Sugarcane Stem Borer Varietal Resistance

Blake Wilson

LATMC Sugarcane Breakout

Marksville, LA

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Stem Borers Attacking Sugarcane

Mexican Rice Borer (MRB)
Eoreuma loftini

Sugarcane Borer (SCB)
Diatraea saccharalis

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Sugarcane Borer IPM

- 1920s-1940s – cultural controls
  - 15-20% crop loss annually
- 1950-60s – 12 insecticide applications
  - Inorganic materials, organochlorines
  - 10% crop loss, not counting input costs
- 1970s-1980s – 3 applications/year[1]
  - Economic thresholds
  - Organophosphates
- 1990s-2000s – 1.5 insecticide applications/year[2]
  - Widespread scouting
  - Selective chemistries (Confirm, tebufenozide)
  - Conservation biological control (Fire ants, parasitoids, etc)
- 2000s-Present – 0.6 insecticide applications/year[3]
  - Diamides (Prevathon, chlorantraniliprole)
  - Resistant cultivar, L 01-299, >60% of acreage

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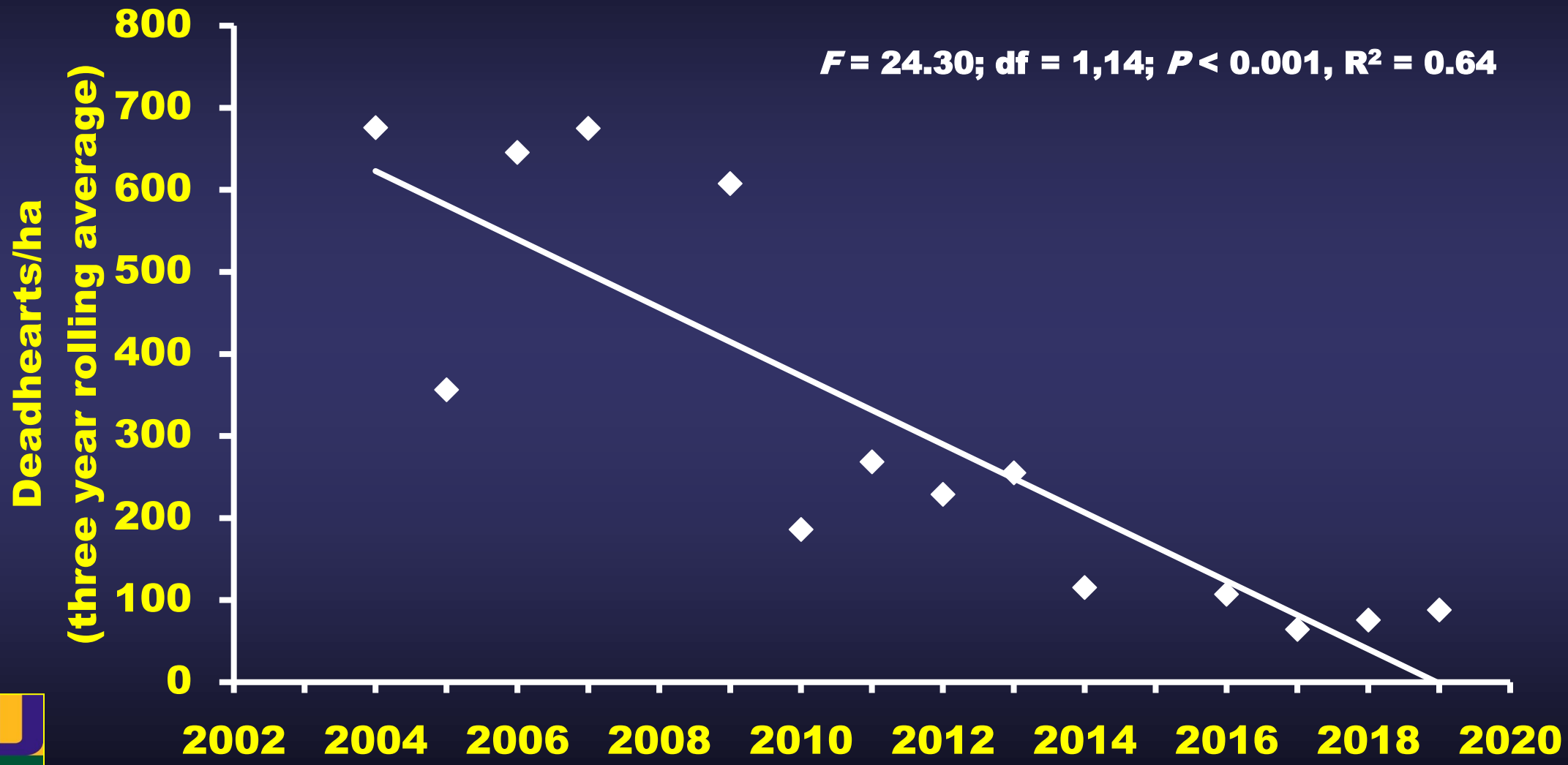
[1]Hensley 1971 – Entomophaga
[2]Reagan 2001 – Louisiana Agriculture
[3]Wilson 2018 – Sugar Bulletin

Declining SCB populations



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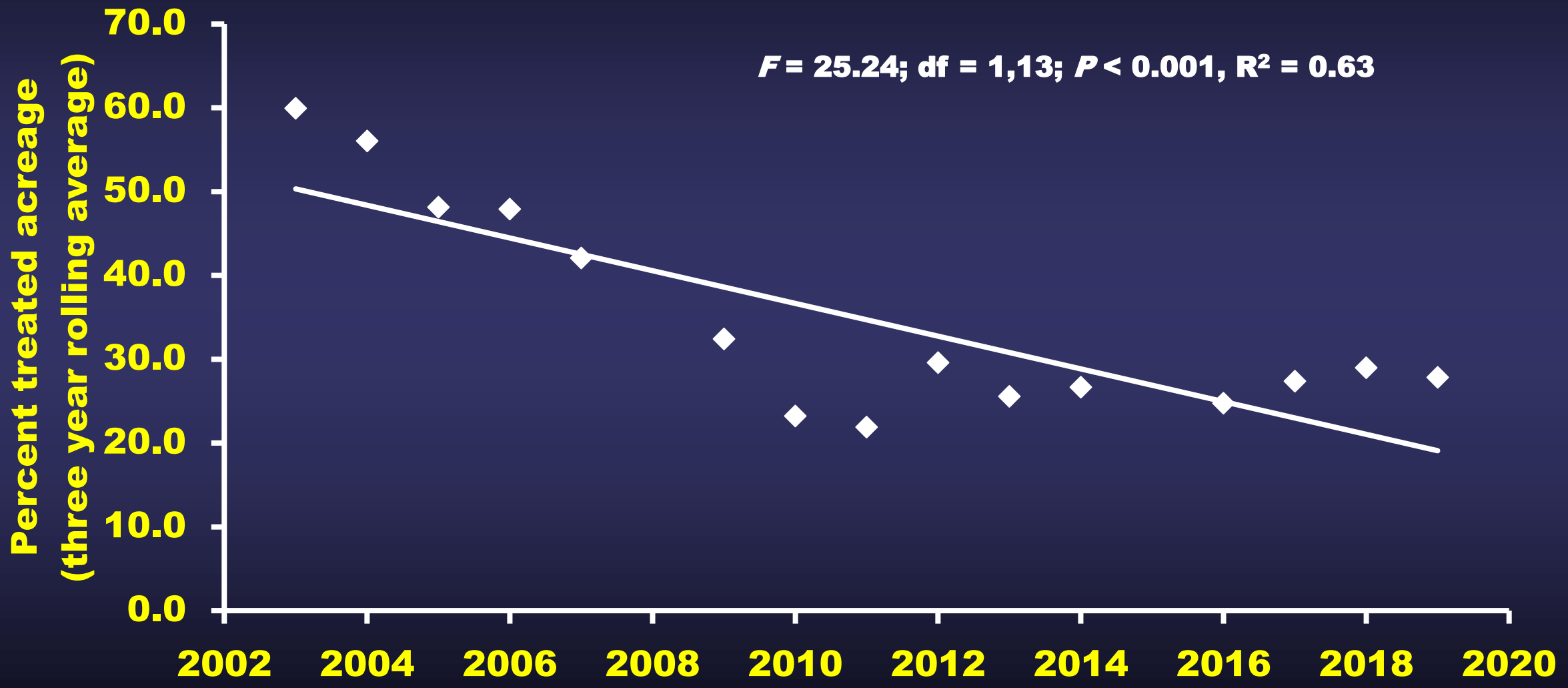
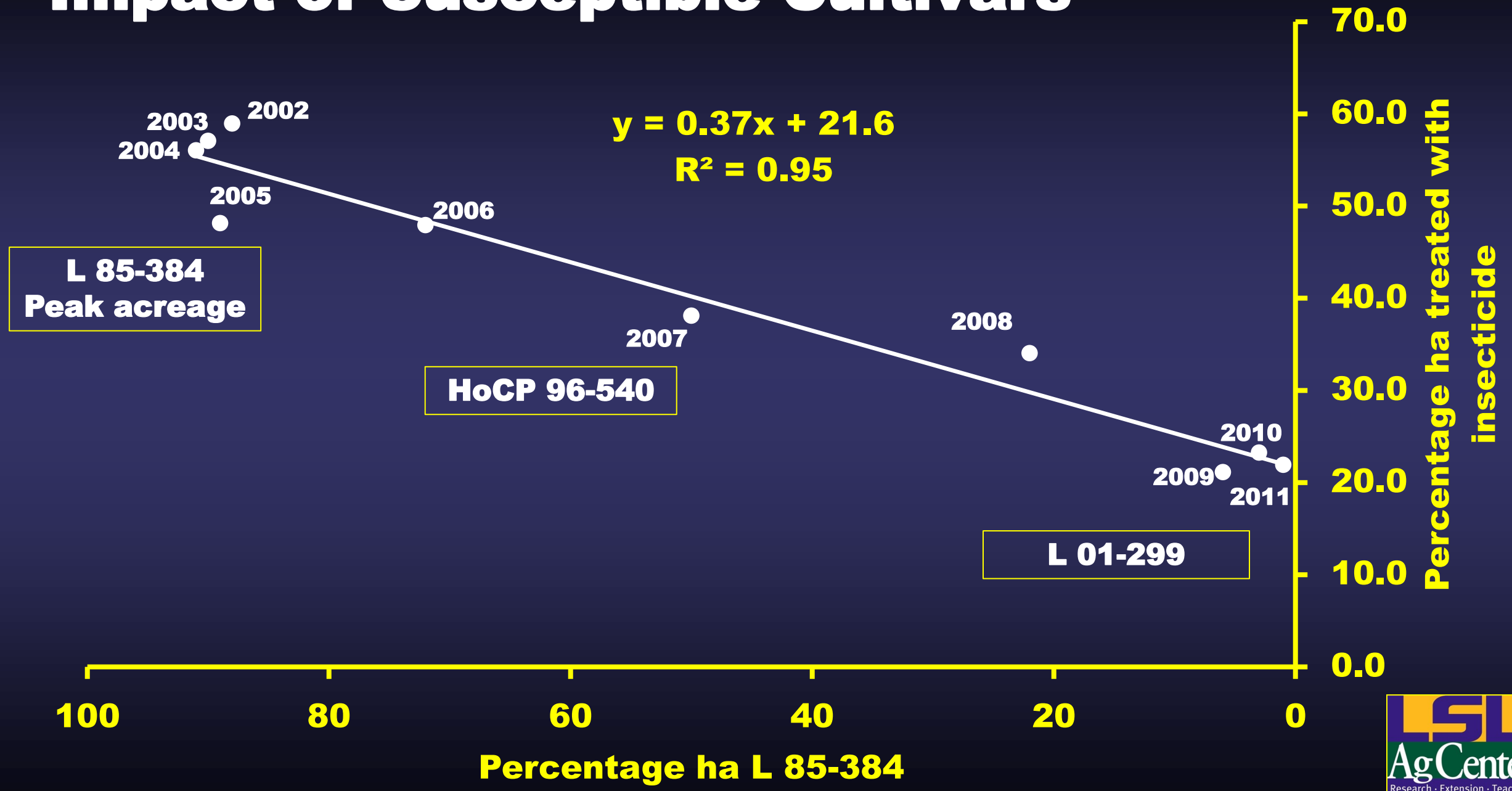
Wilson, B.E., W.H. White, R.T. Richard, and R.M. Johnson. 2020. Environ. Entomol. 49: 1455–1461.

Declining insecticide use



Wilson, B.E., W.H. White, R.T. Richard, and R.M. Johnson. 2020. Environ. Entomol. 49: 1455–1461.

Impact of Susceptible Cultivars



Varietal Resistance to Stem Borers

- Compatible with chemical and biological controls
- Reduces area-wide borer populations
- Reduces reliance on insecticides
  - Economic savings of nearly $4 million/year
  - Mitigation insecticide resistance
- Reduces scouting effort?
  - Improved efficiency

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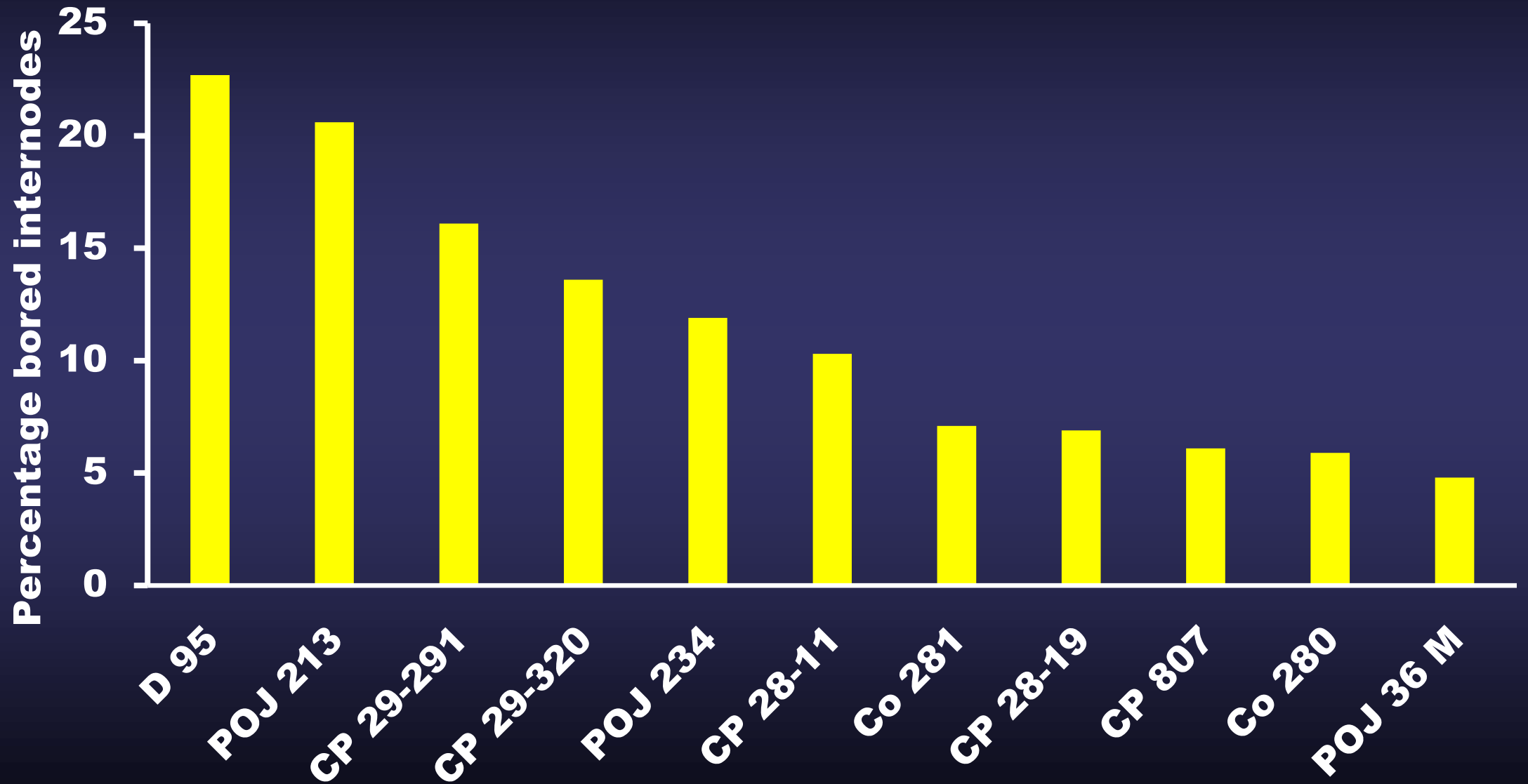
T.E. Holloway SCB Resistance Trials 1930s



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T.E. Holloway SCB Resistance Trials - Conclusions

- **Saw potential impact to pest management**
  - Warns against commercial release of susceptible varieties
- **Multiple mechanisms of resistance**
  - Larval vs moth resistance
- **Inconsistent heritability**
  - Difficulty in breeding for resistance
- **Consistent resistance expression**

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Varietal Resistance to Stem Borers

- **Multiple mechanisms of resistance**
  - **Rind harness** (Holloway 1935, Salgado 2022)
  - **Leaf sheath tightness** (Coburn and Hensley 1972)
  - **Antibiosis, defensive compounds** (Meagher et al. 1996)
  - **Leaf pubescence** (Sosa 1988)
  - **Fiber and pith** (White et al. 1999)
- **One or more contribute to resistance**

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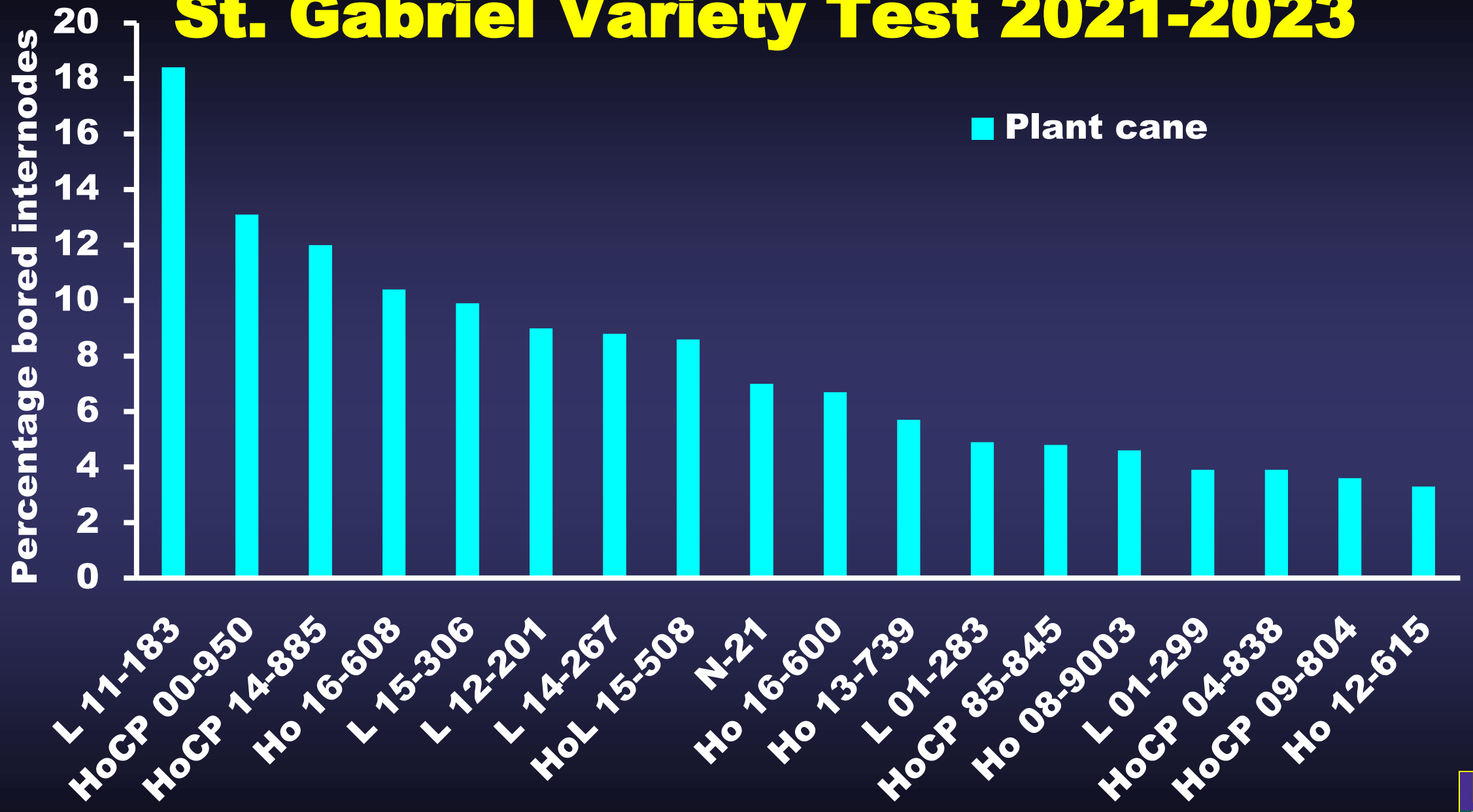
St. Gabriel Variety Test 2021-2023



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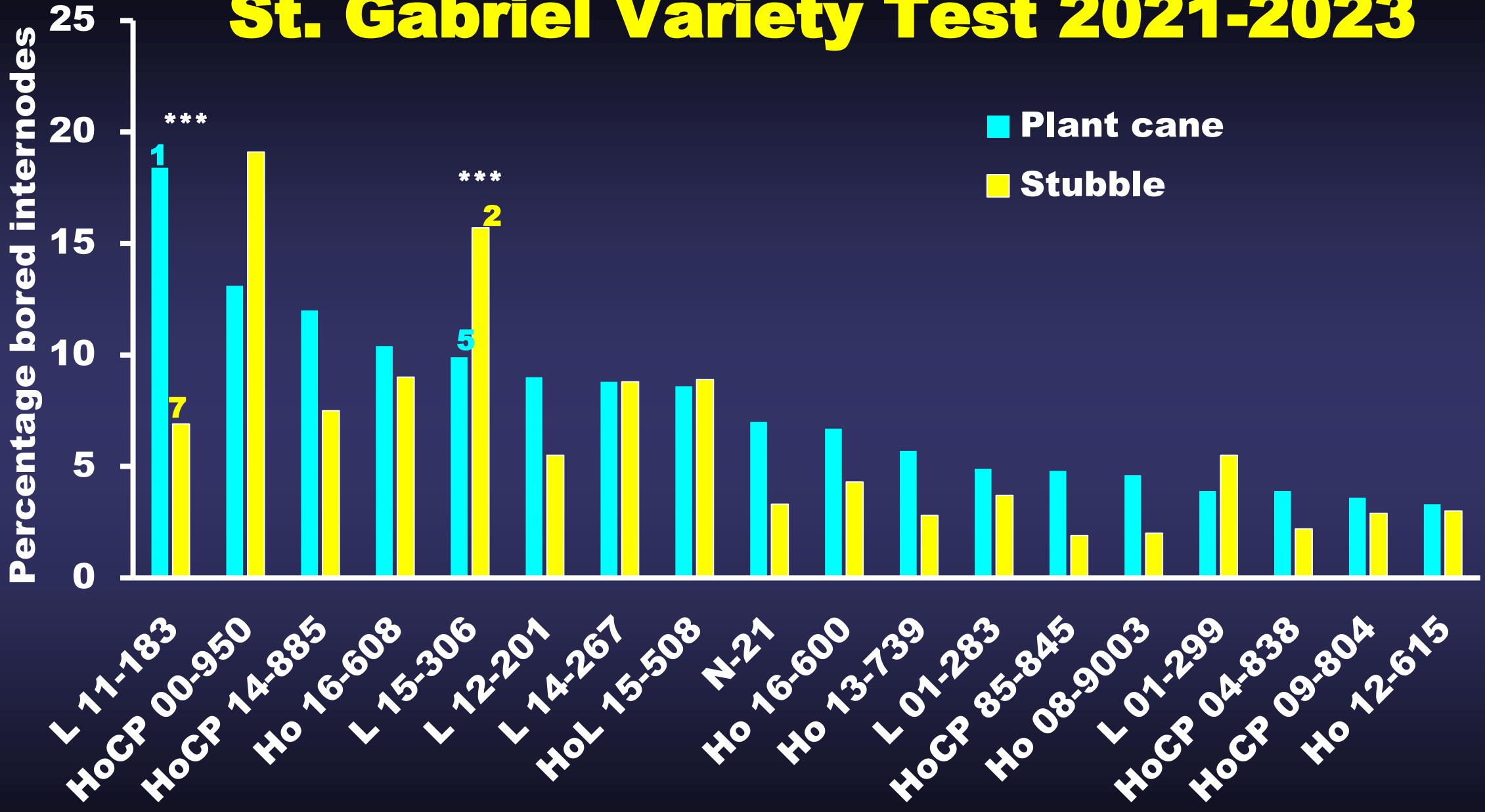
St. Gabriel Variety Test 2021-2023



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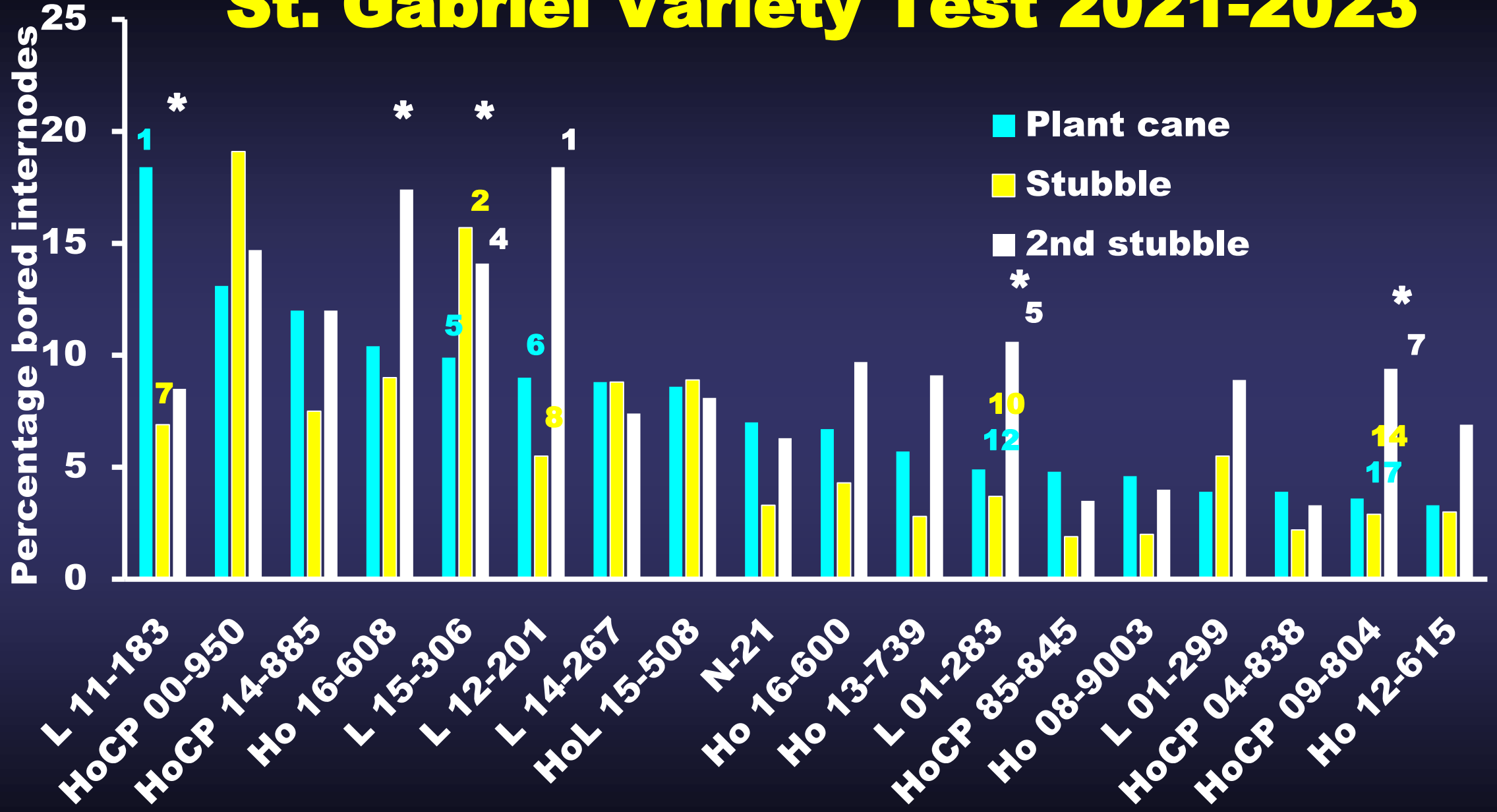
St. Gabriel Variety Test 2021-2023



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MRB resistance in HoCP 04-838 - 2010

Table 3. Screening for cultivar resistance to *E. loftini*, Jefferson Co., TX, 2010

Cultivar	Description[a]	Percentage of bored internodes (LS means ± SE)[b,*]	No. emergence holes/stalk (LS means ± 0.09 [SE])	Relative survival (LS means ± 0.075 [SE])	Relative resistance ratio (LS means ± 0.066 [SE])*	Resistance category[c]
Ho 06-563	ES	20.3 ± 4.7a	0.38	0.148	0.724abc	Susceptible
HoCP 05-902	CS	14.4 ± 3.7ab	0.22	0.150	0.756ab	Susceptible
HoCP 04-838	CS	10.9 ± 2.9bc	0.20	0.134	0.712abc	Susceptible
Ho 07-612	ES	10.0 ± 2.7bcd	0.18	0.130	0.700abc	Susceptible
L 03-371	CS	9.5 ± 2.7bcd	0.14	0.174	0.764ab	Susceptible
HoCP 96-540	CS	7.8 ± 2.2b–e	0.08	0.060	0.516a–f	Intermediate
L 07-57	ES	7.1 ± 2.1c–f	0.31	0.206	0.785ab	Susceptible
Ho 07-604	ES	6.3 ± 1.9c–f	0.04	0.026	0.440c–h	Intermediate
US 01-40	SCB-R	5.8 ± 1.8c–g	0.06	0.052	0.460b–h	Intermediate
N-27	SAS	5.7 ± 1.7c–g	0.12	0.226	0.796a	Susceptible
Ho 06-537	ES	5.7 ± 1.7c–g	0.18	0.194	0.716abc	Susceptible
Ho 07-613	CS	5.4 ± 1.6c–g	0.02	0.008	0.288e–i	Resistant
N-17	SAS	5.4 ± 1.6d–g	0.08	0.050	0.428c–h	Intermediate
HoCP 05-961	CS	5.2 ± 1.6d–g	0.12	0.196	0.724abc	Susceptible
US 08-9001	SCB-R	5.2 ± 1.6d–g	0.04	0.024	0.312e–i	Resistant
Ho 06-9610	SCB-R	4.9 ± 1.5d–g	0.04	0.110	0.472b–g	Intermediate
HoCP 00-950	CS	4.5 ± 1.3d–h	0.04	0.200	0.664a–d	Susceptible
L 07-68	ES	4.0 ± 1.3e–h	0.12	0.162	0.560a–e	Intermediate
Ho 07-617	ES	3.9 ± 0.9e–h	0.06	0.082	0.420c–i	Intermediate
US 08-9003	SCB-R	2.6 ± 0.9fgh	0.06	0.098	0.412c–i	Intermediate
N-24	SAS	2.4 ± 0.9fgh	0.00	0.000	0.148hi	Highly resistant
L 01-299	CS	2.2 ± 0.6fgh	0.04	0.080	0.352d–i	Resistant
US 93-15	SCB-R	1.2 ± 0.4gh	0.00	0.005	0.225f–i	Resistant
HoCP 85-845	CS	1.0 ± 0.4h	0.00	0.000	0.164ghi	Highly resistant
N-21	SAS	1.0 ± 0.4h	0.00	0.000	0.112i	Highly resistant
F		17.7	1.6	1.0	13.4	
df		24, 98.0	24, 94.0	24, 94.1	24, 98.0	
P		<0.001	0.067	0.457	<0.001	

[a] CS, commercial sugarcane; ES, experimental sugarcane; SAS, South African sugarcane; SCB-R, *D. saccharalis* resistant.

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Wilson et al. 2015

MRB resistance in HoCP 04-838 - 2011

Table 4. Screening for cultivar resistance to *E. loftini*, Jefferson Co., TX, 2011

Cultivar	Description[a]	Percentage of bored internodes (LS means ± SE)[b,]*	No. emergence holes/stalk (LS means ± 0.09 [SE])	Relative survival (LS means ± 0.072 [SE])	Relative resistance ratio (LS means ± 0.095 [SE])*	Resistance category[c]
HoCP 08-726	ES	18.6 ± 2.4a	0.48	0.214	0.705a	Susceptible
HoCP 04-838	CS	15.3 ± 2.3ab	0.35	0.164	0.600ab	Susceptible
Ho 08-711	ES	14.5 ± 2.1ab	0.46	0.322	0.705a	Susceptible
L 08-090	ES	13.9 ± 2.1ab	0.36	0.259	0.711a	Susceptible
HoL 08-723	ES	13.6 ± 2.0ab	0.10	0.086	0.526ab	Intermediate
Ho 08-717	ES	12.3 ± 1.9ab	0.21	0.165	0.563ab	Intermediate
Ho 07-613	CS	9.7 ± 1.7b	0.28	0.210	0.568ab	Intermediate
Ho 08-706	ES	9.5 ± 1.7bc	0.18	0.211	0.521ab	Intermediate
L 07-57	ES	9.0 ± 1.5bc	0.22	0.168	0.500ab	Intermediate
HoCP 00-950	CS	8.9 ± 1.7bc	0.08	0.118	0.426ab	Intermediate
L 79-1002	EC	8.8 ± 1.6bc	0.18	0.234	0.490ab	Intermediate
Ho 08-709	ES	8.6 ± 1.6bc	0.08	0.044	0.279ab	Resistant
HoCP 91-552	CS	8.2 ± 1.6bc	0.22	0.299	0.558ab	Intermediate
HoCP 05-961	CS	8.1 ± 1.6bc	0.26	0.368	0.563ab	Intermediate
L 08-088	ES	8.0 ± 1.4bc	0.24	0.275	0.532ab	Intermediate
L 08-092	ES	7.8 ± 1.5bcd	0.12	0.140	0.400ab	Intermediate
Ho 02-113	EC	7.7 ± 1.5bcd	0.08	0.127	0.410ab	Intermediate
HoCP 85-845	CS	3.7 ± 0.1cd	0.10	0.213	0.305ab	Resistant
L 08-075	ES	2.8 ± 0.1d	0.02	0.100	0.200b	Resistant
F		8.6	1.9	1.4	2.2	
df		18,76.0	18,76.0	18,76.0	18,76.0	
P		<0.001	0.025	0.162	0.009	

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Wilson et al. 2015

MRB resistance in HoCP 04-838 -2012

Cultivar	Description[a]	Percentage of bored internodes (LS means ± SE)[b]	No. emergence holes/stalk (LS means ± 0.19 [SE])	Relative survival (LS means ± 0.05 [SE])	Relative resistance ratio (LS means ± 0.091 [SE])	Resistance category[c]
L 08-090	ES	26.5 ± 1.7a	1.43a	0.374ab	0.833a	Highly susceptible
CP 79-1210	RGV-S	22.8 ± 2.0ab	0.98ab	0.458a	0.821ab	Highly susceptible
M81E	SS	20.5 ± 1.6abc	0.82ab	0.304a–d	0.750abc	Susceptible
CP 89-2143	RGV-S	19.3 ± 1.5a–d	0.87ab	0.274a–d	0.625a–d	Susceptible
Ho 08-717	ES	18.3 ± 1.4b–e	0.70ab	0.220a–d	0.579a–d	Intermediate
HoCP 04-838	CS	17.2 ± 1.3b–f	0.95ab	0.328a–d	0.675a–d	Susceptible
ES 5140	HBS	16.8 ± 1.2b–g	0.77ab	0.224a–d	0.571a–d	Intermediate
Ho 05-961	CS	16.5 ± 1.3b–g	0.72ab	0.240a–d	0.567a–d	Intermediate
L 08-088	ES	16.4 ± 1.3b–g	1.00ab	0.352abc	0.704a–d	Susceptible
ES 5200	HBS	15.3 ± 1.2b–h	0.98ab	0.296a–d	0.625a–d	Susceptible
TCP 99-4474	RGV-S	14.8 ± 1.3c–i	0.67ab	0.294a–d	0.596a–d	Intermediate
L 08-092	ES	14.5 ± 1.4c–j	0.47ab	0.176bcd	0.463a–d	Intermediate
Ho 08-709	ES	13.4 ± 1.3d–j	0.55ab	0.246a–d	0.513a–d	Intermediate
Ho 07-613	CS	13.4 ± 1.2d–j	0.55ab	0.268a–d	0.508a–d	Intermediate
Ho 08-711	ES	13.2 ± 1.3d–j	0.63ab	0.252a–d	0.417a–d	Intermediate
Ho 07-9014	EC	12.9 ± 1.2d–j	0.32b	0.160bcd	0.400a–d	Intermediate
TCP 87-3388	RGV-S	12.2 ± 1.1e–j	0.28b	0.152bcd	0.363a–d	Resistant
L 79-1002	EC	11.2 ± 1.2f–j	0.20b	0.126bcd	0.342abc	Resistant
Ho 07-9017	EC	11.1 ± 1.1g–j	0.11b	0.062d	0.250d	Resistant
TCP 99-4480	RGV-S	11.0 ± 1.1g–k	0.46ab	0.273a–d	0.500a–d	Intermediate
Ho 07-9027	EC	10.0 ± 1.0h–k	0.23b	0.152bcd	0.333cd	Resistant
Ho 02-113	EC	9.6 ± 1.0ijk	0.28b	0.208a–d	0.421a–d	Intermediate
Ho 07-9076	EC	9.0 ± 0.9jk	0.14b	0.094cd	0.246d	Resistant
HoCP 85-845	CS	6.0 ± 0.8k	0.23b	0.196a–d	0.308cd	Resistant
F		14.5	3.1	3.2	3.5	
df		23,96.0	23,96.0	23,92.0	23,96.0	
P		<0.001	<0.001	<0.001	<0.001	

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Wilson et al. 2015

MRB resistance in HoCP 04-838 - 2016

Table 1. *Eoreuma loftini* injury, survival, and resistance classification among sugarcane cultivars plant cane field trial, Beaumont, TX 2016 [28].

Cultivar	Percentage of Bored Internodes (LS Means ± SEM) [a,*]	Emergence Holes per Stalk (LS Means ± 0.10 [SE])	Relative Survival (LS Means ± 0.584 [SE])	Relative Resistance Ratio (LS Means ± 0.115 [SE])	Resistance Category [b]
HoCP 09-840	5.7 ± 1.0 a	0.09	0.096	0.675	Susceptible
HoCP 04-838	3.5 ± 0.7 ab	0.16	0.199	0.667	Susceptible
HoCP 91-555	3.4 ± 0.7 ab	0.12	0.144	0.600	Intermediate
HoCP 00-950	3.8 ± 0.8 ab	0.28	0.222	0.600	Intermediate
HoCP 96-540	2.7 ± 0.6 bc	0.13	0.232	0.533	Intermediate
Ho 07-613	2.4 ± 0.5 bc	0.16	0.172	0.458	Intermediate
Ho 95-988	3.2 ± 0.7 ab	0.07	0.085	0.492	Intermediate
L 01-226	3.2 ± 0.7 ab	0.08	0.067	0.450	Intermediate
N-21	2.4 ± 0.6 bcd	0.03	0.073	0.433	Intermediate
L 01-299	1.0 ± 0.3 cd	0.04	0.200	0.442	Intermediate
HoCP 09-804	1.8 ± 0.4 bcd	0.08	0.096	0.358	Resistant
HoCP 85-845	0.7 ± 0.3 d	0.01	0.100	0.242	Resistant

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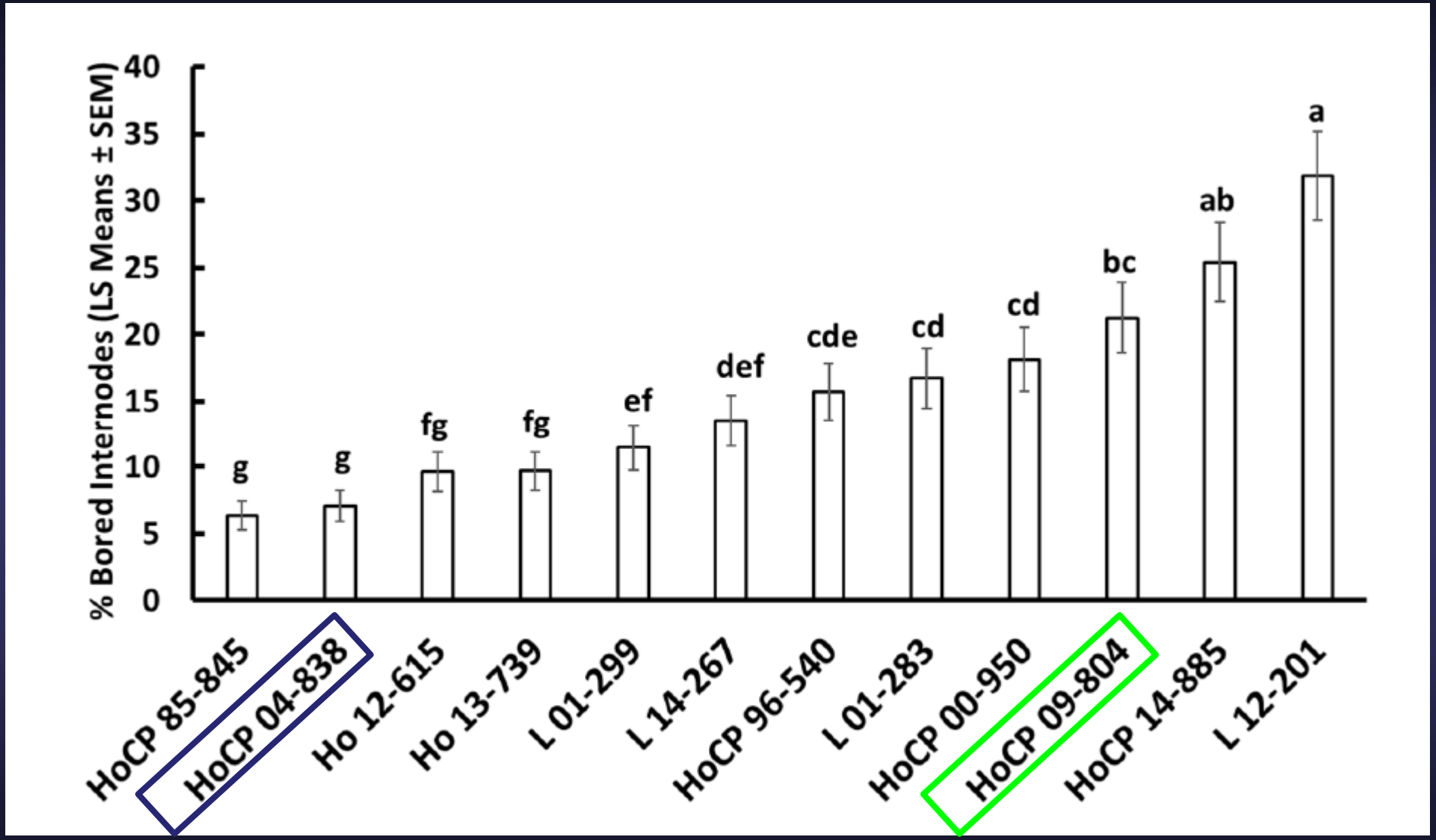
Salgado et al. 2022

MRB resistance in HoCP 04-838 - 2020



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Salgado et al. 2022

Phenotypic plasticity

Varietal resistance appears to be party dependent on environmental factors

- Genotype x environment
- Resistance trait expression
- Insect population variation (biotypes?)

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Future Work

- Cultivar specific thresholds
- Better quantify resistance mechanisms
- Genetic characterization of resistance
  - Heritability?
  - Maintain resistance in variety program
- Examine cross resistance to MRB and SCB
- Continue to release varieties with resistance
  - It's valuable!
  - Insecticide availability/efficacy isn't permanent

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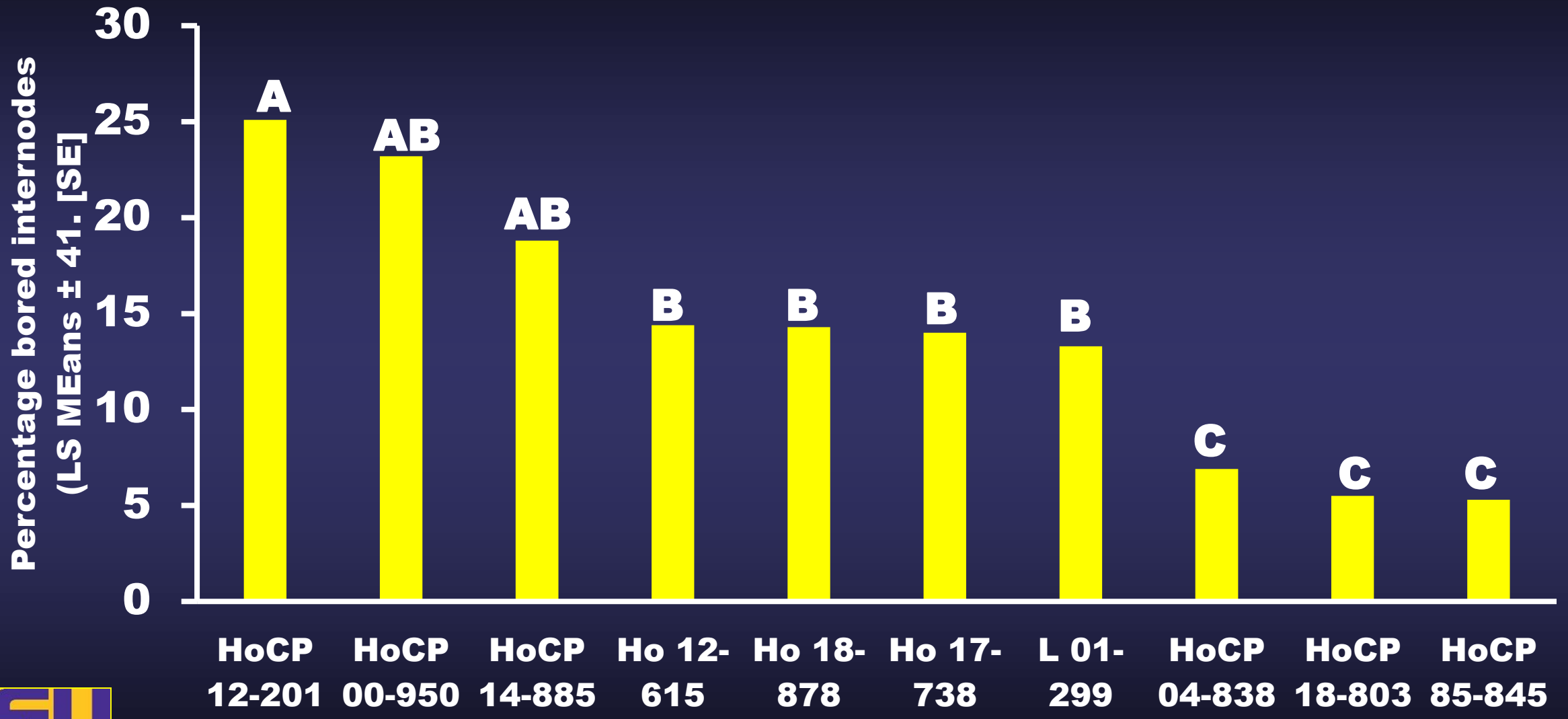
2023 Variety Test – St. Gabriel



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$F = 24.0$, df = 9, 24; $P < 0.001$

New Products Coming?

Sivanto – Caneflies and aphids

- Efficacy work done
- Residue data ongoing
- Submit to EPA Summer 2024

Platinum (Thiamethoxam)?

- Efficacy work ongoing, registration status unclear

Plinazolin – Syngenta

- Efficacy trials for SCB and wireworms

Terraxa or Nurizma (Broflanilide) – Registration not being pursued

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- LSU SRS and USDA SRU Staff
- Graduate and undergraduate student support
- Grower and consultant cooperators

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American Sugar Cane League
Est. 1922
Making Life Sweeter. Naturally

Questions?

Blake Wilson

bwilson@agcenter.lsu.edu

985-373-6193

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