




**Tree Nutrition, Insecticides
and Issues with Gibberellins:
Several Answerable yet
Unanswered Questions**

**Dan Cress – Regenetics
NWSOMA 2016 Meeting**



What the heck is this seedlot?

What the heck is this seedlot?

What do we know?

What don't we know?

What questions should we ask?

How do we address those questions?



Internet: Search for “High-Resolution Bill Murray Image”



**The expected result
(yet surprisingly blurry)**



Internet: Search for “High-Resolution Bill Murray Image”



The expected result
(yet surprisingly blurry)



An unexpected result
(on a thigh?)

Explore That Path: Run New Search for “Face Tattoo”



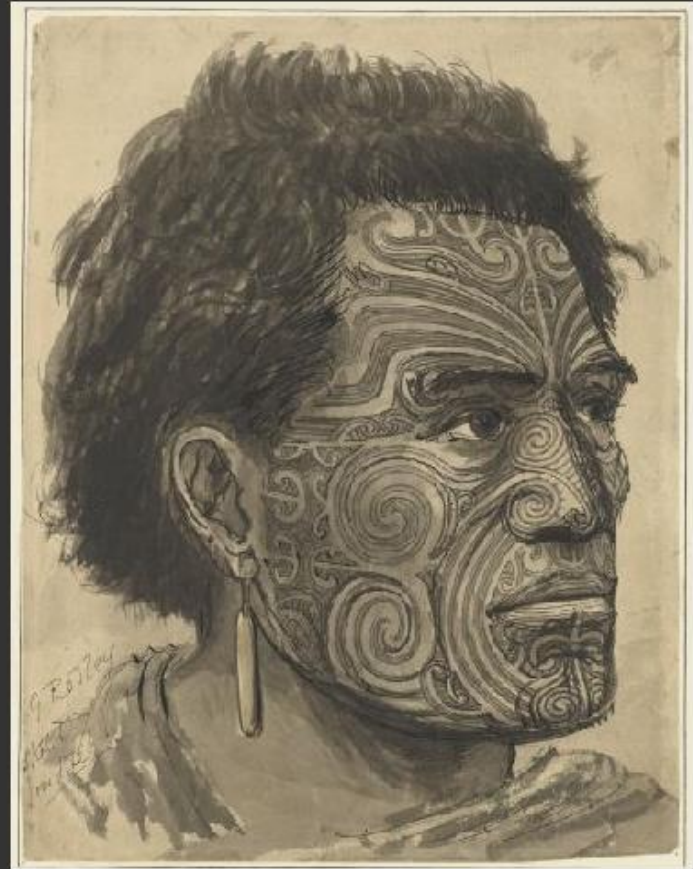
Expected Result



Explore That Path: Run New Search for “Face Tattoo”

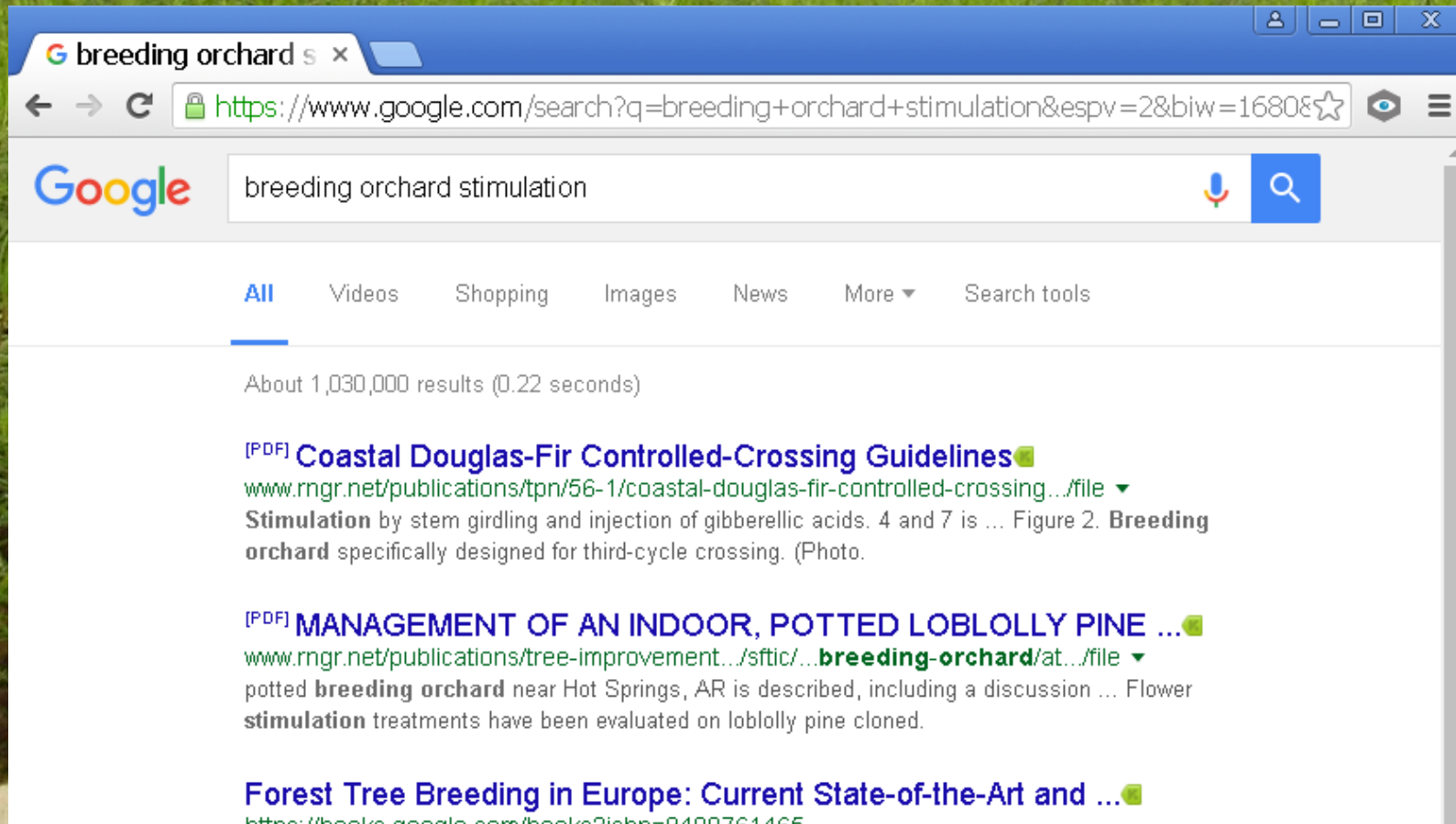


Expected Result



“Oh Yeah” Result

Best to not search for “Breeding Orchard Stimulation” from your office computer !



“About 1,030,000 results” (>4,600 being videos) ???

So, what questions should we pursue and how should we go about it? Are there things that we're yet to have considered?



An example of a topic that's already been explored: Orchard Stocking Levels

- **Tighter if generations are short?**
- **Wider for Douglas-fir than noble fir?**
- **Need for pruning? Costs & logistics?**
- **Ease of applying herbicides / insecticides?**
- **Cone harvesting:**
 - **Expensive if rows are crowded?**
 - **Inexpensive if trees are also topped?**

Another topic that we understand pretty well: Orchard Irrigation

- **Some sites “do fine” without it.**
- **Some sites / species indeed don’t need it.**
- **Drip irrigation:**
 - **Low water usage.**
 - **Need good filtration.**
 - **Need for coyote control.**
- **Fixed-set:**
 - **Adequate water supply?**
 - **Relatively low maintenance.**
 - **Watering grass as well as trees.**

A subject that we haven't thought about for a while!

Periodic Table of the Elements

										Atomic Number										Oxidation States*									
										Symbol										Name									
										Atomic Mass																			
1 1A 1A	2 IIA 2A												13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A											
1 H Hydrogen 1.008													5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180											
3 Li Lithium 6.941	4 Be Beryllium 9.012											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948												
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 8	10 VIII 8	11 IB 1B	12 IIB 2B	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948												
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 84.798												
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294												
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine 209.987	86 Rn Radon 222.018												
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [293]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown												
Lanthanide Series		57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.243	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967													
Actinide Series		89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]													

Alkali Metal

Alkaline Earth

Transition Metal

Basic Metal

Semimetal

Nonmetal

Halogen

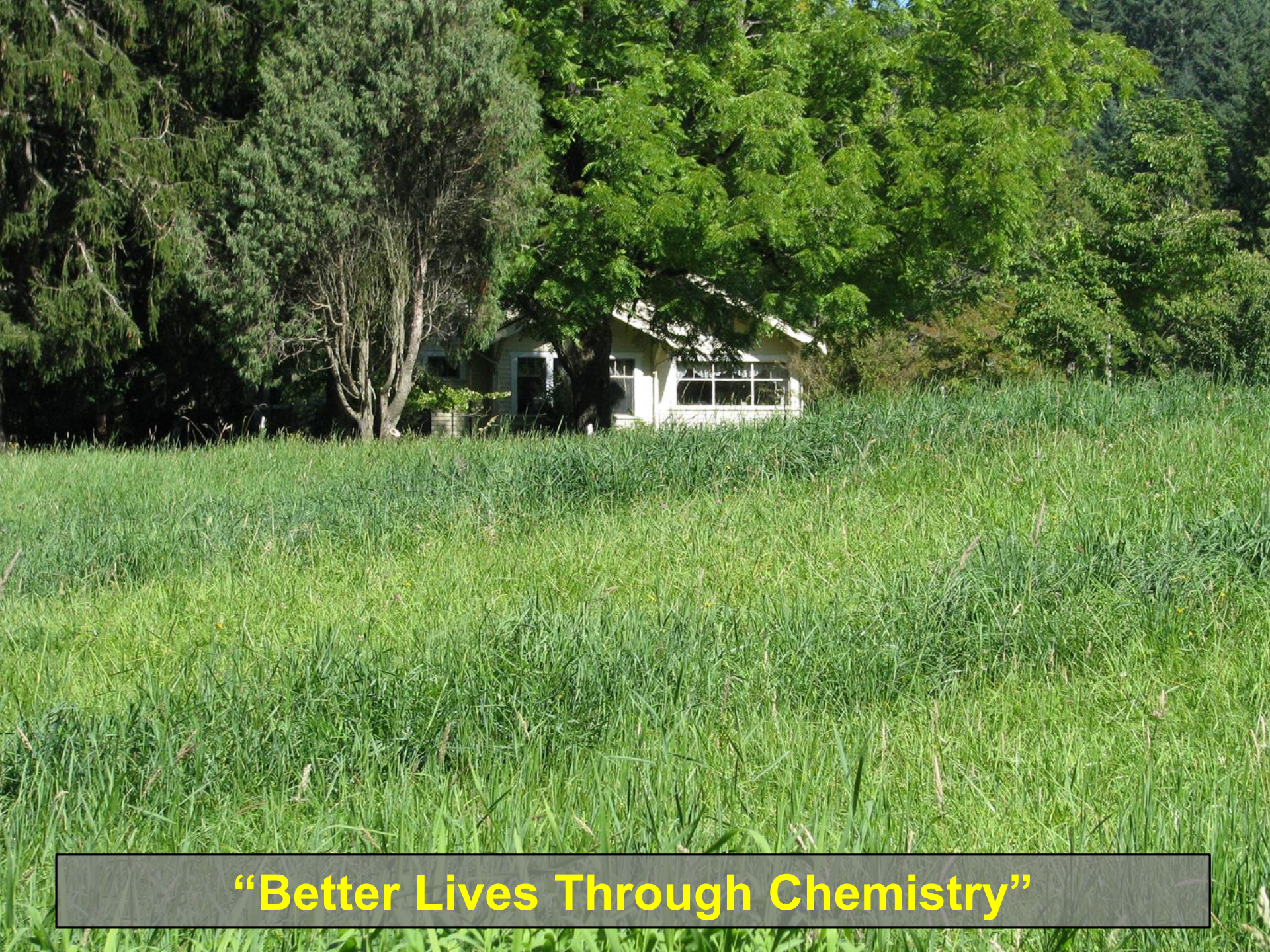
Noble Gas

Lanthanide

Actinide

A topic to explore: Orchard Nutrition

- **Some sites “do fine” without fertilization.**



“Better Lives Through Chemistry”

A topic to explore: Orchard Nutrition

- **Some sites “do fine” without fertilization.**
- **OK to stimulate vigorous trees earlier / harder?**



Trees Being Stimulated 6 Years from Grafting

A topic to explore: Orchard Nutrition

- **Some sites “do fine” without fertilization.**
- **OK to stimulate vigorous trees earlier / harder?**
- **Greater nutrient demands with heavy crops?**



Crop Size vs. Cone and Seed Size

A topic to explore: Orchard Nutrition

- **Some sites “do fine” without fertilization.**
- **OK to stimulate vigorous trees earlier / harder?**
- **Greater nutrient demands with heavy crops?**
- **Benefits of larger seed?**



Size of Endosperm, Cotyledons, etc.

A topic to explore: Orchard Nutrition

- **Some sites “do fine” without fertilization.**
- **OK to stimulate vigorous trees earlier / harder?**
- **Greater nutrient demands with heavy crops?**
- **Benefits of larger seed?**
- **Generic vs. custom blends?**



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\$17.99

SKU: 501616

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Add to Cart

Quantity Available: 409

[Price Break Available - Click Here](#)

Example of a Custom Blend Used in 2016:
11-19-15 +7S + 0.7B = \$16.82 / 50# bag

Sometimes Need Dialogue with Lab(s)

Results last year from orchard with fairly low pH. Standard lab knew to use acetate extraction.

P = 13 ppm

Ca = 100 ppm

Mg = 20 ppm

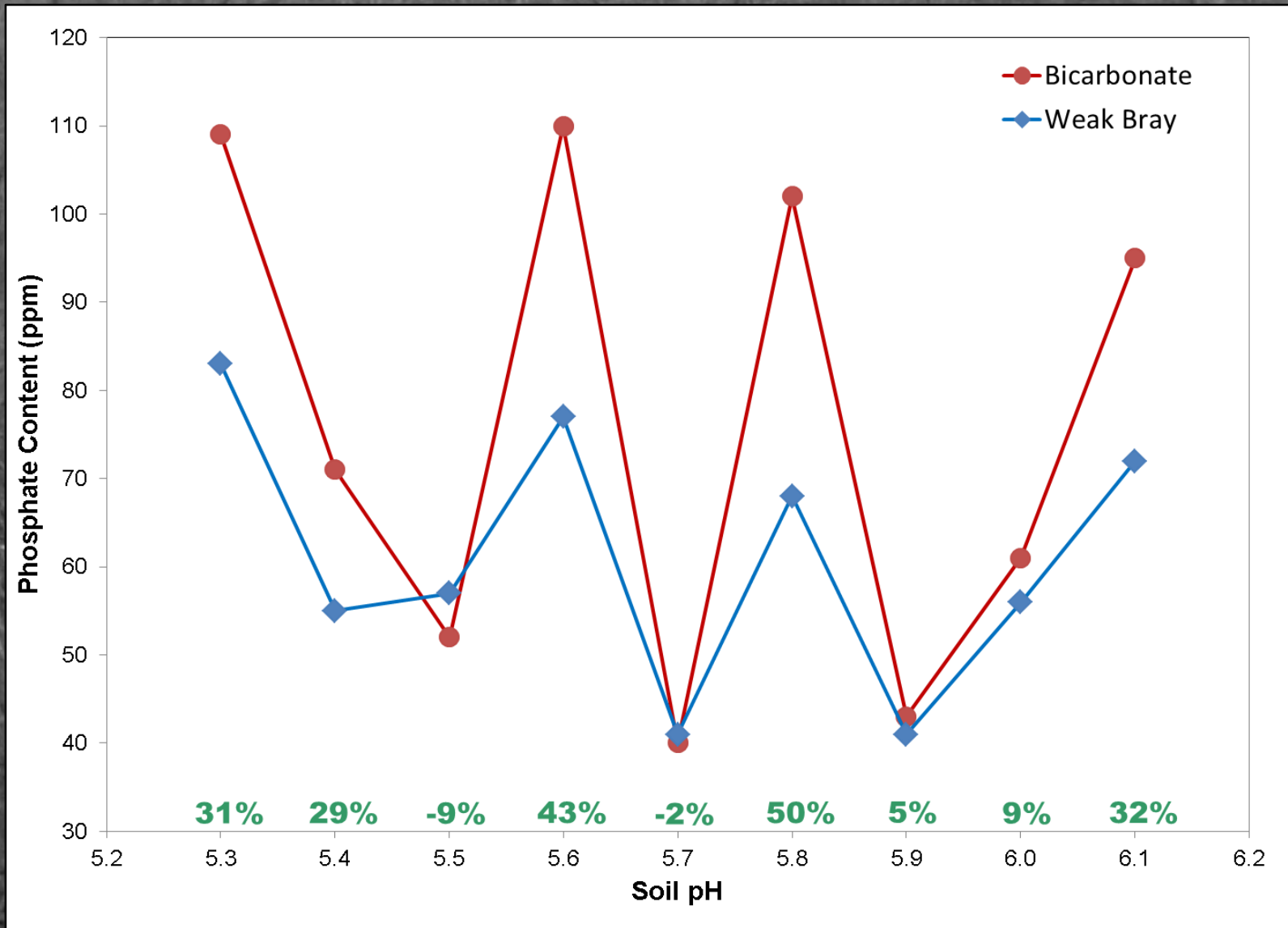
Same orchard this year. New lab assumed that pH was very high so used bicarbonate extraction:

P = 95 ppm

Ca = 2,000 ppm

Mg = 300 ppm

The chemist laughed when asked for conversion factors...



Lab Data vs. Lab Recommendations: For What? Hemlock Seed? Douglas-fir Needle Color? Barley Yields?

PLANT ANALYSIS REPORT

USAg ANALYTICAL SERVICES, INC.

Lab No.

1320 E. Spokane Street

Phone: (509) 547-3838

Fax: (509) 547-8645

Fax: (509) 547-8645

Page: 1 of 2

A & L WESTERN AGRICULTURAL LABORATORIES

10220 SW NIMBUS AVE Bldg K-9 | PORTLAND OREGON 97223 | (503) 968-9225 | FAX (503) 598-7702

REPORT NUMBER:

CLIENT NO:

SUBMITTED BY:

SEND TO:

GROWER:



Sampled By:

Date Sampled:

Date Received:

Date Reported:

DATE OF REPORT:

SOIL ANALYSIS REPORT

PAGE: 1

SAMPLE ID	LAB NUMBER	Organic Matter		Phosphorus		Potassium	Magnesium	Calcium	Sodium	pH		Hydrogen	Cation Exchange Capacity	PERCENT CATION SATURATION (COMPUTED)				
		% Rating	ENR lbs/A	P1 (Weak Bray) ppm	NaHCO ₃ -P (MisenMethod) ppm	K ppm	Mg ppm	Ca ppm	Na ppm	Soil pH	Buffer Index	H meq/100g	C.E.C. meq/100g	K %	Mg %	Ca %	H %	Na %
		3.8H	107	102VH	68**	239M	257M	1623L	47L	5.8	6.1	2.6	13.6	4.5	15.5	59.5	19.0	1.5
3.2M	95	61VH	56**	248M	390M	2025L	37VL	5.8	6.5	3.3	17.4	3.6	18.4	58.0	19.0	0.9		
2.3M	76	52VH	57**	179M	304M	1665L	18VL	5.4	6.5	4.5	15.9	2.9	15.7	52.4	28.5	0.5		
2.0L	71	110VH	77**	265H	203M	1208L	23VL	5.6	6.6	2.6	11.1	6.1	15.0	54.4	23.5	0.9		
2.5M	80	95VH	72VH	303H	314M	1816M	31VL	6.4	6.6	1.2	13.8	5.6	18.7	65.7	9.0	1.0		

SAMPLE NUMBER	Nitrogen	Sulfur	Zinc	Manganese	Iron	Copper	Boron	Excess Lime	Soluble Salts	Chloride	PARTICLE SIZE ANALYSIS			
	NO ₃ -N ppm	SO ₄ -S ppm	Zn ppm	Mn ppm	Fe ppm	Cu ppm	B ppm	Rating	mmhos/cm	Cl ppm	SAND %	SILT %	CLAY %	SOIL TEXTURE
	5L	6L	2.9M	3M	163VH	1.0M	0.3VL	L	0.3L					
11L	7L	1.6M	3M	165VH	1.5H	0.4L	L	0.3L						
7L	6L	0.8L	4M	144VH	0.9M	0.3VL	L	0.2VL						
6L	3VL	1.4M	3M	164VH	0.6L	0.3VL	L	0.2VL						
17M	6L	1.1M	2L	135VH	0.8L	0.4L	L	0.4L						

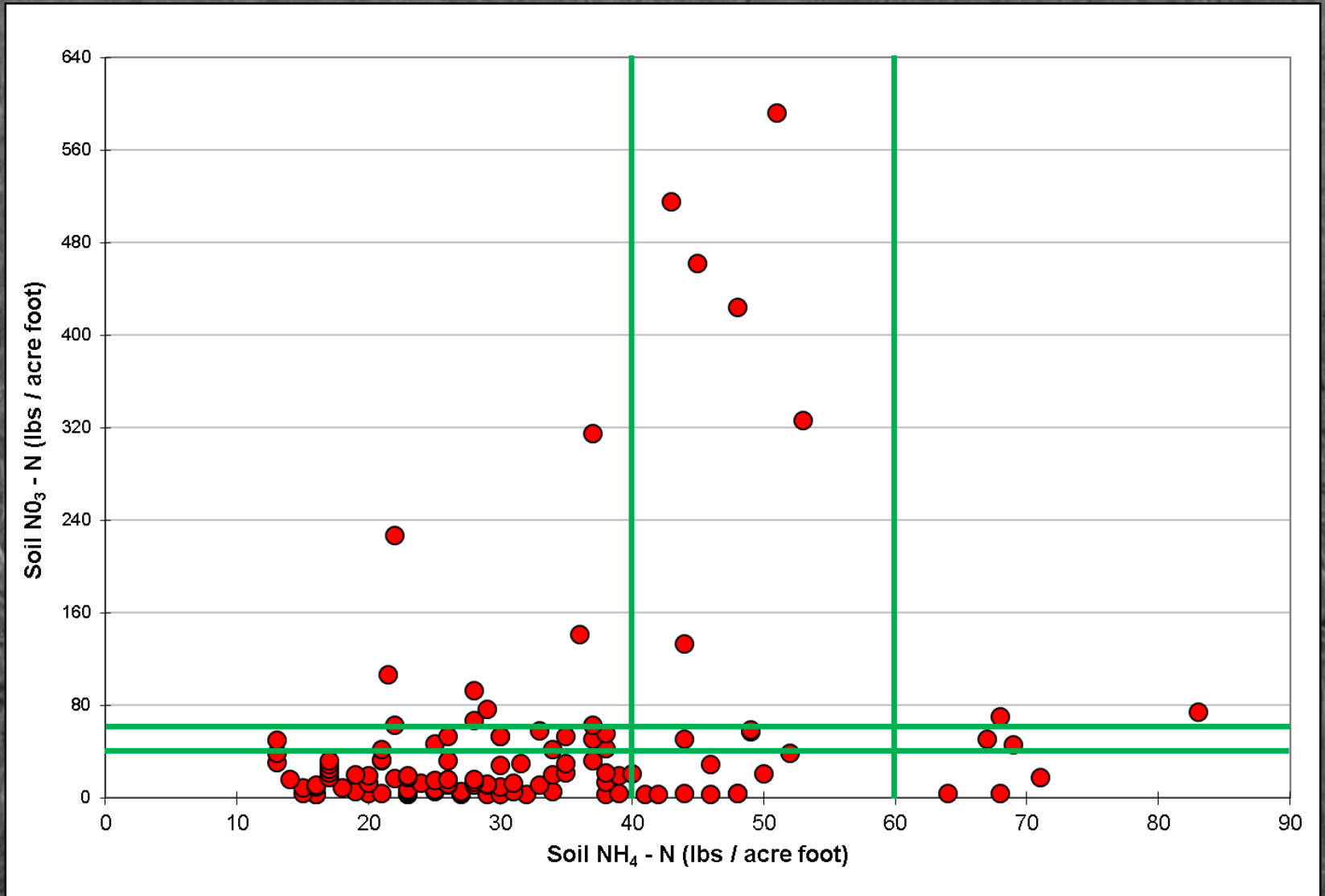
* CODE TO RATING: VERY LOW (VL), LOW (L), MEDIUM (M), HIGH (H), AND VERY HIGH (VH).
 ** ENR - ESTIMATED NITROGEN RELEASE
 *** MULTIPLY THE RESULTS IN ppm BY 2 TO CONVERT TO LBS. PER ACRE OF THE ELEMENTAL FORM
 **** MULTIPLY THE RESULTS IN ppm BY 4.6 TO CONVERT TO LBS. PER ACRE P₂O₅
 ***** MULTIPLY THE RESULTS IN ppm BY 2.4 TO CONVERT TO LBS. PER ACRE K₂O
 MOST SOILS WEIGH TWO (2) MILLION POUNDS (DRY WEIGHT) FOR AN ACRE OF SOIL 6-2/3 INCHES DEEP

This report applies only to the sample(s) tested. Samples are retained a maximum of thirty days after testing.

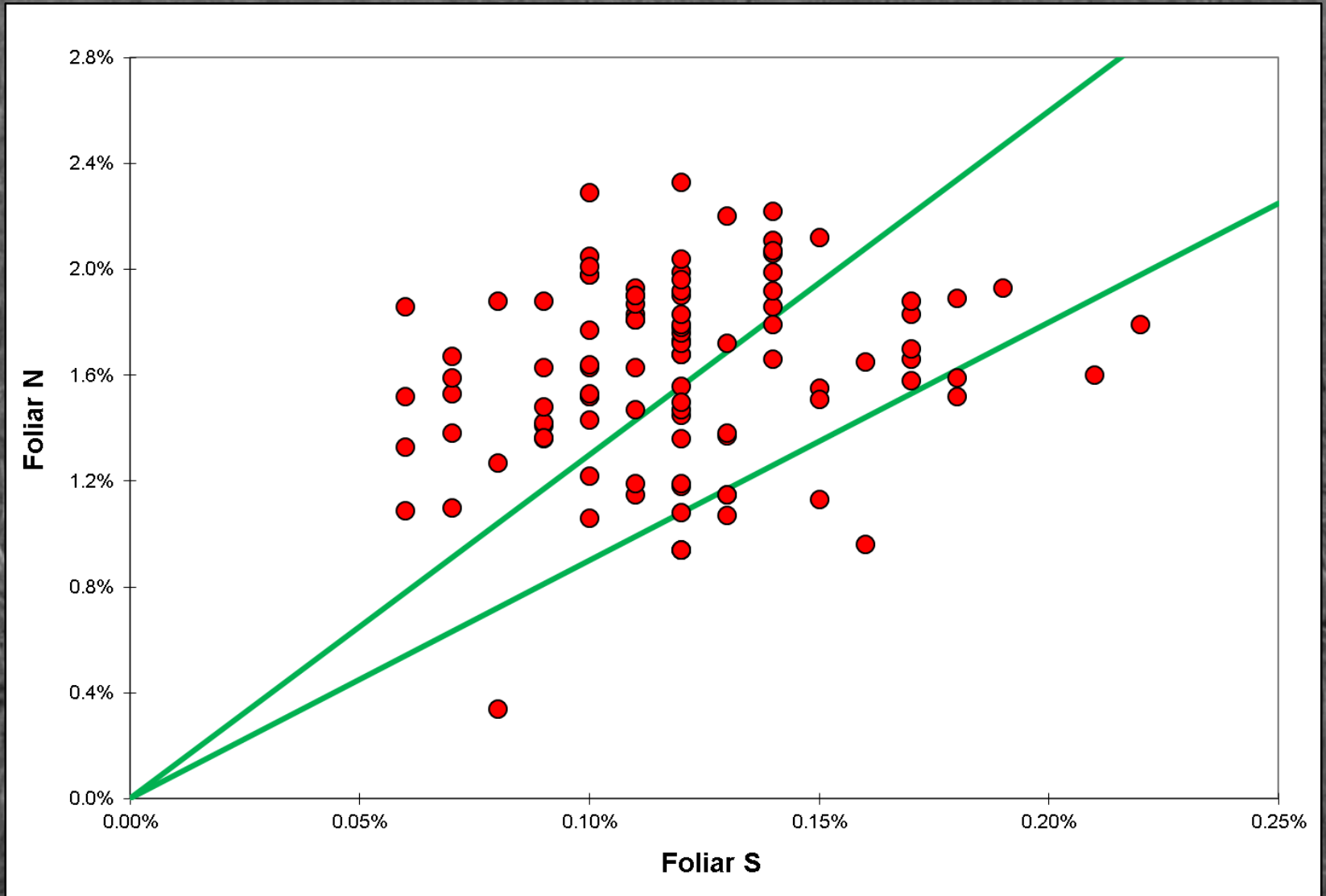
Darcy L. Peebles
 Darcy L. Peebles, CCA
 A & L WESTERN LABORATORIES, INC.

	Zn ppm	Mn ppm	Fe ppm	Cu ppm
1	35	143	79	7
2	41	414	138	7
3	46	238	69	7
4	53	343	102	8
5	50	291	86	8
6	47	280	110	6
7	57	368	86	8
8	45	186	85	7
9	47	395	124	8

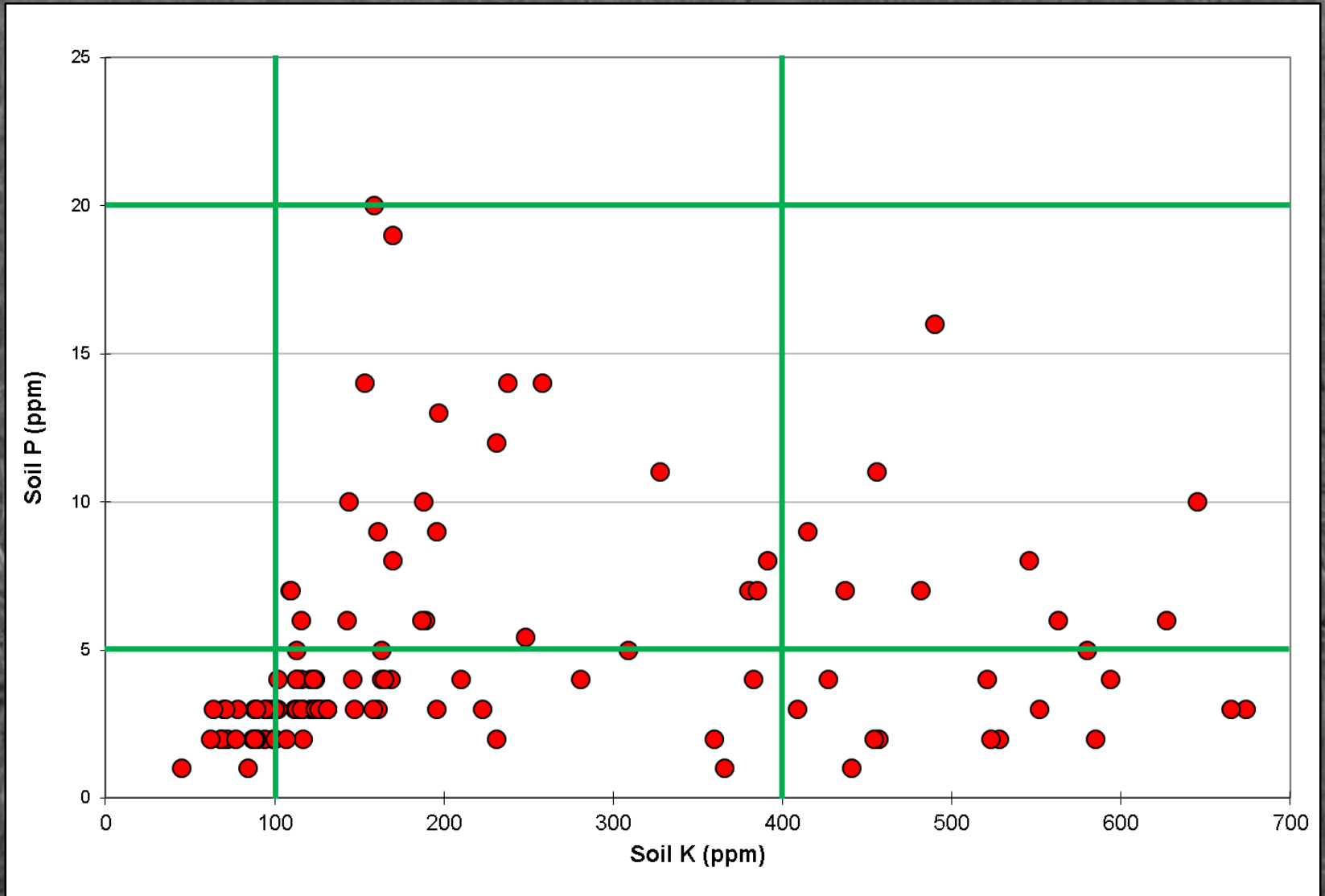
What are our ideal targets for various forms of soil nitrogen?



Adequate sulphur if foliar N:S is $> 13:1$?



Ideal phosphate & potash levels? Any fertigation potential?



Questions to address (both now and later)

- Different needs by species and/or age?
- Any interactions with stimulation treatments?
- Need to increase pH? Watch base saturation?
- What practices are used with loblolly, radiata, etc.?
- What's the ideal time to sample and to fertilize?
- 50 years of breeding/testing yet few orchard studies!
- How do we optimize orchard production?
- Alternatives to waiting for grad students?

Sucking Bugs? Wasps? Chewing Moth Larvae?

Small pests that (sometimes) cause massive damage.



Insecticides and their Application

RESTRICTED USE PESTICIDE
 DUE TO TOXICITY TO FISH AND AQUATIC ORGANISMS.
 For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification.

DUPONT GROUP INSECTICIDE

DuPont™ Asana® XL insecticide

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS

IMA-JET Systemic Insecticide for Micro-Infusion®

SYSTEMIC INSECTICIDE
 Micro-Injectable Systemic Insecticide for use with the Arborjet Injection System in the Management of Specific Insect Pests of Forests, Trees, Landscape Ornamentals and Interior Plantings.

ACTIVE INGREDIENT:
 Imidacloprid 1, [(6S)-2-chloro-3-pyridylmethyl] N-methyl-*N*-nitrosoguanidine

OTHER INGREDIENTS:
 TOTAL: 100%

Net Contents: See Individual Container

KEEP OUT OF REACH OF CHILDREN

STOP - READ LABEL CAREFULLY
 Preparation of mixtures is critical to product performance. Do not use if you do not understand the label. Read the label carefully before use.

HAZARD TO HUMANS
 If swallowed, inhaled or absorbed through the skin, it may cause temporary eye injury. Do not wash thoroughly with soap and water. Do not induce vomiting unless directed by a physician. Keep clothing before reuse. Keep children and pets away from treated areas until injection and uptake are complete.

IF SWALLOWED:
 Call a poison control center or doctor immediately for treatment advice. Do not induce vomiting unless directed by a physician. Keep clothing before reuse. Keep children and pets away from treated areas until injection and uptake are complete.

IF INHALED:
 Move person to fresh air. If breathing is difficult, call 911 or an ambulance, then preferably mouth-to-mouth respiration. Call a poison control center or doctor for further treatment advice.

IF IN EYES:
 Hold eye open and rinse with clean water for 15-20 minutes. Remove contact lenses, if present, after the first rinsing.

IF ON SKIN OR CLOTH:
 Take off contaminated clothing. Rinse skin immediately with plenty of water. Call a poison control center or doctor for treatment advice.

NOTE TO PHYSICIAN:
 If on skin, after drying, apply a soothing emollient.

KEEP OUT OF REACH OF CHILDREN

WARNING
 If used as directed, this product is expected to be safe. If it causes a reaction, find someone to help you.

IF SWALLOWED:
 Call a poison control center or doctor immediately for treatment advice. Do not induce vomiting unless directed by a physician. Keep clothing before reuse. Keep children and pets away from treated areas until injection and uptake are complete.

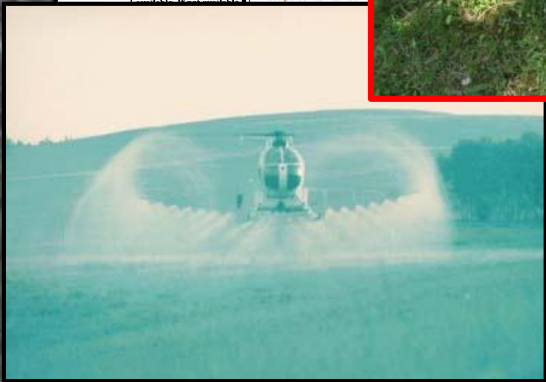
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EPA Reg. No. 352-515



2012 Injection Trials with Alex Mangini



Big Trees, 4 Orchard, 2 Chemicals, Plugged or Not

2012 Injection Trials with Alex Mangini

Big Trees, 4 Orchards, 2 Chemicals, Plugged or Not



PROC GLM – ANOVA and CONTRASTS – Orchard A						
Treatments	% Healthy Cones		% CGM Cones		% CW Cones	
Parameter	t Value	Pr > t	t Value	Pr > t	t Value	Pr > t
HEIGHT and TREATMENT						
Imajet: mid vs top	0.68	0.4988	-0.50	0.6223	-1.80	0.0795
Treeage: mid vs top	2.75	0.0089	2.89	0.0063	2.76	0.0077

PROC GLM – ANOVA and CONTRASTS for HEIGHT and TREATMENT – Orchard A				
Parameter	Estimate	Standard Error	Pr > t	
Imajet avr over ht vs Contr				
Treeage avr over ht vs Cont				

Dependent Variable – % CGM by Ramet				
Parameter	Estimate	Standard Error	Pr > t	
Imajet: plug vs dowel, mid				
Treeage: plug vs dowel, mic				
Imajet: avr t				
Treeage: avr t				
Imajet vs Tr				
Imajet avr o				
Treeage avr				

PROC GLM – ANOVA and CONTRASTS for METHODS – Orchard A				
Parameter	Estimate	Standard Error	Pr > t	
Imajet: plug vs dowel, mid	-0.16137807	0.95121318	0.8661	
Treeage: plug vs dowel, mic	-1.15009519	0.92190798	0.2193	
Imajet vs Tr				
Imajet avr o				
Treeage avr				
Imajet: plug vs dowel, mid	2.18475624	2.62918359	0.4210	
Treeage: plug vs dowel, mid	-1.67926230	2.62918359	0.5341	
Imajet vs Treeage avr over methods except open	-2.59057000	1.58859999	0.1269	
Imajet avr over methods except open vs Control	-1.30790617	2.19723737	0.5619	
Treeage avr over methods vs Control	1.28266383	2.14671941	0.5604	

Bottom Line: Was unimpressive on those huge trees. No need to plug holes. Some relationship with height. Differences between orchards, chemicals and insects?

**2015 / 2016 Injection Trials
with Alex Mangini & Brian Strom:
Assess Imidacloprid in Younger and/or Shorter Orchards**



2015 / 2016 Injection Trials with Alex Mangini & Brian Strom

Assess Imidacloprid Potential Vegetatively
(independent of infestation levels)



2015 / 2016 Injection Trials with Alex Mangini & Brian Strom

Sampling Dates:		November 2015	January 2016	March 2016	May 2016
Tree Tops	Foliage	6 "Old" Clones @ 3 Ramets Each 7 "Young" Clones @ 3 Ramets Each	6 "Old" Clones @ 3 Ramets Each 7 "Young" Clones @ 3 Ramets Each	6 "Old" Clones @ 3 Ramets Each 7 "Young" Clones @ 3 Ramets Each	6 "Old" Clones @ 3 Ramets Each 7 "Young" Clones @ 3 Ramets Each
	Females	6 "Old" Clones @ 3 Ramets Each 7 "Young" Clones @ 3 Ramets Each	(no samples)	(no samples)	6 "Old" Clones @ 3 Ramets Each 7 "Young" Clones @ 3 Ramets Each
Mid-Crown	Foliage	6 "Old" Clones @ 3 Ramets Each 7 "Young" Clones @ 3 Ramets Each	6 "Old" Clones @ 3 Ramets Each 7 "Young" Clones @ 3 Ramets Each	6 "Old" Clones @ 3 Ramets Each 7 "Young" Clones @ 3 Ramets Each	136 "Old" Clones @ 3 Ramets Each 7 "Young" Clones @ 3 Ramets Each
	Females	6 "Old" Clones @ 3 Ramets Each 7 "Young" Clones @ 3 Ramets Each	(no samples)	(no samples)	6 "Old" Clones @ 3 Ramets Each 7 "Young" Clones @ 3 Ramets Each
Total Samples:		156	78	78	156

2015 / 2016 Injection Trials with Alex Mangini & Brian Strom

Overview of ELISA

Just in time for summer: Save up to \$300 or get a T-shirt! [Get details >](#)

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Overview of ELISA

Protein Biology Resource Library
Pierce Protein Methods

ELISA (enzyme-linked immunosorbent assay) is a plate-based assay technique designed for detecting and quantifying substances such as peptides, proteins, antibodies and hormones. Other names, such as enzyme immunoassay (EIA), are also used to describe the same technology. In an ELISA, an antigen must be immobilized to a solid surface and then complexed with an antibody that is linked to an enzyme. Detection is accomplished by assessing the conjugated enzyme activity via incubation with a substrate to produce a measurable product. The most crucial element of the detection strategy is a highly specific antibody-antigen interaction.

Page contents

- [Introduction](#)

[ELISA 5: Enzyme-linked immunosorbent assay](#)

Give Feedback

2015 / 2016 Injection Trials with Alex Mangini & Brian Strom

The screenshot shows a web browser window with the URL <https://www.thermofisher.com/us/en/home/life-science/protein-biology/protein-assays-analysis/elisa/elisa-reagents-accessories/coated-microplates.html>. The page features a dark blue header with a promotional message: "Just in time for summer: Save up to \$300 or get a T-shirt!" and a "Get details" button. The ThermoFisher Scientific logo is on the left, and navigation links for "Contact Us", "Sign In", and "Quick Order" are on the right. The main content area is titled "Coated Microplates" and includes a sidebar with navigation links: "ELISA Reagents and Accessories", "Labware and Accessories for ELISA", "Blocking Buffers for ELISA", "Coated Microplates", and "Conjugates and Probes for ELISA". A large image of a white 96-well microplate is shown. To its right, a text block states: "We offer a wide selection of high-performance surface coated plates (pre-coated and pre-blocked polystyrene 96-well and 384-well microplates) in clear, white, and black. These coated microplates can be used for ELISA development and other plate-based assays with standard or fluorescent plate readers." Below this is a "Popular products" section with three items: "NeutrAvidin® Coated Plates —Standard Capacity", "NeutrAvidin® Coated Plates —High Capacity", and "NeutrAvidin® Coated Plates —High Sensitivity". A vertical "Give Feedback" button is located on the right edge of the page.

ELISA Catalog | TI x Coated Microplate: x

← → ↻ <https://www.thermofisher.com/us/en/home/life-science/protein-biology/protein-assays-analysis/elisa/elisa-reagents-accessories/coated-microplates.html> 🔍 ☆ ☰

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Coated Microplates

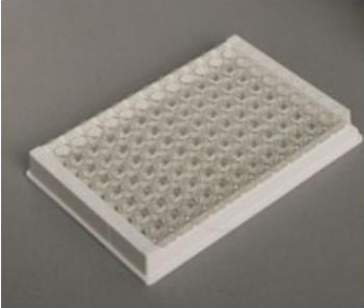
◀ [ELISA Reagents and Accessories](#)

Labware and Accessories for ELISA

Blocking Buffers for ELISA

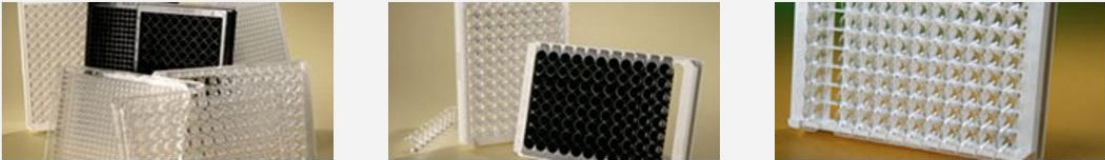
Coated Microplates

Conjugates and Probes for ELISA



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Popular products



[NeutrAvidin® Coated Plates —Standard Capacity](#)

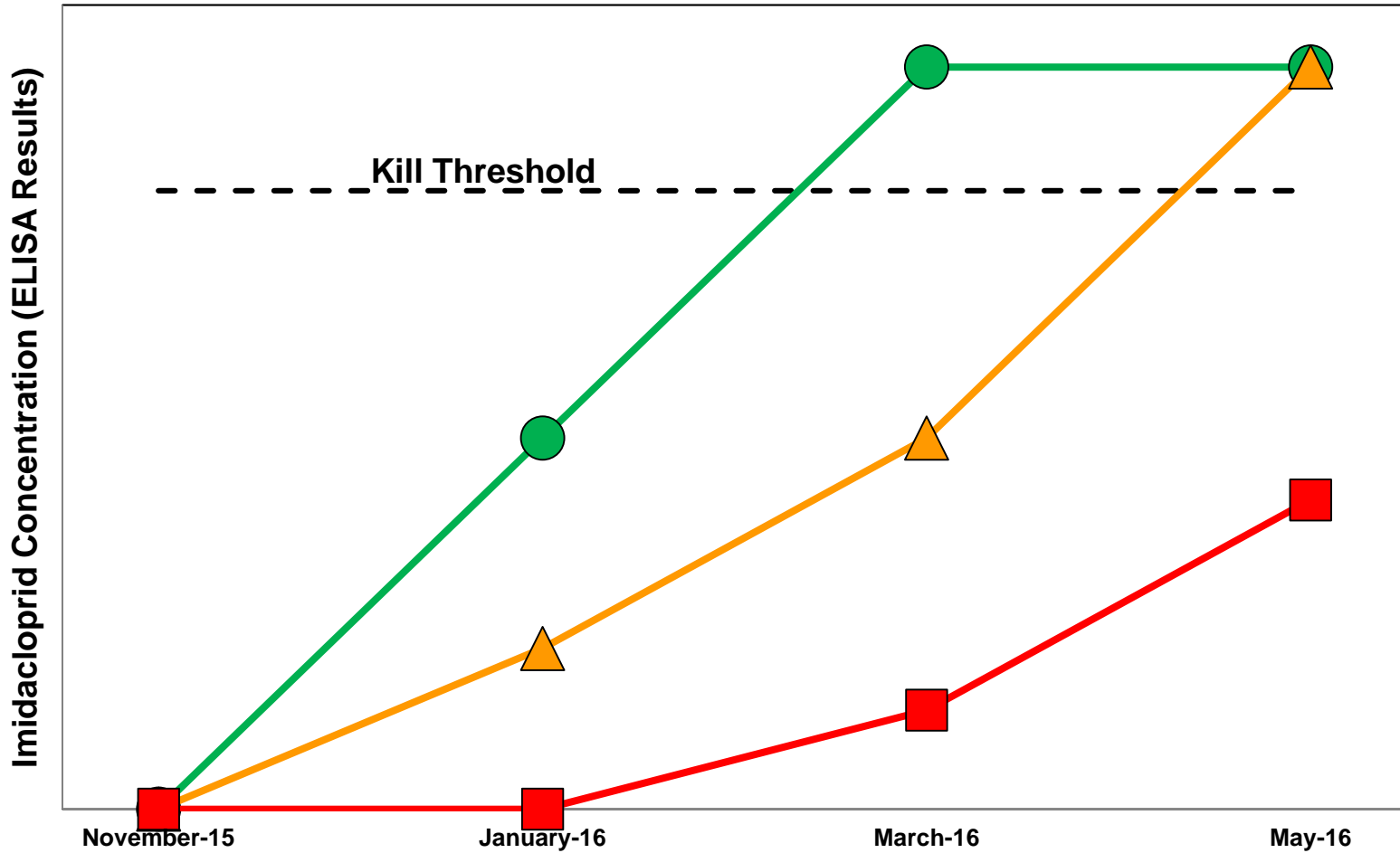
[NeutrAvidin® Coated Plates —High Capacity](#)

[NeutrAvidin® Coated Plates —High Sensitivity](#)

Give Feedback

2015 / 2016 Injection Trials with Alex Mangini & Brian Strom

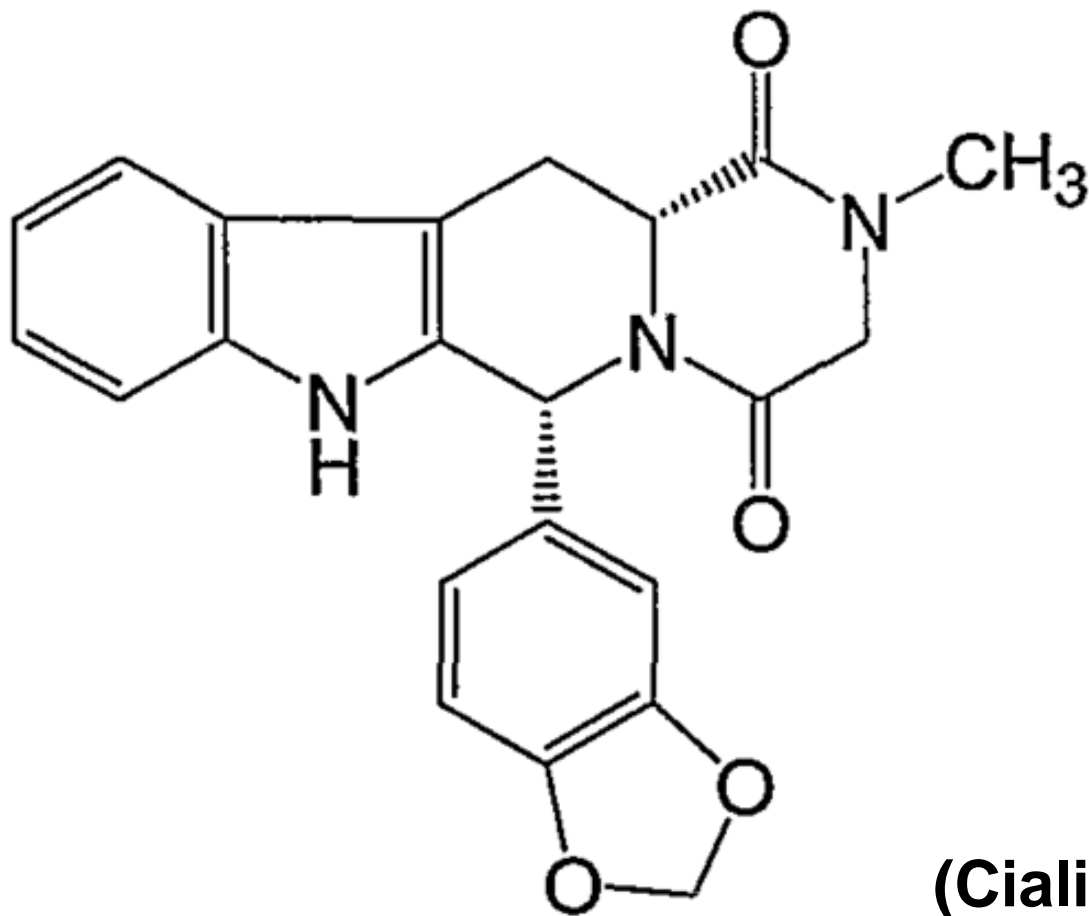
3 Hypothetical Outcomes



Questions to Address (both now and later)

- Were any of the imidacloprid concentrations high enough?
- How did the concentrations vary over time?
 - Differences by tree size?
 - Differences among clones?
 - Differences among ramets within clones?
- Did any levels degrade over time?
- How wide might the treatment window be?
- How are the logistics compared to aerial application(s)?
- What are the costs and labor requirements?
- What insects are/aren't controlled?
- Are there options for treating other tree and insect species?
- Who will address such questions? How soon?

93,500 Internet Hits for “Conifer Stimulation””



Gibberellins? Calcium Nitrate? Girdling? Root Pruning? All Four?



Gibberellins: Phytotoxicity can be touchy yet the math is easy.

Tree Size			ml ProCone / Tree		Holes to Drill (6" Apart)	ml ProCone / Hole		GA Cost/Tree (\$320/pint)	
DBH (inches)	Circumference (in)	Basal Area (cm ²)	Low Dosage (0.018 ml/cm ²)	High Dosage (0.036 ml/cm ²)		Low Dosage	High Dosage	Low Dosage	High Dosage
2	6.3	20	0.4	0.7	1	0.4	0.7	\$0.25	\$0.49
3	9.4	46	0.8	1.6	2	0.4	0.8	\$0.56	\$1.11
4	12.6	81	1.5	2.9	2	0.7	1.5	\$0.99	\$1.97
5	15.7	127	2.3	4.6	3	0.8	1.5	\$1.54	\$3.09
6	18.8	182	3.3	6.6	3	1.1	2.2	\$2.22	\$4.44
7	22.0	248	4.5	8.9	4	1.1	2.2	\$3.02	\$6.05
8	25.1	324	5.8	11.7	4	1.5	2.9	\$3.95	\$7.90
9	28.3	410	7.4	14.8	5	1.5	3.0	\$5.00	\$10.00
10	31.4	507	9.1	18.2	5	1.8	3.6	\$6.17	\$12.34
11	34.6	613	11.0	22.1	6	1.8	3.7	\$7.47	\$14.93
12	37.7	730	13.1	26.3	6	2.2	4.4	\$8.89	\$17.77
13	40.8	856	15.4	30.8	7	2.2	4.4	\$10.43	\$20.86
14	44.0	993	17.9	35.8	7	2.6	5.1	\$12.09	\$24.19
15	47.1	1,140	20.5	41.0	8	2.6	5.1	\$13.88	\$27.77
16	50.3	1,297	23.3	46.7	8	2.9	5.8	\$15.80	\$31.59
17	53.4	1,464	26.4	52.7	9	2.9	5.9	\$17.83	\$35.67
18	56.5	1,642	29.6	59.1	9	3.3	6.6	\$19.99	\$39.98

An Excerpt from the ProCone Label:

APPLICATION TIMING

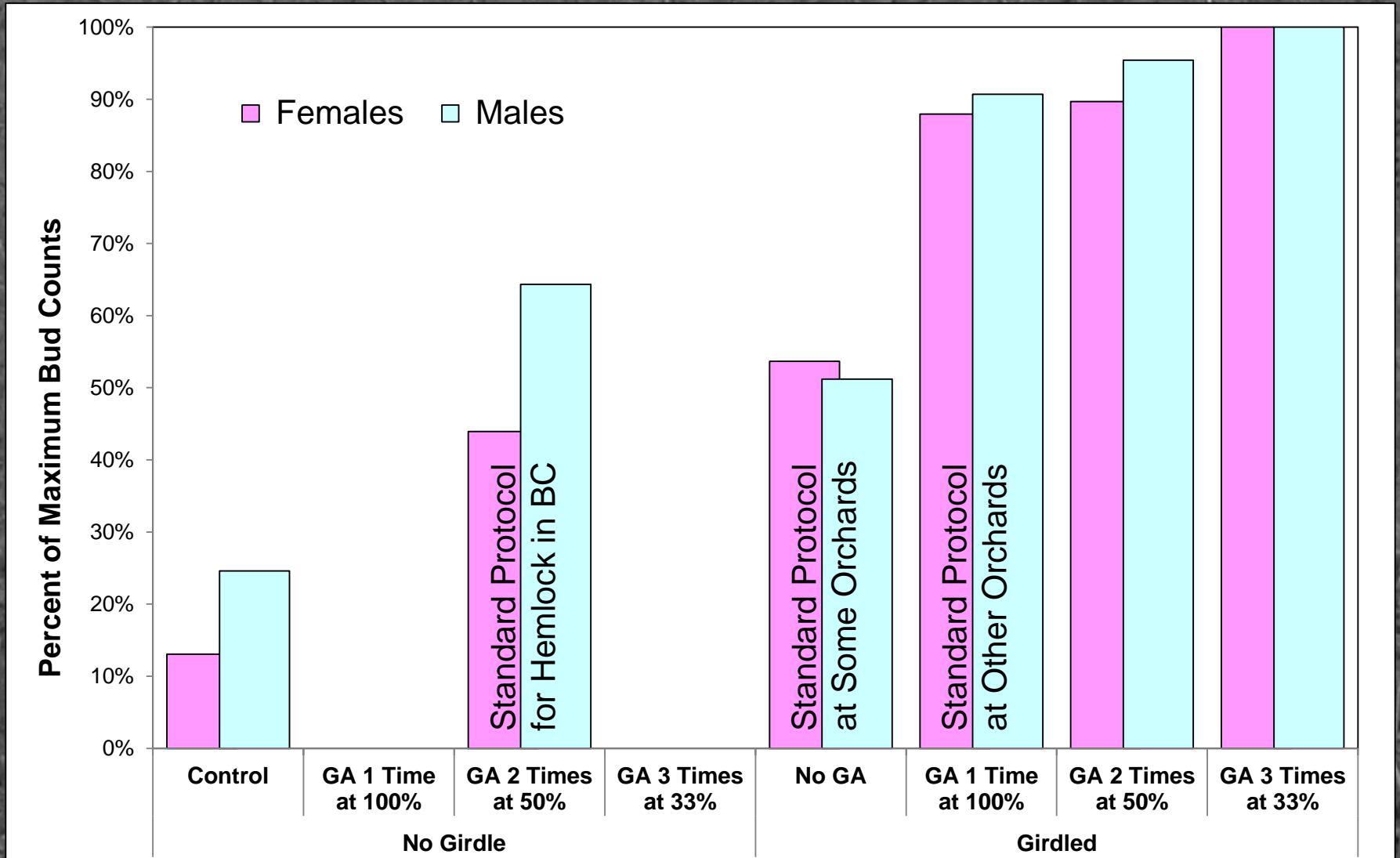
...Treatments during shoot elongation tend to promote pollen cones and treatments **after shoot elongation** tend to promote seed cones. For injections into branches or into the main stem, single applications are effective. For Picea species, ProCone should be injected when new shoots are 70 to 90% elongated. For Pinus, a single early injection near the end of shoot elongation may promote pollen cones; later injections may be required for seed cones. More than one injection date may be necessary...

May 2016 Literature Review by Candace Cahill:

...generally not much known about timing of GA injections favoring either male or female production, except possibly for western hemlock...

Paper by BC Ministry of Forests in 1988

(Douglas-fir at Nanaimo)



Is Treatment Timing Truly Critical?



Inject within days
of vegetative budburst
to differentiate buds
months later on the
very tips of those
eventual branches?

Actually need to girdle
weeks earlier during
pollen bud swell?

Green cells could be used to contrast operational logistics vs. flowering responses

		Girdling Date			
		None	At Pollen Bud Swell	At Vegetative Budburst	Determined by Logistics
GA Injection Date	None	(control)		S.O.P. at some sites	S.O.P. at some sites
	At Pollen Bud Swell				
	At Vegetative Budburst	S.O.P. at some sites	S.O.P. at some sites		
	Determined by Logistics				(simultaneous treatments)

Questions to Address (both now and later)

- Should we confirm/refine the earlier findings about timing and rates? The label recommendations are generic and somewhat counter-intuitive.
- Can we in fact skew the male/female bud ratios? Can we generate less pollen from low-ranked clones and keep the overall pollen cloud adequately dense?
- Urea (46-0-0) and ammonium sulphate (21-0-0) are NH_4^+ . Calcium nitrate (15.5-0-0) is NO_3^- . How does this affect male and females bud initiation?
- Fertilize at with $\text{Ca}(\text{NO}_3)_2$ at 300# N/Acre vs. 200#/Acre? A diminishing return doesn't imply poor returns. What are the actual costs / benefits?
- Are there options for treating other species?
- **Who will address these/other questions? How soon?**