Effects of Aqueous Sprays of Silverleaf Whitefly Honeydew Sugars on Cotton Lint Stickiness

T. J. Henneberry, L. Forlow Jech, D. L Hendrix, and T. Steele
USDA-ARS, Western Cotton Research Laboratory
4135 E. Broadway
Phoenix, AZ 85040-8803

ABSTRACT

Sprays of commercially-procured sugars that are also found in silverleaf whitefly Bemisia argentifolii *Bellows and Perring [=* B. tabaci *(Gennadius) Strain B] honeydew were applied to clean cotton lint to determine the relationship between the sugars and cotton lint stickiness. Increasing concentrations of the sugars resulted in increasing thermodetector counts.*

Introduction

The sticky cotton problem is widespread and apparent in many parts of the world (Hector and Hodkinson 1989). Most serious sticky cotton problems have been associated with honeydew contamination as a result of whitefly *Bemisia argentifolii* Bellows and Perring [= *B. tabaci* (Gennadius) Strain B] or aphid, *Aphis gossypii* Glover, infestations (Hector and Hodkinson 1989). The recent upsurge in whitefly problems throughout the world beginning about 1986 (Gerling and Mayer 1996) has resulted in a concurrent increase in the occurrence of sticky cottons. Research to identify the sugar components of *Bemisia* honeydew has revealed that, for whiteflies feeding on cotton, two insect-produced sugars, trehalulose and melezitose (Tarczynski et al. 1992, Hendrix et al. 1992) are the major honeydew components, but a number of other sugars occur in lesser amounts. Some of the same sugars found in honeydew occur as physiological sugars in the cotton plant (fructose, glucose, and sucrose), and the contributions to lint stickiness of plant physiological and *B. argentifolii*-produced sugars cannot be separated following extraction from honeydew contaminated lint. The thermodetector is a readily available device that provides a direct measurement of cotton lint stickiness. It is the internationally accepted method of detecting and quantifying sugar spots on cotton lint (Brushwood and Perkins 1993). Very simply described, a 2.5-g sample of cotton lint is spread into a thin mat and layered between two sheets of aluminum foil and heated under pressure. Thereafter, the foil is removed and the number of sticky spots on the foil counted. Processing samples by this method is relatively slow, and the numbers of samples that can be measured within a realistic time frame is limited.

The objectives of our current studies were to compare cotton lint stickiness caused by trehalulose, melezitose, fructose, glucose, and sucrose as measured by the thermodetector methods.

Materials and methods

Aqueous stock solutions of 40% (W:V) glucose, fructose, melezitose, sucrose and trehalulose were made and diluted to deliver 5, 10, 15, 20, 25, 30, 35, or 40 mg of the individual sugar, respectively, per g of cotton lint. Five cotton lint samples were sprayed at each rate and the entire experiment repeated three times. All sugars, with the exception of trehalulose, were obtained from Sigma Chemical Co. (St. Louis, MO). Trehalulose as a 93% pure syrup was

This is part of the 2000 Arizona Cotton Report, The University of Arizona College of Agriculture, index at http://ag.arizona.edu/pubs/crops/az1170

obtained from Dr. A. J. Kowalczyk (Südzucker Ag, Mannheim/Ochsenfurt, Germany). The syrup was purified by a charcoal treatment. All spray applications of sugars were applied with a Badger Professional Air Brush (Grainger Industries and Commercial Supply, Phoenix, AZ). All spray-treated lint samples were air dried following treatment. Manual thermodetector analyses were conducted at the USDA-ARS, Cotton Quality Research Laboratory, Clemson, SC.

Results

Increasing rates of glucose, fructose, trehalulose, sucrose, and melezitose applied to uncontaminated cotton lint were significantly related to increasing thermodetector counts (r^2 = 0.94, 0.85, 0.98, 0.81, and 0.80, respectively; n = 8; $P \leq 0.01$) (Fig. 1). The overall average thermodetector counts for sucrose, melezitose, trehalulose, fructose, and glucose over all rates show significant differences for sucrose and melezitose compared with all other sugars (Table 1). Sucrose and melezitose had significantly higher thermodetector counts compared with all other sugars tested. Thermodetector counts for trehalulose were significantly higher than for the fructose or glucose and glucose thermodetector counts were higher compared to those for fructose. In general, average thermodetector counts for each individual sugar increased with increased rates applied to cotton lint (Table 1). The differences in all cases, however, were not statistically significant.

Discussion

Economic losses as a result of cotton lint stickiness from insect honeydew contamination have been poorly documented (Hector and Hodkinson 1989). However, discounts of 10% or more for contaminated lint, losses occurring from reduced cotton ginning efficiency, and increased costs of machinery maintenance have been reported. Solutions to the sticky cotton problem are needed. Increasing our knowledge of the carbohydrate composition of honeydew and the relative importance of individual sugars to stickiness may help in the development of chemical or enzymatic methods that can degrade or inactivate the sugars and result in a partial solution to the problem (Hendrix et al. 1993). Our results with respect to comparative stickiness of cotton lint induced by individual sugars found in whitefly honeydew agree with those of Miller et al. (1994) for trehalulose, sucrose, fructose, and glucose; however, we found cotton lint more sticky following melezitose applications compared with the results of those authors.

Acknowledgments

The authors appreciate the financial support of Cotton Incorporated through Cooperative Agreement 5344-21220-009-07R that partially defrayed the costs of these studies. We are also particularly grateful to D. E. Brushwood and the ARS, Cotton Quality Research Laboratory for thermodetector analyses of cotton lint samples.

Literature Cited

Brushwood, D. E., and H. H. Perkins. 1993. Cotton stickiness potential as determined by minicard, thermodetector, and chemical methods, pp. 1132-1135. *In* D. J. Herber and D. A. Richter, [eds.] Proc. Beltwide Cotton Prod. Res. Conf., Natl. Cotton Council of Amer., Memphis, TN.

Gerling, D., and R. T Mayer. 1996. Introduction, p. 5. *In* D. Gerling and R. T Mayer [eds.] *Bemisia*: 1995 Taxonomy, Biology, Damage, Control and Management. Intercept LTD. Andover, Hants, UK.

Hector, D. J., and I. D. Hodkinson. 1989. Stickiness in cotton. CAB International, Oxon.

Hendrix, D. L., B. Blackledge, and H. H. Perkins, Jr. 1993. Development of methods for the detection and elimination of insect honeydews on cotton fiber, pp. 1600-1602. *In* D. J. Herber and D. A. Richter, [eds.] Proc. Beltwide Cotton Prod. Res. Conf., Natl. Cotton Council of Am., Memphis, TN.

Hendrix, D. L., Yuan-an Wei, and J. E. Leggett. 1992. Homopteran honeydew sugar composition is determined by both the insect and plant species. Comp. Biochem. Physiol. 101B: 23-27.

Miller, W. B., M. E. Peralta, D. R. Ellis, and H. H. Perkins, Jr. 1994. Stickiness potential of individual honeydew carbohydrates on cotton lint. Textile Res. J. 64: 344-350.

Tarzcynski, M. C., D. N. Byrne, and W. B. Miller. 1992. High performance liquid chromatography analysis of carbohydrates of cotton phloem, sap and of honeydew produced by *Bemisia tabaci* feeding on cotton. Plant Physiol. 98: 753-756.

TABLE 1. Mean Numbers of Thermodetector Counts for Cotton Lint Sprayed with Individual Honeydew Sugars at Different Rates.

Treatment (mg/g lint)	Honeydew Sugars					Means for Rates[a]
	Glucose	Fructose	Trehalulose	Sucrose	Melezitose	
0 (water)	3.6 f	1.6 e	3.4 e	6.8 d	5.6 c	4.2 f
5	6.2 ef	1.4 e	3.2 e	11.2 cd	13.0 bc	7.0 f
10	10.2 de	2.8 de	12.6 de	15.4 c	18.0 b	11.8 e
15	11.6 cde	7.6 bc	14.0 d	18.2 c	27.6 a	15.8 d
20	12.0 bcd	9.0 abc	20.0 cd	31.0 b	29.2 a	20.2 c
25	12.6 bcd	6.2 cd	27.0 bc	36.2 b	32.8 a	23.0 bc
30	16.8 abc	9.8 abc	29.8 bc	32.6 b	30.8 a	24.0 b
35	17.2 ab	10.8 ab	35.0 ab	47.2 a	36.4 a	29.3 a
40	21.0 a	13.0 a	44.4 a	36.0 b	33.2 a	29.5 a
Means for sugars[b]	12.4 c	6.9 d	21.0 b	26.1 a	25.2 a	--

[a] Means for rates in a column not followed by the same letter are significantly different. $F = 62.31$; df = 8,176; $P \leq 0.01$

[b] Means for sugars in a row not followed by the same letter are significantly different. $F = 92.45$; df = 4,176; $P \leq 0.01$.

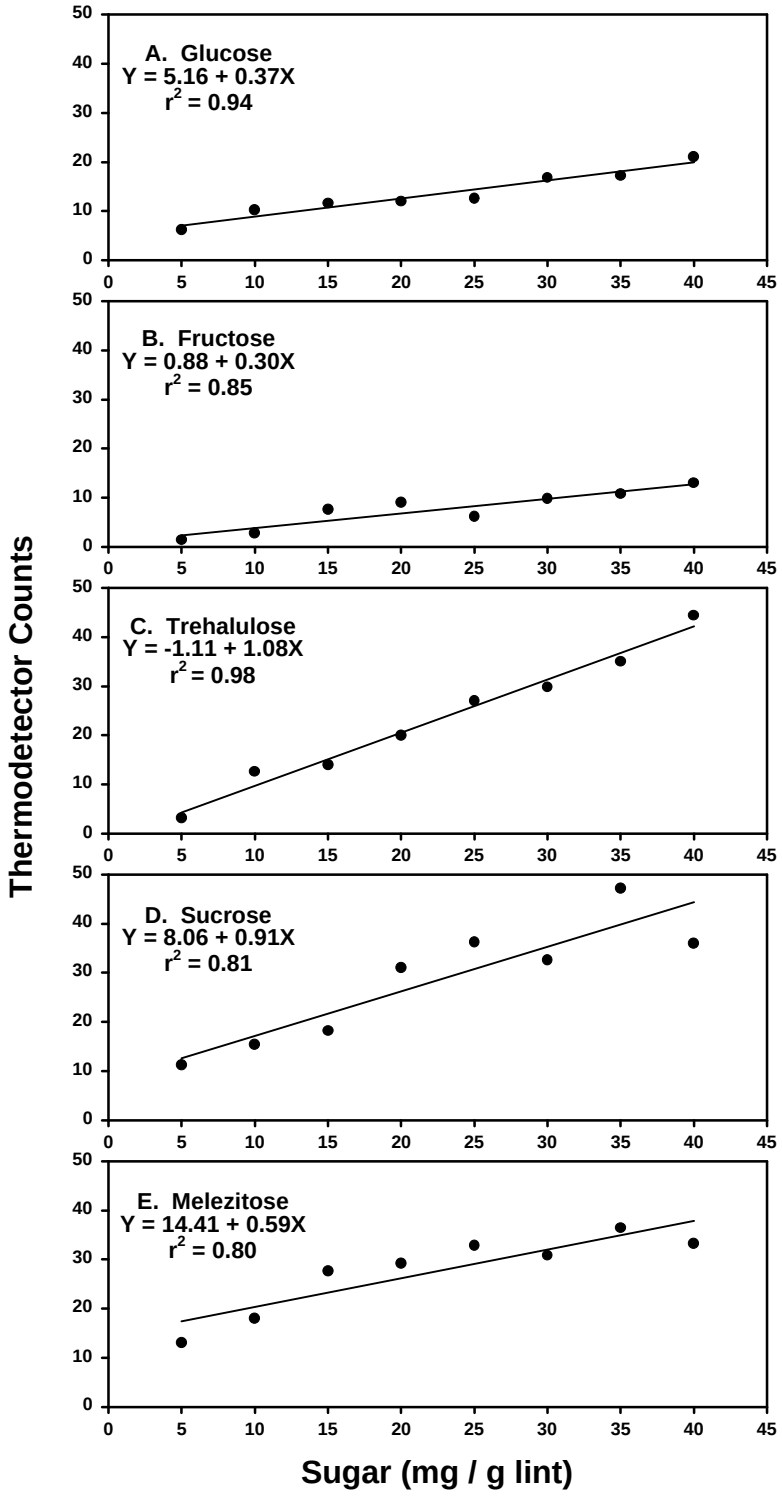

Figure 1. Mean numbers of thermodetector counts for cotton lint sprayed with individual honeydew sugars at different concentrations.