Disease Update:
Tomato corky root and vine decline

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Infosheet

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BACKGROUND

In recent seasons, poor growth or premature decline of the foliage has been seen in a number of processing tomato fields. The symptoms are usually associated with brown root lesions, loss of fine feeder roots, or root rot. The 2009 season seemed to be especially severe, but symptoms were again widespread across the growing region in 2010. Impacts on yield and quality in severely affected fields can be significant. The term **vine decline** is being used to denote what we believe is a complex of factors contributing to poor health in these fields. **Corky root rot** seems to be one of the key factors involved. However, if substantial and universal yield reductions are part of the definition of a plant disease epidemic, then vine decline or corky root rot do not qualify as yet. Average tomato yields in Ontario were high in 2009 and 2010 even though there were severely affected corky root hot spots.

It is likely that the corky root pathogens have been present in our soils for a long time and are part of a complex of root and foliar pathogens interacting with other stresses. Similar symptoms have been seen over many years, but the corky root rot pathogens were not detected because these fungi are slow-growing and not easily cultured using standard media. The root symptoms can be found across the processing tomato growing area and the patterns of incidence do not suggest a recent introduction.

Although foliar bacterial disease can cause loss of foliage and stunted growth, it does not cause the root symptoms. The combination of foliar bacterial disease and root rot infections, however, may increase the impact on the crop.

Surveys and research projects in 2009 and 2010 have looked into the causes of these problems.

CORKY ROOT ROT

A key diagnostic symptom seen in problem fields is the presence of brown, corky bands on the roots. A team led by Dr. Jim Traquair at Agriculture and Agri-Food Canada in London has found that the corky root symptoms are caused by *Pyrenochaeta terrestris*, *Pyrenochaeta lycopersici*, and *Rhizopycnis vagum* (alone or in combination).

Fusarium and some degree of associated brown rot of fine roots were found at all sample sites in 2009 and 2010, both at sites that appeared healthy and at those with vine decline symptoms. Black dot root rot, caused by *Colletotrichum* was also present at many healthy and vine decline sites. All the pathogens were frequently isolated from severely rotted roots and in these cases, *Colletotrichum* black dot root rot may have been there as a secondary infection, after the roots were weakened by the corky root rot pathogens.

Pyrenochaeta terrestris

This is the most frequently found corky root rot fungus in tomato root samples from Essex and Kent counties. This pathogen is normally associated with pink root of onion in warm climates. However it has a very wide host range, including many of the crops commonly grown in rotation with processing tomatoes in Ontario. It is associated with a pink discolouration of some roots. This pathogen was also isolated from red roots of corn (volunteer corn or a neighbouring field) and from nightshade (in the tomato field).

P. terrestris has been reported to survive on soybean, pea, millet, oats, barley, wheat, corn, squash, cucumber, cantaloupe, muskmelon, tomato, pepper, eggplant, cauliflower, carrot, spinach, and onion. It is not reported to cause significant disease on all of these crops, but it does cause red root rot of corn and pink root of onion.

This pathogen occurs in many soil types and can survive in soil for many years.

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Pyrenochaeta lycopersici

This corky root rot fungus was found in some Essex county samples, but was not as common as *P. terrestris*. This pathogen is more commonly a problem on greenhouse tomatoes and occurs worldwide, but it has been reported to be sporadic on field tomatoes in European countries, California and Florida.

Host crops include tomato, pepper, eggplant, cucumber, melon, and squash. Beet is also reported to be a symptomless host. Some solanaceous weeds such as Jimsonweed and nightshade may also be hosts.

Rhizopycnis vagum

This fungus was found in many tomato samples and also in corn from Essex and Kent counties. It has been reported to cause vine decline of melons in Spain, the south-western USA, and Central America, and to cause root lesions on onion in Iran and tomato in Italy.

Other factors

In some of these fields, additional stresses were also identified such as other root pathogens, foliar pathogens, and/or high nematode levels. In many fields, examination of the root systems showed that they were also being physically restricted by soil compaction. We are likely dealing with a complex of stresses that include pathogens and the growing environment. Preliminary observations point to differences in susceptibility among tomato varieties, as well.

WHAT IS CORKY ROOT?

Symptoms (see photos page 4)

- stunting, slow growth
- premature defoliation
- brown bands on roots that may develop into dark, rotted roots; loss of small feeder roots
- no discolouration of internal root tissue
- on severely affected roots, the outer layer (cortex) can be easily pulled off the root core (stele)

Biology

All of the corky root rot fungi identified produce microsclerotia which provide a means of survival in the soil from one growing season to the next and probably over several years. One of more of the corky root fungi may attack the roots under almost any soil temperature. In addition, each of the pathogens and particularly, *P. terrestris*, has a fairly wide host range.

P. terrestris has an optimum temperature for growth and development of 25-28°C (77-82°F), but infection may occur down to 16°C (61°F). *P. lycopersici* develops best at 15-20°C (59-68°F). *Rhizopycnis vagum* is favoured by temperatures of 25-27°C but will infect roots at 20°C. All can survive deep in the soil.

These pathogens can produce pycnidia containing conidia (spores) on diseased roots and root debris but in the field, the major means of dispersal is thought to be through movement of soil and plant debris containing the microsclerotia (survival structure of the fungi). The soil could be moved within the field and from field to field by wind, runoff and farm equipment. Preliminary tests in the laboratory have shown that *Pyrenochaeta* and *Rhizopycnis* conidia and microsclerotia can survive in water for 6 months. In fact, the microsclerotia can survive in a wide range of conditions. One of the ways of preserving strains of these fungi is to air dry microsclerotia in sterile soil and to freeze them in dry soil at -20°C.

Management

Management of corky root rot and the vine decline complex in field tomato will be difficult and will require an integrated approach involving many mechanisms, especially those focussed on maintaining general soil and plant health. There are limited products available for the management of soil-borne pathogens such as the corky root fungi. Fields with severe and yield-reducing infestations will warrant intensive and probably expensive corky root rot management measures.

Chemical and biological control

Results with fumigation in other affected areas have been inconsistent, even with three-tiered injection depths. Yield losses have been reported from tomato vine decline in both non-fumigated and fumigated fields in Ontario. Methyl bromide, chloropicrin and thiocarbamates (metam sodium) are listed for corky root rot management in California and other parts of the world, but in practice, results are inconsistent. Chloropicrin and metam sodium are currently registered for some soil-borne diseases and nematodes in Canada, but it is expected that restrictions on their use will become more stringent over time. Research is underway to test efficacious rates of metam sodium on these pathogens in Ontario. The efficacy of biofumigants such as mustard green manures that release inhibitory isothiocyanates is being investigated in some field sites in Ontario. Management is made more difficult because the fungi can be found deep in the soil and will be able to infect the plant through roots that penetrate below the fumigated zone, or simply outside the fumigated band.

Research is also underway to investigate the impact of biological control through the establishment of protective microbial endophytes (bacteria and fungi antagonistic to growth of corky root pathogens) in the roots of tomato plug transplants and plant defense inducers applied before and after transplanting. Research in other areas has shown conventional fungicide treatments to be ineffective.

Crop rotation

Crop rotation has been the primary cultural practice aimed at slowing the build-up of many soil pathogens, but will probably do little to reduce levels of the corky root fungi in infected fields. Reports of these diseases in other parts of the world have shown that each pathogen has a fairly wide host range including most if not all the traditional rotation crops. Our surveys have shown that *Pyrenochaeta terrestris* and *Rhizopycnis vagum* can be found on corn, onion and solanaceous weeds such as nightshade. Brassica crops, such as turnip and canola, or leguminous forage crops, such as clovers and alfalfa, are not reported hosts. Incorporating these crops into a rotation program may limit the buildup of corky root pathogens in the soil.

Other cultural practices

Other cultural practices that promote healthy plants and production of adventitious roots such as proper fertilization, irrigation, management of other diseases and management of plant parasitic nematodes may help the tomatoes to avoid or compensate for infection by corky root fungi. Finally, the ultimate control measure would be the growing of corky root resistant varieties. Limited host resistance to corky root rot and other root rots has been reported by breeders for greenhouse and some fresh market varieties of tomato. Screening for root vigour and corky root resistance, and incorporation of these characteristics into field varieties is underway but it will be a slow process.

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Early decline of foliage.


Range of tomato root symptoms.


Healthy tomato roots (for comparison).


Symptoms of *Pyrenochaeta terrestris* and *Rhizopycnis vagum* infection on corn (left) and *P. terrestris* on nightshade roots (right)

REFERENCES

Aegerter, B.J., T.R. Gordon, and R.M. Davis. 2000. Occurrence and pathogenicity of fungi associated with melon root rot and vine decline in California. Plant Disease 84: 224-230.

Anonymous. 1990. Onion pink root. University of Illinois Extension, Department of Crop Sciences. http://web.aces.uiuc.edu/vista/pdf_pubs/932.pdf.

Armengol, J. A. Vicent, P. Martinez-Culebras, B.D. Bruton and J. Garcia-Jimenez. 2003. Identification, occurrence and pathogenicity of *Rhizopycnis vagum* on muskmelon in Spain. Plant Pathology 53: 68-73.

Biesiada, A., E. Kolota, S. Pietr, M. Stankiewicz, and K. Matkowski. 2004. Evaluation of some biological methods of pink root rot control on leek. Proc. XXVI IHC – Managing Soil-Borne Pathogens. Acta Hort. 635.

Biles, C.L., M. Holland, M. Ulloa-Godinez, D. Clason, and J. Corgan. 1992. *Pyrenochaeta terrestris* microsclerotia production and pigmentation on onion roots. American Society for Horticultural Science, Alexandria, VA, US.

Campbell, R.N., V.H. Schweers, and D.H. Hall. 1982, Corky root of tomato in California caused by *Pyrenochaeta lycopersici* and control by soil fumigation. Plant Disease 66: 657-661.

Carroll, R.B. (Editor). 1999. Compendium of Corn Diseases, 3rd Edition. American Phytopathological Society Press, Saint Paul MN, 104 pp.

Farr, D.F., Miller, M.E., and B.D. Bruton. 1998. *Rhizopycnis vagum* gen. et. sp. nov., a new coelomycetous fungus from roots of melons and sugarcane. Mycologia. 90(2):290-296.

Fiume, G. and F. Fiume. 2008. Biological control of corky root in tomato. Communications in agricultural and applied biological sciences 73(2).

Frye, Jeffrey. *Phoma terrestris*. NC State University, Department of Plant Pathology. http://www.cals.ncsu.edu/course/pp728/Phoma/Phoma_terrestris.html.

Grove, G.G. and R.N. Campbell. 1987. Host range and survival in soil of *Pyrenochaeta lycopersici*. Plant Disease 71: 806-809.

Jones, J.B., John Paul Jones, R.E. Stall, and T.A. Zitter (Editors) 1991. Compendium of Tomato Diseases. American Phytopatholological Society Press. Saint Paul MN, 73 pp.

Kim, Y., S. Lee, H. Shim, C. Lee, and H. Kim. 2003. Pink Root of Onion Caused by *Pyrenochaeta terrestris* (syn. *Phoma terrestris*). Plant Pathol. J. 19(4):195-199.

Portia-Puglia, A., N Pucci, G. Di Giambattista, and A. Infantino 2001. First report of *Rhizopycnis vagum* associated with tomato roots in Italy. Plant Disease 85: 1210.

Rabiei-Motlagh,E., M Falahati-Rastegar, H. Rouhani, B. Jafarpour, and V. Jahanbakhsh. 2010. Root diseases of onion caused by some root colonizing fungi in Northeast Iran. American-Eurasian J. Agric. and Environmental Science 7(4): 484-491.

Shishkoff, N., and R.N. Campbell. 1990. Survival of *Pyrenochaeta lycopersici* and the influence of temperature and cultivar resistance on the development of corky root of tomato. Plant Disease 74: 889-894.

Schwartz, H. F. and S.K Mohan (Editors). 1995. Compendium of Onion and Garlic Diseases. American Phytopathological Society Press, Saint Paul MN, 54 pp.

Sumner, D.R., R.D. Gitaitis, J.D. Gay, D.A. Smittle, B.W. Maw, E.W. Tollner, and Y.C. Hung. 1997. Control of Soilborne Pathogenic Fungi in Fields of Sweet Onion. Plant Dis. 81(8):885-891.

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