

Establishment report:
Comandra Resistance Trial

FIA Project # 2317001

FSP Project # Y051364

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Executive summary

This trial series was established in 2004 to identify and rank rust resistant seed orchard parents in Seed Orchard 219, which provides seed for the Bulkley Valley low elevation Seed Planning Unit (SPU). Results will allow collection of custom seedlots with resistance to comandra rust.

Five test sites were established in areas of high rust incidence. One hundred and thirty seedlots were included, focussing on families represented in Seed Orchard 219, located at the Vernon Seed Orchard Company (VSOC) orchard site. Trial assessments in 2006 and subsequent years will allow collection of resistant seedlots for deployment in disease-prone areas, possibly beginning in 2006.

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1.0 Introduction

This report documents the establishment, in 2004, of a trial on five sites to test offspring of Bulkley Valley parents in Seed Orchard 219 for susceptibility to comandra blister rust (*Cronartium comandrae* Peck.). All test sites are in the Lakes and Morice TSAs. Seed Orchard 219, located at the Vernon Seed Orchard Company site, supplies seed for the Bulkley Valley low elevation Seed Planning Unit (SPU), which includes much of these two TSAs.

1.1 Associated electronic files

The following thirteen excel worksheets are contained in a file on the accompanying CD.

- Site 1 Thompson map
- Site 1 Thompson concordance
- Site 2 George map
- Site 2 George concordance
- Site 3 Endako map
- Site 3 Endako concordance
- Site 4 Gold map
- Site 4 Gold concordance
- Site 5 Parrott map
- Site 5 Parrott concordance
- Field layout: sites 1 - 3
- Field layout: site 4
- Field layout: site 5

2.0 Test objective

The objective of this trial series is to identify and accurately rank seed orchard parents for rust resistance, so that custom seedlots with high resistance to comandra rust can be produced for deployment in disease-prone areas. Additional seedlots representing rust-resistant provenances or crosses among putatively resistant parents were also included, as were a number of operational seedlots.

3.0 Study population

One hundred and thirty-one seedlots were sown, of which 130 produced plantable seedlings used in the trial (one seedlot, sow code 348, produced no germinants). Seedlots were allocated and maps produced using the sowing code as the sole seedlot identifier; sowing codes run sequentially from 301 to 431. Fillers and surrounds were drawn from surplus experimental stock. Actual seedlot identity was not maintained for fillers and surrounds; these are coded 999 in concordance files and maps. Families were classified by groups according to descriptions in Table 1. A breakdown of operational seedlots is shown in Table 2, with elevation and origin.

Table 1. Description of seedlot groupings

group	description	number of seedlots	parent in orchard
1	orchard seed	51	yes
2	o.p. seed only (no orchard seed of same family available)	18	yes
3	o.p. seed (orchard seed of same family also included)	37	yes
4	operational seedlots	13	no
5	susceptible seedlots	2	no
6	controlled crosses with putative comandra resistance	9	some

Table 2. Operational seedlots included in trial

sowcode	Seedlot	Elevation (m)	Owner	Origin	Genetic Class
406	33201	825	Babine	Snake Lake	B
407	33209	800	Babine	Snake Lake	B
408	33216	975	Babine	Anders Lake	B
409	39411	1070	West Fraser	Fraser Lake	B
410	39544	945	Babine	Anita Lake	B
411	42843	1050	West Fraser	Bird Lake	B
412	47310	1040	West Fraser	Graham Lake	B
413	47373	780	West Fraser	Square Lake	B
414	47391	800	West Fraser	Bungalow Lake	B
415	47935	960	West Fraser	Oie Lake	B+
416	61033	887	West Fraser	Orchard 219 (VSOC)	A
417	61039	879	West Fraser	Orchard 219 (VSOC)	A
418	61041	877	West Fraser	Orchard 219 (VSOC)	A

Table 3 lists all seedlots included in the trial, together with their grouping, infection rates (proportion infected, as observed in the earlier assessment of the lodgepole pine progeny test at the Chowsunket test site) and infection rate ranking at Chowsunket. Families with the same infection rate have the same ranking, and many seedlots in this trial series were not represented at Chowsunket, so ranks go only to 34.

Table 3. Listing of tested seedlots

group	permanent MoF ID	sowing code	infection	infection rank
1	223	301	0.15625	18
1	233	302	0.18750	22
1	236	303	0.15625	18
1	250	304	0.18750	22
1	258	305	0.15625	18
1	266	306	0.03125	3
1	276	307	0.09375	11
1	284	308	0.09375	11
1	291	309	0.06250	7
1	299	310	0.18750	22

group	permanent MoF ID	sowing code	infection	infection rank
1	346	311	0.15625	18
1	375	312	0.31250	29
1	385	313	0.15625	18
1	392	314	0.15625	18
1	402	315	0.09375	11
1	406	316	0.09375	11
1	422	317	0.06250	7
1	428	318	0.06250	7
1	430	319	0.15625	18
1	431	320	0.06250	7
1	445	321	0.12500	14
1	472	322	0.06250	7
1	479	323	0.12500	14
1	480	324	0.15625	18
1	483	325	0.06250	7
1	484	326	0.06250	7
1	488	327	0.25000	26
1	490	328	0.28125	27
1	491	329	0.25000	26
1	495	330	0.12500	14
1	499	331	0.12500	14
1	501	332	0.25000	26
1	502	333	0.09375	11
1	1630	334	0.12500	14
1	1666	335	0.28125	27
1	1730	336	0.21429	24
1	1733	337	0.09375	11
1	1739	338	0.15625	18
1	1740	339	0.21875	25
1	1741	340	0.18750	22
1	1745	341	0.21875	25
1	1770	342	0.12500	14
1	1773	343	0.34375	31
1	1775	344	0.18750	22
1	1779	345	0.34375	31
1	1795	346	0.00000	1
1	1799	347	0.21875	25
1	1822	349	0.12500	14
1	F2001219	350		N/A
2	224	351	0.06250	7
2	275	352	0.09375	11
2	327	353	0.06250	7
2	428	354	0.06250	7
2	478	355	0.18750	22
2	1616	356	0.03125	3
2	1618	357	0.03571	4
2	1629	358	0.09375	11

group	permanent MoF ID	sowing code	infection	infection rank
2	1679	359	0.39286	34
2	1732	360	0.25000	26
2	1736	361	0.09375	11
2	1740	362	0.21875	25
2	1772	363	0.21875	25
2	1791	364	0.09375	11
2	1792	365	0.15625	18
2	1804	366	0.12500	14
2	1809	367	0.09375	11
2	1820	368	0.15625	18
3	223	369	0.15625	18
3	233	370	0.18750	22
3	250	371	0.18750	22
3	258	372	0.15625	18
3	276	373	0.09375	11
3	299	374	0.18750	22
3	346	375	0.15625	18
3	375	376	0.31250	29
3	385	377	0.15625	18
3	392	378	0.15625	18
3	402	379	0.09375	11
3	406	380	0.09375	11
3	422	381	0.06250	7
3	430	382	0.15625	18
3	431	383	0.06250	7
3	472	384	0.06250	7
3	479	385	0.12500	14
3	480	386	0.15625	18
3	483	387	0.06250	7
3	484	388	0.06250	7
3	488	389	0.25000	26
3	490	390	0.28125	27
3	491	391	0.25000	26
3	495	392	0.12500	14
3	1630	393	0.12500	14
3	1730	394	0.21429	24
3	1733	395	0.09375	11
3	1739	396	0.15625	18
3	1741	397	0.18750	22
3	1745	398	0.21875	25
3	1770	399	0.12500	14
3	1773	400	0.34375	31
3	1775	401	0.18750	22
3	1779	402	0.34375	31
3	1795	403	0.00000	1
3	1799	404	0.21875	25
3	1822	405	0.12500	14

group	permanent MoF ID	sowing code	infection	infection rank
4	33201	406		N/A
4	33209	407		N/A
4	33216	408		N/A
4	39411	409		N/A
4	39544	410		N/A
4	42843	411		N/A
4	47310	412		N/A
4	47373	413		N/A
4	47391	414		N/A
4	47935	415		N/A
4	61033	416		N/A
4	61039	417		N/A
4	61041	418		N/A
5	44201	419		N/A
5	45786	420		N/A
6	1809x1617	421		N/A
6	1809x1834	422		N/A
6	1610x1619	423		N/A
6	433x1617	424		N/A
6	433x1619	425		N/A
6	1618x1611	426		N/A
6	1618x1616	427		N/A
6	1809x1616	428		N/A
6	1829x1611	429		N/A
1	275	430	0.09375	11
1	1732	431	0.25000	26

4.0 Stock production

Sowing

- Date: May 2003
- Location: Landing Nursery, Vernon
- Grower: Dave Enns
- Two 410A styroblocks (112 cavities per block) were single sown per seedlot; excess seed was double sown.

Lift

- Dates: December 2 - 4, 2003
- supervised by Sally John, Mike Carlson (MoF)

5.0 Experimental design

5.1 Design parameters

Sites 1-3

Type:	Alpha design
Number of seedlots:	130, 121 and 111, sites 1, 2 and 3 respectively
Number of reps:	50; interlocking reps were used, so that pairs of reps (1 & 25, 2 & 26, etc.) occupied the same area, with adjacent trees of alternate reps.
blocks per rep:	12 blocks/rep. Blocks are numbered consecutively across reps within each site, so that blocks 1-12 are rep 1, blocks 13-24 are rep 2, etc.; thus block numbers are 1 - 600 on each site.
trees /block:	9 - 11 single-tree plots
rep shape:	rectangular; filler were used to fill in rectangle. Note interlocking. See layout file.
block shape:	follows s-shape within rep, so some blocks will be linear while others will be "folded" (see site maps).

Sites 4 & 5

Type:	Alpha design
Number of seedlots:	79 and 67, sites 4 and 5 respectively
Number of reps:	45 per site; interlocking reps were not used, and reps are consecutive.
blocks per rep:	2, 3 or 4. Blocks are not numbered consecutively across reps, but start again from 1 with each new rep.
trees/block:	3 - 20 single-tree plots
rep shape:	Reps are assigned to 8-tree-wide strips. Within the strip, reps are s-shaped; next rep (within a given strip) starts immediately after the last tree of the previous rep. See layout file.
block shape:	s-shaped, so some smaller blocks will be linear while others will be folded (see site maps).

Seedling numbers established by family on each site are shown in Table 4.

Randomisations (rep and block composition) are detailed in concordance files on the accompanying CD.

Table 4. Seedlot allocation by site

Seedlot	1Thompson	2George	3Endako	4Gold	5Parrott	all
301	31	39	24			94
302	49	48	50	30	35	212
303	47	45	49	6	5	152
304	49	49	49	32	35	214

Seedlot	1Thompson	2George	3Endako	4Gold	5Parrott	all
305	50	49	51	32	30	212
306	50	50	50	17	13	180
307	50	51	50	15	5	171
308	50	49	50	33	28	210
309	49	50	50	21	24	194
310	52	51	50	29	31	213
311	51	49	50	30	29	209
312	24					24
313	50	51	50	29	28	208
314	50	49	50	35	34	218
315	50	50	50	30	29	209
316	50	50	50	31	34	215
317	50	50	49	20	23	192
318	10					10
319	50	50	50	30	27	207
320	14					14
321	49	50	50	15	15	179
322	24	1	1			26
323	50	51	50	32	33	216
324	50	50	51	30	34	215
325	50	51	49	10	7	167
326	48	50	50	20		168
327	49	50	50	22	23	194
328	39	40	52	13	1	145
329	50	49	48	20	25	192
330	5					5
331	57	53	53	11		174
332	46	49	50	15	14	174
333	49	50	50		5	154
334	51	50	50	11	11	173
335	20	19				39
336	50	50	49	28	27	204
337	50	50	50	29	30	209
338	50	50	50	24	28	202
339	37	38	50			125
340	30	36	25			91
341	50	49	49	15		163
342	25	25	7			57
343	50	46	46	20	24	186
344	48	50	39			137
345	29	30	9			68
346	49	50	47		5	151
347	50	49	49	25	25	198
349	50	50	49	34	35	218
350	50	50	49	31	29	209
351	50	50	50	15	18	183
352	49	49	50	13		161

Seedlot	1Thompson	2George	3Endako	4Gold	5Parrott	all
353	15	1				16
354	12					12
355	50	49	51	30	35	215
356	26	33	22			81
357	49	50	17			116
358	12					12
359	30	36	30			96
360	40	39	43			122
361	50	49	50	8		157
362	50	50	50	6		156
363	35	38	21			94
364	50	50	50	14	10	174
365	50	50	52	15	15	182
366	50	50	47	13	1	161
367	49	49	50	14	1	163
368	50	50	50	4		154
369	48	50	50	13	14	175
370	49	50	48	15		162
371	34	35	28			97
372	40	40	37			117
373	47	45	49	2		143
374	50	50	50	6		156
375	23	14				37
376	20					20
377	31	26		1		58
378	40	50	25			115
379	50	50	49	6		155
380	37	39				76
381	26	19				45
382	36	29	4			69
383	48	50	40			138
384	35	40	29			104
385	50	50	45			145
386	23	12				35
387	25	26	5			56
388	49	49	50	14	13	175
389	50	50	49			149
390	49	51	50		1	151
391	24	21				45
392	50	49	49	15		163
393	24	16				40
394	51	48	51	22	22	194
395	39	41	36			116
396	45	45	37			127
397	28	31	9			68
398	50	50	49	13		162
399	39	42	34			115

Seedlot	1Thompson	2George	3Endako	4Gold	5Parrott	all
400	13					13
401	30	34	22			86
402	4					4
403	50	49	50	15		164
404	41	40	29			110
405	46	51	49	12		158
406	51	48	49	15	15	178
407	50	50	52	25	10	187
408	49	50	49	27	27	202
409	50	50	50	28	30	208
410	51	51	50	28	31	211
411	50	50	50	18	19	187
412	49	48	50	22	20	189
413	50	50	49	31	35	215
414	50	50	49	31	28	208
415	49	50	51	24	25	199
416	50	50	50	27	27	204
417	49	49	51	24	24	197
418	50	50	49	27	27	203
419	50	50	50	26	25	201
420	50	49	50	29	27	205
421	50	49	50	20	17	186
422	50	51	36			137
423	50	50	50	19	19	188
424	50	49	50	15	15	179
425	51	49	53	24	25	202
426	49	50	47	20	18	184
427	50	51	50	8	2	161
428	51	50	50	20	20	191
429	39	41	36			116
430	19	1				20
431	32	37	31		1	101
All experimental	5481	5324	4852	1599	1398	18654
999	1958	2077	2348	414	401	7198
unplanted (x)	1	38		3	1	43
All trees	7440	7439	7200	2016	1800	25895
# of families	130	121	111	79	67	130

6.0 Test sites

This trial was established on five sites within the Morice and Lakes TSAs.

6.1 Site selection

- Dates: September-October, 2003

All test sites were established in previously established juvenile pine stands that had experienced high levels of rust-induced mortality. Newly logged sites in high-risk areas were considered but rejected, due to the difficulty of predicting subsequent presence and levels of alternate hosts and of rust.

The primary site selection criterion was the presence of high levels of comandra rust, although other rusts (stalactiform rust (*Cronartium coleosporioides*) and western gall rust (*Endocronartium harknessii*) were often present as well, and were considered. The presence of alternate hosts (northern bastard toad-flax [*Geocaulon lividum*], for comandra rust, and cow-wheat [*Melampyrum lineare*] and indian paintbrush [*Castilleja* spp.] for stalactiform rust; western gall rust has no alternate host) were also taken into account. Summary descriptions of test sites are given in Table 5. Sites were selected by Sally John from potential blocks identified by Alex Woods (MoF), Brian Walker (WF), Bill Chapman and Alistair Schroff (BFP).

Table 5. Test site identification and description

site	Co.	ID	local name	origin	summary comments
1	BFP	CP 28 Bk 05	Thompson	15 year old plantation	lots of toadflax; lots of disease (all three) on Pl. Excellent test site
2	WF	CP 48 Bk 4	George Lk	~20 year old stand	cow wheat present; toadflax abundant; heavy disease; all 3 rusts present. Ideal accessibility
3	BFP	CP 51 Bk 05	Endako	12-yr old plantation w. ingress	v. high rust on Pl. small amount of toadflax in plantation and adjacent timber; toadflax infected.
4	MoF	Gold Creek	Gold Creek	underplanted with Sw (2003)	very high rust; pine plantation failed
5	MoF	Parrot 93L018-09	Parrott Lakes	very heavy rust; high mortality	highly variable site; wet to very dry

6.2 Site preparation

- Dates: October-November, 2003

Sites 1 - 3 previously supported 12 - 20 year-old stands. Existing trees were destroyed using an excavator mounted with a mowing head. All standing trees were destroyed within the trial area and in a buffer area extending several meters beyond the perimeter of each installation. On sites 4 and 5, pine trees remaining from the failed plantation were cut and then hand piled and burned on the edge of the site prior to planting.

7.0 Trial establishment

Dave Yole supervised layout, planting and data collection on all sites.

7.1 Site layout

- Dates: October-November, 2003 and May, 2004

All sites were laid out as regular rectangles (no uneven edges) with square spacing within sites. See site layout maps on accompanying CD. On all sites, unplantable spots were dealt with by planting filler trees

(code 999); the filler tree was established as close as possible to each unplantable spot. Unplantable spots (code x) were defined as those where a plantable spot could not be located within a 40cm radius of the planting spot pin.

Sites 1 - 3

Sites 1 - 3 were planted at a spacing of 1.5 m x 1.5 m, with reps interlocking. Figure 1 shows detail for one set of interlocking replicates, rep 2 and rep 27. Rep 2 trees occupy the blue squares while rep 27 trees occupy white squares. Reps were squared off, so that fillers were used to complete the rectangle, before starting the next rep at a pre-assigned spot (see layout map).

A systematic thinning could be applied if desired, when growing space becomes limiting, by taking out all trees in reps 26-50, leaving remaining trees at a square spacing of 2.12 m x 2.12 m on the diagonal.

Figure 2 shows detail of on-the-ground marking before planting; red dashes were painted between trees in adjacent rep pairs, while blue spots were painted on the ground to mark positions of trees in reps 1 through 25. Unpainted spots were allocated to reps 26 through 50.

Two rows of border surrounds were established at each edge of sites 1 - 3.

Sites 4 and 5

Sites 4 and 5 were planted at 2 m x 2 m and reps were not interlocking. Sites 4 and 5 had no surrounds. Reps were assigned to and established within 8-tree-wide strips (see maps); Planting of reps (and blocks) was continuous, so that no fillers were required to "square off" rep ends.

8.0 Assessments

Concordance file

The concordance file for each site is included on the accompanying CD.

A field data recorder should be used for all assessments. Prior to going to the field, the appropriate number of tree positions from the concordance file should be downloaded. If seedlot for each position is also downloaded, time may be saved in assessments by ignoring trees coded 999. Rep and block are not required by field assessment crews. Tree positions starts at the "0" location on the appropriate field layout excel sheet. Numbers shown on the field layout sheets are stake numbers (so tree 10 is at stake 1, tree 20 at stake 2. etc.). Once an initial assessment has been completed, it will helpful to download the data from the first assessment to validate subsequent assessments.

Position numbers to be assessed, by site, are:

- Sites 1, 2 and 3: 1 through 7440
- Site 4: 1 through 1677 (the "seedlot 999s" from positions 1678 through 2016 at the end are fillers and can be left unassessed)
- Site 5: 1 through 1490 (the "seedlot 999s" from positions 1491 through 1800 at the end are fillers and can be left unassessed)

A printed copy of the appropriate field layout sheet (from the CD) will help to orient the assessor.

Once an assessment is complete, data can be downloaded. Using the concordance file, data can be matched by tree position to the appropriate seedlot, rep and block number for analysis.

9.0 Related documents and selected references

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