



**MISSISSIPPI STATE**  
UNIVERSITY™

# Management of Bollworm in Cotton

WHITNEY D CROW

# Current Day

- Widespread Bt Adoption
  - Strong Selection Pressure
  - Corn and Cotton
    - VIP corn adoption
- Technology
  - BG4
  - Diamides

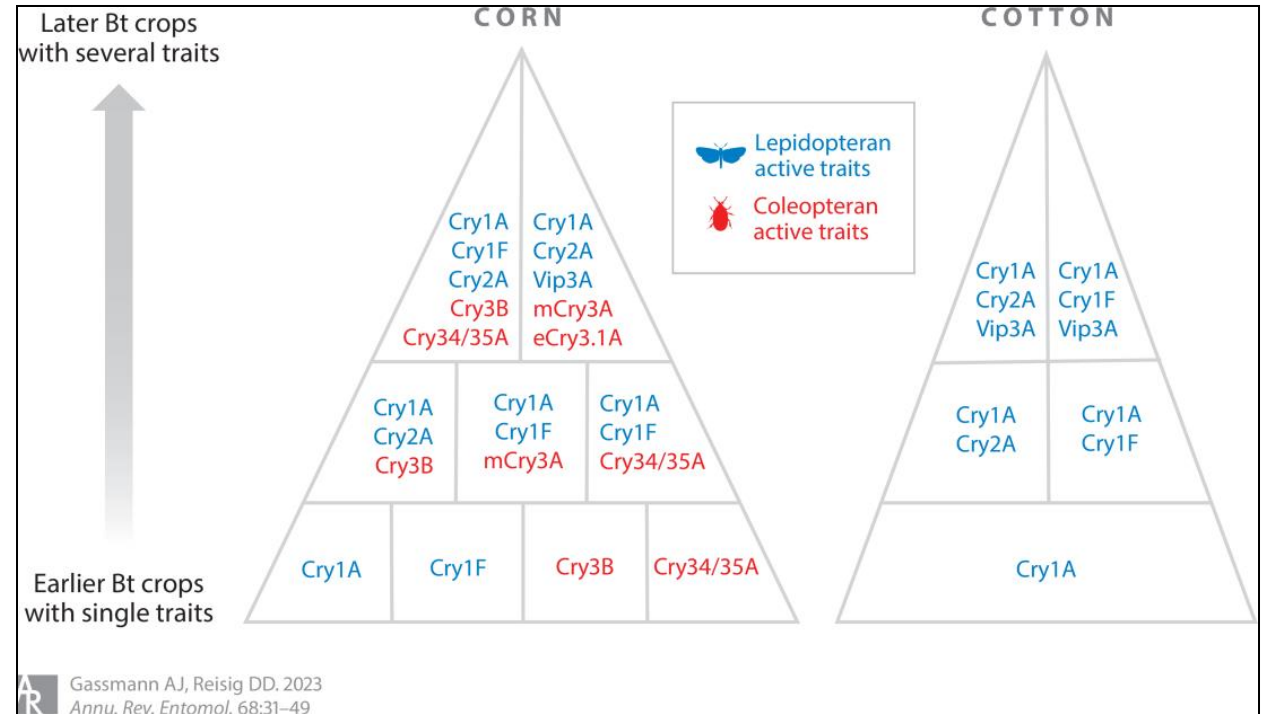


Table 1. LC<sub>50</sub> and 95% confidence limits (CL) based on larval mortality of *Helicoverpa zea* to **Cry1Ac** protein in Texas in 2023, n=22

Insect strain	N	LC <sub>50</sub> (95% CL) (µg/cm <sup>2</sup> )	Slope ± SE	X <sup>2</sup>	df	Resistance ratio
<b>CBW-BZ-SS</b>	<b>512</b>	<b>0.10 (0.08, 0.13)</b>	<b>1.24 ± 0.10</b>	<b>36.9</b>	<b>26</b>	<b>1.0</b>
CBW-Hutto TX-Intrasect	512	370.04 (143.48, 2570)	0.89 ± 0.17	24.5	26	3700.4
CBW-Hutto TX-NBT	512	304.20 (141.77, 1127)	0.87 ± 0.13	18.2	26	3042
CBW-Hutto TX-VT2P	512	268.14 (128.82, 921.05)	0.87 ± 0.13	24.9	26	2681.4
CBW-Malone TX-Intrasect	512	15.66 (8.93, 31.57)	1.14 ± 0.17	72.9	26	156.6
CBW-Malone TX-NBT	512	250.73 (119.01, 850.19)	0.80 ± 0.12	19.8	26	2507.3
CBW-Malone TX-VT2P	512	85.04 (63.86, 127.0)	1.84 ± 0.26	12.5	26	850.4
CBW-Snook TX Early-Intrasect	512	46.02 (30.44, 78.35)	0.96 ± 0.10	22.4	26	460.2
CBW-Snook TX Early-NBT	512	36.84 (24.96, 59.98)	0.98 ± 0.09	31.9	26	368.4
CBW-Snook TX Early-VT2P	512	41.32 (29.13, 63.83)	1.14 ± 0.12	11.2	26	413.2
CBW-Snook TX Late-Intrasect	512	594.24 (97.67, 126017)	0.50 ± 0.13	68.6	26	5942.4
CBW-Snook TX Late-NBT	512	1775121 (8990, 1.18E19)	0.27 ± 0.09	30.7	26	17751210
CBW-Snook TX Late-VT2P	512	6469 (642.06, 2416435)	0.35 ± 0.08	36.9	26	64690
CBW-Taylor TX-Intrasect	512	152.98 (83.95, 383.91)	0.90 ± 0.12	20.9	26	1529.8
CBW-Taylor TX-NBT	512	243.13 (67.76, 10598)	0.80 ± 0.22	57.4	26	2431.3
CBW-Taylor TX-VT2P	512	6265 (257.73, 7.35E10)	0.27 ± 0.09	52.9	26	62650
CBW-Thrall TX-Intrasect	512	189.69 (65.58, 1332)	0.56 ± 0.09	41.8	26	1896.9
CBW-Thrall TX-NBT	512	996.74 (236.19, 16677)	0.45 ± 0.08	35.8	26	9967.4
CBW-Thrall TX-VT2P	512	71.39 (43.06, 150.25)	1.10 ± 0.15	32.9	26	713.9
CBW-Comanche TX-NBT-F2	512	54.72 (32.04, 112.80)	0.74 ± 0.08	23.3	26	547.2
CBW-Comanche TX-Intrasect-F2	512	114.85 (61.00, 291.60)	0.74 ± 0.09	17	26	1148.5
CBW-Comanche TX-VT2P-F2	512	55.52 (36.53, 96.10)	0.98 ± 0.11	18.1	26	555.2
CBW-Wallis TX-WS3 Cotton	512	59.92 (38.69, 107.38)	0.96 ± 0.11	13.2	26	599.2

Resistance ratio = LC<sub>50</sub> of a field population / LC<sub>50</sub> of the susceptible strain.

≥ 10 = resistant; 22:22

Table 2. LC<sub>50</sub> and 95% confidence limits (CL) based on larval mortality of *Helicoverpa zea* to **Cry1Ac** protein outside of Texas in 2023, n=15

Insect strain	N	LC <sub>50</sub> (95% CL) (µg/cm <sup>2</sup> )	Slope ± SE	X <sup>2</sup>	df	Resistance ratio
<b>CBW-BZ-SS</b>	<b>512</b>	<b>0.10 (0.08, 0.13)</b>	<b>1.24 ± 0.10</b>	<b>36.9</b>	<b>26</b>	<b>1.0</b>
CBW-Epps LA-Clover	512	354.21(97.90, 29658)	0.91 ± 0.27	33.7	26	3542.1
CBW-Stoneville/Leland MS-Clover	512	396.93(164.68, 1849)	0.77 ± 0.12	22.5	26	3969.3
CBW-Winnsboro LA-NBT	512	129.62(73.15, 340.48)	1.16 ± 0.19	13	26	1296.2
CBW-Winnsboro LA-VT2P	512	179.76(81.33, 933.38)	1.06 ± 0.22	27.1	26	1797.6
CBW-Stoneville MS-NBT	512	38.57(21.30, 88.33)	0.79 ± 0.10	30.1	26	385.7
CBW-Keiser AR-NBT	512	7667(722.74, 3284833)	0.35 ± 0.08	20.9	26	76670
CBW-Keiser AR-VT2P	512	23486 (1004, 4.52E9)	0.40 ± 0.12	41.5	26	234860
CBW-Jonesboro AR-NBT	512	30.97 (21.36, 48.74)	0.99 ± 0.10	12.3	26	309.7
CBW-Jonesboro AR-VT2P	512	18.30 (12.41, 28.71)	1.18 ± 0.13	29.3	26	183
CBW-Stuttgart AR-NBT	512	61.65 (27.81, 232.82)	0.80 ± 0.14	58.6	26	616.5
CBW-Stuttgart AR-VT2P	512	59.23 (31.00, 158.87)	0.86 ± 0.13	38.3	26	592.3
CBW-Jackson TN-NBT	512	1438 (170.77, 1183524)	0.43 ± 0.12	58.2	26	14380
CBW-Jackson TN-VT2P	512	135.34 (63.32, 669.45)	1.14 ± 0.25	32.9	26	1353.4
CBW-Jay FL-Mixed	512	3.51 (1.90, 6.68)	0.61 ± 0.08	45.4	26	35.1
CBW-Starkville MS-TLP cotton	512	10298 (254.62, 1.87E18)	0.25 ± 0.10	52	26	102980

Resistance ratio = LC<sub>50</sub> of a field population / LC<sub>50</sub> of the susceptible strain.

≥ 10 = resistant; 15:15

Table 3. LC<sub>50</sub> and 95% confidence limits (CL) based on larval mortality of *Helicoverpa zea* to **Cry2Ab2** protein in Texas in 2023, n=22

Insect strain	N	LC <sub>50</sub> (95% CL) (µg/cm <sup>2</sup> )	Slope ± SE	X <sup>2</sup>	df	Resistance ratio
<b>CBW-BZ-SS</b>	<b>576</b>	<b>0.32 (0.24, 0.43)</b>	<b>1.10 ± 0.08</b>	<b>14.5</b>	<b>30</b>	<b>1.0</b>
CBW-Hutto TX-Intrasect	512	2.05 (0.95, 5.39)	0.80 ± 0.15	111.3	26	6.4
CBW-Hutto TX-NBT	512	31.73 (14.76, 132.25)	0.93 ± 0.17	21.9	26	99.2
CBW-Hutto TX-VT2P	512	7.07 (3.89, 16.25)	1.05 ± 0.17	69.6	26	22.1
CBW-Malone TX-Intrasect	512	7.72 (4.89, 13.87)	1.37 ± 0.21	40.2	26	24.1
CBW-Malone TX-NBT	512	20.14 (8.55, 116.67)	0.99 ± 0.22	69	26	62.9
CBW-Malone TX-VT2P	512	48.43 (23.15, 154.90)	0.71 ± 0.09	26.4	26	151.3
CBW-Snook TX Early-Intrasect	512	6.54 (3.42, 16.49)	1.00 ± 0.17	82.7	26	20.4
CBW-Snook TX Early-NBT	512	2.12 (1.13, 4.32)	1.05 ± 0.17	75.7	26	6.6
CBW-Snook TX Early-VT2P	512	18.83 (10.82, 43.40)	0.97 ± 0.13	28.7	26	58.8
CBW-Snook TX Late-Intrasect	512	25.00 (15.20, 51.97)	0.96 ± 0.12	29.5	26	78.1
CBW-Snook TX Late-NBT	512	4.52 (2.49, 9.47)	1.26 ± 0.22	55.1	26	14.1
CBW-Snook TX Late-VT2P	512	25.15 (14.97, 53.38)	0.91 ± 0.11	21.02	26	78.6
CBW-Taylor TX-Intrasect	512	8.51(5.01, 17.66)	1.00 ±0.14	41	26	26.6
CBW-Taylor TX-NBT	512	8.83 (5.46, 16.80)	0.97 ± 0.12	30.3	26	27.6
CBW-Taylor TX-VT2P	512	7.39 (4.14, 16.60)	1.02 ± 0.16	54.7	26	23.6
CBW-Thrall TX-Intrasect	512	326.56 (74.22, 6611)	0.48 ± 0.09	36.8	26	1020.5
CBW-Thrall TX-NBT	512	8.86 (5.12 , 19.32)	1.15 ± 0.19	55.6	26	27.7
CBW-Thrall TX-VT2P	512	133.32 (36.30, 6920)	0.85 ± 0.23	25.5	26	416.6
CBW-Comanche TX-NBT-F2	512	26.68 (14.03, 75.99)	0.92 ± 0.14	24.6	26	83.4
CBW-Comanche TX-Intrasect-F2	512	9.23 (6.62, 13.89)	1.46 ± 0.18	14.4	26	28.8
CBW-Comanche TX-VT2P-F2	512	34.70 (20.02, 81.42)	0.97 ± 0.13	12.7	26	108.4
CBW-Wallis TX-WS3 Cotton	512	19.35 (10.54, 49.64)	0.89 ± 0.13	21.2	26	60.8

Resistance ratio = LC<sub>50</sub> of a field population / LC<sub>50</sub> of the susceptible strain.

≥ 10 = resistant; 20:22

Table 4. LC<sub>50</sub> and 95% confidence limits (CL) based on larval mortality of *Helicoverpa zea* to **Cry2Ab2** protein outside of Texas in 2023, n=15

Insect strain	N	LC <sub>50</sub> (95% CL) (µg/cm <sup>2</sup> )	Slope ± SE	X <sup>2</sup>	df	Resistance ratio
<b>CBW-BZ-SS</b>	<b>576</b>	<b>0.32 (0.24, 0.43)</b>	<b>1.10 ± 0.08</b>	<b>14.5</b>	<b>30</b>	<b>1.0</b>
CBW-Epps LA-Clover	512	17.97 (8.38, 62.93)	0.66 ± 0.11	41.5	26	56.2
CBW-Stoneville/Leland MS-Clover	512	0.079 (0.023, 0.174)	0.60 ± 0.10	52.1	26	0.25
CBW-Winnsboro LA-NBT	512	17.89 (12.08, 30.79)	1.14 ± 0.14	10.5	26	55.9
CBW-Winnsboro LA-VT2P	512	26.93 (16.20, 57.26)	0.97 ± 0.13	12.5	26	84.2
CBW-Stoneville MS-NBT	512	264.07 (73.56, 3705)	0.64 ± 0.12	18.7	26	825.2
CBW-Keiser AR-NBT	512	6.31 (3.38, 15.03)	0.84 ± .013	49.6	26	19.7
CBW-Keiser AR-VT2P	512	4.06 (2.20, 8.85)	0.99 ± 0.16	63.2	26	12.7
CBW-Jonesboro AR-NBT	512	6.85 (5.32, 9.08)	1.50 ± 0.15	6.4	26	21.4
CBW-Jonesboro AR-VT2P	512	26.84 (10.74, 142.61)	0.62 ± 0.11	43.1	26	83.9
CBW-Stuttgart AR-NBT	512	9.78 (4.55, 36.19)	1.34 ± 0.34	44.8	26	30.6
CBW-Stuttgart AR-VT2P	512	136.45 (45.37, 1011)	0.58 ± 0.10	21.6	26	426.4
CBW-Jackson TN-NBT	512	34.92 (19.99, 83.33)	0.96 ± 0.13	9.3	26	109.1
CBW-Jackson TN-VT2P	512	75.99 (35.46, 303.30)	0.92 ± 0.15	19.1	26	237.5
CBW-Jay FL-Mixed	512	1.14 (0.70, 1.92)	0.88 ± 0.11	51.8	26	3.6
CBW-Starkville MS-TLP cotton	512	388.80 (66.78, 43754)	0.56 ± 0.13	32.1	26	1215

Resistance ratio = LC<sub>50</sub> of a field population / LC<sub>50</sub> of the susceptible strain.

≥ 10 = resistant; 13:15

Table 5. LC<sub>50</sub> and 95% confidence limits (CL) based on larval mortality of *Helicoverpa zea* to Vip3Aa39 protein in Texas in 2023, n=21

Insect strain	N	LC <sub>50</sub> (95% CL) (µg/cm <sup>2</sup> )	Slope ± SE	X <sup>2</sup>	df	Resistance ratio
<b>CBW-BZ-SS</b>	<b>512</b>	<b>0.30 (0.18, 0.51)</b>	<b>1.26 ± 0.17</b>	<b>61.8</b>	<b>26</b>	<b>1.0</b>
CBW-Hutto TX-Intrasect	448	0.050 (0.041, 0.059)	3.03 ± 0.41	6.1	22	0.17
CBW-Hutto TX-NBT	448	0.049 (0.042, 0.058)	3.78 ± 0.50	3.8	22	0.16
CBW-Hutto TX-VT2P	448	0.070 (0.057, 0.084)	2.62 ± 0.30	5.6	22	0.23
CBW-Malone TX-Intrasect	448	0.028 (0.019, 0.035)	2.80 ± 0.53	7	22	0.09
CBW-Malone TX-NBT	448	0.071 (0.059, 0.085)	3.02 ± 0.36	12.6	22	0.24
CBW-Malone TX-VT2P	448	0.047 (0.039, 0.056)	3.37 ± 0.46	5.6	22	0.16
CBW-Snook TX Early-Intrasect	448	0.099 (0.084, 0.118)	3.19 ± 0.35	16.4	22	0.33
CBW-Snook TX Early-NBT	448	0.031 (0.024, 0.036)	4.18 ± 0.84	25.9	22	0.10
CBW-Snook TX Early-VT2P	448	0.039 (0.034, 0.046)	4.61 ± 0.70	3.6	22	0.13
CBW-Snook TX Late-Intrasect	448	0.049 (0.038, 0.060)	2.44 ± 0.33	8.5	22	0.16
CBW-Snook TX Late-NBT	448	0.063 (0.051, 0.076)	2.66 ± 0.33	16.5	22	0.21
CBW-Taylor TX-Intrasect	448	0.099 (0.084, 0.118)	3.09 ± 0.34	11.1	22	0.33
CBW-Taylor TX-NBT	448	0.085 (0.069, 0.104)	2.49 ± 0.27	22.7	22	0.28
CBW-Taylor TX-VT2P	448	0.087 (0.073, 0.103)	3.14 ± 0.35	12.9	22	0.29
CBW-Thrall TX-Intrasect	448	0.030 (0.021, 0.038)	2.52 ± 0.44	3.8	22	0.10
CBW-Thrall TX-NBT	448	0.028 (0.020, 0.034)	3.37 ± 0.67	3.6	22	0.09
CBW-Thrall TX-VT2P	448	0.013 (0.002, 0.021)	2.12 ± 0.61	10.7	22	0.04
CBW-Comanche TX-NBT-F2	448	0.035 (0.029, 0.040)	4.65 ± 0.85	3.4	22	0.12
CBW-Comanche TX-Intrasect-F2	448	0.035 (0.030, 0.040)	4.70 ± 0.85	3	22	0.12
CBW-Comanche TX-VT2P-F2	448	0.036 (0.031, 0.042)	4.90 ± 0.85	3.1	22	0.12
CBW-Wallis TX-WS3 Cotton	448	0.11 (0.093, 0.139)	2.41 ± 0.25	10	22	0.37

Resistance ratio = LC<sub>50</sub> of a field population / LC<sub>50</sub> of the susceptible strain.

≥ 10 = resistant; 0:21

Table 6. LC<sub>50</sub> and 95% confidence limits (CL) based on larval mortality of *Helicoverpa zea* to Vip3Aa39 protein outside of Texas in 2023, n=15

Insect strain	N	LC <sub>50</sub> (95% CL) (µg/cm <sup>2</sup> )	Slope ± SE	χ <sup>2</sup>	df	Resistance ratio
<b>CBW-BZ-SS</b>	<b>512</b>	<b>0.30 (0.18, 0.51)</b>	<b>1.26 ± 0.17</b>	<b>61.8</b>	<b>26</b>	<b>1.0</b>
CBW-Epps LA-Clover	448	0.046 (0.033, 0.060)	1.83 ± 0.24	21.3	22	0.2
CBW-Stoneville/Leland MS-Clover	448	0.049 (0.035, 0.063)	1.91 ± 0.25	23.3	22	0.16
CBW-Winnsboro LA-NBT	448	0.036 (0.030, 0.043)	3.79 ± 0.61	3.1	22	0.12
CBW-Winnsboro LA-VT2P	448	0.040 (0.035, 0.046)	5.43 ± 0.85	3.1	22	0.13
CBW-Stoneville MS-NBT	448	0.068 (0.058, 0.080)	3.40 ± 0.41	7.6	22	0.23
CBW-Keiser AR-NBT	448	0.054 (0.042, 0.067)	2.28 ± 0.29	12.4	22	0.18
CBW-Keiser AR-VT2P	448	0.060 (0.048, 0.074)	2.37 ± 0.29	14.1	22	0.2
CBW-Jonesboro AR-NBT	448	0.037 (0.029, 0.045)	2.92 ± 0.46	11.4	22	0.12
CBW-Jonesboro AR-VT2P	448	0.017 (0.006, 0.025)	2.47 ± 0.64	6.5	22	0.06
CBW-Stuttgart AR-NBT	448	0.036 (0.027, 0.044)	2.71 ± 0.43	9.8	22	0.12
CBW-Stuttgart AR-VT2P	448	0.048 (0.040, 0.057)	3.67 ± 0.49	3	22	0.16
CBW-Jackson TN-NBT	448	0.046 (0.040, 0.053)	4.98 ± 0.64	3.8	22	0.15
CBW-Jackson TN-VT2P	448	0.032 (0.026, 0.038)	3.81 ± 0.68	4.1	22	0.11
CBW-Jay FL-Mixed	448	0.032 (0.024, 0.039)	3.12 ± 0.54	5.6	22	0.11
CBW-Starkville MS-TLP cotton	448	0.089 (0.074, 0.105)	3.11 ± 0.35	4.4	22	0.30

Resistance ratio = LC<sub>50</sub> of a field population / LC<sub>50</sub> of the susceptible strain.

≥ 10 = resistant; 0:21



Texas and Mid-South  
Percentage of populations with RR > 10X

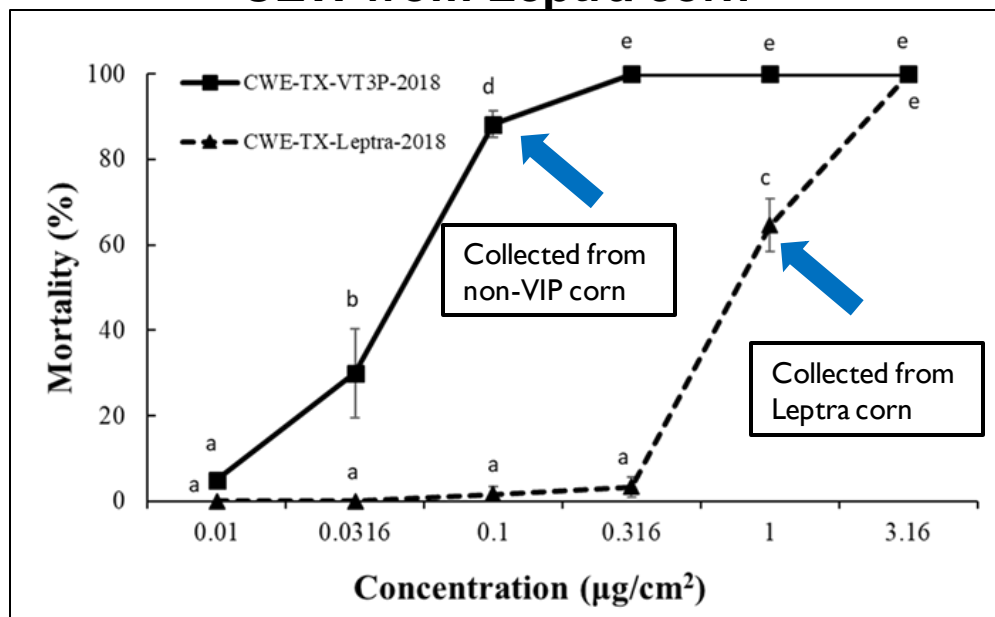
Bt protein	Texas and Mid-South Percentage of populations with RR > 10X							
	2016 n=5	2017 n=14	2018 n=13	2019 n=13	2020 n=5	2021 n=12	2022 n=37	2023 n=37
Cry1Ac	40%*	100%	94%	96%	100%	92%	100%	100%
Cry2Ab2	80%	77%	73%	73%	100%	92%	74%	97%
Cry1F	ND	100%	100%	100%	ND	ND	ND	ND
Vip3Aa	0%	0%	0%*	0%*	0%	0%	0%	0%

## Summary of Bt Resistance Surveys

# VIP3Aa COTTON UXI EVENTS

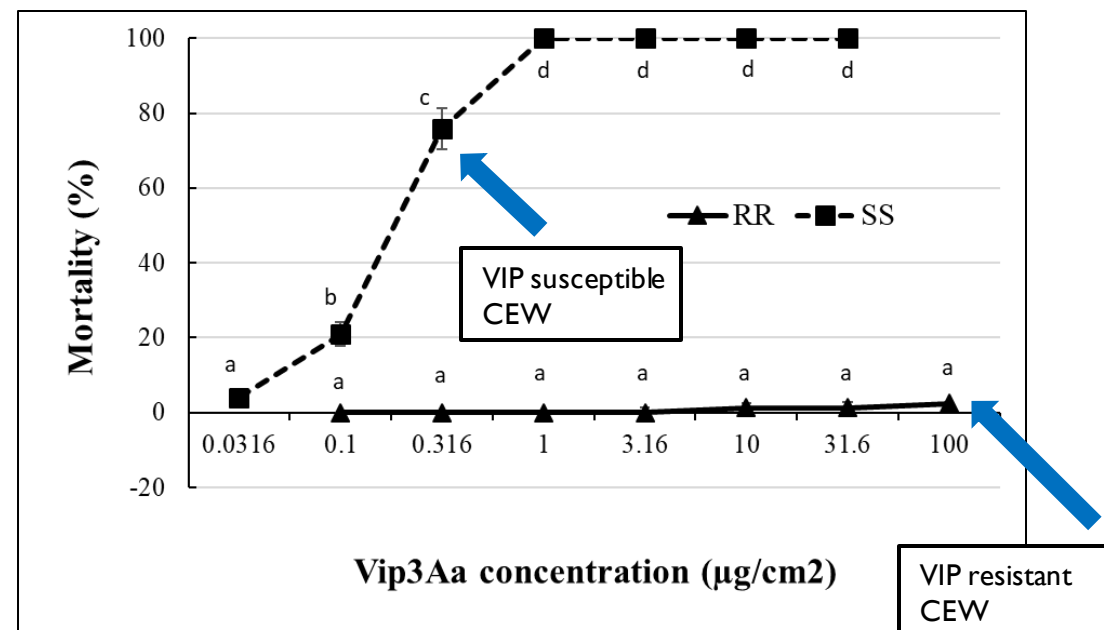
Location	Technology	% damaged fruit	Resistance Ratio		
			Cry1Ac	Cry2Ab2	Vip3Aa39
Starkville, MS	TwinLink Plus	17%		1215	0.30 (7.50)
Wallis, TX	WideStrike 3	6% (25%)	599.2	60.8	0.37 (9.25)

### CEW from Leptra corn



Low level of resistance  
(probably minor genes?)

### CEW from TX light trap



Complete resistance  
(major gene controlled)

# ***H. zea*-F<sub>2</sub> FAMILIES SURVIVING THE DIAGNOSTIC CONCENTRATION OF VIP3Aa39 (3μg/cm<sup>2</sup>)**

<b>Collection site</b>	<b>Year of collection</b>	<b>Method to establish the F<sub>2</sub> families</b>	<b>Number of F<sub>2</sub> families screened</b>	<b>Number of surviving F<sub>1,2</sub> families</b>	<b>Estimated number of resistance alleles<sup>3</sup></b>	<b>Estimated resistance allele frequency</b>	<b>Confidence Interval (95%)</b>
<b>Texas</b>	<b>2018-2019<sup>1</sup></b>	Cross with SS♂ Light trap	126	2 <b>(1.59%)</b>	2	0.0042	(0.0011 – 0.0151)
<b>Midsouth</b>	<b>2019-2020<sup>2</sup></b>	Cross with SS♀	192	5 <b>(2.60%)</b>	5	0.0130	(0.0056-0.0301)
<b>Overall</b>	<b>2018-2020</b>	Cross with SS♂ Light trap Cross with SS♀	318	7 <b>(2.20%)</b>	7	0.0081	(0.0039-0.0166)

1. Total insects assayed in 2018 and 2019 = 16,128 larvae
2. Total insects assayed 2019 and 2020 = 24,576 larvae
3. Based on 128 larvae per bioassay/F<sub>2</sub> family
4. 5 survivors ≥ 2nd instar with at least 1 larva ≥ 3rd instar
5. Number of resistant alleles based on results from simple monogenic inheritance models ( $\chi^2 < 3.841$  with 1 df,  $p > 0.05$ )

# VIP3Aa RESISTANT STRAINS IDENTIFIED

Insect Family	Origin	Host	N	No. survivors			
					2nd instar	3rd instar	4th instar
LA-M1	Alexandria, LA	BG2 Cotton	128	21	0	4	17
LA-AC4	Winnsboro, LA	VT2P Corn	128	20	0	6	14
MS-R2	Stoneville, MS	Cry1Ab Sweet corn	128	2	1	0	1
MS-R15	Stoneville, MS	Cry1Ab Sweet corn	128	22	3	19	0
MS-R21	Stoneville, MS	VT2P Corn	128	1	0	0	1

Survivorship when exposed to 3.0 ug/cm<sup>2</sup> Vip3Aa39 diet overlays

In 2019-2020 we identified 5 - F2 families carrying Vip3Aa resistant alleles

## VIP3Aa RESISTANT ALLELES

Insect Family	Origin	Host	N	Observed survivors	Expected survivors for 2 alleles	$\chi^2$	P-value
LA-M1	Alexandria, LA	BG2 Cotton	128	22.9	32	3.441	0.064
LA-AC4	Winnsboro, LA	VT2P Corn	128	22.5	32	3.738	0.054
MS-R15	Stoneville, MS	Cry1Ab Sweet corn	128	24.8	32	2.141	0.143

*Survivorship when exposed to 3.0 ug/cm<sup>2</sup> Vip3Aa39 diet overlays*

P-values > 0.05; indicated that these families were carrying 2 resistant alleles and were homozygous resistant for Vip3Aa

The collection from the Cry1Ab sweet corn in Stoneville, MS yielded - 3 Vip3Aa resistant alleles (RR, RS)

# COMPARISON OF THE GENETIC BASIS OF VIP3A RESISTANCE IN DIFFERENT HOMOZYGOUS RESISTANT STRAINS OF *H. zea*

Insect strain	No. tested	Survival at Vip3Aa 10.0 ug/cm <sup>2</sup>	Genetic Basis
F1: CBW-MS-R2-RR X CBW-TX-LT#70-RR	256	0	Different
F1: CBW-MS-R15-RR X CBW-TX-LT#70-RR	256	0	Different
F1: CBW-LA-AC4-RR X CBW-TX-LT#70-RR	256	0	Different
F1: CBW-LA-AC4-RR X CBW-MS-R15-RR	256	0	Different
F1: CBW-MS-R2-RR X CBW-MS-R15-RR	256	255	Similar
F1: CBW-LA-M1-RR X CBW-TX-LT#70-RR	256	256	Similar

*Among these 5 strains there appears to be 3 different major gene loci conveying resistance*

*The MS strains are similar to each other* CBW-MS-R2-RR CBW-MS-R15-RR

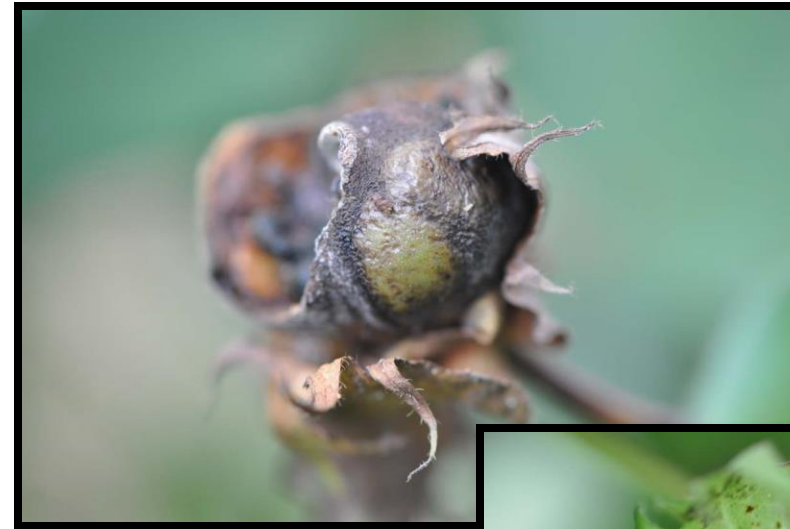
*The TX strain is similar to one of the LA strains* CBW-TX-LT#70-RR CBW-LA-M1-RR

*One LA strain is unique* CBW-LA-AC4-RR

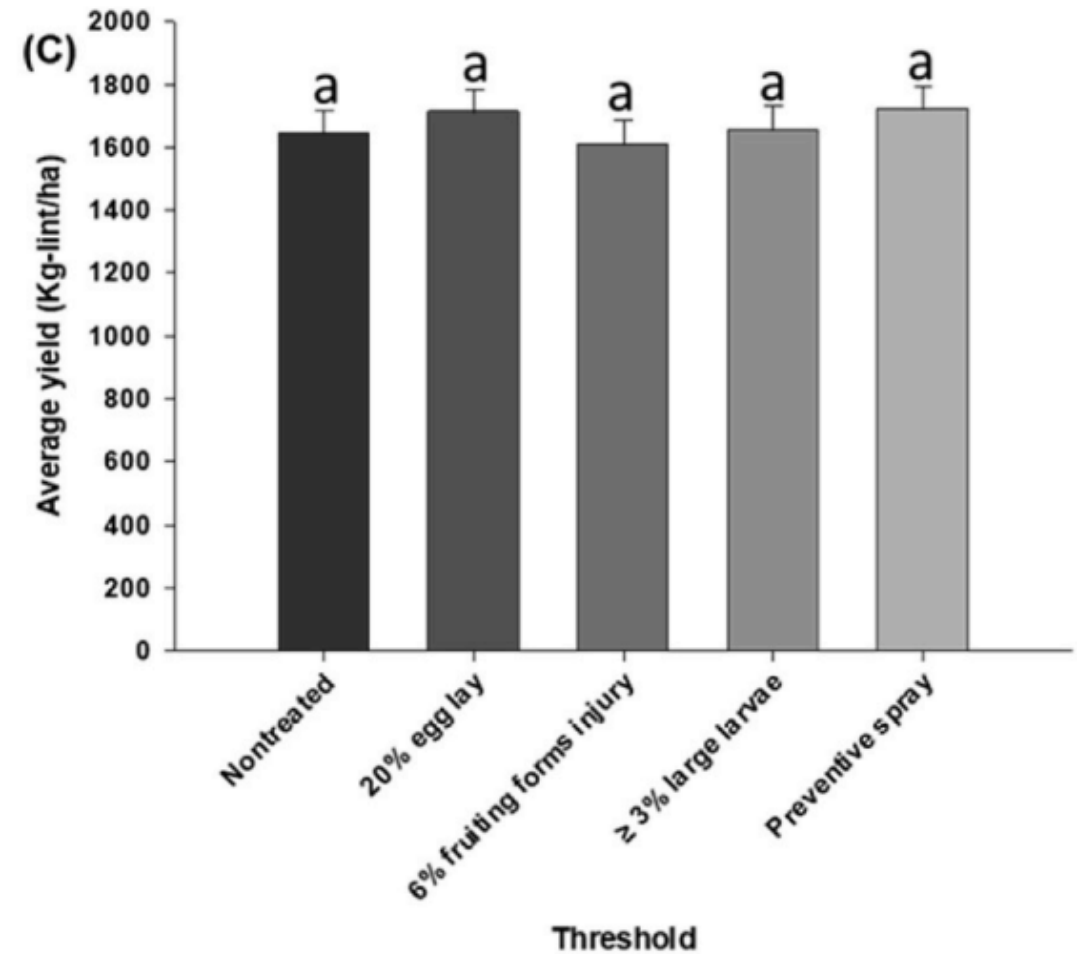
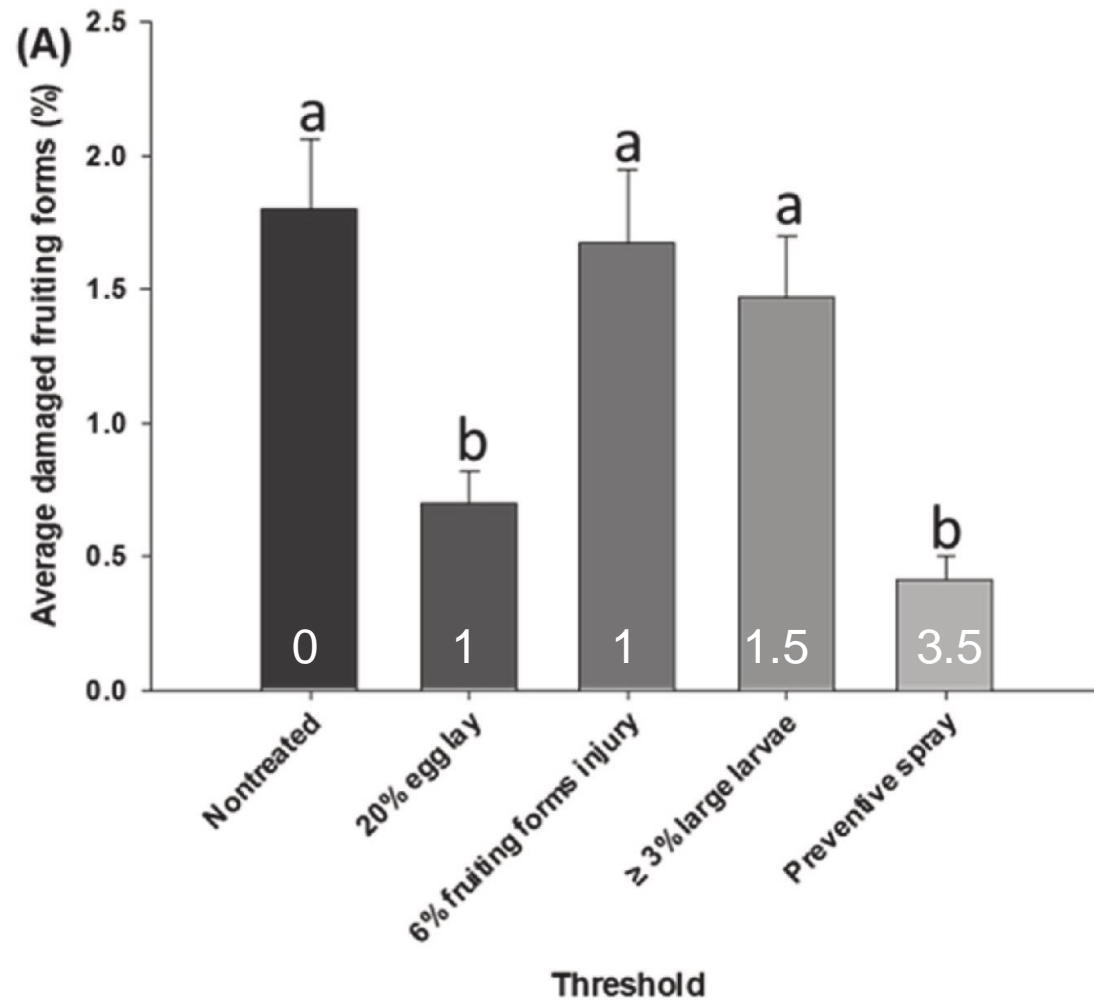
# Resistance Monitoring Summary

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- Frequency of resistance is gradually increasing
- Future field control
  - Corn sentinel plot monitoring
  - Cotton sentinel plot monitoring
  - Field calls



# Two-Gene System

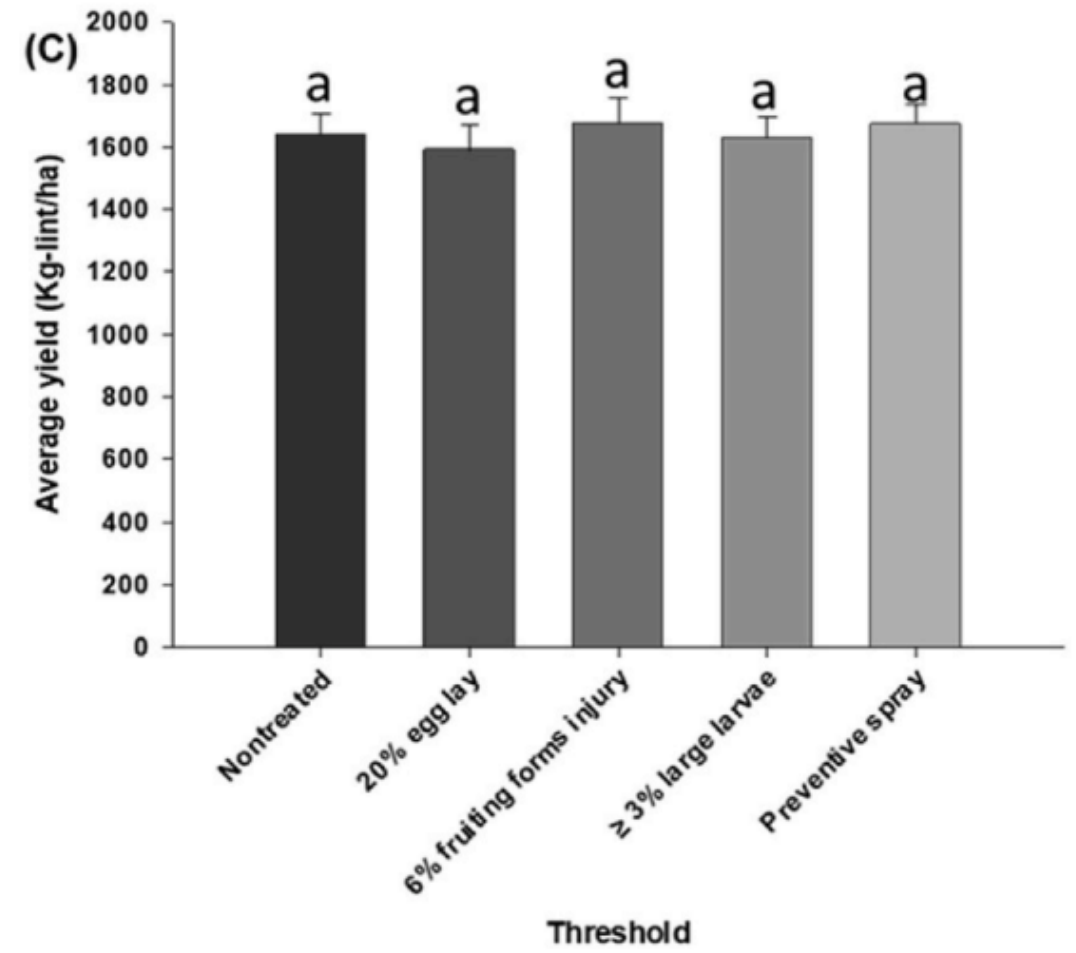
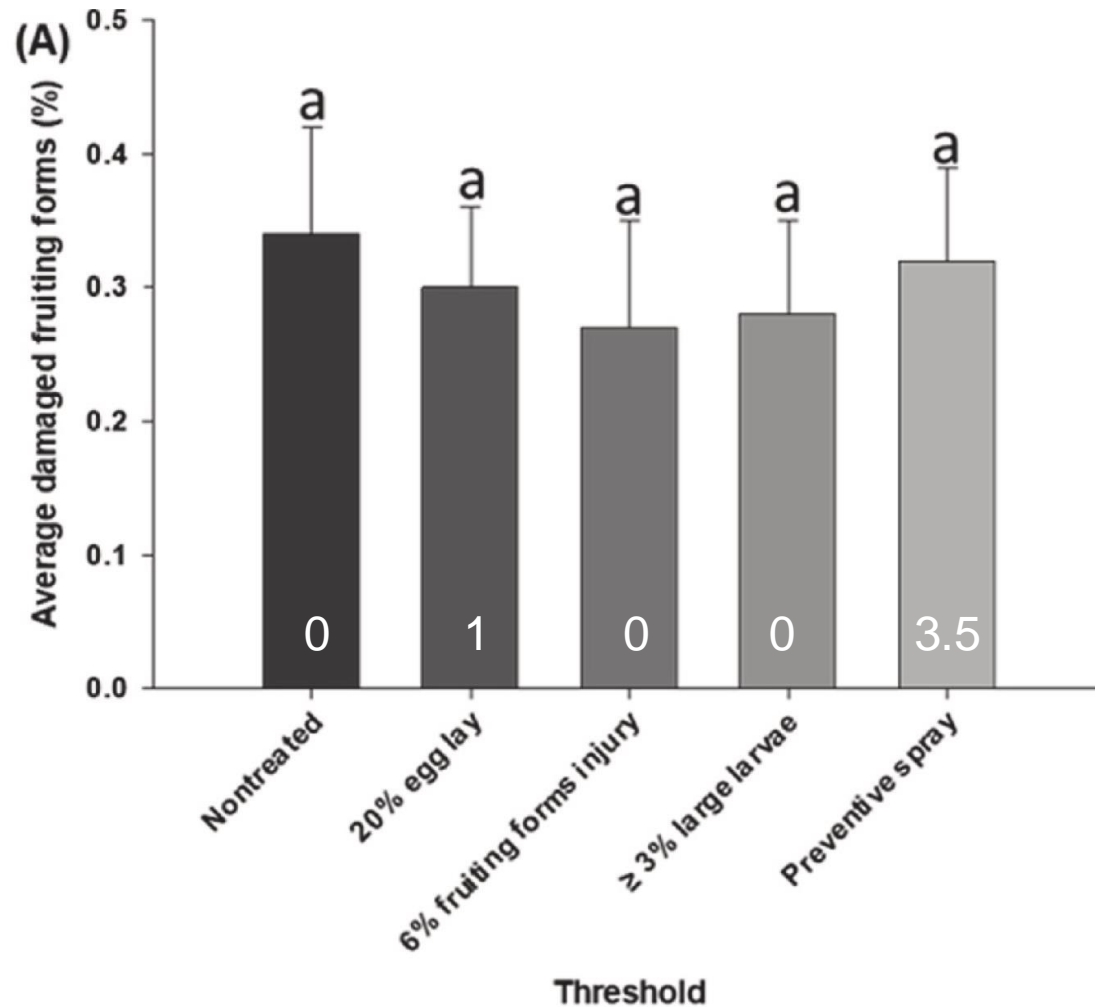


Calvin et al. 2023





# Three-Gene System

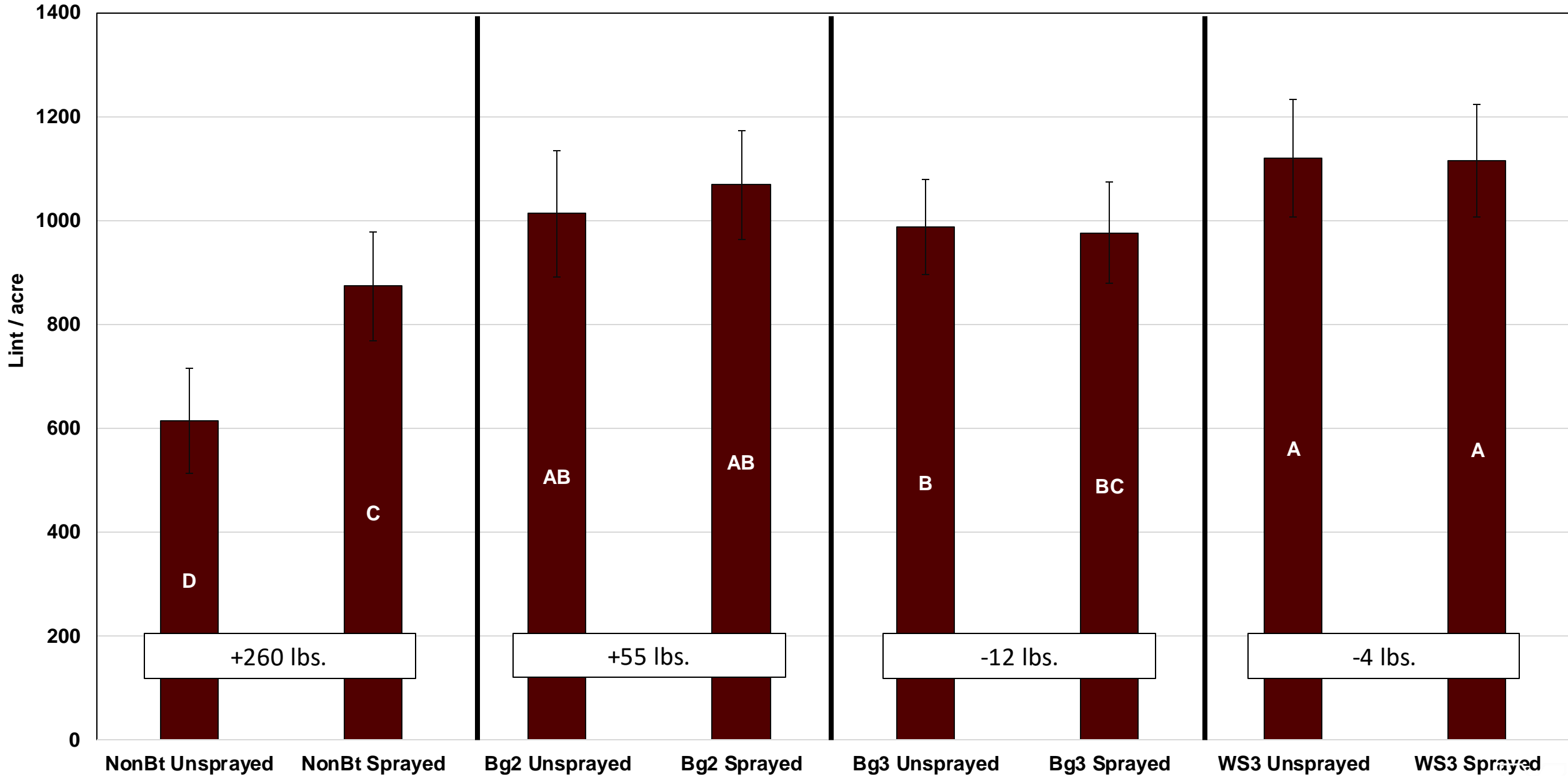


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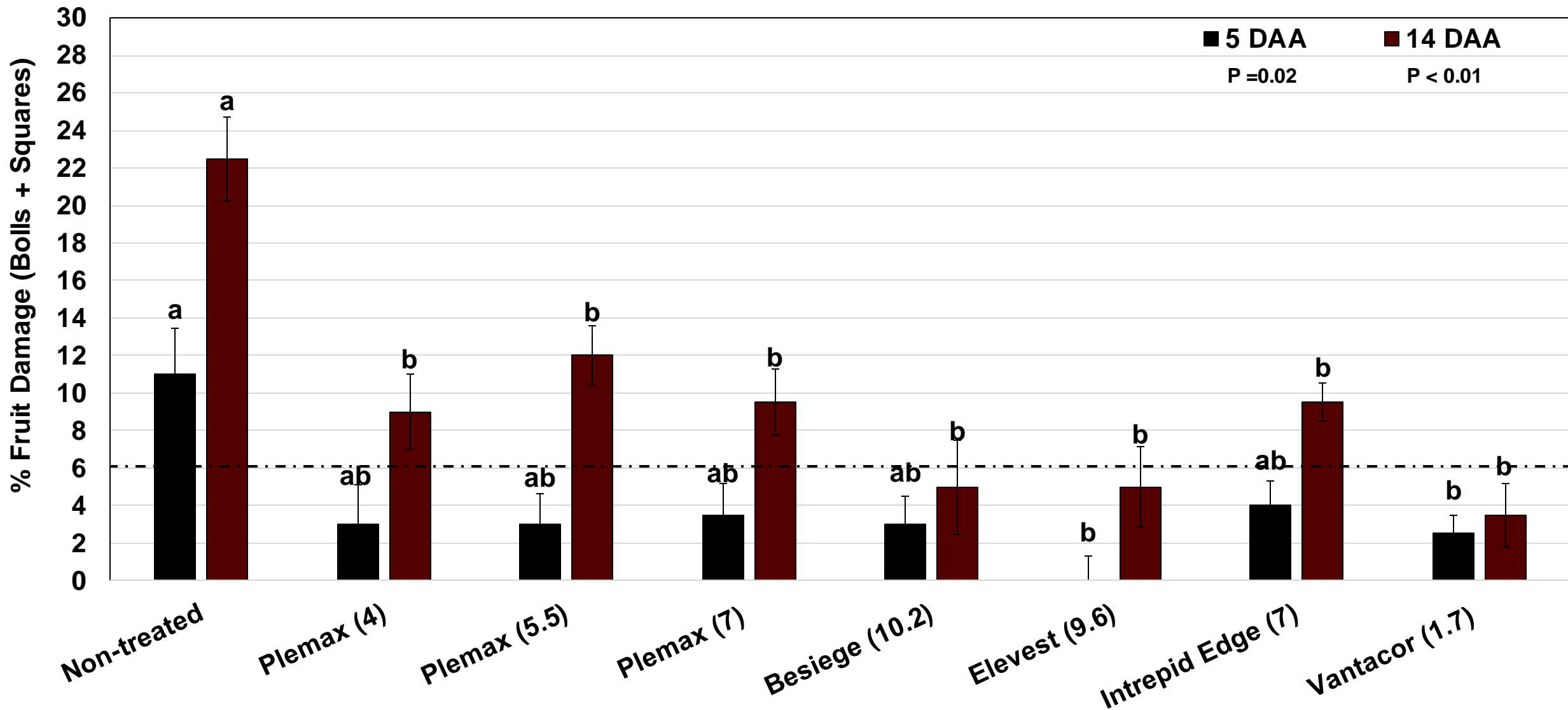


# Diamide Applications and Cotton Technology – Effects on Yield

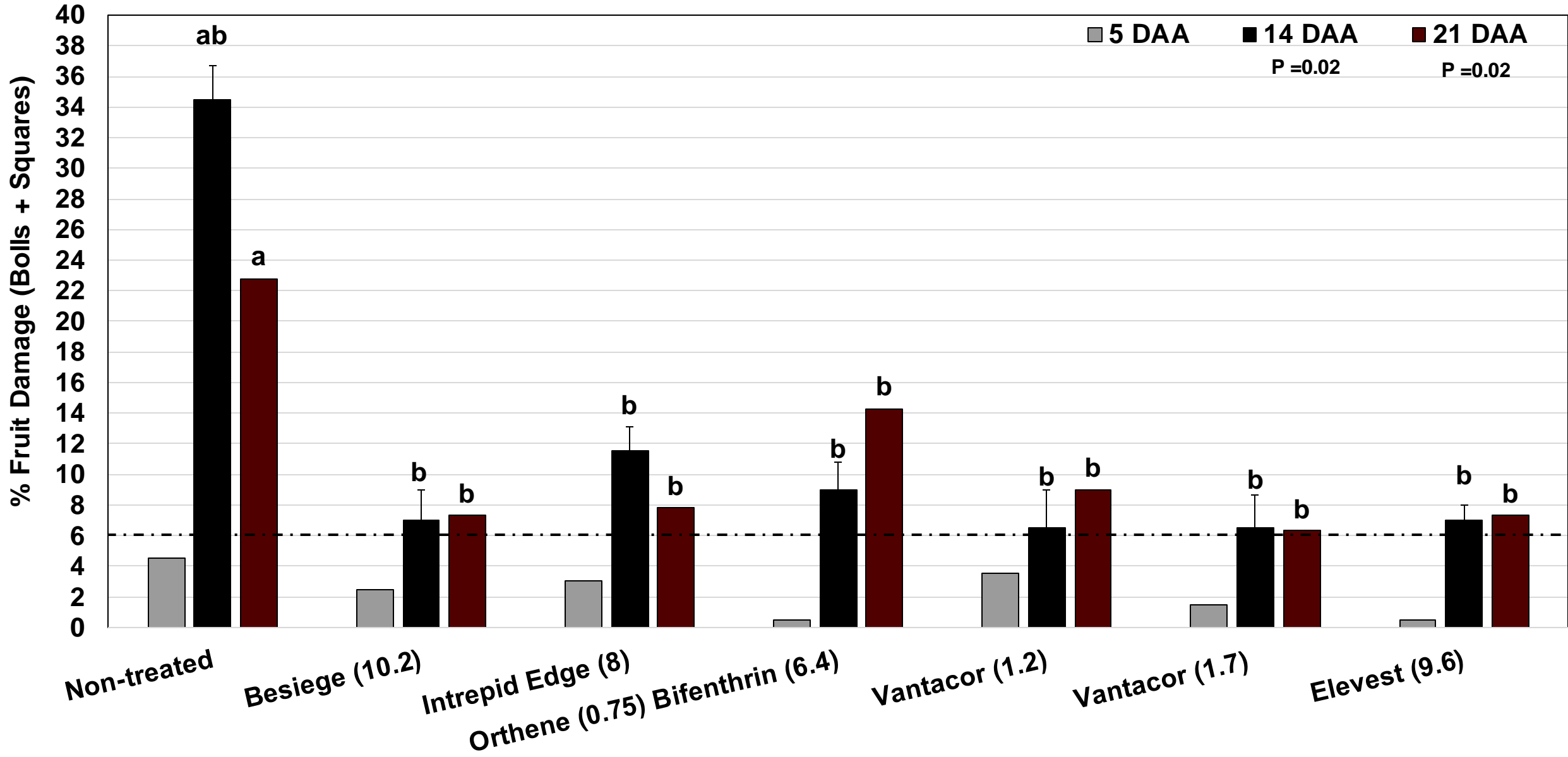
## 5 locations – LA, MS, AR, TN



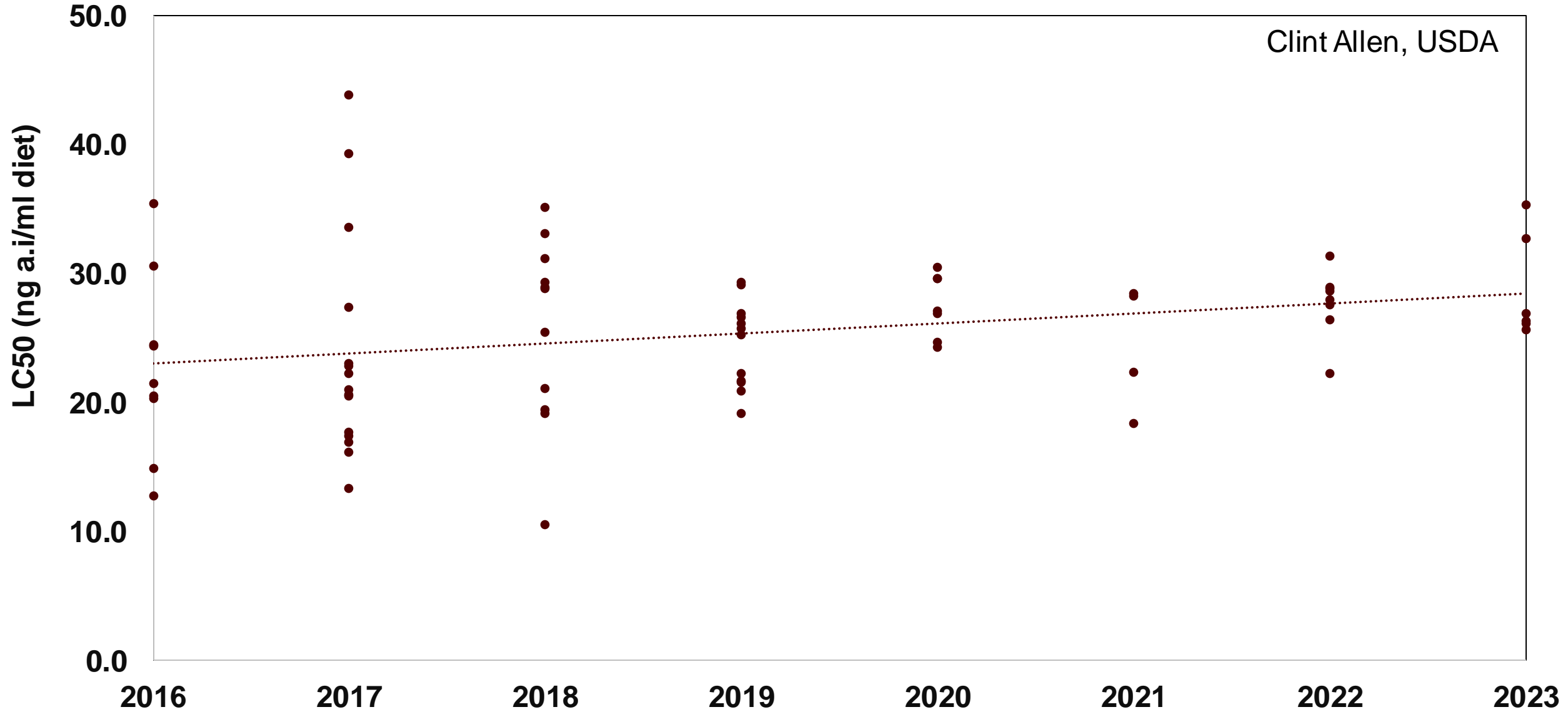
# Foliar Insecticide Performance – Stoneville, MS 2023



# Foliar Insecticide Performance – Bollworms in Cotton 2023 Stoneville, MS



Estimated LC50 values of neonate bollworms exposed to chlorantraniliprole in diet incorporated bioassays after seven days. Survival based on larvae moving and having molted at least one time.



# Conclusions



Avoid 3-gene corn and remember your refuge



Gradual increases in resistance



Not economical to spray on eggs



Remember feeding must occur for Bt ingestion



Call us with unexpected injury

QUESTIONS?

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