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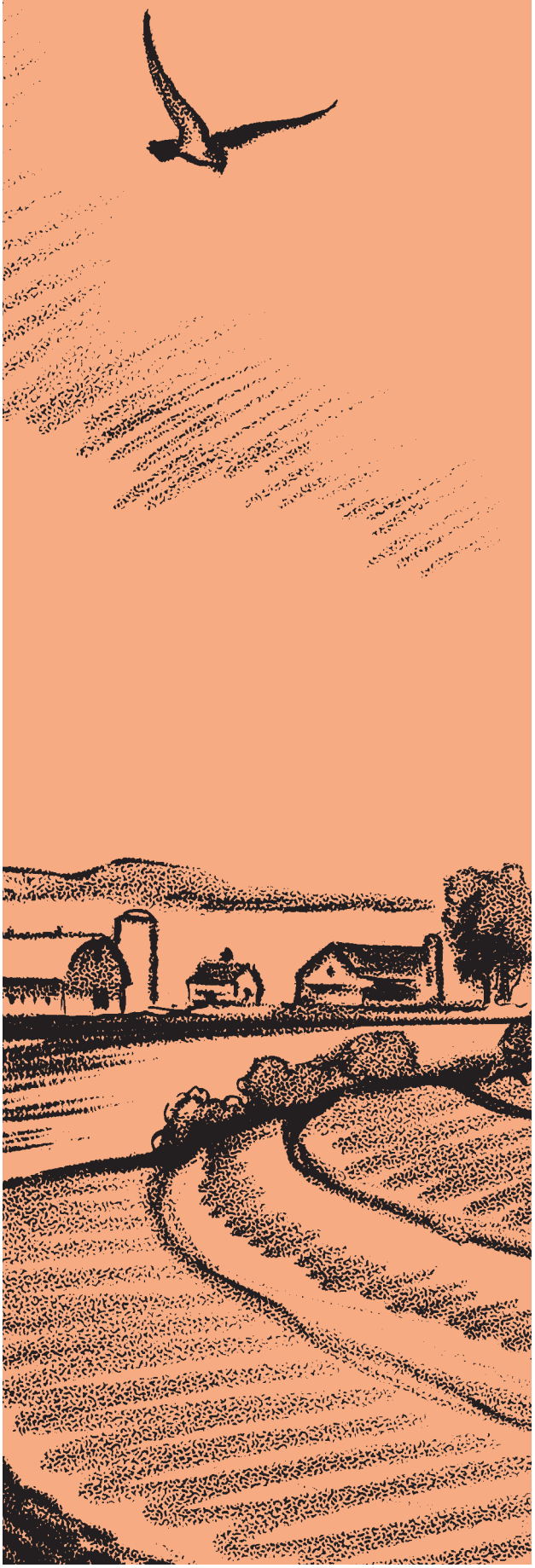

Growing pumpkins and other vine crops in Wisconsin

A guide for fresh-market growers

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Contents

Successful fresh-market gardening involves more than just a talent for growing high-quality vegetables. You also need to find a market for them. Before you start, visit other growers, develop a marketing plan, and evaluate the feasibility of your proposed business. Think about what is unique about your product. Are you promoting the product for taste, freshness, health benefits, value-added, or time of availability? For assistance determining your market, consult with your county Extension agent or refer to Extension publication *Direct Marketing of Farm Produce and Home Goods* (A3602).

Pumpkins and squash are the most common vine crops for market gardeners. Melons are temperamental and require optimum growing conditions to be deliciously sweet. However, once you are able to grow delectable melons, your market is almost guaranteed. A pumpkin crop can bring customers to your farm, particularly if you include other marketing strategies such as hay rides, apple cider, or a haunted house. If you grow cucumbers, be sure your crop is of excellent quality since many home gardeners grow their own. Growing vine crops is an excellent way to bring a weed-infested field into production. Their sprawling habit and dense plant canopy will suppress weed seed germination for much of the season.

Plant description

Cucumbers, melons, pumpkins, and squash are all members of the Cucurbit family. Cucurbits originated in both the Old and New Worlds. Cucumbers (*Cucumis sativus*) are native to India while muskmelon (*Cucumis melo*) and watermelon (*Citrullus lanatus*) originated in Africa. Pumpkins (*Cucurbita pepo)*, summer squash (also *C. pepo*), winter squash (*Cucurbita maxima* and *C. moschata*), and some gourds all belong to the genus *Cucurbita* which originated in the New World.

Cucurbits are warm-season, herbaceous annuals. The growth habit of individual plants may either be determinate (shoot tip ends in a flower) with a bushy growth habit or indeterminate (shoot tips grow continuously with flowers in leaf axils) with a prostrate and spreading growth habit (figure 1). Leaves are borne singly and may be simple or lobed. Tendrils are found in the leaf axils on all species except some species in the genus *Cucurbita.* All plants in the Cucurbit family have extensive, shallow root systems. Cucurbit flowers vary considerably in color, size and shape, and may be perfect (have both male **and** female flower parts) or imperfect (have either male **or** female flower parts). Individual plants may bear a combination of flower types. Only female flowers and perfect flowers will set fruit. Terminology describing flowering characteristics of vine crops can be quite complex, so some of the terms used throughout this publication are defined in table 1.

Table 1. Flower morphology and terminology

Term	Definition
Perfect	A flower that contains both male parts (stamen) and female parts (pistil).
Imperfect	A flower that lacks either stamen or pistils.
Staminate (male) flower	Individual, imperfect flower with only male parts. A single plant may bear both staminate and pistillate flowers.
Pistillate (female) flower	Individual, imperfect flower with only female parts. A single plant may bear both pistillate and staminate flowers.
Monoecious	A plant that bears two different types of flowers: staminate (male) and pistillate (female).
Dioecious	A condition where staminate (male) and pistillate (female) flowers are borne on separate plants.
Gynoecious	A dioecious plant that bears only pistillate (female) flowers.
Pollination	Pollen transferred from male flower parts to female flower parts.
Fertilization	Pollen unites with ovules to form fruit.
Self pollinated*	Plant can produce fruit with own pollen or pollen from another plant of the same cultivar and species.
Cross pollinated*	Plant can produce fruit with pollen from another plant of the same species but different cultivar or variety.

*Terms defined by common usage. Botanically, pollination refers only to pollen transfer and the terms “self fertile” and “cross fertile” are used for subsequent fruit production.

Figure 1. Determinate plants (left) form flowers at the ends of branches while indeterminate plants (right) produce flowers in leaf axils.

Genetics, day length, and temperature are the key factors that determine which type of flowers are produced on monoecious cucurbit plants. Early in the season, as day length increases, the first flowers produced are male. Once the days begin to shorten after the summer solstice, female flowers begin to appear. Female flowers are typically produced through July, and then male flowers predominate once again.

Gynoecious plants produce only female flowers throughout the entire season. However, under moisture stress, cool temperatures, or crowded conditions, gynoecious plants will begin to produce male flowers, and will continue to produce only male flowers even when conditions improve. If you grow gynoecious cultivars, be sure to plant separate plants with male flowers to pollinate the female plants, and provide more bees for pollination. It's easy to tell which flowers are male and which flowers are female (figure 2). Male flowers have a relatively long peduncle or flower stalk. Female flowers have a shorter peduncle which ends in a small, round or elongated ovary at the base of the flower. As the female flower develops, the ovary begins to resemble the mature fruit.

Honeybees are the main pollinators of all vine crops and one to three active bee colonies will pollinate an acre. Poor fruit set or misshapen fruit may be an indication of poor pollination or weather stress such as wind, rain, or cold which reduced bee activity during the time pollination should have occurred.

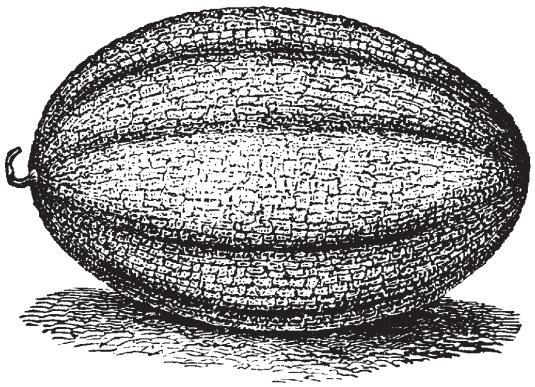
Some vine crops are self pollinated and others cross pollinate. Cross pollination never affects the flavor, size, shape or color of the fruit, but it does affect the genetic characteristics of seed borne in that fruit. If you save seeds from cross pollinated plants and plant them, the new fruit might have any combination of new characteristics.

Cucumbers

Cucumbers (*Cucumis sativus*) produce trailing vines which spread in all directions. Leaves and stems are covered with numerous spines. Cucumber leaves are triangular with rounded lobes, the middle lobe being longer than those on either side. Small yellow flowers approximately 1 inch in diameter are borne in leaf axils. Wasp-shaped cucumbers in which the middle section of the fruit is narrower than the ends occurs from late pollination or low soil potassium levels.

Cucumbers are self pollinated and will not cross pollinate. Originally all cucumber cultivars were monoecious. Today, gynoecious hybrids are available which

Figure 2. Female flowers have a short stalk and an enlarged ovary, male flowers have a long stalk



produce mostly female flowers and subsequently set more fruit. Seed dealers usually supply 10–15% male pollinator seeds in gynoecious cucumber seed packets to ensure fertilization of female plants.

The cucumber plant produces cucurbitacin, a chemical which causes bitterness and makes cucumbers difficult for some people to digest. When cucumbers are allowed to fully mature, cucurbitacin becomes concentrated in the skin and may be removed by simply peeling the cucumber before use. "Burpless" cultivars have genetically lower levels of cucurbitacin.

Muskmelons and watermelons

Melon (*Cucumis melo*) leaves are oval to kidney shaped with five to seven shallow lobes. Plants produce trailing vines and yellow flowers similar to cucumbers, but flowers may be male (staminate), female (pistillate), or perfect. Melons can cross pollinate only with other melons of the same species. There are three botanical varieties within the species and cross pollination can occur among these: *C. melo* var. *cantaloupensis*—the true cantaloupe (not grown in the United States), *C. melo* var. *reticulous*—the netted muskmelon, and *C. melo* var. *inodorus*—the late-ripening winter melons including honeydew, crenshaw, casaba, and Persian. Melons slip off the vine when ripe.

Watermelon (*Citrullus lanatus*) leaves are heart-shaped with three to seven lobes per leaf and are produced on trailing vines. Plants are monoecious with yellow flowers that are approximately 1¾ inches in diameter. Small "icebox" watermelons weigh 7–10 pounds and are produced early. They are well suited for local sale and home gardens, especially in northern climates.

Although watermelons are self or cross pollinated by insects, some female flowers will set fruit without pollination. If the pollen is incompatible with the ovules, then no fertilization will occur and seeds won't develop. Normally watermelons have two sets of chromosomes (they are diploid). Some watermelons have four sets of chromosomes (tetraploid). Normal diploid pollen is incompatible with tetraploid ovules, so seedless triploid (three sets of chromosomes) watermelons result from the cross. Seeds to produce seedless watermelons are expensive and are usually started indoors as transplants. Seedless watermelon plants are weaker than seeded.

Pumpkins, squash, and gourds

Pumpkin, squash, and gourd cultivars may be vining or bush-like. Leaves have three lobes and may be deeply indented between the lobes (*C. pepo*) or may appear entire (*C. maxima*). The plants are monoecious and bear both male and female yellow flowers.

The individual species within the genus *Cucurbita* are characterized by the fruit size, shape, flavor, color, and by the shape of the fruit stem (table 2). Gourds grown for decoration are usually *Cucurbita pepo* (small) or *C. maxima* (large). Dipper, bottle, or birdhouse gourds are cultivars of *Lagenaria siceraria*. Pumpkins, squash, and gourds can cross pollinate only with other cultivars of the same species, for example acorn squash can cross pollinate with delicata, but not with butternut.

Table 2. *Cucurbita* species

Species	Types
Cucurbita pepo	acorn, delicata, Jack-o-lantern and pie pumpkins, patty pan, small gourds, spaghetti squash, summer squash, zucchini
Cucurbita maxima	banana, buttercup, Hubbard, kabocha, large gourds, turban, very large pumpkins
Cucurbita moschata	butternut

Site selection

Vine crops require full sun, heat, and a long growing season. Choose well-drained soils that warm quickly. Poorly drained soils tend to stay cool longer in the spring and contain less soil oxygen which increases the incidence of root rot diseases. Light, sandy soils with high amounts of organic matter are best for cucurbits. Be sure irrigation is available on well-drained soils. Late-season melon crops perform well on heavier soils because these soils retain moisture. Mineral soils are recommended over organic soils since vine crops grown on peat or muck soils tend to produce fruit with low sugar content and soft flesh. The ideal soil pH for vine crops is 6.0–6.8.

Cultivar selection

Cucumbers

Choose cultivars resistant to two or more diseases. Cucumber cultivars may be classified as pickling, slicing, greenhouse, or gherkin. Slicing cultivars are long and tapered with smooth, glossy green skin and a few white spines. Some slicers are burpless types.

Pickling cucumbers tend to be blunt, angular, warty, and light green with black or white spines.

Greenhouse cultivars are seedless slicing types which do not require insect pollination. They have

Table 3. Recommended cultivars

Cucumbers	Melons	Pumpkins	Squash
Slicing	**Muskmelon**	**Miniature**	**Summer squash**
Armenian	Classic	Baby Bear	Early Prolific Straightneck
Dasher II	Delicious 51	Baby Boo	Peter Pan
Fanfare	Earliqueen	Jack-Be-Little	Scallopini
Marketmore 76	Earlisweet	Munchkin	Seneca Butterbar
Marketmore 86	Gold Star	Spooktacular	Sunburst
Orient (burpless)	Harper	**Small**	Sundance
Raider	Iroquois	Baby Pam	Tromboncino
Salad Bush	Saticoy	New England Pie	**Zucchini**
Suyo Long (burpless)	Supermarket	**Medium**	Chiefini
Tasty Green (burpless)	Sweet 'n Early	Autumn Gold	Clarimore
Pickling	**Honeydew**	Casper	Gold Rush
Arkansas Little Leaf H-19	Orange Blossom	Cinderella (Rouge Vif d'Etampes)	Greyzini
Calypso	Tangiers	Ghostrider	Spineless Beauty
County Fair	**Watermelon**	Lumina	**Winter squash**
Liberty	Golden Crown	Small Sugar	Burgess Buttercup
Regal	Honey Heart (seedless)	Spirit	Butternut Ultra
Greenhouse	Jack-of-Hearts (seedless)	Trick or Treat	Carnival
Aria	King-of-Hearts (seedless)	**Large**	Cream of the Crop
	Paradise	Atlantic Giant	Delicata
	Royal Jubilee	Connecticut Field	Emerald Bush Buttercup
	Sugar Baby	Howden	Kabocha types
	Sweet Favorite	Prizewinner	Moorgold
	Yellow Baby		Pasta (Spaghetti)
	Yellow Doll		Red Kuri Buttercup
			Sugar Loaf
			Sweet Dumpling
			Sweet Mama
			Table Ace
			Table Gold
			Table King
			Waltham Butternut

Note: Choose cultivars according to your own situation and needs. Consider what your market demands, the length of your growing season, your soil, pests, diseases, irrigation, cultivars other growers like, and cultivars you personally like. When trying a new cultivar, do not use it exclusively. Grow new trials next to old standbys so you may compare the characteristics objectively.

thin, dark green skin and milder flavor than field-grown slicing cucumbers.

Gherkins are *Cucumis anguria*, a different species from common cucumber. They are small, oval, prickly, and primarily pickled.

Melons

Melons were initially bred to resist powdery mildew fungus, but today melons are bred for multiple disease resistance. A wide range of flavors and sizes is available.

Recent breeding efforts in watermelon have focused on disease resistance, yield, earliness, and smaller, more manageable sized fruit. Flesh color ranges from pink to red to yellow.

Pumpkins and squash

Cultivar variation in pumpkins is based on shape and size of the fruit, color, and, for pie pumpkins, flesh quality.

Squash cultivars can be divided into summer squash which have thin skin and mature midseason, and winter squash which mature late in the season, store well, and have a thick rind. Both summer squash and winter squash come in a wide variety of flavors, shapes, colors, and sizes.

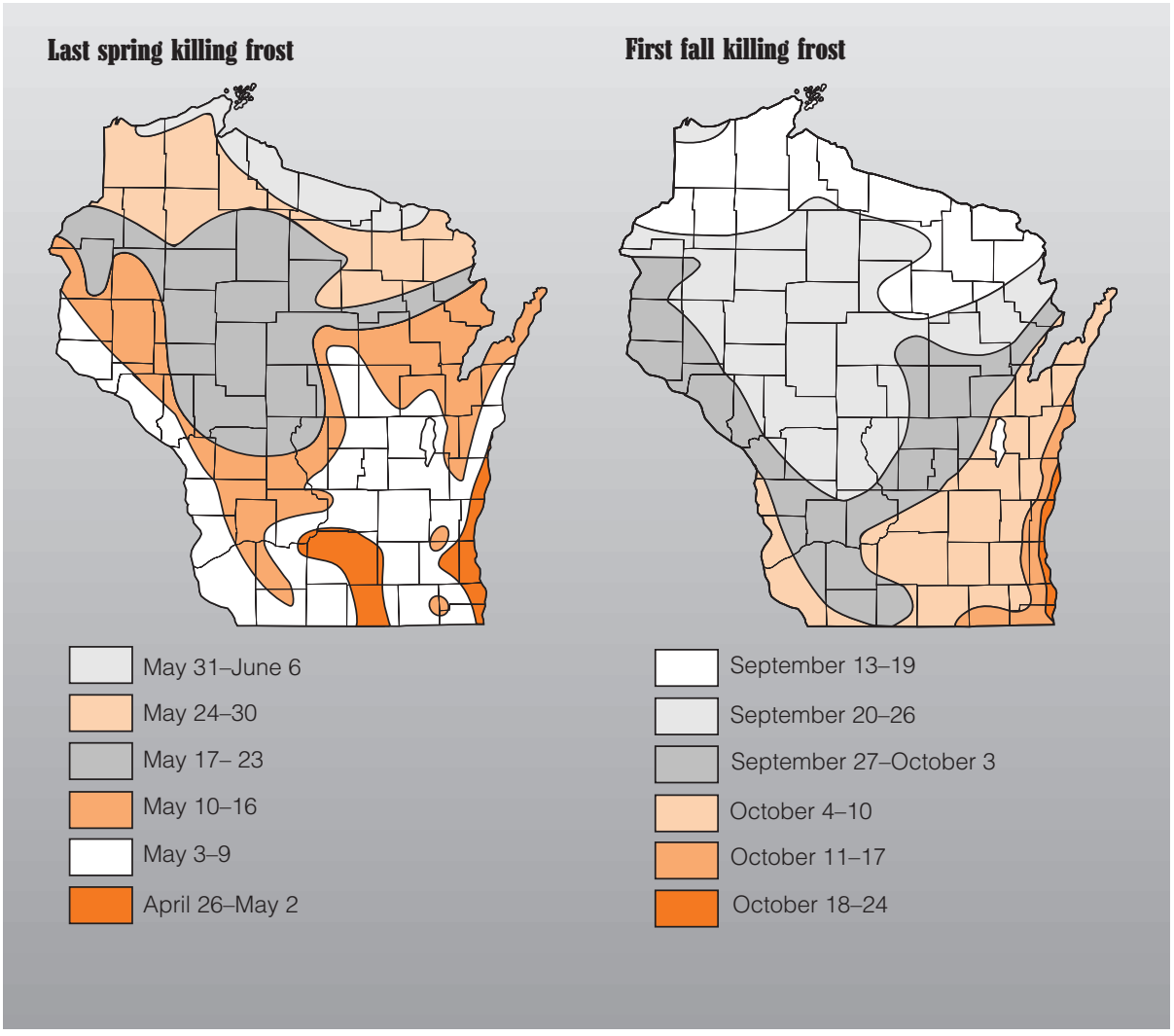
Planting, transplanting, and culture

Starting seeds and transplanting

Vine crops cannot tolerate root disturbances and do not transplant well. In areas which have a growing season that is too short to produce a crop, you can start seeds in a greenhouse and try to produce a crop from transplants. Start cucumbers 4–5 weeks before the last spring killing frost date (see figure 3); start muskmelons, watermelons, pumpkins, and squash 3–4 weeks before.

You can buy or mix your own sterile potting mix for starting transplants. The mix should include peat, sphagnum, or compost to retain moisture; vermiculite or perlite for aeration; and mineral and nutrient sources to encourage growth after the first roots form. Fill plastic or polystyrene cell trays with media, or make individual blocks with a soil blocker. Vine crops can be sown in individual pots or individual cells in trays, but they do not tolerate transplanting from undivided flats. Cells that are 2 inches in diameter work well. Prevent bacterial and fungal infections by sterilizing transplant trays in a 10% bleach solution before you plant. Sow cucumber and melon seeds ½ inch deep and pumpkin and squash seeds ½–1 inch deep. Label transplant trays with cultivar and planting date. Keep media moist but not wet. Germination will occur within 10 days. Maintain soil temperature at 70°F with a heating mat or cable. Keep daytime temperatures in the greenhouse at 70°–75°F and 60°–62°F at night. Melons grow best at slightly higher temperatures.

Figure 3. Approximate dates for first and last killing frosts



Thin seedlings to one to two plants per cell or plug using scissors to clip out the unwanted plants so roots are not disturbed. Four to seven days before transplanting into the field move plants into a cold frame where lower temperatures will harden them off. Harden off plants by reducing water, fertilizer, and temperatures to acclimate them to field conditions. Vine crops cannot tolerate cool temperatures, so be sure to bring them inside the greenhouse if the temperature threatens to dip below 40°–45°F.

Transplants can be planted to the field after all danger of frost and when the soil temperature is at least 60°F. Do not bury vine crop stems deeper than the transplant soil line. Transplants can be planted with a tractor-pulled mechanical transplanter or by hand. Handle plants gently at transplanting so you don't disturb roots.

Refer to table 4 for the estimated amount of seed required, seed planting depth, yield, planting date, spacing, and days to first harvest. Give vine crops enough space to sprawl so each plant receives adequate amounts of water, nutrients, and light without competition. Spacing is especially important for indeterminate cultivars. If growing Atlantic Giant or Prizewinner pumpkins, allow more space between plants and between rows to allow for their large size. Some of the bush-type squash and icebox watermelon can be grown closer together with only 36 inches between plants. Small-scale market gardeners often use a walk-behind plate seeder.

Soil preparation

Control weeds prior to planting the bed. Work beds 7–8 inches deep to promote deep rooting. Raised beds or hills are an alternative to the conventional field planting method. This planting system improves soil drainage and allows access to the crop without causing soil compaction. Raised beds are typically 4–5 feet wide and 100 feet long. The width is determined by the type of equipment used and by the crop. Leave a 1-foot aisle on either side of each bed to accommodate foot traffic.

Cucumber culture

Cucumbers are a warm-season crop and grow best at temperatures between 60°F and 75°F. Temperatures above 90°F or below 60°F will slow growth and may cause bitter flavor. Soil temperatures should be at least 60°F at planting. In southern Wisconsin, cucumbers should not be planted before May 27. In northern Wisconsin, delay planting an additional 1–2 weeks depending on location. Cucumbers don't transplant well because broken roots seal themselves off (suberize) rapidly, which reduces the uptake of water and nutrients. Cucumbers can be trellised on strong wire mesh to save space. In the field, a yield of 300–400 bushels/acre can be expected with gynoecious cultivars yielding more than monoecious cultivars.

Table 4. Planting guide

Vegetable	Planting time in southern WI[a]		Plants or seeds needed for 100 ft of row	Seed depth (inches)	Spacing (inches)[b]		Days to first harvest[c]	Estimated yield (lb/ft of row)[d]
	Indoors	Outdoors			Between rows	Between plants		
Cucumber		May 27 (seeds)	⅓ oz	1–1½	36–72	8–12	45–55	1–1¼
Muskmelon	May 1	May 20 (plants)	34–50 plants	½–1	60–84	8–12	90–125	2
Pumpkin	May 1	May 20 (plants)	34–50 plants	1–1½	48–72	24–60	90–120	2
		May 10 (seeds)	½ oz	1–1½	48–72	24–60	90–120	2
Squash, summer		May 20	½ oz	1–1½	48–60	24–48	50–60	2
Squash, winter	May 1	May 20 (plants)	34–50 plants	1–1½	72–96	36–96	90–120	2
Watermelon	May 1	May 20 (plants)	½ oz	½–1	60–96	36–96	75–125	2

[a]Plant about 1 week later along the lower lake shore and in the central part of state and about 2 weeks later in northern counties.

[b]If using a plate-type seeder, spacing between plants will be determined by plate configuration.

[c]Cultivars vary greatly in time needed to reach harvest stage; extend the harvest season by planting cultivars of different maturity dates or by making successive plantings of the same cultivar.

[d]Estimated yields under less than ideal growing conditions; actual yields will vary widely with weather, soil fertility and cultural practices.

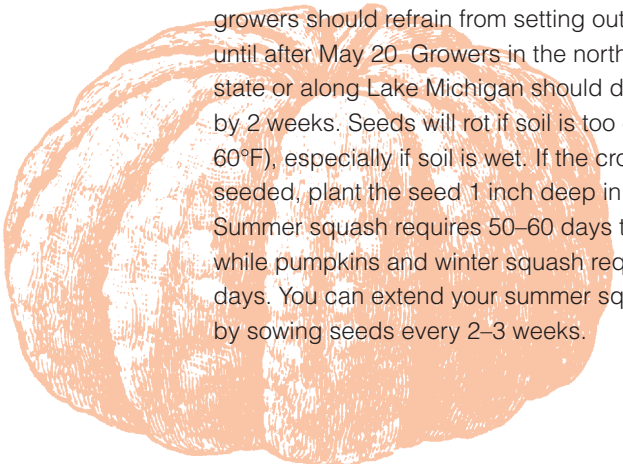
Greenhouse cucumbers. Cucumbers can be grown on trellises in a greenhouse to extend the short Wisconsin growing season. Typically, early spring and fall crops are produced in a plastic hoop house, avoiding the dark months of December, January, and February. Read about the details of greenhouse cucumber production in *Commercial Greenhouse Production: Cucumbers,* from Kansas State Extension. This publication covers costs, returns, construction, heating, ventilation, cucumber varieties, growth, training, watering, fertilizer needs, pests, and diseases.

Muskmelon and watermelon culture

Melons require a long growing season of 90–125 days with temperatures averaging between 70°–80°F for optimal growth. Melon seedlings are transplanted in southern Wisconsin after May 20 and 2 weeks later for areas along Lake Michigan and in the northern part of the state. Plant melons according to the spacing in table 4 and the growth habit of the cultivar. Once the plants begin to set fruit, only allow one to two fruit to grow per plant. This will produce optimum size and quality fruit. Muskmelons are sensitive to environmental conditions and will become bitter if temperatures are too high, if they receive too little or too much water, or if the weather is too cloudy during ripening.

Pumpkin and squash culture

Pumpkins and squash are warm-season crops which may be direct seeded or transplanted. Both crops grow best at temperatures of 65°–75°F. Seeds can be sown as early as May 10 in southern Wisconsin but growers should refrain from setting out transplants until after May 20. Growers in the northern part of the state or along Lake Michigan should delay planting by 2 weeks. Seeds will rot if soil is too cool (below 60°F), especially if soil is wet. If the crop is direct seeded, plant the seed 1 inch deep in the soil. Summer squash requires 50–60 days to first harvest while pumpkins and winter squash require 90–120 days. You can extend your summer squash harvest by sowing seeds every 2–3 weeks.



Season extenders

You can lengthen the growing season by protecting plants from late spring frosts and early fall frosts. There are a variety of ways to prolong the growing season, including planting on a southern slope, creating a warmer microclimate using floating row covers, dark plastic mulch to warm the soil, clear plastic tunnels, cold frames, or using windbreaks to shield plants.

Plastic mulch. Plastic mulch raises the soil temperature early in the season and can boost crop maturity by 1–3 weeks. In Wisconsin, vine crops respond very well to growing on dark plastic mulch. Plastic mulch also suppresses weeds and reduces some disease problems by providing a barrier between soilborne pathogens and leaves. Some growers plant a row of vine crops along the edge of the field on yellow or gold plastic to attract and control cucumber beetles. Lay wide strips of 1.25–1.5 mil black polyethylene plastic over the beds before planting, using a plastic mulch layer or by hand. Place soil along all the edges of the plastic to anchor it from wind. Clear plastic raises the soil temperature more than dark plastic, but it doesn't shade out weeds. If puddles form on top of the plastic, poke tiny drain holes to prevent a wet environment suitable for fungi.

Cut or burn holes (with a propane torch) into the plastic where you want to plant. Remove loose plastic flaps which might abrade tender stems. Plants grown on dark plastic need more water. Before laying plastic, consider placing drip irrigation tape along plant rows under the plastic.

Floating row covers. Floating row covers of spunbonded polypropylene allow sunlight and water to pass through the fabric, but prevent insects from reaching the plants. Row covers can be used to cover low-growing crops and protect them from frost. They also serve as windbreaks and protect crops against insect pests. Depending on the fabric weight, row covers can provide 4°–8°F of frost protection.

Row covers are not typically used for warm-season crops such as vine crops but they may serve as a temporary emergency frost protection blanket.

Row covers can be held in place by burying the edges or by weights such as reebar. Completely seal all four edges to the ground if you use row covers as

an insect barrier. If not using row covers as an insect barrier, remove covers when the average daily temperature is warm enough for crop growth. Be sure to vent the beds on hot days and to let plants harden off for a few days to prevent burning before completely removing the row covers. Harden plants by removing covers on overcast days or for a few hours on sunny days.

Tunnels and cold frames. Slitted clear poly tunnels increase daytime temperatures 10°–30°F, and provide 1°–4°F of frost protection. Cold frames can be used to harden off crops before transplanting into the field. Consult the references listed at the end of this publication for more information on cold frames and tunnels.

Windbreaks. A grove of trees to block the prevailing winds can serve as a windbreak. Windbreak effects typically extend to 2½ times the height of the windbreak. For example, a 10-foot-tall windbreak will reduce air flow up to 25 feet away on the lee side. Less-permanent windbreaks include planting a tall cover crop such as grain rye upwind or between rows to reduce wind gusts or placing a semipermeable fabric or poly fence on the upwind edge of the field.

Table 5. Nutrient composition of various organic fertilizers

Material	N	P_2O_5	K_2O
Alfalfa hay	2.0–3.0	0.2–0.6	2.0–3.2
Bone meal	0.2–1.0	12.0–14.0	—
Compost[a]	0.5–3.5	0.5–1.0	1.0–2.0
Fish meal	9.0–11.0	5.0–8.0	0.0–3.0
Greensand	—	—	7.0
Manure, cow	0.5–0.7	0.2–0.4	0.5–0.8
Manure, sheep	1.0–2.0	0.7–1.0	0.5–2.0
Manure, poultry	1.1–1.7	1.0–1.3	0.5–1.0
Rock phosphate	—	20.0–30.0	—
Soybean meal	7.0	0.5	2.3

[a]Nutrient analysis of compost will vary based on the source.

Soils and nutrient management

Obtain a soil test for available nutrients before planting a field for the first time and routinely thereafter at least once every 3 years. After 3 years, soil conditions can change enough to make your current fertility management program obsolete. For information on how to collect good samples and where to send them for analysis, see Extension publication *Sampling Soils for Testing* (A2100).

Routine soul tests include pH, organic matter content, phosphorus, and potassium. Special tests are available on request for nitrate-nitrogen, calcium, magnesium, sulfur, boron, manganese, and zinc. You will receive the results of your soil test along with fertilizer recommendations based on your cropping history and planned use of the field.

Soil pH. Soil pH between 6.0 and 6.8 is recommended for maximum fruit set of cucumbers and best production of melons. Pumpkins, squash, and gourds grow well in a wide pH range of 5.5–7.5. Watermelons do best in pH 6.0–6.8, but can tolerate acid soils of 5.5–6.0.

Fertilizer needs. Plants take up nitrogen as nitrate (NO_3^-) or ammonium (NH_4^+), phosphorus as phosphate (P_2O_5), and potassium as potash (K_2O). These chemicals, as fertilizers, can come from organic or inorganic sources. With adequate environmental conditions, soil microbes break down organic matter and supply the chemicals that plants need to their roots. Organic fertilizers can also improve soil tilth and health. Inorganic fertilizers can be used to supply a more readily available form of primary nutrients to plants.

Organic fertilizers can come from a variety of sources such as manures, compost, fish meal, and bone meal. Each material contains varying amounts of specific nutrients. Table 5 lists organic fertilizers and the amounts of nutrients in each. For more information on this subject, refer to Extension publication *Organic Soil Conditioners* (A2305).

Nitrogen. Refer to table 6 for the amount of nitrogen to apply annually, and split it into two or more applications. At planting, broadcast nitrogen and work it into the soil. When the plants have two or three true leaves, band the second nitrogen application. A third application, if required, should be applied when the vines begin to fill the rows. It is important to provide adequate nitrogen as a deficiency will limit growth, reduce fruit set, and impair color development. With cucumbers, however, too much soil nitrogen may cause a bitter flavor.

Potassium and phosphorous. Potassium is sufficient for growing any of the vine crops if the test results fall between 100–200 ppm depending on the subsoil type. Optimum levels of soil phosphorus also depend on the subsoil type and range from 26–50 ppm. Phosphorus and potassium should be applied at planting at the rates suggested in table 6. The amounts to apply will be specified on your soil test report.

Irrigation

Moisture stress can reduce crop yields. If leaves begin to wilt midday, plants are moisture stressed. Plants that wilt intermittently may produce smaller yields, while plants that wilt frequently or that wilt too long die due to irreversible cell damage.

Both drip and overhead sprinkler irrigation systems are effective, such as trickle tape, solid set, and traveler hose wheel. Drip irrigation works particularly well with black plastic mulch that is used as a season extender.

All vine crops require supplemental irrigation of 1 inch of water every week to assure a constant supply of moisture, particularly during bloom and fruit development. Pumpkins and squash are especially heavy water users. When irrigating vine crops, it is important to keep water away from the crown of the plant as even a few hours of crown wetness can damage the root system. Trickle or drip irrigation works best to supply adequate moisture without wetting the foliage.

Table 6. Annual nitrogen, phosphate (P_2O_5), and potash (K_2O) recommendations

	Nitrogen			Phosphate and potash				
	Organic matter	Amount to apply		Yield goal	Amount to apply[a]			
					P_2O_5		K_2O	
Vegetable	%	lb/a	oz/100 sq ft		lb/a	oz/100 sq ft	lb/a	oz/100 sq ft
Cucumber	<2	100	3.75	300–400 bu/acre	10	0.4	30	1.1
	2.0–4.9	80	3.0					
	5–10	60	2.2					
	>10	40	1.5					
Melon	<2	100	3.75	8–10 tons/acre	40	1.5	140	5.25
	2.0–4.9	80	3.0					
	5–10	60	2.2					
	>10	40	1.5					
Pumpkin and squash	<2	100	3.75	15–20 tons/acre	50	1.9	110	4.1
	2.0–4.9	80	3.0					
	5–10	60	2.2					
	>10	40	1.5					

[a]Amounts of P_2O_5 and K_2O are for optimum soil test levels. Apply half the given rate if the soil test is high and omit if the soil test is excessively high. If soil test is low or very low, increase rates according to the soil test recommendations.

Irrigation scheduling software is available from the University of Wisconsin-Extension to help you determine your irrigation needs. For more information on this software, contact your county Extension agent.

Harvest, handling, and storage

Cucumbers

Harvest fresh-market cucumbers by hand when fruit reach a marketable size. Slicing cucumbers are typically 6–8 inches long while greenhouse-grown cucumbers are 14–16 inches. Harvest will typically begin a few days to 12 days after pollination. Harvest three times a week when fruit is growing rapidly to sustain plant productivity. Oversize fruit left on the vine will prevent subsequent fruit from developing.

Wipe cucumbers clean or wash them in a water bath. Pack them in waxed cardboard boxes. Maintain high humidity and provide evaporative cooling by lining the box with a clean, damp cloth. Cucumbers can be stored for up to 2 weeks at 40°–45°F and relative humidity of 85–95%.

Muskmelons and watermelons

Harvest muskmelons by hand when they reach the stage referred to as “half-slip” or “full-slip.” At this stage, the fruit readily separates (slips) from the stem, leaving a clean stem cavity or scar. Muskmelons are usually harvested every 3 days. Remove field heat as soon as possible to prevent fruit deterioration. Do this by transporting muskmelons to a cooler immediately after harvest, or by hydrocooling them in a cool water bath for a few minutes. Dry muskmelons and keep the skin dry in storage to prevent decay. Pack muskmelons in waxed cardboard boxes. Muskmelons harvested between half-slip and full-slip can be stored for about 1 week at 55°–60°F with a relative humidity of 85–95%.

It is difficult to know when to harvest watermelons. If your crop is large enough, you can periodically sample fruit for flavor. Another method is to observe the part of the fruit that touches the soil, called the ground spot. When the ground spot changes from white to creamy yellow, the melon is ripe and ready for harvest. A deep-yellow ground spot indicates overripe fruit. A third method to determine watermelon ripeness involves observing the tendril nearest the melon. If the tendril is firm and green, the melon is not yet ripe. If the tendril is wilting, the melon is ripe. If the tendril is completely wilted, the melon is overripe. Watermelons can be washed or simply wiped clean. Pack watermelons in waxed cardboard boxes. Watermelons will keep for 1 week if stored at 55°–60°F with a relative humidity of 85–95%.

Harvesting & packing tips

When you harvest vine crops, change your position often to minimize stress and fatigue to your body. You might wear kneepads or sit on a small cart. Use garden carts and wagons as much as possible to minimize lifting and hand carrying heavy produce. Standardized vented plastic containers that stack are easy to load and unload, and clean.

With a smooth level floor in the packing area, a palletized packing and storage system can be designed to fit small-scale operations (small pallets moved with a hand-pulled pallet-jack) or large operations (pallets moved by forklift). Heavy boxes of produce can be moved from one area to another on roller tables.

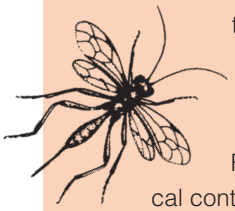
Layout your washing and packing area to minimize stooping, lifting, and carrying. Set up screen tables or water baths at table height. Ideally, tables could be adjusted to match each worker, so that work is performed at a height between wrist and elbow.

Pumpkins and squash

Summer squash is ready to hand harvest 7–8 weeks after seeding. Harvest every 3–5 days when fruit are 2–3 inches in diameter and up to 7 inches long to maintain plant productivity. Some fresh-market customers seek "baby" or immature summer squash. Squash blossoms are edible and some growers harvest and sell them. Handle summer squash gently since it bruises easily. You can cushion a waxed cardboard box by lining it with a dry towel. Summer squash is sensitive to cold temperatures and does not need hydrocooling. Squash can be wiped clean with a damp cloth. Summer squash should be stored at 40°–45°F with 95% relative humidity and will keep for 1 week.

Winter squash and pumpkins are hand harvested 3–4 months after planting, when the outer skin resists fingernail pressure. After harvest, pumpkins and winter squash should be "cured" by exposing them to temperatures of 80°F for 7–10 days to toughen or suberize the skin before long-term storage. Winter squash and pumpkins can tolerate some frost before harvest without harming quality. Both winter squash and pumpkins should be stored at 40°–45°F and a relative humidity of 85–95% and will keep for 2–3 months. Unwashed fruit will last longer in storage since handling may abrade skin and open it up to bacterial or fungal infection. For market, pumpkins and winter squash can be simply wiped clean. Pack them in waxed cardboard boxes.

Conservation of natural enemies



Not all insects are pests. Beneficial insects prey on other insects, helping to keep populations in check. You can take advantage of this free natural resource by minimizing the use of broad-spectrum insecticides. For more information about biological controls, see Extension publication *Biological Control of Insects and Mites: An Introduction to Beneficial Natural Enemies and Their Use in Pest Management* (NCR481).

Insect management

Seed corn maggot

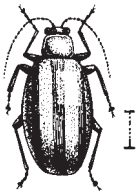
Description: The seed corn maggot (*Hylemya platura*) is the larva of a fly that resembles a housefly. The larvae are yellowish-white, ¼ inch long when fully grown, legless, and wedge-shaped with a pointed head. The pupae are brown, ⅕ inch long, cylindrical in shape, and rounded at both ends. The flies are dark gray, ⅕ inch long, and their wings are held overlapped over their bodies while at rest. This pest can be potentially serious every year.

Life cycle: Seed corn maggots overwinter as dark brown pupae in the soil. The adult flies emerge in April. They're attracted to areas with high levels of organic matter where they lay their eggs. These areas include fall-seeded cover crops that have been disked within 3 weeks of planting. Once the eggs hatch, the pale yellowish-white, legless maggots begin boring into the newly planted seeds. There are three generations per year, but the first generation larvae, which feed between April 15 and June 1, are the most damaging.

Damage/Symptoms: Damaged seeds may fail to germinate or may produce stunted plants.

Management: If seed corn maggots have been a problem in your field in past years, you can take several steps to prevent future outbreaks. Disk or plow cover crops into the ground at least 4 weeks before planting. This allows the organic matter to decompose before the seeds are planted. Plant into warm soils to speed germination and shorten the period that the crop is susceptible to damage. If you're unable to plow cover crops early enough and the soil is too cool for rapid germination, consider an insecticidal seed treatment if planting in problem areas. Scouting is not recommended since there are no controls once an outbreak occurs.

Striped and spotted cucumber beetles



Striped

Spotted

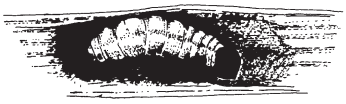
Description: Striped cucumber beetles (*Diabrotica vittatum*) and spotted cucumber beetles (*Cerotoma trifurcata*) are serious pests of vine crops. In Wisconsin, the striped cucumber beetle is more of a problem. Both insects are yellow-green in color and ⅕ inch long. The striped cucumber beetle has three black stripes running the length of its back while the spotted has 12 black spots on its back. The adult striped cucumber beetle resembles the western corn rootworm beetle, which can often be found feeding on the pollen of cucurbit blossoms later in the summer. To distinguish between the two, turn them over. The cucumber beetle has a black abdomen while the western corn rootworm has a yellow-green abdomen.

Life cycle: Striped cucumber beetles overwinter as adults in protected sites. They become active in mid- to late May. After mating, the female lays eggs in the soil at the base of cucurbits. The beetles are attracted to the cucurbitacin produced by the plants. Once the eggs hatch, the larvae feed on plant roots for 2–3 weeks. They pupate in the soil. There is one generation per year in Wisconsin. Spotted cucumber beetles do not overwinter in Wisconsin. Adult beetles migrate into the state in early to mid-July. Because they arrive later in the season, they pose less of a problem than their striped counterpart.

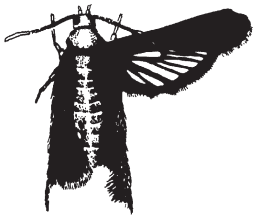
Damage/Symptoms: Feeding damage by the striped cucumber beetle larvae can stunt or kill seedlings or transplants. Adult beetles feed on the aboveground plant parts and fruit. More importantly, these beetles spread the bacteria that causes bacterial wilt. This disease plugs the water-conducting vessels of the plant, eventually resulting in plant death. The adult cucumber beetles are such efficient carriers (vectors) of the bacteria that serious crop damage can occur if only 10% of the beetles are infective.

Management: Scout fields two to three times per week early in the season for early migrants and the early emergence of the overwintering population. Beetles are usually localized in the field and spot treatments are effective. Some growers plant a row of vine crops near the upwind edge of the field on yellow or gold plastic mulch. This colored mulch attracts cucumber beetles to the crops in that row where they can be killed or removed. Muskmelon and cucumbers are particularly susceptible to bacterial wilt; treatment is required to prevent disease transmission. Watermelon is not susceptible to bacterial wilt, so do not treat except to prevent heavy feeding damage. Insecticides kill bees, so spray late in the day or at night to protect these important pollinators. Discontinue treatments after the initial peak declines as the insecticides may reduce fruit set or cause flowers to abort.

Squash vine borer



Larva



Adult moth

Description: The squash vine borer (*Melittia cucurbitae*) is an annual pest of pumpkins and squash. The borer is 1½–2 inches long. The adult is a clear-wing moth that has cloudy greenish-brown forewings and transparent hindwings with a fringe of reddish-brown hairs. The wingspan is 1¼–1½ inches.

Life cycle: Squash vine borers overwinter as pupae in the soil. They emerge as moths in July. Female moths lay small, brown eggs singly at the base of plants. The eggs hatch 7 to 10 days later. The young larvae bore into the plant where they feed for 14–30 days. Fully grown larvae leave the plant to pupate. There is one generation per year.

Damage/Symptoms: The first symptom of feeding damage is when plants wilt midday. As the larvae tunnel through the vines they destroy the vessels that transport water. These wilt symptoms may be confused with those caused by bacterial wilt or *Fusarium* wilt. Look for entrance holes near the base of wilting

pumpkin or squash stems and for sawdust-like frass near these holes. If frass is present, split the stem lengthwise to confirm the presence of larvae. Fields that have been severely damaged in the past are more likely to be damaged again.

Management: Currently, there are no treatment thresholds for squash vine borers. Begin monitoring fields once 900 degree days have accumulated using a base temperature of 50°F (see the sidebar for information on calculating degree days). Treat at 1000 DD_{50} when moths are laying eggs. Treat fields if you observe adult moths while pumpkin or squash vines are less than 2 feet long. Treat fields every 5–7 days over the 3-week egg-laying period to control newly hatched larvae before they burrow into the vine.

Disease management

Vine crops are susceptible to many plant diseases. The diseases described here are economically important. With the exception of viruses, which can infect plants at any stage of growth, diseases are listed in the order they're likely to appear.

Damping off

Hosts and severity: Damping off is one of the first diseases to appear after seedlings emerge. All vegetable seedlings are susceptible. Three fungi are commonly associated with damping off: *Pythium* spp., *Rhizoctonia solani,* and *Thielaviopsis basicola.*

Calculating degree days

Temperature affects the rate of development of plants and insects. Cold weather slows development while warm weather accelerates it. For this reason it is misleading to describe development in terms of time alone. To monitor crop development and predict pest behavior, professional pest managers often use a system that takes into account the accumulation of heat with passing time. This system is based on degree days (DD).

A degree day (DD) is a unit of measure that occurs for each degree above a base temperature during a 24-hour period. The base temperature is the temperature below which there is no plant or insect development. Specific insects have specific base temperatures. Most plants use a base temperature of 50°F. Cool-season plants, such as peas, grow in cooler temperatures and have a base temperature of 40°F. Begin recording degree day accumulations for Wisconsin on March 1.

To monitor plant and insect development using degree days, you will need a maximum/minimum thermometer to obtain the daily high and low temperatures. Calculate degree days using the equations below.

Example: Assume you have accumulated 200 degree days to date using a base temperature of 40°F. If yesterday's high temperature was 75°F and the low was 60°F, then the daily average temperature would be 67.5°F [(75 + 60) ÷ 2]. To calculate the degree day accumulation, subtract the daily average from the base temperature for a total of 27.5DD (67.5 – 40). Add this number to the total number of degree days to date (27.5 + 200) for a new total of 227.5.

(daily high[a] + daily low[b]) ÷ 2 = daily average temperature
daily average temperature − base temperature = degree day accumulation

[a]Use 86°F if the high temperature for the day is more than 86°F.
[b]If the daily low is less than the base temperature, use the base temperature.

The pathogens infect plant roots soon after germination. The tissue at or below the soil line becomes soft and can no longer support the plant, causing it to topple. As plants mature, the stems become more woody and resistant to infection. Damping off is often limited to low spots of the field. Heavy, wet soils tend to have more problems with this disease than lighter, well-drained soils. Excess nitrogen can increase the incidence of disease.

Disease cycle: The fungi that cause damping off are soilborne and infect the roots of seedlings soon after germination. *Rhizoctonia solani* can live indefinitely in the soil. *Pythium* and *Thielaviopsis basicola* can live 2–3 years.

Symptoms: The first sign of infection is the presence of small, firm, dark green spots. These spots later turn tan or brown and collapse. In wet weather, threadlike, white to cream-colored mycelium may cover the lesions. Secondary soft rots may succeed *Rhizoctonia* infections.

Management: To prevent outbreaks on transplants, use sterile, soilless potting mix. Direct-seeded plantings may be protected by treating the seed with a fungicide prior to planting. Because *Rhizoctonia solani* can live indefinitely in the soil, rotate out of vine crops for at least 4 years. Corn and small grains are not susceptible. Harvest ripe fruit promptly and destroy crop residues to prevent the buildup of the pathogen in the soil.

Alternaria leaf blight

Hosts and severity: *Alternaria* leaf blight is a fungal disease caused by the pathogen *Alternaria cucumerina*. Infected plants eventually lose their leaves, reducing fruit size and quality. It can be particularly severe on muskmelon but also affects cucumbers, squash, and watermelon. Infection is most likely to occur on vine crops weakened by poor growing conditions or aging.

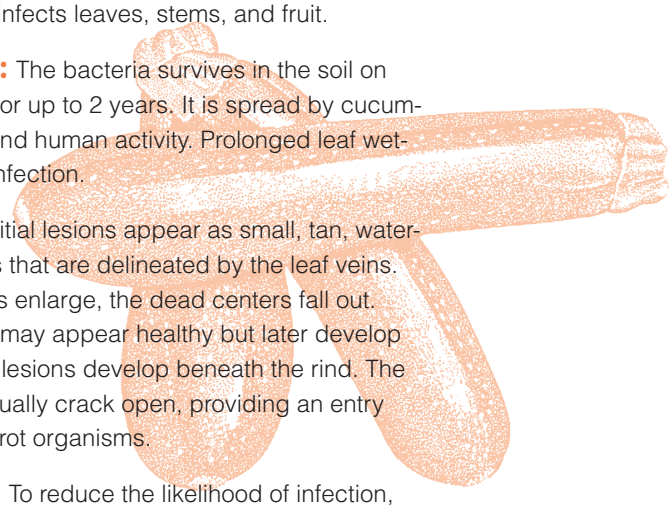
Disease cycle: The fungus overwinters in infected plant debris, cucurbit weeds, and infected seed. Spores may be spread by wind, water, and human activity. The fungus survives for less than a year.

Symptoms: Symptoms first appear in the middle of the season on the leaves nearest the center of the plant. The lesions are tan, often water-soaked, and roughly circular in shape. The lesions become target-shaped and may enlarge to ¾ inch in diameter on muskmelons and ⅓ inch on cucumbers, squash, and watermelons. Infected fruit have circular, sunken brown spots that develop into a dark olive-green or black powdery mat.

Management: To help prevent this disease, maintain proper soil fertility and moisture throughout the season. Also, avoid working in the field while the soil is wet to reduce compaction. If the crop becomes infected, rotate out of cucurbits for at least 1 year. Edisto is a resistant muskmelon cultivar; there are no resistant cultivars of cucumbers, squash, or watermelon available for Wisconsin. Fungicide treatments will protect healthy plants. Begin treatment as soon as symptoms appear.

Angular leaf spot

Hosts and severity: Angular leaf spot is a bacterial disease that can be economically important on cucumbers, honeydew melon, and zucchini grown in Wisconsin. The bacteria, *Pseudomonas syringae* pv. *lachrymans*, infects leaves, stems, and fruit.



Disease cycle: The bacteria survives in the soil on plant debris for up to 2 years. It is spread by cucumber beetles and human activity. Prolonged leaf wetness favors infection.

Symptoms: Initial lesions appear as small, tan, water-soaked spots that are delineated by the leaf veins. As the lesions enlarge, the dead centers fall out. Infected fruit may appear healthy but later develop soft spots as lesions develop beneath the rind. The lesions eventually crack open, providing an entry point for soft rot organisms.

Management: To reduce the likelihood of infection, rotate out of cucurbits for at least 2 years and use disease-free seed. Resistant cucumber varieties are available, including Calypso, Dasher, Dasher II, Pioneer, Raider, and Regal. Copper fungicides applied every 5–10 days may be helpful, particularly after rain or wind storms.

Powdery mildew

Hosts and severity: Powdery mildew is a foliar disease that occurs late in the season on cucumbers, gourds, muskmelons, pumpkins, and squash. It is less common on watermelon. On susceptible crops, this disease is often severe enough to significantly reduce yields.

Disease cycle: Two fungi are responsible for powdery mildew: *Erysiphe cichoracearum* and *Sphaerotheca fuliginea*. These fungi overwinter on perennial hosts in southern states. Each year fungal spores are blown north. Infection is favored by warm, humid weather.

Symptoms: Symptoms first appear as pale yellow spots on the oldest leaves. As the disease progresses, a white or brownish powdery growth covers affected plants. Eventually, affected plants wilt and die.

Management: For cucumbers and muskmelons, plant resistant varieties. On susceptible crops, fungicides may be applied every 5–7 days once the disease appears in the field to protect healthy plants. Continue treatment until harvest.

Bacterial wilt

Hosts and severity: Bacterial wilt is a common and severe disease of vine crops. Cucumbers and muskmelon are the most severely infected, but pumpkins and squash are also susceptible.

Disease cycle: The bacterium, *Erwinia tracheiphila*, overwinters in the cucumber beetle. It is transmitted when the beetle feeds. Once the bacteria is in the plant, it travels through the vascular system and blocks the food- and water-conducting vessels. Seven to ten days after infection occurs, leaves begin to flag or wilt.

Symptoms: Initially, leaves wilt during the day but recover at night or on cloudy days. To distinguish wilting caused by *Erwinia* from that caused by the squash vine borer or *Fusarium*, cut the stems of symptomatic plants. Hold the cut edges together for 10 seconds, then slowly pull them apart. If you find a sticky white sap, the plant is infected with the bacteria. Plants of any age are susceptible.

Management: There is no treatment for infected plants. It is therefore important to control cucumber beetles early in the season to prevent spread of this disease. Remove infected plants immediately or they will serve as a reservoir for the pathogen. Consider growing extra transplants to replace plants lost early in the season.

Fusarium wilt

Hosts and severity: A second wilt disease of cucurbits is *Fusarium* wilt. Cucumbers, muskmelon, and watermelon are all susceptible. Each host crop is susceptible only to its own particular strain of the fungus. *Fusarium oxysporum* f.sp. *cucumerinum* affects cucumbers, *F. oxysporum* f.sp. *melonis* affects muskmelon, and *F. oxysporum* f.sp. *niveum* affects watermelon. Within each strain of the fungus, different races attack different cultivars.

Disease cycle: *Fusarium* is a soil-borne fungus that overwinters in plant debris, seed, and soil. The pathogen can attack plants at any stage of growth. Warm temperatures and excessive wetness favor infection.

Symptoms: On infected seedlings, the cotyledons and small leaves turn pale green and wilt. Older plants wilt midday starting at the tips of the runners and moving toward the crown of the plant. In muskmelon, early symptoms appear as a stunting or yellowing with a water-soaked tan streak along the vine. Vines may crack open and ooze sap. Late in the disease, vines may be covered with white or pink mycelium. To distinguish these wilt symptoms from those caused by bacterial wilt or squash vine borer, cut open the lower stem. Plants infected with *Fusarium* will show yellow, brown, or reddish-brown discoloration.

Management: Use resistant varieties to prevent problems with *Fusarium* wilt. Rotating fields out of cucurbits for 5–10 years is also advised to prevent the buildup of the pathogen in the soil.

Anthracnose

Hosts and severity: Anthracnose is a destructive fungal disease of the foliage, stems, and fruit of watermelons, gourds, muskmelons, and cucumbers.

Disease cycle: The fungus that causes anthracnose (*Colletotrichum lagenarium*) overwinters in plant debris, soil, or on seed. It may survive in the soil for up to 2 years. Moisture is required for the spread of disease and warm, rainy weather favors infection.

Symptoms: Symptoms begin as small, yellowish or water-soaked lesions that rapidly enlarge and turn brown. On fruit, the symptoms are circular, sunken, water-soaked lesions with a black center. Fruit infection usually doesn't appear until fruit is nearly mature. Although the lesions don't penetrate the edible flesh, they may serve as entry points for secondary rots.

Management: The best way to control anthracnose is to plant resistant varieties. Using certified seed and rotating fields out of cucurbits for at least 3 years is also helpful. If infection should occur, fungicides may be used to protect healthy plants from becoming infected. Begin spraying when plants have two leaves and continue every 7–10 days until harvest. During rainy periods, treat every 5–7 days.

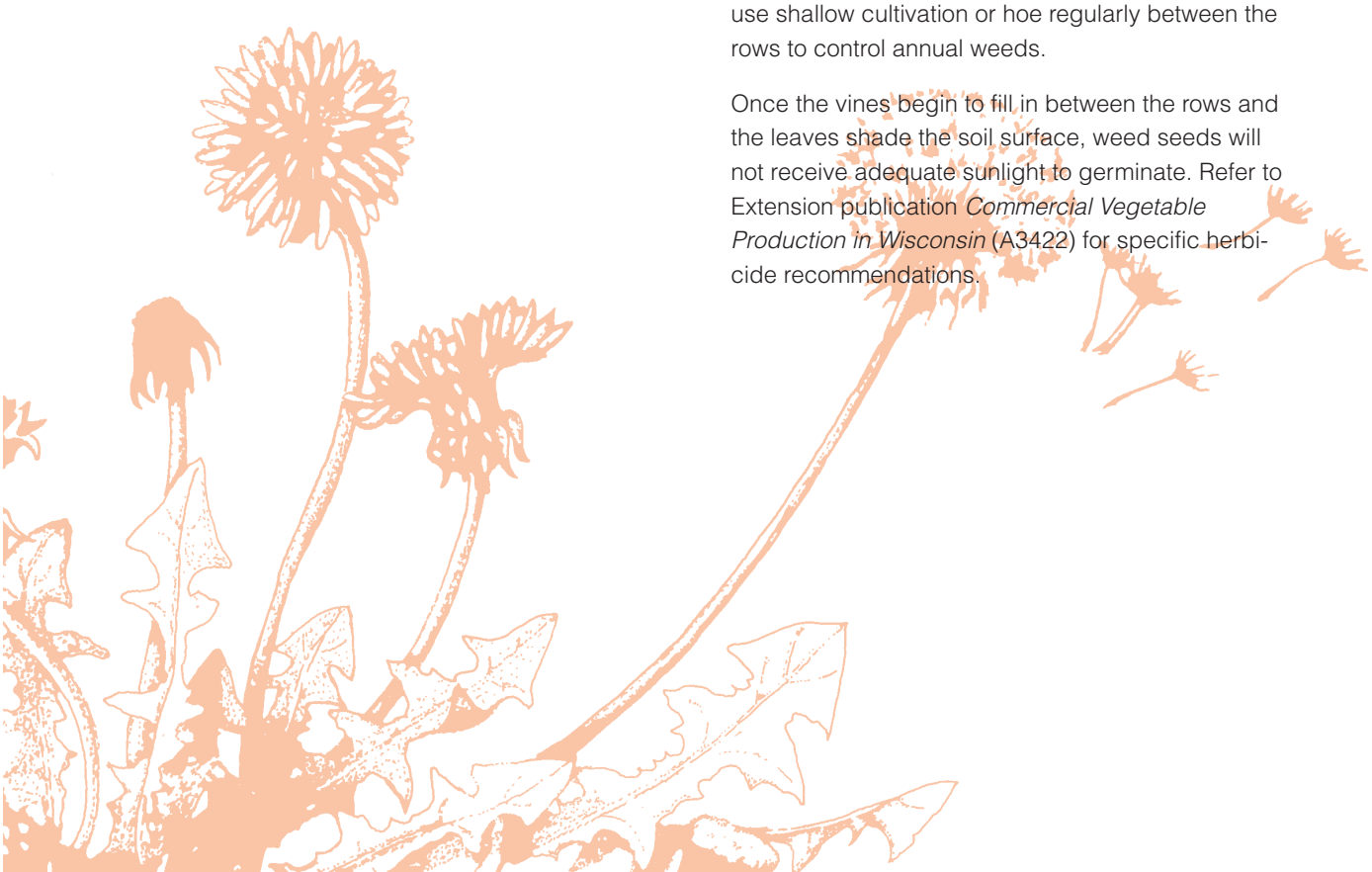
Viruses

More than 30 virus diseases affect cucurbits. Many can be very destructive and difficult to control. Some viruses are seedborne while others must be transmitted to susceptible plants by insect vectors. Once a plant becomes infected with a virus, there is not cure. Therefore, prevention is the best control. Control the vector that transmits the disease, control weeds that may serve as reservoirs for the virus, or use resistant cultivars.

Weed management

Weed management is essential for crops to produce maximum yields. Weeds compete with crop plants for sunlight, water, nutrients, and space. Before planting, reduce perennial weed populations by smothering with a cover crop (such as buckwheat), by solarization with black plastic, by hand removal, or by using herbicide sprays. Pre-emergent herbicides may be used to clean up any annual weeds present in the field at the time of planting. Vine crops in Wisconsin are often grown on black plastic, which acts as a weed barrier. A thick straw mulch will also prevent weed germination and growth. After planting, use shallow cultivation or hoe regularly between the rows to control annual weeds.

Once the vines begin to fill in between the rows and the leaves shade the soil surface, weed seeds will not receive adequate sunlight to germinate. Refer to Extension publication *Commercial Vegetable Production in Wisconsin* (A3422) for specific herbicide recommendations.



Additional reading

Culture

Commercial Greenhouse Production: Cucumbers. William J. Lamont Jr. and Charles W. Marr. Kansas State Extension.

Direct Marketing of Farm Produce and Home Goods—Direct Marketing Alternatives and Strategies for Beginning and Established Producers (A3602). John Cottingham, James Hovland, et al. 1994. University of Wisconsin-Extension.

Growing For Market Newsletter. Fairplain Publications, P.O. Box 3747, Lawrence, Kansas 66046. A monthly newsletter with practical articles on all aspects of small-scale fresh market farming,

Harvesting Vegetables from the Home Garden (A2727). H.C. Harrison. 1996. University of Wisconsin-Extension.

Knotts Handbook for Vegetable Growers, Fourth Edition. Donald N. Maynard and George J. Hochmuth. 1997. Wiley.

The New Organic Grower. Second Edition. Eliot Coleman. 1995. Chelsea Green Publishing.

The New Seed Starters Handbook. Nancy Bubel. 1988. Rodale Press.

Producing Vegetable Crops. Fourth Edition. John M. Swiader, George W. Ware, and J.P. McCollum. 1992. Interstate Publishing.

Soil Test Recommendations for Field, Vegetable, and Fruit Crops (A2809). K.A. Kelling, L.G. Bundy, S.M. Combs, and J.B. Peters. 1998. University of Wisconsin-Extension.

Storing Vegetables at Home (A1135). H.C. Harrison. 1996. University of Wisconsin-Extension.

Rodale's All New Encyclopedia of Organic Gardening. Edited by Fern Marshall Bradley and Barbara W. Ellis.1992. Rodale Press.

World Vegetables: Principles, Production, and Nutritive Values. Second Edition. Vincent E. Rubatzky and Mas Yamaguchi. 1997. Chapman and Hall.

Pests

Biological Control of Insects and Mites: An introduction to Beneficial Natural Enemies and Their Use in Pest Management (NCR481). Daniel L. Mahr and Nino M. Ridgway. 1993. University of Wisconsin-Extension

Commercial Vegetable Production in Wisconsin (A3422). L.K. Binning, C.M. Boerboom, et al. Updated annually. University of Wisconsin-Extension.

Disease-Resistant Vegetables for the Home Garden (A3110). D.E. Brown-Rytlewski, M.F. Heimann, et al. Updated annually. University of Wisconsin-Extension.

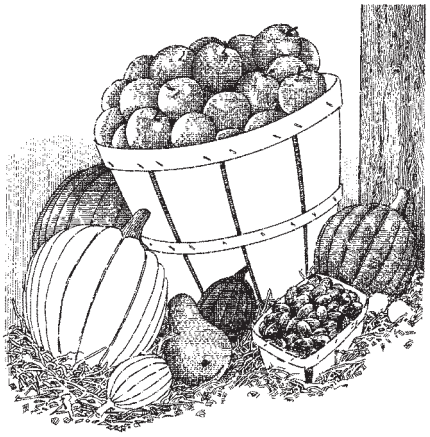
Identifying Diseases of Vegetables. A. A. MacNab, A. F. Sherf, and J.K. Springer. 1983. Pennsylvania State University College of Agriculture.

Pests of the Garden and Small Farm: A Grower's Guide to Using Less Pesticide. Mary Louise Flint. 1990. University of California, publication #3332.

Rodale's Color Handbook of Garden Insects. Anna Carr. 1979. Rodale Press.

Vegetable Insect Management with Emphasis on the Midwest. Rick Foster and Brian Flood, editors. 1995. Meister Publishing Company.

Weeds of the North Central States. North Central Regional Research Publication No. 281. 1981. University of Illinois at Urbana-Champaign, College of Agriculture.



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A3688 Growing Pumpkins and Other Vine Crops in Wisconsin: A Guide for Fresh-Market Growers

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