Effect of Planting Date, Variety, Nitrogen Fertilizer Rate and Sampling Date on Lignin Content of Sugarbeet Roots

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Summary

In some years, central Arizona sugarbeet crops have contained fibrous material in quantities large enough to cause problems during processing. This fibrous material was found to consist of strands of heavily lignified vascular tissue. Large increases in lignin concentration in roots occurred at the time seedstalks were produced. This study indicates that roots of adapted varieties not producing seedstalks may contain enough lignified tissue to be a problem during processing. Increasing the nitrogen fertility level resulted in increased lignin concentration in roots.

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Sugarbeet crops produced in central Arizona have occasionally contained large amounts of fibrous material. When these crops are processed there has been a heavy accumulation of fibrous tissue on the cutting blades of the rotary slicers. Other growing areas have encountered the same problem when overwintered beets with a high percentage of bolters are processed. The roots, crowns and seed stalks of plants that have bolted are normally very woody. Plants not producing seedstalks can contribute large amounts of fibrous material during processing if petiole and leaf tissue is not properly removed in the topping operation. However, beets harvested in central Arizona have generally produced only a low percentage of bolters and have been topped reasonably well. Examination of the fibrous material that accumulated on the cutting blades revealed that it consisted of heavily lignified vascular tissue.

Lignin production in sugarbeet roots would appear to be related to seedstalk development since the function of lignin in plants is to give strength and rigidity to the cell wall. Even though only a low percentage of plants of adapted varieties produce seedstalks under Arizona conditions, some of the physiological changes associated with sexual reproduction may take place.

The tests reported here were conducted to determine the effect of two planting dates, two N fertilizer rates and four varieties on lignin concentration of sugarbeet roots. Root samples were collected on May 10 and July 9 for microscopic examination for the presence of lignin and chemical analysis for lignin concentration. To indicate the presence of lignin, tissue was stained using phloroglucinol and hydrochloric acid. Lignin concentration was determined by the Van Soest Method.

Results

An examination of root tissue showed that the thick walled vessels of the xylem were the most heavily lignified. In more extreme cases, the small celled parenchymatous tissue surrounding the vessels was also lignified. This was common in roots of plants that produced seedstalks. In most plants with seedstalks, lignified vascular tissue extended from the seedstalk through the crown and well into the root.

The effect of cultural treatments on the concentration of lignin in root tissue is shown in Table 1. A variety that has been grown in Arizona for seed production had the highest root lignin concentration. This seed beet, GW H23, produced nearly 90 percent bolters by May. The remainder of the varieties tested were considered adapted and these produced less than one percent bolters. The few seedstalks produced by these varieties were produced at the same time as those of the seedbeet.

There was no difference between planting dates of September 20 and October 18 in lignin content of roots (data not shown). The difference of one month in age did not appear to affect lignin production. This would indicate that lignification is not strictly an aging process in the sugarbeet root.

Increasing the N fertility level resulted in a significant increase in lignin concentration of roots. All of the adapted varieties showed a decrease in lignin concentration from May to July. During this same period root yields increased an average of 5.7 tons per acre. Consequently, although the percentage of lignin decreased, the total amount of lignin present in roots did not change after May 10.

In a test the next season we sampled roots of an adapted variety with bolting resistance and a seed beet to monitor the lignin content from February through July. That year the weather was cool in the spring and the seed beet did not bolt until late May and early June. The lignin concentration in roots of both varieties was greater than in the previous year's study (Table 2).

The largest change in lignin concentration occurred in seed beet roots when the plants bolted. A large increase also occurred in roots of the adapted variety during bolting, even though only a few seedstalks were produced ($<1\%$). The increase in the lignin concentration at the time seedstalks are produced and the lack of lignin production after the normal time for seedstalk formation indicates that

lignin synthesis in roots of adapted varieties may be triggered by a reproductive stimulus.

Although seedstalks and foliage from beets not properly topped are likely the main source of fibrous material at the processing plant, this study indicates that in some years roots of adapted varieties not producing seedstalks may contain enough lignified tissue to contribute to the problem.

Table 1. Effect of variety, N fertilizer rate and sampling date on lignin concentration of sugarbeet roots.

	Sampled May 10			Sampled July 9		
	N - lbs/A		Variety	N - lbs/A		Variety
Variety	110	190	Ave.	110	190	Ave.
			(% lignin - fresh wt. basis)			
GW H23	.168	.193	.181 a[1/]	.119	.173	.146 a
A66194	.126	.121	.124 b	.079	.109	.094 b
US H8	.098	.141	.120 b	.109	.152	.131 a
S-301H6	.125	.139	.132 b	.062	.100	.081 b
Ave.	.129	.149		.092	.134	
Ave. sampling dates			.139			.113

[1/] Means for varieties within a sampling date followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Table 2. Seasonal changes in the lignin concentration of roots of two sugarbeet cultivars.

Sampling date	S-301H	Seedbeet	Ave.
		(% lignin - wet wt. basis)	
Feb. 14	0.21	0.24	0.23
Mar. 19	0.16	0.20	0.18
Apr. 17	0.15	0.28	0.22
May 16	0.15	0.27	0.21
June 16*	0.25	0.42	0.34
July 14	0.27	--	--

*Bolting occurred in late May and early June.

Effect of Delayed Lifting of Sugarbeet Roots After Topping

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Summary

The sucrose concentration in beets topped but not lifted decreased significantly by the fifth day. Topped roots showed visible signs of regrowth in three to five days. Root yield was not significantly affected by delaying lifting of topped roots for 15 days. About 12 percent of plants topped but not lifted for 15 days showed rot symptoms compared to less than one percent in plants not topped until harvest.

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