Aster yellows is caused by a mycoplasma carried by the aster leafhopper (Macrosiphum rosae), which is primarily a disease of lettuce, celery, and carrots, but it also infects onion. Onions infected with the disease have soft, small bulbs and long, yellow-green leaves. The bulbs do not dry well during curing and often sprout in storage because they do not become dormant. Under extreme disease conditions, infection may approach 5 to 10 percent. The main problem caused by the disease is poor drying of onion bulbs in storage, which may lead to subsequent rots. Because the disease is transmitted from infected weed and crop hosts by leafhoppers, it can be controlled only by reducing the presence of host plants near onions and controlling the leafhoppers in host crops. It is of little value to spray onions to control aster leafhoppers.

Weeds

Weed control is a major expense and concern in onion production. Onions are very poor competitors, and weed pressure any time before bulb formation will reduce yields. Weeds that emerge late in the season keep onion leaves from drying quickly and interfere with harvest. A good weed control program consists of pre- and post-emergence herbicide applications. Once or twice a season it may be necessary to remove by hand large weeds that have escaped herbicide applications. Cultivation at the two- to four-leaf stage may remove some weeds and help aerate the soil.

Pesticide Information

Pesticides must be registered with the U.S. Environmental Protection Agency (EPA) 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 all instructions and limitations on it must be followed closely. 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 conviction of the crop.

Additional Information

More information on onion production is available in the following bulletins, available from county MSU Extension offices, or from the MSU Bulletin Office, 10-B Agriculture Hall, East Lansing, Michigan 48824-1039. (All orders totaling less than $100 must be prepaid.)

E-312 – Control of Insects, Diseases and Nematodes on Commercial Vegetables.
E-5908 – Fertilizer Recommendations for Vegetable Crops in Michigan.
E-800 – Nematode Detection.
E-972 – Lettuce and Onion Insect Pests.
E-1409 – Temperature and Humidity Guides to Curing and Storing Onions.
E-1721 – Diseases of Onions.
E-1751 – Identifying Diseases of Vegetables.

Production and Use

The average yield of U.S. No. 1 pungent yellow onions in Michigan is 16.5 tons (660 50-lb bags) per acre. With irrigation and good cultural practices, it is possible to obtain marketable yields of 20 to 25 tons (800 to 1,000 50-lb bags) per acre. Spanish onions from transplants yield 500 to 550 bags per acre. Green onions yield 8 to 10 tons (1,000 to 1,200 boxes) per acre. Most Michigan onions are packed for fresh market, either soon after harvest or from storage.

Types and Cultivars

Onions may be classified in several ways: by shape – flat, round or globe; by color – red, yellow or white; by pungency – mild (sweet or Spanish) or pungent; and by bulb shape – long or round. Most onions grown in Michigan are of the pungent yellow globe type. Only long-day cultivars can be grown from seed in Michigan. Intermediate- or short-day cultivars can be grown successfully from transplants. Seed catalogues often give days to maturity for onion cultivars, but these are relative estimates of normal maturity. Maturity is also influenced by the date of planting, weather during the season and location in the state. In a normal year, early-maturing onions (90 to 100 days) that are seeded in April are ready for harvest by late August. Late-maturing onions (110 to 120 days) mature in mid- to late September. Spanish cultivars developed for the northwestern states usually do not mature in Michigan if grown from seed.

Climatic Requirements and Irrigation

Onion is a biennial plant, forming a bulb the year of planting seed and a seed stalk the following year after a period of rest and cold temperature. However, onions can form seed stalks prematurely (bolting) the year of seeding if they are subjected to cold temperatures after reaching the five-leaf stage. Temperatures must be below 50 degrees F for several days to induce bolting. The effect is cumulative – more bolting occurs at lower temperatures and with a longer period of cold temperatures. Some cultivars are more susceptible to cold temperatures than others. Onions grown from sets and transplants are very susceptible to bolting because they can be induced to bolt before planting. Plant onions early in the spring so that the plants produce maximum foliage growth before bolting is initiated in mid-June. May 10 is normally the last day to plant full-season cultivars and to obtain normal maturity. Early-maturing
cultivars can be seeded as late as May 20, but size and yields may be reduced. Onions initiate bulbing in response to day length. Long-day cultivars require at least 14 hours of daylight (10-hour dark period) to initiate bulbing; some require a longer period of daylight. Onion seeds germinate at temperatures above 45 degrees F, but optimum germination occurs at 75 degrees F. Optimum fall growth occurs at 65 to 68 degrees F. Onion seedlings can tolerate light frosts (28 degrees F) but may be killed by colder temperatures. Onions grow slowly in cold, wet soils.

Onions do not tolerate extremely high temperatures well. Growth rate declines when temperatures exceed 90 degrees F for several days. High temperature hastens maturity if it occurs and lingers late in the growing season. This may result in smaller bulbs and reduced total yields. Hot, humid conditions also are conducive to foliar disease development, which may reduce bulb growth. Because of their limited root system, onions require a constant supply of water throughout the growing season. Deep brick soils with a high water table may produce a good crop of onions without irrigation, but most land needs irrigation to produce profitable yields. If rain is inadequate, supply 1 inch of water per week until July 1 and 1.5 inches per week until onions begin to fall over. Dry weather or tops fall over will help onions mature faster, resulting in better quality onions.

**Field Preparation**

Most onions produced in Michigan are grown on muck soils. Deep muck soils are ideal for onion production because of their good water retention, high nitrogen content, ease of nutrient management and ease of harvest. When onions are grown on sandy or marl mucks or mineral soils, more careful irrigation and fertilizer management are required. Onion yields decrease under continuous production. Insects and diseases build up with continuous production of a single crop, and yields and quality often decline. In addition, onions return very little organic matter to the soil, causing soils in continuous onion production to become hard and compacted. Carrots, celery and potatoes are common rotational crops for onions. Corn, sorghum, mint or a small grain also should be included in the rotation every 3 to 5 years to add large amounts of organic active matter to the soil. If possible, plant a rye or barley cover crop in the fall on onion plots. Plow 8 to 10 inches deep shortly before sowing onions to retain as much soil moisture as possible. If the cover crop grows too vigorously, mow it before plowing. After plowing, use a roller to pack the soil to form a firm seedbed, and sow seed immediately.

**Interplanted Cover Crops**

Most seeded onions in Michigan are interplanted with a small grain, which serves as a nurse crop until the onions are well established. The small grain then is killed with a herbicide. Barley is the most suitable small grain for interplanting because of its rapid emergence and upright growth habit. Broadcast 0.8 to 1.0 bushel of barley either shortly before planting or at planting. The small grain seedler should be mounted on the front of the onion planter so that soil moved by the seedler will cover the grain seeds. The small grain should be killed with a granicide when it is 5 to 6 inches tall. It will slowly and continue to provide protection for at least 2 to 3 weeks.

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**Plowing on Raised Beds**

Land subject to standing water may be more productive if onions are planted on raised beds. Form beds with a passive shaper mounted on the onion drill in front of the seed unit. Beds 4 to 6 inches high will raise the plants sufficiently to avoid being covered by water in all but the most severe situations.

**Seed Treatment**

Smut is a serious disease of onions that is best controlled by treating the seed with a fungicide. Seed can be ordered with the fungicide included in a thin coating on the seed or in the pellet of pelleted seed. Fungicides may reduce germination over time. An insecticide for maggot control also may be included in the coating.

**Fertilizer Requirements**

Maintain a pH of 5.3 to 6.5 on muck soil and 6.2 to 6.8 on mineral soils. If the pH falls below these levels, add lime. Apply lime as necessary to raise the pH. Spots with very low pH often occur in shallow or sandy muck soils. Onions growing on these spots appear yellow and small compared with those in the rest of the field because of reduced availability of phosphorus and potassium and possible manganese toxicity. Sample these spots separately from the rest of the field when testing soil pH and apply lime as necessary to raise the pH.

Onions require high soil nutrient levels to attain maximum yields. Where onions will be grown on a regular schedule, it is wise to build up soil nutrient levels so that moderate amounts of fertilizer can be added each year. Maintain a phosphorus (P₂O₅) level of 120 to 150 lb/acre and a potassium (K₂O) level of 500 to 350 lb/acre. Add additional fertilizer on the basis of a complete soil test. Test soil every 2 years.

**Planting on Raised Beds**

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they mature. Also, egg mortality is high because of hot soil surface temperatures during July and August -- eggs are killed by temperature if F or higher, and soil surface temperatures often exceed 140 degrees F. Adults of the second generation emerge in late August and September.

Third generation eggs usually are laid on cultivated or damaged onion transplants, especially those brought in from southern planting. Onion plants should be checked carefully for thrips weekly, prior to transplanting and burying cull onions after harvest to reduce the increase in maggot numbers that may occur at this time. The third part of this management approach is to reduce foliar insecticide treatments to the very minimum necessary to control onion thrips. Foliar insecticides have no effect on onion maggot damage, but they kill natural enemies and increase insecticide resistance in the onion maggot. Alternating insecticides from different chemical groups also will help reduce resistance problems. For example, Amino (a pyrethroid) could be alternated with Lannate (a carbamate). Consult Extension bulletin E-312 for a list of insecticides and their chemical groups and for specific recommendations for control of onion thrips.

Nematodes
Northern root-knot, root-lesion, onion blight and stubby-root nematodes are found in Michigan fields and can reduce yields. If nematode problems are suspected, have soil and root tissue tested for nematodes. (See Extension bulletin E-800, "Nematode Detection.) If nematodes are present in numbers above an action threshold, an appropriate nematode management procedure will be recommended.

Diseases
Smut (Urocytis colchici) is a soil-borne fungus that causes black streaks in the outer bulb scales and leaves of young plants. Leaves often twist and turn yellow. The black streaks in bulbs and leaves are filled with black, dusty spores. Infected young plants usually die, but some infected plants survive to develop small bulbs. Smut infection greatly reduces yields and quality. The fungus overwinters in the soil. Virtually all Michigan onion fields are infected by smut. Symptoms in onions over 2 inches in diameter are the same as for small bulb onions. To avoid Mn deficiency, apply 1/2 lb Mn per acre (10 lb zinc sulfate) in the banded fertilizer at seeding. To determine how much seed per pound is needed, check the number of seed per pound and the germination rate of the seed. Then divide the desired plant population by the number of live seeds per lb to determine the amount of seed required per acre. For example, if there are 100,000 onion seeds per lb and the seed has a 90 percent germination rate, each pound of seed will produce about 90,000 plants. Dividing 300,000 plants per lb by 90,000 live seeds per lb equals 3.3 lb of seed per acre. A seeder used for sowing onions must be adjustable to be able to plant different populations. The seeder also must be able to apply insecticide and fungicide in the furrow with the seed. Onions grow in soil moist 0.5 to 1 inch deep. Dry onions also can be grown from sets. Approximately 800 lbs of sets 7/8 inch or less in diameter are needed to plant 1 acre. Fertilization practices are the same as for seeded onions. Sets usually mature 2 to 3 weeks earlier than onions grown from seed, so harvest should be scheduled to be harvested before frost and should not be stored.
Transplanted onions

Spanish onions mature very late in the season when grown from seed in Michigan. However, they can be grown successfully from transplants. Short-day cultivars will produce large, early onions if grown from transplants that are at least 8 to 10 weeks old at transplanting. They begin to bulb about one month earlier than long-day onions in Michigan. Approximately 120,000 to 140,000 plants are needed to plant 1 acre. Plant the seedlings 3 to 4 inches apart in rows 15 to 24 inches apart with a transplanting machine. The greatest difficulty with Spanish onion production is their susceptibility to bacterial soft rot.

Plants usually are obtained from the southern United States but can be grown in the greenhouse. To have plants ready to plant in April, sow seed in mid-January. Good plants are 1/8 to 1/4 inch in diameter at the base. Trim plants to 4 to 6 inches to facilitate transplanting and to reduce dehydration of the plants in the field.

When plants arrive from the South, they should be planted as soon as possible. If they have to be stored more than two days, open the boxes and remove some plants to allow good air circulation through the boxes. Keep them cool (40 to 50 degrees F) but do not refrigerate below 40 degrees F. They should remain good for about 2 weeks. Do not plant seedlings that have been soft and rotten. If the leaves are dry but bulbs are not soft, you probably will grow.

Seed Storage

Onion seed loses its viability rapidly. Check each lot of seed for germination before planting to determine seedling rate. This is especially important for seed more than 1 year old.

Onion seed can be stored successfully with little loss of viability for 2 to 3 years if kept at 50 percent or lower relative humidity and 32 degrees F. If packed in air-tight containers and refrigerated, seed will last up to 10 years.

During the Growing Season

During the growing season, check onions at least weekly to monitor insects, diseases, weeds and plant nutrition. A rapid response to growth impediments will help keep onion leaves green and ensure a productive harvest. If folk diseases, thrips, nutritional deficiencies or weeds get out of hand, leaves green and ensure a productive harvest. If foliar diseases such as purple blotch, Botrytis blight and downy mildew. If a large portion of foliar tissue dies, yields may be reduced. Good cultural practices and disease control and timely irrigation will help avoid tipburn. When possible, select cultivars with pink root tolerance.

Insects

Onion maggots (Oeilia antiqua) is the most severe pest of onions in Michigan. Photos of onion maggot larvae, pupae, adults and damage are shown in Extension bulletin E-972, "Leek and Onion Pests." The onion maggot is adapted to cool weather and damage is most severe during years with cool, wet spring weather. Onion plant stand may be reduced to 40 to 80 percent in severe situations.

Onion maggots overwinter as pupae in the soil. Adults (1/4 inch long, brownish gray) emerge from overwintering in the early spring and lay eggs on onion bulbs and new seedlings. The first eggs are laid on the volunteers because they are larger and more attractive to the females. Early-seeded onions are more attractive than later plantings because of plant size.

The white, oval-shaped eggs often can be seen at the bases of the plants. They also are laid in cracks in the soil next to the onion plants. Larvae are white, up to 1/4 inch long, with no legs or distinct head region. After larvae hatch from the eggs, they feed on the onion roots and bulbs. When onion plants are small, several plants in a row can be destroyed by one onion maggot before it is fully grown and pupates in the soil under the row. Adults emerge in July and early August.

The second generation of onion maggots (eggs laid from July through early August) is much less damaging than the first generation. Onion maggot females are most attracted to previously damaged onions for egg laying. This is probably because newly hatched onion maggots are not able to penetrate the thick scales that healthy onions develop as