2003 SUGARBEET RESEARCH AND EXTENSION REPORTS. VOLUME 34, PAGE 300-304

EVALUATION OF ZONE TILLAGE, FUMIGATION, AND A SYSTEMIC ACQUIRED RESISTANCE INDUCER ON RHIZOMANIA OF SUGARBEET

Carl A. Bradley[1], Mohamed F. R. Khan[2], Norman R. Cattanach[3], and Randy S. Nelson[3]

[1]Extension Plant Pathologist, North Dakota State University
[2]Extension Sugarbeet Specialist, North Dakota State University and Univ. of Minnesota
[3]Research Specialist, North Dakota State University

Rhizomania, caused by *Beet necrotic yellow vein virus* (BNYVV), is becoming more prevalent in the Red River Valley sugarbeet production region and is nearly endemic in the southern Minnesota sugarbeet production region. Resistant cultivars and crop rotation have been the main tactics used to manage the disease. More rhizomania management options may be needed in the future due to the recent spread of the 'P' strain in Europe and appearance of a new strain of BNYVV in California that are able to cause disease on Rhizomania-resistant cultivars that use the 'Holly' gene (Harju et al., 2002; Liu et al., 2003). The effect of tillage has not been evaluated for effects on rhizomania. It is possible that deeper tillage prior to planting may allow better drainage and better root growth thus providing a less adequate environment for disease infection. The use of fumigation has been evaluated for control of rhizomania in California, Texas, and the United Kingdom (Harveson and Rush, 1994; Henry et al., 1992; Martin and Whitney, 1990), but has not been evaluated in North Dakota and Minnesota. The systemic acquired resistance (SAR) inducer 1,2,3-benzothiadiazole-7-thiocarboxylic acid-S-methyl-ester manufactured by Syngenta and known as Actigard in the U.S. and BION in Europe has been evaluated for control of rhizomania of sugarbeet in Germany (Mouhanna and Schlosser, 1998).

OBJECTIVES

The objectives of the two studies presented herein were: i) to evaluate the effects of zone tillage on rhizomania of susceptible and resistant cultivars; and ii) to evaluate the effect of fumigation with Telone II and seed treatment with Actigard on rhizomania of susceptible and resistant cultivars.

MATERIALS AND METHODS

Both the tillage study and the fumigation/SAR study were conducted at the rhizomania nursery in Glyndon, MN. A minimum of 5 plants per plot were collected for BNYVV testing. Root hairs were removed from each beet and analyzed using a double-antibody sandwich enzyme-linked immunosorbent assay (DAS ELISA) technique with a BNYVV reagent set (Agdia, Elkhart, IN). Absorbance values of each ELISA reaction were obtained using an ELISA plate reader at 405 nm. Specific details regarding the field components of each study are contained below.

Tillage study. A steel shank was used to till the soil at a 12 in. depth for half of the plots immediately prior to planting. The shank was positioned so that it would be directly in each row of sugarbeet plants (zone tillage). Plots were either planted to the rhizomania-resistant cultivar Van der Have H46177 or the rhizomania-susceptible cultivar Crystal 952 on 23 May 2003. Plots were harvested 1 Oct 2003. Plots were 6 rows wide on 22 in. centers, 30 ft long, and organized as a 2 x 2 factorial in a randomized complete block design with 3 replications. The general linear model procedure (PROC GLM) in SAS (SAS Institute, Inc., Cary, NC) was used for statistical analysis.

Fumigation/SAR study. Two chemical treatments were evaluated and compared to an untreated control in this study. The treatments consisted of: plots fumigated with Telone II (dichloropropene) at 12 gal/acre on 6 Nov 2002, plots planted to seed treated with Actigard 50WG (1,2,3-benzothiadiazole-7-thiocarboxylic acid-S-methyl-ester) at 3 g/kg seed, and an untreated control. Plots were either planted to the rhizomania-resistant cultivar Van der Have H46177 or the rhizomania-susceptible cultivar Crystal 999 on 12 May 2003. Plots were 6 rows wide on 22 in. centers, 30 ft long, and organized as a randomized complete block design with 4 replications. The general linear model procedure (PROC GLM) in SAS was used for statistical analysis.

RESULTS AND DISCUSSION

Tillage study. No significant cultivar x tillage interactions were detected; therefore, main effects only are reported. The rhizomania-resistant cultivar Van der Have H46177 had greater ($P \leq 0.05$) sucrose concentration, recoverable sugar per ton, recoverable sugar per acre, and root yield than the susceptible cultivar Crystal 952 (Table 1). However, Van der Have H46177 had less sugar loss to molasses than Crystal 952. There was not a significant difference between cultivars for absorbance, which is an indirect quantitative measurement of BNYVV titer, although Crystal 952 had a numerically greater absorbance (more titer) than Van der Have H46177. No significant differences were detected between zone tillage and the control for absorbance, sucrose concentration, recoverable sugar per acre, and root yield (Table 2). The 12 in. tillage depth had greater (P = 0.0756) recoverable sugar per ton than the control.

Fumigation/SAR study. No significant cultivar x treatment interactions were detected; therefore, main effects only are reported. The rhizomania-resistant cultivar Van der Have H46177 had greater ($P \leq 0.05$) sucrose concentration, recoverable sugar per ton, recoverable sugar per acre, and root yield than the rhizomania-susceptible cultivar Crystal 999 (Table 3). There was not a significant difference between cultivars for absorbance. There were no significant differences among the untreated control, Telone II fumigation, and Actigard treated seed (Table 4).

The rhizomania-resistant cultivar Van der Have H46177 consistently performed better than susceptible cultivars in the studies, even though significant differences for BNYVV titer were not detected between resistant and susceptible cultivars. Lack of significant differences between cultivars for absorbance and overall low absorbance values from ELISA may have been due to sampling sugarbeet root hairs too late in the season, which may have allowed the BNYVV titer to be reduced.

Harveson and Rush (1994) reported that there was a benefit of using Telone fumigation depending on cultivar planted in Texas. Martin and Whitney (1990) reported that fumigation with products that contained dichloropropene such as Telone II were effective in reducing Rhizomania in California. Henry et al. (1992) reported that methyl bromide fumigated plots reduced BNYVV in the soil to undetectable levels in the United Kingdom, but did not evaluate Telone. Telone II is a cheaper and more “environmentally safe” product than methyl bromide, which would be more ideal for sugarbeet growers in North Dakota and Minnesota. In our field trial, however, there were no benefits detected with the use of Telone II fumigation.

Mouhanna and Schlosser (1998) evaluated BION (contains the same active ingredient as Actigard) treated seed at 1 g/kg seed on a rhizomania susceptible and resistant cultivar in a greenhouse study. They reported that the resistant cultivar plants from BION treated seed had reduced BNYVV titer compared to plants from untreated seed. In our field study, however, plants from Actigard treated seed did not perform better than untreated seed.

Based on results from the studies presented in this paper, the best management tactic to use for rhizomania control in the Red River Valley sugarbeet production area is the use of resistant cultivars. Resistant cultivars consistently performed better than susceptible cultivars in our trials. All information presented is based on 1 year of data. More data is needed to make sound conclusions.

ACKNOWLEDGEMENTS

Thank you to: the Sugarbeet Research and Education Board of Minnesota and North Dakota for partial funding of this research; the NDSU Plant Diagnostic Lab for processing samples and conducting ELISA; J. Giles for management of the research site; and J. Luecke for technical help.

LITERATURE CITED

Harju, V. A., Mumford, R. A., Blockley, A., Boonham, N., Clover, G. R. G., Weekes, R., and Henry, C. M. 2002. Occurrence in the United Kingdom of *Beet necrotic yellow vein virus* isolates which contain RNA 5. Plant Pathol. 51:811.

Harveson, R. M. and Rush, C. M. 1994. Evaluation of fumigation and rhizomania-tolerant cultivars for control of a root disease complex of sugar beets. Plant Dis. 78:1197-1202.

Henry, C. M., Bell, G. J., and Hill, S. A. 1992. The effect of methyl bromide fumigation on rhizomania inoculum in the field. Plant Pathol. 41:483-489.

Liu, H. Y., Sears, J. L., and Lewellen, R. T. 2003. Study of *Beet necrotic yellow vein virus* pathotypes in California. Phytopathology 93:S54 (Abstract).

Martin, F. N. and Whitney, E. D. 1990. In-bed fumigation for control of rhizomania of sugar beet. Plant Dis. 74:31-35.

Mouhanna, A. and Schlosser, E. 1998. Effect of BION on the viruses and their vector in rizomania of sugar beets. Med. Fac. Landbouww. Univ. Gent. 63 (3b):977-982.

Table 1. Comparison of sugarbeet cultivars in the tillage study at Glyndon, MN in 2003.

Cultivar	Absorbance	Sucrose (%)	Loss to molasses (%)	Recoverable sugar (lb/t)	Recoverable sugar (lb/A)	Root yield (t/A)
Cr 952	0.100	14.4	1.2	264	1920	7
VDH 46177	0.058	15.7	1.1	291	3985	14
P > F	0.4440	0.0017	0.0453	0.0019	0.0005	0.0012

Table 2. Comparison of tillage treatments at Glyndon, MN in 2003.

Tillage treatment	Absorbance	Sucrose (%)	Loss to molasses (%)	Recoverable sugar (lb/t)	Recoverable sugar (lb/A)	Root yield (t/A)
Control	0.090	14.8	1.2	272	3128	11
Zone tillage	0.069	15.3	1.1	283	2777	10
P > F	0.6952	0.1149	0.0152	0.0756	0.2942	0.2588

Table 3. Comparison of sugarbeet cultivars in the fumigation / systemic acquired resistance study at Glyndon, MN in 2003.

Cultivar	Absorbance	Sucrose (%)	Loss to molasses (%)	Recoverable sugar (lb/t)	Recoverable sugar (lb/A)	Root yield (t/A)
Cr 999	0.031	14.6	1.3	267	2715	10
VDH 46177	0.024	16.2	1.0	303	4320	14
P > F	0.3917	0.0009	0.0090	0.0013	0.0068	0.0315

Table 4. Comparison of treatments in the fumigation / systemic acquired resistance study at Glyndon, MN in 2003.

Treatment	Absorbance	Sucrose (%)	Loss to molasses (%)	Recoverable sugar (lb/t)	Recoverable sugar (lb/A)	Root yield (t/A)
None	0.026	15.5	1.1	287	3745	13
Actigard	0.031	15.4	1.1	287	3249	11
Telone II	0.025	15.3	1.2	281	3660	12
$P > F$	0.8197	0.8803	0.6229	0.8280	0.7312	0.7759