHI: 0 days.
Efficacy: Fair to poor.
Notes: This material has a high dermal LD-50 (>1800), and is moderately toxic to bees. Evergreen is also labeled for aphid control. Growers indicate that it is not used.

Pyrethrins (Pyganic)
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 16-64 fl. oz. of Pyganic /A, used in combination with another labeled aphicide. Repeat as needed at weekly intervals.
Method: Foliar spray when aphids are present.
REI: 12 hr.
PHI: 0 days.
Efficacy: Fair.
Notes: No mammalian toxicological information (LD-50) is available for Pyganic. Pyganic is toxic to bees. Because the crop is generally cut prior to flowering, bee exposure not likely. This material is also labeled for aphid control. Growers indicate that this material is not used.

Aphids

Green peach aphid [*Myzus persicae* (Sulzer)]
Potato aphid [*Macrosiphum euphorbiae* (Thomas)]
Melon aphid [*Aphis gossypii* (Glover)]
Mint aphid [*Ovatus crataegarius* (Walker)]

Occurrence: Annual, sporadic. Aphids are a potential problem at any time during the basil growing season, but due to the short duration of individual crops, they are infrequently encountered.

Damage: Aphids extract plant sap from tissue and can weaken plants and cause discoloration. In basil, the greatest potential threat from aphids is that they serve as a contaminant when they are present on leaves at harvest. This threat may be mitigated to varying extents with washing of the plants or leaves prior to sale.

Alternative management strategies used in combination with chemical control:
Separation of fields is helpful to limit easy access from recently harvested areas to new plantings. Planting flowers attractive to aphid predators in close proximity to crops that serve as aphid hosts may encourage adequate biological control of these pests.

Chemical Control

Soil Applied Materials

Imidacloprid (Admire Pro) (Generics available)
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 7.0 -10.5 fl oz./A of Admire Pro at planting.
Method: Banded spray over row, at- or prior to planting.
REI: 12 hr.
PHI: 14 days.
Efficacy: Good
Notes: 10.5 fl. oz./A/crop is maximum allowable. This material also effectively controls Japanese beetles. Due to application method, there is little potential for worker exposure to this material. The dermal LD-50 is extremely high (>5000), making it quite safe for handlers as well. Imidacloprid is toxic to bees, but due to application method, exposure is unlikely.

Foliar Applied Materials

Azadirachtin (Aza-Direct)
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 1-2 pt. of Aza-Direct/A
Method: 2-3 foliar sprays at 7-10 day intervals when aphids are present.
REI: 4 hr.
PHI: 0 days.
Efficacy: Fair to poor.
Notes: 3.5 pt./A/crop is maximum allowable. This product also has fair to poor efficacy against Japanese beetles. High dermal LD-50 (>2000) makes the product quite safe for workers, but growers indicate that it is not used. Azadirachtin is not toxic to bees.

Peppermint, Rosemary Oils (Ecotrol EC)
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 1-3 pt. of Ecotrol EC/A in a minimum of 25 gal. of total solution.
Method: Foliar sprays when beetles are present and damage is occurring.
REI: 0 hr.
PHI: 0 days.
Efficacy: Fair.
Notes: This material is not toxic to vertebrates, and not known to be toxic to bees. Growers indicate that this material is not used.

Pyrethrin + PBO (Evergreen EC 60-6)
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 2-16 fl. oz. of Evergreen EC 60-6/A.
Method: Foliar sprays when aphids are present.
REI: 12 hr.
PHI: 0 days.
Efficacy: Fair.
Notes: This material has a high dermal LD-50 (>1800), and is moderately toxic to bees. Growers indicate that it is not used.

Imidacloprid (Provado)
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 3.5 fl oz. of Provado /A .
Method: Foliar spray when beetles are present and damage is occurring.
REI: 12 hr.
PHI: 7 days.
Efficacy: Good
Notes: For Provado, 10.5 fl. oz. /A/crop is the maximum allowable. A 5-day minimum spray interval must be observed for resistance management. This material is also labeled for aphid control. The high dermal LD50 (>5000) makes the material quite safe, although it is toxic to bees. However, because the crop is generally cut prior to flowering, bee exposure less likely. Provado will also suppress Japanese beetles at this labeled rate. Growers indicate that this material is not used due to the long PHI and the short duration between cuttings.

Potassium salts of fatty acids (M-Pede)
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 1-2% v/v in total solution of M-Pede /A, used in combination with another labeled aphicide. Repeat as needed at weekly intervals.
Method: Foliar spray when aphids are present.
REI: 12 hr.
PHI: 0 days.
Efficacy: Fair, when mixed with OLF.

Notes: M-Pede should be applied in a minimum of 50 gal. of total solution/acre. This material should not be reapplied within 7 days. M-Pede is not believed to be toxic to mammals, and has no determined LD-50. M-Pede is labeled for control of Africanized honey bees, and so is toxic to bees. Because the crop is generally cut prior to flowering, bee exposure not likely. Growers indicate that this material is not used.

Pyrethrins (Pyganic)
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 16-64 fl. oz. of Pyganic /A, used in combination with another labeled aphicide. Repeat as needed at weekly intervals.
Method: Foliar spray when aphids are present.
REI: 12 hr.
PHI: 0 days.
Efficacy: Fair.
Notes: No mammalian toxicological information (LD-50) is available for Pyganic. Pyganic is toxic to bees. Because the crop is generally cut prior to flowering, bee exposure not likely. This material is also labeled for Japanese beetle control. Growers indicate that this material is not used.

Pyrethrins + Rotenone (Pyrellin)
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 16-32 fl. oz. of Pyrellin /A in 25-100 gal. of water. Repeat as needed at intervals of 7-days or less.
Method: Foliar spray when aphids are present.
REI: 12 hr.
PHI: 0 days.
Efficacy: Fair.
Notes: The posted toxicological information via oral ingestion for rats is quite high (LD-50=1620mg/kg.) No dermal LD50 is available for Pyrellin. Inhalation is thought to be the most dangerous form of exposure to the rotenone component. Pyrellin is toxic to bees due to the pyrethrins component. Because the crop is generally cut prior to flowering, bee exposure not likely. Growers indicate that this material is not used.

Grasshoppers

Differential grasshopper, *Melanoplus differentialis* (Thomas)
Redlegged grasshopper, *Melanoplus fermurrubrum* (DeGeer)

Occurrence: Annual, sporadic in late summer. Grasshoppers can become an economic problem late in the season as host forages dry down. They will move into irrigated crops, and are general foliage feeders.

Damage: Grasshoppers consume large quantities of foliage, especially when they infiltrate fields in large numbers.

Alternative management strategies used in combination with chemical control:
Avoid planting target crops like basil near hay or fallow fields with known populations of grasshoppers. There is no effective alternative to chemical control if grasshoppers begin feeding on basil. However, weekly scouting to help identify their presence prevents the use of unnecessary insecticide applications.

Chemical control

Pyrethrin + PBO (Evergreen EC 60-6)
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 2-16 fl. oz. of Evergreen EC 60-6/A.
Method: Foliar sprays when grasshoppers are present.
REI: 12 hr.
PHI: 0 days.
Efficacy: Fair.
Notes: This material has a high dermal LD-50 (>1800), and is moderately toxic to bees. Growers indicate that it is not used.

Azadirachtin (Neemix)
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 7-16 fl. oz. of Neemix/A
Method: 2-3 foliar sprays at 7-10 day intervals when grasshoppers are present and damage is occurring.
REI: 12 hr.
PHI: None on label.
Efficacy: Fair to poor. Because this material has a mode of action that inhibits molting, it is not effective on adult insects.
Notes: This product has fair to good efficacy against aphids. High dermal LD-50 (>2000) makes the product quite safe for workers, but growers indicate that it is not used, likely because it is not effective against adult grasshoppers. Azadirachtin is not toxic to bees.

Notes on insecticides and nematicides:
Generally, pesticides available for insect and nematode control in basil are covered by broader labels for herbs. As a result, there are a number of insecticides that are labeled for basil but not used either due to the target pest not affecting basil, or that pest not affecting basil in New Jersey.

This group of insecticides/nematicides includes:

Compound	Trade Name	Target Pest(s)
Abamectin	Agri-mek	Leaf miners
Bacillus thuringiensis st. azaiwai	(Agree, Xentari)	Lepidopteran larvae

Bacillus thuringiensis st. kurstaki	(Crymax, Dipel, Biobit, Javelin)	Lepidopteran larvae
Spinosad	(Entrust, Spintor)	Lepidopteran larvae, thrips, leafminer
Spinetoram	(Radiant)	Lepidopteran larvae
1-3 dichloropropene + chlorpicrin	(Telone)	Nematodes
(S) – Methoprene	Extinguish	Fire ants
Metam-Sodium	Vapam HL	Nematodes

Diseases of Basil in New Jersey

Important diseases of basil in New Jersey are damping-off, root-rots, and botrytis (gray mold). Fusarium wilt is a potential problem, and growers concerned about the disease typically utilize varietal resistance. Fusariam-resistant 'Nufar', which is a Genovese-type basil with strong resistance, is typically planted in Fusarium-infested fields.

Fungicide Resistance Management:

Fungicides are organized according to FRAC (Fungicide Resistance Action Committee) codes (see Table 1) based on chemistry. Members of a FRAC code are often analogs built from the same basic chemical structure, and generally have a similar mode-of-action, control similar type of fungi, and share the same risk for resistance development. Over- or misuse of some classes of fungicides such as the QoI's (FRAC code 11), DMI's (FRAC code 3), phenylamides (FRAC code 4) and benzimidazoles (FRAC code 1) may result in the development of resistant populations of fungi. Fungicides in FRAC codes such as these are referred to as "at- or high-risk" fungicides. Therefore, do not apply fungicides in these FRAC codes exclusively in a disease control program. Fungicides considered high-risk should be tank-mixed or rotated with fungicides from other FRAC codes. Protectant fungicides (FRAC codes M1, M3, M5), should be tank-mixed with high-risk fungicides whenever possible to delay the development of resistant strains of fungi. Do not use high-risk fungicides as rescue treatments for disease control.

Figure 1. FRAC table for basil and other herb crops

Fungicide	Active	FRAC CODE	Risk Management	Damping-off caused by Pythium	Fusarium wilt and crown rot	Rhizoctonia solani	Sclerotinia sclerotiorum (White mold)	Grey mold (Botrytis cinerea)	Leaf Spots	Powdery Mildew	Bacterial blight	Fungicide Resistance Management Guidelines***
sulfur	sulfur	M1	L							x		for use on spearmint and peppermint
fixed copper	copper	M2	L						x		x	See labels for specific crops
Nova	myclobutanil	3	M						x	x		for use on spearmint and peppermint
Ridomil	mefenoxam	4	H	x								Do not apply within 21 days of harvest
Quadris	azoxystrobin	11	H						x	x		Rotate with other chemistries
Maxim	fludioxonil	12	L		x	x						use as seed treatment
Switch	cyprodinil + fludioxonil	9 + 12	M					x	x			Rotate with other chemistries
Armicarb, Kaligreen, Milstop*	Potassium bicarbonate	NC	L					x	x	x		Rotate with other chemistries
Serenade Max*, Rhapsody*	*Bacillus subtilis*	bio	L					x	x	x	x	Biological control agents, refer to label for rates and application specifics
Plantshield HC*, SoilGard*, RootShield*	*Trichoderma harzianum*	bio	L					x		x		
Contans*	*Conithyrium minitans*	bio	L				x					

Fungicide resistance management guidelines for Herb Crops** grown in the mid-Atlantic region - 2008

FRAC code: M = multi-site MOA, numbered codes = chemistries with similar mode-of-action, specific site (MOA)
Risk management: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop, H^R = Known resistance reported
High-risk fungicides with similar MOA (ie. same FRAC code number) should not be sprayed consecutively

* OMRI approved
** This list includes basil, cilantro, dill, lavender, dried parsley, pennycrest, rosemary and thyme. See labels for specific crops and application ra
*** See labels for specific crops and rates

Damping-off or Root-rot caused by *Pythium* spp. and *Rhizoctonia solani*

Occurrence: Annual, sporadic. Favored by excessively damp soil (Pythium).

Damage: Damping-off and root-rot results in decreased stands. The pathogen attacks and kills plants after transplanting in the field. In general, bed systems that promote quick drainage will help limit the incidence of root-rot caused by *Pythium*. *Rhizoctonia* can affect plants where drainage appears adequate. Mature plants are less susceptible to mortality from damping–off and root-rots.

Alternative management strategies used in combination with chemical control:
Crop rotation with less-susceptible crops such as corn is helpful. Improvement of soil drainage with cultivation allowing water to run off the field and eliminating or avoiding low spots will help mitigate losses from root-rots.

Chemical Control (Pythium only):

mefenoxam (Ridomil Gold SL) FRAC code 4
Percent acres treated: 0 %
Active ingredient used (lbs.): 0
Rate and Frequency: 1-2 pts. of Ridomil SL/treated A. as a soil application with water or liquid fertilizer and incorporated into the top 2 inches of soil.
Method: Pre-plant incorporated.
REI: 0 hr. when material is incorporated into soil.
PHI: N/A
Efficacy: Good
Note: This product is not to be used at any other time on a planting if it has been used as a pre-plant incorporated treatment.

Hydrogen dioxide (Oxidate) FRAC: Not Classified
Percent acres treated: 8%
Active ingredient used (lbs.): 63
Rate and Frequency: 40-128 fl. oz. of Oxidate /100 gal of water at 5 day interval.
Method: Foliar spray prior to disease development.
REI: 0 hr.
PHI: 0 day.
Efficacy: Fair.
Note: Growers indicate that this material used, but not for Pythium root rot. It is a general surface sanitizer. As such, it is used for suppression of foliar fungi and bacterial infections, real or perceived.

Chemical Control (Pythium and Rhizoctonia)

azoxystrobin (Quadris) FRAC code 11
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: .4-.8 oz. of Quadris or /1000 row feet just after transplanting.
Method: Directed spray to plant base.
REI: 4 hr.
PHI: 0 day.
Efficacy: Good
Note: 1.5 lb. of active ingredient per crop per season is maximum allowable. Fungicides in FRAC code 11 should not be applied more than twice in sequence in order to delay the development of resistance. Azoxystrobin has little risk to workers, with a dermal LD-50 of >5000.

Chemical control (Fusarium and Rhizoctonia)

fludioxonil (Maxim) FRAC code 12
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 0.08-0.16 fl. oz. of Maxim /100 lbs. of seed prior to planting.
Method: Seed treatment.
REI: 12 hr., except where contact with seed is not likely.
PHI: N/A.
Efficacy: Good.
Note: Growers indicate that this material is not used because Rhizoctonia is not frequently encountered and Fusarium is typically managed with varietal resistance.

Chemical control (Fusarium, Pythium, Rhizoctonia)

Potassium salts of phosphorous acid (Fosphite, Fungi-Phite, Topaz) FRAC: Not Classified
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 2-3 qt. of Fosphite in a minimum of 100 gal. of water (through trickle irrigation) or 2-4 qt. of Fosphite in 100 gal. of water (via overhead irrigation) with normal irrigation schedule.
Method: Applied with irrigation prior to disease occurrence.
REI: 4 hr.
PHI: 0 day.
Efficacy: Fair.
Note: Should not be applied at less than 3 day intervals.

Shoot and stem blight caused by *Botrytis cinerea* Pers.:Fr.

Occurrence: Annual, sporadic.

Damage: *Botrytis* typically enters the plant through wounds produced when stems are cut for harvest. The fungal infection proceeds down the affected stem from the wound, infecting leaves along the way, and can kill the plant if it reaches the plant crown. Infections can spread to healthy plants where healthy leaves are in contact with infected ones. Infections result in large numbers of conidia being produced, and under humid conditions, infections can become widespread.

Alternative management strategies used in combination with chemical control:
Avoiding overhead irrigation helps to reduce humidity and leaf wetness, thereby reducing the ability of *Botrytis* to sporulate and infect host tissue. Adjusting plant spacing such that a dense canopy doesn't form will increase air flow and help foliage dry more quickly. Avoid cutting stems during periods of wet, cloudy weather. Removal of diseased tissue from the field is also beneficial.

Chemical Controls:

azoxystrobin (Quadris) FRAC code 11
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 4-5 oz. of Quadris or 3.2-8 oz. of Heritage/A at 7-14 day interval.
Method: Foliar spray when aphids are present.
REI: 12 hr.
PHI: 0 day.
Efficacy: Good
Note: 1.5 lb. of active ingredient per crop per season is maximum allowable. Fungicides in FRAC code. 11 should not be applied more than twice in sequence in order to delay the development of resistance. There is potential for worker exposure due to the 0-day PHI, although there would be little value in applying the material within 1-2 days of harvest. Azoxystrobin has little risk to workers, with a dermal LD-50 of >5000.

Potassium bicarbonate (Armicarb 100, Kaligreen, Milstop) FRAC code: Not Classified
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 2.5-5 lbs. of Amicarb 100/100 gal. of water at 7-14 day interval as conditions warrant.
Method: Foliar spray prior to appearance of Botrytis.
REI: 4 hr.
PHI: 0 day.
Efficacy: Fair.
Note: Spray solution should be applied within 12 hours of mixing. Growers indicate that this product is not used, most likely due to the availability of other effective products.

Chemical control (Botrytis and Fusarium)

cyprodinil + fludioxonil (Switch) FRAC codes 9 + 12
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Rate and Frequency: 11-14 fl. oz. of Switch /acre in a minimum of 30 gal. of water at 7-10 day intervals when disease is anticipated.
Method: Foliar application.
REI: 12 hr.
PHI: 7 days.
Efficacy: Good.
Note: Maximum amount allowable per acre is 56 fl. oz. No more than 2 consecutive applications of Switch should be made without changing to materials with different modes of action for at least two applications. Growers indicate that this material is not used because *Fusarium* is typically managed with varietal resistance, and other materials available for botrytis control have shorter PHI's.

Nematodes

Although nematodes are capable of causing injury to basil, and two nematicides are labeled for use on basil in New Jersey, grower surveys indicate that no controls are applied for these pests.

Major Weed Pests of Basil in New Jersey

Annual Grasses:

Barnyardgrass (*Echinochloa crus-galli*)
Barnyardgrass is a summer annual grass that may grow to 4' tall, with an upright habit and a seed head that may be green, or reddish in color. Barnyardgrass reproduces by seed that germinates from spring through summer, and can spread by tillering. It does very well in warm irrigated soils.

Crabgrass (*Digitaria* spp.)
Crabgrass species are summer annual grasses with prostrate or ascending growth habits. Seeds germinate when soil temperatures exceed 55°F for 7-10 consecutive days, and soil is adequately moist. Reproduction is by seed or rooted tillers.

Fall Panicum (*Panicum dichotomiflorum*)
Fall panicum is a summer annual grass that can reach a height of 6-7' and is characterized by a stem that develops a zig-zag pattern due to bending at the nodes. Reproduction is by seeds, which overwinters. The seeds are borne on an open panicle and germinate throughout the summer.

Foxtail (*Setaria* spp.)
Foxtail species are clump forming annual grasses that have a prostrate to erect growth habit. Reproduction is by seeds, which germinate in the late spring and summer when soil temperatures are warm. All species are characterized by a bushy, "foxtail like" seed head.

Winter Annual Grasses:

Annual Bluegrass (*Poa annua*)
Annual bluegrass is a clump-forming light green grass that may grow to a height of 5-6". It reproduces by seed that germinates in the late summer and fall as soil temperatures begin to fall. Seeds may be produced as quickly as 8 weeks on new plants. Plants grow quickly in the spring as the soil warms, but may not thrive in the hot summer months.

Broadleaf Annuals:

Common lambsquarters (*Chenopodium album*)
Common lambsquarters is a summer annual growing to 3.5 ft. with light green, triangular leaves. Flowers are produced from July to Sept. and reproduction is by seed. Seed overwinters and germinates in disturbed soil the following spring.

Common purslane (*Portulaca oleracea*)
Common purslane is a prostrate succulent summer annual plant that spreads out from a central rooted stem. Stems may be up to 12" long with oval, fleshy, stalkless leaves. Reproduction is by seed, and sometimes vegetatively as broken stems re-root with adequately moist soil. Flowering occurs from mid-summer through fall. Seeds germinate the following spring, although they may persist in the soil for many years. This is probably the most important weed pest in arugula production.

Black nightshade (*Solanum nigrum*)
Black nightshade is a summer annual exhibiting extensive branching, growing to 1-2 ft. Leaves are alternate and oval-shaped. Flowers are white in color and resemble tomato blossoms in shape. Black nightshade produces green berries that ripen black, and are toxic to mammals. Reproduction is by seed. Seeds germinate the following spring when soil temperatures are sufficiently warm.

Jimsonweed (*Datura stramonium*)
Jimsonweed is a summer annual growing to 5 ft. with broad, coarsely serrated leaves, white or purple trumpet shaped flowers, and oval, plum-sized seed pods covered with spines. Reproduction is by seed. Seeds germinate the following spring when soil temperatures are sufficiently warm. The entire plant is toxic to humans and animals.

Galinsoga (*Galinsoga ciliate*)
Galinsoga is a summer annual growing to around 2 ft. with opposite, oval, toothed leaves and small yellow and white rayed flowers. Stems and leaves are hairy. Flowers are produced from June through autumn. Reproduction is by seed, which germinate during the current season, or the following spring.

Common cocklebur (*Xanthium strumarium*)
Common cocklebur is a summer annual that grows to 3 ft. with rough, heart-shaped, toothed leaves. Reproduction is by seed. Flowers are produced late summer through fall, and seeds are contained within bristly burs. One seed per bur germinates the following season, while others are dormant until the second year.

Ragweed (*Ambrosia spp*.)
Common and giant ragweed are summer annuals that may grow to 3 ft. and 15 ft. respectively. Leaves are deeply lanceolate. Reproduction is by seed. Flowers are produced from August through autumn, and seeds germinate the following spring and may remain viable for 5 years.

Pigweed (*Amaranthus spp*.)
The pigweeds are summer annuals growing to 4 ft., and are inhabitants of disturbed soils. Leaves are oval and somewhat rough. Inconspicuous flowers are produced from mid-summer through autumn. Reproduction is by seed. Thousands of seeds are produced by a single plant, and germinate the following spring.

Morning glory (*Ipomoea spp*.)
Morning glories are summer annuals having a vine-like growth habit. They become entangled in crop plants and can become difficult to control. Reproduction is by seed. Seeds are produced during the summer months and germinate in the spring.

Velvetleaf (*Abutilon theophrasti*)
Velvetleaf is a summer annual growing to 3-8 ft. Plants have large heart-shaped leaves and are completely covered with soft, fine hairs. Reproduction is by seed, and flowers are produced from July through October. Seeds germinate continuously through the season, as warm conditions permit.

Winter Annual Broadleaves:

Shepherd's Purse (*Capsella bursa-pastoris*)
Shepherd's purse is a winter annual that grows as a rosette of leaves and produces a flower stalk that may grow to 24". Seed capsules are heart-shaped or triangular in shape. Reproduction is by seed. Seeds germinate in late summer and early fall. Plants remain dormant through the winter. Growth resumes in the spring and seeds are produced prior to summer, when plants die.

Perennial weeds:

Yellow nutsedge (*Cyperus esculentus*)
Yellow nutsedge is a perennial that grows from tubers (nutlets) and rhizomes and may reach a height of 2 ft. Stems are triangular in cross-section, and leaves are yellowish-green in color. Yellow nutsedge tolerates moist conditions and is capable of forming dense stands. New plants may emerge through some types of black plastic mulch.

Quackgrass (*Elytrigia repens*)
Quackgrass is a rhizomatous perennial grass having an upright growth habit and may grow to 4 ft. Reproduction is by seed rhizome. Stems grow from nodes on the rhizomes, and may produce seed heads. Rhizomes may fork, expanding the patch.

Weed Control

Occurrence: Annual, frequent (depending on field conditions, weed and crop history).

Damage: Competition from weeds for nutrients, water, and sunlight can result in yield reduction and poor quality crop. Additionally, weeds can block foliar pesticide treatments, and when dense, increase canopy moisture. Both are factors in decreased insect and disease control. Some weeds are alternate hosts for pests of basil. Excessive weed growth increases harvest time as workers seek less weedy areas or try to sort weeds from harvestable basil.

Timing of control measures: Pre-plant, pre-emergence, post-emergence, post-harvest.

Cultural controls: Crop rotation, hand weeding, cultivation, early harvest.

Post harvest control measures: Non-selective herbicide for destruction of weeds and crop residue, cut-harrowing to destroy crop and weeds.

Alternative management strategies used in combination with chemical control: Hand weeding and mechanical cultivation are common practices in New Jersey basil production. Surveys indicate that smaller acreage growers often do not use herbicide on this crop.

Chemical Control:

Pre-plant, pre-emergence weed control (fumigation):

Metam-sodium [**Vapam HL**(and other generic forms)]
Target weeds: non-selective (fumigant).
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Average rate and frequency of application: 37.5-75 gal. of Vapam HL/A one time 2-3 weeks prior to planting.
Method of application: Injected into soil by means of spray blades or injection knives.
REI: 48 hours.
PHI: Pre-plant application only.
Efficacy: Good for eliminating some weed seeds and newly germinated seedlings. Also offers some suppression of nematodes and certain fungal pathogens.
Notes: Soil should be rolled just after application and watered lightly to create a less permeable upper layer that will delay loss of the volatile compound. Tarps may be used to contain the volatile as an alternative. 14-21 days should elapse prior to seeding/transplanting of the crop into

treated soil. New Jersey growers indicate that this material is not used, likely due to the efficacy of available herbicides and the difficulty inherent in applying a soil fumigant.

Pre-plant, pre-emergence weed control (fallow or stale seed bed application):

A number of materials are labeled for basil production in New Jersey that may be used to eliminate weeds from basil beds prior to seeding. For this use, beds are prepared well in advance of seeding and weeds are allowed to germinate. Once weeds develop, a "burn-down" application of one of the following non-selective herbicides is made:

Carfentrazone-ethyl (Aim EC)
Target weeds: non-selective (foliar desiccant).
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Average rate and frequency of application: up to 2 fl. oz. of Aim EC /A one time.
Method of application: Pre-plant spray to soil surface where weeds have emerged.
REI: 12 hours.
PHI: Pre-plant application only.
Efficacy: Good for actively growing weeds up to 4 inches.

Glyphosate (Roundup (and other generic forms**))**
Target weeds: non-selective (systemic).
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Average rate and frequency of application: 16-32 fl. oz. of Roundup Original in 3-10 gal. of water/A one time.
Method of application: Pre-plant spray to soil surface where weeds have emerged.
REI: 12 hours.
PHI: Pre-plant application only.
Efficacy: Good for annual weeds, particularly when small.

Pelargonic acid (Scythe)
Target weeds: non-selective (foliar desiccant).
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Average rate and frequency of application: 75-200 gal of 3-5% solution of Scythe in water /A one time.
Method of application: Pre-plant spray to soil surface where weeds have emerged.
REI: 12 hours.
PHI: Pre-plant application only.
Efficacy: Good for desiccation of actively growing succulent tissue.

Pyraflufen-ethyl (ET Herbicide)
Target weeds: non-selective (foliar desiccant).
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Average rate and frequency of application: 0.5-2.0 fl. oz. of ET Herbicide in a minimum of 10 gal. of water/A one time.
Method of application: Pre-plant spray to soil surface where weeds have emerged.
REI: 12 hours.
PHI: Pre-plant application only.
Efficacy: Good for some broadleaf weeds under 4 inches tall. Must be mixed with other herbicide(s) for control some broadleaves and grasses.

Post-seeding, pre-emergence (crop) application:

Napropamide (Devrinol)
Target weeds: some broadleaf annuals and grasses.
Percent acres treated: 80%
Active ingredient used (lbs.): 180
Average rate and frequency of application: 2-4 lbs. of Devrinol 50DF/A one time in 20-100 gal. of water.
Method of application: Pre-plant or pre-emergence (crop) spray to soil surface.
REI: 12 hours, unless soil incorporated and contact is not likely.
PHI: N/A
Efficacy: Good for some broadleaf weeds and grasses. Devrinol should be incorporated to a depth of 1-2 inches.
Notes: Devrinol is available for use on basil in New Jersey under a 24(c) label (EPA SLN No. NJ-070002). New Jersey growers indicate that this material is applied at a rate of 1 lb./A, after seeding the basil crop, and incorporated with overhead irrigation. Hand weeding is performed later in the life of the crop to manage weeds not controlled by the herbicide.

Clethodim (Select Max)
Target weeds: Annual and some perennial grasses.
Percent acres treated: 0%
Active ingredient used (lbs.): 0
Average rate and frequency of application: 9-16 fl. oz. of Select Max/A one time in 5-40 gal. of water.
Method of application: Post-emergence (grass and crop) spray.
REI: 24 hours.
PHI: 14 days.
Efficacy: Good for annual grasses.
Notes: Select Max should be applied with a non-ionic surfactant at a rate of 0.25% v/v. Growers indicate that this material is not used due to the efficacy of Devrinol against grasses and the long PHI (14 days) on Select Max.

Worker Pesticide Exposure – Basil in New Jersey

IPM scouts and others may visit basil fields 1-2 times a week starting at plant emergence and make recommendations for pest control until harvest. Field workers generally do not enter basil fields until harvest.

Worker exposure to herbicides is unlikely in the production of basil in New Jersey. The vast majority of the crop is seeded mechanically, and weed control is obtained with the herbicide napropamide (Devrinol) followed by mechanical cultivation as necessary. With a 12 hr. REI, field scout and worker exposure to Devrinol is not likely. A small percentage of the crop is transplanted, but in this circumstance, plastic mulch is used and herbicides are not applied until later as post-emergence applications between the beds. The one herbicide that is labeled for post-emergence application is clethodim (Select Max). New Jersey basil growers indicate that it is not used because of the efficacy of Devrinol and the relatively long PHI (14-day) for Select Max. Growers typically opt for hand or mechanical weeding if necessary.

Labeled fungicides for basil all have REI's of 12 hrs. or less and PHI's of 0 days, with the exception of the combined fludioxonil and cyprodinil product (Switch) which is labeled for *Fusarium* control and has a 7-day PHI. Worker and field scout exposure to any of these materials is unlikely because *Fusarium* is managed with varietal resistance, and the other pathogens are not considered serious by New Jersey basil growers. The result is that fungicide use is rare to nonexistent. Some hydrogen dioxide (Oxidate) is used to combat dark leaf spots (possibly bacterial in origin, but this remains unclear). This material has a 0-hr. REI and a 0-day PHI.

Basil Pest Management Problems that Need Addressing

Growers lack labeled insecticides for basil that are effective against Japanese beetle and grasshoppers. These pests can appear late in the life of the crop, resulting in reduced marketability or outright crop loss.

All labeled insecticides have REI's of 12 hrs. or less, and 0-day PHI's, with exceptions being the soil-applied neonicotinoid material Admire (imidacloprid) with a 14-day PHI, and Provado (the foliar- applied version of the same active ingredient) with a 7-day PHI. Both are 12 hr. REI materials. Because of the long PHIs, growers do not use these materials (despite their efficacy on target pests). Other labeled materials are less effective on target pests.

In general, there is a need in basil production for foliar applied insecticides with short REIs and PHI's (3 days or less) that provide quick knock-down of target pests like Japanese beetle and grasshoppers. Several synthetic pyrethroid materials fit this description and are labled for use on other crops in New Jersey. An example would be beta-cyfluthrin (Baythroid), which is labeled for crops like parsley, escarole, mustard, and turnip greens where leaf material is harvested and consumed. This insecticide has a 12 hr. REI and 0 day PHI for these crops. There is a need for the labling of such synthetic pyrethroids for use on grasshopper and Japanese beetle pests on basil.

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Key Contacts:

Primary Contact:

Kristian E. Holmstrom
Project Coordinator II
Rutgers New Jersey Agricultural Experiment Station
Cooperative Extension
Vegetable IPM Program
Blake Hall Rm. 243; 93 Lipman Dr.
New Brunswick, NJ 08901-8524
Holmstsrom@njaes.rutgers.edu
732-932-9802

Reviewers and Contributors:

Entomology
Dr. Gerald M. Ghidiu; Specialist in Vegetable Entomology
Rutgers Agricultural Research and Extension Center
121 Northville Rd.; Bridgeton, NJ 08302-5919
Ghidiu@njaes.rutgers.edu
732-932-4000 X-4116

Pathology
Dr. Christian A. Wyenandt; Specialist in Vegetable Pathology
Rutgers Agricultural Research and Extension Center
121 Northville Rd.; Bridgeton, NJ 08302-5919
Wyenandt@njaes.rutgers.edu
732-932-4000 X-3133

Weed Science
Dr. Bradley A. Majek; Specialist in Weed Science
Rutgers Agricultural Research and Extension Center
121 Northville Rd.; Bridgeton, NJ 08302-5919
Majek@njaes.rutgers.edu
732-932-4000 X-4122

SURVEY OF NEW JERSEY GROWERS OF BASIL: 2008

Information on basil production is not as readily available as for many of the larger vegetable crops. In order to develop information for this crop profile, seven New Jersey basil growers were surveyed during the winter of 2008 regarding varieties, cultural and pest management practices, and marketing strategies.

The survey was conducted by Kristian Holmstrom and Joseph Ingerson-Mahar of the Rutgers New Jersey Agricultural Experiment Station (NJAES) Vegetable IPM Program. Participants represented growers of basil for bunched sale (fresh market). Wholesale and retail growers were represented. Surveyed participants were from Cumberland, Gloucester, Hunterdon, Monmouth, Morris and Warren counties.

SUMMARY OF SURVEY RESULTS

1. County?

Surveyed growers were from Hunterdon, Morris, and Warren counties (northern NJ); Monmouth County (central NJ); and Cumberland and Gloucester counties (southern NJ).

2. How much basil do you grow per season?

Acreage ranged from .1 to 35 acres.

3. What varieties of basil do you grow?

Varieties included 'DiGenova', 'Genovese', 'Italian Large Leaf', 'Martina Genovese', and 'Nufar'.

4. Is crop direct seeded or set out as transplants?

The three largest acreage growers surveyed all direct seed the crop. The four smaller acreage growers (all from northern NJ) use transplants.

5. When/how often do you seed/plant?

The larger growers (1.5-35 acres) begin seeding after last frost (mid-April to mid-May). Seeding frequency ranges from three times a season to weekly.

The smaller acreage growers (.1-.5 acres) begin setting out transplants in mid-May with planting frequency ranging from twice a season to every two weeks.

For all growers, the last plantings of the season are initiated in August.

6. Describe field culture, i.e. bed configuration, irrigation, mulch.

The three larger acreage growers (1.5-35 acres) all plant on bare-ground, raised beds with 4-rows/bed and overhead irrigation.

The 4 smaller acreage growers (.1-.5 acres) all plant two-row beds with plastic mulch and trickle irrigation. Two growers use raised beds, and two use flat beds.

7. Fertility program.

Two of the three larger acreage growers (1.5-35 acres) used 14-7-14; one as a broadcast and plow down application prior to making beds, the other uses the fertilizer 2-3 times as a side dress. The third broadcasts and plows down 10-10-10, and side dresses later with 16-8-8.

The four smaller acreage growers (.1-.5 acres) all utilized some type of broadcast and plow down application of balanced fertilizer based on a soil test for the nearest vegetable crop, i.e. tomatoes or cucumbers. Typically, this was followed by a side dress application through the trickle irrigation of a balanced material such as 15-15-15, or straight nitrogen.

8. Herbicide/weeding program?

All three larger acreage growers (1.5-35 acres) utilized Devrinol, which is available in NJ under a 24(c) label. This was followed by hand weeding or mechanical cultivation as necessary.

The four smaller acreage growers (.1-.5 acres), all used some type of herbicide to manage weeds between the plastic beds. There was no broadcast or overhead application of herbicide. Typically weeds were managed with a glyphosate or paraquat based material as necessary between the beds.

9. What insect pests do you have?

All growers who indicated that they had pest issues on basil emphasized Japanese beetle as the primary pest. One grower also mentioned grasshoppers as a late season pest. Several of the northern (small acreage) growers did not have insect pest problems.

10. How do you control them?

Three of the four small acreage growers (.1-.5 acres) do not use insecticides because they have not experienced insect problems with their basil crop. The remaining four growers all resort to non-labeled pyrethroid insecticides to manage Japanese beetle. This is because there are no effective materials with PHI's of less than 7 days. Additionally, there are no effective grasshopper materials labeled for basil in New Jersey.

11. What diseases do you encounter?

Although Fusarium and other root rots as well as botrytis are diseases of basil, these are rarely encountered by NJ basil growers. Fusarium is managed with resistant varieties where there is grower concern for the disease. Other root rots are managed culturally, by not over watering. Botrytis was not named by any grower as a problem.

12. How do you manage them?

Growers who believe that there is a potential Fusarium problem opt for a resistant variety. None of the surveyed growers utilizes fungicides.
One grower uses the surface sterilizing agent hydrogen dioxide (Oxidate) to manage "black spots" which he believes are bacterial in origin. This material is applied when black spots appear on the foliage; typically during prolonged damp, cloudy weather.

13. How and when is crop harvested?

Two of the smaller acreage growers (.1-.5 acres) always cut stems by hand at the 10-12" stage. Each crop is cut 2-3 times. One of these growers pulls the plants after re-growth following the last cutting. The plants are then sold with the roots attached.

All of the other growers hand pull the plants at the 10-12" stage and sell them bunched or singly with the roots on.

14. How is crop marketed?

The larger growers all wholesale by the box to other growers or at auction. Boxes range from 12-15 bunches each, with bunched material being either cut stems or whole plants.

The smaller acreage growers all sell bunched stems or rooted plants by the bunch or plant at their own retail outlets.

15. What is a typical price for your basil?

Wholesale prices range from $6-8/box, while bunches or plants retail for $1-2.