ENFERMEDADES DEL CRISANTEMO: UNA GUIA PARA PRODUCTORES

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RESUMEN. La disponibilidad de esquejes libres de enfermedades, y los medios estériles, han permitido que el crisantemo (**Chrysanthemum morifolium**) se haya convertido en un de los cultivos floricolas más importantes en el mundo. Las enfermedades altamente destructivas, como los marchitamientos por Verticillium y Fusarium, y otras enfermedades por virus y viroides, especialmente los enanismos, se mantienen bajo control por los productores comerciales, a través del uso de cultivos asépticos y con procedimientos de cotejo para la presencia de virus y viroides. Como resultado, los productores pueden obtener esquejes sanos, y por ende, programar sus cultivos de crisantemo para que florezcan en cualquier época del año.

PALABRAS CLAVES: esquejes sanos, fusarium, verticillium.

CRYSANTHEMUM DISEASES: A GROWER'S GUIDE

SUMMARY. The availability of disease-free cuttings and sterile media has allowed chrysanthemum (**Chrysanthemum morifolium**) to become one of the most important floral crops worldwide. Highly destructive diseases such as Verticillium and Fusarium wilts and certain virus and viroid diseases, especially stunt, are held in check by commercial propagators through the use of culture and virus and viroid-indexing procedures. As a result, growers can obtain healthy cuttings and, thereby, program their culture of chrysanthemums for flowering at any time throughout the year.

KEY WORDS: healty cuttings, fusarium, verticillium.

Fusarium wilt (*Fusarium oxysporium*)

Fusarium wilt of chrysanthemum has been very destructive recently, especially to pot mum growers. It is not limited to pot culture, however, as it also occurs in beds and in the field. Fusarium wilt may be considered a chronic disease problem of nums. It has been a threat to the industry for a number of years and epidemics occasionally occur, probably because known control measures are relaxed.

Fusarium wilt of chrysanthemum is caused by the soil-inhabiting fungus *Fusarium oxysporum*. The disease is widespread but occurs sporadically in the greenhouse and in the field. Frequently one wilted plant in a pot of five is observed. Wilting occurs one to several weeks after potting.

Symptoms. Initial symptoms of the disease are the yellowing and stunting of a basal leaf or two. This is followed by one-side wilting of a leaf or two and finally by total wilting and death. Fusarium wilt is considered to be a vascular disease-that is the fungus develops in and disrupts the vessels in the roots, stems, and leaves that carry water and nutrients for the plant. As a result of this disruption, the vascular area just inside the stem turns brown and may be observed by cutting lengthwise just under the outer layer of stem tissue. This vascular discoloration is another characteristic symptom of Fusarium wilt which usually occurs by the time the first symptoms of yellowing or wilting are seen. In some cultivars, flowers of diseased plants do not open properly.

The rate of disease development and, thus, symptom expression depends upon several factors including temperature, nutrition, and cultivar selection. Fusarium wilt is a warm season disease. It is most severe when temperatures (F) remain in the 80's and 90's. Little or no disease development occurs at temperatures of 70'F and below. Chrysanthemum cultivars vary greatly in susceptibility to Fusarium wilt. Resistance to Fusarium wilt in chrysanthemum is confounded by the prevalence of two forms of the causal fungus, *Fusarium oxysporum chrysanthemi* and *Fusarium oxysporum tracheiphilum* race I. Cultivars may be resistant to one but susceptible to the other. However, the *chrysanthemi* form is the predominant form on chrysanthemum.

1 Strider, D.L. 1994. Emeritus Professor, Depart ment of Plant Pathology, North Carolina State University, Re leigh, NC 27695-7616.The use of trade names in this article does not imply endorsement of products named by the North Carolina Agricultural Research Service nor criticism of similar ones not mentioned.

While infection by this insidious pathogen usually occurs early, obvious wilt symptoms may not appear until plants are half to fully grown. At this late date, and after most all of the costs of production have been expended, one or two plants per pot may develop wilt symptoms (many times, it seems, as the result of the added stress which occurs during bud and flower development), resulting in the loss of the whole pot.

Table 1. Fusarium wilt resistance chrysanthemum cultivars.

Very resistant

Accord	Matador
Aggie	May Shoesmith
Albatross	Mellow
Alert	Minnautumn
Aspen	Minngopher
Ballerina	Minnwhite
Bandit	Minnyellow
Bright Golden Ann	Mrs. Roy
Cambria	Nimrod
Calvacade	Pearls
Camelot	Penguin
Cavalier	Pink Nova
CF No. 2 Indianapolis Bronze	Pinocchio
Champ	Polaris
Chardunnay	Puritan
Charm	Quaker
Charlie	Rawhide
Classic	Red Belair
Cymbals	Red Dandy
Darkchip	Riot
Debonair*	Ritz
Dillon Beauregard	Ruby Mound
Dolly	Sequest
Dolli Ette	Sequoia
Donlopes White Spider	Shamrock
Donlopes Yellow Spider	Southern Sun
Dragon	Showoff
Echo	Splendor
Eclipse	Starfire
El Charo	Statesman
Explorer	Stingray
Favor	Surf
Flaming Sun	Surfine
Giant No. 4 Indianapolis	Tinsel
Goldmine	Treasure Chest
Goldstrike	Tuneful
Goldtone	Venture
Grandchild	Viking
Grenadine	Westpoint*
Hawkeye	White Grandchild
Heirloom	Wilcat
Improved Indianapolis Yellow	Yellow Cambria
Ironsides	Yellow Jacket
Jamboree	Yellow Knight
Luyona	Yellow Nova
Marmalade	Zonta
Maple Leaves,	
Resistant,	
Cloud 9	Promenade
Elegant Cushion	Songster
Husky	Sunbeam
Mountain Pink	Tiger
Mountain Snow	Tuneup
Mystic,	

*The reaction of these cultivars to **Fusarium oxysporum** f. sp. **chrysanthemi** has varied and, therefore, needs re-evaluation.

Control. Control of this disease is provided, in large part, by propagation specialists via a culture-indexing program (refer to chapter on "Disease Control"). The culture-indexing program is designed to provide growers with cuttings free of the fusarium wilt pathogen and other systemic bacterial and fungal pathogens. Even with culture-indexed cuttings, growers still must use sterile soil, strict sanitation, and fungicide drenches of susceptible cuttings to prevent Fusarium wilt. This is especially important in areas where the disease has been a problem in the past few years. One of the best methods of controlling this disease, and disease in general, is through the use of resistant cultivars. A number of resistant cultivars are available and are recommended for the grower who is experiencing problems with Fusarium wilt of mums. The resistance fo chrysanthemum cultivars to *Fusarium oxysporum chrysanthemi* are listed in Tables 1 and 2.

Fusarium wilt is a serious disease and will reoccur, especially in areas where it has occurred in recent years because the fungus survives on debris, soil, flats, benches, etc. for several years. It is, therefore, very important to give special consideration to measures for control of this disease.

If the disease is present in your mums now:

A. Carefully place the contents of any pot (or plant in the field) in a plastic bag and dispose of it several miles away from the growing area so that it will not serve as a source of inoculum in the future. If pots are kept, place them in area outside the greenhouse for prompt sterilization.

B. Drench remaining plants with Topsin-M or Banrot at the manufacturer's recommended rates to inhibit the spread of disease.

C. Observe frequently for further disease development.

To prevent the occurrence of the disease in your mums in the future:

1. Obtain cuttings **only from a source that uses a culture indexing system for Fusarium wilt control.**
2. Consider using resistant cultivars.
3. Since the causal fungus can survive in the absence of a mum crop on most any object that moves in or out of the greenhouse-on plant debris, pots, flats, benches, hose nozzles, irrigation equipment, etc.-a *thorough* sanitation program should be initiated between crops. All equipment, supplies, and benches in areas where Fusarium wilt was present the past season should be sterilized with steam or methyl bromide or disinfested with a 10% solution of commercial bleach (10% Clorox).
4. Use only sterile media in sterile containers.

Table 2. Fusarium wilt susceptible chrysanthemum cultivars.

Very susceptible	
Baby Tears	Lancer
Bravo	Lobo
Brown Eyes	Luv
Bruin	Maytime
Cinnamon	Nob Hill
Cirbronze	Powder River
Compatriot	Rocket
Cougar	Roll Call
Encore	Royal Trophy
Excel	Southern Comfort
Festive Cushion	Stargazer
Fireside Cushion	Starlet
Fortune	White Sands
Foxy	White Stardom
Freedom	Winter Carnival
Frisky	Yellow Bonnie Jean
Hostess	Yellow Cloud
Jackpot	Yellow Delaware
Susceptible,	
Applause	Nuggets
Bluechip*	Orange Bowl
Brunhilde Eckstrom	Pancho
Buckeye	Patriot
Calico	Pinktive
CF 773 Marguerite	Purple Waters
Circus	Redcoat
Delaware	Remarkable
Escapade*	Revere
Flare	Snowdon
Giant No. 4 Indianapolis	Spartan
Iceburg	Stardom
Illini Trophy	Sunburst Cushion
Indianapolis White	Sun Devil
Indian Summer	Tempter
Lipstick	Tinker Bell
Mandalay	Torch*
Minnpink	Yellow Starlet

*The reaction of these cultivars to **Fusarium oxysporum** f. sp. **chrysanthemi** has varied and, therefore, need re-evaluation.

5. Raise the pH of the medium to about 6.5. Be prepared to add minor elements should deficiency symptoms appear.
6. Use nitrate sources of nitrogen since ammonium forms tend to increase disease severity.
7. Drench the medium with Topsin-M or Banrot at the manufacturer's recommended rates (1/2 pt/6" pot) at potting and again two weeks later.
8. Observe plants daily for first symptoms of disease. If symptoms are seen-yellowing, wilting, vascular necrosis-collect specimens and send to your County Extension Agent for positive identification and notify your supplier.
9. Repeat steps A-C.

Without adequate controls, Fusarium wilt of chrysanthemum can be devastating. With strict adherence to control measures, however, Fusarium wilt can be avoided.

Verticillium Wilt (*Verticillium albo-atrum* and *V. dahliae*).

In the past, Verticillium wilt was an extremely common and very destructive disease of chrysanthemum. With the development and commercialization of cultivar-indexing procedures, the use of sterile media, and perhaps to the southern location of commercial propagators, this disease, currently, is seldom a problem, leastwise in southern states. But, if control measures are relaxed, this devastating disease, for sure, will be back.

Symptoms. The outward symptoms of Verticillium wilt are very similar to those of Fusarium wilt-yellowing and wilting of folaige beginning at the base of the plant. Initial symptoms are usually one-sided. Symptoms of Verticillium wilt are unlike those of Fusarium wilt in that vascular tissues of stems and roots of plants affected with Verticillium wilt seldom become brown or black as they do in the case of Fusarium wilt.

Control. Control of Verticillium wilt of chrysanthemum depends upon the use of culture-indexed, Verticillium-free cuttings and the use of sterile planting media. Resistant cultivars are available and should be considered in problem areas. If plants are grown in a field with a history of wilt, the soil should be treated with a sterilant such as chloropicrin, methyl bromide, or metam-sodium (Vapam).

Bacterial Leaf Spot and Bud Blight (*Pseudomonas cichorii*).

Bacterial leaf spot and bud blight of chrysanthemum caused by *Pseudomonas cichorii* was first observed in the United States in Florida in 1957. It was first observed in garden chrysanthemum (=mums) in North Carolina in 1975. The disease has since become widespread and it is now considered the most important disease problem of garden mums in North Carolina. Most mum cultivars are susceptible but the disease becomes a problem only under wet and warm conditions. Most garden mums are grown outside and are subject to the natural dew and precipitation of the area; hence, if the inoculum is present and if precipitation is abundant as it normally is in North Carolina in summer (July and August), bacterial leaf spot of garden mums becomes a serious problem. Once it becomes a problem, little can be recommended to the grower to control he disease during that season. Severely diseased plants can be rogued to reduce inoculum levels, plants can be spaced

for better aeration, and, most importantly, the foliage must be kept as dry as possible.

Symptoms. Symptoms of this disease are characterized by dark brown or black circular or angular leaf spots Spots are black and active under moist conditions but become brown and inactive under dry conditions. The pathogen causes bud blight during prolonged wet weather and peduncles collapse. The pathogen that causes bacterial leaf spot and bud blight of chrysanthemum has a wide host range including species of *Philodendron, aglaonema, Scindapsus,* cabbage, and celery.

Control. Control involves the use of cuttings or seed free of the pathogen and a strict sanitation program. If plants become diseased, they should be removed from healthy plants and destroyed. Plants should be spaced to provide adequate aeration. Overhead irrigation should not be used or used only during fast-drying conditions as the pathogen is disseminated in water. Foliar applications of copper hydroxide have been recomended for protection against the spread of this disease.

All cultivars of garden mums tested at North Carolina were susceptible to the disease; however, the degree of susceptibility varied greatly (Table 3). Growers who have experienced problems with this disease in the past should avoid growing highly susceptible cultivars and, if possible, choose cultivars from the slightly susceptible category. Regardless of cultivars chosen, efforts should be made to avoid wetting foliage when possible. If it is not possible to avoid wetting the foliage, then irrigate only under rapid drying conditions and spray with copper hydroxide.

Table 3. Reaction of chrysanthemum (mostly garden types) to bacterial leaf spot and bud blight caused by Pseudomonas cichorii.

Slightly susceptible		
Diamond	Minngopher	Sun Devil
Foxy	Minnpink	Yellow Jacket
Golden Dream	Starlet	Yellow Starlet
Moderately susceptible		
Aggie	Goldstrike	promenade
Alert	Goldtone	Purple Pirate
Ann Ladygo	Golden Tranquility	Purple Waters
Autumn Delight	Grenandine	Redcoat
Ballerina	Gypsy Queen	Red Desert
Bandit	Hansel	Remarkable
Best Regards	Husky	Revere
Brown Queen Indian Summer	Rocket	
Brown Eyes	Indian White	Roll Call
Buckeye	Ironside	Rosado Queen
Calico	Jewel Box	Royal Trophy
Camelot	Johnny Appleseed	Ruby Mound
Cameo	Lancer	Shining Light
Cinnamom	Larry	Sleigh Ride
Cirbronze	Lawrence Blaney	Small Wonder
Circus	Lipstick	Snow Queen
Classic	Lobo	Spartan
Cloud 9	Mango	Stargazer
Compatriot	Maple Mound	Stardom
Corsage Cushion	Martian	Starleteer
Couger	Minnautumn	Sunbeam
Daredevil	Minnehaha	Sunburst Cushion
Debonaire	Minnwhite	Tango
Dolli Ette	Minnyellow	Tinker Bell
Drummer Boy	Muted Sunshine	Viking
Escapade	Mystic	Violet Queen
Festival Cushion	Newgo	Westpoint
Fire Queen	Nuggets	Whippoorwill
Fireside Cushion	Ostosa	White Marble
Flaming Sun	Pancho	White Stardom
Flare	Patriot	Wolverine
Frisky	Pearls	Yellow Cloud
Garden Magic	Penguin	Yellow Pomp
Glow Worm	Powder River	Yellow Supreme
Goldmine	Princess	Zonta
Gold Queen	Princess Kay	
Highly susceptible		
Apache	Freedom	Red Dandy
Baby Tears	Grandchild	Quaker
Bruin	Gypsy Wine	Starfine
Elegant Cushion	Jackpot	Tiger
Fortune	Purple Waters	White Grandchild

Stunt (Viroid)

Several important diseases of chrysanthemum are caused by viroids and viruses. The most important of these is stunt, a viroid disease.

Symptoms. The characteristic symptoms are a general stunting of plants and a pale, unusually upright growth of young leaves. Flowering may occur prematurely and they may be reduced in size and quality. White or yellow flocking or blotching occur on leaves of some cultivars infected with the stunt viroid.

The stunt viroid survives from season to season in infected stock plants and is transmitted mechanically during handling of the crop such as pinching, pruning, taking cuttings, etc. No insect vector is known.

Control. Control of stunt is provided by commercial propagators through a viroid-indexing program. Plants suspected of being infected with the stunt viroid should be destroyed, and the supplier should be notified.

Septoria Leaf Spot *(Septoria chrysanthemella* and *S. obesa)*

Septoria leafspot is important on chrysanthemums grown in the field under humid conditions.

Symptoms. Leaf spots caused by *S. chrysanthemella* are circular of irregular in shape and usually develop from the base of the plant upward. The spots are bronze or reddish brown initially and gradually become black. Spots enlarge to about 1/2 inch in diameter and are somewhat veindelimited. With the aid of a hand lens, small black bodies may be seen in the center of spots, especially on the lower leaf surfaces. During moist conditions, spores are extruded from these black bodies in large numbers appearing, with the aid of hand lens, as white spore horns.

Leaf spots caused by *S. obesa* first appear as small, circular red dots which may increase to about 1/4 inch in diameter. The spots become reddish purple with black margins and gray or white centers. Blak bodies may also be found in the center of these spots, but they are small and more difficult to see than those formed by *S. chrysanthemella*.

Control. Control of Septoria leaf spot can be obtained by using Septoria-free cuttings and by watering to avoid wetting the foliage or by watering only during fast drying conditions. In the field, plants should be protected with fungicides beginning a few days after transplanting and continuing on a 7-10 day schedule depending upon the frequency of rain. Effective fungicides include benomyl, captan, ferbam, and mancozeb.

Burn or destroy plant debris after each crop to reduce inoculum carry-over.

Ascochyta Ray Blight *(Mycospharella ligulicola)*

Aschochyta ray blight is an important disease in all areas where chrysanthemums are grown under moist conditions.The disease is most important in field-grown plants during bloom and during shipping.

Symptoms. The initial symptom is bud rot. Unopened buds turn dark brown or black and bud stems (peduncles) may rot for a distance of 1-2 inches which may result in the collapse of the bud. The fungus produces pycnidia and spores on these rotting buds which are then splashed to petals of opening blossoms. Flower-head infections may be one-sided if infection occurs early in flower development or the entire blossom may be uniformly infected if infection occurs later in flower development. At first, infected tissue is usually pink in color and later becomes tan, then brown. Disease progresses rapidly across the disc at the base of florets and affected florets may collapse and fall.

Symptoms on leaves appear as irregular black lesions which may be up to an inch in diameter. The disease may then progress up the petiole and into the stem.

The fungus may also cause a cutting rot in the propagation bed.

Control. The use of clean cuttings (Ascochyta-free) and watering to avoid wetting foliage will control this disease in the greenhouse. Control in the fiel again relies upon the use of clean (Ascochyta- free) cuttings, watering to avoid wetting foliage, or watering during fast-drying conditions and the use of protective fungicides on a 7-10 day schedule. Effective fungicides include: benomyl, chlorothalonil, and mancozeb. Stock plants in areas where ray blight has been a problem should not be used for cuttings. Old crop debris should be removed and destroyed.

Botrytis Petal Blight or Gray Modl *(Botrytis cinerea)*

A chapter has been devoted to this extremely common and, therefore, extremely important pathogen. The reader is refered to that chapter for a detailed account of the pathogen and the disease it causes. The spotting and blighting of chrysanthemum flowers in the greenhouse and during shipping can be serious.

Symptoms. First spots or specks on petals are usually pink or brown and are noted on the older, outer florets. Under moist conditions, spots rapidly enlarge to involve the entire floret. The lower portions of affected flowers turn tan and may become covered with a grayish-brown fuzzy growth of spores of the fungus (= gray mold). Lower leaves may become necrotic and covered with gray mold also which, under extended periods of high moisture, may extend into and girdle the stem.

Control. Again, the reader is referred to the chapters on "Disease Control" and *Botrytis Diseases* for an extensive treatment of this disease. Control of Botrytis petal blight and gray mold in the greenhouse is dependent upon keeping the relative humidity of the greenhouse below 85% to prevent condensation. This is done by proper spacing, venting, and heating. Of course, sanitation is also very important to remove debris and dying blossoms to eliminate sources of inoculum. Should the problem arise in the greenhouse or in the field, water to avoid wetting the foliage or water during fast drying conditions and apply a preventative fungicide on a 7 day schedule such as vinclozolin, thioplanate-methyl, or chlorothalonil.

Rusts *Puccinia chrysanthemi,* **brown rust;**

Puccinia horiana, white rust)

There are two distinct rust diseases of chrysanthemum; one is called brown rust or simply rust, and one called white rust. Brown rust occurs infrequently and is considered of minor importance. White rust was first found in New York and Pennsylvania in 1978 and is

rarely seen in the U.S. thanks to stringent inspection and federal and state quarantine regulations.

Symptoms. Brown rust, as the name implies, is characterized by dark brown powdery pustules, predominantly on lower leaf surfaces. Rings of secondary pustules usually develop around the original pustule. Initially, symptoms consist of pale white or yellow flecks visible on both leaf surfaces which later develop into the typical brown pustules. Eventually the center of the pustules become necrotic. Generally, affected leaves may wither and die.

First symptoms of while rust appear on lower leaf surfaces as circular white to yellow waxy cushions up to 1/2 inch in diameter which soon turn brown. On upper leaf surfaces, a slight depression develops which is lighter green than the surrounding leaf tissue.

Control. Rust is kept under control in the U.S. through the use of clean (rust-free) cuttings and through state and federal quarantine regulations and inspections. Many cultivars are resistant to brown rust also. Should the problem arise, destroy severely infected plants and spray remaining plants with a protective fungicide such as thiadimefon, mancozeb, or zineb.

Foliar nematodes *(Aphelenchoides ritzemabosi)*

Foliar nematodes have been an occasional problem on chrysanthemum for a long, long time. These microscopic worms live primarily on leves and buds, but can survive (and overwinter) for short periods in soil and plant debris. When stems are wet, the nematodes can swim up the stem in a film of water and enter leaves, usually through natural openings. Here they reproduce rapidly and feed within the leaf.

Symptoms. Symptoms of foliar nematode damage on chrysanthemum develop slowly as a result of the feeding of the nematodes on the internal tissues of leaves. Initial symptoms are small, grayish- green areas on lower leaves which gradually turn yellowish. These areas, usually angular in shape, enlarge and typically become "V" shaped constricted by veins. Disease development proceeds upwards, the "V" shaped areas gradually turn brown, and finally whole leaves shrivel and die.

Control. Foliar nematode problems seldom arise in today's industry because growers can obtain clean cuttings and because growers apply insecticides on a regular basis for other pests. If the problem should arise, severely affected plants should be destroyed and remaining plants treated with aldecarb, oxymyl, or demeton according to manufacturer's recommendations.

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