

Sustainable Orchard Systems in Vermont and Implications on Tree / Crop Protection

Testimony on H.739 and H.758

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Disclaimer

This testimony is based on my professional experience , but it does not reflect the views of the University of Vermont, UVM College of Agriculture and Life Science, UVM Extension, or any other affiliated entity. I am making no recommendation in support nor opposition of the bills that are present before the Vermont legislature or this committee.

Dr. Terence Bradshaw

UVM Tree Fruit & Viticulture Specialist

- Raised on dairy farm in Chelsea, VT
- UVM Plant & Soil Science B.S., 1996
- Commercial fruit grower, 1997-1999
- Manager / director UVM orchards and vineyards, 2000-present
- UVM research technician / specialist, 2000-2014
- UVM Plant & Soil Science M.S. 2012, Ph.D. 2015
- UVM Faculty and Director UVM Fruit Program, 2014-present



UVM Fruit Program: What we do

- Cultivar and germplasm evaluation
- Orchard management systems
- Assessment of organic apple and grape production
- Cider apple research
- Public service
- Teaching
- Extension outreach



UVM Fruit Program

- Chair, Northeast Tree Fruit IPM Working Group
- Primary technical support provider for apple & grape producers in VT
- Distribution list of ~400 recipients
- 50+ electronic alerts during the growing season
- Convener: VT Tree Fruit Growers, VT Grape & Wine Council annual meetings
- Regional collaborator: annual joint meetings & presentations in New England & New York



Apples: Reclaiming a Historical Vermont Export Crop

UVM researchers partner with Vermont fruit growers to navigate the evolving apple market.

Vermont Apples: 2nd Largest Specialty Crop

Apples are grown on ~1500 acres in VT

- \$18.5 M direct farmgate sales 2017.
- Est. \$30 M total revenue with value-added
- ~40 orchards active with VTFGA

Year	bearing acres	yield/ acre (bu)	total production (bu)	utilized production	utilized price/ bu	value of utilized production \$1,000	% util
2009	2800	340	952	881	9.94	8760	92.5%
2010	2800	298	833	786	12.99	10210	94.4%
2011	2800	286	798	631	12.75	8044	79.1%
2012	2800	217	607	571	18.21	10405	94.1%
2013	1600	507	810	738	18.93	13970	91.1%
2014	1700	412	700	671	17.09	11470	95.9%
2015	1700	507	862	855	18.14	15517	99.2%
2016	1700	376	640	636	28.77	18293	99.4%
2017	1700	350	595	593	31.16	18477	99.7%

Source: NASS New England Fruit and Vegetable Report; USDA Agriculture Census

Note: NASS data collection has been substantially reduced in the past decade

Future (Present?) Growth in the VT Apple Industry

61% of VT Orchards planned to pass the farm on to the next generation

97% of farms plan to increase or maintain acreage or production in the next 5 years

14% plan to increase acreage, *but*

- 56% plan to increase production (bushels)

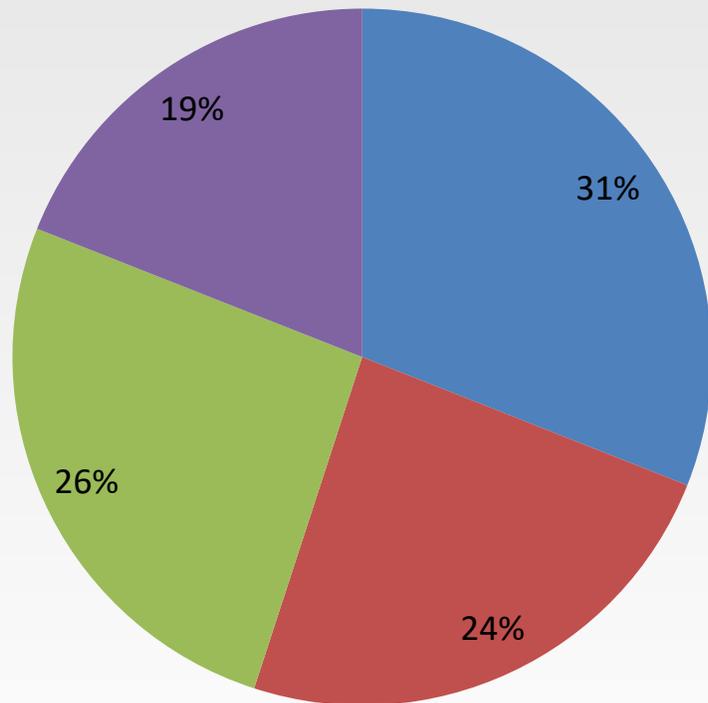
Bradshaw, T. (2013). Strategic Planning for the Vermont Apple Industry: Planning for Success in the 21st Century. Retrieved from <http://www.uvm.edu/~orchard/2013VermontAppleIndustryStrategicPlan.pdf>



Vermont Apple Production Trends

Annual Production (bu)
(percent of VT orchards within range, 2011)

■ <500 ■ 501-5,000 ■ 5,001-25,000 ■ 25,000+



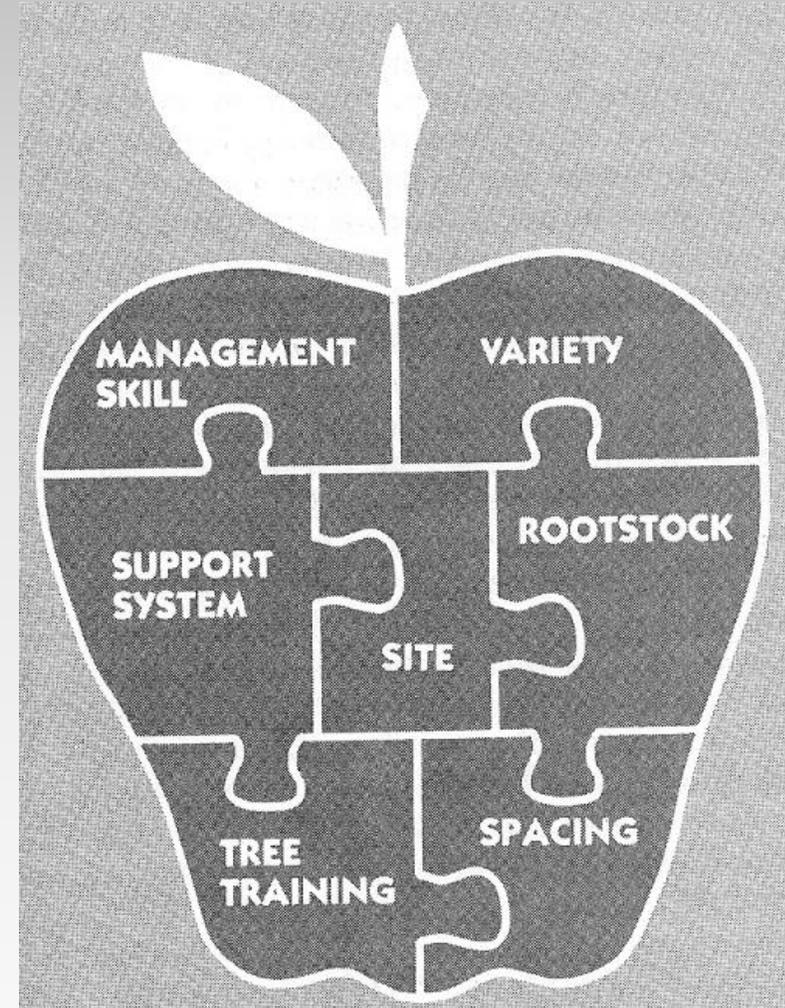
Approximately 50% of Vermont's apple crop is produced by less than 10 farms

50% of Vermont apple orchards are small (< 5000 bushel), direct-market farms

VT's apple industry is *diverse*, encompassing large, wholesale farms and small, direct market / PYO operations

Orchard Systems

- +Orchard spacing (tree and row)
- +Management
- +Support system
- +Rootstock
- +Variety
- +Site aspects
- +Spacing
- +Training system



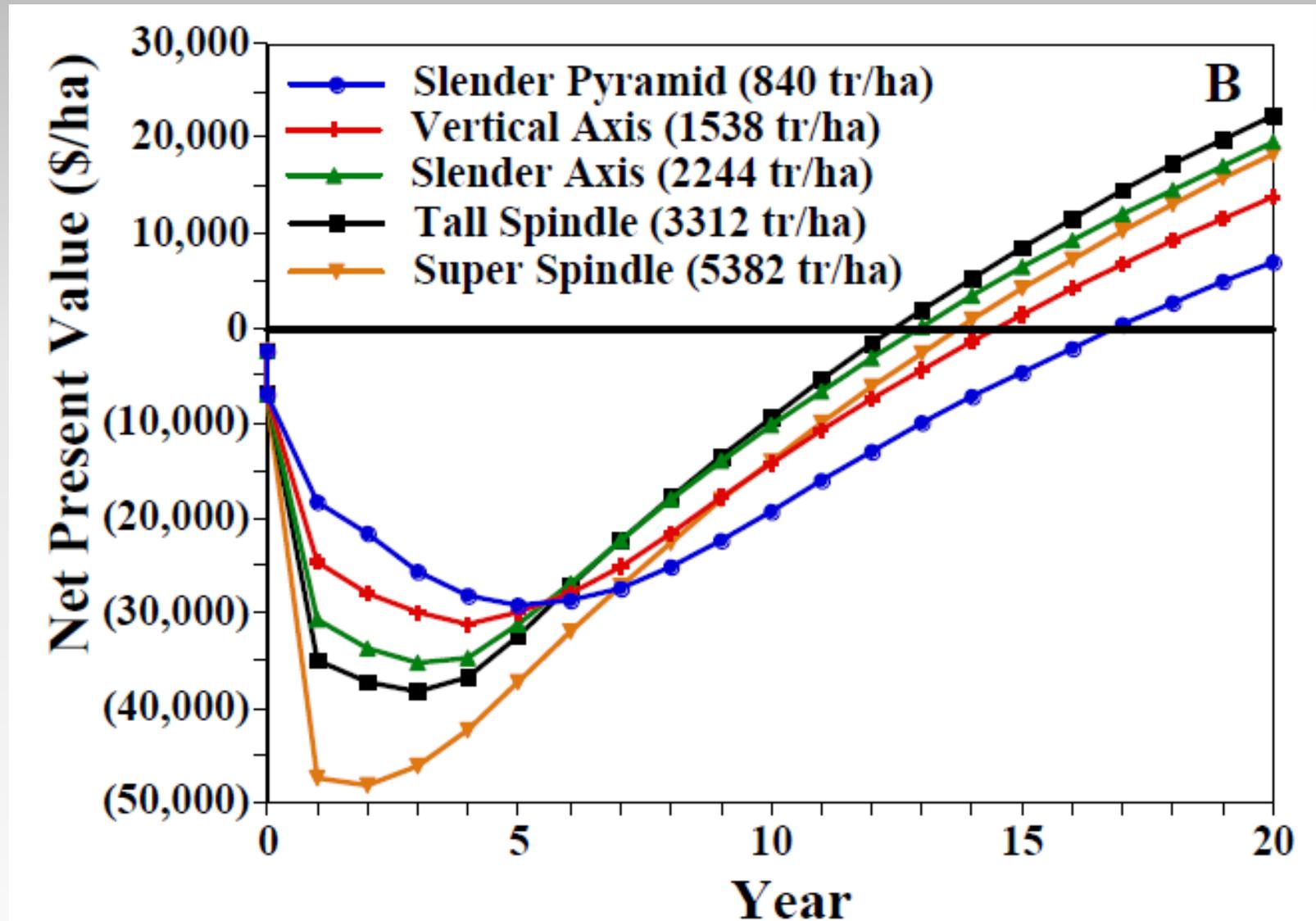
Barritt, Bruce H. "Intensive orchard management: a practical guide to the planning, establishment and management of high density apple orchards." Good Fruit Grower Press. 1992.

Changes in apple production systems

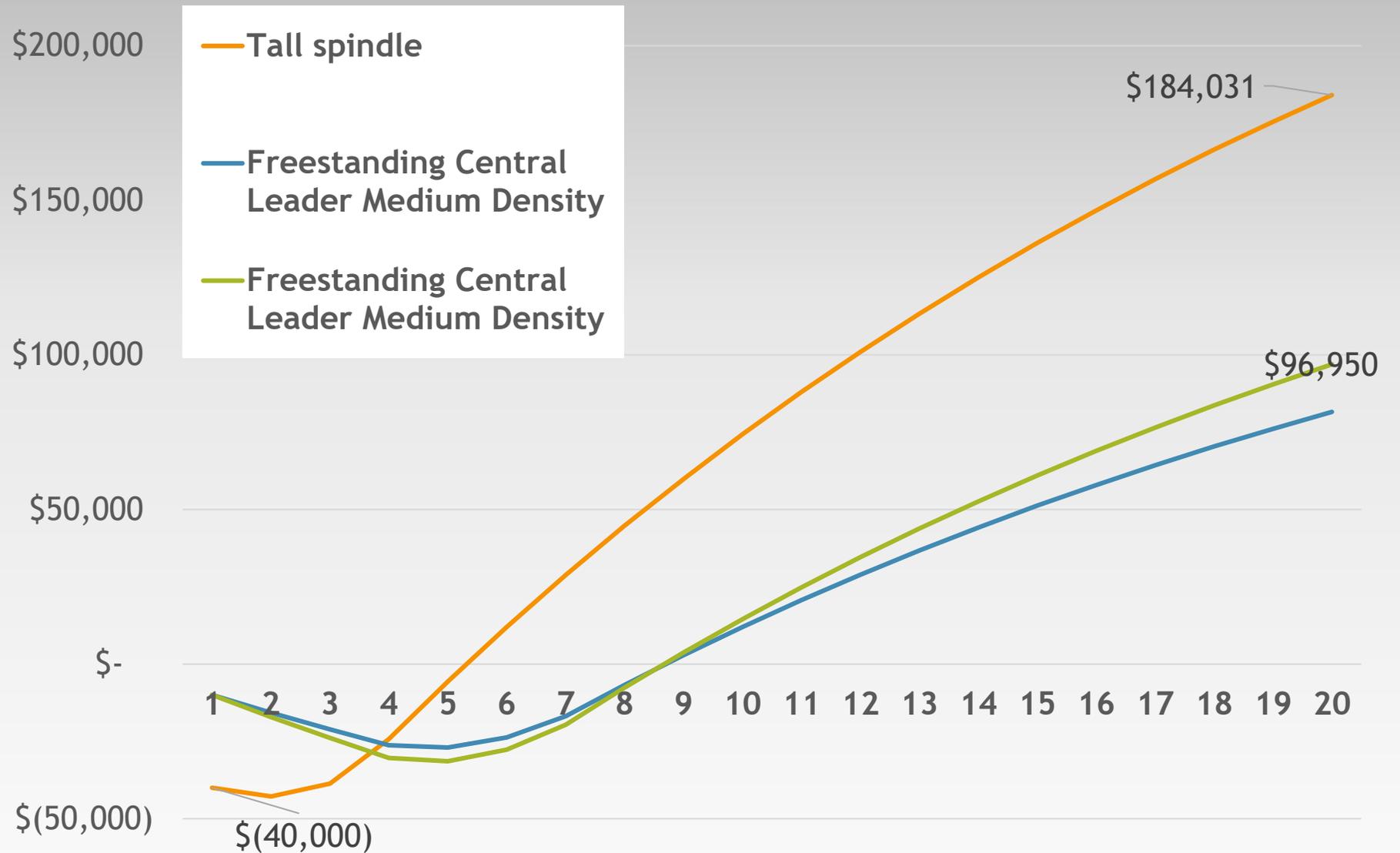


High density =
more
profitability

Robinson, T., DeMarree, A., & Hoying, S. (2007). An economic comparison of five high density apple planting systems. *Acta Hort*, 732, 481-489.



- FSCL orchards are cheaper to establish but longer time to reach bearing, lower annual yield, higher labor costs, lower fruit quality make them half as profitable as TS systems.



Net Present Value (\$US/acre) of Orchard Investment Over 20 Years

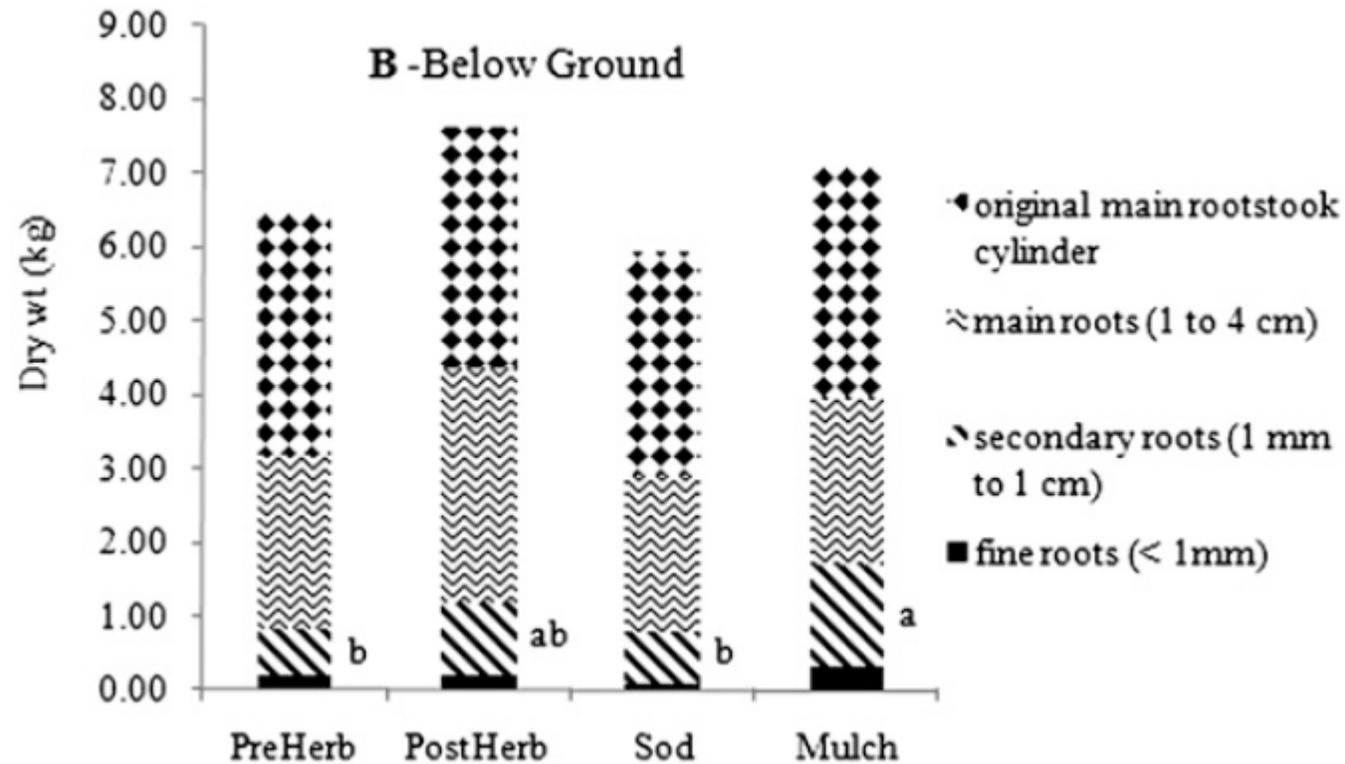
Bradshaw model, unpub.

Increase in vulnerable trunk area in high density orchard systems

	Freestanding Central Leader	Tall Spindle
Diameter (in.)	6	3
Length (in.)	18	18
Vulnerable trunk area (sq. in.)	509	127
Trees/acre	200	2000
Vulnerable trunk area / acre (sq. in.)	101,787	254,469



Orchard Row: Why Maintain A Weed-free Strip?



Atucha, A., Merwin, I.A., and Brown, M.G. (2011). Long-term Effects of Four Groundcover Management Systems in an Apple Orchard. HortScience 46, 1176-1183.

Efficacy of weed management in orchards: A 2013 study

New Findings in Weed Control in Young Apple Orchards

Deborah Breth and Elizabeth Tee
Cornell Cooperative Extension, Lake Ontario Fruit Program
Albion, NY

Breth, D., & Tee, E. 2013. New Findings in Weed Control in Young Apple Orchards. New York Fruit Quarterly 21(4) pp13-18.

Table 1. Herbicide treatments, rates and timings (Lamont Fruit Farms 2012, with Irrigation)

Pre-emergent Herbicide Treatment	Date applied	Post-emergent Trt	Dates applied
Prowl H2O (4 qts./a)	Apr 18	Gramoxone (2 pts./a) Rely (2.5 qt.)	Apr 18, Jun 20, Jul 19, Aug 21 May 21
Prowl H2O (4 qts./a)	Apr 18	Touchdown IQ (2 qts./a)	Apr 18, Jun 28, Aug 7
Prowl H2O (4 qts./a) plus Chateau WDG (12 oz./a)	Apr 14	Gramoxone (2 pts./a) Rely (2.5 qt.)	Apr 14, Jun 20, Jul 19 May 21
Prowl H2O (4 qts./a) plus Chateau WDG (12 oz./a)	Apr 14	Touchdown IQ (2 qts./a)	Apr 14, May 21, Jul 19, Aug 7
Prowl H2O (4 qts./a) plus GoalTender (3 pt./a)	Mar 21	Gramoxone (2 pts./a) Rely (2.5 qt.)	Mar 21, Jun 28, Aug 7 May 21
Surflan (4 qts./a)	Apr 18	Gramoxone (2 pts./a)	May 25, Jul 13, Aug 17
Surflan (3 qts./a) plus Chateau WDG (12 oz./a)	Apr 14	Gramoxone (2 pts./a) Rely (2.5 qt.)	Apr 14, Jun 28, Aug 7 May 21
Surflan (3 qts./a) plus GoalTender (3 pt./a)	Mar 21	Gramoxone (2 pts./a) Rely (2.5 qt.)	Mar 21, Jun 28, Jul 19, Aug 21 May 21
Surflan (3 qts./a) plus Matrix (4 oz./a)	Apr 18	Gramoxone (2 pts./a)	Apr 18, Jun 6, Jun 28, Jul 19, Aug 7
Surflan (3 qts./a) plus Matrix (4 oz./a) plus GoalTender (3 pt./a)	Mar 21	Gramoxone (2 pts./a)	Mar 21, Jun 6, Jun 20, Jul 19, Aug 21
Sinbar (8 oz./a)	Apr 18	Gramoxone (2 pts./a) Rely (2.5 qt.)	Apr 18, Jun 20, Jul 19, Aug 7 May 21
Post-emergence TRT		Gramoxone (2 pts./a) Rely (2.5 qt.)	Apr 18, Jun 20, Jul 19, Aug 7 May 21
Untreated control	handweeded on Aug. 17		

AMS included with Touchdown IQ and Rely mixtures

All mixes that included Gramoxone, Touchdown IQ, or Rely included NIS (Induce) at .25% v/v

Results

Treatment	Mean TCSA	apples / tree	bu/a	\$/acre
Lamont (1584 trees/acre, 4 fruit per cm², \$7/bu, 88 count/bu)				
Prowl + G	7.7 A	31	553	3874
Surflan/GoalTender + P, R	6.8 AB	27	491	3436
Prowl/Chateau + G	6.7 ABC	27	483	3381
Prowl/Chateau + P, R	6.5 ABCD	26	468	3279
Prowl/GoalTender + P, R	6.3 BCDE	25	454	3180
Prowl + P, R	6.2 BCDEF	25	449	3146
Surflan/Chateau + P, R	6.1 BCDEF	24	436	3055
Surflan + P, R	5.4 CDEF	22	392	2744
Post-emergence TRT	5.3 DEF	21	381	2669
Surflan/Matrix + P	5.2 DEF	21	378	2643
Surflan/Matrix/GoalTender + P	5.2 EF	21	373	2613
Sinbar + P, R	5.0 FG	20	359	2515
Untreated	3.8 G	15	273	1914

Treatment	Mean TCSA	apples / tree	bu/a	\$/acre
Mason (889 trees/acre, 4 fruit per cm², \$7/bu, 88 count/bu)				
Allon + P, R	10.2 A	41	412	2887
Prowl + P	8.6 AB	35	349	2440
Surflan/GoalTender + P	7.9 ABC	32	320	2241
Surflan/Matrix + P	7.8 ABC	31	317	2218
simazine/diuron + P	7.8 ABC	31	314	2198
Prowl + G	7.6 BC	30	307	2151
Post-emergence TRT	7.6 BC	30	306	2139
Surflan + P	7.4 BC	30	301	2106
Prowl/GoalTender + P	7.2 BC	29	292	2046
Prowl/Chateau + P	7.0 BC	28	282	1976
Surflan/Chateau + P, R	6.6 BC	26	267	1867
Matrix + P, R	6.5 BC	26	264	1847
Sinbar + P	6.4 BC	26	260	1821
Prowl/Chateau + G	6.4 BC	26	258	1804
Surflan/Matrix/GoalTender + P	6.3 BC	25	254	1781
Untreated	5.4 C	22	220	1537

Management practices for attaining acceptable weed management

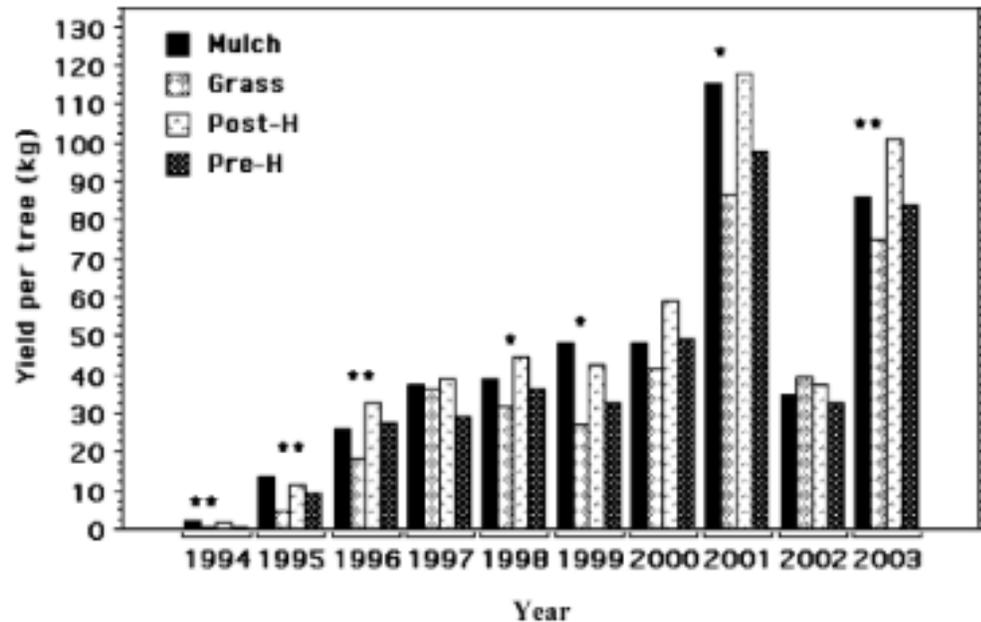


Figure 5. Average yields (kg fruit tree⁻¹) from 1994 to 2003, for trees in each GMS treatment. Significant differences among GMS treatment means (n = 3) are denoted by asterisks (*P = 0.10; ** P = 0.05) for each year.

- Mowed grass / sod almost always has lower tree growth and productivity than managed tree row
- Mulches perform well but are prohibitively expensive for use as a primary weed control strategy *and may exacerbate vole issues*
- Preemergent herbicides prevent weed growth season-long and thus reduce nutrient cycling, soil organic matter, and overall soil health
- Postemergent herbicides allow for a balance of weed control and in-row nutrient cycling

Post emergent herbicide options

- Glyphosate
 - Systemic post emergent
 - Low mammalian toxicity (REI 4 hrs)
 - Potential for long-term tree damage based on timing, tree contact
 - TS trees more prone / susceptible to damage than FSCL



Figure 1. Lower limbs of a Jonamac tree (left) showing dieback from winter injury that occurred after these limbs were exposed to sublethal drift from glyphosate applied the previous season (Photo by Mike Fargione).

Rosenberger, D., Watkins, C., Miranda-Sazo, M., Kahlke, C., Fargione, M., Nock, J., & Rugh, A. (2013). Effects of glyphosate on apple tree health. *New York Fruit Quarterly*, 21(4), 23-27.

Post emergent herbicide options

- Glufosinate

- Non-systemic post emergent
- Low mammalian toxicity (REI 12 hrs)
- In some cases, contact with trunk tissue has caused cankers that lead too secondary infection of wood rotting fungi
- Some Extension professional warn against any use of glufosinate on apples, peaches



Rosenberger, D. (2014). Apple Summer Diseases, Herbicide Problems, and Irrigation
Tree Fruit Diseases: Observations and Archives. <https://blogs.cornell.edu/plantpathhv/>

Post emergent herbicide options

- Paraquat
 - Non-systemic post emergent
 - Higher mammalian toxicity
 - Inactivated by adsorption to soil particles (REI 12 hrs)
 - No preharvest interval in apple (not absorbed / translocated to crop)
 - Lower potential for tree damage esp. on thin bark trunks and young trees



Breth, D. (2015). [Critical Weed Control Requirements in High Density Apple Orchards](#). Proc. GLFW Annual Meeting, 2015.

Rodent (vole) damage

- Rodent girdling (Exacerbated greatly by weedy tree row strips)
- Unmanaged voles may girdle and potentially kill 30-100% of trees in one season
- Most Vermont orchards that use rodenticides apply them in bait stations that reduce application rate by 90% from broadcast rate on label
- BMP: weed management, trunk guards, rodenticides



Borer damage

- Trunk boring insects can cause substantial tree damage
- Weeds at the trunk base greatly exacerbate damage
- Dogwood borer present throughout Vermont, weakens trees
- Roundheaded apple borer can kill trees in 2-3 years, present in low-spray, organic orchards



LIVE DWB FEEDING IN
CANKERS OF TREE



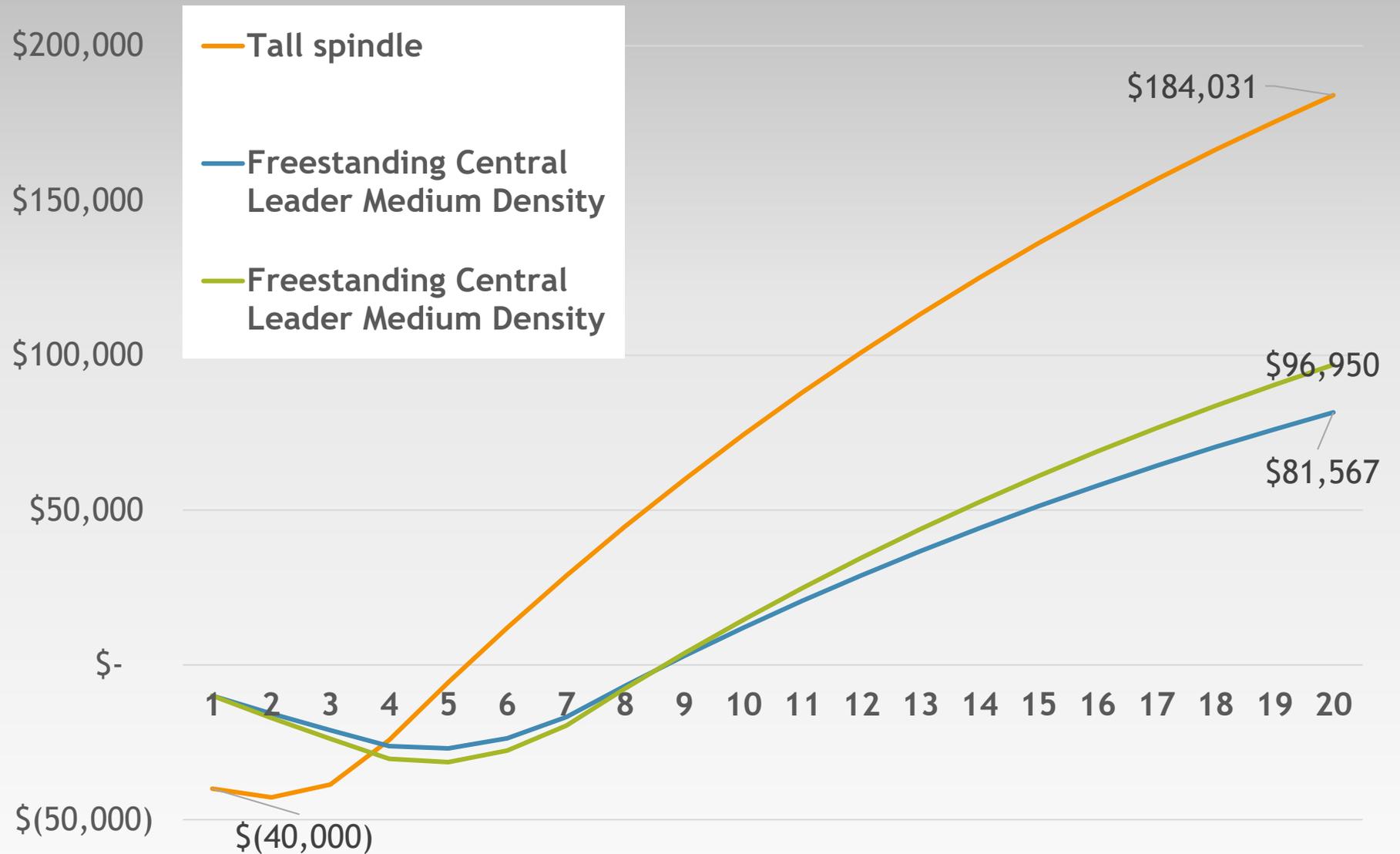
Larva is a fleshy, cream-colored, legless grub with a dark brown head and blackish mandibles. The first thoracic segment is broader than the rest of the body.

NY State Ag Experiment Station

Michigan State University Extension, n.d.
Roundheaded appletree borer.
https://www.canr.msu.edu/ipm/diseases/roundheaded_appletree_borer?language_id=#gallery

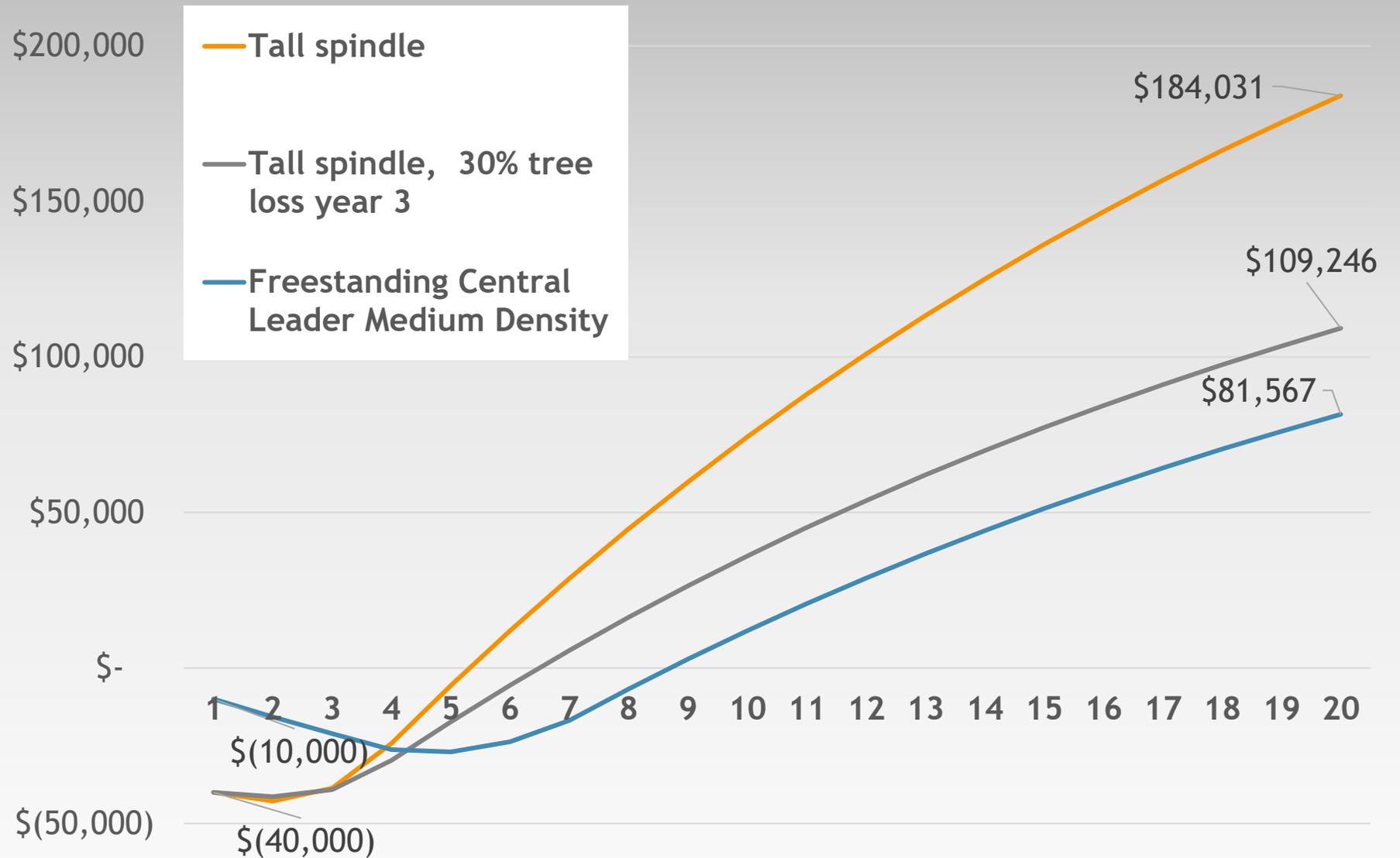
Jentsch, P. 2016. [Managing Stress: Dogwood Borer in High Density Apple » The Jentsch Lab](#)

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Net Present Value (\$US/acre) of Orchard Investment Over 20 Years
Bradshaw model, unpub.

- FSCL orchards are cheaper to establish but longer time to reach bearing, lower annual yield, higher labor costs, lower fruit quality make them half as profitable as TS systems.
- 30% tree loss in year 3 (from voles, weed pressure, herbicide damage) leads to 80% reduction in NPV revenue

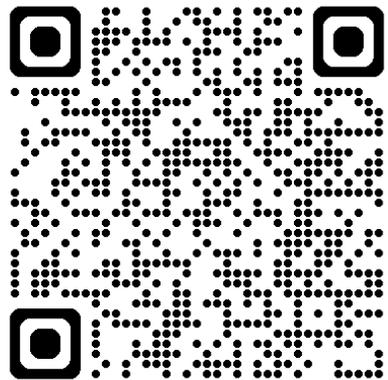


Net Present Value (\$US/acre) of Orchard Investment Over 20 Years

Bradshaw model, unpub.

Questions?

<http://go.uvm.edu/alebradshaw>



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