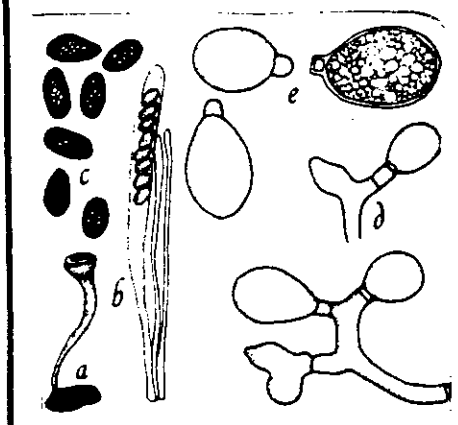
Volume VIII Number 1



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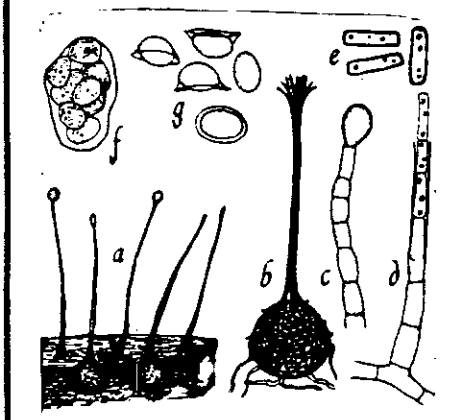

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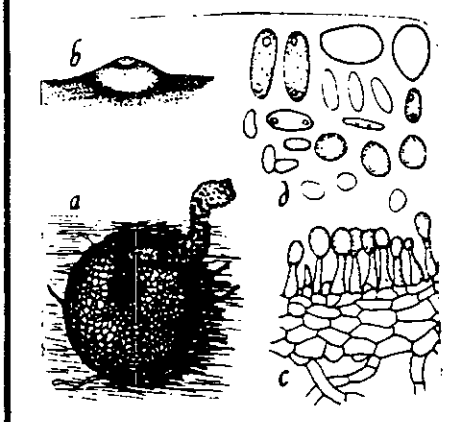

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PLANT DIAGNOSTICIAN'S QUARTERLY

March, 1987

Feature

PROGRAMMED DISEASE CONTROL

A) FOR GERANIUMS

B) FOR CHRYSANTHEMUMS - GREENHOUSE CUT FLOWERS

Illustrations by Lenore Gray

The Plant Diagnostician's Quarterly (PDQ) is a nonprofit publication which serves plant pathologists in extension, regulatory and industrial clinical laboratories, private consultants, and other interested persons. PDQ is published four times a year, in March, June, September and December. Yearly subscription fees:

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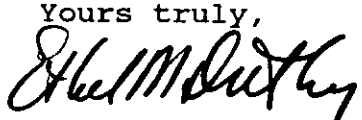
Editor's letter.

The March issue is a slim one. Please note the report from Sally Miller on the Diagnostic's Committee sponsored Workshop "Rapid Diagnostic Assays for Plant Pathogens." This will be a ticketed event at the Cincinnati meeting, so look for it when you receive your registration materials.

Rob Wick reports that the pre-meeting workshop on Phytophthora is progressing well. Be sure to contact Rob if you are interested. The June PDQ will have a description of the Phytophthora Workshop, and greetings from the new Diagnostic's Committee chair, Jack McRitchie, in addition to the features.

Yours truly,



Ethel M. Dutky
Editor

Editor's Note on March, 1987 Feature.

Programmed Disease Control

A) For Geraniums

B) For Chrysanthemums - Greenhouse Cut Flowers

I have collected these two extension recommendations written by Dr. Malcolm Shurtleff (University of Illinois) for this month's feature.

There is a lot of interest in the use of interactive computer programs as an alternative to or an addition to traditional print media for providing extension recommendations. It seemed to me that these were organized so that they could be converted to such a format.

Have any PDQ readers developed interactive Plant Pathology programs? If so, please contact me. I would like to have a feature on your experience.

Ethel M. Dutky
Editor

PROGRAMMED DISEASE CONTROL FOR GERANIUMS

Malcolm C. Shurtleff
Extension Plant Pathologist
University of Illinois at Urbana-Champaign

PRODUCTION PRACTICE	DISEASES CONTROLLED Disease	 Causal Organism
I. PROPAGATION		
A. Flower nucleus of disease-free stock plants only to verify variety. Remove and destroy other flowers in the bud stage. Grow in an isolated, locked greenhouse. Reindex plants at least annually, or start with new stock plants each year.	I. (A and B) Botrytis blight	*Botrytis cinerea*
B. Vent and heat at sundown to reduce the relative humidity to 90% during the spring and autumn.		
C. One month before taking first cuttings, thermal dust stock plants each week with EXOTHERM TERMIL* or spray with DACONIL 75% WP*, ORNALIN 50% WP*, ZINEB 75% WP (Dithane Z-78*), MANEB 80% WP (Dithane M-22*), or MANCOZEB (Fore*) plus BENOMYL 50% WP (Benlate*).	I. (C) Botrytis blight Alternaria leaf spot Cercospora leaf spot	 *Botrytis cinerea* *Alternaria alternata* *Cercospora brunkii*
D. Use an automatic, surface-watering system. If this cannot be used, hang hose so nozzle does not touch greenhouse floor. Avoid overhead watering.	I. (D,E,F,G,H & I) Bacterial blight (stem rot, leaf spot and wilt)	 *Xanthomonas campestris* pv. *pelargonii*
E. Observe good sanitation practices (see Sanitation Tips)	Verticillium wilt	*Verticillium albo-atrum* and *V. dahliae*
F. Select a raised propagating bench away from other areas of geranium production.	Pythium blackleg Fusarium blackleg	*Pythium* spp. *Fusarium* spp.
G. Place propagating medium and tools on propagating bench and steam for 1/2 hour at 180° F (or 160° F for 1 hour) at the coolest point.	Bacterial fasciation or leaf gall	*Corynebacterium fascians*

H. Wash hands thoroughly with hot, soapy water. Break cuttings from dry stock plants only and place in clean, sterile flats lined with new newspapers or clean plastic.

OR

Wash hands thoroughly in hot, soapy water. Remove cuttings with a knife disinfested by:

1. Dipping in 70% alcohol and flaming, or
2. Soaking for 5 minutes in fresh sodium hypochlorite bleach, 10% Clorox (1 oz Clorox in 9 oz of water).

Change knives between stock plants. Place cuttings in clean, sterile flats lined with new newspapers or clean plastic.

OR

If entire stock plant is harvested at one time, cut stock plant at base, take to bench or table washed thoroughly to remove dirt and disinfested with 10% Clorox.

I. Take cuttings from flats and strike directly in steamed propagating medium in benches or pots.

Southern bacterial wilt	Pseudomonas solanacearum
Bacterial leaf spot	Pseudomonas cichorii
Cottony stem rot, Sclerotinia crown rot	Sclerotinia sclerotiorum
Rhizoctonia crown and root rot	Rhizoctonia solani
Southern blight	Sclerotium rolfsii
Black root rot	Thielaviopsis basicola
Crown gall	Agrobacterium tumefaciens
Armillaria root rot	Arillaria mellea
Pelargonium viruses	Ringspots (tobacco and tomato)
	Leaf curl or crinkle
	Ring pattern
	Line pattern
	Leaf breaking and mosaic (tobacco and cucumber)
	Yellow-net vein
	Flower break
	Spotted wilt
	Leaf cupping
	Tobacco necrosis
	Tomato black ring
	Arabis mosaic
	Pelargonium zonate spot
Nematodes	Numerous endo- and ectoparasitic species

II. PREPARATION FOR PLANTING

A. Purchase cultured-virus-indexed (CVI) pathogen-free cuttings or F_1 Hybrid seed from a specialist producer or use cuttings from disease-free stock plants (see under PROPAGATION above)

II. (A,B,C,D, & E) All geranium diseases listed above plus pre- and postemergence damping-off (if starting with seed)	Pythium spp. Rhizoctonia solani

B. Prepare porous, screened growing medium, adding peat moss, Perlite, or other amendments before steaming.

C. Fill pots with medium and place on the production bench. Steam pots, bench, and potting tools at 180° F for 1/2 hour (or 160° F for 1 hour) or use aerated steam (140-160° F).

D. If staring with seed, drench with BANROT® to prevent damping-off problems.

E. Observe good sanitation practices (see SANITATION TIPS.

III. PLANTING

A. Wash hands thoroughly in hot, soapy water. If cultured-virus-indexed (CVI), pathogen-free cuttings are purchased, plant from shipping container directly into steam-treated growth medium in pots on production bench.

OR

Remove rooted cutting from propagating bench, and place in clean sterile flats lined with new newspapers or clean plastic. Plant from flats directly into steam-treated growth medium in pots on production bench.

III. (A)
All geranium diseases listed above, but primarily
Bacterial blight — Xanthomonas campestris pv. pelargonii

IV. GROWING PLANTS

A. Use an automatic surface watering system. If this cannot be used, hang hose so that nozzle does not touch the greenhouse floor. Avoid overhead watering and sprinkling.

IV. (A,B,C,& D)
All geranium diseases listed above, but primarily
Bacterial blight — Xanthomonas campestris pv. pelargonii

B. Wash hands thoroughly in hot, soapy water before pinching plants.

C. Remove and destroy flowers before they shatter and petals fall on leaves.

IV. (C)
Botrytis blight — Botrytis cinerea

D. Observe good sanitation practices (see SANITATION TIPS)

E. Thermal dust or spray weekly with same materials as in C under PROPAGATION above.	IV. (E) Botrytis blight Alternaria leaf spot Cercospora leaf spot	 Botrytis cinerea Alternaria alternata Cercospora brunkii
F. If rust is a problem, destroy diseased plants and spray remainder at weekly intervals with ZINEB 75% WP (Dithane Z-78*), MANEB 80% WP (Dithane M-22*), MANCOZEB 80% WP (Fore*), or TRIADIMEFON, 25% WP (Bayleton*).	IV. (F) Rust	 Puccinia pelargoniizonalis
G. Vent and heat at sundown to reduce the relative humidity to 90%. Space plants for good ventilation. Water only in morning; avoid overwatering when cool, cloudy and damp. Provide best environmental conditions (proper light, temperature, relative humidity, air circulation, carbon dioxide, etc).	IV. (G) Botrytis blight Alternaria leaf spot Cercospora leaf spot Rust Oedema or corky scab	 Botrytis cinerea Alternaria alternata Cercospora brunkii Puccinia pelargoniizonalis Noninfectious
H. If stem (crown) or root rot appears, drench soil with BANROT*	IV. (H) Root and crown (stem rots)	 Rhizoctonia solani Pythium spp. Botrytis cinerea Fusarium spp. Thielaviopsis basicola Sclerotinia sclerotiorum Sclerotium rolfsii Armillaria mellea

* When using any fungicide carefully follow label directions and safety precautions as to dosage, timing, and method of application. Be sure the product is currently labeled for geraniums. Where trade names are used no discrimination is intended and no endorsement by the Cooperative Extension Service is implied.

SANITATION TIPS

Pathogens causing diseases spread by way of infected plants or soil. Always think, "Could this action introduce a disease-causing organism or agent?", before you act. Common sense precautions will help avoid contamination of healthy plants with pathogenic organisms.

Destroy infected plants. Immediately remove and destroy all plants infected with bacterial blight, rust, or a virus; preferably by burning.

Take care with cuttings. Transfer cuttings from stock plants in one part of a greenhouse range to the propagation area in clean polyethylene bags. Break or snap cuttings off stock plants rather than cutting them off. When cutting, use a freshly sterilized cutting knife or razor blade for each stock plant.

Bench sterilization. Sterilize benches and growth media by steaming. If flats, pots or other containers must be placed on unsterilized benches or the ground, place them on clean sheet plastic, on new boards, or boards disinfested with copper naphthenate (CUPRINOL or others). Always wash hands in hot, soapy water between blocks of plants, benches, or cultivars. Wear clean coats or coveralls when entering an isolated area, and remove and leave them in the area when finished.

Use care in watering. If watering with a hose, take care not to splash. Splashing can move pathogens and bits or soil from untreated soil or other sources to sterilize soil and growing plants. If you spray or water with a hose, complete the watering operation during the morning hours so that plants will be dry well before evening. Take care to keep the nozzle and hose off the ground, walkways, or other surfaces that may be contaminated. If a hose nozzle is dropped on the ground, soak it in a disinfectant before using. Don't drag hoses on the ground and then across a bench or flats. If the hose and nozzle become contaminated, microorganisms may be spread by watering. Provide a hook near the faucet to keep the nozzle off the ground.

Keep benches and premises clean and free of all infected plant parts, debris, weeds, and old containers. It is especially important to keep all flowers picked from stock plants. All soil, pots, benches, watering systems, wheelbarrows, shovels, hoes, everything that will come into contact with the plants directly or indirectly must be clean. Do not walk on treated benches or flats of soil or expose treated soil to blowing dust.

Benches--Do not rest your feet on sides of low benches, as bits of soil falling from your footwear may be contaminated.

Keep walkways and areas beneath benches clean and free of plant debris and weeds. Keep debris in covered containers, because it may become overgrown with Botrytis or the spores of other fungi and contaminate the entire area.

Never use tobacco products in the greenhouse. This practice helps to avoid the introduction of viruses. After using tobacco products, wash hands in hot soapy water before handling plant material.

Treated soil--Keep treated soil in new or treated containers to avoid contamination. If soil is kept on the floor or in bins, treat floor and walls

with fresh CLOROX solution (1 part Clorox in 5 parts of water). Keep the surface of treated soil piles covered with clean plastic to reduce the chances of recontamination.

Keep insects under control. Insects transmit viruses and carry fungus spores and bacteria on their mouth parts and bodies.

Keep propagation in a separate area away from crop production and commercial areas.

Keep employees from going to the dump site and then returning directly to the greenhouse.

These practices will reduce the inoculum potential of disease-causing fungi, bacteria, viruses, and nematodes and result in healthier crops of geraniums.

Useful References

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2. Baker, K. F. et al. 1957. The U.C. System for producing healthy container grown plants. Univ. Calif. Agr. Exp. Sta. Manual 23.

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9. Stevens, C. T. 1981. Geranium rust. Mich. St. Univ. Ext. Bul. E-1493.

10. Steven, C. T., S. Perry, and J. Vincent. 1981. Bacterial wilt of geraniums. North Central Reg. Ext. Publ. No. 171.

11. Thorn-Horst, H., R. K. Horst, S. H. Smith, and W. A. Ogelvee. 1977. A virus-indexing tissue culture system for geraniums. Flor. Rev. 160 (4148):28-29, 72-74.

12. Worf, G. L. 1982. Geranium (Pelargonium spp.) disorder: Bacterial stem rot and leaf spot. Univ. of Wis. Ext. Publ. A2559.

13. Several Reports on Plant Diseases (RPD) covering the diseases of geranium are available for 25 cents each from your county Extension office or by writing to Extension Plant Pathology, N-533 Turner Hall, 1102 S. Goodwin Ave., Urbana, IL 61801. Checks should be made out to the University of Illinois.

1. Bacterial diseases of geranium. RPD 607.
2. Virus diseases of geranium. RPD 608.
3. Damping-off and root rots of house plants and garden flowers. RPD 615.
4. Fasciation, or leafy gall. RPD 619.
5. Botrytis blight or gray mold of house plants and garden flowers. RPD 623.
6. Oedema or corky scab. RPD 629.
7. Pot plant disease control guide. RPD 645.
8. Disease control programs for flowers and other nonwoody ornamentals. RPD 646.
9. Crown gall. RPD 1006.
10. Sclerotinia disease, white mold or watery soft rot. RPD 1008.
11. Verticillium wilt disease. RPD 1010.
12. Collecting and submitting soil samples for nematode analysis. RPD 1100.
13. Root-knot nematodes. RPD 1101.
14. Lesion nematodes. RPD 1103.
15. The ectoparasitic nematodes of Illinois. RPD 1106.

PROGRAMMED DISEASE CONTROL FOR CHRYSANTHEMUMS
- GREENHOUSE CUT FLOWERS -

Malcolm C. Shurtleff
Extension Plant Pathologist
University of Illinois at Urbana-Champaign

PRODUCTION PRACTICE	DISEASES CONTROLLED	
	Disease	Causal Organism
I. PREPARATION FOR PLANTING		
A. Hang hose nozzle so that it does not touch greenhouse floor. Observe good sanitation practices (see Sanitation Tips)	I. (A, B, C, D) Verticillium Wilt	Verticillium albo-atrum and V. dahliae
	Fusarium Wilt	Fusarium oxysporum f. spp. chrysanthemi
B. Remove and destroy large roots, stems, and other debris from previous crop. Break up clods.	Bacterial Blight	Erwinia chrysanthemi
	Pythium Root and Basal Stem Rot	Pythium species
C. Prepare porous soil mix for planting. Allow for good aeration. Check the soluble salts level.	Rhizoctonia Basal Stem Rot	Rhizoctonia solani
	Sclerotinia Stem Rot	Sclerotinia Sclerotiorum
D. Steam treat benches, soil and tools at 180°F for 1/2 hour at coolest spot or use aerated steam (140-160°F)	Ascochyta Ray Blight	Aschochyta chrysanthemi
	Septoria Leaf Spots	Septoria species
	Ray Speck	Stemphylium or Alternaria species
OR		
Fumigate benches, soil and tools with 2/3 chloropicrin-1/3 methyl bromide mixture. (When using a soil fumigant follow manufacturer's directions carefully)	Gray Mold or Botrytis Blight	Botrytis cinerea
	Nematodes (soil and foliar)	many genera and species
	Chloropicrin is the most effective fumigant treatment for control of Verticillium Wilt)	
II. PLANTING		
A. Purchase culture-virus indexed (CVI), pathogen-free cuttings from a specialist producer. Plant directly from shipping carbon. Space plants for good ventilation. Always wash hands thoroughly with hot, soapy water before planting or pinching	II. (A) Virus, viroid, and mycoplasm diseases plus the other diseases as listed above	

III. YOUNG PLANTS

A. Make one soil drench application[1,2/] of SUBDUE, TRUBAN, TERRAZOLE, or BANOL plus PCNB (TERRACLOR) OR use BANROT. Follow label directions. Mist-spray base of plants with SUBDUE, TRUBAN, TERRAZOLE, or BANOL plus BENLATE at one teaspoonful of each per gallon of water.	III. (A) Rhizoctonia Basal Stem Rot Pythium Root and Basal Stem Rot Sclerotinia Stem Rot	 Rhizoctonia solani Pythium species Sclerotinia Sclerotiorum

IV. GROWING PLANTS

A. Reduce relative humidity to 85-90% by venting and heating at sundown. Use an automatic surface-watering system where possible. If this cannot be used, hang hose so that nozzle does not touch greenhouse floor. Avoid overhead watering and sprinkling. Water only in the morning; avoid overwatering during cool, damp, cloudy weather. Provide best environmental conditions (proper light, temperature, air circulation, carbon dioxide, etc.)	IV. (A, B, C, D)	
B. Spray growing plants on a 7- to 14-day schedule, covering both leaf surfaces. Start when disease first appears[2]. Spray with maneb, zineb, captan, DACONIL 2787, BENLATE, DUOSAN, ZYBAN, folpet (PHALTAN), or CHIPCO 26019. Mix BENLATE with another fungicide. Always follow label directions.	Septoria Leaf Spots Ascochyta or Ray Blight Gray Mold or Botrytis Blight Ray Speck	Septoria species Ascochyta chrysanthemi Botrytis cinerea Stemphylium or Alternaria species
C. For rust use mancozeb, zineb, ferbam, or BAYLETON. Start spraying a week before rust is expected. Follow label directions.	Rust	Puccinia chrysanthemi
D. For powdery mildew use ACTIDIONE PM, BENLATE, KARATHANE, BAYLETON, or MILBAN. Spray at 7- to 14-day intervals starting when mildew first appears. Milban is a restricted use fungicide. Follow all label directions.	Powdery Mildew	Erysiphe cichoracearum

V. FLOWERING

When flower buds begin to show color:

A. Reduce relative humidity to 85-90% by venting and heating at sundown. Keep water off the foliage and flowers. Observe good sanitation practices (see Sanitation Tips)	V. (A,B)	
B. Spray foliage or mist-spray blooms weekly during cool, damp, overcast periods. Spray with BENLATE, ORNALIN, DACONIL 2787, DUOSAN, ZYBAN, CHIPCO 26019, or TOPSIN M. Use fungicides at 1/2 or 1/3 normal strength on blooms. If fumigating, use EXOTHERM TERMIL or ORNALIN FUMIGATOR. Always follow label directions.	Gray mold or Botrytis Blight Ascochyta or Ray Blight Ray Speck	Botrytis cinerea Ascochyta chrysanthemi Stemphylium or Alternaria species

VI. FLOWER STORAGE AND TRANSIT

A. Control measures for flower spots and rots in storage or shipment must be applied in the greenhouse. Mist-spray before cutting using BENLATE, ORNALIN, DACONIL 2787, DUOSAN, ZYBAN, CHIPCO 26019 or TOPSIN M at 1/2 to 1/3 normal strength.	VI. (A) Gray Mold or Botrytis Blight Ascochyta or Ray Blight Ray Speck	Botrytis cinerea Ascochyta chrysanthemi Stemphylium or Alternaria species

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1/ Fungicide drenches should not be required except as spot treatments where chance contamination occurs, then only the contaminated area plus a 2- to 3-foot margin should be drenched. If experience shows that widespread contamination often occurs, then treat BEFORE root and stem rot diseases appear. Repeated drenches should be avoided. Drenches exceeding labeled rates are illegal and may cause plant injury (phytotoxicity).

2/ When using any fungicide carefully follow all label directions and safety precautions as to dosage, timing, and method of application. Be sure the product is currently labeled for chrysanthemums.

Where trade names are used no discrimination is intended and no endorsement by the Illinois Cooperative Extension Service is implied.

CHRYSANTHEMUM DISEASES

Disease (Pathogen)	Symptoms	Survival of Pathogen	Favored by	Cultural Conditions
Verticillium Wilt (*Verticillium albo-atrum* and *V. dahliae*)	Starts as yellowing, wilting or marginal scorching of lower leaves which may be one-sided. Leaves wilt, yellow, die, and dry from base of plant upward. Plants stunted, sickly.	In soil for many years; carried in cuttings and root divisions	Cool weather (under 75°F).	Use cultured cuttings or clean stock. Steam soil and all tools 180°F for 30 min or fumigate with 2/3 chloropicrin-1/3 methyl bromide mixture under poly cover for 48 hours or more. Many resistant cultivars.
Fusarium Wilt (*Fusarium oxysporum* f. sp. *chrysanthemi*)	Lower leaves turn yellow and wither; finally whole plant wilts and dies. Dark brown stem rot with masses of pinkish or white *Fusarium* spores.	In soil and crop refuse.	Temperature above 80°F.	Same as for Verticillium wilt (above), except that the resistant cultivars are probably not the same. Rooted cuttings may be symptomless carriers. Avoid high N fertilization.
Pythium Root and Basal Stem Rot (*Pythium* species)	Plants stunted, may suddenly wilt. Girdling black stem rot near the soil line. Roots decay starting at the tips.	Soil-borne fungi. Spores spread in water.	Excess soil moisture and poor drainage too deeply.	Treat soil as for Verticillium wilt (above). Avoid overwatering and slow-draining soil mix. Do not set cuttings.
Rhizoctonia Basal Stem Rot (*Rhizoctonia solani*)	Brown, sunken lesions near soil line. Plants stunted, may wilt and die. Dark fungus strands may be visible with hand lens. Roots may decay.	Common soil-borne fungus.	Warm, moist conditions.	Use sterilized soil mix and cultured cuttings or clean stock. Do not set cuttings too deeply. Avoid high salt concentrations in the soil mix. Strict sanitation.
Gray Mold or Botrytis Flower Blight (*Botrytis cinerea*)	Brown, water-soaked spots on petals. Woolly, gray fungus grows on decayed tissues. Rotting of lower leaves. Infection may enter and girdle stem causing death of the plant.	In plant debris. Spores air-borne.	High humidity; poor air movement.	Use cultured cuttings. Keep foliage dry and humidity below 85-90% by proper heating and ventilation at sundown. Clean and burn all crop residues. Stringent sanitation is important!
Sclerotinia Stem Rot (*Sclerotinia sclerotium*)	Stem rotted; flower rot is similar to Gray mold. Cottony fungus rowth may form on rotted tissues. Hard, black bodies (sclerotia) may form on and inside stem.	Sclerotia in soil. Air-borne spores.	High humidity; crowded plants.	Same as for Gray mold and Rhizoctonia Basal Stem Rot (above). Clean up and burn all crop refuse. Sanitation is important.
Ascochyta or Ray Blight (*Ascochyta chrysanthemi* = *Mycosphaerella ligulicola*)	Marginal, dark brown to black leaf spots or basal leaf and stem rot. Below ground stem infection may cause one-sided distortion and dying of foliage. Brown to blackish rot of petals (ray blight) may extend into flower stalk.	In plant refuse from crop to crop. Air- and water-borne spores.	Wet or damp weather; high humidity; 70-80°F.	Same as for Ascochyta or Ray Blight and Gray mold (above). Cultivars differ in their susceptibility. Sanitation is important. This disease should not be a problem in greenhouses.
Septoria Leaf Spots (*Septoria obesa* and *S. chrysanthemella*)	Round to irregular, dark brown or black leaf spots that start at base of plant. Black specks (fungus fruiting bodies) form in centers of older spots. Infected leaves wither and die early.	In plant and soil debris for 2 years; water-borne spores.	Wet or damp weather; high humidity; 70-80°F.	Same as for Ascochyta or Ray Blight and Gray mold (above). Cultivars differ in their susceptibility. Sanitation is important. This disease should not be a problem in greenhouses.
Ray Speck (*Stemphylium* or *Alternaria* spp.	Small brown or white spots in flower petals; spots sometimes have a distinct 'halo.'	In plant debris. Air- and water-borne spores.	High humidity; temperature 70-80°F.	Same as for Ascochyta or Ray Blight and Gray mold (above). Sanitation is important

CHRYSANTHEMUM DISEASES

Disease (Pathogen)	Symptoms	Survival of Pathogen	Favored by	Cultural Conditions
Rust (Puccinia chrysanthemi)	Small, powdery, chocolate-brown pustules on undersides of leaves and on stems. Found where foliage is crowded and damp with poor air circulation.	Air-borne spores on living plants.	Free water on foliage; crowding of plants.	Keep humidity low (85-90%) and the foliage dry. Ventilate properly. Resistant cultivars are available. This disease should not be a problem in greenhouses.
Powdery Mildew (Erysiphe cichoracearum)	Superficial, white powdery growth on upper surfaces of leaves, and on buds and stems.	Air-borne spores on living plants.	High humidity, cool weather crowding.	Space plants and keep humidity down. Ventilate properly.
Bacterial Blight (Erwinia chrysanthemi)	Water-soaked stem lesions; tops turn black and exude drops of liquid; pith is reddish-brown and jellylike. Stem may collapse or crack open; later becomes hollow.	In plant debris; bacterium is very contagious.	High humidity; water on foliage.	Same as for Bacterial Blight (above). Disease is much more common on outdoor mums in south following frequent and heavy rains.
Foliar Nematode (Aphelenchoides ritzema-bosi)	Dark green to dark brown, wedge-shaped areas in leaves; develops progressively upward from base of plant. Leaves wither and hang downward.	In plant debris, buds, and growing points.	Spread by splashing water on foliage.	Use cultured cuttings or disease-free plants. Keep foliage dry and avoid overhead sprinkling. Sterliize soil between crops.
Stunt (viroid)	Plants 1/2 - 2/3 normal size. Leaves and flowers smaller and paler than normal. Flowers are 7-10 days early; flecking occurs on some cultivars.	Viroid easily spread by foliage contact, handling, cutting knives, etc. Not transmitted by insects.		Use cultured cuttings from indexed, disease-free stock. Buy from a propagation specialist. Carefully destroy all diseased plants when first found.
Chrysanthemum Mosaics (viruses)	Plants stunted, blooms smaller and later; stems weak; leaf mottling is almost symptomless in some cultivars.	Viruses are transmitted by aphids as they feed; not by handling or cutting knife, etc.		Use cultured cuttings from virus-indexed, disease-free stock. Destroy plants when symptoms first appear. Control aphids. Keep down weeds. Screen vents.
Tomato Aspermy (virus)	Flowers small, mildly to severely distorted; often show 'color breaking.' Plants may be somewhat stunted.	Virus is transmitted by aphids as they feed.		Same as for Chrysanthemum Mosaics (above. Tomato and weeds are also hosts for this virus.
Chrysanthemum Flower Distortion (viruses)	Flowers markedly dwarfed and distorted. Plants develop no foliar symptoms.	Vector is unknown; virus is spread by handling; cutting knife, etc.		Same as for Chrysanthemum Mosaics (above).
Spotted Wilt (virus)	Plants often one-sided. Ring and line patterns on leaves of some cultivars. Leaf distortion with dead areas. Dead streaks in stems of some cultivars.	Thrips-transmitted; not by cutting knife. Many virus reservoirs including both weeds and ornamentals.		Eliminate weeds and susceptible ornamentals from in and around greenhouse. Screen greenhouse with cheesecloth. Control thrips. Use cultured cuttings.
Aster Yellows (mycoplasma)	Plants stunted, new growth is yellow. Flowers distorted, may be converted to green, leafy structures.	Spread only by leafhoppers; not spread by handling or cutting knife, etc.		Use cultured cuttings. Do not propagate from field-grown plants. Control leafhoppers.
Soil Nematodes (many genera and species)	Plants stunted, pale, and lack vigor. Roots have swellings; or are short, stubby, and discolored.	In soil and mum roots.	Temperature over 80°F.	Use cultured cuttings and sterilized soil mix. See Verticillium wilt (above).

AGRI-DIAGNOSTICS ASSOCIATES

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March 4, 1987

Dr. A.R. Weinhold
Department of Plant Pathology
University of California
Berkeley, CA 94720

Dear Dr. Weinhold:

Please find attached the list of participants for the Workshop - "Rapid Diagnostic Assays for Plant Pathogens", which will be held during the upcoming APS Meeting in Cincinnati. The participants are listed in alphabetical order, and all of the presentations will be held simultaneously, in a "bazaar" format. Each presentation will last 35-45 minutes, and each participant will make four presentations during the workshop to groups of ten people.

Since this will be a Hands-On workshop, we will limit participation to 60 people. In addition, a registration fee of $5.00 will be required. We feel that this nominal fee will provide funds to help cover expenses of the workshop, and will also limit registration to those persons who are really interested in the techniques that will be presented. The companies involved in the workshop have agreed to provide refreshments. I have contacted Steve Nelson at APS regarding these matters, as you suggested.

As I mentioned during one of our telephone conversations, we would like to have this workshop scheduled on Monday afternoon, August 3, if possible. This would allow people who are not able to attend the workshop or miss some of the demonstrations to visit the participants later in the meeting. Most of the commercial participants will also have a booth at the meeting.

Thank you for your help during the last month in getting this workshop put together. Please let me know if you need additional information.

Sincerely,

Sally A. Miller
Diagnosticians
Committee

cc: E. Dutky
J. McRitchie
M. Niedbalski Cline
J. MacDonald

Workshop - Rapid Diagnostic Assays for Plant Pathogens

List of Participants

Participant	Title of Presentation
Solke De Boer Agriculture Canada Vancouver Research Station 6660 NW Marine Dr. Vancouver, B.C. Canada V6T 1X2	Immunofluorescence Using Monoclonal Antibodies for Bacterial Pathogen Detection
Vonnie Estes Agri-Diagnostics Assoc., Inc. 2611 Branch Pike Cinnaminson, NJ 08077	Dipstick Immunoassays for Detection of Fungal Pathogens of Turfgrass
Jyh-Dar Lei Agdia, Inc. 1901 N. Cedar St. Mishawaka, IN 46545	ELISA for Bacteria
Robert Mansfield Neogen Corporation 620 Lesher Place Lansing, MI 48912	Mycotoxin Detection Assays
Gordon Stiegler Agri-Sciences, Inc. 655 Deep Valley Drive Suite 125 Rolling Hills Estates, CA 90274	Bacterial Diagnostics
Chester Sutula Agdia, Inc. 1901 N. Cedar St. Mishawaka, IN 46545	ELISA for Viruses/ELISA Instrumentation

Ministry of Agriculture and Food
Ontario

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THIS IS IN COLOR

ROOT, CROWN AND BASAL STEM DISEASES OF WINTER WHEAT

J.C. Sutton and R. Hall,
Department of Environmental Biology, University of Guelph

Several diseases affect the roots, crowns and basal stems of winter wheat. These diseases are of economic importance because they reduce the yield and quality of the crop. Root diseases usually become evident to growers during the last four or five weeks of the growing season. Wheat crops which looked promising immediately after the heads emerged may later appear sparse or unthrifty, and the heads fail to fill properly. In some instances the heads bleach long before normal senescence. Healthy-looking wheat crops may lodge unexpectedly in stormy weather or even in moderate winds. In each of these situations the source of the problem almost invariably is disease on the lower stem, crown or roots.

The main purpose of this Factsheet is to aid identification of the principal diseases on the basal stem, crown and roots. It provides key information for the grower and disease management specialist on how the diseases develop in relation to crop growth, weather, soil conditions, and cultural practices. Practical steps for managing the diseases and minimizing losses in yield and quality are summarized.

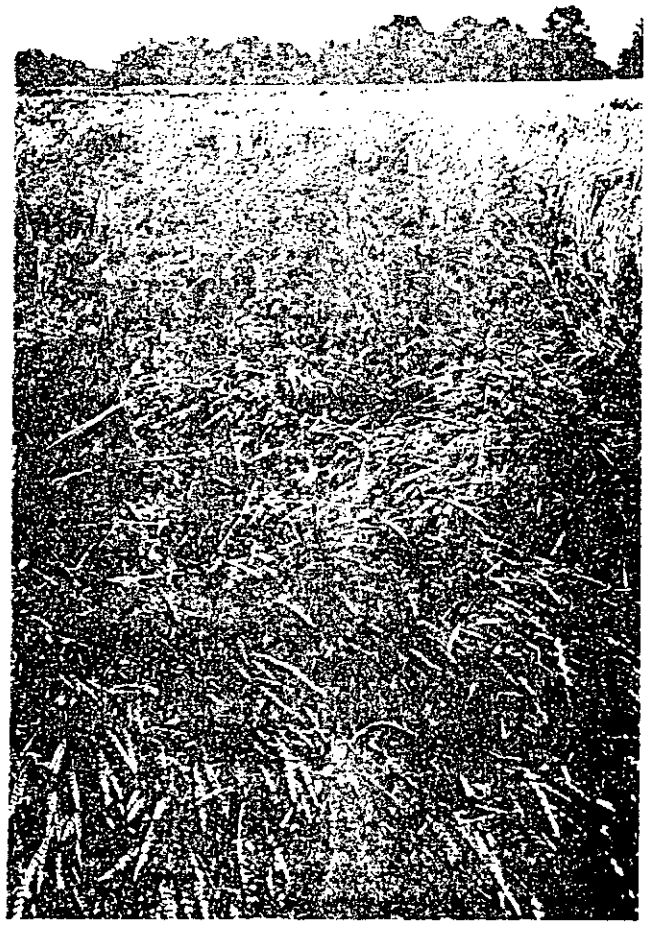

Figure 1. Effects of eyespot or strawbreaker in maturing wheat. Note that the wheat has lodged in many directions.

EYESPOT or STRAWBREAKER (Figures 1 and 2)

Symptoms. Eyespot is most easily recognized after the wheat has headed. Pale brown spots, each about 1-3 cm in length, may be seen on the lower 10-15 cm of the stem after the leaf sheaths have been peeled downwards. One

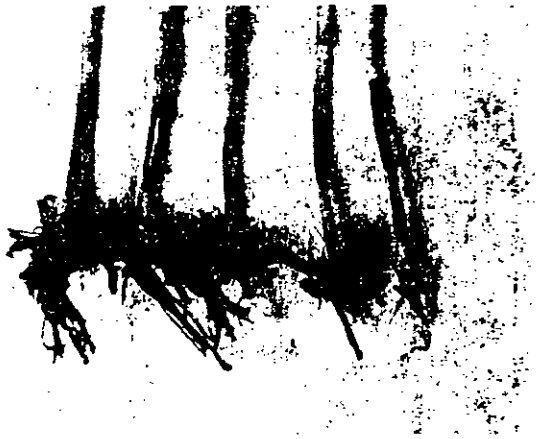

Figure 2. Eye-like spots of eyespot disease on wheat stems after removal of the leaf sheaths. The centre of each spot would darken within a few days.

to several spots may form on each stem. The centre portion of each spot darkens to give a charred pupil-like appearance. Wefts of whitish fungal material may be observed within the hollow stems beneath the spots. The spots at first are firm but later become brittle. Symptoms before heading are more difficult to recognize. During April and May spots about 0.5 to 1.5 cm long appear on the leaf sheaths near soil level.

Stems weakened by eyespot often topple over in various directions giving an untidy mess of criss-crossed stems, a condition sometimes called straggling. Plants affected by eyespot tend to mature early. The heads may be partially empty and the grains shrivelled. Severe eyespot may kill tillers or whole plants outright.

Cause. Eyespot is caused in various cereals and grasses by a fungus (*Pseudocercosporella herpotrichoides*). Winter wheat is more severely affected than spring wheat, rye, oats or barley.

Disease cycle. The eyespot fungus survives in stubble residues of the various host plants for three years or longer. However, amounts of the fungus decline with time. Spores of the fungus produced on the residues are splashed by rain to wheat plants in the fall or spring. The spores infect the leaf sheaths near soil level and spots eventually appear on the sheaths. The fungus later penetrates to the stems where it produces the characteristic eyespot symptoms. Spores formed on the spots may spread to other tillers and produce a second generation of spots, but these develop late in the season and appear inconsequential to yield of the current crop.

SHARP EYESPOT (Figure 3)

Symptoms. Spots about 1-2 cm long form on the lower leaf sheaths and stem when the wheat is heading. The spots resemble those of eyespot but are more superficial and their margins are sharply delineated. The margin is dark brown while the centre is more or less straw-colored and sometimes stippled with brown specks. Affected plants may lodge, bending or breaking over where the spots formed.

Another phase of sharp eyespot occurs on young wheat in the fall. The spots form on the short portion of stem between the crown and the seed. The seedlings may be killed, often in patches.

Cause. Sharp eyespot is caused by a fungus. *Rhizoctonia cerealis*, which attacks oats, barley, corn, potatoes, grasses, legumes and several other kinds of crop plants in addition to wheat. The fungus is widely distributed in southern Ontario. On the sharp eyespot lesions in wheat, the fungus produces a network of brown strands which are easily scraped off. Unlike the true eyespot fungus, it does not produce wefts of whitish fungal material in the stem cavity. However, it may produce flattened brown to black bodies (sclerotia), up to 3 mm in diameter, inside the stem or beneath the leaf sheaths.

A closely related fungus, *Rhizoctonia solani*, also occurs on wheat roots, crowns and stems. The two species are distinguished in the laboratory by counting nuclei in each fungal cell (two nuclei per cell in *R. cerealis* and more than two in *R. solani*). The economic importance of *R. solani* on wheat in Ontario is unclear.

Disease cycle. The fungus resides in the soil, often in association with infested crop residues. It grows as microscopic brown filaments (hyphae) through the soil and over the crowns and stems of developing wheat, which it eventually penetrates and produces the the spots. Ontario isolates of the fungus produce spots at 10-25°C (optimum near 20°C). Incidence of sharp eyespot may be high on acid, sandy soils, which dry down quickly after rain. Dry conditions in fall and spring favor development of sharp eyespot.

TAKE-ALL (Figure 4)

Symptoms. Take-all usually becomes noticeable at the heading stage when the heads, stems and leaves of badly affected plants become prematurely bleached. The bleaching of tillers takes only 2 or 3 days. Affected plants occur in circular patches, one to several metres across, or as individuals or small clusters scattered across the field. Many plants appear moderately to severely stunted and bear few tillers. The bleached heads (white-heads or dead-heads) normally are sterile. Whiteheads may also be caused by factors other than take-all. Dark-colored molds tend to grow on the whiteheads, especially in damp weather. The conspicuous bleaching is secondary to disease on the roots, crown and lower stem.

The roots of diseased plants are sparse, blackened and brittle. The dark-colored rot often extends to the crown and basal stem. Removal of the lowest leaf sheath reveals a dark shiny layer of fungal material on the stem that is easily scraped off. Weakened stems lean or lodge in various directions as in eyespot. In many instances, the disease is confined to the roots, and no symptoms appear on the crowns, stems and heads.

Figure 3. Spots of sharp eyespot on wheat stems. Note the dark brown margins of the spots.

Figure 4. White-heads produced by take-all disease among normal green heads of winter wheat. The white-heads usually appear 3-5 weeks before ripening.

Cause. Take-all is caused by a fungus (*Gaeumannomyces graminis* var. *tritici*) which attacks wheat, barley and rye in descending order of severity. This variety of the fungus also attacks various grasses, including brome grass, orchard grass, fescue, ryegrass and, to a lesser extent, timothy and quackgrass. Other varieties of the fungus are highly aggressive on oats and grasses.

The wheat take-all fungus produces spores (ascospores) inside tiny black structures (perithecia) on the sheath of the lower leaf, and on stubble residues at the soil surface. Dark spore-bearing structures (pycnidia) of an unrelated fungus (*Wojnowicia graminis*), which causes slight darkening of the lower stem, are also common on the bases of wheat stems with take-all symptoms.

Disease cycle. The main source of the fungus is infested crop residues in the soil. The fungus survives best in the residues when the soil nitrogen content is high. Brown strands (hyphae) of the fungus grow from the residues, through the soil and over the surface of the roots, crowns and stems. The fungus spreads from plant to plant by means of "root bridges". Using a hand lens, it is often possible to see the brown strands on the roots while the roots remain whitish. The roots turn black after the fungus penetrates into them. Invaded crowns and stems develop a brownish dry rot.

Severity of take-all generally increases as soil alkalinity increases (pH rises) and fertility (especially nitrogen and phosphorus) decreases. Wet soil, especially in spring and early summer, is highly favorable to the disease. Soil compaction aggravates take-all. Cool weather (12-18°C) is more favorable than warm weather. The disease is more severe when wheat is sown early than when sown near the end of September or in October. When wheat is grown continually on the same land, take-all becomes increasingly severe during the first 3-5 years, but subsequently declines. Take-all predisposes wheat to drought stress, especially in June and July.

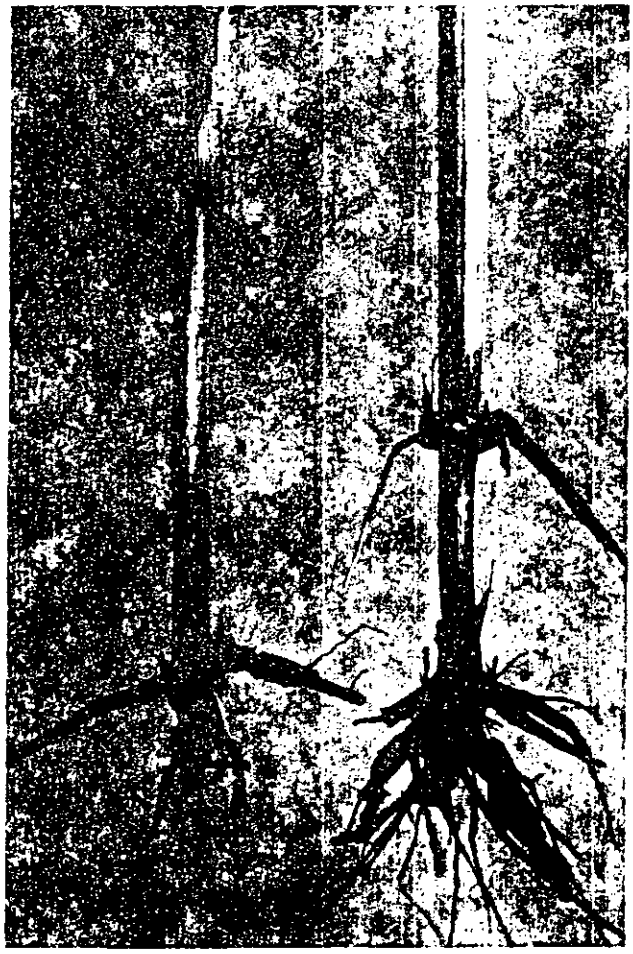

Figure 5. Blackened roots, crowns and lower stems of winter wheat affected by take-all. The blackening does not always extend to the stem from the roots.

Figure 6. Crown rot, characterized by red-brown rotting of crowns, roots and lower stem.

CROWN ROT (Figure 6)

Symptoms. The crown, roots, or lower stem show a brown to red-brown rot. Brown or reddish streaks may occur on the stem. Lesions are variable in shape and size and do not have distinct margins. The disease may occur on plants of all ages, causing death or stunting of seedlings, a reduction in the number or size of tillers and white and shrivelled heads.

Cause. Several species of the fungus *Fusarium* can cause the disease but the most important are *F. culmorum*, *F. graminearum* and *F. avenaceum*. *Fusarium culmorum* is the most destructive to older plants while *F. avenaceum* and *F. graminearum* are more damaging to seedlings.

Disease Cycle. These fungi infect many cereals, grasses and other plants, including corn. They survive in seed, in crop residue and in soil. During the fall they grow from these sources into the crown, roots or leaf sheaths. At this stage they can cause seed decay and seedling blight. In spring, the lesions continue to expand so that crown rot, stem rot and root rot develop. Moist soil in the fall favors infection of the plant but dry soil and high levels of nitrogen fertilizer favor the progress of the disease in the spring. The fungi, especially *F. graminearum*, also infect heads and contaminate seed (see OMAF Factsheet *Head Diseases of Winter Wheat*). The disease is likely to be more severe on wheat that follows wheat, barley or corn.

PYTHIUM ROOT ROT

Symptoms. Plants in fall or early spring appear stunted and pale-green to yellowish. The fine roots show a light-brown rot and readily break off. Affected plants often are in patches.

Cause. Several species of the fungus *Pythium*.

Disease cycle. The disease-fungi survive in the soil and crop residues. They produce spores (zoospores) which swim through moisture films on soil particles and invade the wheat roots. Some species are most damaging in warm soils, while others prefer cold soils. The disease is less severe when phosphate levels are adequate for good root growth.

DISEASE MANAGEMENT

Severity of the various diseases is related to the amounts of the disease-causing fungi present in the field or on the seeds at planting time, and to conditions that affect disease development during the growing season. In most instances the diseases may be managed effectively by applying appropriate practices.

1. **Crop rotation.** Rotation of winter wheat with nonsusceptible crops is a necessary practice for managing eyespot, take-all and some crown rots. Production of wheat immediately after wheat is usually disastrous, largely due to the combined effects of these diseases. Avoid other small-grained cereals and grasses in the rotation. A rotation that includes two or more years of nonsusceptible crops is more effective than one for a single year. Take-all is sometimes severe after legumes because nitrogen produced by these crops helps the take-all fungus to survive. Rotation is ineffective for sharp eyespot and culmorum crown rot, but these diseases are less damaging in Ontario than eyespot or take-all. The effect of a successful rotation is to reduce amounts of disease-causing fungi surviving in the field when the next wheat crop is grown.
2. **Tillage practices.** Practices that bury stubble in the soil, especially mouldboard plowing, are effective for reducing eyespot severity. Eyespot can be severe when the stubble remains on the surface. Effects of tillage practices on take-all and crown rot are unclear.
3. **Choice of wheat variety.** All wheat varieties are susceptible to the diseases considered here. Stiffer-strawed varieties suffer less lodging associated with eyespot and sharp eyespot. Spring wheat usually escapes severe disease for reasons related to the season in which it is grown.
4. **Seed selection and treatment.** Certain of the *Fusarium* fungi that cause crown and root rots are carried on the seed. Use seed that appears healthy and free from reddish, brownish or blackish discoloration. Broad-spectrum fungicides help to reduce seed rot and certain seedling diseases (consult the current issue of OMAF Publication 296, *Field Crop Recommendations*). Fungicide seed treatments for managing take-all or eyespot are not yet registered.
5. **Seeding date.** Winter wheat should not be sown too early or too deeply. Take-all, eyespot, sharp eyespot and crown rot will be less severe with increased delay in sowing. Allow sufficient time, however, for the wheat to grow and tiller before onset of winter conditions. Shallow seeding helps to avoid severe sharp eyespot.
6. **Fertilizer.** Provide adequate but not excessive nitrogen for good growth of the foliage. High nitrogen increases crown rot. Ammonia-based and slow-release forms of nitrogen normally support less take-all than nitrate fertilizers. Adequate phosphorus and potassium will help to maintain root growth in plants with root rot.
7. **Fungicide sprays.** Fungicides applied to control leaf and head diseases (e.g., powdery mildew, septoria tritici blotch) do *not* control diseases of the lower stem, crown or roots, and may increase lodging unless a growth regulator also is applied. We have controlled eyespot effectively with fungicides applied in experimental plots, but these fungicides are **not registered** for use on winter wheat in Canada at this time.
8. Growth regulators such as CCC [(2-chloroethyl) trimethylammonium chloride] strengthen the straw and generally reduce lodging associated with eyespot and sharp eyespot.
9. **Further information.** Consult the current issue of OMAF Publication 296, *Field Crop Recommendations*, for recommended fungicide treatments and varieties. The following publications give information on other diseases and disorders of winter wheat: OMAF Fact-sheets *Leaf Diseases of Winter Wheat*, Agdex 273/600, *Head Diseases of Winter Wheat*, Agdex 112/630, *Cereal Virus Diseases*, Agdex 110/632, *Oat-Cyst Nematodes*, Agdex 113/632, and *Manganese in Soybean and Small Grain Production*, Agdex 100/531.

DIRECTOR, PEST DIAGNOSTIC CLINIC

DESCRIPTION Applications are invited for Director, Pest Diagnostic and Advisory Clinic within the Department of Environmental Biology, University of Guelph. The clinic serves the Ontario Ministry of Agriculture & Food, and the public at large.

RESPONSIBILITIES The Director administers the Clinic and is responsible for its effective operation. The Director responds to inquiries regarding insects, diseases and weed problems, and gives advice on specific control applications. Other duties include the supervision of personnel and the maintenance of records and accounts. The Director will also assemble a collection of extension information as a resource for distribution to clients. The Director may be responsible for original articles on insects, diseases and weeds, and will offer public lectures as occasion demands. The Director will also have some teaching opportunities with graduate students in areas of diagnostics and pest management.

QUALIFICATIONS Applicants should have a M.Sc. or Ph.D. with interest and experience relevant to entomology, plant pathology and weed science. They must also have the ability to interact favorably with the public, with agricultural personnel, and with advanced level students.

APPLICATION PROCEDURE The position is available immediately. Salary range is $28,610 - 42,914. (21,457 - 32,185 US) Applications including a complete cirriculum vitae, academic transcript, a clear statement of interests and experience, and the name of three referees should be sent to:

Dr. S. B. McIver, Chairperson
Department of Environmental Biology
University of Guelph
Guelph, Ontario N1G 2W1

CLOSING DATE: April 15, 1987

In accordance with Canadian Immigration requirements, this advertisement is directed to Canadian citizens and permanent residents.