Rowcovers and Mulch Alter Seasonal Strawberry Carbon Metabolism

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Under the short days and low temperatures of autumn, short-day strawberry plants accumulate carbohydrates and initiate floral buds, but as temperatures decline, leaf function slows and floral initiation ceases (Austin et al., 1961; Moore and Hough, 1962). Higher temperatures and greater exposure to light in autumn and spring under synthetic rowcovers may enhance some temperature-limited developmental processes in strawberry (Gast, 1988). Plants overwintering under rowcovers had higher and earlier yields than non-covered controls (Pollard and Cundari, 1988).

Evidence on whether higher temperatures under rowcovers during autumn and spring alter carbohydrate metabolism might be found by examining carbohydrate levels in plants grown under rowcovers. The objective of this experiment was to determine if rowcover/mulch treatments in autumn and spring affect carbohydrate partitioning in strawberry by analyzing total nonstructural carbohydrates (TNSC), glucose, and fructose levels.

Dormant crowns of 'Earliglow' strawberry were planted on 5 June 1986 in a raised bed system, 0.9 m between rows and 10 cm between plants. Two treatments, rowcovers applied in autumn with a short-term winter straw mulch removed 27 Mar. 1987 and a control of no rowcovers in autumn with a long-term winter straw mulch removed 24 Apr. 1987, were replicated six times. Treatment selection represented recommended commercial practices. Each replicate contained 11 sample plots of 10 plants. The rowcover, an extruded polypropylene-polyamide mesh (20 g·m⁻¹; Agronet, CDK International, Marietta, Ga.), was applied 12 Sept. 1986 and removed at flowering on 12 May 1987.

To determine TNSC and soluble sugars in leaves, roots, and crowns during autumn and spring, plants were removed from randomly assigned sample plots at 3-week intervals from 11 Sept. until 3 Dec. 1986 and from 27 Mar. until 27 May 1987. TNSC were determined according to Smith (1979). Soluble sugars were determined via modifications (Gast, 1988) of an ethanol extraction method (Ferguson et al., 1979) and of Pierce Chemical Co. gas-liquid chromatography preparation method #18 (1986–87 Handbook and Gen-

eral Catalog, Pierce Chemical Co., Rockford, Ill).

In autumn, no treatment differences were found for TNSC levels over the sampling period for any plant part. Significantly higher ($P < 0.05$) soluble sugars levels occurred in December in rowcovered leaves than in controls (data not shown). This finding does not support the hypothesis that plants under rowcovers in autumn store more carbohydrates than control plants, but does indicate rowcovered leaves sustained translocate metabolism longer.

In spring, rowcovered root TNSC levels were consistently greater in the spring, although this difference was significant only with the onset of rapid growth (Table 1). Rowcovered root carbohydrate reserves were either not used for spring growth or were replenished. Although no treatment main effect differences for crown TNSC levels were found over the spring sampling period, there was an important significant treatment × sample data interaction. Rowcovered crowns had lower TNSC levels than controls on the first two spring sampling dates and higher levels on the last two dates. Earlier exposure to light and higher temperatures under the rowcovers may have resulted in the earlier use of crown carbohydrates to support earlier growth in the plants. By the last two sampling dates, photosynthates appeared to have been translocated into the rowcovered crowns.

This is not surprising, since leaf TNSC, fructose, and glucose levels were higher in rowcovered plants than controls (Table 1).

Rowcover effects on carbon metabolism were most apparent in spring. Leaves apparently became photosynthetically independent sooner, as seen in higher TNSC, glucose, and fructose levels under rowcovers. This effect, in turn, altered the typical spring plant source-sink relationships in the rowcover plants. Carbohydrate losses from normal sources for early spring growth and development, i.e., the roots and crowns, were prevented by the presence of an earlier functioning leaf surface. Plant carbohydrate levels may be one of the factors limiting the potential development of subsidiary floral buds into producing marketable fruit. This study shows that rowcovers appear to be affecting the carbohydrate pool in the plants, especially in spring.

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Table 1. Percent of dry mass for TNSC of roots, crowns, and leaves and percent of dry mass for leaf fructose and glucose for 'Earliglow' strawberry, Spring 1987.

Treatment	Sampling date				Analysis over time
	27 Mar.	15 Apr.	6 May	27 May	
Roots (%)					
Rowcover	6.75	6.35	5.70	7.42	Treatment (T)*
Control	6.16	6.20	3.99	3.81	Time (T)*
Significance	NS	NS	NS	**	T × T*
Crowns (%)					
Rowcover	7.89	4.59	8.57	7.90	Treatment (T) ^{NS}
Control	9.26	7.25	5.21	4.94	Time (T)* ^{NS}
Significance	*	***	**	**	T × T ^{NS}
Leaves (%)					
Rowcover	7.19	9.28	11.28	13.28	Treatment (T) ^{NS}
Control	5.13	4.98	7.90	9.90	Time (T) ^{NS}
Significance	*	**	***	**	T × T ^{NS}
Leaf fructose (%)					
Rowcover	1.00	1.40	1.32	0.89	Treatment (T)**
Control	0.94	0.66	0.80	0.81	Time (T) ^{NS}
Significance	NS	**	*	*	T × T**
Leaf glucose (%)					
Rowcover	0.89	1.15	1.16	0.82	Treatment (T) ^{NS}
Control	0.82	0.53	0.65	0.65	Time (T) ^{NS}
Significance	NS	**	**	*	T × T**

^{NS,*,***} Nonsignificant or significant at $P = 0.05$, 0.01 , or 0.001 , respectively, by F test.

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