



Scouting vegetables for pests

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The **Integrated Pest Management Program** expands the use of IPM in Wisconsin crops to reduce the use of chemical pesticides, increase the use of cultural and biological pest control tactics, improve production efficiency and maintain the competitiveness of Wisconsin growers by producing crops with the lowest pesticide inputs necessary. Go to <http://ipcm.wisc.edu> for more information.

PURR is the collective effort of 14 agricultural organizations that are working together to reduce pesticide use and risk through Integrated Pest Management and other system strategies. For more information on PURR and its member organizations, go to <http://www.thinkIPM.org>

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Scouting vegetables for pests

The cornerstone of any Integrated Pest Management (IPM) program is regular scouting of the crop at hand. It's important that the scouting or monitoring practices are done systematically and at regular intervals. In order for a scouting program to be effective, you must be familiar with what the crop should look like, which can be tricky in the case of some unusual cultivars of vegetables. You also must know the key pests of each crop. This publication will help you know what insects and diseases to look for on each particular crop family, when they are likely to be a problem, how you can monitor their population levels, and at what threshold levels you should consider controlling the population to prevent crop loss. See the publications referenced throughout this report for pest descriptions, biology and specific controls.

There are several tools that can be used to monitor vegetables including visual observation, sweep net sampling, trapping, and environmental monitoring.

Visual Observation

Visual observation works well to monitor exposed feeding insects such as potato leafhopper nymphs; Colorado potato beetle; potato, cabbage, and turnip aphids; European corn borer; seed corn maggot; corn rootworm beetles; spider mites; cole crop caterpillars; thrips; fleabeetles; leafminers; cucumber beetles; and the squash vine borer. Visual observation can also be used to determine whether there are beneficial insects present and the level of parasitism of the beneficial insects on pest insects. Plant diseases, environmental disorders, and improper cultural practices can also be observed visually. Visual observation can be very subjective, so it's important that the same person monitors the crop throughout the season.

Randomly select plants along a W pattern through the crop. Examine the upper and lower leaf surfaces, the growing point, where the stem enters the ground, and any fruit that may be present. One tool that may help with visual observation is a hand lens. A 10X magnifying hand lens will enlarge tiny insects to help in distinguishing key identifying characteristics, and will help you see if a lesion has fungal spore present to distinguish it from an environmental cause.

Sweep Net Sampling

Small insects are best monitored with a sweep net, particularly if there is a large area to cover. From a practical standpoint, sweep net sampling works best on low-growing, flexible crops like carrots, peas, and leafy greens. Sweep nets are available in muslin or sailcloth. Choose a muslin sweep net for scouting vegetables as it's lighter, more flexible,



Sweep net sampling of low-growing, flexible vegetables for small insects



Blacklight traps are useful in monitoring population levels and development of night flying moths

and will dry more quickly. Some insects that are easily monitored with a sweep net include aster and potato leafhopper adults, flea beetles, tarnished plantbugs and pea aphids. To effectively use a sweep net, swing the net in an arc in front of your body as you walk through the field. One “sweep” is considered going from right to left and back again in a 180° arc.

Trapping

Blacklight, pheromone and dishpan traps can assist in insect monitoring. Blacklight traps are effective for night-flying insects such as the European corn borer, cutworms, armyworms, stalk borers, and some loopers. They are non-specific in the insects trapped and are quite expensive to purchase, so they are often not used by individual growers. However, blacklight trap results are available throughout the season from the Wisconsin Department of Agriculture, Trade and Consumer Protection’s Cooperative Pest Survey Bulletin at

<http://datcp.state.wi.us/arm/environment/insects/pest-bulletin/>



Hartsack pheromone trap for corn earworms

Pheromone traps are much easier to use and are pest specific. They monitor adults of a given insect species and are primarily used for lepidopterous insects (butterflies and moths) of which the juvenile stage, caterpillars, are vegetable pests. Armyworms, cutworms, and the corn earworm are commonly monitored with pheromone traps. A lure impregnated with a chemical attractant is placed inside or on the trap, depending on the trap design. This lure emits a sex pheromone produced by the female of the species to attract a mate, thus luring male insects to the trap. For more information on the use of traps and trap catch data for the management of corn borers and earworms, refer to “Monitoring European Corn Borers & Corn Earworm” on page 27.

Dishpan traps consist of a yellow dishpan filled with soapy water. If placed on a dark background such as soil, the adult flies of the cabbage, onion, and seed corn maggots as well as aphids will be attracted to the traps, and populations can be monitored to see if there is a potential problem to the crop. Place the traps at 100 foot intervals along the field edges and check them every 3-4 days. Replace the soapy water as needed.

Environmental Monitoring

Environmental or weather monitoring can help predict insect pest outbreaks and determine when disease outbreaks are likely to occur due to wet or humid conditions. At the very minimum, every farm should have a maximum/minimum thermometer with which the operator can monitor temperature and calculate degree days to aid in insect pest prediction. The following sections on “Degree Days for Pest Prediction” and “Common Vegetable Insects Monitored Using Degree Days” will tell you how to use the temperature data you collect to determine which pests will become a problem at what degree day accumulations.

Degree Days for Pest Prediction

Degree days (also known as heat units or thermal units) are a way of incorporating both temperature and time into one measurement to quantify the rate of plant or insect development. All plants and insects develop in response to temperature. They develop quickly in warmer weather and more slowly at cooler temperatures. But all species have a cutoff temperature below which no development occurs. This base temperature, or developmental threshold, differs depending on the species. As the ambient (air) temperature increases above the threshold, development occurs. The higher the temperature, the faster the rate of development. The most common developmental threshold is 50°F. This is the temperature at which dormancy is broken in most plants and when many insects become active. But there are a number of insects, particularly those that are active early in the spring, that have a lower threshold (38°F or 43°F). The base temperature is often noted as a subscript number following the abbreviation for degree day: DD₅₀. Many cool-season vegetables, such as cole crops and peas, have a base temperature of 40°F.

Degree days are accumulated whenever the temperature exceeds the predetermined developmental threshold. A certain number of units are added each 24-hour period, depending on how much the temperature exceeds the threshold—to produce a cumulative total of degree days. The mathematics for calculating actual degree days can be very complex (determining the area under the curve for the graph of time vs. temperature), but easy mathematical equations yield approximate figures satisfactory for practical applications.

If you're not inclined to dig out your calculator and record daily temperatures, you can visit the University of Wisconsin's Soil Science website at <http://www.soils.wisc.edu/wimnext/asos/SelectDailyGridDD.html> and use their computerized degree day calculator. High and low temperatures from nearby weather stations will be extrapolated for your area to determine DD accumulations for your location. All you need to know is your latitude and longitude coordinates. However, because of the wide array of microclimates that exist due to topography and the buffering effects of lakes, these readings will be less accurate for your farm than if you record your own temperature data.

If you would like to calculate degree days, all you need is a maximum/minimum thermometer. Each day, record the high and low temperatures. Determine the average daily temperature by adding the daily high temperature and low temperature together and dividing by 2:

$$\text{Avg. Daily Temp.} = \frac{(\text{High Temp.} + \text{Low Temp.})}{2}$$



Yellow disphan traps monitor the adult flies of the cabbage maggot



A weather monitoring station records high and low temperatures, humidity and wind speed

Example:
$$\text{Avg. Daily Temp.} = \frac{(60 + 50)}{2} = 55$$

Next, subtract the base temperature from the average daily temperature to get the number of degree days for that day:

$$\text{Daily DD}_{50} = \text{Avg. Daily Temp.} - \text{Base Temp.}$$

Example:
$$\text{Daily DD}_{50} = 55 - 50 = 5 \text{ DD}_{50}$$

If the average degree day value for a given day is less than zero, just record zero, not a negative number.

Finally, to keep track of degree day accumulation, keep a running total of all degree days accumulated from the 1st of the year. In Wisconsin, we often don't accumulate many degree days before April 1, so if you wish to take a break from the math from January to April, go ahead.

The above equation is a very rough estimate of degree day accumulation. There is also an upper threshold for development in insects, above which there is no appreciable increase in the rate of development. This is obviously of more concern later in the season than in the spring. To compensate for the reduced growth rate at high temperatures, modified degree days use an upper threshold of 86°F as well as the lower threshold. Whenever the actual temperature is below the base temperature, the base temperature is substituted as the low temperature for the day. Similarly, whenever the daily high is above 86°, 86° is used as the high temperature for the day.

Example: **Daily High = 90 and Daily Low = 45**

$$\text{Avg. Daily Temp.} = \frac{(86 + 50)}{2} = 68$$

$$\text{Daily DD}_{50} = 68 - 50 = 18 \text{ DD}_{50}$$

Common Vegetable Insects Monitored Using Degree Days

Certain insects can be monitored using degree day accumulations. However, for this to be effective, the insect species must meet two criteria: they must overwinter in Wisconsin **AND** they must have discrete life generations. Pests such as the aster leafhopper or corn earworm that migrate up from the Gulf States each summer cannot be monitored with degree days. The reason is that they are exposed to a wide range of

environmental conditions during the course of their migration. Similarly, insects such as aphids in which all life stages (adults and nymphs) are present at the same time cannot be monitored with degree days. Finally, degree days may be difficult to use when the insect pest has multiple biotypes. For example, the European corn borer has two distinct generations in most areas of Wisconsin but only one generation in some regions, particularly the east-central part of the state.

In some cases, indicator plants whose life events are unrelated to either the pest life stages or the host plant can be used to predict insect development. These indicator plants and their life stages are listed in parentheses after the pest's degree day accumulations in the following list.

Colorado potato beetle, 1st generation

Base temperature = 50°F

Begin counting degree days when first eggs appear

1st instar larva at 185 DD₅₀

2nd instar larva at 240 DD₅₀

3rd instar larva at 300 DD₅₀

4th instar larva at 400 DD₅₀

Pupa at 675 DD₅₀

Common asparagus beetle

Base temperature = 50°F

Egg laying at 150 – 240 DD₅₀ (Amelanchier full bloom, redbud early to full bloom, Black Hills spruce bud caps splitting)

Black cutworm

Base temperature = 50°F

Egg hatch at 310 DD₅₀

Most damage to crops between 562-640 DD₅₀

Squash vine borer

Base temperature = 50°F

Egg laying at 900-1000 DD₅₀ (Chicory full bloom)

European corn borer

Base temperature = 50°F

Pupate when Mountainash blooms

1st spring moths at 375 DD₅₀ (Spiraea x vanhouttei in full bloom)

1st eggs at 450 DD₅₀ (Pagoda dogwood late bloom)

Peak spring moths at 631 DD₅₀ (Black locust full bloom)

1st summer moths at 1400 DD₅₀ (Mountainash fruit golden yellow, most Canada thistle seed ripe)

1st eggs at 1450 DD₅₀

1st egg hatch at 1550 DD₅₀

Peak summer moths at 1733 DD₅₀
Summer treatment period at 1550 – 2100 DD₅₀ (Queen Anne's Lace full bloom – 1500 to goldenrod early bloom – 2100)

Corn rootworm

Base temperature = 50°F
Adult beetles present at 1300 DD₅₀ (Canada thistle seed ripe, Queen Annes' Lace early bloom)

Fleabeetles

Base temperature = 50°F
150-200 DD₅₀ (Norway maple late bloom, Amelanchier blooming, redbud early bloom)

Imported cabbageworm

Base temperature = 50°F
Adult butterflies at 150-240 DD₅₀ (Amelanchier full bloom, redbud early to full bloom, Black Hills spruce bud caps splitting)
Larvae at 300-400 DD₅₀

Cabbage maggot

Base temperature = 43°F
300, 1476, 2652 DD₄₃ for 1st, 2nd, & 3rd generations flies
1st generation eggs are laid when the common lilac is in full bloom

Onion maggots

Base temperature = 40°F
680, 1950, 3230 DD₄₀ for 1st, 2nd, & 3rd generation flies
1st generation eggs laid 230-280 DD₄₀

Key Pests: How, When, and Where to Scout

Diseases: There are no formal monitoring practices for many of the soil-borne or virus plant diseases that affect vegetables because in many cases, once a disease is present, there are no effective and economic control practices for the current season's crop. However, foliar fungal and bacterial diseases may be managed during the current season with pesticides.

As you visually monitor your crop for various insect pests, note whether there are any disease symptoms present. If you notice something, further determine the extent of the disease. This includes the location on the plant, type of symptoms expressed, percentage of plant tissue affected, percentage of the crop affected, and dispersal and location within the planting.

These observations should be made and recorded weekly so you can determine whether the problem is worsening and at what rate. There are only a few instances where thresholds have been established for plant diseases. In some cases, there is a zero tolerance for any infection. In many other cases, fungicides and bactericides must be applied as PROTECTANTS to prevent the spread of disease and will not cure infected tissue. Therefore, monitoring vegetables for disease is commonly done so problems are detected early.

Key diseases for each vegetable crop are listed in the following section. These are the diseases for which you should monitor the crop. Consult UWEX publications for specifics on many of these diseases. These will be referenced by publication number after the pest name. Go to <http://cecommerce.uwex.edu> and click on 'Horticulture' and then 'Vegetables.' For recommended chemical controls, refer to A3422 *Commercial Vegetable Production*, also available at this web site.

Insects: Not all insect pests have a discrete window when they're active. For these insects, it's difficult to capture on the timeline calendar when to scout for them, hence you should be keeping an eye out for the insects for which no calendar exists as long as the crop is in the ground.

The following section provides an outline of diseases and insect pests for common vegetable crops. See the scouting calendars and list of practices for more information. References to specific suppliers and manufacturers are not endorsements of their products and are for illustrative purposes.

April			May			June			July			August			September		
early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late
									Asparagus aphid								
			Common asparagus beetle						Common asparagus beetle								
						12-spotted asparagus beetle											

Asparagus

Diseases: Rust

Insects: Asparagus aphid

- Calendar – early July through mid-August
- Monitor fields once or twice per week after harvest for aphids or distorted ferns resulting from aphid feeding.
- Monitor new plantings closely for aphid activity.
- Treat when 5% of ferns show injury, young plants tolerate less injury.

Common and Twelve-spotted asparagus beetles (Publication A3760E)

- Calendar – spotted: mid-May through the end of July; common: late April through mid-June AND early July through late August
- Use degree day prediction from pages 3-4.
- Sample 20 randomly-selected plants in 5 locations in the field for adults, feeding, or eggs in spring.
- Observe spears for injury when harvesting.
- Treat when 10% of crowns are infested with beetle adults.

April			May			June			July			August			September				
early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late		
			Seed maggot																
			European corn borer																
			Potato leafhopper																
			Tarnished plant bug																
										Soybean aphid									
												Corn earworm							
			Bean leaf beetle																
									Cabbage looper										

Beans

Diseases: Angular leaf spot, Bacterial blights, Botrytis gray mold, Sclerotinia white mold, Rust

Insects: Bean and Soybean aphids

- Visual observation. Pay attention to lower leaf surfaces and terminal shoots.
- Examine the terminal shoots of 15 consecutive plants.
- Aphid populations will increase rapidly in hot weather, so check plants frequently.
- An infestation level of 5-10% of the plants warrants control.

Bean leaf beetle

- Calendar – the month of June
- Problem in seedling to pod stage beans
- Treat when >1 beetle/row foot or >50% defoliation.

Corn earworm (Publication A3655)

- Monitor with a Hartstack pheromone trap and Hercon brand lure.
- Begin checking traps daily in early July.
- Beans harvested before July 10 are not likely to be attacked by corn earworms.
- Treat if >10 moths/trap/night and beans are between 30-7 days before harvest.

Cutworms

- Monitor with a blacklight or pheromone trap.
 - A “significant” moth flight of ≥ 9 moths per pheromone trap in two consecutive nights is used as an indicator to start counting degree days.
 - Begin scouting for cutting at 300 DD₅₀ after the first significant moth catch (562-640 DD₅₀ total accumulated DD for the year).
- Look for seedling beans that have been cut off at the soil level. Use a trowel to look for cutworms in the soil nearby.
- Treat when ≥ 2 cutworms/row foot.

European corn borer (Publication A1220)

- Use a blacklight trap to monitor life stages and populations.
 - < 10 moths/night indicates you should be prepared for increasing moth numbers.
 - > 10 moths/night for 3 consecutive nights means moths are laying eggs and treatment should be implemented.
 - > 100 moths/night indicates egg-laying is very high.
- 1st generation moth flights peak at 631 DD₅₀, 2nd generation moth flights peak at 1733 DD₅₀.
- Check plants when beans begin to bloom and continue until harvest.
- Examine stems, leaves, buds, and flowers.

Cabbage looper (Publication A3724)

- Calendar – mid-July through late September
- Use a blacklight trap to monitor migration.
- Shake plants to dislodge larvae onto the ground or a drop sheet.
- Treat when there are more than 2-4 larvae/row foot during flowering.

Potato leafhopper (Publication A3723E)

- Monitor when nearby alfalfa is cut, as leafhoppers will migrate to beans.
- Use visual examination and a sweep net to monitor populations.
- Treat
 - seedling beans when $\frac{1}{2}$ leafhopper/sweep or 2/row foot
 - 3rd 3-part leaf to bud stage when 1 adult/sweep or 1 nymph/10 leaves

Tarnished plant bug

- Sweep net sample.
- Treat when more than 1 plant bug/sweep.

Beet

Diseases: Cercospora leaf spot (Publication A3806)

Insects: Aphids (Publication A3757E)

- Visual observation. Pay attention to lower leaf surfaces and terminal shoots.
- Rarely cause direct feeding damage, but green peach and black bean aphids can transmit viruses.

Flea beetles (Publication A3720E)

- Visually monitor every other day during the entire crop season.

Leafminers (Publication A3754E)

- Plants past the 8-leaf stage can withstand most damage and still produce a marketable crop.

Carrot

Diseases: Alternaria & Cercospora leaf blights (Publication A3807)

- Randomly examine 50 leaves from the field each week from crop emergence through harvest.
- Treat if 1-2% of the leaf samples exhibit leaf or petiole lesions.

Insects: Aphids (Publication A3757E)

- Visual observation. Pay attention to lower leaf surfaces and terminal shoots.
- Treat when 25% of plants are infested.

Aster leafhopper & Aster yellows (Publication A3679)

- Monitor migration through reports in DATCP's Cooperative Pest Survey Bulletin at <http://datcp.state.wi.us/arm/environment/insects/pest-bulletin/>
- Sweep net sample of 25 sweeps. Multiply by 4 to determine Aster yellows index. Aster yellows index is 100 for resistant varieties, 75 for intermediate varieties, and 50 for susceptible varieties. See the section on 'Aster yellow index' on page 26 to determine how to calculate how many leafhoppers will exceed this threshold.
- Place yellow sticky cards just above the crop canopy with 1 card per acre and check the cards for leafhopper every few days early in the season to monitor their possible migration to susceptible crops.

- Between transplant and cupping of cabbage, treat when > 30% of plants are affected.
- Treat cabbage plants that have begun to cup until early heading when > 20% of plants are infested.
- Treat when 10% of plants are infested from early heading until harvest.
- Treat broccoli and cauliflower transplants until first flower or curd when 50% of the plants are infested.
- Treat broccoli and cauliflower when 10% of the plants are infested, once flowers or curds begin to develop.

Flea beetles (Publication A3720E)

- Visually monitor every other day during the entire crop season.
- Overwintering adults migrating into newly transplanted fields in spring are the most damaging.

Onion thrips (Publication A3721E)

- Place yellow sticky traps on field edges to monitor migrating thrips.
- Note the presence of thrips and their numbers when scouting for caterpillar pests.
- Monitor more closely when nearby small grains are cut.

April			May			June			July			August			September		
early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late
Wireworm																	
			Striped and Spotted cucumber beetles														
			Seed maggot														
Aphid									Aphid								
									Mite								

Cucumber

Diseases: *Alternaria leaf blight*, *Angular leaf spot* (Publication A3801), *Anthracnose* (Publication A3279), *Powdery mildew* (Publication A3805)

Insects: *Cucumber beetles* (Publications A3751E and A3272)

- Visually examine entire planting in a W pattern 2-3 times per week as beetles will be localized initially.
- Striped cucumber beetles have a **black** abdomen. Western corn rootworm beetles (which resemble cucumber beetles) have a yellow-green abdomen and are not pests of cucurbits.
- Treat when > 4-5 adults/50 plants.
- > 20 beetles/plant will transmit bacterial wilt before insecticides can control the beetles.

Aphids (Publication A3757E)

- Visually examine entire planting in a W pattern as aphids will be localized initially.
- Check lower leaf surfaces and terminal shoots.
- Aphid populations will increase rapidly in hot weather, so check plants more frequently.
- Note whether aphid mummies are present, indicating parasitism.

Spider mites

- Visually examine field edges as this is where mites will appear first. Examine the crown leaves of 10 plants in 10 locations along the field edge for yellow or speckled leaves.
- Look at lower leaf surface near where the major veins join the petiole as mites tend to appear here first.
- Hot, dry weather will favor mite populations.

Eggplant

Insects: Colorado potato beetle (Publication A3678)

- Visually examine plants in spring for adults, eggs or larvae.
- Use degree day prediction from pages 3-4.
- Treat when ≥ 2 small or 1 large larvae or adult/plant when plants are < 6 inches tall.
- Treat when ≥ 4 small or 2 large larvae or adults/plant when plants are > 6 inches tall.

Flea beetles (Publication A3720E)

- Monitor every other day during the entire crop season.
- Overwintering adults migrating into newly transplanted fields in spring are the most damaging.
- Treat when 2 beetles/plant when plants < 3 inches tall.
- Treat when 4 beetles/plant when plants between 3-6 inches tall.
- Treat when ≥ 8 beetles/plant when plants are > 6 inches tall.

April			May			June			July			August			September			
early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	
			Flea beetle															
			Leafminer												Leafminer			
			Aster leafhopper															
				Aphid														
					Looper													

Leafy Greens

Diseases: Bottom rot, Drop, Damping off

Insects: Aphids (Publication A3757E)

- Monitor fields twice/week during the seedling stage then once/week.
- Visually examine 30 plants/field in a W pattern across the planting.
- Yellow sticky traps at the planting edge will alert you to migrating aphids.
- Watch weather for ecasts: hot weather will cause populations to explode while heavy rains will dislodge aphids from the plant.
- Treat seedling plants if ≥ 1 aphid/plant.
- Treat established plants if ≥ 10 aphids/plant.

Aster leafhopper (Publication A3679)

- Monitor migration through reports in DATCP's Cooperative Pest Survey Bulletin at <http://datcp.state.wi.us/arm/environment/insects/pest-bulletin/>
- Sweep net sample of 25 sweeps. Multiply by 4 to determine the Aster yellows index. Aster yellows index is 25. See the 'Aster yellow index' on page 26 to determine how to calculate how many leafhoppers will exceed this threshold.
- Place yellow sticky cards just above the crop canopy with 1 card per acre and check the cards for leafhopper every few days early in the season to monitor their possible migration to susceptible crops.

Black cutworm

- Monitor with a blacklight or pheromone trap.
 - A “significant” moth flight of ≥ 9 moths/pheromone trap in two consecutive nights is used as an indicator to start counting degree days.
 - Begin scouting for cutting at 300 DD₅₀ after the first significant moth catch (562-640 DD₅₀ total accumulated DD for the year).
- Look for seedling plants that have been cut off at the soil level. Use a trowel to look for cutworms in the soil nearby.
- Treat when $> 3\%$ of the planting has been affected.

Melon (*see calendar, page 14*)

Diseases: Alternaria leaf blight, Anthracnose (Publication A3279),
Powdery mildew (Publication A3805)

Insects: Cucumber beetles (Publication A3751E)

- Visually examine entire planting in a W pattern 2-3 times per week as beetles will be localized initially.
- Striped cucumber beetles have a **black** abdomen. Western corn rootworm beetles (which resemble cucumber beetles) have a yellow-green abdomen and are not pests of cucurbits.
- Treat when > 4-5 adults/50 plants.
- > 20 beetles/plant will transmit bacterial wilt before insecticides can control the beetles.
- Watermelon is not susceptible to bacterial wilt, so treatment is only necessary when plants are small and beetles numerous.

Aphids (Publication A3757E)

- Visually examine entire planting in a W pattern as aphids will be localized initially.
- Check lower leaf surfaces and growing points.
- Aphid populations will increase rapidly in hot weather, so check plants more frequently.
- Note whether aphid mummies are present, indicating parasitism.

Spider mites

- Visually examine field edges, as this is where mites will appear first. Examine the crown leaves of 10 plants in 10 locations along the field edge for yellow or speckled leaves.
- Look at lower leaf surface near where the major veins join the petiole as mites tend to appear here first.
- Hot, dry weather will favor mite populations.
- Most serious on watermelon.

Squash bug (Publication A3755E)

- Visually examine several plants in the field for eggs.
- Check the lower leaf surface for eggs. Eggs will hatch in 1-2 weeks.
- Must be controlled when nymphs are young and plants haven't yet begun to bloom.
- Large numbers of overwintering nymphs can cause severe crop damage to young plants.
- Treat if the average number of egg masses is >1 egg mass/plant before flowering.

April			May			June			July			August			September		
early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late
			Onion maggot						Onion maggot						Onion maggot		
						Onion thrip											

Onion

Diseases: **Botrytis leaf blight and neck rot** (Publication A3803), **Downy mildew**, **Fusarium basal rot** (Publication A3114), **Purple blotch** (Publication A3804), **Smut** (Publication A3796), **Soft rot** (Publication A3797)

Insects: **Onion maggot** (Publication A3722E)

- Use degree day prediction on pages 3-4 for adults.
- Yellow dishpan trap.

Onion thrips (Publication A3721E)

- Visually inspect by pulling apart the leaves and looking for thrips in the base of the plant.
- Treat when there are ≥ 7 thrips/plant.

April			May			June			July			August			September				
early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late		
			Aphid																
			Caterpillar contaminants																

Pea

Diseases: *Ascochyta blight*, *Bacterial blight*, *Fusarium*, *Powdery mildew*, *Pythium & Aphanomyces* (All in Publication A1167)

- The fall prior to planting peas, a soil sample should be collected and submitted for testing to determine the level of aphanomyces and pythium inoculum present. This is particularly important if you've had wilting problems in the past.
- Disease indices between 0-50 are safe for planting, 51-69 are questionable, and 70-100 shouldn't be planted.

Aphids (Publication A3757E)

- Sweep net sampling.
- Treat when one aphid/pod or 10/sweep if peas are more than 10 days from harvest.

Pepper

Diseases: *Bacterial spot* (Publication A2604), *Phytophthora blight*

Insects: *European corn borer* (Publication A1120)

- Blacklight trap to monitor life stages and populations
- Treat when 4 moths caught/night when pepper fruit is developing
- Examine individual plants when fruit begins to form.

Green peach aphid

- Monitor throughout crop season.
- Visually inspect 5 plants at each of 5 sites per planting. Pay attention to the lower leaf surface and the terminal shoots.

April			May			June			July			August			September		
early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late
			Colorado potato beetle, 1st gen.			both generations			2nd generation only								
			Potato leafhopper														
						Potato aphid											
						Tarnished plant bug											
			Aster leafhopper														
									Green peach aphid								

Potato

Diseases: Early & late blights, White mold

Insects: Colorado potato beetle (Publication A3678)

- Begin scouting for eggs when the first plants emerge.
- Visually examine plants in spring for adults, eggs or larvae.
- Use degree day prediction from pages 3-4.
- Treat pre-flowering 6-8 inch plants if > 30% defoliated.
- Treat flowering plants when 5-10% defoliated.
- Treat tuber-forming plants when 30% defoliated.

Aphids (Publication A3757E)

- Visually examine entire planting in a W pattern as aphids will be localized initially.
- Check lower leaf surfaces and growing points.
- Aphid populations will increase rapidly in hot weather, so check plants more frequently.
- Note whether aphid mummies are present, indicating parasitism.
- Treat when 3 aphids/10 leaves.

Flea beetles (Publication A3720E)

- Monitor every other day during the entire crop season.
- Overwintering adults migrating into newly planted fields in spring are the most damaging.

Potato leafhopper (Publication A3723E)

- Monitor when nearby alfalfa is cut as leafhoppers will migrate to potatoes.
- Use visual examination and a sweep net to monitor populations.
- Treat when more than 1/2 leafhopper/sweep or 2 1/2 nymphs/25 plants.

April			May			June			July			August			September		
early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late
									Striped and Spotted cucumber beetles								
									Aphid								
									Squash bug								
								Squash vine borer									
								Mite									

Pumpkin

Diseases: **Alternaria leaf blight**, **Angular leaf spot** (Publication A3801), **Anthracnose** (Publication A3279), **Phytophthora**, **Powdery mildew** (Publication A3805)

Insects: **Cucumber beetles** (Publication A3751E)

- Visually examine entire planting in a W pattern 2-3 times/week as beetles will be localized initially.
- Striped cucumber beetles have a **black** abdomen. Western corn rootworm beetles (which resemble cucumber beetles) have a yellow-green abdomen and are not pests of cucurbits.
- Treat when > 4-5 adults/50 plants.
- > 20 beetles/plant will transmit bacterial wilt before insecticides can control the beetles.

Aphids (Publication A3757E)

- Visually examine entire planting in a W pattern as aphids will be localized initially.
- Check lower leaf surfaces and growing points.
- Aphid populations will increase rapidly in hot weather, so check plants more frequently.
- Note whether aphid mummies are present, indicating parasitism.

Spider mites

- Visually examine field edges as this is where mites will appear first. Examine the crown leaves of 10 plants in 10 locations along the field edge for yellow or speckled leaves.
- Look at lower leaf surface near where the major veins join the petiole as mites tend to appear here first.
- Hot, dry weather will favor mite populations.

Pumpkin, continued

Squash bug (Publication A3755E)

- Visually examine several plants in the field for eggs.
- Check the lower leaf surface for eggs. Eggs will hatch in 1-2 weeks.
- Must be controlled when nymphs are young and plants haven't yet begun to bloom.
- Large numbers of overwintering nymphs can cause severe crop damage to young plants.
- Treat if the average number of egg masses is >1 egg mass/plant before flowering

Squash vine borer (Publication A3756E)

- Use degree day prediction from pages 3-4.
- Once 1000DD₅₀ have accumulated, check the base of the stem on several plants for signs of frass indicating larval feeding
- There are currently no treatment thresholds.

Squash (*see calendar, page 21*)

Diseases: Alternaria leaf blight, Angular leaf spot (Publication A3801), **Anthracnose** (Publication A3279), **Phytophthora, Powdery mildew** (Publication A3805)

Insects: Cucumber beetles (Publication A3751E)

- Visually examine entire planting in a W pattern 2-3 times per week as beetles will be localized initially.
- Striped cucumber beetles have a **black** abdomen. Western corn rootworm beetles (which resemble cucumber beetles) have a yellow-green abdomen and are not pests of cucurbits.
- Treat when > 4-5 adults/ 50 plants.
- > 20 beetles/plant will transmit bacterial wilt before insecticides can control the beetles.
- Hubbard and butternut squash are susceptible to bacterial wilt, so beetles must be monitored closely.
- Second generation beetles can cause serious injury to squash if plants are not yet touching within the row. Threshold at this stage is >5 beetles/plant.

Aphids (Publication A3757E)

- Visually examine entire planting in a W pattern as aphids will be localized initially.
- Check lower leaf surfaces and growing points.
- Aphid populations will increase rapidly in hot weather, so check plants more frequently.
- Note whether aphid mummies are present, indicating parasitism.

Spider mites

- Visually examine field edges as this is where mites will appear first. Examine the crown leaves of 10 plants in 10 locations along the field edge for yellow or speckled leaves.
- Look at lower leaf surface near where the major veins join the petiole as mites tend to appear here first.
- Hot, dry weather will favor mite populations.

Squash bug (Publication A3755E)

- Visually examine several plants in the field for eggs.
- Check the lower leaf surface for eggs. Eggs will hatch in 1-2 weeks.
- Must be controlled when nymphs are young and plants haven't yet begun to bloom.
- Large numbers of overwintering nymphs can cause severe crop damage to young plants.
- Treat if the average number of egg masses is >1 egg mass per plant before flowering.

Squash vine borer (Publication A3756)

- Use degree day prediction from pages 3-4.
- Winter squash is most susceptible to damage.
- Once $1000DD_{50}$ have accumulated, check the base of the stem on several plants for signs of frass indicating larval feeding.
- There are currently no treatment thresholds.

April			May			June			July			August			September		
early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late
Armyworm																	
Cutworm																	
Flea beetle																	
			European corn borer, 1st gen.						European corn borer, 2nd gen.								
			Corn leaf aphid														
			Stalk borer larvae														
			Hop vine borer larvae														
			Corn rootworm, larvae						adults			← egg laying begins					
						Corn earworm											
									Fall armyworm								

Sweet Corn

Diseases: Rust (Publication A3800)

Insects: Corn leaf aphid

- Visual observation. Examine the tassels.
- Treat if <50% of the crop has pollinated and >50% of the plants are infested with >50 aphids/plant.

Corn earworm (Publication A3655)

- Pheromone trap
- See 'Monitoring European corn borers & Corn earworm' section on page 27.

Cutworm

- Monitor with a blacklight or pheromone trap.
 - A “significant” moth flight of ≥ 9 moths/pheromone trap in two consecutive nights is used as an indicator to start counting degree days.
 - Begin scouting for cutting at 300 DD₅₀ after the first significant moth catch (562-640 DD₅₀ total accumulated DD for the year).
- Look for seedling plants that have been cut off at the soil level. Use a trowel to look for cutworms in the soil nearby.
- Treat when > 35% of the plants are damaged.

European corn borer (Publication A1120)

- Use a blacklight trap to monitor life stages and population.
- 1st generation moth flights peak at 631 DD₅₀, 2nd generation moth flights peak at 1733 DD₅₀

- See 'Monitoring European corn borers & Corn earworm' section on p. 27.

Corn rootworm beetles (Publication A3328)

- Monitor adults in current season to determine larval pressure the following season.
- Visually examine silks for beetles.
- Adults can clip silk off pollinating plant. Treat if >5 beetles/plant and corn is <75% silked and silks are pruned to <1/2 from husk.

TOMATO SCOUTING CALENDAR FOR INSECT PESTS																	
April			May			June			July			August			September		
early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late	early	mid	late
			Black cutworm														
			Flea beetle														
									Variegated cutworm								
									Tomato hornworm (European corn borer)								
									Tomato fruitworm								

Tomato

Diseases: Bacterial spot (Publication A2604), **Early blight & Septoria leaf spots** (Publication A2606), **Fusarium & Verticillium wilts** (Publication A2617)

Aphids (Publication A3757E)

- Visually monitor 10 plants in 10 sites in the field for aphids.
- Yellow sticky traps at the edge of the planting will alert you to migrating aphids.
- Watch weather forecasts: hot weather will cause populations to explode, while heavy rains will dislodge aphids from the plant.

Hornworms & fruitworm (Publication A3752E)

- Tomato fruitworms are the same insect as corn earworm and hence are monitored with a Hartstack pheromone trap and Hercon brand lure.
- Begin checking traps daily in early July.
- Treatment threshold is ≥ 7 moths in the trap per week.
- Visually monitor fruit by examining 10 plants in each of 10 sites in the field for damage. Treat if any fruit damage is found.

AsterYellows Index

Each spring, entomologists from the University of Wisconsin travel to the Gulf States to monitor the migratory aster leafhopper population. They determine the potential severity of aster yellows on susceptible crops (carrots, celery and lettuce) for the upcoming season. Aster yellows severity depends on the

- susceptibility of the crop,
- number of leafhoppers, and
- percentage of leafhoppers carrying the disease.

As the aster leafhoppers are carried northward on storm fronts, the entomologists follow them to monitor whether they are taking an easterly (Wisconsin, Michigan, Illinois), central (Minnesota, Iowa), or western (Dakotas, Nebraska, Kansas) path. Along the way, leafhoppers are collected by the entomologists and taken back to the University so they can feed on aster plants to determine what percentage of the population sample is carrying the disease. This, along with the Aster yellows index for each susceptible crop, is then used to determine how many leafhoppers vegetable growers can tolerate before having to implement controls.

The Aster yellows index depends on the number of insects caught in 100 sweeps and the percentage of insects carrying the disease. The index is calculated with the following formula:

$$\text{Aster yellows index} = \% \text{ infectivity in leafhoppers} \times \left(\frac{\text{number of leafhoppers}}{100 \text{ sweeps}} \right)$$

Crop Aster yellows index	
Carrot – resistant	100
Carrot – intermediate	75
Carrot – susceptible	50
Celery	35
Lettuce	25

If, for example, you are growing lettuce and the percentage of insects carrying the disease is 2.5%, the table indicates that your Aster yellows index is 25. Therefore, if you are collecting 10 or more aster leafhoppers/100 sweeps you will need to treat your lettuce crop to prevent infection. To learn the current Aster yellows index, visit the DATCP website in May when it is reported at

<http://datcp.state.wi.us/arm/environment/insects/pest-bulletin/>

Monitoring European Corn Borers and Corn Earworm

Corn earworms, which do not overwinter in Wisconsin, are easily monitored with the use of pheromone traps. Wire Hartstack traps and nylon-mesh Scentry traps may be used to monitor adult migrations. Traps should be placed 4-6 feet from the ground on the south or west side of a field in which the corn is in the green silk stage. Ideally, every silking sweet corn field should have its own trap. Traps should be in place by July 1 in Wisconsin to catch any early migrations that may occur. Traps should be moved to new fields entering the silking stage as the silk in the current field becomes brown. Pheromone lures should be changed every 2 weeks with the unused lures kept frozen until they are needed. Used lures should be removed from the trap area to prevent confusion of adult moths by more than one source of the pheromone. Traps should be checked daily once migration has begun. When ≥ 5 moths have been trapped each night for 3 consecutive nights in the Hartstack trap or ≥ 2 moths/night have been captured in the Scentry trap, treatment should be initiated in sweet corn. Scentry traps typically attract fewer moths than the wire Hartstack traps. A local supplier of the Scentry trap and a scaled-down version of the Hartstack trap is Gemplers. To request a catalog call 800-382-8473 or visit their website at <http://www.gemplers.com> To purchase or build a full-size version of the Hartstack trap, contact Karen Delahaut at 608-262-6429 or kadelaha@wisc.edu

European corn borer adults are monitored with blacklight traps. Unlike the pheromone traps used to monitor the corn earworm, blacklight traps do not need to be located on every farm. It is the developmental progression of this insect that is important and fields located within the same climatic regions may share a trap. Several newsletters provide information on blacklight trap catches on a weekly basis. However, growers of large acreages of sweet corn may be interested in investing in their own blacklight trap to identify what populations are on their farm on a daily basis. Similarly, groups of smaller growers in a localized area may wish to form a network and purchase a blacklight trap so they can monitor European corn borers more frequently. Degree day accumulations can also be used to predict when corn borers will become a problem in a given area. Degree day information is available at <http://www.soils.wisc.edu/wimnext/corn/corn.html>

Optimum Treatment Time

The critical period for the management of ear contaminants in fresh market sweet corn is when plants are silking. Insecticides need not be applied to non-silking fields. It is important to begin treatment when a sustained flight of moths is first detected. A sustained flight is when several moths are caught on consecutive nights. Delays in treatment may result in a 10-15% reduction in clean ears for every day delayed. When applying an insecticide, it is important to get the material onto the corn plants near the ear. Spray equipment with nozzles directed over the top as well as toward the ear assure proper placement and good coverage of the target area. The objective is to get the insecticide onto the silks so developing larvae will ingest the material as they feed.

This is particularly important for organic sweet corn growers as Bt **must** be ingested to be effective. Once the larvae enter the ear, they are protected by the plant and treatments will be ineffective. Aerial applications of insecticides are less effective than ground applications. Mist blowers have been proven ineffective in controlling corn borer and corn earworm larvae as they don't provide thorough coverage to the target area.

Spray Schedule for Nightly Trap Catches When Temperatures are Less Than 85°F

Corn Earworm Moths					
Corn Borers	< 2/night	2-5/night	5-10/night	10-50/night	>50/night
< 5/night	Do nothing	Do nothing	Do nothing	4 day interval	3 day interval
5-10/night	6 day interval	6 day interval	5 day interval	4 day interval	3 day interval
10-20/night	5 day interval	5 day interval	5 day interval	4 day interval	3 day interval
>20/night	4 day interval	4 day interval	4 day interval	4 day interval	3 day interval

Spray Schedule for Nightly Trap Catches When Temperatures are Greater Than 85°F

Corn Earworm Moths					
Corn Borers	<2/night	2-5/night	5-10/night	10-50/night	>50/night
<5/night	Do nothing	Do nothing	Do nothing	3 day interval	2 day interval
5-10/night	5 day interval	5 day interval	5 day interval	3 day interval	2 day interval
10-20/night	5 day interval	5 day interval	5 day interval	3 day interval	2 day interval
>20/night	4 day interval	4 day interval	4 day interval	3 day interval	2 day interval

Reference: Flood, B., R. Foster, and B. Hutchinson. 1995. Sweet Corn: Chapter 2 in *Vegetable Insect Management with Emphasis on the Midwest*. R. Foster & B. Flood eds.

For more information on IPM for vegetable crops, refer to the publication *Integrated Pest Management: An Overview for Market Growers*. For integrated weed management options, refer to *Integrated Weed Management for Fresh Market Production*. Both are available from the Center for Integrated Agricultural Systems at <http://www.cias.wisc.edu>

