# ETIOLOGY OF BLINKERS IN FIELDS PLANTED TO RHIZOMANIA RESISTANT CULTIVARS

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Beet necrotic yellow vein virus, the cause of rhizomania, is the most economically important virus disease of sugar beet in Minnesota and North Dakota. Fortunately, breeders have identified resistance to rhizomania and named the resistant gene the *Rz* gene. The *Rz* gene has been incorporated into regionally adapted cultivars and in most cases disease tolerance is very good and rhizomania tolerant cultivar typically produce better root yields and root quality than susceptible cultivars when planted in fields infested with BNYVV. However, in recent years blinkers have been showing up in these fields and are causing concern. Blinkers are single sugar beet plants that exhibit florescent yellow foliar symptoms of rhizomania, in fields planted to rhizomania tolerant cultivars. Because of their bright yellow foliage, they readily stand out in a field of otherwise healthy plants. Since a new virulent strain of BNYVV that is capable of overcoming the *Rz* gene was discovered in the Imperial Valley of California it is important to determine the cause of blinkers in the Minnesota/North Dakota production areas and a study was initiated in 2004.

## Materials and Methods

Plants for this study were collected from three rhizomania strip trials located near Crookston, Moorhead, and Renville, MN. The trials were established by agriculturalists from American Crystal and Southern Minnesota Sugar Beet Cooperatives. At each strip trial, at least 8 blinkers and 2 healthy beets were selected from each cultivar planted in the trial. The rhizomania tolerant and susceptible cultivars included in the test are show in Table 1.

Table 1. Rhizomania resistant and susceptible cultivars used in blinker study.

| Rhizomania Tolerant: | Susceptible CKs: |
|---|---|
| Beta 1305, 4818 | Beta 3800 |
| Crystal 826 | Crystal 725 |
| Hilleshog 2411, 2463, 2467, 2469 | |
| Seedex 0831, Rezult | |
| Vanderhave 46177, 46519 | |

Plants were individually rated for rhizomania severity on 0 – 4 scale with 0 = no symptoms and 4 = extremely severe root stunting, constriction, and bearding. Foliage from each plant was collected and scanned using a hyperspectral radiometer to quantify the degree of leaf chlorosis, and root and rhizosphere soil was collected so BNYVV could be baited from individual plants if deemed necessary. After roots were rated and rhizosphere soil collected, all blinkers from a single strip were bulked, as were the healthy plants from the same strip, and percent sucrose was determined. Subsamples of root tissue from each plant were tested for BNYVV by the ELISA test and leaf tissue was sent to the various cooperating seed companies (KWS, Van der Have, and Syngenta) to test for the presence of the *Rz* gene. Data collected was subjected to a variety of statistical tests to determine whether the presence of the *Rz* gene had a significant effect on measured variables such as disease severity and percent sucrose.

## Results

In general, the results obtained from the different cultivars were similar so results from all cultivars were merged and analyzed together (Tables 2 & 3). When the data was sorted between healthy plants and blinkers, healthy plants had a significantly lower reflectance at 555 nm than blinkers, which was expected because 555 nm is the yellow-green wavelength (Figures 1 & 2). Healthy plants also had a significantly lower disease rating and percentage of plants testing positive for BNYVV. However, 44% of the healthy plants tested positive for BNYVV even though disease symptoms were typically minimal. This was not unexpected because plants possessing the *Rz*

gene are tolerant to rhizomania but not resistant to infection by BNYVV. Blinkers had significantly lower sugar content and a lower percentage of plants testing positive for the *Rz* gene than healthy plants.

Table 2. Results of blinker study with data sorted by plant type.

| Plant Type | Disease Rating | %Positive for *Rz* Gene | Reflect. 555 nm | %Positive ELISA | Sucrose |
|---|---|---|---|---|---|
| Blinkers | 2.95 | 52% | 26.58 | 88% | 13.98 |
| Healthy | 1.14** | 80%** | 19.04** | 44%** | 15.67 ** |

Table 3. Results of blinker study with data sorted by presence or absence of the *Rz* gene.

| *Rz* Category of Blinkers | % *Rz* Gene in Blinkers | Disease Rating | %Positive ELISA | Reflectance at 555 nm |
|---|---|---|---|---|
| *Rz* Negative | 57% | 2.88 | 95% | 27.28 |
| *Rz* Positive | 42%* | 2.93 ns | 80%* | 27.61ns |

When only blinkers were evaluated, it was discovered that 42% of the blinkers tested positive for the *Rz* gene. Furthermore the presence of the *Rz* gene did not result in a lower rhizomania disease rating or a lower reflectance reading at 555 nm.

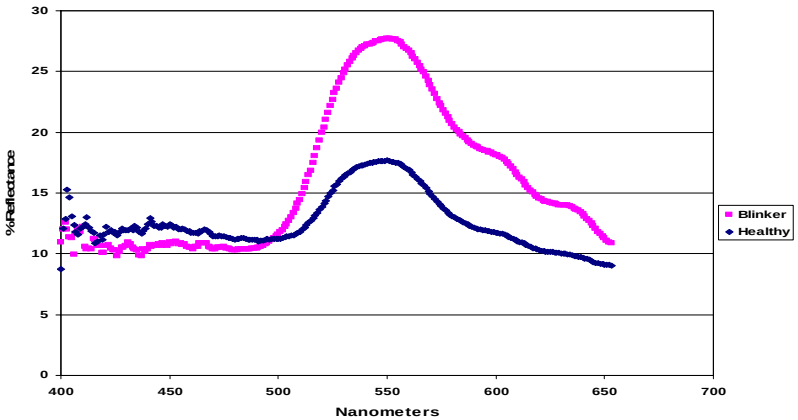


Figure 1. Spectral patterns of healthy and diseased sugar beets.
The best separation was achieved at 555 nm.

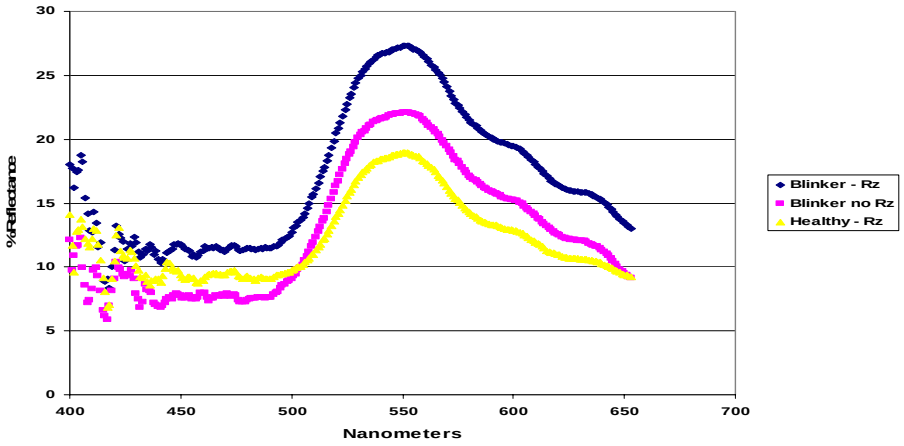


Figure 2. Spectral patterns of healthy and diseased sugar beets. In this specific cultivar, reflectance for the healthy plant was significantly less than for the two blinkers and the blinker with the *Rz* gene was significantly greater than the blinker without the *Rz* gene. When all blinkers were merged, the *Rz* gene had no effect on reflectance at 555 nm.

## Discussion

The results of this study verified that a relative high percentage of blinkers do posses the *Rz* gene and that the presence of the gene did not reduce the severity of rhizomania. This result is worrisome because it indicates that for some reason BNYVV has overcome resistance. However, the reason for this is unclear and does not necessarily indicate that the virus has mutated to a new strain able to overcome resistance. Inoculum density of *Polymyxa betae* and BNYVV could be unusually high for some reason or there could be other possible explanations. However, if the seed companies own results for the presence or absence of the gene are correct, then it is important to identify the reason that plants with the *Rz* gene became infected and expressed severe rhizomania symptoms. The fact that every seed company involved in this project had rhizomania tolerant lines that exhibited severe rhizomania symptoms also suggests that the problem is not isolated to a single cultivar and probably not a result of minor genes that are important in root yield and quality of tolerant cultivars in BNYVV infested fields.

Although the results of this study raise concerns, they should not produce panic. The incidence of blinkers in any individual field was typically less than 5% and only 42% of the blinkers possessed the *Rz* gene. That indicates that the other blinkers resulted from absence of the gene due to pollination problems or other issues related to seed production. No rhizomania tolerant seed lot ever has 100% tolerant seed and the incidence of blinkers without the *Rz* gene likely falls within industry standards. Rhizomania tolerant cultivars had significantly higher sucrose and root yields than susceptible cultivars so it is important that producers still plant rhizomania resistant lines in BNYVV infested fields. Producers should also use 3-4 year rotations to limit increase of BNYVV inoculum. This will be especially important if BNYVV is mutating to a strain capable of overcoming the *Rz* gene.