Root Crop Disease Update from Down Under!

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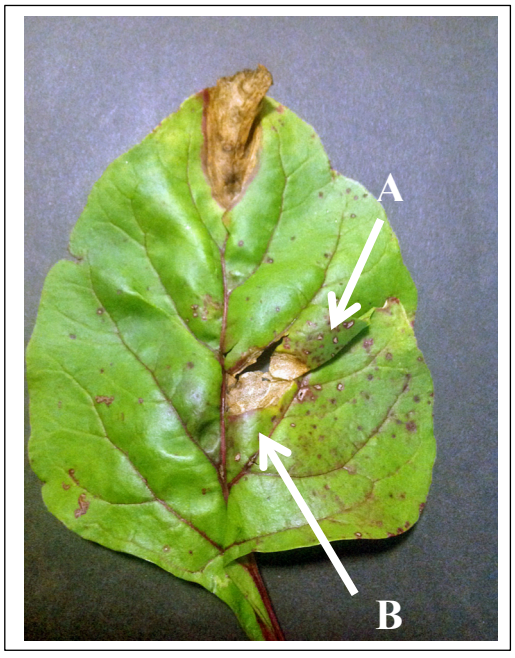
Table beets are grown in New York (NY) for processing and fresh markets. Fresh market production is exponentially increasing due to popularity in juices, and the use of foliage and roots in salads. One of the major factors affecting beet productivity is diseases. For the processing industry, maintenance of green leaf area is critical for root development and to facilitate mechanical harvesting through pulling of the roots by the tops. For the fresh market, foliar diseases affect quality and size of the salable products.

Cercospora Leaf Spot. The predominant disease affecting table beet in NY is Cercospora Leaf Spot (CLS), caused by the fungus, *Cercospora beticola*. Symptoms are small, circular lesions with purpling at the margin of the lesion. The center of the lesions is straw-colored (Fig. 1A). Under conducive environmental conditions, these lesions increase in number and size leading to severe defoliation. A critical tactic in the management of CLS in processing crops is the regular application of fungicides. However, a control failure related to resistance within the *C. beticola* population to strobilurin fungicides (e.g. azoxystrobin; Quadris®) was reported in NY in 2012.

Fig. 1. Cercospora Leaf Spot (*Cercospora beticola*; A) and Phoma Leaf Spot (*Phoma betae*; B).



Phoma Leaf Spot. This disease is found at lower prevalence and frequency than CLS. Phoma Leaf Spot is caused by the fungus, *Phoma betae*. Symptoms of this disease are light-brown, round to oval-shaped lesions (Fig. 1B). The lesions may also contain dark concentric rings.

Pocket Rot. Table beets are affected by a range of root rots, such as Pocket Rot, caused by the fungus, *Rhizoctonia solani*. Affected plants are usually randomly scattered throughout the field. Initial symptoms are sudden wilting and necrotic (brown) lesions initiated at the crown. Brown and black lesions caused by *R. solani* are often observed on the root surface.

Integrated Disease Management:

Planning the season. Farm hygiene practices which prevent pathogen introduction include:

1. **Clean seedballs**. Ensure the use of high quality seedballs treated with efficacious fungicides.
2. **Farm hygiene**. Prevent transport of infested soil on contaminated machinery or debris.
3. **Crop rotation**. The wide range of crops susceptible to *R. solani* means that rotation to cereals is important. At least two years between susceptible crops is recommended (Table 1).

Table 1. Additional crops also susceptible to the major fungal pathogens affecting table beet.

Pathogen (Disease)	Additional Susceptible Crops
Cercospora beticola (Cercospora leaf spot)	Swiss Chard; Spinach; Sugar Beet
Phoma betae (Phoma leaf spot)	Sugar Beet
Rhizoctonia solani AG2.2 (Pocket rot)[a]	Wide range of vegetables, dry beans, soybeans, forage crops (alfalfa, clover, etc.), cover crops (e.g. vetch, mustard, radish, etc)

[a]*Rhizoctonia solani* exists as multiple 'strains' referred numerically as 'anastomosis groups; e.g. AG2.2'.

4. **Weed management**. Many broadleaf weeds are also susceptible to *C. beticola*, including lambsquarters, pigweed, mallow and bindweed. The wide range of broadleaf weeds that may also be susceptible to *R. solani* make weed management during rotation to non-hosts critical for reducing pathogen populations.
5. **Tillage**. Depending on the pathogen, survival varies in the soil and may be affected by exposure to wet/dry and freezing/thawing cycles as well as the microbial communities and other soil qualities.

During the season. Disease severity is exacerbated by factors promoting canopy growth. Pocket rot is also exacerbated by poor drainage resulting from degraded soil structure. Row orientation and row spacing is important to reduce the duration and frequency of leaf wetness that may promote infection. Moreover, throwing infested soil on the lower stem and crown areas during cultivation has been shown to contribute to the development of severe Pocket Rot development and further exacerbated during wet periods.

Fungicides. Here we present the results of a replicated trial conducted at The New York Agricultural Experiment Station, Geneva (2014) to quantify the efficacy of fungicides for foliar diseases of table beet. The trial was planted on 6 June (var. 'Ruby Queen') and fungicides were applied following severe hail damage (31 July) and after moderate CLS development (average of 1.6 lesions/leaf), on 26 August and 10 September. The efficacy of fungicides on CLS severity and yield (9 October) was assessed. All fungicides included in this trial, with the exception of Tilt®/Copper, significantly reduced CLS severity (Table 2). The most efficacious treatments were combinations including chlorothalonil (e.g.

Copper/Bravo® and Bravo®/Bravo®), two applications of Tilt®, and both rates of Vertisan®. Fungicide application had no significant effect of yield (Table 2).

Table 2. Efficacy of fungicides on Cercospora Leaf Spot severity and yield in table beet.

Product (rates)[a]	Active Ingredient (s)	Resistance Group[b]	Cercospora Leaf Spot Severity (%)	Yield/10 ft (lb)
Nontreated			7.0 a	13.0
Vertisan® (30 oz/ 30 oz)	Penthiopyrad	7 (H)	4.8 bcd	12.8
Tilt®/Tilt® (4 oz/ 4 oz)	Propiconazole	3 (M)	3.8 cd	13.0
Vertisan® (15 oz/ 15 oz)	Penthiopyrad	7 (M)	5.0 bc	13.8
Tilt®/Copper (4 oz/64 oz)*	Propiconazole/ Copper oxychloride	3 + M1 (L)	5.8 ab	14.4
Bravo®/Bravo® (2 lb)	Chlorothalonil	M5 (L)	4.0 cd	13.2
Bravo®/Copper (2 lb/64 oz)	Chlorothalonil/ Copper oxychloride	M5 + M1 (L)	5.0 bc	11.6
Bravo/Tilt (2 lb/4 oz)	Chlorothalonil/ Propiconazole	M5 + 3 (L)	4.5 bcd	12.2
Bravo®/Quadris® (2 lb/12 oz)	Chlorothalonil/ Azoxystrobin	M5 + 11 (M)	4.0 cd	13.6
Tilt®/Quadris® (4 oz/12 oz)	Propiconazole/Azoxystrobin	3 + 11 (M)	4.3 cd	13.1
Copper/Bravo® (64 oz/2 lb)	Copper oxychloride/chlorothalonil	M1 + M5 (L)	3.5 d	14.2
P = (LSD)[c]			<0.05 (1.3)	>0.05 (ns)

[a]Applied on 26 August and 10 September, respectively. Tilt® and copper formulations are registered in NY on table beet.

[b]Risk of resistance development according to the Fungicide Resistance Action Committee: L = low; M = medium; H = high.

[c]Test of significance (least significant different at *P* = 0.05 presented parenthetically); ns = not significant.

These findings enable the selection of active ingredients for the development of durable management practices. Registration of Bravo® on table beets is currently not likely due to on-going review by the EPA. Emergency registrations of Manzate® and Vertisan® have been submitted to IR-4.

Varietal resistance. Susceptible varieties include: 'Ruby Queen' (Processing; P), 'Pablo' (P), 'Early Wonder Tall Top' (Fresh; F), 'Chioggia Guardsmark' (F), 'Touchstone Gold' (golden-flesh; F), 'Bull's Blood' (F), 'Red Ace' (P), 'Vulture' (P)' and 'Eagle' (P/F). Varieties with intermediate resistance to CLS include: 'Detroit Supreme' (F), 'Solo' (P/F), 'Merlin' (P/F), 'Pacemaker' (P/F), 'Kestrel' (P/F). Varieties with CLS resistance are: 'Avalanche' (white-flesh) and 'Boldor' (golden-flesh).

Further Work

Research is ongoing to develop durable disease management strategies for table beet production in NY.

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