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Comparison of visual and remotely sensed Cercospora leaf spot ratings on sugar beets.

ABSTRACT

Cercospora leaf spot (CLS), caused by *Cercospora beticola* Sacc., is the most devastating foliar disease of sugarbeets (*Beta vulgaris* L.) grown in warm humid climates. Control measures for CLS are the production and use of resistant cultivars and timely applications of foliar fungicides. Both of these applications require a great deal of field-testing to assess differences between cultivars or treatments. The standard method of rating leaf damage is through visual ratings with the KWS scale. If only one rating is done on a plot the results are highly variable and subject to personal bias. If multiple ratings are done on each plot a great deal of time is required. Thus, there is a trade-off between accuracy and speed. Also, different raters will give different ratings, requiring each rater to individually assess each trial. This can be a burden when trials are spread across a large growing region or multiple regions where results are to be compared against each other. An additional problem with visual assessments is that the human eye has poor visual acuity in intermediate ranges. Additional problems with visual ratings are the variability that is apparent when a single person rates an experiment several times or when multiple people rate an experiment.

The ideal rating system should be fast, accurate, and free from bias. It should also have minimal variation when used repetitively on the same experiment, or by different researchers. It would also be advantageous to eliminate the need for highly trained raters, allowing technicians to rate the plots. A rating system based on the spectral properties of the canopy would eliminate most of these problems. Radiometers can be easily calibrated which would make them accurate and free from bias. Multiple radiometers could be used across growing regions, and through the use of calibrations, the results would be comparable. If the equipment is easy to use, a technician could make the ratings. This gives the advantage of reducing the costs of a trial through reducing the burden on the researcher as well as making it practical to take more frequent ratings on trials with greater replication than was possible with visual ratings.

We evaluated the Cercospora leaf spot control plot located at Renville in September of 2000 with a CropScan MSR16 hand-held radiometer. Plots were 6 rows wide and 35 feet long. The middle 4 rows of each plot received each treatment. Yield was taken from the middle 2 rows of each plot. The first 3 of the 6 replicate plots were read with the radiometer. One scan was taken from each plot with the radiometer at a height of 6 feet above the canopy and centered on the middle two rows. This resulted in an area approximately 5.5 feet across being included in each scan. The CropScan MSR16 is equipped with sensors reading at 9 different wavelengths. The sensors are arranged in pairs to read both the intensity of ambient light as well as the intensity of the light reflected from the crop canopy. This allows for automated calculation of reflectance. This standardization allows for results from different years, different areas, and different researchers to be compared. In order to compare visual ratings with the radiometer

readings an unbiased estimator of disease had to be chosen. We chose to use recoverable sugar as an estimate of disease, since this is the economic impact of CLS. Several factors not related to CLS also influence Sucrose content of beets and will affect the strength of the statistics used. However, theses factors are kept as constant as possible in a field trial to minimize these effects.

Cercospora leaf spot damage was moderate to high with untreated check plots having a rating of 7.5 on the KWS scale. Fungicide treatments ranged from 3.5 up to 7.0 on the KWS scale. Several wavebands from the radiometer were significantly correlated with recoverable sugar, but visual ratings were not significantly correlated with recoverable sugar. Several wavebands from the radiometer were significantly correlated with the visual ratings. All correlation coefficients were low but this is likely due to the numerous other factors that influence sugar content. In an analysis of variance, visual ratings gave the best separation of treatment means. Several of the radiometer bands were also able to differentiate treatments, as was percent recoverable sugar, but not as well as visual ratings. Regression analysis showed the radiometer to be a better predictor of yield than the visual ratings. While CLS may have minimal effect on root yield, several wavebands from the radiometer in this test were significantly correlated with yield but visual ratings were not correlated with root yield.

While many of the wavebands measured with the radiometer showed significant correlations with the visual ratings, all of the correlation coefficients were very small suggesting that the two techniques are measuring different things. The radiometer was better able to predict sugar content than visual ratings but the visual ratings were better able to differentiate between treatments. At this point in time it is unclear which technique is better. These discrepancies could be due to a number of different factors.