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Commercial Vegetable Recommendations

Celery

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Production

The average yield of packed, full-sized celery in Michigan is 23 tons per acre (760 60-lb boxes). With good management and irrigation on deep, nematode-free muck, production may exceed 40 tons per acre (1,330 60-lb boxes). Production for processing may approach 50 tons per acre.

Celery heart production averages about 10 tons per acre (650 30-lb boxes).

Use

About 60 percent of Michigan celery is packed for fresh market as full-sized (2 to 6 dozen) stalks in 60 lb crates. About 15 percent of the crop is packed as hearts, using stalks that are too small for regular pack. Twenty-five percent of Michigan celery is processed for frozen food, soup, juice, or other products.

Types and Cultivars

Green (pascal) celery is the most popular type of celery in the United States. There is a small demand for blanched (white or yellow) celery.

Good celery cultivars have a tight, upright growth habit. The individual petioles are well attached to the butt of the plant and are not excessively brittle. The petioles should be long, preferably over 10 inches from the base to the first node, and uniformly wide. The plants should produce few suckers; the butt should be tight and rounded. The plants should not become overmature and pithy soon after maturity. Color should be uniformly dark green. Cultivars should be adapted to the area where they are grown and yield consistently good quality stalks year after year.

In addition to horticultural characteristics, disease resistance is important. Fusarium yellows, a soil-borne disease for which there is no chemical control, is spreading in Michigan fields. Where it is present, only resistant cultivars should be planted. Resistance to foliar blights is being incorporated into some new cultivars. Resistance to bolting is important for early season production.

Recommended Cultivars

Early:
- Green Giant
- Ventura

Main season:
- Florida 683
- Utah 52-70 R
- Utah 52-70 HK (resistant to Fusarium yellows)
- Deacon (resistant to Fusarium yellows)

White celery:
- Golden Detroit
- Golden Self Blanching
- Golden Spartan

Transplant Production

All Michigan celery is established from transplants. Because of the high cost of production, a complete stand of uniform, perfectly spaced plants is needed to obtain maximum yields. Good seedling production is an essential first step in celery production.

The flowering habit of celery produces differences in seed size and embryo development. This results in non-uniform germination in the seed bed. In addition, the celery seed coat contains chemicals that inhibit germination. To promote uniform germination, use seed graded by size, with the small seeds removed, and prime or wash the seeds at 50°F to remove germination inhibitors.

Temperature

Celery seed is subject to thermodormancy: it may not germinate if temperatures are maintained above 80°F in the dark. To avoid thermodormancy, maintain germination temperatures below 75°F until seedlings have emerged, and sow seed very shallowly so that some light can reach the seeds.

The optimum germination temperature is 50° to 70°F. The higher the temperature within this range, the faster and less uniform the germination. Alternating day and night temperatures of 70° and 60°F appear to improve the uniformity and percentage of germination. Once the seedlings have emerged, maintain growing temperatures between 60° and 80°F.

Plants may be induced to form seed stalks if exposed to temperatures below 55°F for several days. If celery plants are grown in ground beds in the greenhouse, install a sheet of insulation inside the outer wall from 8 inches below the soil surface to 18 inches above the soil, to protect plants nearest the wall from cold temperatures. Circulating fans will keep air moving and help prevent cold spots.

Seeding

Spores of two common leaf blights of celery (*Cercospora* and *Septoria*) are carried on the seed. The fungal spores die within about 2 years, so disease incidence can be reduced by storing seed for 3 years before planting. If 3-year-old seed is not available, use hot-water treated seed to help prevent foliar blights.

About 2 ounces of seed will produce enough plants for 1 acre. The seed can be sown close together in a seedling bed and transplanted, after 4 weeks, to a wider spacing, or direct-seeded to the spacing desired.

Transplanting of seedlings in the greenhouse (called double rooting) is labor-intensive, but results in more uniform seedlings for transplanting in the field. The seedlings are usually transplanted into ground or raised beds on a 1.1 × 1.1 inch grid, giving each plant about 1.2 square inches of growing space.

It is difficult to produce uniform plants by direct-seeding into transplant beds. If transplants are grown from direct seeding, sort the plants at transplanting and use only large, uniform plants.

Celery seed is sown in the greenhouse starting February 1 for transplanting in the field after April 1. Sow seed 2 or 3 times each week to provide a constant supply of plants throughout the season. After April 20, seedbeds can be established in the field. The last seed is normally planted about June 1 for transplanting in mid-July.

Water

After seeding, the seedbeds must be watered regularly to avoid seed desiccation and to wash out germination inhibitors in the seed coat. Apply enough water several times a week to soak the soil to a depth of 6 to 8 inches.

Soil, Media, and Fertilizer

The soil in transplant beds should be fumigated in the fall when soil temperatures are above 50°F to kill insects, nematodes, disease organisms and weeds.

Pest-free field muck soil is a satisfactory medium for transplant production in raised or ground beds. For plant pro-

duction in cells, a fine peat/vermiculite mix that drains well is preferable to field muck.

Seedbed soil should be tested each year for soluble salts, pH, and nutrients with a greenhouse soil test, which gives recommendations specifically for transplant production. Many transplant production problems are caused by high or low soil pH, or high soluble salts in the soil. These conditions can be checked regularly by growers with a pH meter and conductivity meter (solubridge).

The pH is a measure of soil acidity. Plants growing in soils with pH below 5.5 or above 7.0 develop slowly and often exhibit foliar chlorosis (yellow leaves) as a result of poor nutrient uptake. Add lime to raise soil pH. It is difficult to lower pH.

To measure pH with a pH meter, mix 1 part of soil media with 1 part distilled water (by volume); mix thoroughly and insert the probe of the pH meter. Read the meter 30 seconds after inserting the probe.

Measure soluble salts with a conductivity meter. The meter measures electrical conductivity in the soil solution. A low reading indicates a lack of nutrients. High salt content results in poor plant development, yellowing, death of leaf fringes, and browning and death of roots. For celery plants, the desirable range (by the saturation extract method used for the MSU soil test) is 1.50 to 3.50 mS/cm (millisiemens/per centimeter; formerly: millimhos).

To measure soluble salts, mix 1 part of soil media with 2 parts distilled water (by volume) and test the mixture with a solubridge. The acceptable range by this method is 0.50 to 1.25 mS/cm.

If soluble salts are too high they can be removed by leaching. Thoroughly soak the plant beds for 1 to 2 hours, 2 or 3 days in succession. Avoid the use of high-salt index fertilizers, such as 0-0-60 (potassium chloride).

Water seedlings in germination beds at least once a week with a nutrient solution after true leaves have emerged. Use a water-soluble starter fertilizer such as 10-52-17 or 10-30-10 at 1 to 2 ounces per 100 square feet. After the seedlings have been transplanted in the greenhouse, water once with starter fertilizer at the above rate. Then apply a water-soluble fertilizer high in nitrogen (N) and potassium (K), such as 14-0-44 (potassium nitrate) at 2 ounces per 100 square feet at least once a week until the plants are pulled for transplanting in the field.

If celery plants are grown to transplant stage directly from seed (i.e., not double-rooted), use the starter fertilizer for the first 4 weeks, and the 14-0-44 for the last 4 weeks that the plants are in the greenhouse.

These recommendations are also applicable for plants grown in cells. Because of the small amount of soil in each cell and the confined root space, however, use care when watering and fertilizing to avoid missing some plants. With very small cells, it may be necessary to cut the fertilizer rate in half and fertilize 2 or 3 times per week to maintain uniform growth.

For field seedling beds, apply 800 lb 15-15-15, or the equivalent per acre before seeding. Topdress 4 to 6 weeks after emergence with 500 lb 14-0-44 per acre.

Plant Production in Cells

Many growers are now producing their celery transplants in cells. Cell plants suffer less shock when transplanted into the field and often mature a week earlier than similarly grown bare rooted plants. Seeds can be planted directly into cells (which usually results in 10 to 20 percent empty spaces) or transplanted into cells.

Plants grown in cells need about 1.2 square inches of space for maximum growth. Smaller cells (0.5 inch diameter) can be used for celery plant production, but they require more careful water and nutrient management. Plants grown in very small cells cannot be held long if planting in the field is delayed because they quickly become root-bound.

Water plants grown in cells uniformly so that each cell receives sufficient water. Small cells dry out quickly and may require more than 1 daily watering.

Transplant Production in the Field

Transplant beds can be established in the field after about April

20. Rows are normally 4 to 6 inches apart, with about 24 to 30 plants per foot of row. The plants should be grown with sprinkler irrigation to maintain a constant supply of moisture and to protect them in case of prolonged frost. Celery plants usually develop slower in a field seedbed than in the greenhouse.

Seed Enhancement

The seed industry is utilizing several techniques to improve the quality of celery seed and to improve the uniformity of germination. One technique is to produce seed in the greenhouse to avoid contamination by fungal blights. The seed is harvested by hand as it matures to obtain seed that is at a very uniform stage of maturity. The seed is then carefully sized to achieve an additional degree of uniformity.

Germination and emergence can be improved by priming the seed in a salt solution, which initiates several of the physiological processes that precede germination. After priming, the seed may be dried to its original moisture content.

Seed coating of primed or raw seed is a common practice to facilitate seeding with a tray seeder for transplant production in cells. Pelletizing the seed may delay germination, but allows accurate placement of seed into cells.

Clipping

Celery plants are usually ready for transplanting in the field 8 weeks after seeding. If transplanting is delayed or plants develop rapidly, they can be clipped with a mower to keep them short. The longest leaves can be cut back to the petiole when the plants are 5 to 6 inches high. New leaves will soon develop. Be careful not to injure the youngest leaves when clipping. If possible, use a mower that picks up the clippings so that they do not fall back onto the plants. Some growers routinely clip plants 2 or 3 times to form thicker, shorter plants that transplant easier and establish well in the field.

Climatic Requirements and Irrigation

Celery is a cool season crop that produces highest yields and best quality at temperatures of 60° to 80°F. Young and mature plants can withstand light frosts, but prolonged frosts at temperatures below 28°F will damage the crop.

Bolting

Celery is a biennial which normally produces foliar growth the first year and seed stalks the second year. However, celery plants often form seed stalks (bolt) the first year if exposed to temperatures below 55°F for 7 days or longer. Some cultivars are more susceptible to bolting than others. The number of bolting plants increases as the duration of exposure to cold temperature increases. The cold effect accumulates in the plants, but sunshine and warm temperatures immediately after the cold exposure may reverse the effects of cold temperatures, if the apical bud has not already differentiated into a flower bud.

Celery planted in the field before April 20 is usually covered with plastic tunnels to increase daytime temperatures and prevent induction of bolting by low night temperatures. Tunnels are usually ventilated by May 1 and removed around May 15.

Water

Celery is a shallow-rooted crop; most roots are in the upper 18 inches of soil. It is therefore very susceptible to drought. It requires about 1 to 2 inches of water per week throughout the growing season to maintain optimum growth, and it should only be grown where irrigation is available. Hot, dry periods without water reduce growth and may induce blackheart.

Soil Requirements and Field Preparation

In Michigan, celery is usually grown on deep, well drained muck soils because of their good moisture holding capacity and the relative ease of nutrient management. Celery can be grown on sandy muck or on sandy loam soil with careful soil management.

Before planting in the spring, plow the soil 8 to 10 inches deep and roll it to form a firm planting bed. If the soil is dry irrigate it before plowing to soak it thoroughly. After plowing, broadcast and disc in the required fertilizer. Drill in the banded fertilizer under the rows when marking the field for the self-guided transplanter. A modified corn planter works well for drilling fertilizer and marking rows.

Celery should be rotated with other crops whenever possible to avoid a buildup of pests in the soil. Onions or potatoes are good rotation crops with few pests in common with celery. Corn or sudangrass should be included in the rotation every 5 years. A winter cover crop of rye or barley will reduce wind erosion and add active organic matter to the soil.

Fertilizer Requirements

Maintain the soil pH above 5.5 in muck soils and 6.5 in mineral soils. Add lime, as recommended by soil tests, to raise the pH.

Celery requires a high level of soil nutrients for efficient production. It is wise to build up levels of phosphate (P_2O_5) and potash (K_2O) in the soil to high levels and then add moderate amounts of fertilizer each year to maintain those levels. Maintain the P_2O_5 level at 120 to 150 lb per acre and the K_2O level at 400 to 500 lb per acre. Add additional fertilizer as recommended by a complete soil test. The soil should be tested every 2 or 3 years.

A 30 ton (1,000-crate) per acre crop of celery removes about 200 lb of nitrogen (N), 150 lb phosphate (P_2O_5), 600 lb potash (K_2O), 400 lb calcium (Ca), and 30 lb magnesium (Mg) from an acre. To maintain the desired nutrient levels in the soil while producing a 30-ton per acre crop, add at the minimum the following each year: 200 lb N, 150 lb P_2O_5, and 600 lb K_2O. Most muck soils contain adequate levels of Ca and Mg. Several micronutrients are also required.

Celery demand for N is low during the first 25 days in the field; after 25 days, demand for N increases rapidly. Thus, it is more efficient to apply most of the N by side-dressing. Apply the first N sidedressing about 4 weeks after transplanting and reapply every 2 weeks for a total of 3 or 4 applications. Dip celery roots in a high phosphate starter solution before transplanting. Change the starter solution at least once a week. Celery has a very high demand for potassium, so it is especially important to maintain high K levels in the soil.

Fertilizer can be supplied in combinations of preplant broadcast, preplant band and sidedress applications. Possible combinations for muck soil are:

- Broadcast and disc in 600 lb of 0-0-60 per acre (360 lb K_2O). When marking the field, band 4 inches deep directly under the rows 500 lb 8-32-16, 40 lb manganese sulfate, and 20 lb borax per acre (40 lb N, 160 lb P_2O_5, 80 lb K_2O, 10 lb Mn, and 2 lb B). Side-dress 3 times with 120 lb of 46-0-0 (urea) or 160 lb of 34-0-0 (ammonium nitrate) per acre (54 lb N each time).
- Broadcast and disc in 700 lb of 0-0-60, 450 lb of 8-32-16, and 20 lb of borax per acre (36 lb N, 150 lb P_2O_5, 492 lb K_2O, and 2 lb B). Three to 4 weeks after transplanting, side-dress with 400 lb of 12-12-12 and 40 lb manganese sulfate per acre (48 lb N, 48 lb P_2O_5, 48 lb K_2O and 10 lb Mn). Side-dress 2 times with 100 lb 46-0-0 (urea) or 135 lb 34-0-0 (ammonium nitrate) per acre (45 lb N each time).
- Broadcast and disc in 700 lb of 0-0-60, 500 lb of 12-12-12, and 20 lb of borax per acre (60 lb N, 60 lb P_2O_5, 480 lb K_2O, and 2 lb B). Side-dress 4 times with 200 lb 20-10-10 per acre (40 lb N, 20 lb

P_2O_5, and 20 lb K_2O each time). Add 40 lb manganese sulfate per acre in the first side-dressing.

On mineral soils, follow one of the above recommendations, but add an additional sidedressing of N, if necessary.

Secondary and Micronutrients

Celery responds to several of the secondary and micronutrients. Careful management will help avoid micronutrient deficiencies.

Calcium (Ca) deficiency in the growing point of the plant causes a physiological disorder called blackheart. It is usually not a result of insufficient Ca in the soil, but rather of poor uptake or distribution of Ca in the plant during hot, dry periods or periods of rapid growth. Irrigation on a regular schedule will minimize this problem. The plants should never be subjected to moisture stress. Check plants regularly during hot, dry periods for evidence of browning young leaves in the heart of the plant. If prolonged hot, dry weather is forecast, or if evidence of blackheart occurs, apply 10 lb calcium chloride or 15 lb calcium nitrate per acre in 100 gal of water as a foliar drench, directed into the hearts of the plants. Apply weekly during hot, dry periods.

Magnesium (Mg) deficiency is a problem in some cultivars that are inefficient in its uptake. Most of the cultivars used in Michigan do not have this problem, but the deficiency sometimes occurs on very acid or sandy mucks. Magnesium deficiency causes chlorosis (yellowing) on the tips of older leaves that progresses around the leaf margins and inward between the veins. To overcome the problem, apply 20 lb Epsom salts (magnesium sulfate) per acre (2 lb actual Mg) as a foliar spray in at least 30 gal of water. If deficiency symptoms persist, reapply after 10 days.

Manganese (Mn) deficiency regularly occurs in celery if Mn is not applied to soil or plants. It causes chlorosis between the veins, appearing initially in the younger leaves but soon covering the whole plant. Apply 10 lb actual Mn each year in the banded or side-dressed fertilizer. In addition, apply 4 lb manganese sulfate (1 lb Mn) per acre in 3 or 4 weekly foliar sprays starting 6 weeks after transplanting.

Boron (B) deficiency causes a physiological disorder called cracked stem. Apply 2 lb actual B (20 lb borax) each year in the broadcast or banded fertilizer to avoid the problem. Be sure that the B is thoroughly mixed with the granular fertilizer to obtain uniform distribution in the field. If symptoms appear during the season, apply 1.5 lb *Solubor* (0.3 lb B) per acre as a foliar spray when the plants are 8 to 10 inches tall, and repeat 2 weeks later.

Spacing and Planting

Celery is transplanted into the field from about April 1 through July 30. It is possible to replant for a second crop after early celery has been harvested. Reduce fertilizer rates by 30 to 50 percent for the second crop.

Plant populations for full-sized celery should be 30,000 to 35,000 plants per acre. Rows should be 30 to 34 inches apart, with 6 to 7 inches between plants. If celery is grown specifically for heart production, increase plant population to 40,000 plants per acre. This population can be obtained by spacing plants 4 ½ to 5 inches apart in 34-inch rows.

Celery is normally planted with a self-propelled, 2- or 4-row transplanter. The machine is self-guided in marks made in the field earlier. When planting celery seedlings grown in cells, it may be necessary to add extensions to the fingers on the transplanter to hold the plants.

Plant enough celery each day to meet packing shed capacity for one day. In middle and late summer celery grows faster, so plantings mature closer together. This may result in a harvest that exceeds packing capacity or the market. The market sometimes becomes flooded with this excess celery, prices drop, and in some cases celery is dumped or left in the field. Experience provides the best measure of how much celery to plant each day.

Harvest

Celery harvest normally begins about July 1 in Michigan. The earliest harvest is of small plants for hearts. Full-sized celery harvest usually begins about 1 week after heart harvest begins. Harvest continues until the end of October, when celery is either completely harvested or frozen beyond recovery. Earliest plantings mature in 90 to 100 days. Midsummer celery matures in 80 to 90 days. Celery planted after July 15 takes 90 to 110 days to mature.

A field is ready for harvest when a majority of the plants are of the desired sizes. When celery is growing rapidly it is ready for harvest for about 6 to 8 days, after which the plants become pithy and the marketable yield declines.

Most celery in Michigan is harvested with a mechanical harvester that cuts the tops off the stalks, cuts off the roots below the soil surface and then elevates the stalks into a wagon. They are then taken to a packing shed for trimming, washing and packing. Some full-sized celery is cut by hand and trimmed in the field. Much of the early celery grown specifically for hearts is cut by hand.

Trimming and Packing

In the packing shed, the loose, outside petioles and suckers are pulled off, leaving a tight, compact stalk. The stalks are trimmed to a maximum length of 14½ in. They are then packed by size into cardboard boxes or wirebound wooden crates. The most common pack sizes are 2, 2½, 3, 4, or 6 dozen stalks per box. The smallest stalks are packed in plastic sleeves as hearts, with 1, 2, or 3 hearts per sleeve. Two dozen sleeves are packed in boxes with a net weight of 24 to 30 lb.

Standards for Celery Grown for Sale Under the Michigan Seal of Quality

The grade standards for Michigan Seal of Quality are equal to or better than U.S. Extra No. 1. To meet the standard, stalks must be fairly well developed and well formed, have good heart formation and a uniform green color; they must be fresh and crisp, well trimmed, compact, and clean. The average midrib length of the outer petioles must be at least 8 inches between the butt and the first node. The stalks must be no more than 1½ inches shorter than the width of the container (the direction the celery lies from butt to tip). Container width must be given in whole, even numbers, such as 14 or 16 inches. Thus for 16 inch boxes, the celery must be at least 14½ inches long. Full-size boxes must average 65 lb gross weight and 58 lb net weight when packed.

The stalks must be free from blackheart, brown stem, soft rot, pink rot, and other diseases. There can be no damage from freezing, growth cracks, horizontal cracks, pith, seedstems, or suckers.

Postharvest

Celery should be cooled to 45°F as soon as possible after harvest. The temperature should be measured ½ inch inside the butt end of the stalks with a probe thermometer. Ideally, celery should be hydrocooled or vacuum cooled after packing and before shipping or storage. At the minimum, it should be placed in cold storage at 40°F immediately after packing, with sufficient air space between boxes to permit cold air circulation around the boxes. If celery is not cooled immediately after harvest, shelf life and quality will be greatly reduced.

The half-cooling time with cold water, for celery packed in full-sized crates, is approximately 9 minutes. This means that the temperature of the celery will drop 50 percent of the difference between the cooling water temperature and the temperature of the celery in 9 minutes. For example, if the celery is 72°F and the water is 32°F, the difference is

40°. Therefore, the temperature of the celery will drop 20° (half of 40°) to 52°F in 9 minutes. Another 9 minutes of cooling will reduce the temperature 10° (half of 20°) to 42°F. The half-cooling time with forced air is 35 minutes. Celery packed in cardboard cartons takes longer to cool than celery packed in wooden crates because of reduced passage of air and water through the small holes in the boxes.

If celery is cooled immediately after harvest, it should store well for 2 to 3 months at 32°F and 95 percent relative humidity. It is important to maintain good air circulation during storage.

Physiological Disorders

Blackheart is a result of poor calcium distribution in the plant during hot, dry periods or periods of rapid foliar development. Calcium is relatively immobile in plants and follows the transpiration stream to larger, older leaves. The tips of newly forming leaves turn brown and then dry out and turn black. In severe cases the entire growing point dies. If the problem is recognized early, it can be overcome and avoided in most plants. Irrigate regularly to avoid moisture stress. If brown fringing of youngest leaves occurs, drench the plants with a calcium solution (see Fertilizer section).

If the damage is minor, the plants often outgrow it with no permanent damage. However, the black inner leaf makes the stalk unattractive. If it is a single leaf, it can be removed by hand, but this slows the packing process. More extensive damage may make the stalks unmarketable.

Cracked stem is a result of boron deficiency. The first symptoms of boron deficiency are brownish mottling along the margins of the youngest leaves. The browning expands to petioles of mature leaves, with brown stripes along the ribs. The petioles become brittle and begin to crack horizontally. Boron deficiency also causes roots to turn brown and die. To avoid cracked stem, apply boron as recommended.

A problem called brown checking appears to be related to boron deficiency. Brown, superficial lesions occur on the inside of the petioles. The affected petioles may close inward, causing an almost round appearance. Brown checking seems to occur with concurrent high N or K levels and low B levels.

Pithiness is usually a result of over-maturity of celery. It may also be caused by environmental stress. It is often seen in fields that are not harvested on time and in celery fields that have suffered nutrient stress, drought, or flooding. Once pithiness has been induced, it develops rapidly under high temperatures. The first indication of pith is white color around the fibers near the base of the petioles. The white areas soon disintegrate and petioles become hollow and spongy, or "pithy." Celery may become pithy during prolonged storage.

Some cultivars appear to be more susceptible to pithiness than others. To avoid pithiness, harvest celery before it becomes overmature. If celery becomes overmature and there is evidence of pithiness in the field, skip that block and move on to younger celery.

Brown stem is a condition in which the petioles become dark brown, soft, and watery. Several petioles of a plant are usually affected. Soft rot often enters the soft tissue. The cause of brown stem is not known. It appears to be worse during hot, wet growing conditions.

Feather leaf is a loss of chlorophyll (green color) in the inner leaves of mature plants. It detracts from the appearance of the plants but is otherwise not destructive. The exact cause of feather leaf is not known, however, it appears to be more prevalent with closer in-row spacing. During rapid growth, under crowded conditions, the newly expanding leaves may not receive sufficient light to allow chlorophyll to develop. Because it usually occurs in mature celery, it can usually be avoided by harvesting on time. It is rarely seen in cultivars recommended for use in Michigan.

Pencil stripe describes a condition in which dark brown lines appear longitudinally on the inside or outside of the petioles. It appears to be caused by applications of pesticides in combination

with foliar nutrients. It also may be related to low boron and high ammonium levels in the soil. If pencil stripe is a problem, avoid mixing pesticides and foliar nutrients.

Insects

Consult Extension Bulletins E-970, *Celery and Carrot Insect Pests* and E-1427, *Disease and Insect Pests of Celery* for pictures of insect pests and damage and detailed descriptions of life histories. See Extension Bulletin E-312, *Control of Insects, Diseases, and Nematodes in Commercial Vegetables* for current pest control recommendations.

Aster leafhoppers (*Macrosteles fascifrons*), also known as six-spotted leafhoppers, are the major carriers of aster yellows disease. The leafhoppers do little direct damage to celery, but their control is the only way to control the disease. Adults are light gray-green and ⅛ inch long. The aster leafhopper overwinters in Michigan as well as in southern Missouri and Arkansas. Adults begin migrating to celery fields in late May or early June from overwintering hosts such as small grain, grasses and broadleaf weeds (wild carrot, marestail, and pineappleweed). The aster yellows organism is taken up by the leafhopper during feeding. The disease organism must incubate for approximately 3 weeks inside the leafhopper before it can be transmitted to other plants. Check celery fields 1 or 2 times per week, especially when plants are young, and treat for leafhoppers if they are present. Terminate treatment 2 weeks before harvest, since the disease requires at least 2 weeks to cause symptoms in celery.

Variegated cutworms (*Peridroma saucia*) larvae feed on celery stalks and petioles and may be present as a contaminant at harvest. Adults lay eggs on the undersides of the leaves, and the larvae move down into the heart of the plant to feed. Egg-laying in celery begins in mid- to late June and continues until late July or early August. Sex attractant or black light traps can be used to monitor adult activity. Apply routine protective sprays when plants have marketable petioles and adult moths are flying.

Carrot weevil (*Listronotus oregonensis*) can be a serious pest in celery. The tunneling larvae can severely stunt or kill small plants. The adult weevils are brown to black, 5/16 inch long with a medium-length snout. They overwinter in the top 1 to 2 inches of soil and emerge in the spring to lay eggs. They also attack carrots and parsley, and weeds such as dock, plantain and wild carrot. Damage is done by the larvae which emerge about 1 week after eggs are laid.

Because the adults very rarely fly, rotation to a non-host crop is an effective method of control. For rotation to be effective, there must be a barrier, such as a water-filled ditch or a road between the fields, and good control of the weevil's weed hosts. One year of rotation to a non-host crop with proper weed control and field separation will give effective control of weevils for several years.

Because the adults are very hard-bodied and do little feeding, and the eggs and larvae are inside the plant, foliar insecticides provide limited control. Careful scouting and precise timing of insecticide treatment will improve control. For example, insecticides for adult control should be applied after the adults become active in the spring, but before they begin egg laying. Insecticides for larval control should be applied after egg laying has begun, but before serious damage has occurred.

Tarnished plant bug (*Lygus lineolaris*) adults occasionally cause serious damage in celery. They are ¼ to ⅜ inch long, brown to green, with backs shaped like a shield. They attack young leaves in the heart of the plant, sucking plant juices and injecting toxic saliva. Initial damage appears as small, reddish-brown spots on the young petioles. The young leaves die and soft rot sets in. Tarnished plant bugs feed and reproduce on many crops and weeds and move into and out of fields rapidly. Check fields regularly and begin application of an insecticide as soon as plant injury or bugs are evident.

Green peach aphids (*Myzus persicae*) occasionally are an economic pest in celery. If present in large numbers, they can reduce plant growth and contaminate the crop at harvest. Winged aphids

begin migrating into celery fields about mid-June. High populations are usually not present until August. Aphids have many natural enemies, including lady beetles, lacewings, spiders, tiny wasps and diseases, which usually keep aphid numbers low. However, aphid population explosions occasionally occur during periods of hot, humid weather. Frequent applications of insecticides (e.g., synthetic pyrethroids) that do not kill aphids but kill their natural enemies may cause increased aphid problems. Check fields weekly and treat if necessary.

Celery and cabbage loopers (*Anagrapha falcifera* and *Trichoplusia ni*) are similar in appearance: small, green worms, 1 inch long with white stripes on their sides that move by humping their back, and forming a "loop," from which they get their name. Celery loopers overwinter in Michigan and become active in early May. Cabbage loopers migrate into the state and become a problem in late June and July. The damage appears as holes in the foliage and small pits in the petioles. The larvae generally do only minor damage to celery, but may be serious contaminants of harvested celery, and are difficult to wash off.

When the loopers are mature they are hard to control. Therefore, monitor fields regularly for loopers and other insects. Spray with a foliar insecticide when adults or larvae appear and repeat as needed.

Vegetable leafminers can severely injure celery foliage. The larvae tunnel in leaf tissue, causing product contamination and stunted plants if populations are high. Leafminers do not overwinter in Michigan, but may be carried into the state on celery transplants or trimmings, or on other plants, such as chrysanthemums. They are highly resistant to most insecticides. The most effective control is to dispose of infested plants and trimmings by deep burying or composting.

Nematodes are a serious problem in celery production. Northern root-knot, pin, and root-lesion nematodes attack celery and reduce yields. Growth of affected celery is slow and the size of mature plants is reduced by moderate to high nematode populations. Damage is especially apparent during dry periods or in non-irrigated fields.

Although these plant-parasitic nematodes survive on several different crop plants, crop rotation will help reduce infestation. If nematode problems are suspected, have soil and root tissue tested for nematodes. (See Extension Bulletin E-800, *Nematode Detection*). If the nematode population exceeds an action threshold, a management procedure will be recommended.

Diseases

Early blight (*Cercospora apii*) is a serious problem in Ohio and Florida, but less so in Michigan. It is known to attack only celery and celeriac. First symptoms are small yellow spots on both sides of leaves. The spots enlarge, turn gray, and become dry and papery. The entire leaf soon dies. Lesions may also be produced on petioles.

The fungus grows best during warm (71° to 86°F), damp conditions of mid-summer. Heavy dew is especially favorable for disease development.

The spores of the fungus live on celery seed for 2 years. Three-year-old seed appears to be free of the fungus. If symptoms appear in the field, apply a fungicide that will control early blight.

Late blight (*Septoria apiicola*) is a serious disease of Michigan celery. The first symptoms are small (0.2 inch) spots on the leaves containing the small black fruiting bodies of the fungus, which can be seen with the unaided eye. The spots turn gray to tan as the tissue dies. Late blight lesions can be distinguished from early blight lesions by the presence of the black fruiting bodies. The lesions spread to petioles as the disease progresses.

The fungus grows best at 64° to 72°F, temperatures slightly lower than those that foster early blight. It is thus more of a problem in the fall. It is spread rapidly by splashing water and the spores require water to germinate. Infected petioles rot quickly after harvest.

The fungal spores live for up to 2 years on seed, so the use of 3-year-old seed will help prevent the problem. If conditions are good for infection or symptoms appear, apply a foliar fungicide on

a regular schedule. Do not ship or store badly infected stalks.

Two ***bacterial blights*** (*Pseudomonas apii* and *P. cichorii*) affect celery. The spots are yellow at first, then turn rusty red to brown or tan with a slight yellow halo. The spots caused by *P. apii* tend to be distinct and more round than the fungal blights, and are about ⅛ to ¼ inch in diameter. Spots caused by *P. cichorii* are larger and more irregular in shape. If fungicides are applied regularly and the blight persists, it is probably bacterial blight.

If bacterial blight appears, avoid movement of people or machines in fields when leaves are wet. Weekly sprays with fixed copper will help prevent the spread of the bacteria.

Fusarium yellows (*Fusarium oxysporum* f. sp. *apii* race 2) has become a serious problem in many fields in recent years. Fusarium yellows virtually wiped out the Michigan celery industry in the 1940's until resistance was discovered about 1950. A new strain of Fusarium yellows (called race 2) appeared in California about 1960, and appeared in Michigan in the late 1970's. It is now found in most celery growing areas of the state.

Infected plants are stunted, may be yellow, and appear to be deficient in nutrients. Infected young plants often die, but some may survive through the season depending on cultivar and level of soil infestation. The vascular system of the crown of the plant and roots is yellow or brownish red, and brown to red streaks extend into the bases of the petioles.

The fungus lives indefinitely in the soil. Once soil is infested, the only alternatives are other crops or resistant cultivars. Fortunately, there are currently two acceptable cultivars, Utah 52-70 HK and Deacon, that have moderate resistance to Fusarium. Other more resistant cultivars are being developed.

To avoid spread of the disease, do not move machinery or plants between infested and clean fields. Use only healthy transplants.

Pink rot (*Sclerotinia sclerotiorum*) is a fungal disease that attacks mature celery. The disease begins in the field but sometimes develops after harvest and packing. Initial symptoms are small, sunken, watersoaked, white or pinkish lesions on mature petioles. A soft, slimy, pink rot develops on the petioles of the plant. The rotted area is usually covered with a white mold which, if well developed, contains hard, black bodies called sclerotia. The disease develops best under cool (57° to 60°F), wet conditions. The organism is usually present in the soil where celery is grown.

To avoid pink rot, space rows at least 32 inches apart to increase air circulation and apply a fungicide labeled for pink rot to the base of the plants before each cultivation. If symptoms appear in the field, do not pack or store the infected celery.

Celery tissue infected with the *Sclerotinia* organism produces a chemical called psoralin which may cause a rash or severe blistering on human skin after exposure to sunlight. Harvesters and packers should wear long-sleeved shirts to avoid contact with the organism and exposure to sunlight.

Rhizoctonia stalk rot (*Rhizoctonia solani*) causes a rot at the base of the celery stalk. Rhizoctonia lesions are brown and sunken and appear on the outer parts of the petioles. Rhizoctonia causes damping off in seed beds and may be carried to the field on infected plants. Sterilize seed beds to prevent damping off. In addition, treat seedlings with a soil fungicide. Field treatment is the same as for pink rot.

Bacterial soft rot (*Erwinia carotovora*) often invades celery that has been injured by other diseases or insects. A soft, slimy, brown rot covers the heart of the plant. The disease is more of a problem during warm, humid weather. The primary means of control is to avoid other pest problems.

Aster yellows is caused by a very small organism called a mycoplasma, and is spread by aster leafhoppers. It causes extreme yellowing and twisting of petioles, especially on young leaves in the heart of the plant. If the plants are infected early they do not expand completely.

Leafhoppers must be controlled to avoid aster yellows. As soon as leafhoppers appear, apply an insecticide on a regular schedule. Because the organism overwinters

in weeds, clean up fence rows and areas around fields.

Cucumber mosaic virus (CMV) occasionally infests celery in Michigan. The only symptom is brown streaks in the petioles of mature celery. The virus is spread by aphids and mechanical means. A regular insecticide spray program should help prevent virus problems.

Weeds

Annual grasses and broadleaf weeds are the major weed problems in celery. With clean culture, cultivation, and use of herbicides, it should be possible to maintain celery almost free of annual weeds. It is important to control weeds such as wild carrot, pineappleweed, and marestail that serve as hosts for insects and diseases that attack celery.

Perennial weeds, such as yellow nutsedge, and quackgrass, should be killed the year before attempting to grow celery. *Roundup* will kill most perennial weeds if applied at the correct stage of growth (check label for recommendations).

Pesticide Information

Pesticides must be registered with the U.S. Environmental Protection Agency and the Michigan Department of Agriculture before they can be used legally in Michigan. Purchase only pesticides that are labeled for the crop to be treated and the pest to be controlled. Remember that the pesticide label is a legal document on pesticide use and you must follow closely all instructions and limitations specified.The use of a pesticide in a manner not consistent with the label can lead to injury of crops, humans, animals, and the environment, and can lead to civil fines and/or condemnation of the crop. Follow the label for effective, economical, and environmentally sound pest control.

Additional Information

More information on celery production is contained in the following bulletins, available from county Cooperative Extension Service offices, or from the MSU Bulletin Office, P.O. Box 6640, East Lansing, Michigan 48823-6640.

E-312 *Control of Insects, Diseases, and Nematodes on Commercial Vegetables*
E-433 *Weed Control Guide for Vegetable Crops*
E-486 *Secondary and Micronutrients for Vegetables and Field Crops*
E-550 *Fertilizer Recommendations for Vegetable and Field Crops in Michigan*
E-675 *Vegetable Varieties for Commercial Growers*
E-800 *Nematode Detection*
E-890 *Detection and Control of Carrot Weevil*
E-970 *Celery and Carrot Insect Pests*
E-1427 *Disease and Insect Pests of Celery*
E-1736 *Greenhouse Growth Media: Testing and Nutrition Guidelines*
E-1751 *Identifying Diseases of Vegetables*
E-1752 *Cost of Producing Celery in Westcentral Michigan*
E-1823 *Fusarium Yellows of Celery in Michigan*

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