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Sugarbeets Grown on Fumigated Soils

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Summary

A field study was initiated at three locations in northwest North Dakota and northeast Montana to study yield and quality losses of sugarbeets grown in various 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.

Introduction

Sugarbeets are grown on approximately 14,000 acres in western North Dakota (North Dakota Agricultural Statistics, 1998). Producers know that sugarbeet is a high value crop and want to include it in their crop rotation plans 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.

Materials and Methods

Three sites were selected with different rotational histories in north west North Dakota and northeast Montana (Table 1.) The Flynn site was located east of Fairview, ND and the other sites were located at the Eastern Agricultural Research Center (EARC) near Sidney, Montana. A randomized complete block design with six replications was used at all locations. Each plot was 180 ft2 (16.7 m2). 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 ft2 (50g m-2). 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.

Adequate moisture at EARC site #1 and the Flynn site allowed for adequate emergence of the crop but were furrow irrigated on the dates listed in Table 1. Plots at EARC site#2 required sprinkler irrigation for germination and emergence, and then furrow irrigated for the rest of the growing season.

Stand counts were done at emergence and again at harvest. Soil and sugarbeet tissue samples were analyzed by Dr. Barry Jacobsen, extension plant pathologist, Montana State University, Bozeman, MT for disease and nematodes during the growing season. The center row of the three-row plot was harvested, and measured for yield and quality. American Crystal Sugar Company, Sidney, Mt performed the quality analysis.

Results and Discussion

Plant Stand

Plant stand appeared to be injured by methyl bromide treatment at the EARC site #1 (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 was no significant difference in root yield or sucrose yield. There was no significant differences in seedling stand or harvest stand at EARC site #2 (Table 3) where there was a two year break between sugarbeet crops. However at the Flynn site harvest stand for the fumigated plots were denser than the harvest stand on the natural soil plots. At the Flynn site sugarbeets are grown in the same field every other year alternating with spring wheat.

Yield and Quality

No differences were detected between fumigated and natural soil plots when there were two years between sugarbeet crops. However root yield from fumigated plots was nearly 14% greater than from natural soil plots when one year separated sugarbeet crops. No significant difference was detected in sucrose content between fumigated and natural soil plots when there were two years between sugarbeet crops but when a year separated sugarbeet crops at the Flynn site sucrose content was significantly less for sugarbeets grown on fumigated plots compared to natural soil plots. Sucrose yield tended to be higher from the fumigated plots compared to the natural plots at the Flynn site where only a year separated sugarbeet crops but no difference was detected where two years separated sugarbeet crops at the EARC plots. Fusarium oxysporum, *Pythium*, and Rhizoctonia were culture plated from plants that appeared to be affected by disease primarily found in non-fumigated plots.

Quality analysis was not completed for the Flynn site at the time of this report. Quality differences at EARC site #1 were noted. Potassium, amino-N, impurity index, and losses to molasses were greater and sucrose extraction lower in the fumigated than natural plots at this site. No differences in quality between sugarbeets grown on fumigated and natural soil plots were detected at EARC site #2. Sugarbeets injured by the methyl bromide at EARC site #1 may have been more likely to exhibit quality differences to those grown in natural plots.

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 fumigated 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 at one of the three sites was damaged by methyl bromide. Seeding at this site was delayed seven days.

Fumigation with methyl bromide is known to be selective and control some fungi such as a number of Fusarium spp. to be incomplete as is found in partially fumigated soils such as used in this demonstration. (Vanachter V., 1979). Chloropicrin is known to be more effective in the control of Fusarium spp. than methyl bromide (Wilhelm and Koch, 1956).

Implications of Demonstration

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. Chloropicrin may be needed to reduce Fusarium spp. populations but in doing so may require changes in conducting this demonstration.

Additional data should be collected over the next several years to identify yield and quality reducing factors and to establish the role that crop rotations and other management practices may have on sugarbeet production.

Cooperating Producer

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Table 1. Cropping history and agronomic practices at selected fields in northwest North Dakota and northeast Montana, 2000.

Site	Rotation	Sugarbeet variety	Planting date	Harvest date
EARC site #1	1997 sugarbeet, 1998 safflower, 1999 durum	HH111	5/1/00	9/21/00
EARC site #2	1997 sugarbeet, 1998 durum, 1999 safflower	Beta 2185	5/2/00	9/21/00
Flynn site	1997 spring wheat, 1998 sugarbeets, 1999 spring wheat	HH111	4/27/00	10/19/00

Site	Fumigation	Fungicide treatment	Irrigation
EARC site #1	Applied 4/25/00 Tarp removed 5/1/00	Benlate @ 0.5 lb/ac on 7/16/00 Eminent @ 13 oz/ac on 8/8/00	Furrow on 6/26, 7/14, 7/25, 8/7, 8/21/00
EARC site #2	Applied 4/25/00 Tarp removed 5/1/00	None	Sprinkled: 5/8 Furrow on 6/26, 7/14, 7/24, 8/8, 8/23/00
Flynn site	Applied 4/22/00 Tarp removed 4/27/00	Benlate on 7/12/00 SuperTin on 8/3/00	Furrow irrigated on 5/7, 7/24, 8/11/00

Table 2. Stand, yield, and quality of sugarbeets grown on methyl bromide-treated soil or natural soil at Eastern Agricultural Research Center, Sidney, MT, Site #1, 2000.

Treatment	Seedling stand	Harvest stand	Sucrose	Root yield	Sucrose yield	Extractable sucrose

	plants/acre	plants/acre	%	tons/acre	lb/acre	lb/acre
Fumigated	23070	20530	16.12	23.9	7731	7056
Natural	26820	24040	16.80	21.2	7109	6703
Probability	<0.001	0.002	0.096	0.117	0.340	0.660
CV (s/mean)	4.0	5.2	3.6	11.1	12.5	13.2
Treatment	**Na**	**K**	**Amino-N**	**Impurity index**	**SLM**	**Extraction**
	ppm	ppm	ppm			%
Fumigated	591	2002	260	0.955	1.43	91.1
Natural	520	1325	131	0.638	0.96	94.3
Probability	0.332	<0.001	0.003	<0.001	<0.001	0.003
CV (s/mean)	18.9	6.3	24.0	11.2	11.2	1.2

Table 3. Stand, yield, and quality of sugarbeets grown on methyl bromide-treated soil or natural soil at Eastern Agricultural Research Center, Sidney, MT, Site #2, 2000.

Treatment	Seedling stand	Harvest stand	Sucrose	Root yield	Sucrose yield	Extractable sucrose
	plants/acre	plants/acre	%	tons/acre	lb/acre	lb/acre
Fumigated	34690	28600	17.63	29.8	10520	9880
Natural	31540	27550	17.53	29.7	10410	9732
Probability	0.290	0.824	0.942	0.994	0.958	0.917
CV (s/mean)	13.0	14.4	3.9	10.3	8.8	8.8
Treatment	**Na**	**K**	**Amino-N**	**Impurity index**	**SLM**	**Extraction**

	ppm	ppm	ppm			%
Fumigated	379	1596	196	0.718	1.08	93.9
Natural	372	1666	228	0.763	1.14	93.4
Probability	0.983	0.567	0.363	0.633	0.632	0.659
CV (s/mean)	23.9	9.2	23.3	15.0	15.0	1.3

Table 4. Stand, yield, and quality of sugarbeets grown on methyl bromide-treated soil or natural soil at Flynn site near Fairview, ND, 2000.

Treatment	**Harvest stand**	**Sucrose**	**Root yield**	**Sucrose yield**
	plants/acre	**%**	**tons/acre**	**lb/acre**
Fumigated	33620	18.90	31.6	11930
Natural	29780	19.31	27.8	10760
Probability	0.009	0.015	0.036	0.073
CV (s/mean)	5.6	1.1	8.3	8.3