Remote Sensing of Beet Necrotic Yellow Vein Virus and Interactions with Beet Soil Borne Mosaic Virus

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Beet Necrotic Yellow Vein Virus (BNYVV) and Beet Soil Borne Mosaic Virus (BSBMV) are closely related viruses affecting beet production in the sugar beet growing regions of Minnesota and North Dakota. The viruses are vectored by the same soil borne fungus, *Polymyxa betae*. Since the viruses share the same vector, they are frequently found in the same fields and can both be found infecting the same beet. Their close ecological relationship and their relation at the molecular level suggest that recombination is highly possible. This is a recognized method that viruses use to develop new strains that can differ from the two "parents" in virulence. Sugar beet varieties have been developed that have a high degree of resistance to BNYVV, but they are not resistant to BSBMV. At present almost all cultivars resistant to BNYVV in the United States contain the Holly gene. If strains of BNYVV break this resistance, the result to sugar beet production could be devastating. Understanding the relationships between theses viruses will lead to a better understanding of the risks these viruses pose. We have conducted studies to determine the level of genotypic variability in populations of BSBMV and BNYVV and mapped the distribution of these viruses at the field level. We have evaluated various remote sensing techniques to distinguish between rhizomania and nitrogen deficiency.

Methods

Objectives 1 and 2. Determine the level of genotypic variation in populations of BSBMV and BNYVV in Minnesota and map viral populations at the field level. One field in the American Crystal region and one field in the Southern Minn region were grid sampled and the location of soil samples georeferenced with GPS technology. These fields were previously sampled in 1999. BSBMV and BNYVV are being baited from these soil samples. These will be tested for the presence of BNYVV and BSBMV through ELISA. Viral RNA will be extracted and amplified through RT-PCR. The genetic diversity of the viral populations recovered from the samples will be determined over the next several months. The distribution of these viruses will be mapped using geostatistical procedures.

Objective 3. Determine whether various methods of remote sensing can be used to detect and differentiate between rhizomania and nitrogen deficiency. Three fields in the American Crystal region and three fields in the Southern Minn region with discreet rhizomania spots were selected and sampled three times between August and October. At each field four samples from a rhizomania spot and four samples from healthy appearing region were taken. Each sample tested for the presence of BNYVV and BSBMV through ELISA. Spectral properties of each sample were read with a hand-held radiometer, a hyper-spectral integrating sphere, and a scanning spectrophotometer. Yield at each spot was assessed with three 10-foot tare samples. The spectral data is being analyzed to determine which regions of the spectra can best differentiate between rhizomania and

nitrogen, when this differentiation is best, and what instruments are effective. This was the second and final year of this study.

Objective 4. Evaluate the potential of hand held radiometers for measuring leaf spot severity and compare the accuracy and repeatability of results to visual ratings. Due to low disease pressure, cercospora ratings were not done this year.

Results

Genotypic variation in populations of BSBMV and BNYVV in Minnesota. PCR primer pairs have been developed to span the entire genome of both BSBMV and BNYVV. Based on the PCR primer pairs, regions of the BSBMV genome show variability in size between different isolates of BSBMV. These isolates will be sequenced at the Texas A&M sequencing facility. In the next year, these studies will be expanded to look at the variablility of BNYVV. In a growth chamber study, it was found that in the absence of the vector, *Polymyxa*, BSBMV could infect chenopodium at 10°C while BNYVV could not infect until 15°C (table 1). Under field conditions this would suggest that BSBMV could begin infecting sugar beets earlier in the season than BNYVV. Further studies are under way to determine the temperature requirements of the fungal vector.

Table 1. Temperature requirements of BNYVV and BSBMV in chenopodium.

	10°C		15°C		20°C	
Viral Inoculum	% BNYVV	% BSBMV	% BNYVV	% BSBMV	% BNYVV	% BSBMV
BSBMV	0	87	0	100	0	100
BNYVV	0	0	100	0	100	0
BSBMV & BNYVV	0	87	87	100	100	100

Distribution of BSBMV and BNYVV. A disease survey during the 2001 growing season verified that BNYVV is wide spread throughout the entire sugar beet growing regions of Minnesota and North Dakota as far north as Crookston. The widespread distribution of the disease throughout the northern region and within individual fields suggests that the pathogen had been there for some time and that environmental conditions during the growing season were especially conducive for symptom expression. Fields in Minnesota, Colorado, and Texas were sampled on a 1-acre grid for the presence of BNYVV and BSBMV. There was no evidence of spatial structure in any of these fields. This indicates a random distribution of the viruses at the 1-acre level. In general, a random sampling strategy is appropriate for determining the presence of these viruses in these fields. The sensitivity of this sampling will be improved by taking more samples. Intensive sampling of a field in the Southern Minn region showed spatial structure at distances less than 30 meters. Fields in Texas and Colorado that were sampled intensively did not show this spatial structure. Both viruses have been present in these fields longer than the field in Southern Minn. Work is underway to determine if soil population of BNYVV correlate with above ground symptoms of rhizomania.

Remote sensing of rhizomania and nitrogen deficiency. The second year of sampling to assess the practicality of remote sensing of rhizomania were completed this year. Data analysis is currently underway. Preliminary results show clear differentiation of the yellow symptomatic spots from the green spots in August and September, with sensitivity decreasing close to harvest (Figure 1). Analytic techniques are being tested to improve

detection near harvest. The number of beets from yellow symptomatic spots that did not test positive for the presence of BNYVV increased over time. This matches results from other field and greenhouse studies. Virus titer decreases after long periods of infection. As seen in 2000, there were a number of beets in the apparently healthy green areas of the fields that tested positive for BNYVV. We will compare several commercially available data sources, such as Landsat and Ikonos imagery, to determine sensitivity in distinguishing rhizomania.

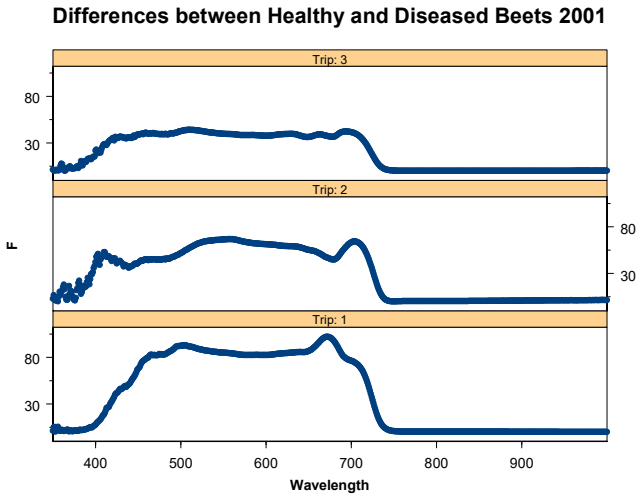

Figure 1. F statistics by wavelength for green healthy beets and yellow diseased beets in 2001. Higher F values indicate greater differences.