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report on
PLANT
DISEASE

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ASTER YELLOWS

Aster yellows is caused by one or more strains of a minute bacterium that lacks a cell wall and therefore is very difficult to culture. This organism is carried primarily to its host plants (Table 1) by the aster or six-spotted leafhopper (*Macrosteles fascifrons*), and is transmitted during the feeding of this insect. Aster yellows causes severe reductions in yield and quality.

Figure 1. Romaine lettuce infected with aster yellows.

This bacterium can infect over 300 kinds of plants in 48 families, including a wide variety of vegetables, ornamentals, field crops, and weeds. The vegetables most commonly damaged include anise, broccoli, cabbage, carrot, cauliflower, celeriac, celery, chicory, dandelion, dill, endive, escarole, lettuce, white mustard, New Zealand spinach, onion, parsley, parsnip, potato, pumpkin, radish, salsify, shallot, spinach, squash, and tomato. Other hosts that are severely affected include asters, canna, chrysanthemum, delphiniums, flax, gladiolus, marigolds, phlox, veronica, and zinnia. Aster yellows is a common and destructive disease worldwide, although it is rare in areas where air temperatures are above 90°F (32°C) for extended periods. Losses from aster yellows vary among the different host crops; the greatest losses, which approach 80 percent, are suffered by carrot and lettuce.

SYMPTOMS

The most common symptom is a general yellowing, stunting of the plant, and rosetting of leaves (Figure 1). On plants that produce a cluster of leaves, the older and outer ones are usually of normal size but may show some purple or red color on the leaf margins; the inner younger leaves are usually dwarfed, yellowed, and may have small brown specks along the margins. The tight rosette or "witches'-broom" is caused by the development of normally dormant buds. On Solanaceous hosts, such as tomato or potato, the leaves curl and twist and turn purple or yellow. The plant is stunted and takes on a stiff, upright growth habit. Normally dormant buds in leaf axils develop into shoots and give plants a bushy, yellowish appearance. Some vascular discoloration and wilt may be associated with the disease. Because of the purple color, the disease is often called "purple top" on

Figure 2. (Top) Healthy carrot; (Bottom) Carrot infected with aster yellows.

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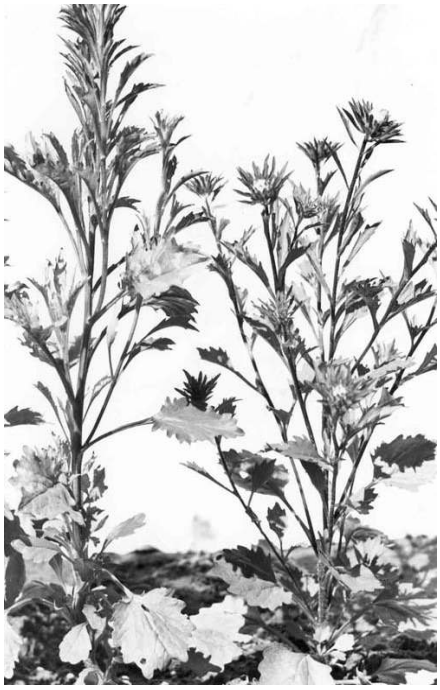

Figure 3. Spindly growth of asters, with branches forming actue angles with the main stem, is typical of aster yellows (IL Natural History Survey photo).

these crops. Taproots, especially those of carrot, develop excessively hairy roots (Figure 2). The roots are tapered, pale, and have a bitter taste. Floral organs are distorted and seed is rarely formed. Leaves often form where flowers should be present and flower petals are frequently green.

Infected ornamental plants are usually yellowish, stunted, stiff and erect, with numerous spindly secondary shoots (Figure 3). Flowers on such plants are often a sickly yellow-green wholly or in part, dwarfed, or lacking (Figure 4).

DISEASE CYCLE

Aster yellows overwinters in infected perennial and biennial hosts, plants in greenhouses, bulbs, corms, tubers, or other propagative stock. Perennial weeds that commonly serve as overwintering hosts in northern states include: thistles, plantains, wild carrot, wild chicory, dandelion, fleabanes, wild lettuce, daisies, black-eyed Susan, rough cinquefoil, and many others (see Table 1). Overwintering also occurs in adults of the leafhopper vector but not in leafhopper eggs.

Aster leafhoppers (Figure 5) acquire the bacterium when feeding on winter grain crops in southern states, such as Arkansas or Oklahoma. In the spring, as wheat and barley mature and are no longer desirable food sources, the leafhoppers leave the grain fields and are carried north by wind. In this way, leafhoppers are distributed over the length and breadth of the upper Midwest. Leafhoppers also overwinter in northern states, such as Illinois, as eggs on wheat, barley, rye, and native grasses. These leafhoppers remain there, feed after hatching, and remain until the cereals ripen or the grass is mowed. The adults then migrate to a neighboring crop or weed plants.

The relationship between the leafhopper and bacterium is an intimate one. The leafhopper acquires the organism by feeding on the phloem cells of an infected plant. After a minimum of 11 days in the insect, the leafhopper transmits the bacterium to another plant when it feeds. Multiplication of the organism occurs within the leafhopper; therefore, the insect can transmit the disease throughout its life, 100 days or longer.

The bacterium must also grow and reproduce in a plant before a leafhopper can acquire and transmit it to another plant. This incubation period varies depending on the temperature (9 days at 78°F or 25°C, 18 days at 68°F or 20°C, and up to 40 days at temperatures close to 50°F or 10°C) and on the maturity of the plant. Once a plant is infected, it remains so for life. Leafhoppers apparently cannot acquire the bacterium from tomato or potato plant hosts. Also, since the organism is totally dependent on leafhopper transfer, the disease will occur most often on hosts on which the leafhopper prefers to feed.

Figure 4. Aster flowers from a plant affected by yellows. The normal color of the petals was purple; the light-colored petals in the photograph had turned a yellowish green. Affected flowers are usually dwarfed, deformed, or lopsided (IL Natural History Survey photo).

The presence of aster yellows is not always correlated with the number of leafhoppers in a field. Other important considerations are the relative abundance and species of overwintering infected host plants, temperature (this affects insect mobility and the incubation period for the bacterium in both the plant and leafhopper), the number of leafhoppers migrating from the south carrying the organism, and other climatic conditions which affect plant growth and insect behavior. Each year, entomologists monitor the movement of leafhoppers up the Mississippi River Valley and determine the percentage of leafhoppers carrying the organism. From this information, the severity of early season aster yellows can be predicted, since early season spread is primarily from the southern migrants and not from overwintering leafhopper eggs in the north.

Figure 5. Aster leafhopper (Macrosteles fascifrons).

High temperatures inactivate the bacterium in insect vectors and plants. Leafhoppers can be freed of the organism by exposing them to a temperature of 88°F (31°C) for 10 to 12 days. Thus, when a hot spell lasts for more than two weeks, the infectability of the vector is much reduced and symptom remission may occur in infected plants. This explains why this disease is rare or absent in hot areas of the world.

CONTROL

Aster yellows is difficult to control because of the number and diversity of plants attacked (Table 1), and because of the lifelong infectiousness of a very efficient insect vector.

1. Where possible, eradicate all susceptible overwintering hosts in and around crop and ornamental plantings. Destroy infected plants as soon as they appear.

2. Do not plant a susceptible crop next to a yellows-infected crop.

3. Spray susceptible plants with an insecticide suggested by Illinois Extension Entomologists to control the aster leafhopper. Refer to Illinois Extension Circular C1373, Midwest Vegetable Production Guide for Commercial Growers (revised annually) available from ITCS, P345, 1917 S. Wright St. Ext., Champaign, IL 61820 or your nearest Extension office. Spray before removing infected crop plants.

4. Weed hosts growing near crops in fields, fence rows, ditch banks, and roadways should be destroyed or should be sprayed early and repeatedly with insecticide to help prevent the spread of disease from these reservoirs.

5. Fast-growing crops such as lettuce or valuable crops such as asters and chrysanthemums should be grown under a cloth screen (22 threads to the inch) or wire screening (18 threads to the inch).

6. In small plantings, placing aluminum foil strips as a mulch between the rows is thought to increase control because leafhoppers are disoriented by bright light from below.

7. In small plantings, removing the first infected plants may slow the spread of the disease.

8. There are no resistant or immune crop varieties available.

Table 1. A partial list of plants susceptible to the aster yellows bacterium.

Vegetables	Ornamentals		Field Crops and Weeds
anise	alkanet or bugloss	goldentuft	barley
broccoli	amaranthus	hydrangea	bidens
cabbage	anemone	jacobs-ladder	birdsfoot trefoil
carrot	asters	Japanese hop	buckwheat
cauliflower	babysbreath	Joe-pye-weed	camomile
celeriac	begonias	larkspur	carrot, wild
celery	black-eyed Susan	lavender, dwarf	chicory, wild
celtuce	boneset	linarias	cinquefoil, rough
chicory	browallia	lobelia	cudweed
cucumber	bur-marigold	marigolds	daisies
dandelion	buttercup	mignonette	dandelion
dill	butterfly-flower	monkeyflower	feverfew, American
endive	calendula	mullein-pink	fieldcress, yellow
escarole	California-bluebell	nasturtium	flax
lettuce	California-poppy	nemesia	fleabane, daisy
mustard, white	camomile, yellow	nemophila	galinsoga
New Zealand spinach	campanula	pansies	globethistle
onion	canna	periwinkle	goatsbeard
parsley	cape-marigold	petunias	bumweed
parsnip	catchfly	phlox	hawkweed
pea	catchfly, German	pimpernel	heliopsis
potato	centaureas	pink, dwarf	henbane
pumpkin	centranth	piqueria or stevia	horseweed
radish	China-aster	poppy	lettuce, wild
salsify	chrysanthemums	primroses	matricary
shallot	cineraria	pyrethrum	milkweed
spinach	clarkia	safflower	mullein
squash	clockvine	salpiglossis	oxslip
tomato	collinsia	salvia	parthenium
	coltsfoot, sweet	scabiosa	pineappleweed
	coreopsis	sea-lavender	plantains
	cosmos	sea-pink or thrift	purslane
	daisies	slipperwort	ragweed
	delphiniums	snakeroot, white	sandverbena
	dragonhead	strawflower	scorpionweed
	English daisy	sunflower	senecio
	erigerons	sunrose	sowthistles
	everlasting, yellow	Swan River daisy	tarweed
	fall-dandelion	sweet pea	thistles
	false-dragonhead	tasselflower	
	forget-me-not	thistle, decorative	
	gaillardia	tobacco, Indian	
	gilias	veronica	
	gladiolus	violets	
	gloxinia	Virginia stock	
	godetia	wallflowers	
	golden-glow	zinnias	