

Chrysanthemum White Rust Bulletin

PROGRAM SUMMARY FOR PREVENTION

The regulations concerning Chrysanthemum White Rust (CWR) and various other diseases are found at 7 CFR 319.37 (or more commonly referred to as Q37). These quarantine rules are aimed at protecting growers from diseases that are not endemic to the United States.

Federal quarantine restrictions include:

- Six-month post entry quarantine of imported chrysanthemum cuttings.
- Prohibition of cutting import from infested countries.
- Certification programs for offshore chrysanthemum cut flower producers exporting to the U.S.
- CWR eradication when found.

CWR is widespread throughout many areas of the world, but is not confirmed as established in the United States. Any offshore introduction of this pathogen is a significant threat to the United States floriculture industry. CWR spreads rapidly in greenhouse and nursery environments, resulting in severe losses. As a quarantine pest, detection of CWR leads to federal and state regulatory action. The prevention and control of CWR depends on:

- Effective plant quarantine laws
- Healthy planting material
- Management of humidity and irrigation
- Proper use and selection of fungicides

CAUSAL ORGANISM

Puccinia horiana Henn. is a filamentous fungus. It is an obligate parasite, meaning it only grows and reproduces on specific host plants.

SYMPTOMS AND SIGNS

Growers who monitor or scout their crops regularly will most likely find potential infections early. Examine all stages of plant production as the disease is capable of infecting young plants as well as finished product.

The first symptoms of CWR are yellow spots on upper leaf surfaces, up to 4 mm in diameter (figs. 1 and 2). These may become sunken and necrotic. At first glance, the yellow spots may be mistaken for some type of spray injury, insect damage, or plant virus. Closely examine any sign of yellow spotting for further evidence of this disease. The subsequent development of prominent pustules on the lower

surface of leaves is characteristic of a rust type pathogen. Pinkish or buff-colored at first (fig. 3), pustules mature to waxy white (fig. 4). Pustules may also develop on stems, bracts or even flowers. Severely infected leaves dry up and hang along the stem (fig. 5). Microscopic

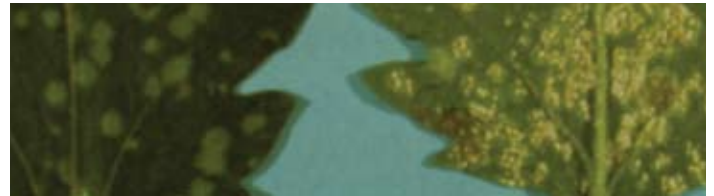


Figure 1. Upper and lower leaf surfaces with mature CWR infection.



Figure 2. Yellow spots (first symptoms) on upper leaf structure.



Figure 3. Pinkish or buff-colored pustules on lower leaf surface.

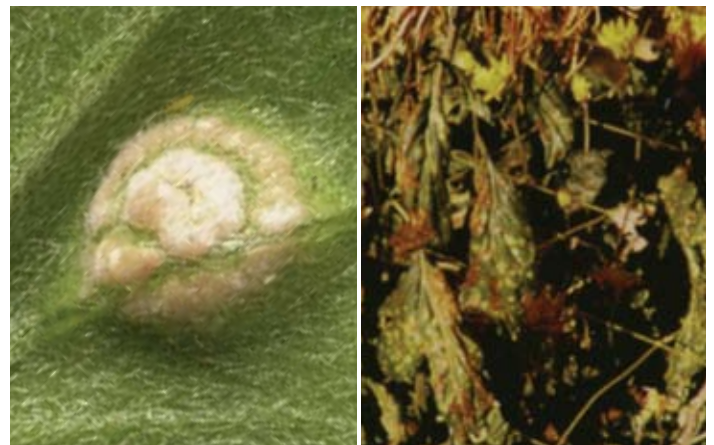


Figure 4. Waxy white pustule on lower leaf surface.



Figure 5. Severe CWR in a finished crop.

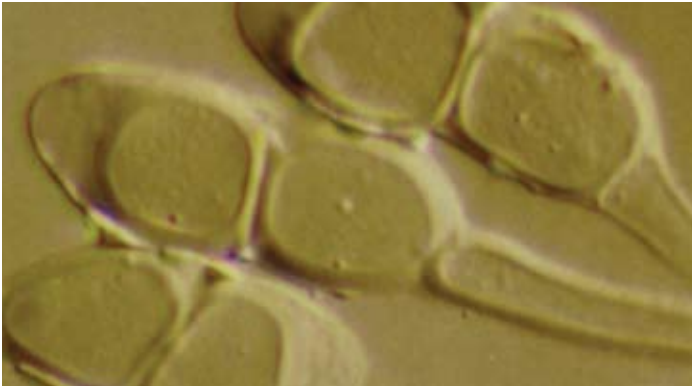


Figure 6. Teliospores of *Puccinia horiana*.



Figure 7. Close-up of mature white pustules.

observation of two-celled teliospores (fig. 6) in pustules (fig. 7) is required to confirm a diagnosis for CWR.

OCCURRENCE AND CURRENT SITUATION

CWR is native to East Asia and was identified just prior to 1900. It is now widespread in Australia, Africa, Europe and South and Central America. The USDA Animal and Plant Health Inspection Service (APHIS) has intercepted CWR on cut chrysanthemum flowers attempted to be imported from infested countries.

Local outbreaks of CWR in North America during the last two decades include incidents associated with the smuggling of cuttings by amateur growers and the handling of offshore cut chrysanthemum flowers inside greenhouses where chrysanthemums were grown. However, the source of the disease has not been determined in every incident. Since detection and eradication action in California in 1991, there have been repeated incidents of CWR in the United States and Canada. One-to-two incidences per year gradually increased to an all time highest number of incidences reported in 2009 (fig. 8). Any incidence of confirmed CWR results in state and federal action to determine source, movement of infected plants, and activation of both quarantine and eradication protocols. These protocols, while quite disruptive to a commercial nursery, are designed and enforced to prevent further spread of this quarantined pathogen throughout the flower industry.

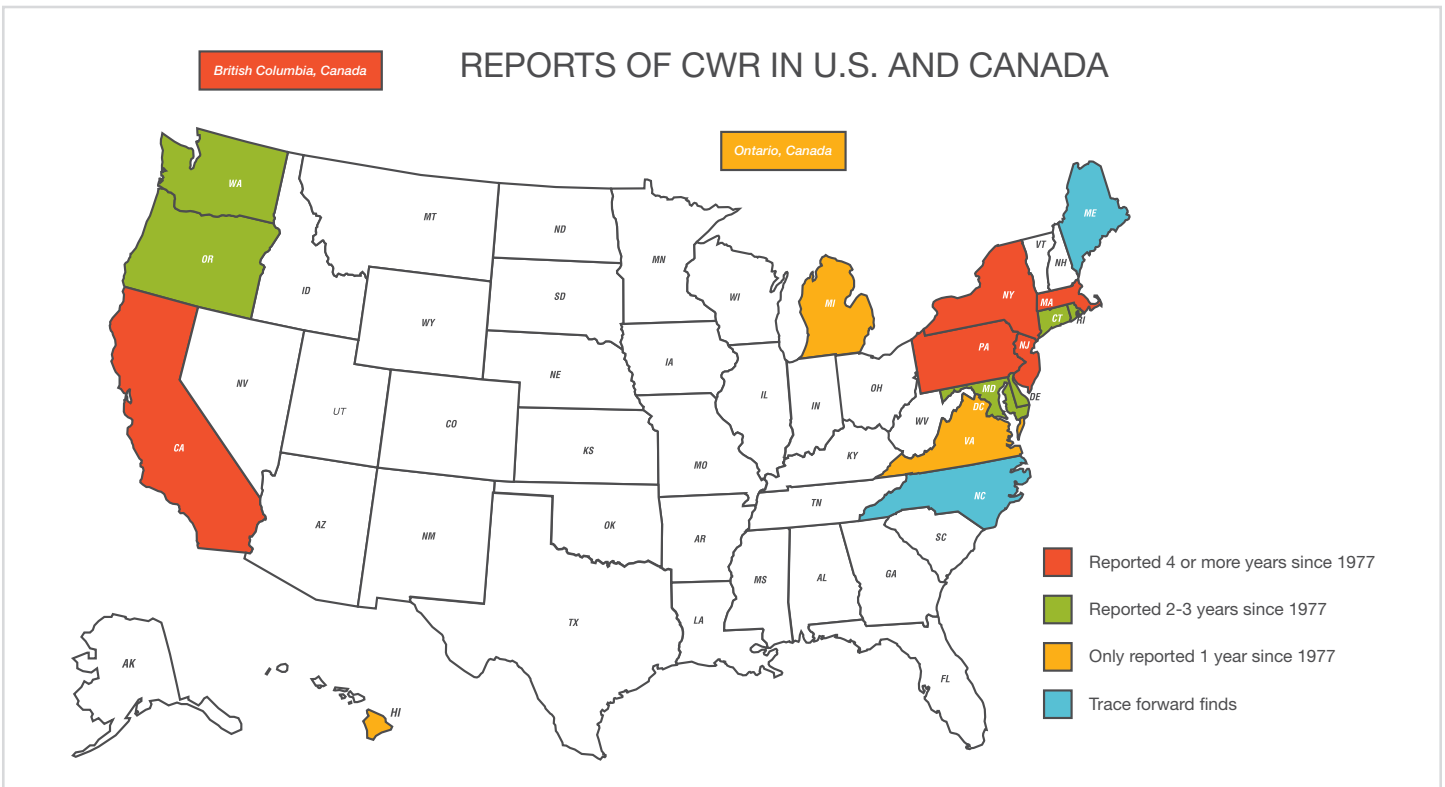


Figure 8. Map of CWR incidences in the United States and Canada.

DISEASE CYCLE

New infections are initiated by basidiospores (see life cycle on last page) released from pustules during periods of high relative humidity (96% to 100%) when temperatures are between 40°F and 73°F (optimum 63°F). Spores landing on a plant surface can germinate and penetrate in as little as two hours at optimum temperatures (63°F to 75°F). A film of free water is required for infection.

For five-to-14 days after infection, the fungus grows within the plant as a latent infection, after which chlorotic (yellow) spots, and ultimately pustules, appear.

Teliospores (fig. 6) produced in pustules remain attached to leaves, germinating in place to produce the next generation of basidiospores when conditions of temperature and humidity are favorable.

DISPERSAL

Long distance dispersal of CWR depends on the movement of infected plant material. Because cuttings may not display symptoms for as long as two-to-three weeks after infection, seemingly healthy cuttings can be infected. The six-month post-entry quarantine for cuttings imported into the United States is required to insure that any presence of CWR is detected.

Basidiospores can be carried short distances by wind currents. These spores are so short-lived that even under ideal conditions (100% humidity, cool temperatures) they only survive long enough to be carried a short distance before dying due to desiccation. In spite of their very brief lives, basidiospores are responsible for the explosive character of local epidemics when conditions are right.

Infested debris carrying viable teliospores may also play a role in dispersal.

SURVIVAL

CWR survives for extended periods only in association with host plant tissue. Basidiospores (the airborne spores) are thin walled and subject to rapid desiccation. They are extremely short-lived, surviving only five minutes at 80% relative humidity and less than one hour at 90% relative humidity. Teliospores (the spores that remain attached to the leaf) survive on dried plant debris for up to eight weeks, but less than eight weeks under moist conditions or buried in soil. CWR is known to overwinter in Europe where chrysanthemums overwinter (average minimum temperatures ranging from -10°F to 10°F).

ENVIRONMENT

Basidiospores are only produced and released during periods of high relative humidity (96% to 100%) and temperatures from 40°F to 73°F (optimum 63°F). A film of free water is required for infection and penetration. Optimum temperatures for infection range from 63°F to 75°F.

CWR is generally most severe in greenhouse environments but it can also be destructive in the outdoors when temperature and humidity conditions are wet and cool.

HOST RELATIONS

The host range of CWR extends to a limited number of species of chrysanthemum and their close relatives. Since 1990, CWR has been detected in the United States and later in Canada in commercial and residential plantings of the chrysanthemum (*Chrysanthemum x morifolium* Ramat *Dendranthema x morifolium* (Ramat.) Tzvelev, the perennial garden plant *Chrysanthemum pacificum* Nakai (synonym *Ajania pacifica* (Nakai) K. Bremer & Humphries), and also the Nippon or Montauk daisy (*Nipponanthemum nipponicum* (Franch. ex Maxim.) Kitam.

Cultivar selection may not be a reliable method of CWR control. Further research is required.

DISTINCTION FROM BROWN RUST OF CHRYSANTHEMUM

Brown rust of chrysanthemum, caused by *Puccinia tanacetii* DC, is established in the U.S. and is not a quarantined pest. Characteristics are chocolate brown pustules on both surfaces of leaves (fig. 9). One-celled uredospores found in brown rust pustules are easily distinguished under a microscope from the two-celled teliospores of CWR.



Figure 9. Brown rust of chrysanthemums caused by *Puccinia tanacetii*.

CWR PREVENTION WITHIN THE UNITED STATES AND CANADA

There are a number of sustainable controls that can be implemented to help protect against CWR:

- Obtain cuttings from a reputable commercial source.
- Do not handle imported chrysanthemum cut flowers in or near production facilities. Cut chrysanthemums from any country known to have CWR are a threat to chrysanthemum crops. CWR can be transmitted by human handling or through air currents.
- Maintain low humidity and dry foliage in the greenhouse. Use fans, vents, plant spacing and heat to move air and reduce humidity. Use drip rather than overhead irrigation to minimize

free water on foliage. Beware of impermeable barriers that retain humidity if using black cloth to control day length.

- Follow good sanitation practices including removal of debris from production.
- Scout regularly.
- Do not keep plants from one season to the next in case of possible CWR overwintering.

IF YOU FIND CWR:

Inform USDA, state or county officials. Regulatory officials will supervise eradication and treatment programs that may include:

- Destruction of infected plants and those immediately surrounding them.
- Treatment with eradicator fungicides.
- Survey of surrounding premises.
- Trace back to attempt source identification and distribution.
- Trace forward to track incidence in shipments.
- More extensive action may be taken if infection is generalized in an operation.

If you find CWR and have questions, please contact:

S. Anwar Rizvi, USDA-APHIS=PPQ-EDP, Unit 160

4700 River Road, Riverdale, MD 20737

Phone: 301-734-4313

E-mail: Anwar.S.Rizvi@aphis.usda.gov

Official control programs of USDA APHIS are subject to revision in the National Protocol for the United States: http://www.aphis.usda.gov/plant_health/plant_pest_info/cwr/downloads/cwrplan.pdf

PROTECTANT FUNGICIDES AND PREVENTIVE SPRAY SCHEDULE

Syngenta has developed the program described below based on its years of experience and chemical knowledge¹. All of the fungicides listed in this program are registered for use on chrysanthemums, and are specifically labeled for *Puccinia* rust prevention. The active ingredients in both the **Heritage**[®] and **Daconil**[®] fungicide products have been shown to be effective in controlling and providing protection against CWR in European trials and production programs to protect against this disease.

It is difficult to predict the amount of disease pressure that may be present in your region. Preventive fungicide applications will help protect your crop from infection when environmental conditions are conducive to CWR. The following disease prevention program for chrysanthemums is suggested based on control efficacy trials and resistance management considerations.

PROPAGATION

Week ²	Fungicide	Application Rate	Comments
1	Heritage [®]	2 oz./100 gal. (spray)	Spray in the evening or when mist is off/reduced.
2	Daconil Ultrex [®]	22 oz./100 gal. OR 1.4 lbs./100 gal. (spray)	Apply foliar spray for prevention of rusts, <i>Botrytis</i> , Leafspot diseases.

AFTER TRANSPLANT

Week ²	Fungicide	Application Rate	Comments
3 or 4	Medallion [®] AND Subdue Maxx [®]	Medallion: 2 oz./100 gal. Subdue Maxx: 1 fl. oz./100 gal. (drench)	Drench with Medallion and Subdue Maxx tank mix for prevention of <i>Fusarium</i> , <i>Rhizoctonia</i> and <i>Pythium</i> .
5	Dithane [®] 75DF OR Mancozeb product	1.5 lbs./100 gal.	Apply foliar spray for control of rust and other foliar diseases.
6	Banner Maxx [®] AND Daconil Ultrex	Banner Maxx: 8 oz./100 gal. Daconil Ultrex: 1.4 lbs./100 gal. (spray)	Apply tank mix as foliar spray for control of rusts and other foliar diseases. *Do not apply Banner Maxx in greenhouses.
7	Daconil Ultrex OR Dithane 75DF Optional spray treatment	Daconil Ultrex: 1.4 lbs./100 gal. Dithane: 1.5 lbs./100 gal.	Apply foliar spray if environmental conditions are conducive to CWR (i.e., wet and 63-75°F/17-24°C), and until color shows.
8	Heritage AND Daconil Ultrex	Heritage: 4oz./100 gal. Daconil Ultrex: 1.4 lbs./100 gal. (spray) OR Heritage: 0.9 oz./100 gal. (drench) Daconil: 1.4 lbs./100 gal. (spray)	Apply tank mix as a thorough foliar spray for control of rust and other foliar diseases. OR Apply Heritage as a drench followed by Daconil Ultrex as a foliar spray. With a drench treatment you may eliminate the Heritage spray treatment Week 10 if environmental conditions are not conducive to CWR. *Do not apply Daconil once color is showing.
9	Daconil Ultrex OR Dithane 75DF Optional spray treatment	Daconil Ultrex: 1.4 lbs./100 gal. Dithane: 1.5 lbs./100 gal.	Apply foliar spray if environmental conditions are conducive to CWR (i.e., wet and 63-75°F/17-24°C), and until color shows. *Do not apply Daconil or Dithane once color is showing.
10	Heritage	4 oz./100 gal.	Heritage can be used after color is showing. Apply sprays as needed based on crop time for prevention of CWR, <i>Botrytis</i> and other foliar diseases.
12	Heritage	4 oz./100 gal.	
14	Heritage	4 oz./100 gal.	

Please notify your state regulatory agency if you suspect or detect CWR in your crop. For questions or additional help regarding your chrysanthemum program, please contact our Technical Services team at flowers.tech.help@syngenta.com.

¹ Please note that the entire program has not been trialed start to finish but the information concerning the use of Heritage and Daconil was developed directly from Syngenta data in Europe.

² Weeks after start of propagation.

Additionally, the following fungicides are labeled for use on *Chrysanthemum* for Puccinia or rust. They also provide protection for other pathogens.

Azoxystrobin (**Heritage**) systemic 4 oz./100 gal. water every 7–28 day intervals. This is effective for *Puccinia* rusts and also *Alternaria*, *Cercospora*, *Peronospora*, *Septoria*, powdery mildew, *Botrytis*, *Phytophthora*, *Rhizoctonia*, *Sclerotium*, *Fusarium*.

Chlorothalonil (**Daconil Ultrex**, **Spectro™ 90 WDG with thiophanate-methyl**) protectant 1.4 lbs./100 gal. water every seven days (minimum). This is effective for *Puccinia* rusts and *Alternaria*, *Ascochyta*, *Botrytis*, *Cercospora*, *Colletotrichum*, *Septoria*, powdery mildew (*Erysiphe*, *Microspheera*).

Kresoxim-methyl (**Cygnus®**) protectant 6.4 oz./100 gal. water at 7–10 day intervals. This is effective for *Puccinia* rusts and powdery mildews, *Alternaria*, *Septoria*.

Mancozeb (**Fore®**, **Dithane 75DF**, **Protect™ DF**) protectant 1.5 lbs./100 gal. water at 7–10 day intervals. This is effective for *Puccinia* rusts and *Ascochyta*, *Botrytis*, *Cercospora*, *Septoria*.

Propiconazole (**Banner Maxx**) systemic 8 oz./100 gal. water at 14 day intervals. This is effective for *Puccinia* rusts and *Ascochyta*, *Cercospora*, *Septoria*, *Rhizoctonia*, powdery mildew.

Pyraclostrobin (**Insignia®**) systemic 4–8 oz./100 gal. water OR 8–16 oz./100 gal. water at 7–14 day intervals. This is effective for *Puccinia* rusts and also *Alternaria*, *Botrytis*, *Cercospora*, *Didymellina*, *Fusarium*, *Phytophthora spp*, *Pythium spp*, *Rhizoctonia*, *Sclerotinia*, powdery mildew.

Pyraclostrobin + boscalid (**Pageant®**) systemic 4–8 oz./100 gal. water OR 6–12 oz./100 gal. water OR 12–18 oz./100 gal. water at 7–10 OR 7–14 day intervals. This is effective for *Puccinia* rusts and for *Alternaria*, *Botrytis*, *Cercospora*, *Fusarium*, *Phytophthora spp.*, *Pythium spp.*, *Rhizoctonia*, *Sclerotinia*, powdery mildew.

Triadimefon (**Strike®**) systemic 1–2 oz./100 gal. water at 7–14 day intervals (outdoor application). This is effective for *Puccinia* rusts and *Cercospora*, *Sclerotinia*, powdery mildew.

Triflumizole (**Terraguard®**) protectant 4–8 oz./100 gal. water at 7–14 day intervals. This is effective for rusts, *Alternaria*, *Botrytis*, *Fusarium*, *Rhizoctonia*, powdery mildew.

CUSTOMER ADVISORY

Syngenta Flowers wishes you the healthiest possible growing season. However, if you find CWR in your crop, we encourage you to report the incident per federal legal requirements. Additionally, please inform Syngenta Flowers so we can better understand potential disease patterns across the United States. If there is a positive find, it should be thoroughly investigated to find the specific entry of the disease organism. By fulfilling your legal responsibility to report any CWR findings, you are also adding to an important knowledge bank dedicated to the elimination of this disease that is a threat to the floriculture industry in United States and Canada.

Likewise, if you are dealing with the inspections of your crop by state or federal agencies, you, the customer, may have the right to protect your crop from CWR. Also, be aware that if a “stop shipment” has been placed on your crop and the inspections are being prolonged while CWR might be spreading, you may have the right to ask that the inspections be done in sections. This may enable you to begin the eradicator fungicide applications in completed areas, thereby better protecting your saleable crop.

THE SYNGENTA FLOWERS CHRYSANTHEMUM SYSTEM

Syngenta Flowers maintains an exacting exclusion system to best assure that the cuttings we deliver are free of certain diseases transmitted through propagation. All chrysanthemum materials entering our system for *any purpose* (trial, breeding, or introduction) are first tested for viruses and viroids and then placed in tissue culture to provide a period of observation in tissue culture. This helps assure that potential problems from outside sources will be contained and that established crops will not be exposed. While in tissue culture all varieties are tested for the presence of systemic fungi and bacteria. The certified nucleus is kept in tissue culture. All of our chrysanthemum products are increased from the certified nucleus material in tissue culture.

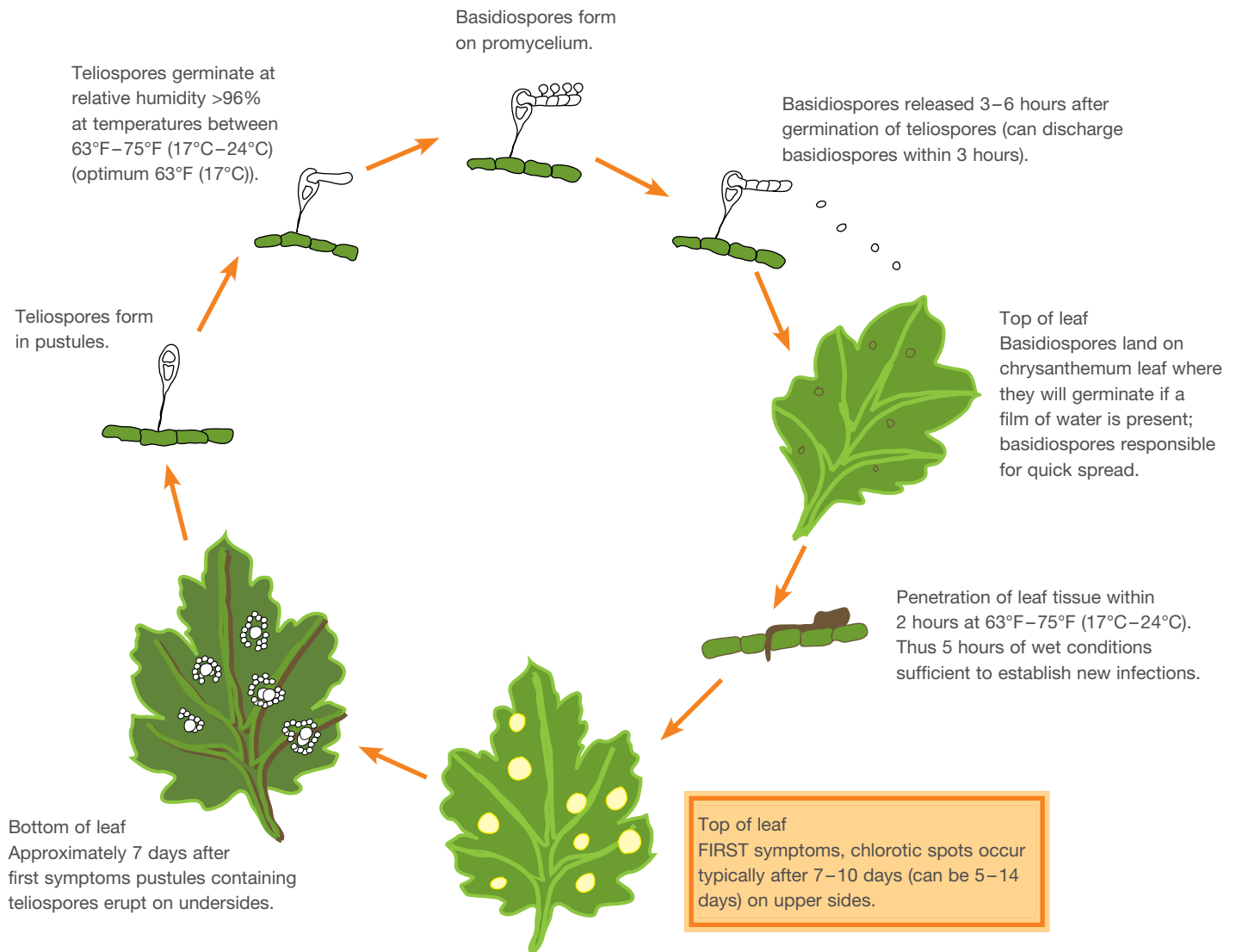
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LIFE CYCLE OF *PUCCINIA HORIANA* HENN.

(based on information from Firman and Martin 1968)



TELIOspores

- Produced in pustules and remain in pustules unless they are aggressively brushed off.
- Produce basidiospores if under moist conditions for at least 3 hours (optimum temperature = 63°F (17°C)).
- May survive attached to dried leaves for 8 weeks at 50% relative humidity or less; die sooner under moist conditions.
- Survive **ONLY** one week if infected tissue is buried under soil.

BASIDIOSpores

- Can cause epidemic if conditions are right.
- Spread from plant to plant by splashing water.
- Must have film of water on plant surface for infection.
- Infection (host penetration) can occur in 2 hours at optimum temperature of 63°F (17°C).
- Can travel short distances of 700 meters = about 1/2-mile by wind currents during moist weather (less than 1/2-mile in most situations).
- Survive 5 minutes when relative humidity is 80% or less and less than 60 minutes when relative humidity is 90%.

6899 Winchester Circle, Suite 102 :: Boulder, Colorado 80301 :: 303-415-1466 :: 800-344-7862 :: Fax 303-415-1605 :: www.syngentaflowersinc.com

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