Development of Thresholds for Management of Sugarcane Aphid on Sorghum

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ABSTRACT

The sugarcane aphid (*Melanaphis sacchari*) is an emerging pest of sorghum. Because this pest can cause significant economic injury to sorghum at various stages of growth, it is necessary to evaluate different treatment trigger levels to determine an economic threshold. Susceptible grain sorghum varieties were subjected to 50, 125, 250 & 500 aphids/leaf treatment trigger levels, as well as a non-treated check. The trials were performed at six locations – two along the Texas gulf coast and one each in Oklahoma, Louisiana, Arkansas, and Georgia. One Texas location was replicated three times and arranged in a CRD. Treatments at all other locations were replicated four times and arranged in a RCB. Leaves were examined weekly beginning with the first detection of aphids. Transform WG was applied to maintain aphid populations at designated treatment levels. Aphid-yield response data were collected and regression analyses were performed to determine economic injury levels and economic thresholds. Yield loss ranged from 120 to 410 pounds/acre per 100 aphids/leaf. The data support an economic threshold of 35-135 aphids per leaf, similar to the 50-125 aphids per leaf economic threshold that was recommended for the 2015 growing season. Measurements such as plant response and percentage of plants infested with >10 or >25 aphids/leaf were considered as an alternative to estimating aphid densities. Alternative methods show promise but will need additional evaluation.

INTRODUCTION

Grain sorghum, *Sorghum bicolor* L., is an important crop in Texas and the Southern United States. In 2015, there were 2.49 million planted acres in Texas and nearly 8 million acres in the U.S., increases of 4.7% and 22.3% from 2014, respectively (USDA-FSA, 2015). The key insect pests of sorghum include several aphid species, sorghum midge, and headworms. Methods for chemical and cultural control of these pests are well known (Cronholm, et al. 2007). The first report of the sugarcane aphid, *Melanaphis sacchari*, in the continental United States was on sugarcane in Florida in 1977 (Denmark 1988). While Denmark also reported that sugarcane aphid would feed on *Sorghum* spp., it was not considered a pest until the recent outreach on sorghum first detected along the Texas Gulf Coast in 2013..

In 2013, this new pest of grain sorghum was detected in 38 counties and parishes in Texas, Louisiana, Oklahoma, and Mississippi (Villanueva et al. 2014). Confirmed sugarcane aphid populations increased to 12 states and more than 300 counties in 2014, and 17 states and more than 400 counties in 2015 (Bowling, et al. In Prep).

The increase in the prevalence of this pest and its potential to impact sorghum production in Texas and other sorghum producing areas prompted an evaluation of economic injury level and economic threshold in 2014 at Texas A&M AgriLife and LSU AgCenter research facilities in South Texas and North Louisiana, respectively. Results from those trials suggested an economic threshold of 50-125 aphids per leaf. This project is a continuation of the work done in 2014, and has been expanded to include partners from Texas, Louisiana, Arkansas, Oklahoma, and Georgia. The objective is to establish an economic threshold using aphid-yield response data obtained at the six locations and to investigate potential alternative scouting methods.

MATERIALS and METHODS

Multiple sequential plantings of grain sorghum were made at five locations with a single planting at the sixth location (Georgia). Because seasonally late occurrence of sugarcane aphid, data from the latest plantings were used in analyses.

Plot sizes ranged from two to six rows of 30 to 40 feet in length. Plots in Rosenberg were arranged in a randomized design and replicated three times. All other locations used a randomized block design with four replications. Plots were planted at seeding rates ranging from 72,000 to 83,000 seed per acre with row spacing from 36" – 40".

Plots were counted weekly after initial aphid detection. Two leaves, one lower and one upper canopy, from ten plants were sampled. The Oklahoma location estimated whole leaf populations by counting one square inch and applying that over the estimated leaf size. All other locations estimated populations based on the entire under side of the leaf being sampled. 0-10 aphids were counted, levels of 11-25, 26-50, 51-100, 101-500, 501-1000, and >1000 (See Figure 1A-F for example) were estimated and the median (18, 38, 75, 350, 750, and 1500, respectively) was used to calculate plot populations.

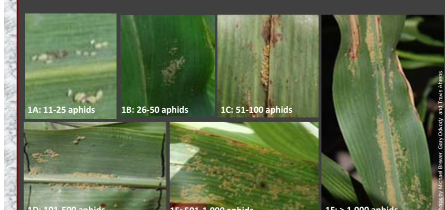


Figure 1A-F: Example of aphid colonies representing each level used for estimating aphid populations in plots.

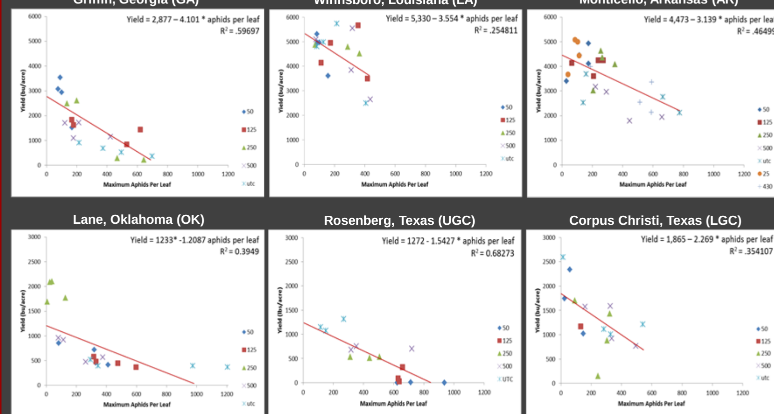
Depending on location, two methods for treatment initiation were used – either each plot was sprayed individually when it reached threshold, or all plots in each treatment level were sprayed when the average population across the treatment level reached threshold. To maintain infestation levels, plots were sprayed with Transform WG (Sulfoxaflor, Dow) at a rate of 1.0 ounce per acre.

Yield was measured in plots maintained at different sugarcane aphid infestation levels by spraying Transform insecticide when aphid densities reached 50, 100 to 125 (depending on location), 250, and 500 aphids per leaf. There was also a non-treated control. The Arkansas location included two additional treatment levels of 25 and 430 aphids per leaf. For Plant response, a 1-9 rating considering leaf chlorosis (similar to what was described by Webster, et al.), honeydew/sooty mold, and leaf death was used to rate 20 plants in each plot at the two Texas locations.

Linear regression was performed with yield per acre as the dependent variable and maximum aphids per leaf, cumulative aphid days, percentage of leaves with >10 or >25 aphids, and plant response as the independent variable for each respective analysis. Economic injury level and economic threshold calculations were based on the yield—aphid density regressions and four control cost and three grain value scenarios, using Pedigo's method (see Table 1 and 4 footnotes)

RESULTS

Yield Response to Maximum Number of Aphids per Leaf by Location:



Estimating Aphids/Leaf		Control Cost $10/acre Aphids/leaf		Control Cost $15/acre Aphids/leaf		Control Cost $20/acre Aphids/leaf		Control Cost $25/acre Aphids/leaf	
Market Value	Location	EIL	ET	EIL	ET	EIL	ET	EIL	ET
$3.50/bushel $6.25/cwt	OK	139	98	209	146	279	195	348	244
	UGC	109	76	164	115	218	153	273	191
	LGC	74	52	111	78	148	104	186	130
	AR	54	38	80	56	107	75	134	94
	LA	47	33	71	50	95	66	119	83
	GA	41	29	62	43	82	57	103	72
$5.00/bushel $8.93/cwt	OK	98	68	146	102	195	137	244	171
	UGC	76	53	115	80	153	107	191	134
	LGC	52	36	78	55	104	73	130	91
	AR	38	26	56	39	75	53	94	66
	LA	33	23	50	35	66	46	83	58
	GA	29	20	43	30	57	40	72	50
$6.50/bushel $11.60/cwt	OK	75	53	113	79	150	105	188	131
	UGC	59	41	88	62	118	82	147	103
	LGC	40	28	60	42	80	56	100	70
	AR	29	20	43	30	58	40	72	51
	LA	26	18	38	27	51	36	64	45
	GA	22	15	33	23	44	31	55	39

Table 1: Economic Injury Level and Economic Threshold for three levels of grain price and four levels of treatment cost. From Pedigo's method EIL = C/(V*I*D*K) where C = control cost, V = $ value of grain, K set at 0.95 as the proportion of the insect population controlled, and I*D is loss estimate from the slope of yield—aphid/leaf regression

	Maximum Aphids Per Leaf				
Location	Slope (lb./acre per aphid/leaf)	Y-intercept (Max. Est. Yield)	R^2	Yield loss per 100 aphids/leaf	Percent Yield loss per 100 aphids/leaf
OK	-1.2087	1,234	0.3949	120 lb./acre	9.8%
UGC	-1.5427	1,272	0.6827	154 lb./acre	12.1%
LGC	-2.269	1,865	0.3541	227 lb./acre	12.2%
AR	-3.139	4,473	0.4650	314 lb./acre	7.0%
LA	-3.554	5,330	0.2548	355 lb./acre	6.7%
GA	-4.101	2,877	0.5970	410 lb./acre	14.3%
Average	-2.636			264 lb./acre	10.3%

Table 2: Summary of regression components for the effect of Maximum Aphid Count on Yield by location. Yield loss of maximum yield (using y-intercept) per 100 aphids/leaf ranges from 6.7% to 14.3%, with an average of 10.3%

	Cumulative Aphid Days		
Location	Slope (lb./acre per aphid day)	Y-intercept (Max. Estimated Yield)	R^2
OK	-0.0081	1,353	0.092
UGC	-0.0764	1,315	0.886
LGC	-0.1081	1,832	0.354
AR	-0.0112	4,392	0.407
LA	-0.4032	5,393	0.47
GA	-0.2856	2,740	0.647

Table 3: Summary of regression components for the effect of Cumulative Aphid Days on Yield.

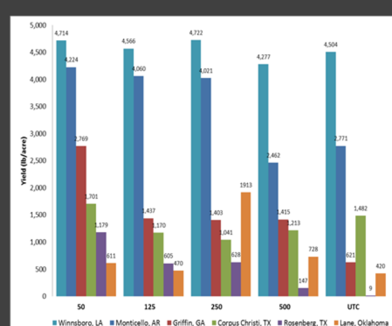


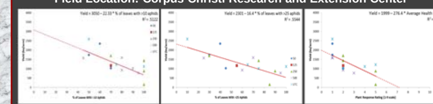
Figure 2: Mean yield by treatment level at all six locations. Variation among locations is due to a combination of effects including irrigation practices and other climatological factors

Figure 3A-C: Crop condition, head size, and maturity of grain sorghum at treatment levels of 50 aphids/leaf (1A), 250 aphids/leaf (1B), and 500 aphids/leaf (1C) at the Rosenberg location 89 days after planting

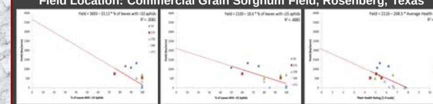
RESULTS

Alternatives to Estimating Entire Leaf Populations

Field Location: Corpus Christi Research and Extension Center



Field Location: Commercial Grain Sorghum Field, Rosenberg, Texas



Preliminary Data: Alternative Scouting Methods		Control Cost $10/acre- % of leaves w/aphids at specified level		Control Cost $15/acre - % of leaves w/aphids at specified level		Control Cost $20/acre- % of leaves w/aphids at specified level		Control Cost $25/acre - % of leaves w/aphids at specified level	
Market Value	Location/Evaluation Level	EIL	ET	EIL	ET	EIL	ET	EIL	ET
$3.50/bushel $6.25/cwt	UGC: % >10 aphids/leaf	5	4	8	5	10	7	13	9
	LGC: % >10 aphids/leaf	8	5	11	8	15	11	19	13
	UGC: % >25 aphids/leaf	9	6	14	10	18	13	23	16
	LGC: % >25 aphids/leaf	10	7	15	11	21	14	26	18
$5.00/bushel $8.93/cwt	UGC: % >10aphids/leaf	4	2	5	4	7	5	9	6
	LGC: % >10 aphids/leaf	5	4	8	6	11	7	13	9
	UGC: % >25 aphids/leaf	6	4	10	7	13	9	16	11
	LGC: % >25 aphids/leaf	7	5	11	8	14	10	18	13
$6.50/bushel $11.60/cwt	UGC: % >10aphids/leaf	3	2	4	3	5	4	7	5
	LGC: % >10 aphids/leaf	4	3	6	4	8	6	10	7
	UGC: % >25 aphids/leaf	5	3	7	5	10	7	12	9
	LGC: % >25 aphids/leaf	6	4	8	6	11	8	14	10

Table 4: Economic Injury Level and Economic Threshold for three levels of grain price and four levels of treatment cost. From Pedigo's method EIL = C/(V*I*D*K) where C = control cost, V = $ value of grain, K set at 0.95 as the proportion of the insect population controlled, and I*D is loss estimate from the slope of yield— % of plants with specified number of aphids/leaf regression

SUMMARY

- Economic Injury Levels are consistent with 2014 data but have been expanded along with the number of locations. Data from 2015 support the economic threshold for sugarcane aphid in grain sorghum ranges from 35 to 135 aphids/leaf (See Figure 1 at grain price of $5 and control cost of $15 and $20).
- A more conservative approach is recommended until we learn more about this aphid: recommend insecticide treatment when levels reach 40 – 75 aphids per leaf - Mean ETs for $5 grain at $10 and $20 control costs are 38 and 76 aphids/leaf, respectively (See Table 1 and Figure 3).
- While there is considerable variation in yields across locations, yield loss per 100 aphids/leaf as a percentage of maximum yield is fairly consistent with an average of 10.3% (See Table 2).
- Some alternative methods to counting aphids look promising but need additional investigation beyond our analyses of data from two locations. While the % of plants with >10 aphids/leaf has a lower threshold than % of plants with >25 aphids/leaf, the % of plants with >25 aphids/leaf is likely more accurate due to a wider range of levels of infestation used in the regression (See Table 4).
- Scouting is still of utmost importance and aphid number estimation using the simple ranges on a leaf basis shown in Fig. 1 is recommended – checking all sides and at least 100' into the field is important to gauge whether or not entire field, edge, or no treatment is needed.

Next steps: We will be continuing this work with an evaluation of weather data and hybrid sensitivity to aphid feeding for a better understanding of the aphid—yield relationship so we may adjust economic thresholds based on weather (See Figure 4 for variation in yields) and the hybrid grown.

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additional information is available at http://ccag.tamu.edu/sorghum-insect-pests