DISEASES OF DRIED FLOWERS IN MINNESOTA

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Production of cut dried flowers is a relatively new industry in the United States and even more so in Minnesota. There are several important diseases that affect the quality and marketability of these plants. The following is a discussion of the major pathogens found on some of the common field grown cut dried flowers in Minnesota.

SOIL PATHOGENS

Seed rot, seedling damping-off and root rot caused by Pythium spp. can result in reduced quality and yield of field grown annuals and perennials. Since most plants grown for dried flowers are established in the field with transplants, Pythium seed rot is not a problem; an exception to this of course is the seeding and production of transplants in the greenhouse. However, root rot can become a concern once the transplants have been planted especially in poorly drained soils. Older plants are seldom killed by this pathogen but the stem and roots can be affected to the point where quality and yields are drastically reduced.

Symptoms caused by Pythium spp. can vary with age and stage of development of the plants. Seeds attacked by the pathogen fail to germinate and this is reflected by a poor stand. Some seedlings may become infected after the seeds germinate and become established above ground. This phase of the disease is called post-emergence damping off. Initial infection of the seedling appears as a dark water-soaked spot which usually occurs at or below soil-line. The infected area enlarges rapidly and the cells collapse and seedling topple over on the soil and soon wither and die. Juvenile roots of older plants that are attacked by Pythium spp. are discolored and slough off leaving only stele of the root which is not usually infected by the fungus, this results in stunting, wilting and sometimes death of the plant.

Soil temperatures of 65-70^{o}F are conducive for disease development especially in poorly drained soils where the soil is maintained at or near saturation for extended periods. Excessive soil nitrogen also favors disease development. Pythium spp. can survive in soil for years as resting spores or on dead plant debris found in soil.

Pythium diseases of seeds and seedlings of annuals and perennials grown in the greenhouse to be used as field transplants can be controlled by seeding into pasteurized planting media. However, control can be more difficult when transplants are planted into the field. It is very important to plant disease free vigorously growing transplants into a well drained soil. The use of raised beds is highly recommended. Excessive nitrogen applications should avoided. Allow sufficient space between rows and plants to provide

for free air movement. Water management is most efficiently accomplished through trickle irrigation. Diseased plants should be removed immediately and destroyed.

Rhizoctonia solani, another soil-borne pathogen represents a potential threat to commercial production of field grown dried flowers. As with Pythium, Rhizoctonia is commonly found in soil and can cause a loss in yield and quality.

Rhizoctonia rot and wilt affects plants at any stage of development from seed rot, recently emerged seedlings and mature flowering plants. This pathogen can occur with Pythium damping-off complex that affects germinating seed and seedlings either as pre or post emergence disease.

Symptoms expressed by older mature flowering plants infected with Rhizoctonia vary considerably. Sunken discolored lesions 1 to 2 cm long commonly occur near or below the soil line. The lesions may be difficult to detect initially but in time discoloration of the stem becomes evident. Splitting the stem through the infected area will reveal the dry decay which usually extends completely through the stem. The lower leaves on the plant turn chlorotic and become necrotic. As the disease progresses, more leaves in the upper portion of the plant continue to wilt and turn necrotic and the plant soon dies. Although it is not uncommon to have sections or portions of the plant die rather than the entire plant. Symptoms on the stem include progressive stem decay; in fact the entire stem is encompassed with a tan-colored dry rot. Plants infected with Rhizoctonia usually exhibit a dry rot, in contrast, plants infected with Pythium spp. which exhibit a soft wet rot. Warm soil temperatures (70-75^{O}F) of intermediate moisture favor the development of Rhizoctonia rot on most flowering field grown plants. Control of this disease include the culture practices discussed under Pythium disease section.

Fusarium root rot caused by Fusarium solani can often times be found in roots of flowering plants infected with Rhizoctonia or Pythium. The importance of this pathogen in the root rot complex is not clear; additional studies are needed to determine the root rot capabilities of Fusarium on the annuals and perennials grown for dried flowers. In general, Fusarium solani growth and development is favored by warm soil temperatures (70-75^{O}F) and if dry soil conditions occur after infection, this will add to the severity of root rot. Soil compaction, high or low pH can adversely affect plant growth and thus, root rot severity is increased. Control of Fusarium root rot is similar to those methods previously discussed for Rhizoctonia and Pythium.

During the 1988 growing season in Minnesota, Pythium, Rhizoctonia, or Fusarium were cultured from severely rooted roots and stems of the following plants: Acroclinum, Ammobium, Larkspur, Gomphrena, Helichrysum, Celosia, Achillea and Limonium.

There are many different types of fungicides that can provide control of root rot pathogens. However, it is the responsibility of the user to read and follow label instructions prior to application of any fungicide. Contact your local county extension agent for additional information on soil fungicides.

FOLIAR DISEASES

One of the most important foliar diseases that affect most flowering plants (greenhouse and field grown) is Botrytis. This pathogen can affect the flowers, leaves and stems causing severe damage and loss in quality of product. The fungus is generally known as "gray mold" because of the tremendous number of gray spores produced on plant tissue. Control of Botrytis blight is difficult because the fungus can attack various plant parts at any stage of growth, because it survives well as a saprophyte, rapid growth rate, rapid rate of spore formation and the susceptibility of many host plants. The spores of Botrytis are disseminated by wind, splashing water, and on dead infected plant parts. High moisture conditions and cool temperatures (50-60^{o}F) are favorable for disease development.

The spores germinate and penetrate plant through undamaged tissue, natural openings or wounds. As the disease progresses, especially under favorable environmental conditions, the affected tissue may become covered with a mass of fuzzy gray spores.

Symptoms of initial Botrytis infections include small water-soaked spots on the leaves, stems or blossoms. The spots enlarge, rapidly coalesce and large portions of the tissue becomes withered and gray-brown. The spores produced then serve as inoculum for new infections on the same plant or on plants in the surrounding area. Symptoms of Botrytis infection on blossoms are characterized by premature fading and dying of the petals which then drop. Symptoms of Botrytis on spikes of field grown Antrirhinuim include pale, brown lesions with darker brown concentric rings. Infected spikes wilt, withers and dies. The lesions sometimes appear as bleached or tan spots on stems or petioles. Based on the discussion thus far, it becomes apparent to the reader that symptoms produced by Botrytis on susceptible plants vary from blights, to spots, stem cankers, blotches and that many plant parts are affected.

Control of Botrytis requires the grower to practice strict sanitation. Dying or dead plants including leaves should be removed and destroyed. This includes weeds as they may serve as a host for the pathogen. Continue sanitation practices throughout production period. Plant disease free transplants and avoid injury to plants at the time of transplanting into the field. It is important to avoid overhead irrigation (trickle irrigation is recommended). Space plants so that leaves do not touch; this will allow air to move freely between plants and rows. There are several different types of fungicides that provide good control of Botrytis. However, the cultural practices listed above must be a part of the strategy to manage this disease. Exclusive reliance on fungicides will not provide effective control. Information on fungicides and Botrytis can be obtained by contacting the Extension Service in your state.

Another important foliar disease of dried flower plants is powdery mildew caused by Erysiphe spp. This fungus, like Botrytis, can attack many different host plants and is commonly observed on many of the annuals and perennials that are grown for cut dried flowers. Thus the quality and marketability of plants are affected by this disease.

Symptoms of powdery mildew are characterized by the white powdery appearance on the leaf, stem or flower surface. Many spores are produced by this pathogen on the upper leaf surface of infected plants. As the spores mature they are disseminated by wind currents. Severe infection may result in yellowing and curling of leaves, stunting of plants, distortion of flowers and necrosis of tissue.

Generally, growth and development of the powdery mildew fungus is favored by warm temperatures (70-80^{o}F). Although, temperature response by the pathogen appears to be conditioned by the environment from which the fungus has been found. Few spores germinate at temperatures above 120^{o}F. Most powdery mildew spores germinate best in near saturated atmosphere. However, some species can germinate over a wide range of relative humidity. Free moisture on the leaves does reduce infection by this pathogen. Warm temperatures and dry conditions tend to stimulate spore maturity and release. It is known that certain powdery mildew spp. can overwinter on alternate host (including weeds) and the following year then infect the primary host.

Control of powdery mildew can be accomplished by application of various fungicides and removal of weeds from within and around the planting. Information on appropriate fungicides can be obtained from your local county extension agent.

Several other diseases were found on various dried flowers grown in Minnesota in 1988. These included an unidentified bacteria and a fungus causing a leaf spot. Additional work needs to be done to confirm and identify these organisms. The bacterial infection was found on Helichrysum and Celosia the fungal leaf spot on Helichrysum, Limonium and Gomphrena.

Tours through the field planting of annuals and perennials grown for dried flowers in Minnesota during 1988 revealed high incidence of aster yellows. This disease occurs in North America and parts of Europe. The virus has an extensive host range including weeds, ornamentals and vegetables. Symptoms of plants infected with this pathogen include: general yellowing, bronzing, reddish color, dwarfing of the plant, abnormal shoot production (witches broom) flower sterility, and general reduction of quality and quantity. Plants infected at an early age may die, older plants that become infected are bushy and of no value.

Aster yellows virus is transmitted by leafhoppers. The insect must feed on infected plants for several hours to acquire the virus. However, the insect cannot transmit the virus immediately after feeding but begins to transmit after an incubation period of 10-45 days, depending on the temperature. It is during this incubation period that the virus multiplies and is distributed within the insect. When the concentration of the virus in the insect reaches a certain level, the disease is transmitted to healthy plants. The insect can transmit the virus the rest of its life.

The virus can overwinter in infected biennial and perennial plants thus producing a source of inoculum for the leafhopper in the spring. There are many weed hosts that can serve as a reservoir for the virus. A few of these weeds are thistle, wild carrot, dandelion, field daisy and wide-

leafed plantain. Infected plants usually show symptoms within 10 days after insect transmission although this depends on temperatures; warmer temperatures decreases the time for symptom development.

Control of aster yellows include eradication of perennial or biennial weed hosts within and around planting. Immediately remove and destroy any infected production plants; this should be done throughout the production season. This will help minimize spread of the disease. The use of insecticides will also help control the aster yellows leafhopper. Please reference the article on insects and dried flowers found in the proceedings for information on insect control of aster yellows.

LITERATURE CITED

Agrios, G.N. 1970. Plant Pathology. Academic Press. 629 pp.

Pirone, P.P. 1970. Diseases of Pests of Ornamental Plants. The New York Botanical Garden. 546 pp.

Sherf, A.F. and MacNab, A.A. 1986. Vegetable Diseases and Their Control. John Wiley & Sons. 728 pp.

Strider, D.L. 1985. Diseases of Floral Crops. Vol. I. Praeger Scientific. 638 pp.

Strider, D.L. 1985. Diseases of Floral Crops. Vol. 2. Praeger Scientific. 579 pp.