ASTER YELLOWS

With the development of specialty cut flower production in Kansas, we are seeing some of the challenges that growers will face in production. The 1992 growing season will perhaps be remembered as the year it was difficult to grow statice and other flowers susceptible to aster yellows. Normally, each year low to moderate levels of aster yellows occur in flower production fields. However, 1992 losses throughout Kansas attributed to aster yellows ranged from 10–70 percent of certain flower plantings.

Aster yellows is caused by a mycoplasmalike organism, a microorganism intermediate between bacteria and viruses. While several strains of the organism have been reported, the eastern strain and the western or California strain are considered most common. The organism is located in the phloem tissues of infected plants and causes a variety of disorders such as distortion, discoloration, stunting and tissue proliferation. Eventually it may kill the plant.

Aster yellows has a broad host range (Table 1), encompassing more than 200 dicot plant species in more than 40 plant families worldwide. The disease is transmitted from plant to plant primarily by the aster leafhopper, *Macrosteles quadrilineatus* Forbes, (Homoptera: Cicadellidae). The highest plant infection rates are thought to be a result of infective aster leafhoppers migrating from southern states. Transmission by native aster leafhoppers acquiring the mycoplasmalike organism from local perennial or biennial plants is thought to account for only a small percentage of aster yellows infections.

Symptoms

Aster yellows has a range of characteristic symptoms which vary with the strain of aster yellows organism, timing of infection, plant species, temperature, age and/or size of the plant. Because of these variables, each plant infected with aster yellows may not display the same symptoms. This symptom variability, along with the broad host range and the habits of the insect vector (leafhopper), makes control difficult. Aster yellows can also be confused with symptoms of growth regulator herbicide damage and the occasional genetic disorder.

Initial symptoms of aster yellows usually appear as vein clearing, which spreads until the entire leaf becomes chlorotic. This is distinguished from nutrient deficiency, in which the veins remain green while the leaf blade becomes chlorotic. As the plant develops, the yellowing caused by aster yellows may spread, or it may remain restricted to one side or section of the plant, the remainder appearing healthy. Mature leaves generally do not change color, but new growth will be yellowish-green. Infection early in the growing season will almost always cause stunting, shortened internodes, and dwarfed, deformed or lopsided flower heads. If infection occurs late in the season, the flowers will be deformed and remain yellowish-green regardless of the variety's normal color. With heavy infections, no flower production will occur.

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One indicative symptom of aster yellows is adventitious shoot proliferation, which appears as a mass of leaves with a bushy or witch's broom effect in place of normal flower production. These leaves are yellowish-green and are smaller and thinner than normal. In late-season, the foliage may become red or bronze colored. Also, the root system of a plant with aster yellows is smaller than normal, predisposing the roots to field or storage diseases.

Aster Leafhoppers

Adult aster leafhoppers are 4mm, slender, wedge-shaped insects with wings held in a rooflike manner over their abdomens. Their nearly transparent wings have a slight tinge of color, ranging from straw-brown to light green. Their heads may have distinctive black spots, visible with the aid of a 10x hand lens. Or, there may not be any black spots. Individual leafhoppers are difficult to observe because of their small size. They are very skittish and fly away when approached. Observers report seeing "little, light-colored, gnat-sized bugs," not realizing they may have been seeing leafhoppers.

As is the case with all Homopterean insects, aster leafhoppers have piercing, sucking mouthparts (stylets), which they use to suck plant juices from deep phloem tissues. They spread salivary secretions while feeding. It is through this saliva that aster yellows is transmitted.

Aster Leafhopper Development. Leafhoppers are paurometabolous; their development is described as gradual or direct. They begin life in the egg stage. The nymphs which emerge from the eggs resemble the adult insects, but lack wings. Nymphs develop gradually, periodically shedding their outer skins as they grow. At maturity, nymphs shed their skins one more time, and pass directly to the adult stage.

This cycle begins when a female leafhopper uses her ovipositor to insert eggs into leaf tissues. Newly emerged nymphs exit the leaf and begin feeding. The duration of their five nymphal stages varies with the host plant and temperature, with more rapid development occurring at warmer temperatures. In general, development from egg to adult takes 21–35 days at temperatures from 68–82°F.

Migrant and Native Populations. Few specific details of aster leafhopper populations in Kansas have been documented. However, there are definitely two population types: migrant and native. Migrants from south and southeast of Kansas in portions of Texas, Louisiana and Oklahoma ride southerly winds into Kansas perhaps as early as mid-March. The heaviest concentration of migrant leafhoppers typically arrives in mid- to late April. These migrants rest and feed before leaving Kansas as they continue their northward migration.

Native aster leafhopper populations arise from overwintered eggs deposited the previous fall in winter grains—mainly wheat. These eggs do not hatch until late spring, after the first wave of migrants arrive in Kansas. The leafhopper nymphs begin their development on wheat plants. As the wheat matures, they seek alternate host plants—flower crops—upon which to complete development. There is a complete second generation in Kansas. It is not known whether the second generation or possibly a third generation deposits overwintering eggs.

Aster Yellows Transmission

Once an aster leafhopper feeds on and acquires the mycoplasmalike organism from an infected plant, 3 weeks will elapse before that leafhopper can transmit the disease to another plant. During this incubation period, the mycoplasmalike organism multiplies within the leafhopper and moves to the salivary glands, from which it will be injected into healthy plants as the leafhopper feeds. Some of the migrants which acquired the aster yellows organism in their overwintering area may have passed through the 3-week incubation period by the time they reach Kansas. Any plants in the field, likely to be small at this time, are thus susceptible to infection when the leafhoppers rest and feed before resuming their northward migration.

In Kansas, native leafhoppers are probably less important in aster yellows transmission. In wheat fields, first generation nymphs emerging during late spring do not feed on infected plants during their development. As adults, they would have to encounter an inoculum source outside the grain field and then pass through the 3-week incubation period before becoming infective. Because flowering plants are larger later in the season, the initial amount of mycoplasmalike organism injected into the plant might not be sufficient to cause symptoms immediately. The organism would have to propagate to a high enough concentration in the plant to adversely affect flower production.

Similarly, second-generation leafhoppers are of minor importance in transmitting aster yellows. The mycoplasmalike organism is not transmitted from parent to offspring through the egg. Thus second-generation nymphs or adults would have to feed on infected plants to acquire the organism. By the time they would become infective, most annuals used as specialty cut flowers already would have been harvested.

Infectivity Rates of Migrant Aster Leafhoppers

University of Wisconsin entomologists have developed an Aster Yellows Index on which vegetable producers in Wisconsin base their decisions to spray for aster leafhoppers. Decisions are based on a crop's particular level of susceptibility to aster yellows, on the number of leafhoppers present as determined by sweep net sampling, and on the percent infectivity rate. Generally, infectivity rates are less than 1 percent. In some years, infectivity rates may be 4–5 percent. The infectivity rate in 1992 was 10 percent, the highest in 30 years. This index might be useful to cut flower growers in northern states who would have information on infectivity rates well before the arrival of the migrant aster leafhoppers. Cut flower growers in southern regions such as Kansas are too close to the source of migrant leafhoppers to use the information.

Treatment Options

The variable nature of the disease and the sporadic way it spreads make control of aster yellows difficult. Control requires an integrated management approach, combining early detection and monitoring, eradication of infected plant material, and control of the aster leafhopper.

Monitor the flower crop and surrounding areas at regular intervals during the growing season, examining the crop for disease symptoms and aster leafhoppers. Rogue infected plants and remove piles of infected plant material from the field. Control weeds in and around the field to prevent infection of an alternate host and overwintering of the disease. Avoid planting annuals near susceptible perennial or biennial plants in the field.

A preventive strategy is to apply the systemic insecticide DI-SYSTON 15% Granular at planting time. If plants are seeded directly into the ground, apply the insecticide as an over-the-row band treatment. If plants are transplanted into the field, apply the insecticide as a side-dress treatment. This treatment should kill aster leafhoppers for 45-60 days, before they can successfully transmit the aster yellows mycoplasma. Treatment and residual effectiveness depend on moisture availability in the soil; if the soil becomes too dry, the insecticide will not be in solution for uptake into the plant via the root system. Irrigate periodically to better ensure effectiveness. As noted on the label, when applying DI-SYSTON 15% Granular by hand, wear heavy rubber or latex gloves with no holes or tears, protective clothing and footwear.

Some foliar sprays registered for use against leafhoppers on ornamentals in 1993 include formulations with the following active ingredients: azinophosmethyl (Guthion), bifenthrin (Talstar), carbaryl (Sevin), chlorpyrifos (Dursban and Pageant), cyfluthrin (Tempo and Decathelon), diazinon, ethyl parathion (Parathion 25WP), fluvalinate (Mavrik) and permethrin (Ambush and Pounce). Apply treatments when leafhoppers appear in the field, and reapply as needed. Read labels to determine whether specific products are registered for use against leafhoppers on target ornamentals. Follow label directions on use rates and phytotoxicity.

Table 1. A Partial List of Plants that can be Infected with Aster Yellows

Family: Genus/species	Common name
Amaranthaceae	
Amaranthus retroflexus	Rough pigweed
Apiaceae	
Anethium graveolens	Dill
Apium graveolens	Celery
Apium graveolens rapaceum	Celeriac
Coriandrum sativum	Coriander
Daucus carota	Carrot
Pastinaca sativa	Parsnip
Apocynaceae	
Catharanthus roseus	Periwinkle
Asclepiadaceae	
Asclepias nivea	Common milkweed
Asteraceae Compositae	
Anthemis cotula	Mayweed

Family: Genus/species	Common name
Aphanostephus humilis	Lazy daisy
Bidens frondosa	Beggar-ticks
Bidens pilosa	Hairy bur marigold
Brachycome iberidifolia	Swan River daisy
Calendula officinalis	Pot marigold
Centaurea americana	Basket flower
Centaurea cyanus	Cornflower, Bachelor's button
Chrysanthemum carinatum	Tricolor chrysanthemum
Chrysanthemum cinerariifolium	Pyrethrum
Chrysanthemum coronarium	Crown daisy
Chrysanthemum frutescens	Marguerite daisy
Chrysanthemum segetum	Corn chrysanthemum
Conyza canadensis	Horseweed
Cichorium endivia	Endive
Cichorium intybus	Common chicory
Coreopsis grandiflora	Tickseed
Coreopsis lanceolata	Tickseed
Cosmos bipinnatus	Cosmos
Dyssodia wrightii	Fetid marigold
Erigeron canadensis	Horseweed
Erigeron linifolius	Flax-leaved fleabane
Erigeron philadelphicus	Philadelphia fleabane
Gaillardia pulchella	Annual blanket flower
Galinsoga parviflora	Small flower galinsoga
Gnaphalium decurrens	California everlasting
Gnaphalium ramosissimum	Pink everlasting
Helenium autumnale	Common sneezeweed, Helen's flower
Helenium latifolium	Sneezeweed
Asteraceae	
Helenium nudiflorum	Purple sneezeweed
Helenium puberulum	Rosilla
Helianthus annus	Common sunflower
Helichrysum bracteatum	Strawflower
Hemizonia corumbosa	Coast tarweed
Lactuca spp. *(altaica, canadensis, floridana, graminifolia, indica, perenis, muralis, raddeana, saligna, spicata, squarrosa, virosa)*	Lettuce
Lactuca sative	Garden lettuce
Lactuca scariola var. *integrata*	Prickly lettuce
Leontodon autumnalis	Fall dandelion
Matricaria suareolens	Pineapple weed
Parthenium hysterophorus	Santa Maria
Picris echioides	Bristly oxtongue
Pyrrhopappus multicaulis	False dandelion
Rudbeckia hirta	Hairy coneflower, Black-eyed Susan
Scorzonera hispanica	Black salsify
Senecio vulgaris	Common groundsel
Sonchus oleraceus	Common sowthistle
Tagetes erecta	African or American marigold
Tagetes patula	French marigold
Tragopogon dubius	Western salsify
Tragopogon porrifolius	Oyster plant
Verbesina enceliodes	Crownbeard
Zinnia elegans	Zinnia
Begoniaceae	
Begonia semperflorens	Wax begonia
Boraginaceae	
Myosotis scorpiodes	Forget-me-not
Brassicaceae (Cruciferae)	
Armoracia rusticana	Horseradish
Brassica campestris	Common yellow mustard
Brassica oleracea var. *botrytis*	Cauliflower
Brassica oleracea var. *capitata*	Cabbage
Brassica oleracea var. *italica*	Broccoli
Capsella bursa-pastoris	Shepherd's purse
Cheiranthus cheiri	Wallflower
Raphanus sativus	Radish
Rorippa curvisiliqua	Western yellow cress
Sisymbrium irio	Mustard
Campanulaceae	
Lobelia erinus var. *compacta*	Edging lobelia
Caricaceae	
Carica papaya	Papaya
Caryophyllaceae	
Dianthus barbatus	Sweet William
Dianthus caryophyllus	Carnation
Gysophila paniculata	Baby's breath
Spergula arvensis	Corn spurry
Stellaria media	Common chickweed
Chenopodiaceae	
Spinacia oleracea	Spinach

Family: Genus/species	Common name
Cistaceae	
Helianthemum chamaecistus	Rockrose
Cucurbitaceae	
Cucurbita muschata	Musky gourd
Cucurbita pepo	Pumpkin
Datiscaceae	
Datisca cannabina	Akalbir
Dipsacaceae	
Dipsacus fullonum	Fuller's teasal
Scabiosa atropurpea	Pincushion flower, sweet scabious
Fabaceae (Leguminosae)	
Medicago hispida	Bur-clover
Trifolium fragiferum	Strawberry clover
Trifolium hybridum	Alsike clover
Trifolium pratense	Red clover
Trifolium repens	White clover
Geraniaceae	
Erodium cicutarium	Redstem filaree
Erodium moschatum	Whitestem filaree
Gesneriaceae	
Didymocarpus horsfeldii	——
Iridaceae	
Gladiolus x *hortulanus*	Gladiolus
Labiatae (Lamiaceae)	
Lamium amplexicaule	Dead henbit nettle
Salvia azurea	Azure sage
Liliaceae	
Allium ascalonicum	Shallot
Allium cepa	Onion
Loasaceae	
Blumenbachia hieronymii	
Cajophora lateritia	
Malvaceae	
Malva parviflora	Little mallow
Malva rotundifolia	Common mallow

Family: Genus/species	Common name
Onagraceae	
Clarkia concinna	Red ribbons
Clarkia unguiculata	Clarkia, farewell-to-spring, godetis
Epilobium californicum	California willow herb
Epilobium paniculatum	Panicled willow herb
Gaura lindheimeri	White guara
Papaveraceae	
Eschscholzia californica	California poppy
Plantaginaceae	
Plantago major	Great plantain
Plumbaginaceae	
Limonium sinuatum	Annual statice
Poaceae (Gramineae)	
Avena sativa	Oats
Polemoniaceae	
Gilia capitata	Globe gilia
Phlox drummondii	Annual phlox
Polygonaceae	
Polygonum convolvulus	Black bindweed
Rumex acetosella	Sheep sorrel
Portulacaceae	
Calandrinia grandiflora	Rock purslane
Portulaca oleracea	Purslane
Primulaceae	
Anagallis arvensis	Scarlet pimpernel
Primula polyantha	Primula
Ranunculaceae	
Anemone coronaria	Poppy anemone
Consolida (Delphinium) ajacis	Rocket larkspur
Delphinium x cultorum	Hybrid larkspur
Nigella damascena	Love-in-a-mist
Ranunculus asiaticus	Persian buttercup
Rosaceae	
Fragaria x ananassa	Garden strawberry
Geum chiloense	Geum

Family: Genus/species	Common name
Scrophulariaceae	
Linaria bipartita	Clover-lip toad flax
Linaria canadensis	Oldfield toad flax
Mimulus cardinalis	Scarlet monkey-flower
Mimulus guttatus	Common monkey-flower
Veronica americana	American speedwell
Veronica buxbaumii	Byzantine speedwell
Solanaceae	
Lycopersicon esculentum (L. lycopersicum)	Tomato
Nicotiana rustica	Wild tobacco
Petunia x hybrida	Garden petunia
Salpiglossis sinuata	Painted-tongue
Solanum nigrum	Black nightshade
Solanum tuberosum	Potato
Tropaeolaceae	
Tropaeolum majus	Garden nasturtium
Urticaceae	
Urtica californica	Nettle

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