

Management of White Pine:
Assessing the effectiveness of
our selection and breeding
programs by measuring
"field resistance"

White Pine Blister Rust
“Field Resistance” observed in
U.S. and Canadian
provenance trials

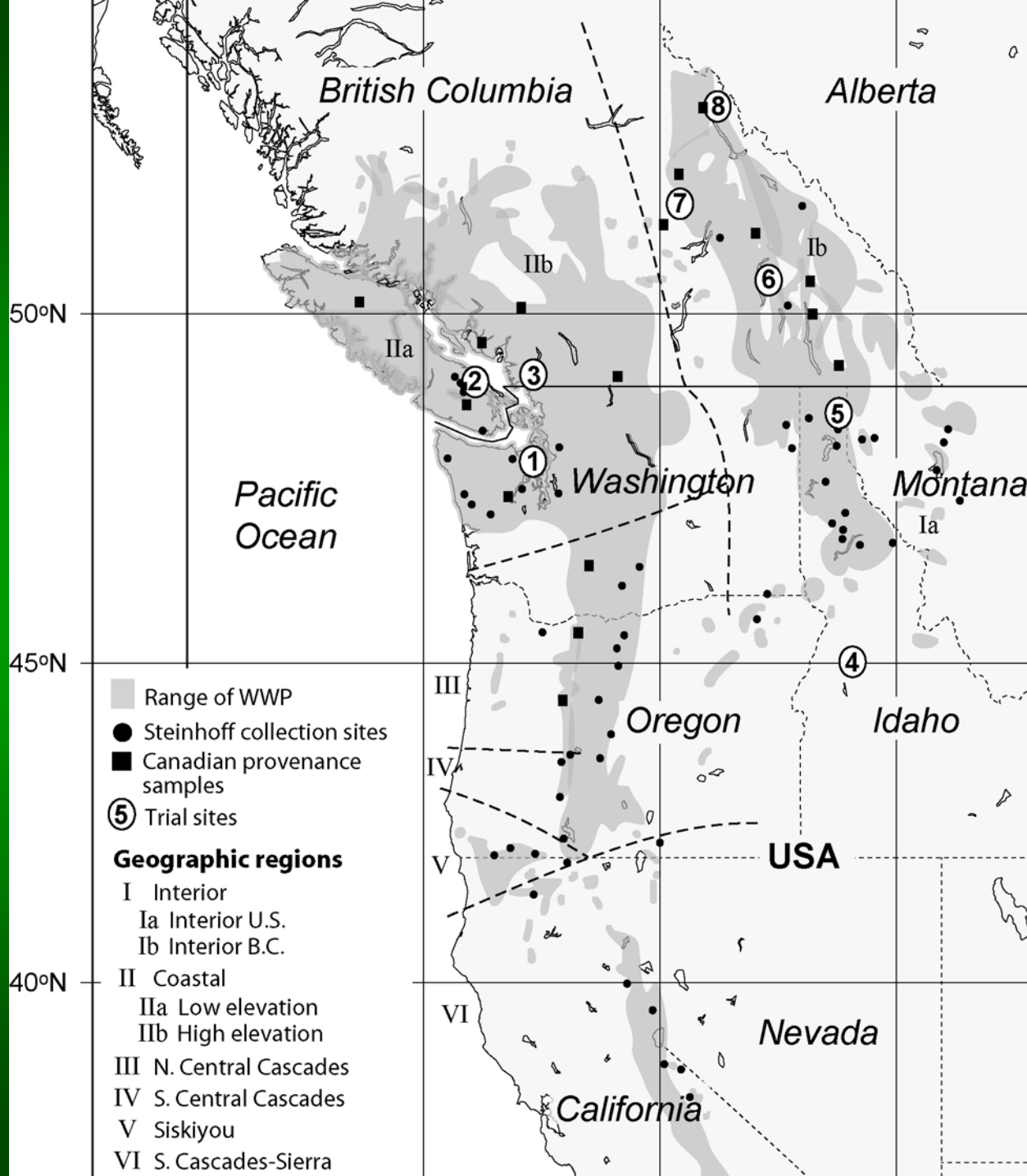


Table 1. Site Descriptions of Provenance Trials Reported.

Site	Agency	Location	Latitude °N	Longitude °W	Elevation m	Mean Height and Age	% Blister Rust Infection overall plantation and Idaho collection	References to Sites or Materials
1 Whidbey Is.	WA DNR	Washington, Coastal	48° 03'	122° 46'	50	123 - 20	54%	1,2
2 Ladysmith	Canadian For. Serv.	BC Coastal	49° 00'	123° 52'	75		68% - 79%	3,4,5,6
3 Sechelt	Canadian For. Serv.	BC Coastal	49° 30'	123° 44'	250		91% - 96%	3,4,5,6
4 Lost Valley	USDA For. Serv. Region 1	Idaho South	44° 59'	116° 30'	1800	35 - 21	85% - 91%	1,2
5 Priest River	USDA For. Serv. Region 1	Idaho North	48° 20'	116° 42'	730	95 - 20	22% - 24%	1,2
6 Nakusp	Canadian For. Serv.	BC Interior (South)	50° 15'	117° 46'	680	46 - 12	38%	3,4,5
7 Barrière	Canadian For. Serv.	BC Interior (Central)	51° 19'	119° 54'	725	52 – 12		3,4,5
8 Valemount	Canadian For. Serv.	BC Interior (North)	52° 41'	119° 03'	760	49 - 12	81%	3,4,5

¹ Steinhoff *et al.* 1983.

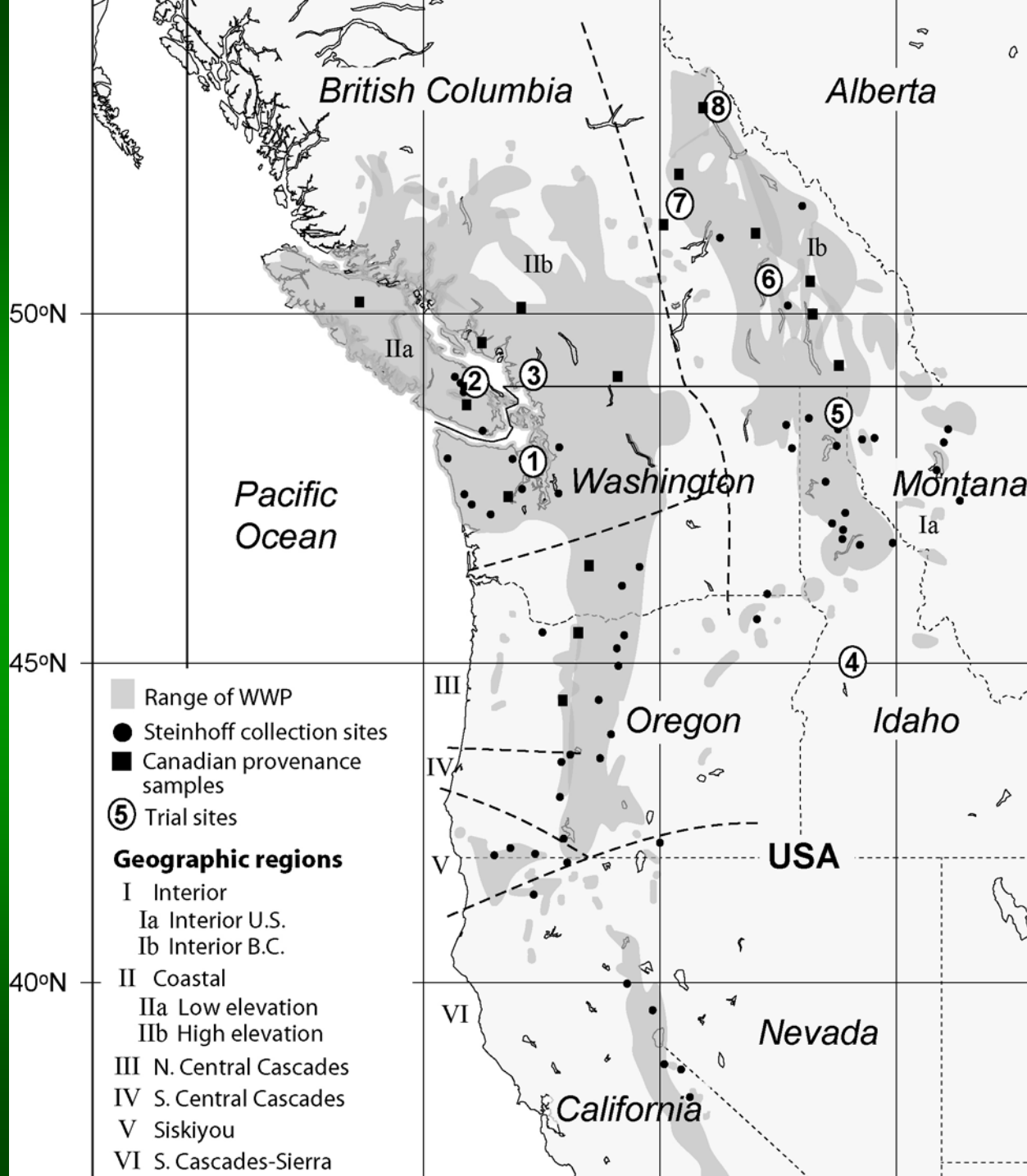
² Rehfeldt *et al.* 1984.

³ Hunt 1984.

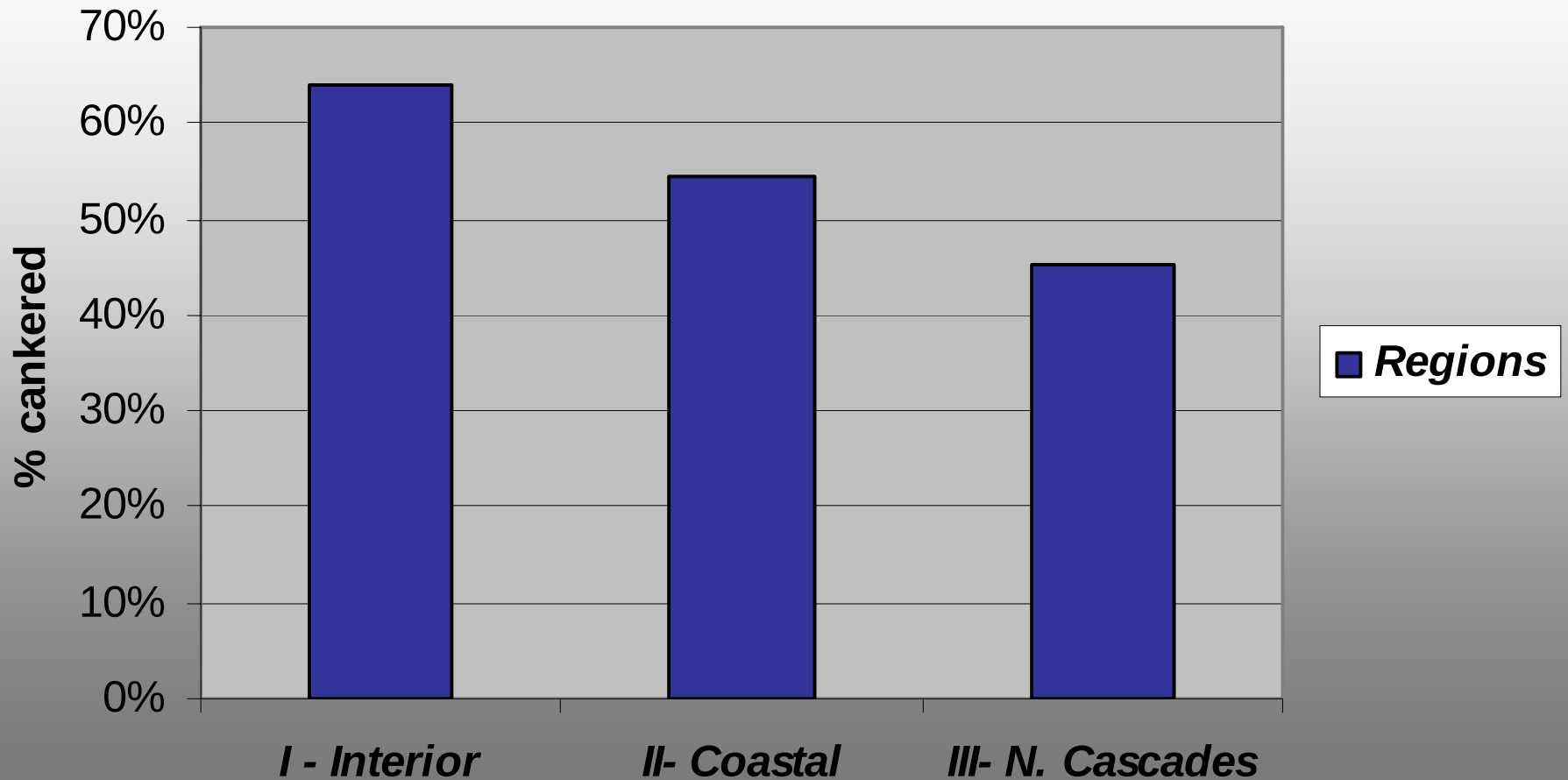
⁴ Meagher & Hunt 1998.

⁵ Meagher & Hunt 1999.

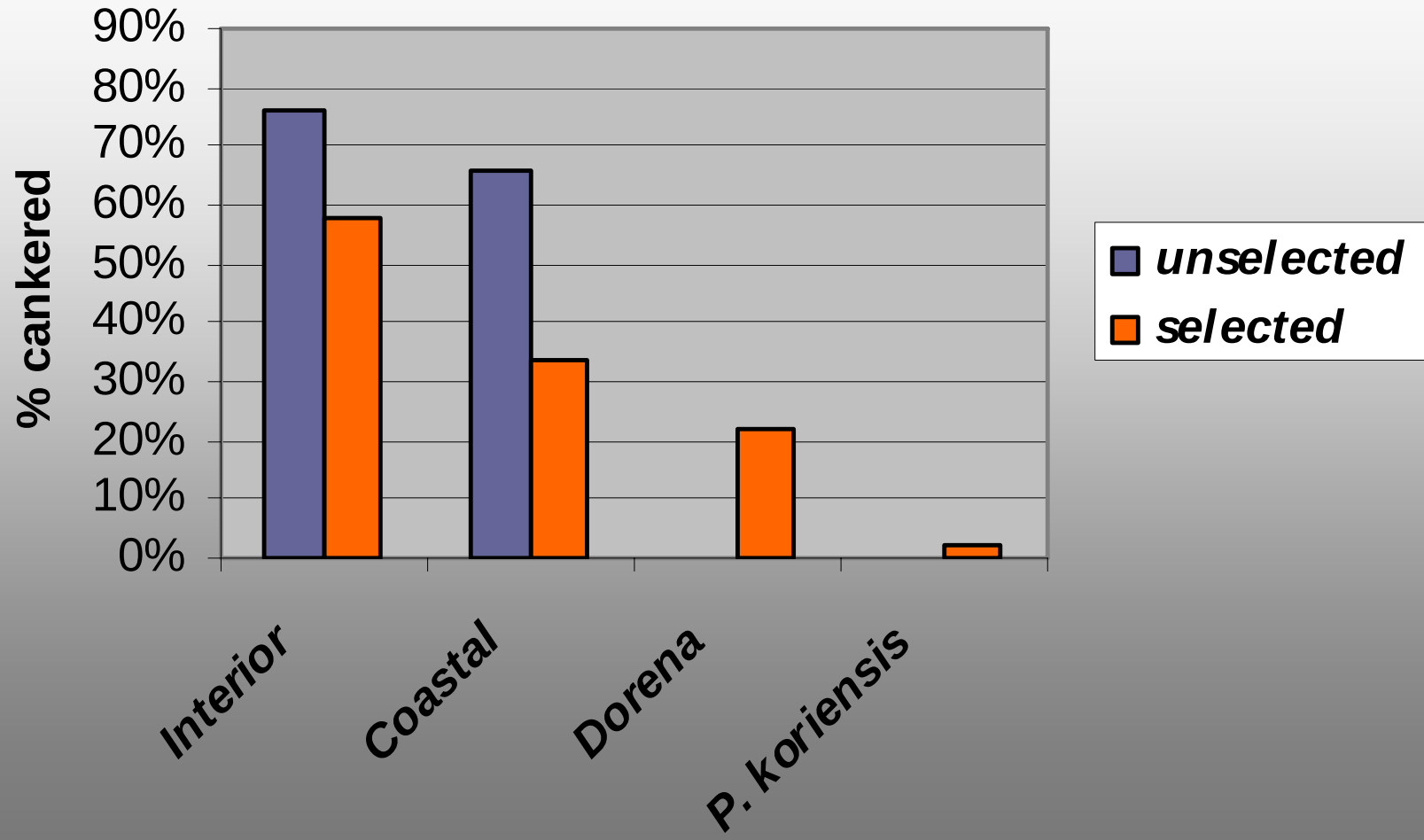
⁶ King & Hunt 2004.



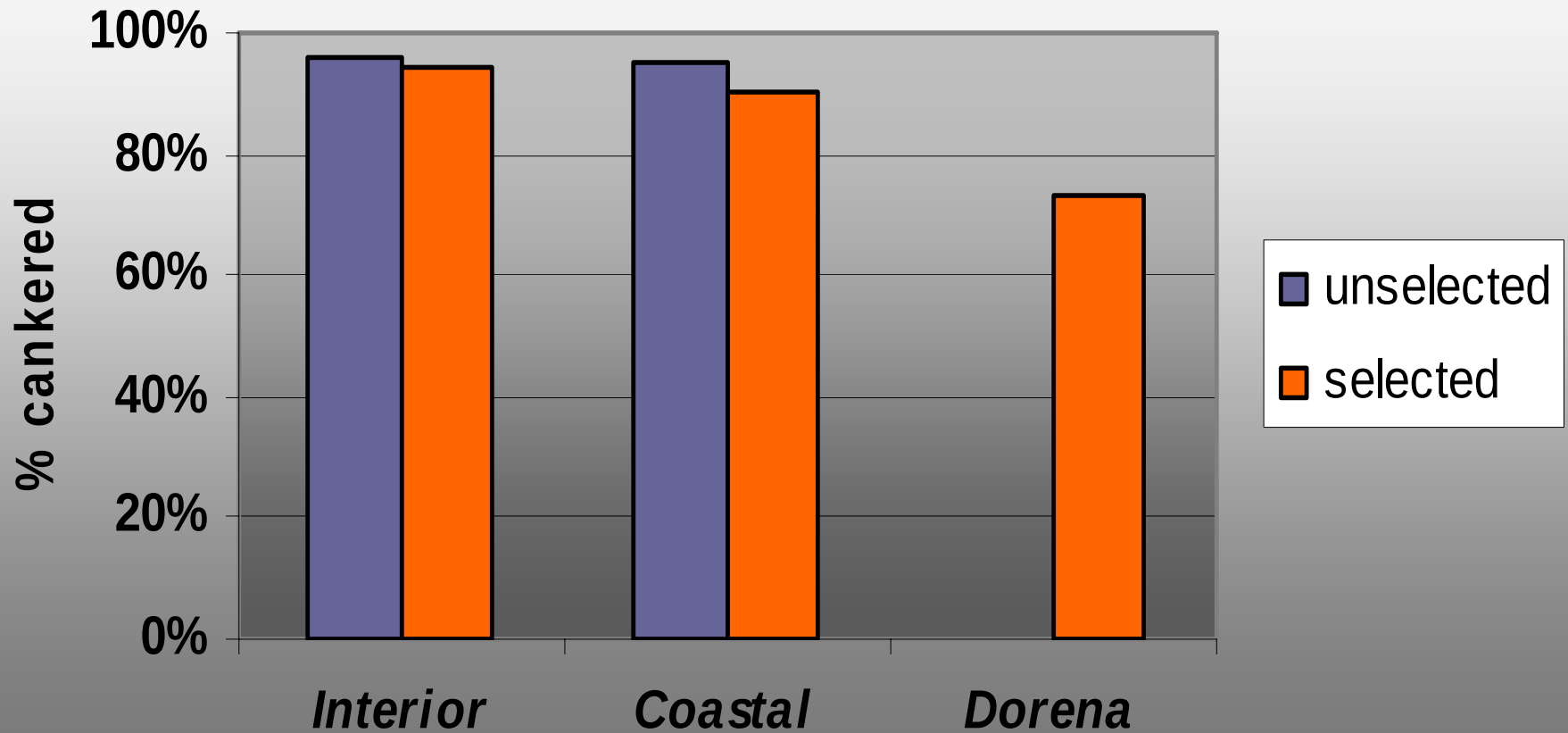
Natural Population Variation - Coastal



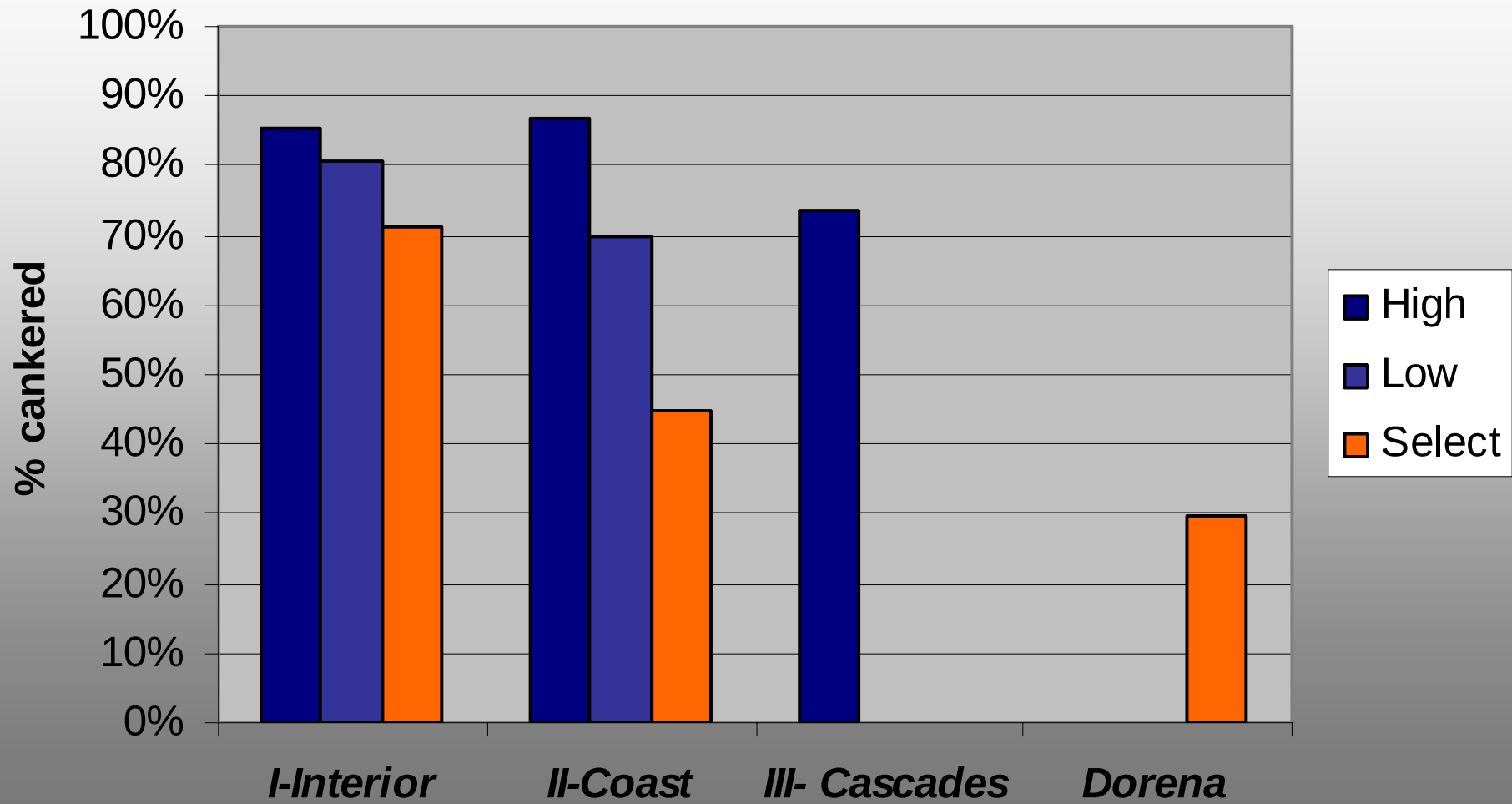
Coastal Canadian Trial Results



Sechelt 2001 observations



Valemont BC



Observations and trends

- As previously shown the Northern Populations are superior for growth and resistance
- Interior populations are more susceptible but are great in vigor and growth
- On the Coast the North Central Cascades are some of the most resistant but taking out high elevation...North Coast is as good....

Observations and trends

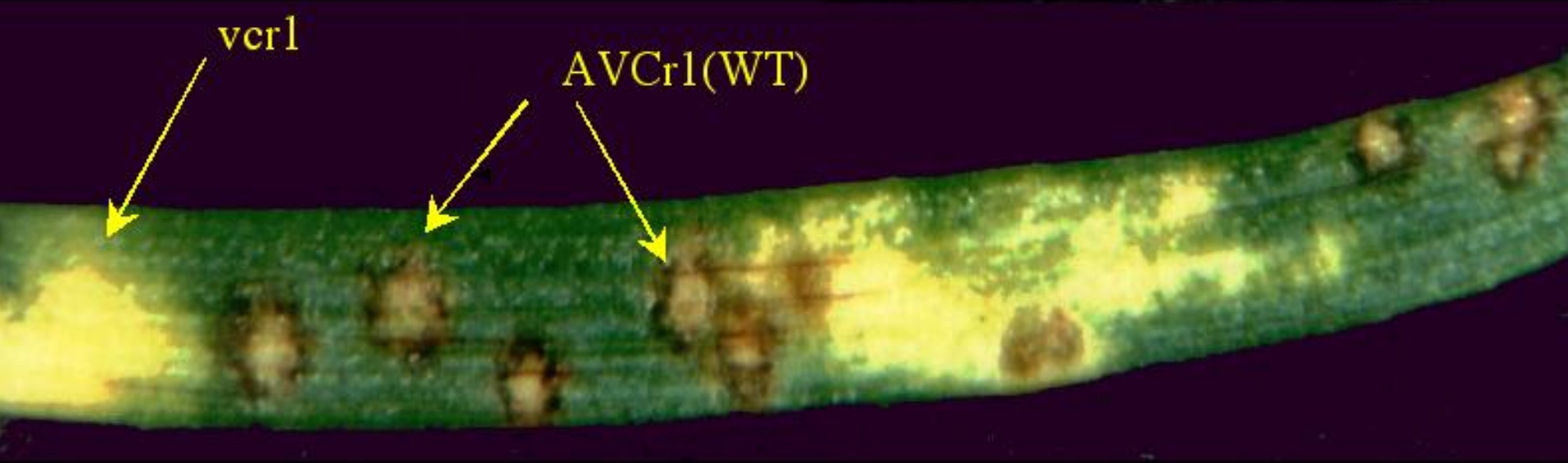
- Selected populations are significantly more resistant than the background variability
- However on the highest rust sights both the effect of natural background variability and selection for partial resistance are defeated
- On these sights only R-gene resistance is shown to hold

Slow rusting - partial resistance

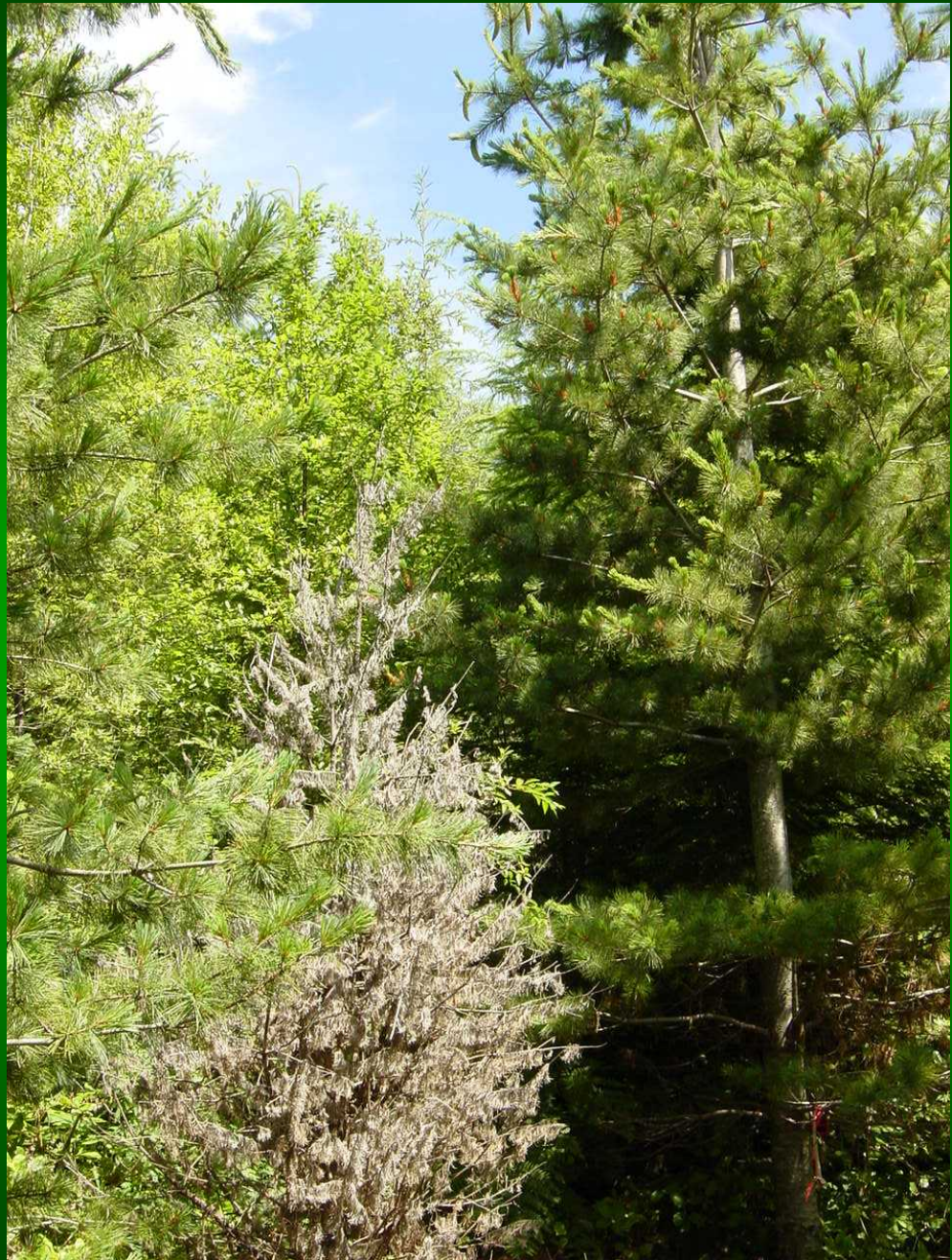
- ♦ Rate of defense response
- ♦ Dose effects cumulative
- ♦ No virulence specific breakdown
- ♦ Subject to developmental and environmental effects
- ♦ Ontogenetic and induced resistance

R gene (Major Gene)

- ♦ Host recognizes pathogen
- ♦ Dominant inheritance
- ♦ Breakdown due to virulence
(though some R genes can be quite long lived)
- ♦ Effective in young tissue “seedling resistance”



Dr Bohun Kinloch, jr, USDA Forest Service ret'd

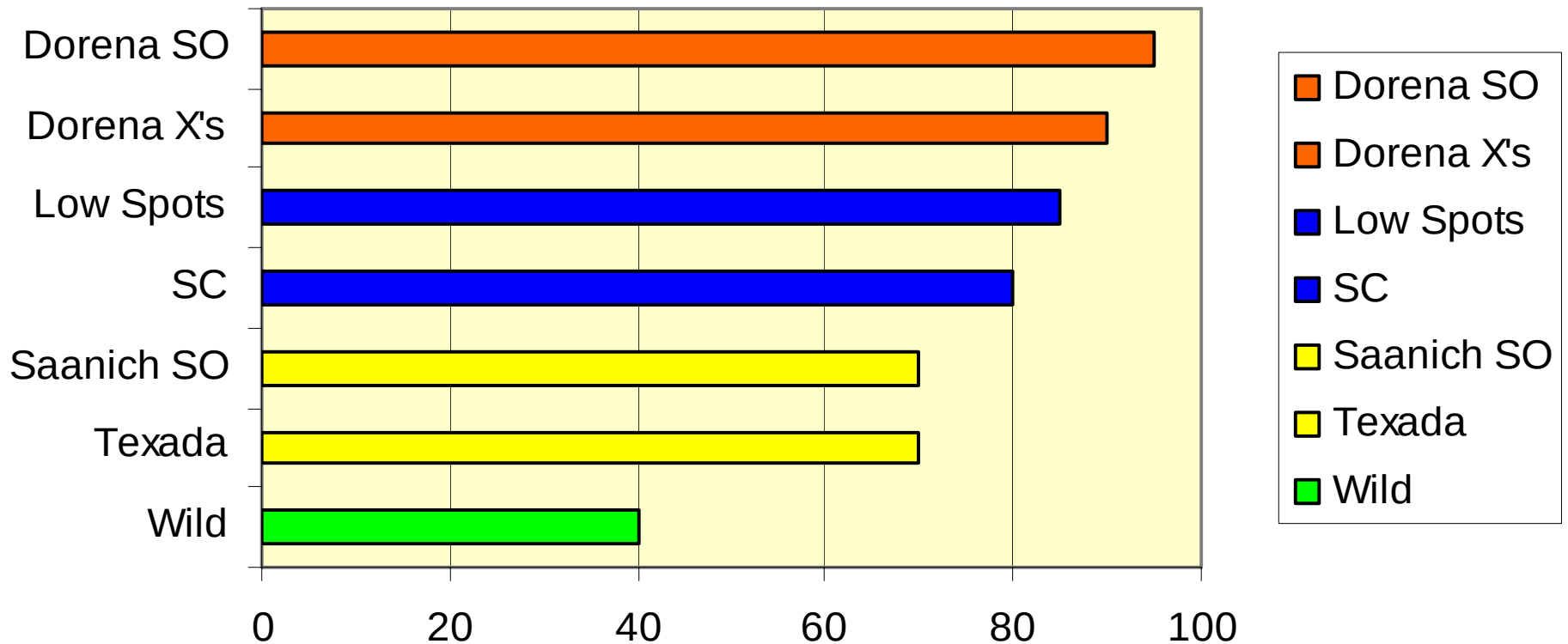


Block Plot's "Realized Gain"

11%	CF	CF	CF	CF	CF	CF	CF	SC		25%	CF	CF	CF	CF	SC	SC	BC	CF		34%	CD	SC	SC	CF	CF	CD	CF	CF
	CF	CF	CF	CF	CF	CF	X	SC			CF	CF	CF	SC	CD	CF	CD	CF			CF	SC	SC	SC	CF	CF	SC	CF
	CF	CF	CF	CF	CF	CF	CF	999			CF	CF	SC	CF	CF	CF	CF	CF			CD	SC	CF	CF	X	SC	CF	SC
	CF	CF	CF	BC	CF	CF	CF	SC			CD	CF	CD	999	CF	CF	999	CF			CF	CF	CF	CF	CF	SC	CF	CF
	CF	CF	CF	999	CF	CF	CF	CF			BC	CD	999	999	999	CF	CF	999			CD	SC	CF	999	CF	CF	CF	CF
	CF	CF	CF	CF	CF	CF	CF	SC			X	CF	CF	CF	CF	CF	CF	999	X		CF	BC	999	SC	CF	CF	CF	SC
	CF	CF	CF	CF	X	X	CF	CF			SC	CF	X	CF	CF	999	CF	CF			CF	CF	CF	CF	CF	SC	999	999
43590-1	CF	CF	SC	CF	CF	CF	CD	CF		SCLS-1	CF	CF	SC	CF	CF	CF	SC	CF		13881-1	CF	BC	999	CF	CF	CF	CF	CF
	CF	CF	CF	CF	CF	CF	999	CD			CF	CF	999	999	CF	CF	CF	CF			CF	CF	999	CF	BC	CF	BC	CF
17%	CF	CF	CF	CF	CF	X	SC	CF		14%	999	CF	CF	CF	999	CF	CF	CF		18%	999	CF	CF	CF	SC	BC	CF	CF
	CF	CF	999	999	999	999	CF	CF			CD	CF	CF	SC	CF	BC	CF	CF			CF	999	999	CF	CF	CF	999	CF
	CF	999	CF	999	CD	CF	CF	CF			CF	CF	CF	SC	CF	CF	CF	CF			999	999	CF	CF	999	CF	999	CF
	CF	SC	CF	CF	SC	CF	CF	CF			999	CF	CF	BC	999	CF	CF	CF	999			999	999	CF	CF	CF	CF	SC
	CF	CF	999	CD	CF	CF	CF	CD			999	CF	999	CF	CF	CF	CF	CF	CF			CF	CF	CF	CF	CF	CF	SC
	999	BC	CF	BC	CF	CF	CF	CF			CF	CF	CF	CF	CF	BC	SC	CF			CF	SC	CF	CF	CF	CF	CF	CF
LS-1	CF	CF	999	CF	CF	999	CF	CF		DBOTH-1	CF	CF	CF	CF	SC	CF	CF	CF		LSBOTH-1	999	CD	CF	CF	999	CF	CF	BC
	CD	CF	BC	CF	CF	CF	999	CF			CF	CF	BC	SC	CF	BC	CF	CF			BC	CF	CF	SC	CF	999	CD	CF
21%	CF	CD	999	CF	CF	CF	CF	SC		44%	CF	BC	CF	SC	SC	CF	CF	CF		64%	CF	SC	SC	CF	CF	SC	CF	SC
	SC	CF	SC	CD	CF	CF	CF	CF			SC	CF	CF	CF	SC	SC	999	999			CF	CF	SC	CF	BC	SC	CD	SC
	CF	CF	999	CF	CF	CF	CF	CF			SC	CF	CF	CD	SC	SC	SC	CF			SC	SC	CD	CF	SC	SC	CF	CD
	CF	CF	CF	CF	CF	CF	SC	CF			CF	CF	CF	CD	SC	CF	CF	CF			SC	999	CF	999	SC	CF	BC	CF
	CF	CF	CF	CF	CF	SC	BC	SC			CF	BC	BC	999	999	SC	SC	999			999	CD	SC	SC	CF	CD	CF	BC
	CF	CF	CF	CF	CF	999	X	CF			CF	CD	CF	CD	CD	CF	CF	CF			CD	SC	SC	SC	CF	CF	BC	SC
DD-1	CF	CF	CF	CF	CF	SC	SC	CF		SC-1	CF	CF	SC	CF	CF	SC	BC	CF		PT-1	SC	SC	SC	SC	BC	SC	999	CD



Coombs for different seedlots - % clean trees



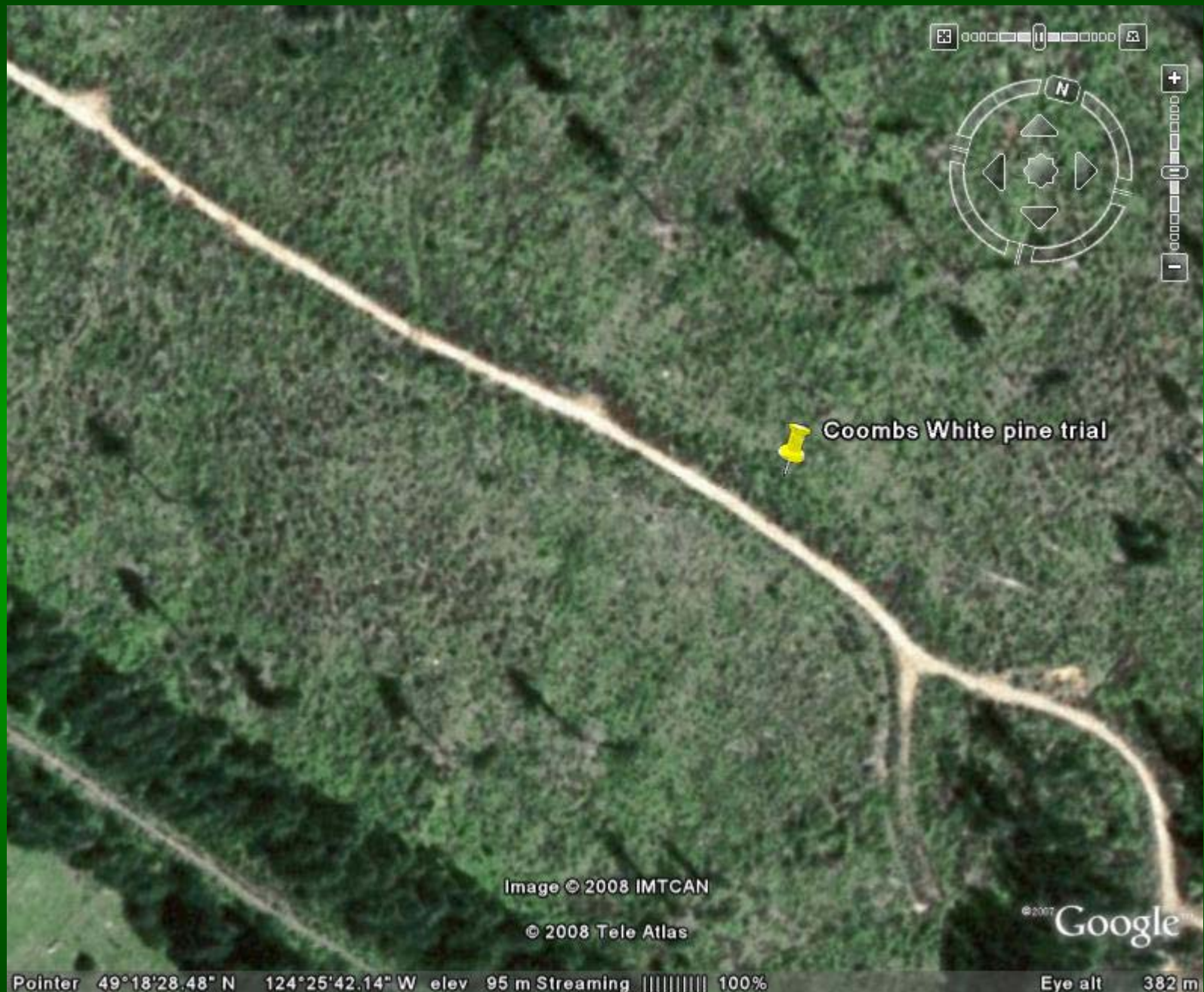


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Pointer 49°18'28.48" N 124°25'42.14" W elev 95 m Streaming 100%

Eye alt 382 m



Performance in Realized Gain Trials

- Demonstrates significant progress over wild trees decreasing infections by one half.
- Site hazard “environment” still a significant and unfortunately unpredictable factor.
- We haven’t got there yet. (MGR deployment).



Field Resistance Assessment in F1 Trials



fam	TYPE	ORIGIN	_FREQ_	mclean	msurv	sclean	ssurv	nobs
334	DDX	DIALLEL 80-4, ID# 9421723	29	90%	90%	26	26	29
300	DDX	DIALLEL 80-6, ID# 9421183	28	86%	89%	24	25	28
303	DDX	DIALLEL 80-6, ID# 9421273	29	72%	90%	21	26	29
302	DDX	DIALLEL 80-6, ID# 9421251	28	71%	82%	20	23	28
301	DDX	DIALLEL 86-6, ID# 9421218	29	69%	72%	20	21	29
339	DDX	DIALLEL 80-3, ID# 9421735	25	68%	84%	17	21	25
313	DDX	DIALLEL 80-4, ID# 9421593	30	67%	87%	20	26	30
315	DDX	DIALLEL 80-2, ID# 9421595	28	61%	82%	17	23	28
342	DDX	DIALLEL 80-3, ID# 9421740	28	61%	82%	17	23	28
332	DDX	DIALLEL 80-4, ID# 9421721	30	60%	63%	18	19	30
307	DDX	DIALLEL 80-4, ID# 9421545	26	58%	65%	15	17	26
327	DDX	DIALLEL 80-2, ID# 9421624	28	57%	61%	16	17	28
106	Coast Parent	Parent tree 461 (coastal)	27	56%	74%	15	20	27
317	DDX	DIALLEL 80-2, ID# 9421597	27	56%	74%	15	20	27
333	DDX	DIALLEL 80-4, ID# 9421722	28	54%	54%	15	15	28
204	DF1	Parent trees 360X21079 Cross	25	52%	76%	13	19	25
74			29	52%	79%	15	23	29
318	DDX	DIALLEL 80-2, ID# 9421608	29	52%	72%	15	21	29
331	DDX	DIALLEL 80-4, ID# 9421715	28	50%	50%	14	14	28
208	DF1	Parent trees 183X21095 Cross	27	48%	67%	13	18	27
308	DDX	DIALLEL 80-4, ID# 9421546	26	12%	38%	3	10	26
228	F1	Parent trees 126X137 Cross	27	11%	44%	3	12	27
237	DF1	Parent trees 21142X145 Cross	28	11%	32%	3	9	28
213	F1	Parent trees 120X47 Cross	29	10%	24%	3	7	29
221	DF1	Parent trees 21145X640 Cross	29	10%	41%	3	12	29
338	DDX	DIALLEL 80-3, ID# 9421734	29	10%	31%	3	9	29
344	DDX	DIALLEL 80-3, ID# 9421743	24	8%	46%	2	11	24
217	F1	Parent trees 239X640 Cross	25	8%	40%	2	10	25
231	F1	Parent trees 372X128 Cross	26	4%	23%	1	6	26
337	DDX	DIALLEL 80-3, ID# 9421733	26	4%	31%	1	8	26
314	DDX	DIALLEL 80-4, ID# 9421594	28	4%	36%	1	10	28
239	Coast Parent	Parent tree 47 OP	29	3%	31%	1	9	29
236	DF1	Parent trees 21142X47 Cross	26	0%	27%	0	7	26
305	DDX	DIALLEL 80-1, ID# 9421521	28	0%	29%	0	8	28

Performance in F1Trials

- We haven't got there yet, but...
- Marked family effects provides an ideal population for recurrent selection.
- Evaluating long term “field resistance” is the only effective way of verifying resistance models and...
- They are relatively cheap and effective.





2003 Inoc Results from “exotics”

seedlot	sample size			CF%
A4-6A		42		74
		39		64
		68		78
T5-10		38		53
		42		64
		56		80
TY2-3		57		93
TY4-4		8		62
ER2-6		22		59
		27		85
		43		86
TU4-6		35		97
		36		83
		36		74
En5-2		24		92
		31		84
		32		87