Commercial Vegetable Recommendations

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LETTUCE

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Production

A good yield of head lettuce is 800 50-lb. boxes per acre; under ideal conditions, production can exceed 1,000 boxes per acre. Other types of lettuce yield 600 to 800 25-lb. boxes per acre.

Use

Approximately 80% of the head lettuce grown in Michigan is packed in cartons for the fresh market; 20% is shredded for use in restaurants.

Types and varieties

Several types of lettuce (*Lactuca sativa*) are commonly grown commercially: crisphead (iceberg), butterhead (bibb, Boston), romaine (cos), looseleaf, and stem lettuce. Endive and escarole (*Cichorium endivia*) are closely related to lettuce and grow similarly in the field.

The following crisphead varieties are suitable for production on muck soil:

Montello forms uniform medium-large heads. Medium-size wrapper leaves provide partial to good protection for the head. The midribs are fairly smooth with little ribbiness, but they are quite subject to cracking. Mature heads are firm with a light green basal color. Flavor is acceptable to good. It has some tolerance to corky root rot.

Green Lake is a sister line of Montello. The heads tend to be slightly larger but less firm than Montello. Wrapper leaves provide good cover over the head. Flavor, midrib characteristics, basal color and tolerance to corky root rot are similar to Montello.

Ithaca forms large firm heads with good flavor. The wrapper leaves do not cover the heads well, leaving them subject to sun scald. Leaves are frequently quite ribby (i.e., very large midribs) which results in cracked midribs at harvest. Ithaca is very susceptible to brown rib.

Raleigh is a recently released variety that has done well in Michigan trials for 3 years. It produces large, firm, uniform heads with good flavor. Large wrapper leaves give protection from sun scald. It has some tolerance to corky root rot. Ribs may become brittle and crack as heads become oversize. Because of its large size, Raleigh may be a substitute for Ithaca. Growers should try it on a trial basis only.

Montello, Green Lake, and Ithaca are also suitable for production on mineral soil.

Butterhead: Bibb, Summer Bibb, Buttercrunch, White Boston

Romaine: Parris Island, Valmaine, Rubra (red)

Leaf: Domineer, Grand Rapids, Waldmann's Green

Stem lettuce: Celtuce

Endive: Salad King, Green Curled

Escarole: Broad Batavian, Florida Deep Heart

Climatic Requirements

Lettuce requires a moderate climate to grow well. It is sensitive to both high and low temperatures, and wet and dry conditions. Lettuce seed germinates at temperatures as low as 40°F, but germinates best at 60° to 70°. However, it is subject to thermodormancy at temperatures above 80°F; i.e., the seed will not germinate, or will germinate erratically.

Lettuce grows best in sunny, dry weather, with daytime high temperatures of 70° to 80°F. Temperatures above 85°F result in sun scald (wrapper leaves break down and stick to the head) and tipburn. Temperatures below 30°F will cause severe frost damage to the heads.

Water and Irrigation

Lettuce deteriorates rapidly under wet soil or very humid air conditions. Several foliar and root diseases thrive in a damp atmosphere. However, lettuce seeds need an adequate supply of moisture to germinate uniformly, and the plants need a constant supply of water throughout their growth and development to produce marketable heads. Balancing the need for moisture and the susceptibility to too much water is probably the most difficult aspect of lettuce production in Michigan.

Lettuce seeds should be planted in moist soil. If the weather is hot at seeding, irrigate with ½ inch of water immediately after seeding, and maintain a moist soil surface until the seedlings emerge.

After thinning, lettuce grown on deep muck usually does not require more irrigation before harvest. For lettuce grown on lighter soils, and during extended hot periods without rain on muck soils, subsequent irrigations may be needed. Irrigate with 1 inch of water every 10 to 14 days before heading and every 7 to 10 days during heading. Irrigate in the morning so that leaves dry out quickly. Be conservative, and do not irrigate if rain is expected.

Lettuce is often seeded on the outer edges of raised beds, to avoid a saturated root zone in case of heavy rain or rain following irrigation. This planting system also allows for better

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air circulation around the base of the plants, which helps avoid foliar diseases and bottom rot.

Soil Requirements

Lettuce grows well on both well-drained muck and mineral soils. It is usually grown on muck in Michigan because muck maintains uniform moisture levels better than mineral soil. Heavy soils hold moisture too long and result in root and bottom rots.

Lettuce should be rotated with other crops to avoid a buildup of soil-borne diseases.

Fertilization

An 800-box per acre crop of head lettuce uses approximately 125 lb. N, 50 lb. P_2O_5, and 200 lb. K_2O from the soil. To maintain soil nutrient levels, add 100 lb. N, 75 lb. P_2O_5, and 200 lb. K_2O per crop. On muck soil, maintain a pH of 5.2-6.0. On mineral soils, maintain a pH of 6.0-6.8.

Phosphorus and potassium fertilizer rates should be based on soil test results. The following recommendations can be followed if a soil test is not available.

To prepare muck soil for planting lettuce, broadcast 300 lb. 0-0-60 (180 lb. K_2O); band at seeding (2 inches to the side and 2 inches below the seed) 300 lb. 8-32-16 and 25 lb. manganese sulfate (24 lb. N, 96 lb. P_2O_5, 48 lb. K_2O, 6 lb. Mn). At thinning, sidedress with 50 lb. N. An alternative method is to broadcast 1,000 lb. 5-20-20 before planting, sidedress with 50 lb. N after thinning, and apply manganese as foliar spray.

On mineral soil, broadcast 700 lb. 8-16-32 and sidedress with 50 lb. N at thinning; or broadcast 300 lb. 0-0-60 and band 300 lb. 8-32-16 at seeding and sidedress with 50 lb. N at thinning.

Apply 1 lb. **boron (B)** (10 lb. borax or 5 lb. Solubor) per acre in the broadcast fertilizer each year before planting. If the pH is between 6.0 and 6.4, add 6 lb. **manganese (Mn)** (24 lb. manganese sulfate) in the banded fertilizer; if the pH is above 6.4, add 8 lb. Mn. If Mn deficiency symptoms appear during the growing season, apply 6 lb. manganese sulfate per acre in a foliar spray 2 or 3 times until symptoms disappear. On new mucks testing below 20 ppm **copper (Cu),** apply 3 to 5 lb. copper per acre (12 to 20 lb. copper sulfate) in the broadcast fertilizer each year until a total of 30 to 40 lb. total copper has been applied. Cu deficiency should not subsequently be a problem.

Lettuce is susceptible to tipburn (see below). To help avoid tipburn, spray lettuce plants twice weekly during hot weather with 10 lb. **calcium** chloride or 15 lb. calcium nitrate in 50 to 100 gallons of water per acre. Direct the spray into the center of the plant. Once heads form, this will not help. Leafy type lettuce and endive and escarole are more susceptible to tipburn than are heading types, and calcium sprays will be more effective on them.

Spacing and planting

Land to be planted to lettuce should be plowed shortly before planting, to a depth of 8 to 10 inches. Plowing too early results in loss of soil moisture. Plow deep enough to turn all trash completely under. Disc or roll the land to make a firm, smooth seedbed and sow immediately. If planting on beds, form the beds and sow in the same operation or the same day.

Plant head lettuce in rows 15 to 18 inches apart, with 12 to 14 inches between plants in the row. Large-headed varieties, such as Ithaca, need the wider spacing. Leaf lettuce may be planted 6 to 10 inches apart. It takes ⅓ to ½ lb. of seed to plant an acre of lettuce. Planters that drop 3 to 4 seeds per hill use about ½ lb. of seed per acre in 18 inch rows with 12 inches between hills.

It is important to have uniform plant spacing and growth to obtain uniform head lettuce at harvest. The most consistent uniformity has been obtained by planting pelleted seed with a precision planter and irrigating after sowing to get uniform emergence.

Lettuce should be planted so that it is easy to thin it to the desired spacing. Plant seeds 2 or 3 inches apart, then thin to stand when lettuce is 1 inch high. An alternative system is to drop 3 or 4 seeds every 12 to 14 inches, and then thin to 1 plant after emergence. Lettuce is thinned by hand, using a small hoe or comparable tool. At 18 inches between rows and 12 inches between plants, there is a potential for 29,000 plants or about 1,200 cartons of head lettuce per acre.

Sow seeds ¼ to ½ inch deep into moist soil. During hot, sunny weather, sow in the late afternoon or evening so that seeds germinate before thermodormancy sets in.

Sowing begins as soon as fields can be worked in the spring. Plant twice a week until May 10 and 3 times a week thereafter until August 1. At each date, plant an area of land that will provide enough lettuce for 2 days of harvest. After sowing, irrigate with ½ inch of water, unless soil is uniformly moist.

Harvest and Post Harvest

Head lettuce takes 55 to 75 days from sowing to maturity, depending on temperatures. Lettuce sown in April matures in about 75 days; May or August—70 days; July—60 to 65 days; June—55 to 60 days.

Lettuce is cut and packed in the field. If possible, harvest in the morning to avoid field heat. Head lettuce is packed 18 or 24 heads to a 1¾ bushel carton, weighing about 50 lb. full. A field is mature when most of the heads have reached desirable size and are solid. Most commercial fields are harvested only once.

To maintain quality, lettuce should be vacuum cooled for 30 minutes. If lettuce is dry, it should be sprinkled with water before vacuum cooling. It can be stored for 2 to 3 weeks at 32 to 34°F and 95% R.H. (relative humidity). Lettuce should be kept dry and not iced in transport or storage.

Physiological Disorders

Bolting (seeders) is a result of lettuce maturing during hot, dry weather. Usually the seedstalks do not emerge from the heads, resulting in a condition called internal seedstalk. The heads appear normal externally but have an elongated core inside and are not acceptable in the trade. Bolting is most likely to occur during the hot weather between July 15 and August 10. Production on moist muck land and irrigation during hot, dry periods will help avoid seeder forma-

tion. All varieties recommended for Michigan will bolt given favorable conditions.

Tipburn is a physiological disorder of lettuce caused by uneven distribution of calcium in the plant. It usually occurs during hot weather when lettuce is growing rapidly. Small, brown spots first appear along the outer margins of outer head leaves, then coalesce and form a brown fringe around the leaves. Soft rot often sets in after initial breakdown of tissue by tipburn. Heads with internal tipburn appear normal but are unsalable. Leaf lettuce, butterhead, and endive are more susceptible to tipburn than is crisphead lettuce. Calcium sprays (see above) and good water management are somewhat helpful in preventing tipburn. Most varieties currently grown in Michigan are quite resistant to tipburn.

Brown rib is a physiological disorder sometimes called rib blight or mahogany rib. In early growth stages, the cells of the outside petioles turn pithy and brown. As the disorder develops, leaf tissue also shows brown streaks, both inside and on the surface. Decay caused by soft rot or other organisms then sets in rapidly.

Brown rib is most severe during periods of high humidity and temperature, especially when it rains shortly before harvest. Planting head lettuce on raised beds and avoiding irrigation during the last 2 weeks before harvest will help reduce the incidence of brown rib. The cultivars Great Lakes 659 and Ithaca are quite susceptible to brown rib.

Ribbiness or ribby lettuce is a physiological disorder that prevents normal head development or results in rough, loose heads. The plants have bulky, prominent outer leaf ribs which do not fit tightly around the head. Ribby lettuce is more of a problem during excessively hot days with warm nights. Shading by windbreaks, cloudy weather, and low soil fertility also seem to increase the frequency of the disorder, which suggests that it may be caused by low carbohydrate synthesis by the plant.

Diseases

Aster yellows is a major disease of Michigan lettuce. Infected plants have a yellowish-green color and are twisted and rough, and usually do not fill out. The disease is caused by a mycoplasma (similar to a virus) transmitted by aster leafhoppers. To control the disease, spray insecticides on the field and borders to control the leafhoppers. Also, kill off weeds such as wild lettuce, pineapple weed, horseweed, and Queen Anne's lace that serve as alternate hosts for the disease and leafhoppers. Chop and plow or disc into the ground any plants left in the field after harvest, to remove sources of infection.

A late infection of aster yellows, which causes pink latex spots on internal leaves, is sometimes confused with tipburn.

"Drop" *(Sclerotinia sclerotiorum)* is a common disease of lettuce grown on muck soil, especially during cool, wet periods. Infected plants collapse suddenly, from which the common name, "drop," is derived. Infected plants are covered to some extent by cottony, white mycelia, and black, hard overwintering bodies, called sclerotia, are formed in the cottony mycelial mats. The same organism causes diseases in several other vegetables, including potatoes, carrots, celery, cole crops, tomatoes, beans, and cucurbits. To avoid "drop," rotate to crops not susceptible to *Sclerotinia*, such as onions, spinach, or small grains. Chopping crop residue and allowing it to dry before plowing it under will reduce inoculum in the soil. New fungicides, such as Ronilan and Rovral, have given some control of "drop."

Gray mold *(Botrytis cinerea)* usually begins on older leaves where they touch the soil. The infection spreads to the stem and then into the head. Infected areas are covered with a brown, watery rot; a fuzzy, gray-colored mold develops on the outside of infected tissues. Later in the disease development, small, hard sclerotia appear on the heads. Gray mold develops most rapidly in cool (65 to 70°F) and damp (90 to 100% R.H.) weather.

Botrytis cinerea and *Sclerotinia sclerotiorum* both form sclerotia which remain viable in the soil for many years. If the soil is badly infested, rotation is of little value in avoiding the disease. To reduce incidence of infection, irrigate lettuce only when necessary, and then do it in the morning so the leaves dry rapidly. Apply fungicides on a regular basis.

Bottom rot *(Rhizoctonia solani)* is a major cause of crop loss in Michigan. The organism causes damping off in seedlings early in the season. If infection occurs later, the organism enters the plant through leaves touching the soil and moves up the stem into other leaves. Tissues break down, becoming brown and slimy. The disease spreads rapidly with wet soil and humid air conditions. If the air and soil dry out, the infected areas may also dry out, leaving the plant erect.

To avoid bottom rot, plant on the edges of beds to maximize air movement and water drainage around the base of the plants. Space plants as far apart as feasible. Apply fungicides as recommended to reduce incidence of infection. Maintain nutrient levels to obtain maximum growth. Do not throw soil against the base of the heads during tillage or thinning.

Downy mildew *(Bremia lactucae)* may be a problem during cool (below 65°F) and damp near 100% R.H. weather. The spores are spread by wind and splashing water, and require free water on the leaves to germinate. Symptoms first appear on older leaves. Pale green spots appear on the upper surface of the leaves. On the lower sides of the leaves, a white mold appears on the infected spots. The spots enlarge and coalesce, but usually do not cross main veins. Infected leaves turn brown, and secondary infection often sets in. The heads themselves may not be infected, but unsightly wrapper leaves make them unsalable. Regular applications of fungicides will help reduce downy mildew. Begin spraying when disease symptoms appear.

Lettuce wilt or stunt *(Pythium tracheiphilum)* is a disease that can cause up to 30% loss of stand in lettuce growing on muck. This disease is particularly prevalent in poorly drained areas and during cool-wet weather in May and June. The disease infects both the vascular and leaf tissues, causing wilting and rapid death of the whole plant and a jelly-like decay in the center of the tap root. Good drainage and crop rotation will help reduce the severity of the disease.

Corky root rot is a dry breakdown of lettuce roots. Decomposing lettuce root residue is a major source of the problem. It is primarily a problem where lettuce has been grown for many years. Plants from contaminated soil show browning and swelling of the roots, which appears to be caused by nematodes. As the problem progresses, the tap root and laterals take on a corky, scabby, rough texture which reduces vigor. In advanced stages, it causes death of small seedlings.

To avoid corky root rot, work plant residues into the soil immediately after harvest. Do not plant lettuce after lettuce the same year and use varieties with some tolerance, such as Montello and Green Lake.

Lettuce mosaic virus (LMV) causes mottling and curling of leaves; plants infected early are stunted and do not mature properly. The virus is seedborne and is spread in the field by aphids. Since original infection usually begins with plants from infected seed, the easiest means of control is to plant disease-free seed. Most seed companies list the level of virus infection of their lettuce seed.

Insects

Aster leafhoppers *(Macrosteles fascifrons)* transmit aster yellows, a major disease of lettuce and several other crops. The leaf hoppers are ⅛ inch long, light green, with 6 black spots on the front of their heads. They overwinter on weeds, winter grain, or other plants, or migrate into Michigan on storm fronts, usually first appearing in vegetable crops in mid-May. They may move into lettuce from other crops or weeds anytime from May to September.

Check lettuce fields for aster leafhoppers twice per week, especially after spring storms, and begin insecticide sprays if they are present. Although the leafhoppers do not always carry the aster yellows mycoplasma, there is at present no way to determine their infectiveness in the field.

Cutworms and armyworms may attack lettuce throughout the growing season. Emerging seedlings may be eaten off at the ground by early-emerging larvae. Later generations damage leaves close to the ground and may enter the head. Apply insecticides as soon as damage becomes evident.

Cabbage loopers *(Trichoplusia ni)* may be a serious pest on lettuce after mid-July. The adults migrate into Michigan from the south, and lay their eggs on the undersides of the leaves. The larvae emerge in about 1 week and begin to feed on the foliage. The larvae develop into light-green caterpillars, ¾ to 1 inch long. They obtain their name from their looping action as they move along.

Loopers must be controlled to obtain high quality lettuce. Begin spraying insecticides as soon as eggs or larvae are present, and continue on a regular schedule until the end of the season. Since loopers migrate into Michigan, time of occurrence and numbers vary greatly from year to year.

Aphids cause damage by reducing the vigor of the plants and by contamination of the lettuce with live aphids, honey dew, and cast skins. Peak numbers occur in August.

Plant bugs feed by puncturing leaf tissue and injecting toxic saliva, which causes local dead areas. They are highly mobile, moving into and out of fields but are usually kept under control by insecticide sprays for other insects.

Weeds

Good weed control is important in lettuce production. Several common weeds are alternate hosts of insect and disease pests of lettuce. Young lettuce plants are poor competitors and many will not survive under weed pressure. Unfortunately, there is a very limited choice of herbicides available to control weeds in lettuce grown on muck soil. Keep fields clean, cultivate, hand hoe, and use herbicides to obtain good weed control.

More information on lettuce production is available in the following bulletins, available from your county Extension office or the MSU Bulletin Office, P.O. Box 231, East Lansing, MI 48824. Check with your local Extension office for prices and availability of bulletins.

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-1278 — Botrytis diseases: recognition and control

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