Walnut Blight Control by Pathogen Population Management

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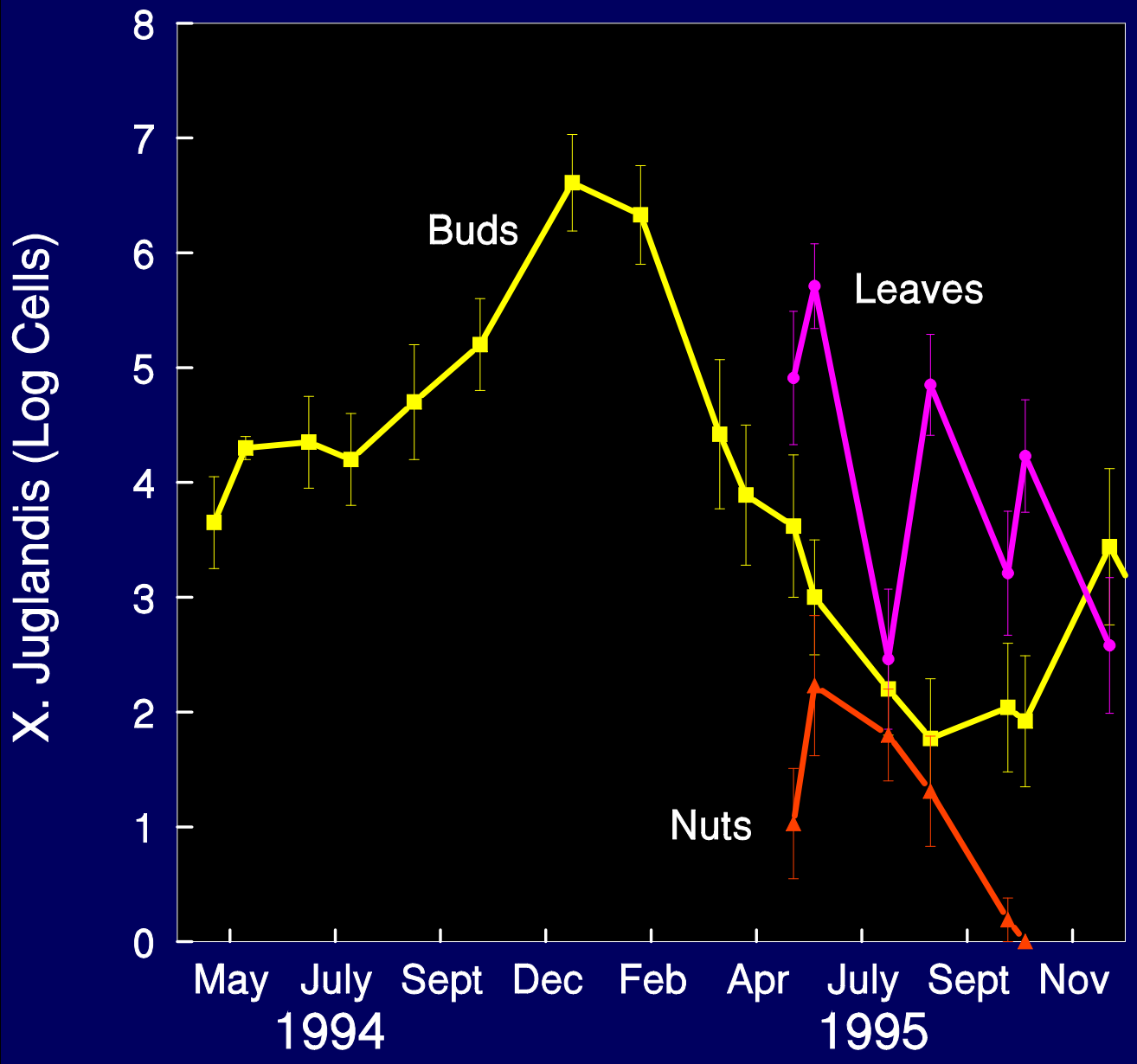
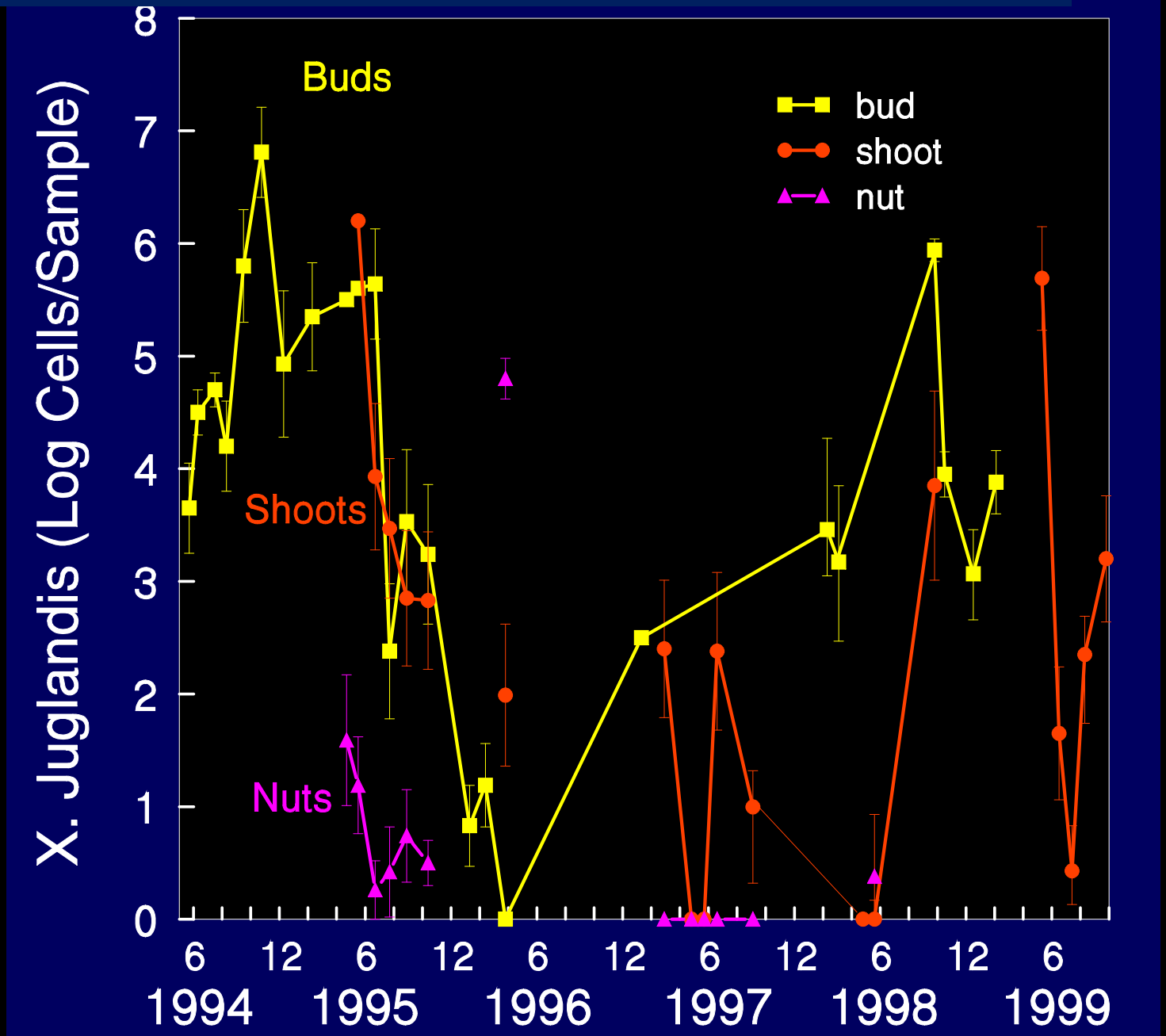
Pathogen – *Xanthomonas arboricola* pv. juglandis

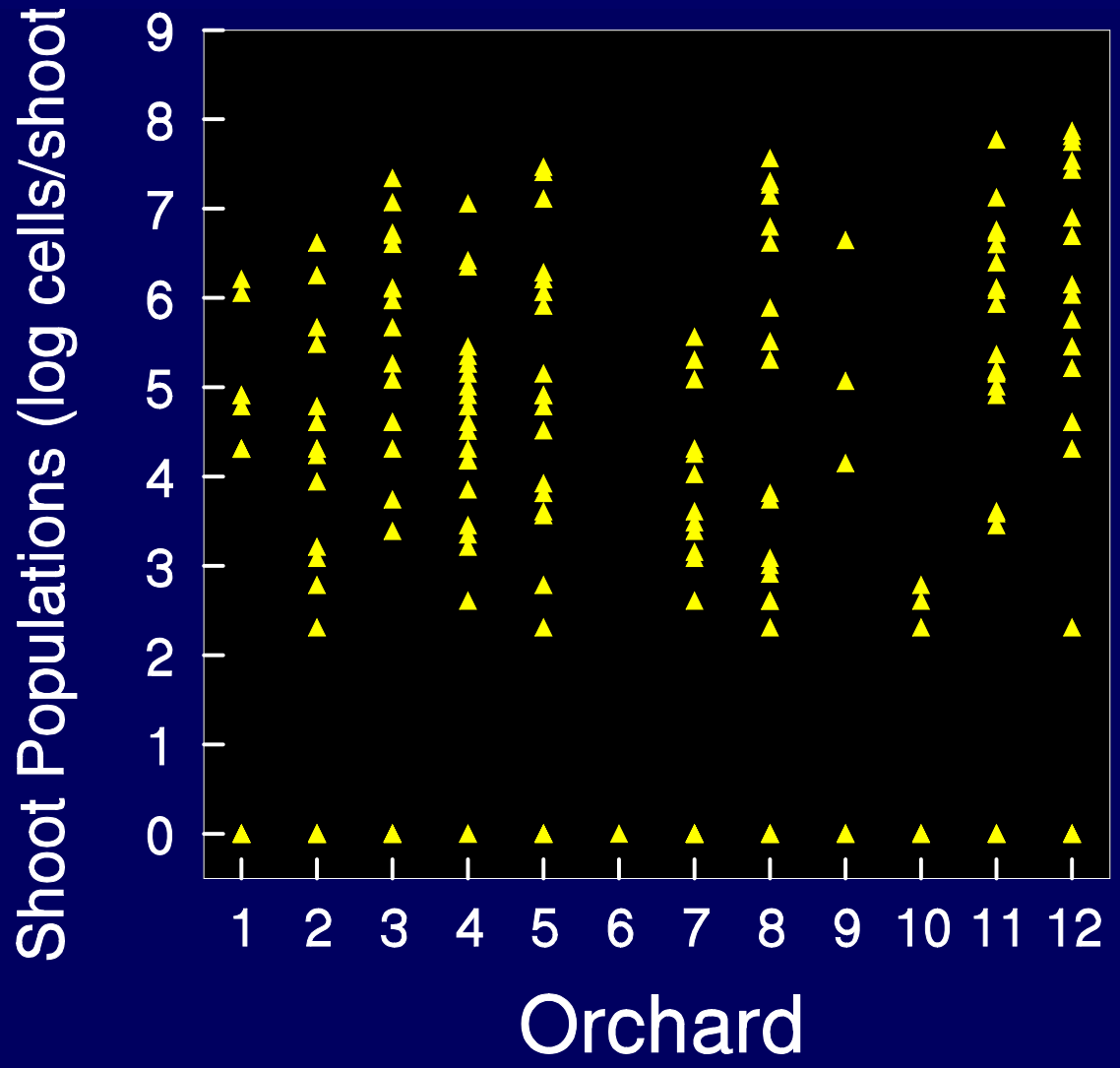
The pathogen prefers to live in buds

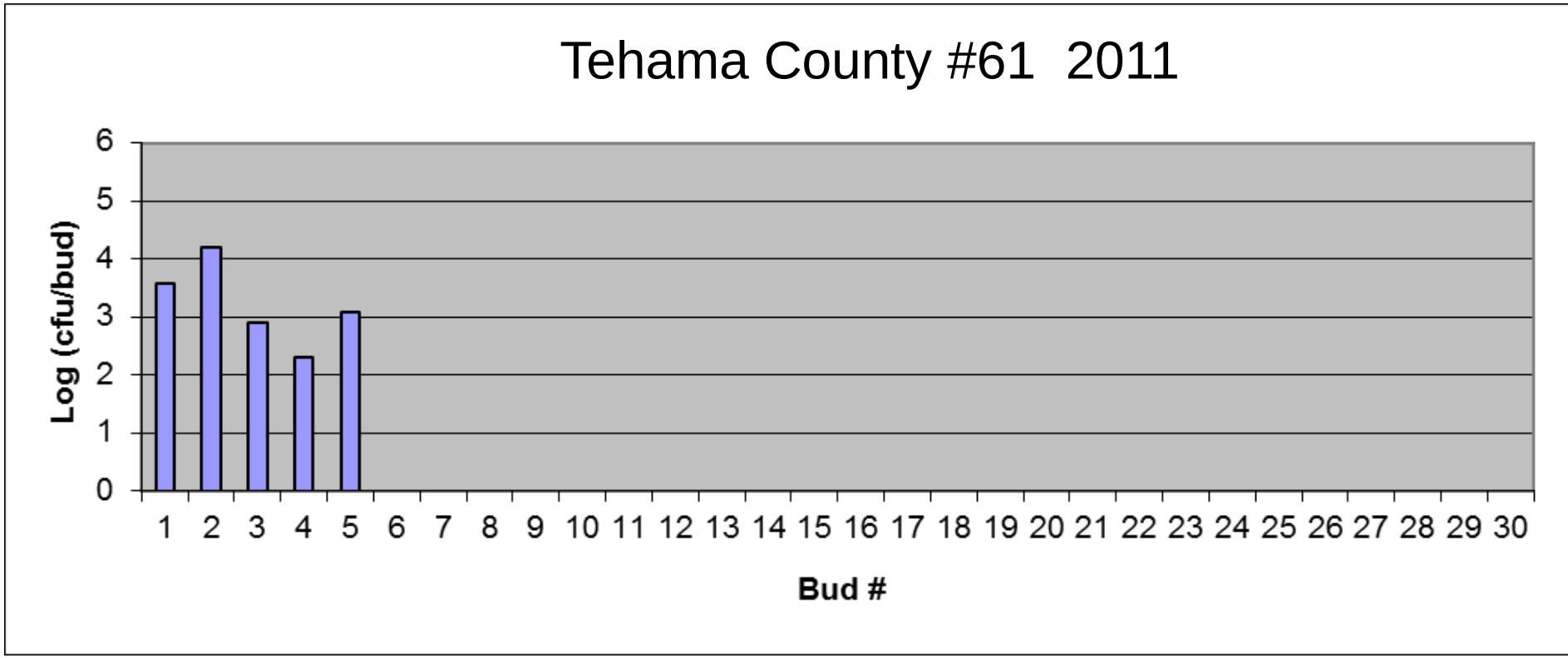


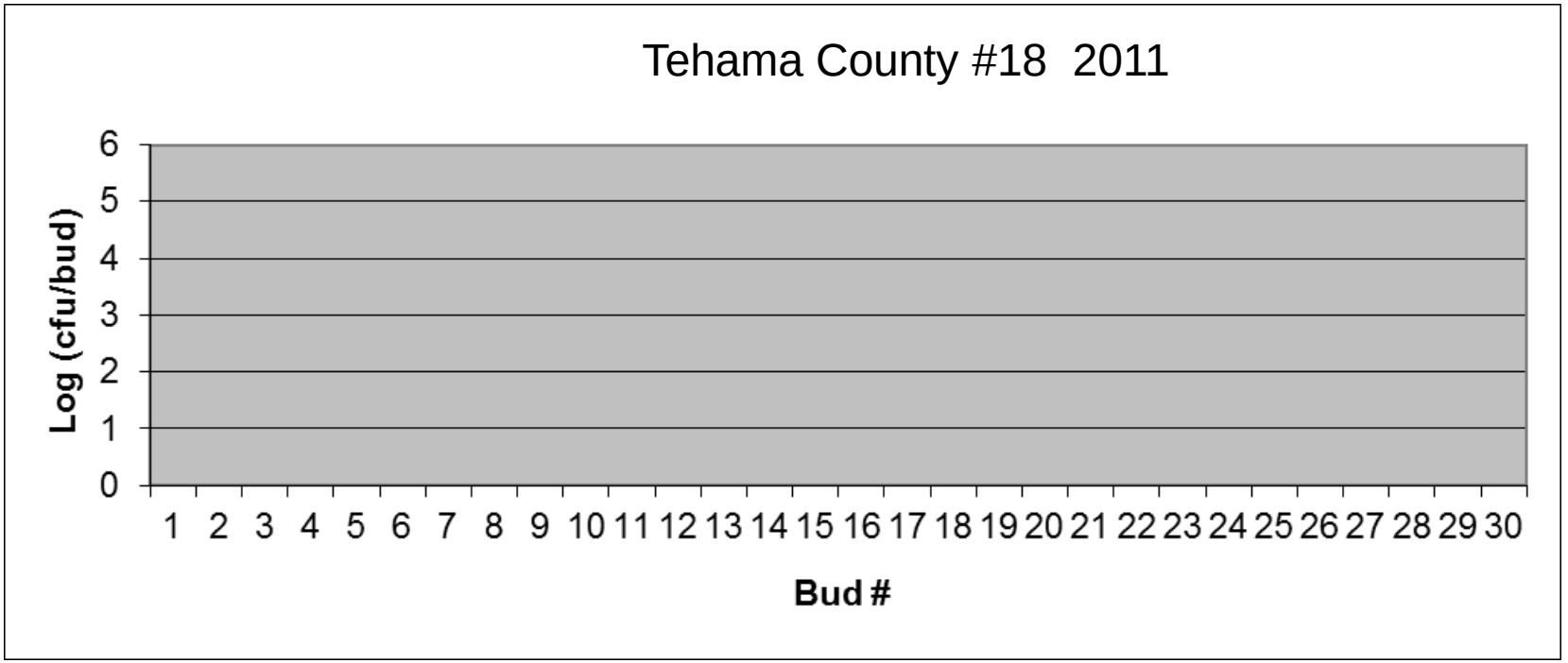
Pathogen populations change over time

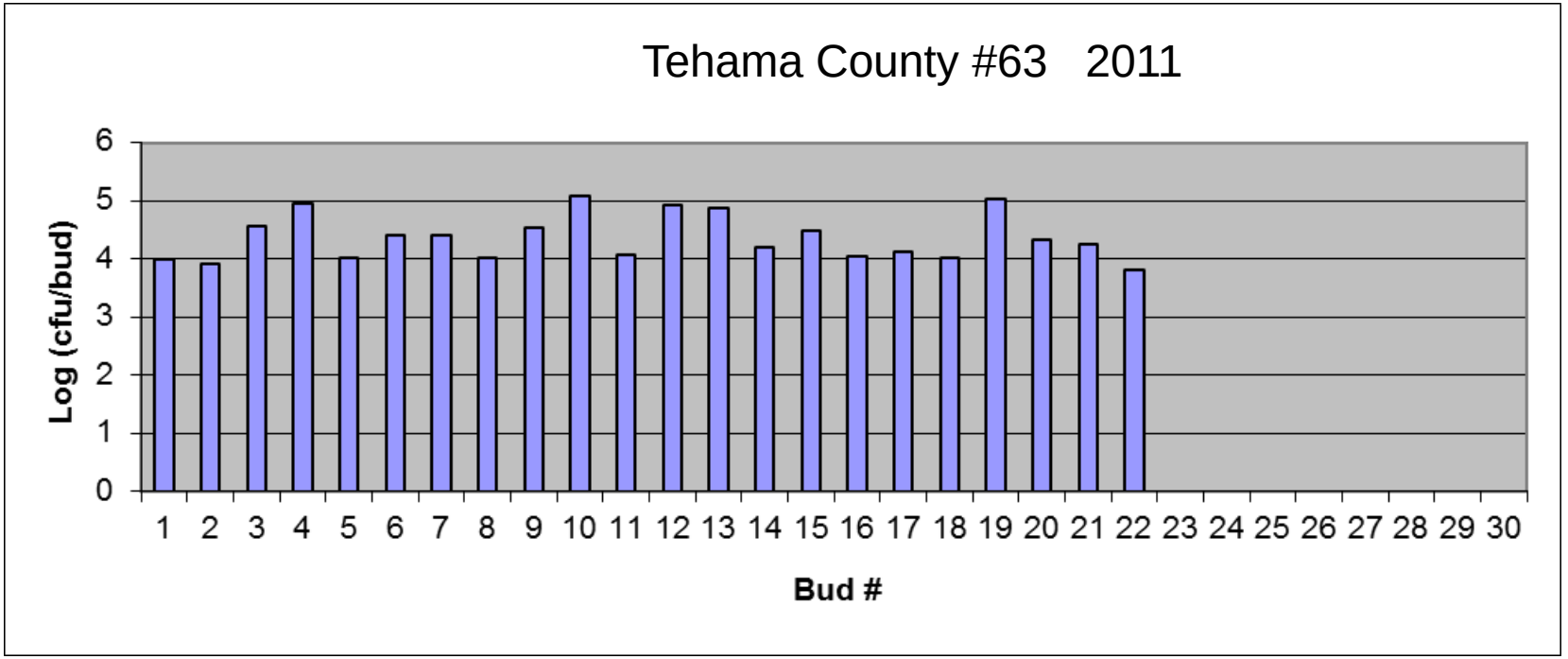


Pathogen populations vary greatly between orchards and between buds within a given orchard

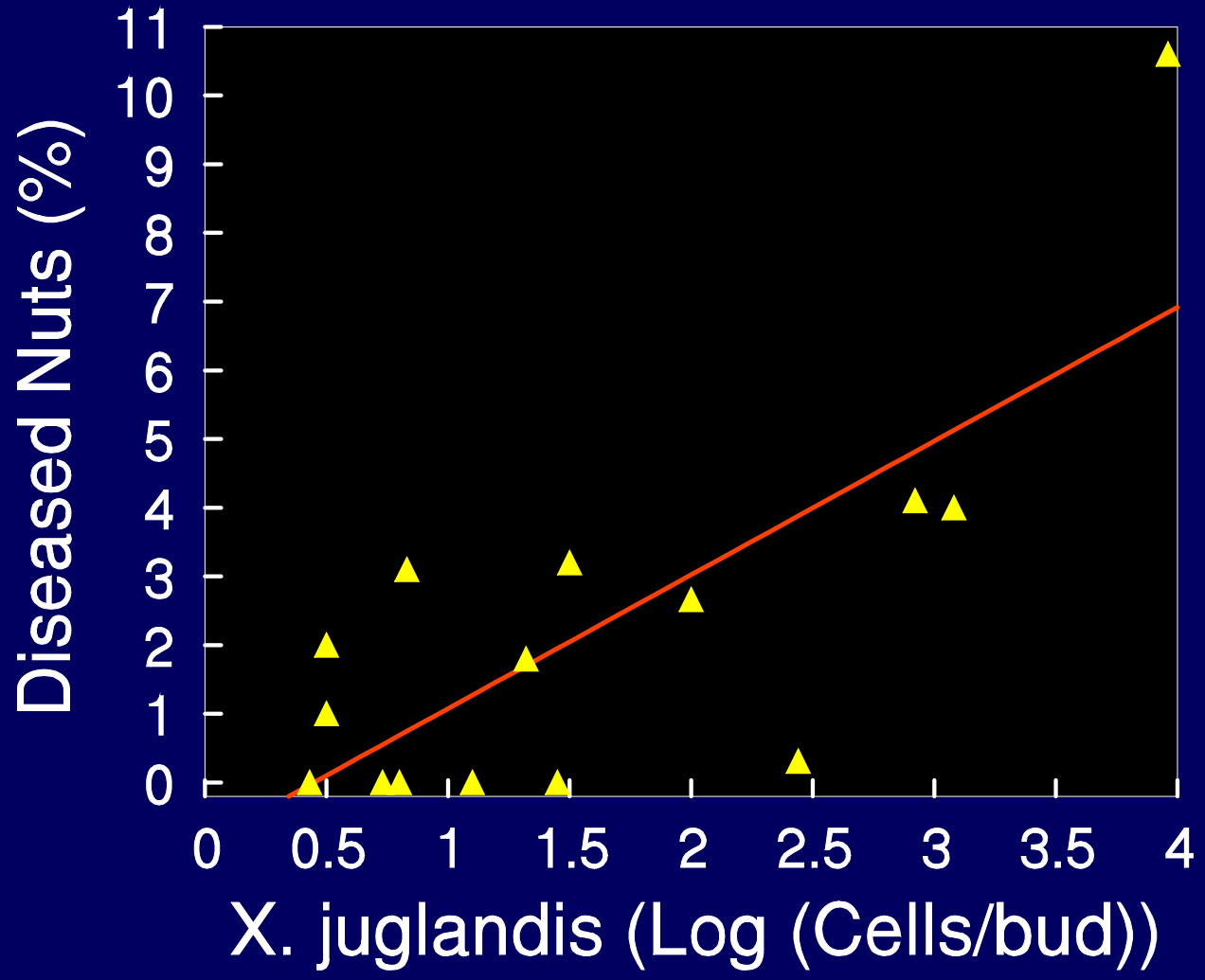



Tehama County #61 2011
Log (cfu/bud)
0
1
2
3
4
5
6
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Bud #

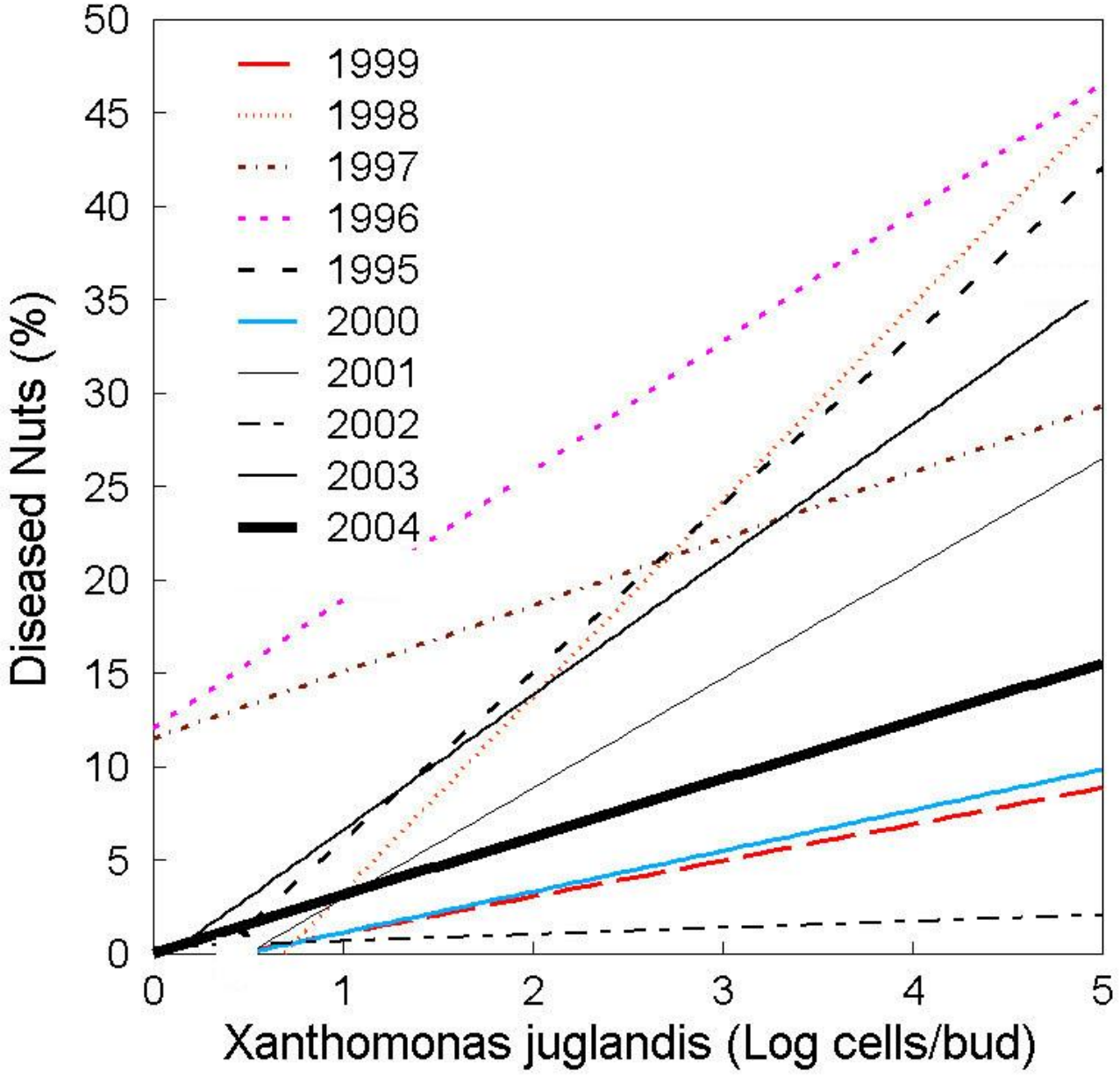

Tehama County #18 2011
Log (cfu/bud)
0 1 2 3 4 5 6
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Bud #


Tehama County #63 2011
Log (cfu/bud)
0 1 2 3 4 5 6
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Bud #

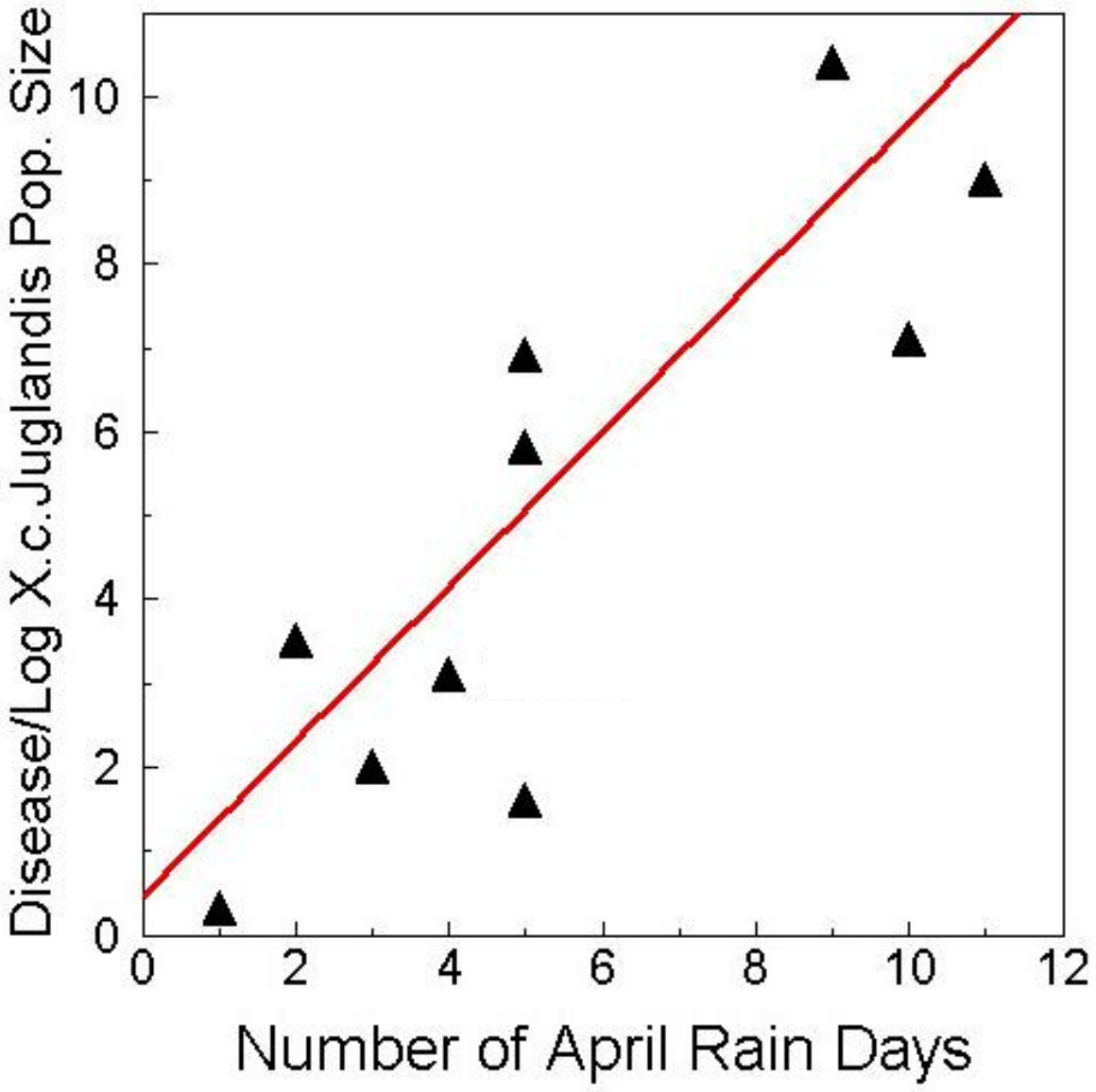
In a given year, disease incidence is predictable from early season populations of pathogen in buds

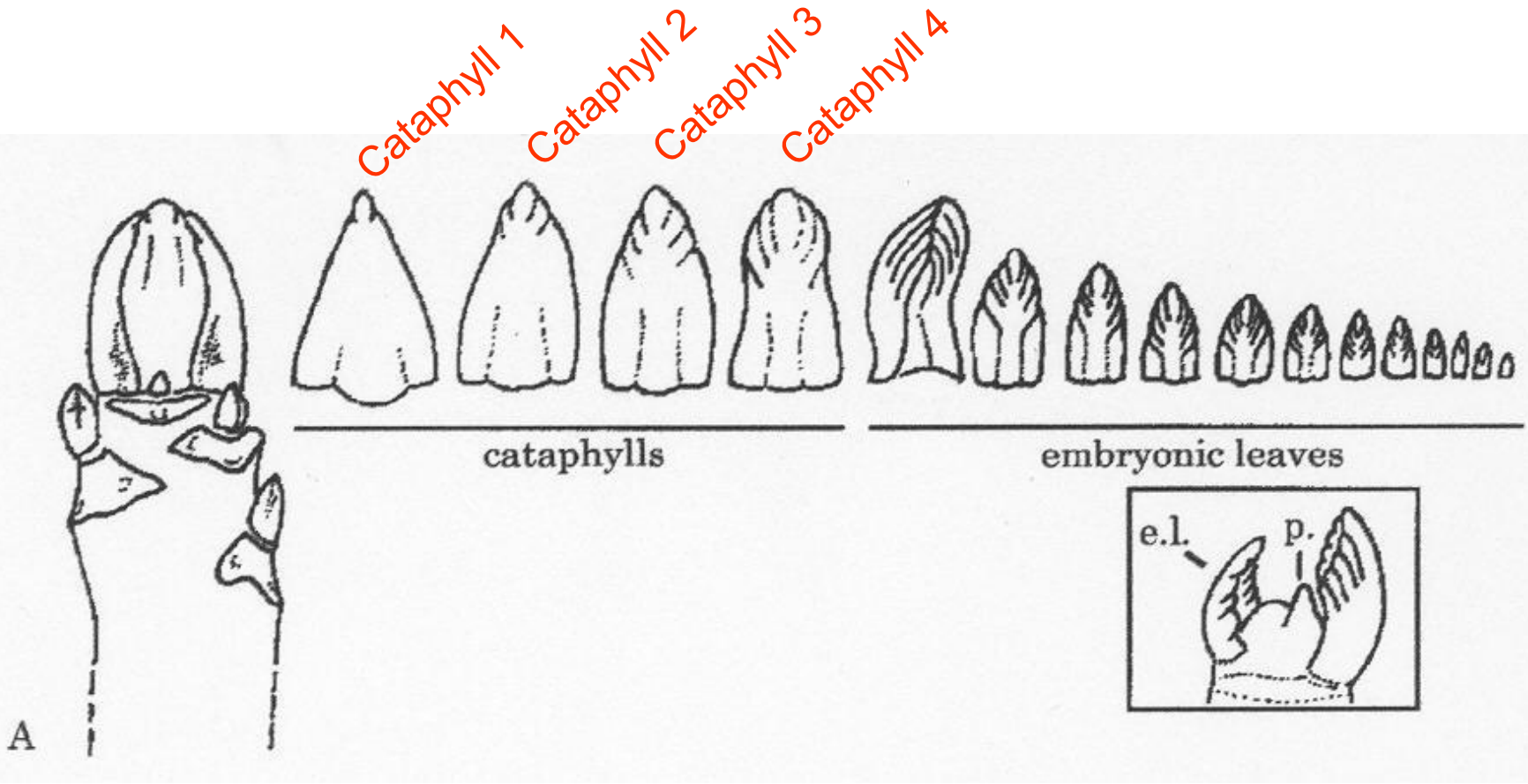


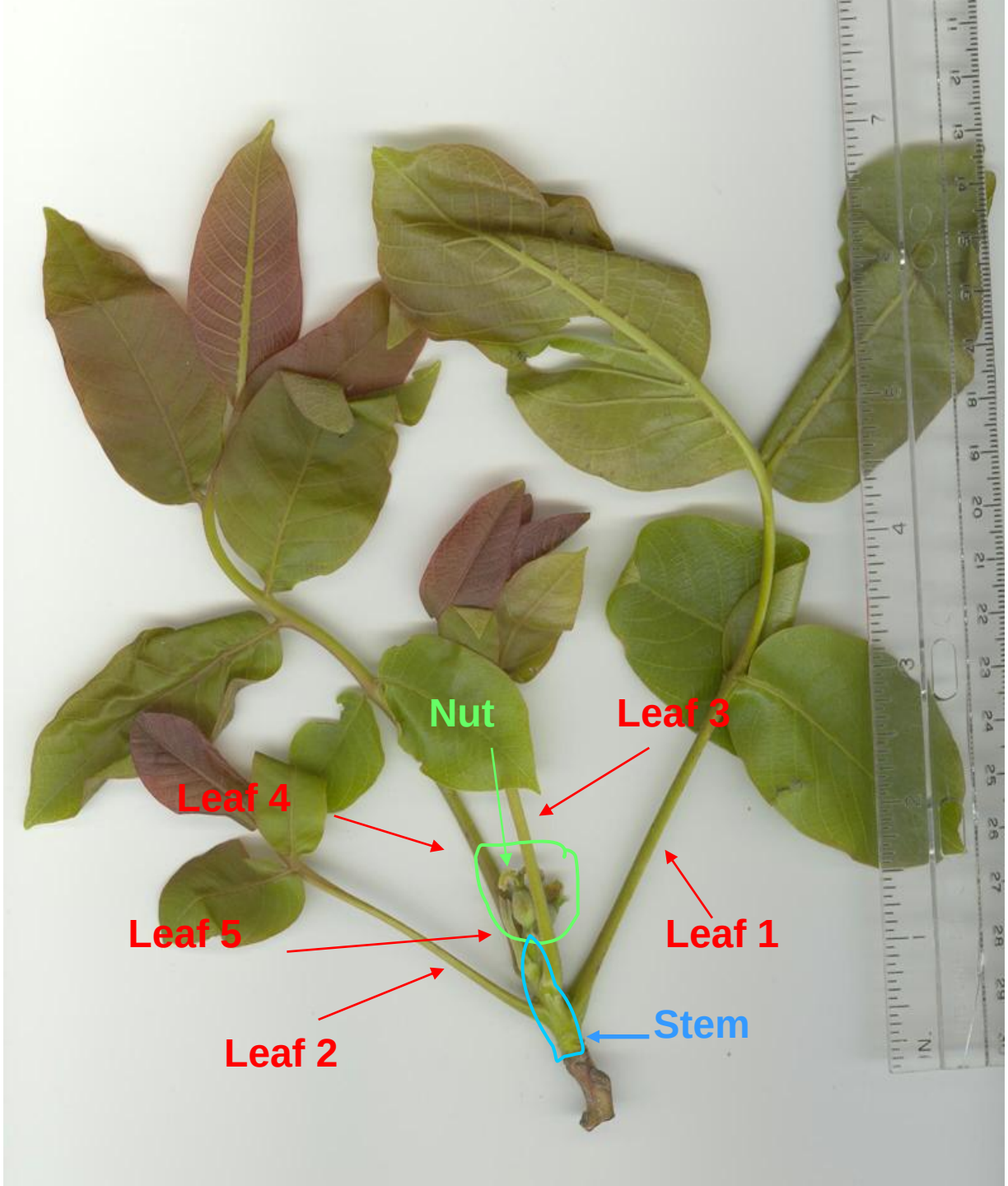
The “efficiency” with which inoculum leads to disease varies from year to year



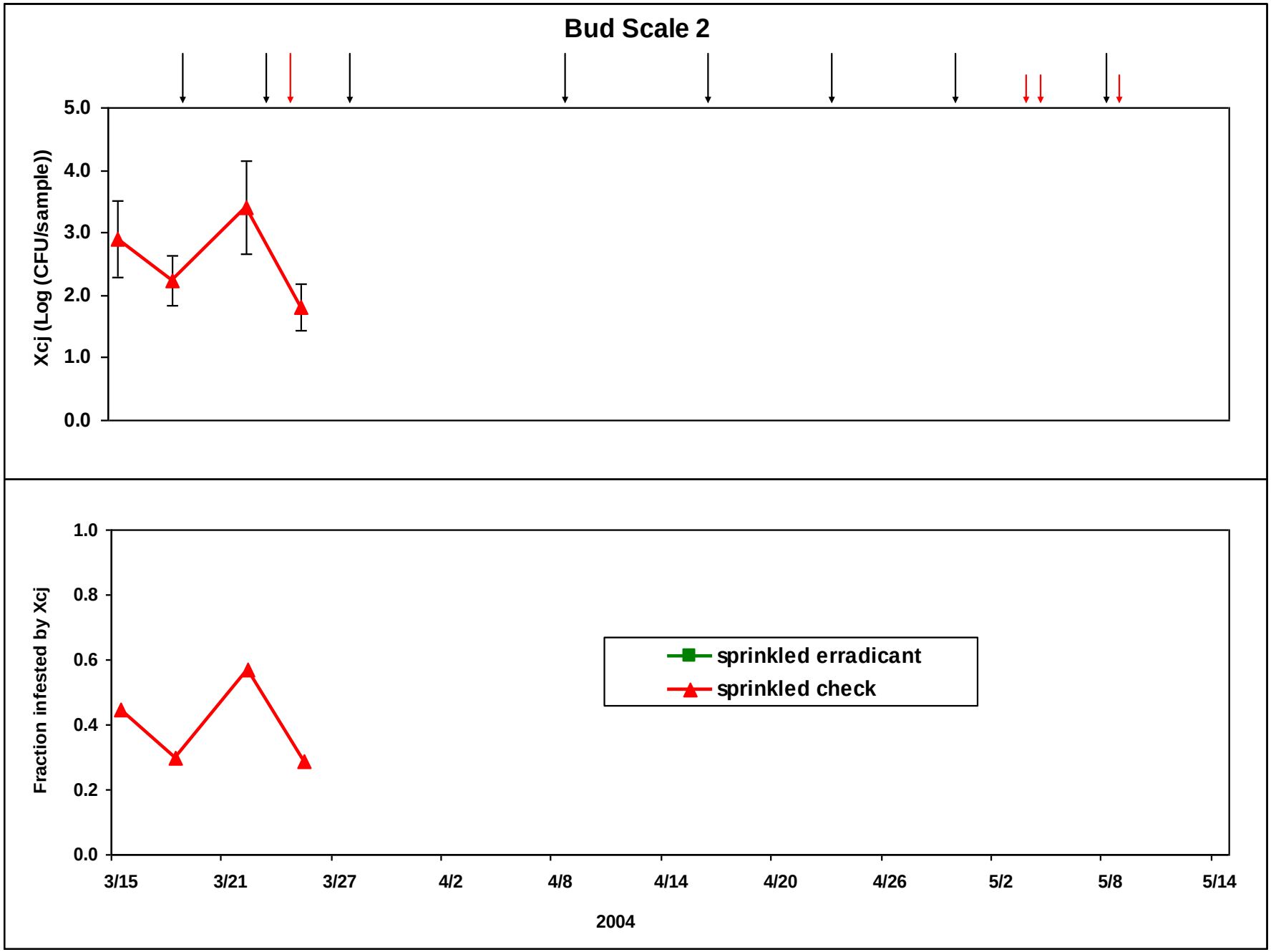
Early season rain promotes infection if inoculum is present in orchard



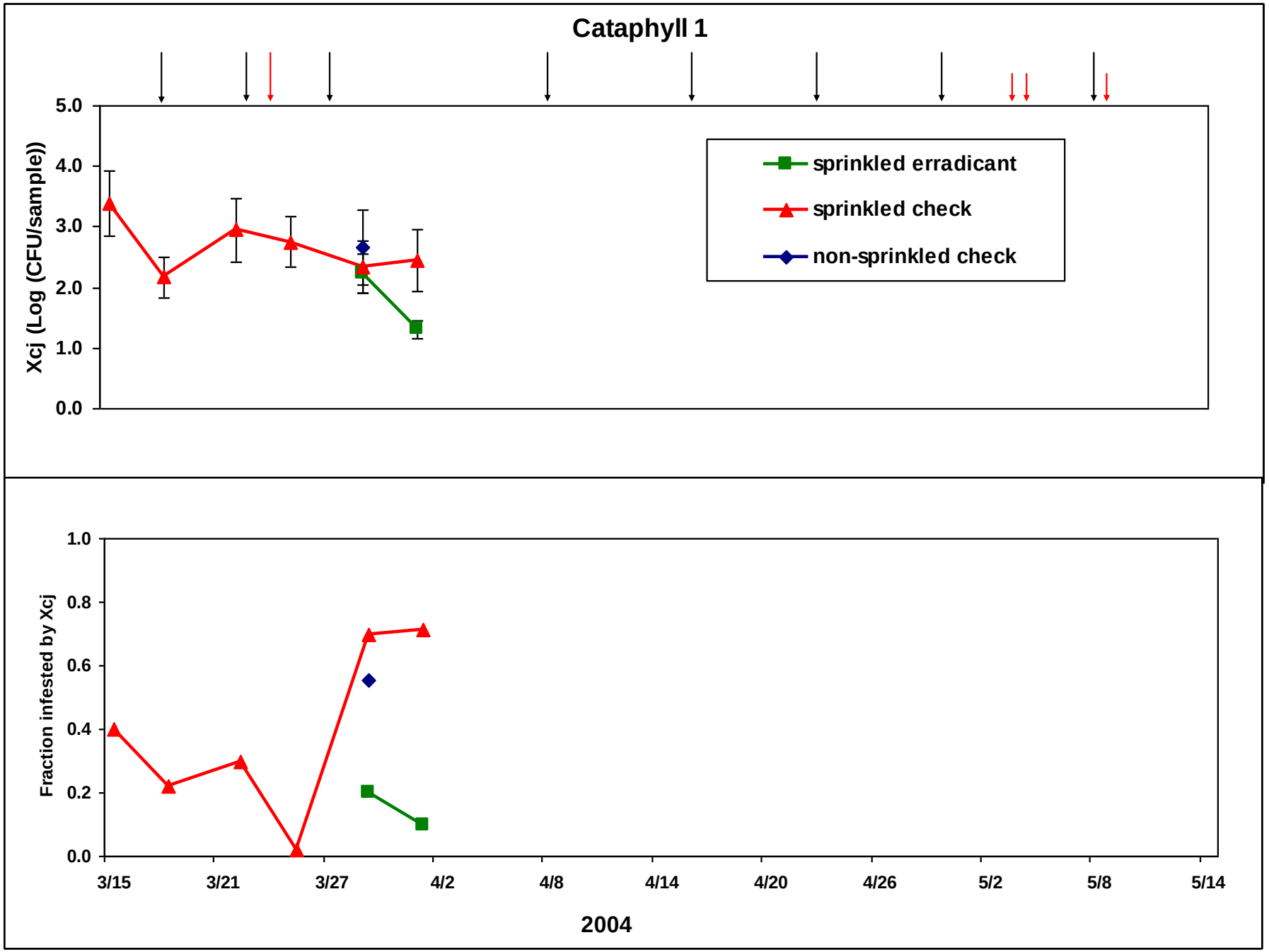

Cataphyll 1
Cataphyll 2
Cataphyll 3
Cataphyll 4
cataphylls
embryonic leaves
e.l.
p.
A


Nut
Leaf 3
Leaf 4
Leaf 5
Leaf 1
Leaf 2
Stem

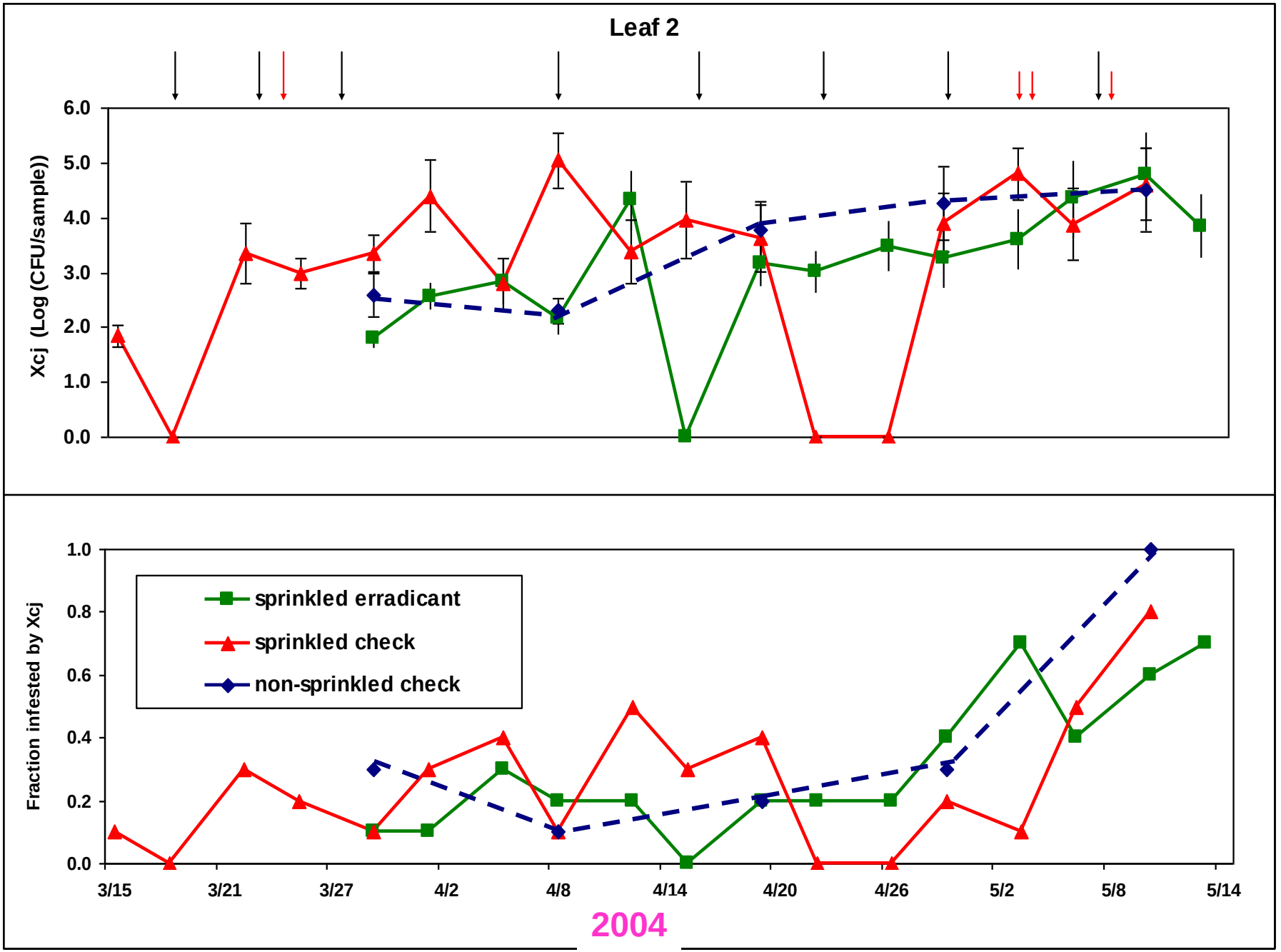
Bud scales are infested with high numbers of pathogen early in spring



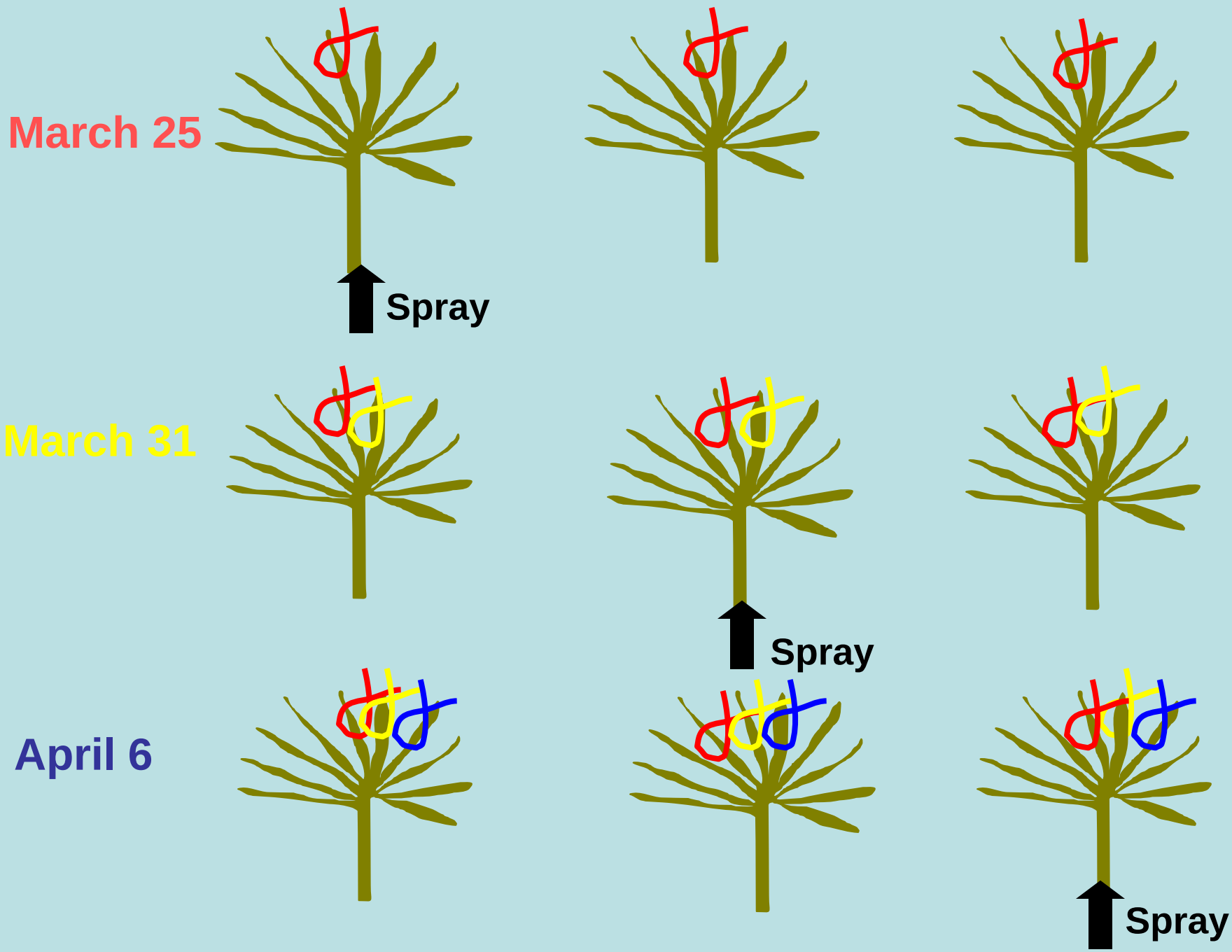
Cataphylls are infested with high numbers of pathogen early in spring

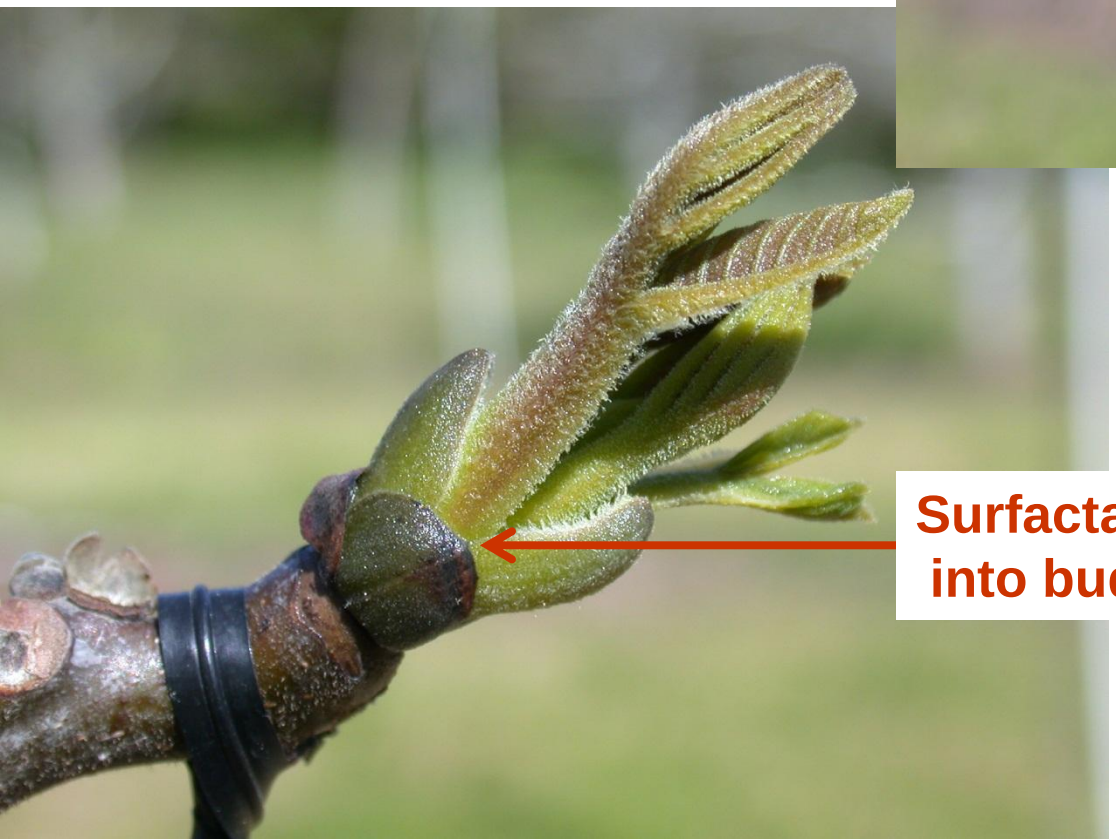


Newly-emerging leaves are largely free of pathogen shortly after opening




Inoculum


March 25
Spray
March 31
Spray
April 6
Spray



Surfactants allow penetration of sprays into bud scale and cataphylls

Sprays made shortly after bud break have largest effect on inhibiting pathogen growth – Prevent growth of inoculum as it spreads from buds

Fold- reduction in population size of *Xanthomonas juglandis* Populations on walnut trees treated once at different times relative to bud break with Kocide+Manex

Spray timing	Sample date April 7	April 26	May 10	Mean
Before Budbreak	6.0			1.9
At Budbreak	44.7	16.6	9.8	25.1
7 Days after Budbreak	1.4	8.7	35.5	15.2
14 Days after Budbreak		9.5		9.5

Early sprays have the most impact on disease control

Incidence of walnut blight on trees treated at various frequencies with Kocide + Manex

Treatment	Week						Disease	Crop	Control	Net	Return on
Eradicant	1	2	3	4	5	6	(%)	Loss($)	Costs($)	Loss($)	Control Costs($)
none							57.4 a	1722	0	722	---
+							25.4 b	762	120	882	8.00
+	+						4.4 c	132	190	322	8.36
+	+	+					4.7 c	141	260	401	6.08
+	+	+	+				1.1 c	33	330	363	5.12
+	+	+	+	+			1.0 c	30	400	430	4.23
+	+	+	+	+	+		1.2 c	36	470	506	3.58
+	+	+	+	+	+	+	0.9 c	27	540	567	3.14
none	+	+	+	+	+	+	1.1 c	33	420	453	4.02

Early buds are most likely to be fruitful

Numbers of nuts harvested from buds tagged on walnut trees as they opened at different times

Spray date	# Nuts/500 buds Bud opening date				
	Closed	Day 0	Day 7	Day 14	Day 21
Day 0	108	290			
Day 7	16	450	256		
Day 14	10	373	260	148	
No Spray	49	267	192	87	7

Pathogen populations vary between orchards, are generally predictive of disease, and are similar from year to year

Orchard	2010 % Buds with Pathogen	2010 Population Log (cfu/g) avg.	2010 % Blight	2011 % Buds with Pathogen	2011 Population Log (cfu/g) avg.	2011 Spray Mix 8lbs. Nu-Cop 50DF, 2.4 lbs. Manzate Pro-stick, 4 oz. Sylgard, 1 lb. Zinc Sulfate	2011 Spray Mix 6 lbs. Nu-Cop 50DF, 2.4 lbs. Manzate Pro-stick, 4 oz. Sylgard, 5 lbs. Potassium Nitrate	2011 % Blight
1) Howard	23	3.079	0.4	13	.43	4/12, 4/20, 5/2	5/12, 5/24	.13
2) Howard	3	3.183	1.8	70	2.56	4/12, 4/20	—	.07
3) Chandler	0	0	0	20	.75	4/16, 4/23, 5/4	5/12, 5/24	.37
4) Hartley	0	0	.03	3	.09	4/14, 4/20, 5/2	5/11, 5/23	.10
5) Chandler	0	0	0	3	.07	4/17, 4/21, 5/5	5/11, 5/25	0
6) Howard	0	0	0	10	.30	4/12, 4/19, 5/4	5/10, 5/28	0
7) Chandler	70	3.547	.16	93	3.59	4/16, 4/23, 5/5	5/9, 5/26	.77
8) Howard	10	2.739	.83	3	.10	4/14, 4/22, 5/6	5/12, 5/28	0
9) Howard	0	0	.56	0	0	4/11, 4/21, 5/4	5/13, 5/24	0
10) Chandler	0	0	0	0	0	4/16, 4/23, 5/5	511, 5/28	0
11) Chandler	0	0	0	10	.30	4/15, 4/22, 5/4	5/13, 5/27	0
12) Howard	—	—	—	6	.17	4/16, 4/20, 5/3	5/10, 5/25	0
13) Chandler	—	—	—	10	.43	4/19, 4/23, 5/5	5/12, 5/24	0
14) Chandler	—	—	—	30	1.21	4/19, 4/23, 5/5	5/12, 5/24	.02

Pathogen populations vary between orchards and are generally predictive of disease

Orchard	% Buds with Pathogen	Population Log (cfu/g) Avg.	Spray Schedule							% Blight
1) Hartley	16	.53	4/15(A) B+PS	4/22(A) NC+PS	5/5(A) B+PS	5/16(G) B+PS	6/2(A) KC+PS			.11
2) Chandler	0	0	4/15(G) B+PS	4/21(G) B+PS	5/5(G) B+PS	5/14(G) B+PS	5/27(G) K+PS	6/3 (G) KC+PS		2.59
3) Chandler	73	3.20	4/15(A) B+PS	4/21(G) B+PS	5/5(G) B+PS	5/13(G) B+PS	5/24(G) K+PS	6/3(G) KC+PS		3.94
4) Chandler	56	2.19	4/14(G) B+PS	4/19(G) B+PS	4/28(G) B+PS	5/13(G) B+PS	5/23(G) K+PS	6/2(G) KC+PS		1.44
5) Ashley	0	0	3/31(A) NC+PS	4/6(A) B+PS	4/14(G) B+PS	4/21(A) B+PS	5/9(G) K+PS	5/20(A) K+PS	6/2(G) KC+PS	5.24
6) Howard	20	.67	4/12(G) B+PS	4/18(G) B+PS	4/26(G) B+PS	5/11(G) B+PS	5/21(G) K+PS	5/31(G) KC+PS		.18
7) Chandler	46	1.77	4/15(A) B+PS	4/22(G) B+PS	5/5(A) B+PS	5/14(G) B+PS	5/24(G) K+PS	6/3(G) KC+PS		1.76
8) Howard	40	1.38	4/13(G) B_PS	4/19(G) B+PS	4/27(G) B+PS	5/11(G) NC+PS	5/20(G) B+PS	5/28(G) K+PS		.79
9) Howard	16	.76	4/12(G) B+PS	4/16(G) B+PS	4/27(G) B+PS	5/12(G) B+PS	5/20(G) K+PS	5/28(G) KC+PS		.68
10) Vina	60	2.50	4/16(A) B+PS	4/12(A) B+PS	4/21(A) B+PS	5/10(G) K+PS	5/20(A) K+PS	6/2(A) KC+PS		2.60
11) Howard	53	1.93	4/14(G) B+PS	4/19(G) B+PS	4/27(G) B+PS	5/12(G) K+PS	5/23(G) K+PS	6/2(G) KC+PS		.41
12) Howard	40	1.29	4/14(G) B+PS	4/19(G) B+PS	4/27(G) B+PS	5/12(G) K+PS	5/23(G) K+PS	6/2(G) KC+PS		4.82
13) Tulare	0	0	4/12(G) B+PS	4/15(G) B+PS	4/21(G) B+PS	5/6(G) B+PS	5/19(G) B+PS	5/30(G) KC+PS		.03
14) Vina	3	.12	4/6(A) B+PS	4/12(A) B+PS	4/22(A) B+PS	5/6(G) B+PS	5/21(A) B+PS	6/2(A) KC+PS		.52
15) Chandler	83	2.81	4/14(G) B+PS	4/20(G) B+PS	4/28(G) B+PS	5/13(G) K+PS	5/23(G) K+PS	6/2(G) KC+PS		2.09

Pathogen populations and disease are not spatially variable

Orchard Location and variety	% Buds with pathogen	Population Log (cfu/g)	Spray Schedule 6 lbs/ac Kocide 2000 plus 2.4 lbs/ac Pro-stick	% Blight
1) Upper, Vina	3	.08	4/12, 4/26 & 5/5	1.58
2) Lower South, Vina	16	.50	4/12, 4/26 & 5/5	1.49
3) Lower Middle, Vina	23	.82	4/12, 4/26 & 5/5	1.23
4) Lower North,Vina	6	.23	4/12, 4/26 & 5/5	2.00

Replicate samples assayed in different labs provide similar estimates of pathogen abundance

	Laboratory A		Laboratory B	
Orchard/Variety	% Buds with pathogen	Population Log (cfu/g) avg	% Buds with pathogen	Population Log (cfu/g) avg
1) Howard	10	.35	13	.43
2) Howard	43	1.49	70	2.56
3) Chandler	16	.41	20	.75
4) Hartley	0	0	3	.09
5) Chandler	0	0	3	.07
6) Howard	23	.65	10	.30
7) Chandler	33	1.37	93	3.59
8) Howard	0	0	3	.10
9) Howard	3	.10	0	0
10) Chandler	0	0	0	0
11) Chandler	6	.23	10	.30
12) Vina	10	.35	23	.82
13) Hartley	20	.67	16	.53
14) Chandler	63	2.25	56	2.19
15) Howard	0	0	20	.67
16) Howard	23	.91	53	1.93
17) Chandler	3	.09	10	.43
18) Howard	20	.61	6	.17
19) Howard	0	0	3	.10
20) Chandler	33	.95	30	1.21

03 Buchner Walnut Blight Walnut Day 2012.ppt