

---

## METHYL BROMIDE ON SUGARBEET

J.L.A. ECKHOFF<sup>(1)</sup>, R.O. ASHLEY<sup>(2)</sup>, J.W. BERGMAN<sup>(1)</sup>

<sup>(1)</sup> *Montana State University Eastern Agricultural Research Center, Sidney, MT, USA*

<sup>(2)</sup> *North Dakota State University Dickinson Research and Extension Center, Dickinson, ND, USA*

### ABSTRACT

Sugarbeet (*Beta vulgaris*, L.) is a high value crop and producers want to include it in the crop rotation as often as possible. However, disease and nematode problems can be caused by shorter rotation and may reduce yield and quality of sugarbeet, making the crop less profitable for both producer and processor. A field study was conducted for two years at three locations in northwest North Dakota and northeast Montana (USA) to study yield and quality losses of sugarbeet grown in several rotations. Methyl bromide, a soil fumigant, was used to reduce disease, nematode and insect populations in replicated plots. After fumigation, producers seeded the plots along with the rest of the field. In cases with three or more years of rotation, plant stand appeared to be injured by methyl bromide treatment, although yield and quality were not always affected. In fields with a two year rotation, fumigation usually improved stand, yield and quality. These data demonstrate that three or more years between sugarbeet crops in a rotation can improve yield and quality of the sugarbeet crop.

### INTRODUCTION

Approximately 15,000 acres in western North Dakota and 27,000 acres in eastern Montana are planted to sugarbeet (USDA National Agricultural Statistics Service). Sugarbeet is a high value crop and producers want to include it in crop rotations as often as they can. However, disease and nematode problems may reduce yield and quality of the crop substantially, making the crop less profitable. Rotation with non-host crops is known to provide time for the reduction of pathogen and nematode populations but may require eight to ten years between sugarbeet crops to reduce sugarbeet cyst nematode and three years or longer to reduce sugarbeet root pathogens.

A field study was initiated at six locations in northwest North Dakota and northeast Montana (the Mondak region) to study yield and quality losses of sugarbeet grown in various rotations. Methyl bromide, a soil fumigant, was used to reduce soil-borne fungal disease, nematode and insect populations in replicated plots in producer and research center fields. Sugarbeet was planted in the fumigated and natural soil for yield and quality comparisons.

## MATERIALS AND METHODS

Three sites with different crop rotation histories were selected in northwest North Dakota and northeast Montana in each of two years (Table 1). The Flynn and Karst sites were located east of Fairview, North Dakota, and the other sites were located at the Eastern Agricultural Research Center (EARC) at Sidney, Montana. A randomized complete block design with six replications was used at all locations. Each plot was 180 ft<sup>2</sup> (16.7 m<sup>2</sup>). Fields at the Flynn and EARC were bedded prior to fumigation. Plots to be fumigated were covered with a six-mil plastic sheet, edges buried in trenches four to six inches deep to seal the covered area, and methyl bromide was metered through plastic hoses at the rate of one pound per 100 ft<sup>2</sup> (50g m<sup>-2</sup>). The fumigated plots remained covered for 48 to 140 hours after which time the plastic was removed. Non-fumigated or natural soil plots served as checks. After the plastic was removed, producers farmed through the fumigated and natural soil plots with their normal management practices, including irrigation, and disease, weed, and insect control.

Stand counts were conducted at emergence and at harvest. Soil and sugarbeet tissue samples were analyzed by Dr. Barry Jacobsen, plant pathologist, Montana State University, Bozeman, MT for disease and nematodes during the growing season. The center row of each three-row plot was harvested, and measured for yield and quality. Tare and sucrose contents were determined at the tare lab at Holly Sugar Corp., Sidney, MT. Quality analyses were performed by Holly Sugar Corp., Sheridan, WY.

Tab. 1. Cropping history at selected fields in northwest North Dakota and northeast Montana.

Site	Rotation	Methyl bromide applied	Planting date
<b>1999</b>			
EARC site	1995 sugarbeet, 1996 barley, 1997 potato, 1998 durum	Apr 24	Apr 28
Karst site	1997 sugarbeet, 1998 small grain	Apr 24	Apr 26
Flynn site	1997 sugarbeet, 1998 small grain	Apr 23	Apr 25
<b>2000</b>			
EARC site #1	1997 sugarbeet, 1998 safflower, 1999 durum	Apr 25	1 May
EARC site #2	1997 sugarbeet, 1998 durum, 1999 safflower	Apr 25	2 May
Flynn site	1997 spring wheat, 1998 sugarbeets, 1999 spring wheat	Apr 22	27 April

## RESULTS

Sugarbeet grown in methyl bromide-treated soil had lower seedling and harvest stands than sugarbeet grown in natural soil at the EARC site in 1999 (Tab. 2). Sugarbeet in methyl bromide-treated soil also had lower sucrose and greater impurities, probably because of the reduced stand.

*Fusarium* was identified at the Flynn site in 1999, and greatly reduced the stand in the natural soil plots (Tab. 2). The *Fusarium* infection was variable within the test site, and reduced stands in some of the plots of both the natural and treated

soils, although stands were reduced more in the natural soil. Root and sucrose yields were also reduced in the natural soil, but reduction was not significant because of the variability caused by the *Fusarium* infection within the test site.

Sugarbeet grown in fumigated soil had lower seedling stand than sugarbeet grown in natural soil at the Karst site in 1999 (Table 2), indicating injury by methyl bromide. However, harvest stands of the two treatments were not different indicating plant stands in natural soil plots were reduced by a greater degree than the fumigated plots over the growing season. No other differences between treatments were detected at the Karst site.

Plant stand appeared to be injured by methyl bromide treatment at the EARC site #1 in 2000 (Table 2). Soil at this site contained more clay than the other two sites in this study. Though harvest stands on fumigated plots were less than natural soil plots at EARC site #1, there were no significant differences in root yield or sucrose yield. Potassium (K) and amino-N contents were significantly greater in sugarbeet grown in fumigated soil than in sugarbeet grown in fumigated soil, probably because of the reduced stand.

Harvest stands on the fumigated plots were denser than harvest stands on the natural soil plots at the Flynn site in 2000 (Table 2). At the Flynn site sugarbeet is rotated with spring wheat in a two-year rotation. Root yield of sugarbeet was greater when grown in fumigated soil than in natural soil, but sucrose content was less. Impurity data from this site were not available.

No differences were detected in root yield between fumigated and natural soil plots when sugarbeet was grown in a three- or four-year rotation at the EARC sites. However, root yield of sugarbeet from fumigated plots was significantly greater than root yield from natural soil plots when one year separated sugarbeet crops at the Flynn site, although this difference was not detected at the Karst site. *Fusarium* was identified at the Flynn site but not at the Karst site. Sucrose content of sugarbeet grown in natural soil was equal to or greater than sucrose content of sugarbeet grown in fumigated soil when there were two years between sugarbeet crops, but when only one year separated sugarbeet crops at the Flynn site, sucrose content was significantly less for sugarbeet grown on fumigated plots compared to natural soil plots. Sugarbeet grown on fumigated soil had significantly greater potassium (K) and amino-N than sugarbeet grown on natural soil when in a three-year rotation. This was probably because of the reduced stand caused by the fumigation.

Van Berkum and Hoestra (1979) suggested that waiting for a period of time between application and seeding is usually not more than seven to ten days when methyl bromide is used to fumigate soils. However in cold and wet soils such as in early spring fumigation, the amount of time between fumigation and seeding should be extended. Plant stands sustained significant damage by methyl bromide in the absence of disease, although stands were improved by fumigation in the presence of disease. Where *Fusarium*, *Pythium*, and *Rhizoctonia* were identified as a cause in reducing stand counts in sugarbeet, yield and sucrose yield reductions occurred. *Fusarium* was also noted in the fumigated plots but to a lesser degree. Fumigation with methyl bromide is known to be selective, and the control of some fungi such as some *Fusarium* species can be incomplete, as is found in partially fumigated soils such as used in this demonstration (Vanchter, 1979). Chloropicrin is known to be more

Tab. 2. Stands, yields and impurities of sugarbeets grown on methyl bromide-treated soil or natural soil.

Eastern Agricultural Research Center, Sidney, MT, 1999							
Treatment	Seedling stand. Plants/ac	Harvest stand. Plants/ac	Percent Sucrose	Root yield. T/acre	Na ppm	K ppm	Amino-N ppm
Fumigated	34650	31780	16.47	26.3	328	2366	239
Natural	39160	35900	17.28	27.4	267	2139	203
probability	0.017	0.028	< 0.001	0.454	0.049	0.033	0.055
CV (s/mean)	6.6	7.5	1.1	7.2	14.5	6.5	12.0
Charles Flynn farm, Fairview, ND, 1999							
Treatment	Seedling stand. Plants/ac	Harvest stand. Plants/ac	Percent Sucrose	Root yield. T/acre	Na ppm	K ppm	Amino-N ppm
Fumigated	42350	41750	19.44	24.0	286	1711	129
Natural	41330	28920	18.89	18.8	295	1457	136
probability	0.665	0.055	0.240	0.386	0.908	0.001	0.694
CV (s/mean)	6.3	26.9	3.6	39.0	16.8	4.8	16.0
Jim Karst farm, Fairview, ND, 1999.							
Treatment	Seedling stand. Plants/ac	Harvest stand. Plants/ac	Percent Sucrose	Root yield. T/acre	Na ppm	K ppm	Amino-N ppm
Fumigated	40730	36060	18.50	32.9	524	2021	219
Natural	45180	37990	18.58	30.9	535	1869	216
probability	0.047	0.371	0.707	0.525	0.962	0.510	0.933
CV (s/mean)	7.3	8.2	1.3	12.3	18.9	15.4	8.5
Eastern Agricultural Research Center, Sidney, MT site #1, 2000.							
Treatment	Seedling stand. Plants/ac	Harvest stand. Plants/ac	Percent Sucrose	Root yield. T/acre	Na ppm	K ppm	Amino-N ppm
Fumigated	23070	20530	16.12	23.9	591	2002	260
Natural	26820	24040	16.80	21.2	520	1325	131
probability	< 0.001	0.002	0.096	0.117	0.332	< 0.001	0.003
CV (s/mean)	4.0	5.2	3.6	11.1	18.9	6.3	24.0
Eastern Agricultural Research Center, Sidney, MT site #2, 2000.							
Treatment	Seedling stand. Plants/ac	Harvest stand. Plants/ac	Percent Sucrose	Root yield. T/acre	Na ppm	K ppm	Amino-N ppm
Fumigated	34690	28600	17.63	29.8	379	1596	196
Natural	31540	27550	17.53	29.7	372	1666	228
probability	0.290	0.824	0.942	0.994	0.983	0.567	0.363
CV (s/mean)	13.0	14.4	3.9	10.3	23.9	9.2	23.3
Charles Flynn farm, Fairview, ND, 2000.							
Treatment	Harvest stand. Plants/ac	Percent Sucrose	Root yield. T/acre				
Fumigated	33620	18.90	31.6				
Natural	29780	19.31	27.8				
probability	0.009	0.015	0.036				
CV (s/mean)	5.6	1.1	8.3				

effective in the control of *Fusarium* spp. than methyl bromide (Wilhelm and Kock, 1956), and will be used in any future studies of this kind.

## CONCLUSIONS

In cases with three or more years of rotation, plant stand was injured by the methyl bromide treatment, which usually resulted in reduced quality. In fields with a two year rotation, fumigation usually improved seedling and harvest stands, yield and quality. These data demonstrate that three or more years between sugarbeet crops in a rotation can improve yield and quality of the sugarbeet crop.

## LITERATURE CITED

1. USDA National Agricultural Statistics Service. 2002. [www.nass.usda.gov/](http://www.nass.usda.gov/)
2. VAN BERKUM, J.A., and H. HOESTRA. 1979. Practical aspects of the chemical control of nematodes in soil. pp. 53-134. In D. Mulder (ed.) Developments in Agricultural and Managed-Forest Ecology, 6, Soil Disinfestation. Laboratory of Phytopathology, Agricultural University, Wageningen, The Netherlands. Elsevier Scientific Publishing Company, New York.
3. VANCHTER, V. 1979. Fumigation against fungi. pp 163-183. In D. Mulder (ed.) Developments in Agricultural and Managed-Forest Ecology, 6, Soil Disinfestation. Laboratory of Phytopathology, Agricultural University, Wageningen, The Netherlands. Elsevier Scientific Publish Company, New York.
4. WILHELM, S. and E.C. KOCH. 1956. Verticillium wilt controlled: chloropicrin achieves effective control of Verticillium wilt in strawberry plantings if properly applied as soil fumigant. Calif. Agric. 10(6): 3-14.