SUGARBEET ROOT APHID MANAGEMENT IN TEXAS

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ABSTRACT

The sugarbeet root aphid (RA) is a frequent and serious pest of sugarbeet in Texas. Losses can be 50% of both tonnage and sucrose but more commonly are several tons and 1 or 2 points of sucrose. Damage is worse during drought or with limited irrigation. Insecticides were unsuccessful in controlling RA. Lack of control is thought to be due to the difficulty of delivering the chemical to the pest. Cultivars which are undamaged by this pest have been stable and highly successful in controlling RA for 20 years or longer in Texas. RA can cause extreme increases in the Na to Amino-N ratio of beet roots at harvest. This ratio can be a diagnostic tool for RA. Screening nurseries for RA are easily conducted (if severe RA occurs) and highly successful in delineating resistant lines.

Introduction

The sugarbeet root aphid is a frequent and serious pest of sugarbeet in Texas and elsewhere in the U.S. The classical life cycle of RA involves narrow leaf cottonwood as the primary overwintering host and sugarbeet as a secondary summer host (4, 7). However, RA can overwinter in the soil without the need for cottonwood trees (7).

Damage has been reported from nearly, if not all, U.S. sugarbeet growing areas (1, 4, 6, 8). Drought or reduced irrigation in dry climates favor damage (1, 8). In Texas, control of this pest is essential to profitable production.

The mechanism of cultivar resistance is not known. It could be antibiosis, meaning the aphids don't reproduce or don't do well on certain cultivars, or it could be non-preference. Whatever the case, we will use the term resistant for those cultivars which don't have aphids. In the field, "resistant" cultivars have few or no aphids present on either the main tap root or on secondary roots. It is not a case of having aphids present with no damage.

The purpose of this paper is to describe how this pest has been successfully managed in Texas and how cultivar improvement and selection has been conducted.

Methods

All tests were conducted on Pullman clay loam soil (fine, mixed, thermic Torrertic Palaustolls). This soil normally cracks severely on drying. In 1979, several experiments were undertaken to determine if sugarbeet cultivars differed in drought tolerance. Main plots were seasonal irrigation frequency (3 or 7 furrow irrigations) with cultivars as subplots within each main plot. Root aphid scores and yields are reported for what turned out to be a root aphid screening trial.

Various chemicals were applied either as granular materials into the crown (1980 and 1982) or soil applied either 6 inches below the seed preplant, modified in furrow at planting, or knifed into the furrow at layby in 1991. These studies included resistant and susceptible cultivars as subplots within the chemical treatments.

In 1994, a cultivar trial of 36 commercial entries was planted on Pullman clay loam soil at Bushland. This test was fully irrigated by graded furrow with six replications.

Cultivar screening for RA resistance has all occurred on Pullman soil with limited irrigation, usually 2 to 4 seasonal furrow irrigations.

Results and Discussion

First appearance and irrigation effects

The first documented severe outbreak of RA in Texas occurred in 1979, although RA was suspected as a problem in 1973 (Table 1).

Table 1. Relative sucrose yields of root aphid resistant (MonoHy D2) and root aphid susceptible (HH23) cultivars during eight years in Texas. Data are a mean of several cultivar tests each year.

Year	D2	HH23	Severe RA
	-------- % --------		
1973	100	81	?
1974	100	93	no
1975	100	101	no
1976	100	94	no
1977	100	102	no
1978	100	96	no
1979	100	79	yes
1980	100	82	yes
Mean	100	91	

RA caused severe damage to susceptible cultivars particularly with limited irrigation in 1979 (Table 2.).

Table 2. Root aphid score and yield at two irrigation levels with resistant and susceptible cultivars on Pullman clay loam soil at Bushland, TX in 1979.

Summer irrigations	Cultivar	Root aphid score	Relative sucrose yield	Root yield	Sucrose
		1 to 5 (5 worst)	%	tons/acre	%
7	D2	1.0	100	35	15.8
	HH23	3.8	71	27	13.7
3	D2	1.1	73	27	15.5
	HH23	4.2	55	21	14.2

Even with full irrigation the yield of HH23 was only 71% of D2 whereas the cultivars had previously yielded similarly (Table 1). Both root yield and sucrose content of HH23 were substantially reduced by RA.

Chemical control studies

In 1980, a drought year, HH23 was devastated by RA with yield losses of approximately 8-10 tons/acre and sucrose reduction of about 6 points. Insecticides were ineffective (Table 3).

Table 3. Sugarbeet response to granular insecticides dropped into the crown on July 26, 1980 when the susceptible cultivar, HH23, averaged four aphids per root. Pullman clay loam soil at Bushland, TX with furrow irrigation. Rainfall totaled 1.4 inches from July 26 to Sept. 1.

Cultivar	Insecticide	Rate	Root yield	Sucrose	Aphid score
		lb/acre ai	tons/acre	%	1 to 5 (5 worst)
D2	Check	-	28.1 a	16.0 a	1.0 b
(res.)	Thimet	1.0	27.4 a	16.3 a	1.0 b
	Thimet	2.0	28.6 a	15.9 a	1.0 b
	Furadan	1.0	29.0 a	16.1 a	1.0 b
	Furadan	2.0	27.9 a	16.3 a	1.0 b
HH23	Check	-	17.8 b	10.3 b	3.5 a
(sus.)	Thimet	1.0	18.1 b	11.5 b	3.0 a
	Thimet	2.0	16.4 b	10.4 b	3.2 a
	Furadan	1.0	15.3 b	10.5 b	3.7 a
	Furadan	2.0	16.9 b	10.9 b	4.0 a

Earlier experiments with long-lived, soil-incorporated chemicals reported some RA control (3). Lack of effectiveness in our studies is thought to be due to inadequate delivery of the insecticide into the soil where RA reside. Furrow irrigation and limited rainfall were apparently not effective in moving the chemical into the soil. A similar experiment conducted in 1982 had almost no RA on either cultivar until nearly harvest (Table 4.).

Table 4. Sugarbeet response to granular insecticides dropped into the crown on Aug. 10, 1982. Pullman clay loam soil at Bushland, TX with flood irrigation (level borders).

Cultivar	Insecticide	Rate	Root yield	Sucrose	Aphid score
		lb/acre ai	tons/acre	%	1 to 5 (5 worst)
D2	Check	-	22.4 a	17.0 a	1.0 a
(res.)	Temik	1.5	24.3 a	17.4 a	1.0 a
	Temik	3.0	23.1 a	16.8 a	1.0 a
	Furadan	2.0	23.3 a	16.8 a	1.0 a
	Thimet	2.0	23.2 a	16.7 a	1.0 a
HH23	Check	-	23.7 a	16.8 a	1.2 a
(sus.)	Temik	1.5	21.9 a	17.4 a	1.0 a
	Temik	3.0	22.0 a	16.3 a	1.2 a
	Furadan	2.0	23.9 a	17.0 a	1.2 a
	Thimet	2.0	23.1 a	17.0 a	1.3 a

The RA level was inadequate to test chemical effectiveness.

By 1982, we were familiar with cultivar resistance and comfortable with relying on this method of control. One additional experiment was conducted in 1991 using newer chemicals and application methods less dependent on rainfall (Table 5).

Table 5. Insecticide effects on resistant and susceptible sugarbeet cultivars with severe root aphids in 1991 on Pullman clay loam at Bushland, TX.

	Insecticides					
Cult.	Preplant	Planting	Layby	Root yield	Sucrose	Root aphid
	chemical (lb/acre ai)			tons/acre	%	1 to 5 (5 worst)
TX18	Th (1.0)	-	-	30.1 a	15.4 a	1.1 b
(res.)	"	C-CR (1.0)	-	29.4 a	15.6 a	1.0 b
	"	C-15G (1.0)	-	26.6 a	15.0 a	1.1 b
	"	-	F-15G (1.0)	30.4 a	15.7 a	1.0 b
	"	-	C-15G (1.0)	29.7 a	15.6 a	1.0 b
HH39	Th (1.0)	-	-	21.7 b	9.8 b	3.3 a
(sus.)	"	C-CR (1.0)	-	19.9 b	9.5 b	2.3 a
	"	C-15G (1.0)	-	18.4 b	8.2 b	2.8 a
	"	-	F-15G (1.0)	20.3 b	9.7 b	3. 0 a
	"	-	C-15G (1.0)	22.7 b	9.0 b	3.0 a

Th = Thimet, C-CR = Counter CR, C-15G = Counter 15G, F-15G = Furadan 15G.

Despite the presence of RA with severe damage, there was again no positive response to planting or layby chemicals on either a resistant or a susceptible cultivar.

Na to Amino-N ratio

In 1994 there were some extraordinary effects of RA on Na and Amino-N impurities in the roots at harvest. With severe root aphids, Na concentrations as high as 20,000 ppm were noted in one susceptible cultivar with high nitrogen. In contrast, Na was less than 1,000 ppm in resistant cultivars in the same test and as low as 250 ppm with low nitrogen conditions. The ratio of Na to Amino-N was about 1.0 to 1.5 with resistant cultivars lacking RA. This ratio was about 5 to 40 in the presence of severe root aphids. The increased ratio was caused by a large increase in Na accompanied by a small decrease in amino-N. Much smaller increases in Na have been reported previously (6).

The Na to Amino-N ratio may be a nice diagnostic tool for the presence of RA. We have used it for that purpose in Texas when we had poor sucrose contents but weren't sure if RA was the primary or even a contributing cause.

The Na to Amino-N ratio was highly correlated with several yield and quality parameters (Table 6.)

Table 6. Correlation coefficients between root aphid ratings, yield, quality, and the Na to Amino-N ratios for 36 cultivars (n = 213) at Bushland, TX in 1994.

	Sucrose	Tons	Aphid rating	Recoverable fraction	Recoverable lb/acre
Tons	0.227				
	0.001				
Aphid rating	-0.566	-0.278			
	0.001	0.001			
Rec. fraction	0.655	0.015	-0.037		
	0.001	0.069	0.001		
Rec. lbs/acre	0.765	0.773	-0.496	0.606	
	0.001	0.001	0.001	0.001	
Na/Amino-N	-0.526	-0.124	0.316	-0.889	-0.487
	0.001	0.072	0.001	0.001	0.001

The ratio was better correlated to recoverable sucrose fraction than was root aphid ratings (-0.889 vs. -0.307). Both the ratio and the rating were significantly correlated with sucrose. Sucrose can be predicted from the ratio using the equation: Sucrose = 14.86 - 0.717 ratio + 0.01238 ratio^2 (R^2 = 0.45). Increasing the Na to Amino-N ratio from 1 to 10 drops sucrose from a predicted value of 14.15% to 8.93%.

Root aphid nurseries

Root aphid screening nurseries of breeding lines and hybrids have been conducted about 10 years since 1980. About half of those years have been highly successful in screening for resistance. In the remaining years there have been inadequate aphids for screening.

Current plot size is two rows on a 40-inch bed. Two reps are satisfactory with a good infestation because differences between cultivars are extreme. Cultivars can be rated both for percentage infested roots and also for degree of infestation. To rate the plots a chisel is pulled about 8 inches deep down the center of the bed. This splits the bed open and exposes the roots and aphids.

A thick stand is best for rating. Planting 10-12 seeds/ft without thinning works well. Many small roots give a better rating than a few large roots. Ratings can be made from September to November with October 15 to Nov. 15 usually excellent.

Cultivar resistance and stability

The primary source of RA resistant cultivars for Texas has been the MonoHy program in Colorado. Resistance in these lines was recognized many years ago (2, 5, 9). This resistance has been stable in Texas since at least 1979 and probably longer (Table 1).

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