Tomato Disease Control Strategies

San Quintin, Mexico

About this publication

Purpose of this publication is to outline disease control strategies for growing healthier fresh market tomatoes in the San Quintin area. Based on our experience of field observations, review of literature and laboratory analysis of samples, we have made suggestions that are practical and may be useful in making your disease management decisions.

Ahern
INTERNATIONAL SEEDS, INC.

"No bird soars too high if he soars with his own wings." - William Blake

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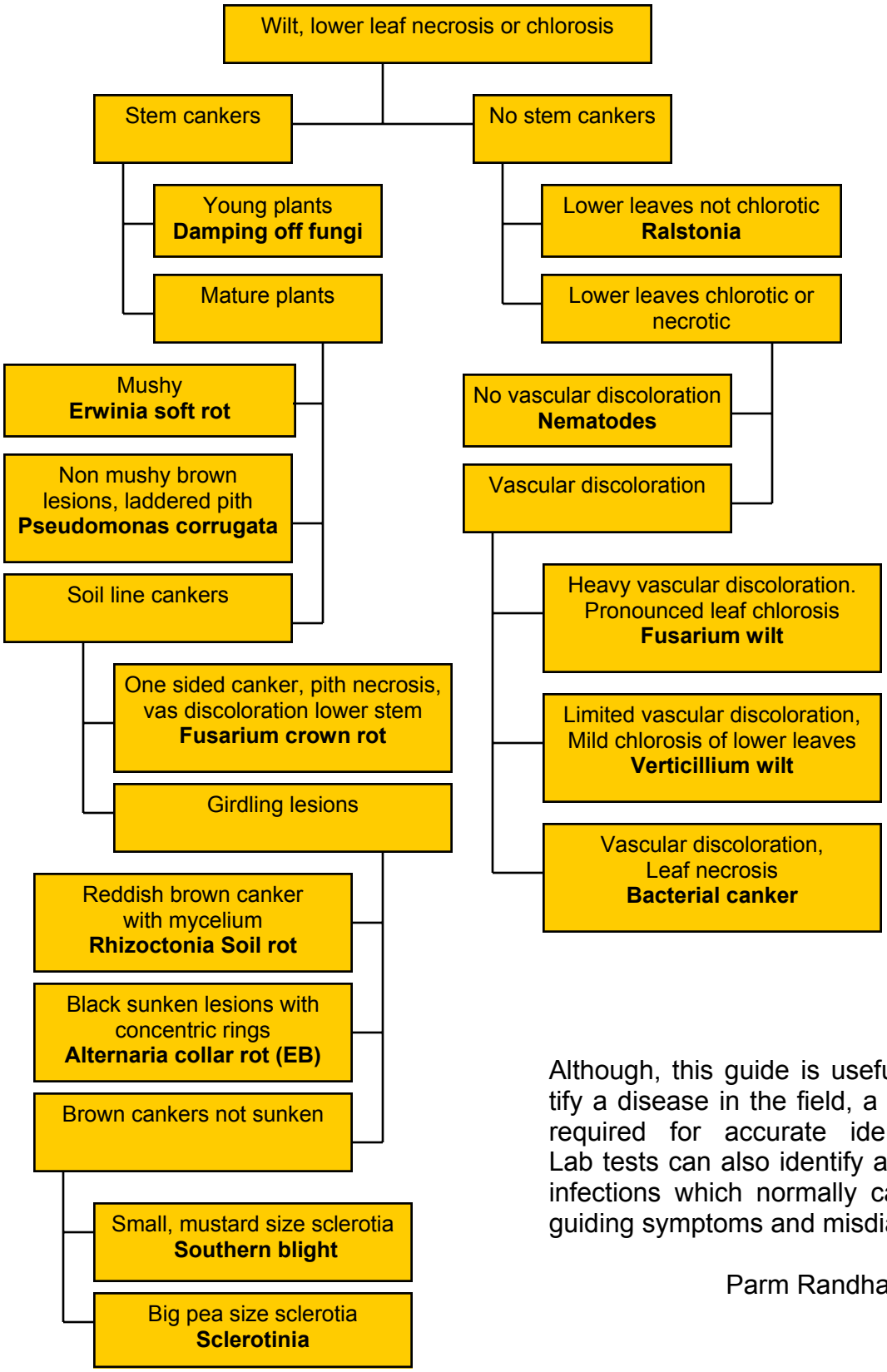
Do-it-yourself
Diagnosis of Root and stem Diseases



Although, this guide is useful to identify a disease in the field, a lab test is required for accurate identification. Lab tests can also identify any double infections which normally cause misguiding symptoms and misdiagnosis.

Parm Randhawa, Ph.D.

Verticillium wilt

Diagnosis

Diseased plants show yellowing of lower leaves and vascular discoloration. Disease is more severe at fruiting stage. Some growers can observe vascular discoloration in the lower stem and make a reasonable diagnosis. However, laboratory analysis should be requested as bacterial canker and Fusarium can cause similar vascular discoloration. In our experience, about 30% samples collected from field as Verticillium suspects showed presence of bacterial canker and/or Fusarium. In general, if Verticillium is isolated from the tissue, it is likely to be pathogenic. However, it should be diagnosed to species level as other less important species of Verticillium may exist. Lab tests are available to easily distinguish species.

Verticillium dahliae (very important)
Verticillium albo-atrum (less important)
Verticillium tricorpus (not important)

Risk assessment

Verticillium produces microsclerotia on tomato plants. These microsclerotia get incorporated in the soil as the crop is harvested and can survive in the soil for many years. The number of microsclerotia in the soil is directly related to severity of disease that will develop in the crop. Following are the general guidelines:

Low risk	= <5 microsclerotia
Medium risk	= 6-12 microsclerotia
High risk	= >12 microsclerotia

If you fumigate fields, there is good chance of eradication of Verticillium from soils. However, if fumigation is not applied correctly (under dose, low or excessive soil moisture, low temperature etc), the pathogen may survive. A soil assay after fumigation will help to predict the risk. If the risk is high, you may want to take additional measures such as introduction of beneficial microbes to the soil. Lab tests are available to estimate microsclerotia by agar plating (30-day test) and PCR (2-day test). Although PCR test gives fast results, dead microsclerotia (due to fumigation) can also give positive results by PCR. Therefore, after fumigation, a soil test should be done by agar plating.

Fumigation and fungicides

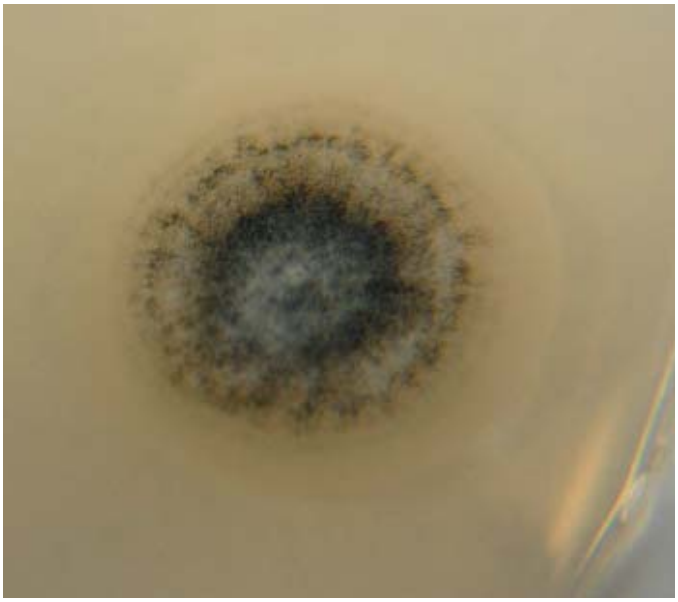
Methyl bromide is the best fumigant. Vapam (metam sodium or metam potassium) is the second best. Fungicides are ineffective and are not recommended.

Resistant varieties

Verticillium dahliae has two races V1 and V2. Most of the varieties available today have resistance to V1 only. Accordingly, if your soil contains V2, disease is likely to develop. Lab tests (based on inoculation of differential varieties) can determine what race you have in your field. If V2 is present, a complete fumigation including the beds as well as aisle area will be beneficial.

Sanitation

Sanitation is always helpful. Any prunings should be removed from the field. After harvest, the plants along with the roots should removed. If removal is not practical for your farm, the trash may be collected in the aisles and burned. These practices will reduce overall microsclerotial inoculum for the next crop.



Verticillium colony with black microsclerotia on selective media NP-10

Fusarium wilt

Diagnosis
Diseased plants show yellowing of lower leaves and pronounced vascular discoloration. The vascular discoloration often extends in the upper stem. Growers often cut the stem to see vascular discoloration to confirm the field diagnosis. Fusarium can be easily isolated from stem tissue. However, if Fusarium is isolated from soil or asymptomatic plants, there are good chances that it is non-pathogenic. Such isolates must be tested for pathogenicity for accurate diagnosis.

Risk Assessment
Fusarium can survive in soil for long periods. While it is important to know how much inoculum is present in your soil, colony counts are not useful. Non pathogenic Fusarium spp are usually present in the soil. Therefore, soil testing to get a Fusarium count is not recommended. It is helpful to know what race of Fusarium is present in your soil. This information will help you select a resistant variety for your field. Most varieties available today are resistant to F1 and F2. If your soil has F3 race, it is likely that disease will develop. In this case, a complete fumigation including the beds as well as aisle area is recommended.

Fumigation / Fungicides
Methyl bromide is the best fumigant. Vapam (metam sodium or metam potassium) is the second best. Although, a few fungicides show inhibition of Fusarium under laboratory conditions, soil applications have been generally ineffective.

Resistant varieties
Resistant varieties are the best method to reduce losses from Fusarium.

Biocontrol
Certain non-pathogenic Fusarium isolates can be helpful to reduce Fusarium disease. One such isolate (isolate CS-20 by R.P. Larkin) gave 60-100% disease reduction in greenhouse experiments

Validamycin A
Recently, Japanese researchers have demonstrated that a single foliar application of Validamycin A (antibiotic) can develop systemic acquired resistance (SAR) in tomato and provide Fusarium control for 64 days (Phytopathology 2005, 95: 1209-1216).

Nutrition
Raising soil pH to 6.5-7.0 and use of nitrate fertilizers can reduce disease severity.

Fusarium symptoms in the field

Field diagnosis: Vascular discoloration extends in the upper stem

Fusarium colonies recovered from soil on KOM media.

Bacterial canker (Cmm)

Diagnosis

Diseased plants show necrosis of lower leaves. The vascular system is discolored. In advanced stages, pith also get discolored. Lab tests are necessary to identify infected plants. Two kinds of lab tests are available. A traditional test is by culturing on selective media and then confirming the isolates by pathogenicity test. This can take up to 14 days. Now PCR test has become available which can be completed in as little time as one hour.

Symptoms: Leaf scorching in advanced stage infections

Risk Assessment

Infected seeds are a well known risk for developing bacterial canker. Therefore, it is very important to know if the seed is clean. Sometimes, seeds are treated with acid. Such a treatment can highly reduce surface bacteria but will not eradicate any infections under the seed coat. For acid treated seeds, special testing methods must be employed to detect any residual infections.

In our field observations in San Quintin area, bacterial canker is endemic. This high incidence indicates infection sources other than seed. Although literature is lacking to support soil as a source, we believe that bacteria lives in the soil during the short, crop free period. Since fumigants are generally not effective on bacterial pathogens, Cmm could persist in the soil and infect the new crop. Consequently, a soil test should be administered in order to assess the risk of Cmm. Traditional plating tests do not work for soil samples. Only PCR tests are effective for testing soil samples.

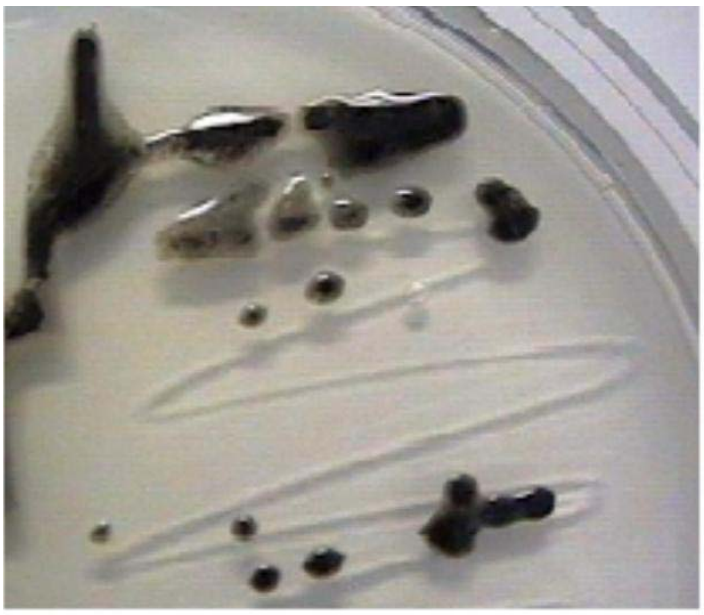
Field diagnosis: Vascular and pith discoloration

Fumigation / bactericides

Methyl bromide can reduce bacterial pathogens in soil. Other fumigants are less effective.

Cultural controls

Sanitation is most important for this disease. The tools used to trim plants, prune leaves should be frequently sanitized with alcohol or bleach. This is important because heavy amount of bacteria gets introduced on the cutting edge of tool even with a single cut of an infected plant. Contaminated tools are very effective for secondary spread. After harvest, all trash should be hauled away or burned.



Clavibacter colonies on SCM media

Tomato spotted wilt virus (TSWV)

Diagnosis

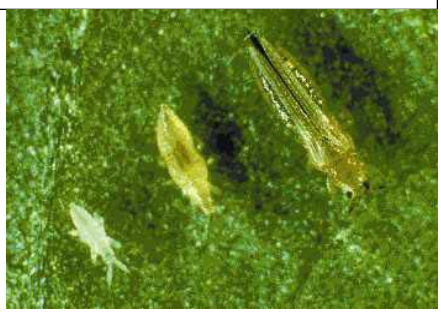
Tomato spotted wilt virus is very prevalent in the San Quintin area. There is a wide range of symptoms, consisting of leaf deformations, stem streaking and fruit mottling. Infected plants can usually be spotted by visual inspection. Since symptoms of most viruses often overlap, laboratory test is required for accurate diagnosis. ELISA technique was commonly used in the past. Now, a more reliable, more sensitive and faster quantitative technique: Real-time PCR ,is available. With this technique results are available in one hour. The results of PCR are visualized on the computer monitor in real-time.

TSWV leaf and fruit symptoms

Risk Assessment

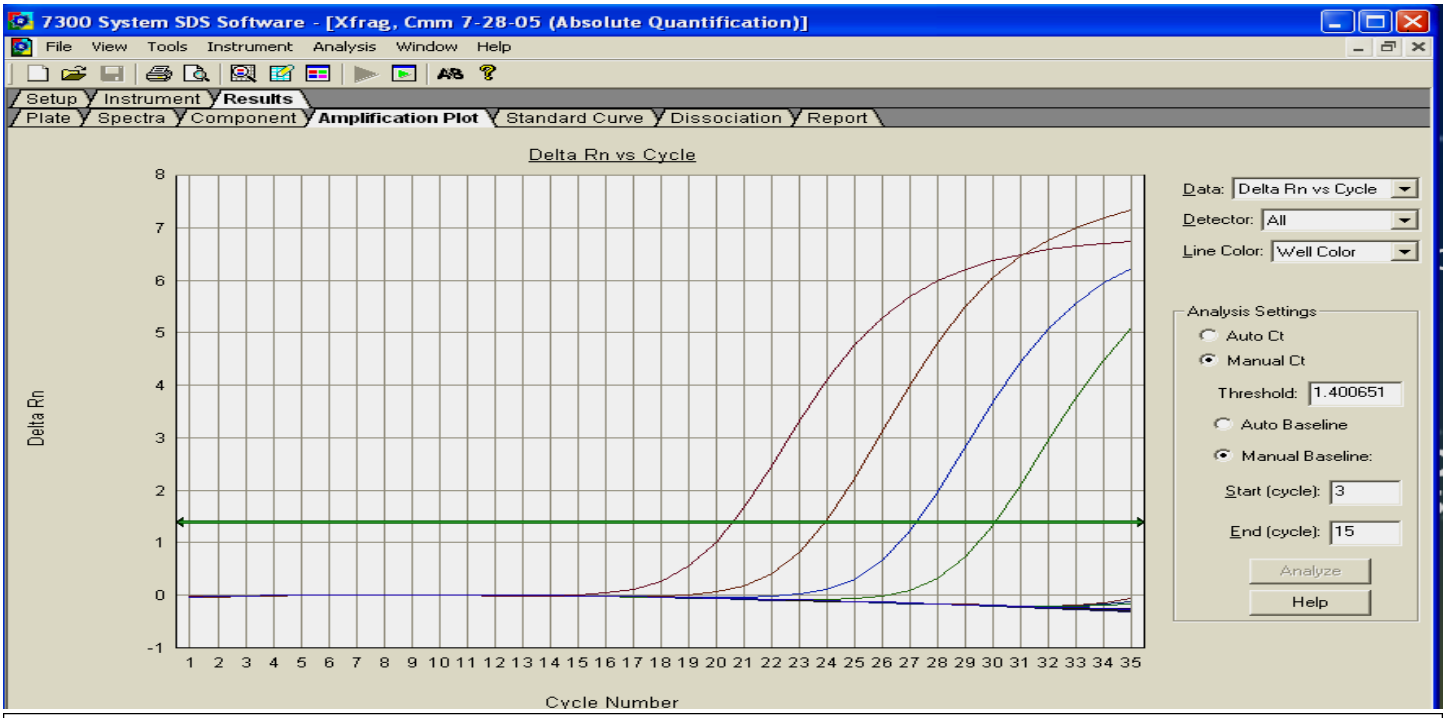
TSWV can live in many hosts including weeds and is introduced in the tomato crop by thrips. The Larvae of thrips can acquire the virus from these hosts. The virus multiplies in the thrips. The adult thrips can transmit the virus to tomato plants. The virus can be acquired from other hosts and introduced to a tomato plant in as little as 7 days (as it takes 7 days for larva to become adult). Therefore, it is important to know if there are infected thrips around your field. The infected thrips can be assayed by two tests (PCR and Petunia test).

PCR can be performed directly on the thrips collected from the blue sticky cards. Blue sticky cards can be placed at specific locations around the fields.



Nymph and adult thrips

In the Petunia test, young potted petunia plants (cultivar Carpet blue, Summer Mad-



Detection of TSWV by Real time PCR. Picture shows 4 positive samples showing PCR amplification. Any sample that crosses green baseline is considered positive. Number of PCR cycles needed to detect virus shown on the X-axis. Less the number of cycles, more the amount of virus in the tissue

TSWV … continued

ness) are placed on a blue surface (blue plastic, pot painted blue etc) at specific locations at the canopy height. All flowers are removed. The thrips are attracted to blue color and land on petunia leaves. Petunia leaves show distinctive brown to black local lesions within 3-7 days when infected thrips feed on them. Since the virus does not become systemic in Petunia, these plants do not serve as inoculum reservoirs and pose any risk to tomato crop.

Petunia indicator plant placement

The petunia plants can be placed an all 4 directions of the field to assess which direction infected thrips could come from. This information may be useful to remove any weed hosts in that direction of the field.

Control

Infections usually start early in the season and symptoms develop at fruiting. Therefore, thrips monitoring should start early in the season and insecticides applied as needed. A regular application of insecticides is also helpful to reduce thrips. Rouging of symptomatic plants will also remove sources of infection in the field.

Petunia leaves showing feeding of infected thrips (upper) and healthy thrips (lower leaf)

Soil Health

Microorganisms play a definitive role in overall soil health. Healthy soils contain a diverse population of protozoa, bacteria feeding nematodes, aerobic bacteria, anaerobic bacteria, spore forming bacteria, molds and actinomycetes. Bacteria thrive on organic matter and nitrogen from air. These bacteria are eaten by protozoa and bacteria feeding nematodes. During this process, nitrogen is released and is directly available to plant roots.

Abundance of anaerobic bacteria indicates lack of oxygen in the root zone (due to flooding, compaction etc). These anaerobic bacteria also produce metabolites that are toxic to roots. Thus when anaerobic bacteria outnumber aerobic bacteria, it signifies a problem.

Several species of bacteria, fungi and actinomycetes are also antagonistic to pathogens and play a role in disease control. Therefore, a significant population of organisms should be maintained in the soil.

Soil type (sandy, clay, etc) and cultural practices, (watering, fertilizers, pesticides, fumigation, etc) influence diversity and population of the microorganisms. For example, sand has more salt and supports less bacteria than clay. Fumigation may kill many organisms and soil will need a replenishment. A compost tea, fish hydrolysate, etc may be applied by drip irrigation to introduce a diverse population of microorganisms back to the soil.

Acceptable levels for Tomato*

Functional group	Per gram 3-8 cms depth
Protozoa	10,000
Nematodes (bacteria feeding)	25
Aerobic bacteria	1-100 x 10^7 cfu
Anaerobic bacteria	At least 10X less than aerobic
Yeasts and molds	5-50 x 10^5 cfu
Pseudomonads (fluorescent group)	1-1000 x 10^3 cfu
Nitrogen fixing bacteria	1x106 cfu

*Lab assays are available for soil samples

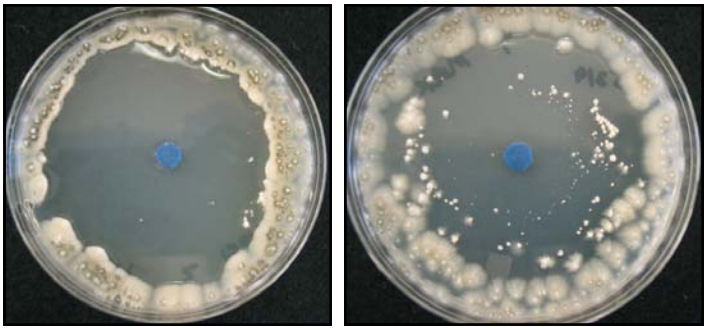
Fungicide / bactericide choices

Fungicide applications are effective for certain diseases (Pythium, Phytophthora, Rhizoctonia and several foliar diseases). Although, fungicide/bactericide drenches are not recommended for Fusarium, Verticillium and bacterial canker, we have found that certain fungicides are effective under lab conditions. Our 21-fungicide panel quick screen protocol is helpful to identify the effective fungicides. The test also identifies if the isolate will easily develop resistance to fungicides.

Inhibition of a Verticillium isolate by 21 fungicides*

Fungicide	A.i.	Rate/acre	Inhibition zone (mm)
Aliette	Fosetyl-Al 80%	5 lbs	-
Benlate	Benomyl 50%	1 lb	50
Cabrio	Pyraclostrobin 20%	14 oz	-
Captan 50WP	Captan 49%	6 lbs	15
Botran 5F	Dichloran 47%	4 pts	-
Champ	Copper hydroxide 38%	2 pts	-
Elevate 50WDG	Fenhexamid 50%	1.5 lbs	-
Flint	Trifloxistrobin 50%	0.2 lb	30R
Maxim 4FS	Fludioxonil 40%	1 pt	30R
Orbit	Propiconazol 42%	0.04 fl oz	-
Phosguard	Phosphite	26 fl oz	-
Pristine	Pyraclostrobin 13% Boscalid 25%	23 oz	-
Quadris	Azoxystrobin 23%	15.4 fl oz	30R
Rally	Myclobutanil	5 oz	30R
Ridomil Gold	Mefenoxam 48%	1 pt	-
Ronilan	Vinclozalin 50%	1.5 lb	-
Rovral	Iprodione 50%	2 lbs	-
Switch	Cyprodinil 38% Fludioxomil 25%	14 oz	25R
Thiram	Thiram 65%	5 lbs	20
Topsin M	Thiophanate M 70%	1 lb	25
Vanguard	Cyprodinil 75%	0.5 lb	-

* R indicates resistant colonies developed



Left: Benlate impregnated disk produced a 50 mm wide inhibition zone against Verticillium. Right: Maxim impregnated disk produced an inhibition zone but resistant colonies developed within the zone.

About the author

Parm Randhawa, Ph.D.

Dr. Parm Randhawa is president of California Seed and Plant Lab., Inc. He received his Ph.D. degree in plant pathology in 1980. He spent a 4-years post-doctorate in plant pathology developing assays for seed borne pathogens. Next 5 years, he was employed as plant pathologist at Yoder Brothers where he developed disease control recommendations for ornamental plants. In 1991, he started consulting with California Department of Food and Agriculture and developed virus-free certification program for nursery stock of fruit trees, grapevines and citrus nurseries in California. He worked in this capacity for 6 years. During this time, he started a private diagnostic laboratory to test diseases of seeds and other planting stock. His laboratory now provides disease testing and genetic fingerprinting to vegetable, strawberry and grapevine industry in California.

Towards his professional career, he is a recipient of USDA and NSF research awards to develop novel test methods for detecting bacteria from seeds. He is an author of over 30 scientific publications and one patent.