Development of Genomic Tools for Almond Rootstock Improvement

Project No.: **12-HORT16-Aradhya/Ledbetter**

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Objectives:

This project is part of a larger project focused on all aspects of rootstock breeding in almonds and walnuts. Specifically this portion of the work aims to:

1. Development of Single Nucleotide Polymorphism (SNP) markers to screen existing and newly developed interspecific *Prunus* hybrids.
2. Molecular characterization and disease testing of a genetically diverse collection of commercially available and experimental rootstocks; and perform association analysis to identify markers linked to disease resistance.

Interpretive Summary:

Development of improved rootstocks with tolerance/resistance to soil borne and replant diseases is the key for sustainable production of almonds and therefore, it is one of the top priorities for the California almond industry. With restriction on the use of fumigants and with aim to attain sustainable production, the industry reliance on rootstocks with field resistance to soil borne pests and diseases is increasing. Though widely used rootstocks (e.g., 'Nemaguard', other peach and peach x almond hybrids) resist the attack of root knot nematodes, they are susceptible to other soil borne pests and diseases, such as lesion and ring nematodes, bacterial canker, crown gall, *Phytophthora,* and *Armillaria*. In this project we are testing novel interspecific hybrids involving peach, wild almond species, and diploid plums

that are potential donors of resistance to soil borne diseases and in some cases drought tolerance.

While hybrids are being screened for disease resistance, genomic tools and methods are being developed to assist in efficient selection of resistance in hybrids. Genome resequencing of a dozen genotypes of cultivated and wild *Prunus* species (spp.) that have been used in hybrid generation (*P. dulcis, P. argentea, P. kanuensis, P. davidiana, P. bucharica, P. kuramica, P. arabica, P. persica*, and *P. fenzliana*) is being currently performed at the Beijing Genome Institute using Illumina HiSeq 2000 platform. The sequence data equivalent to 30x the average size of Prunus genome is expected later this year and will be aligned to discover SNPs.

A second approach to discover SNPs and genotype concurrently has also been undertaken using a new method called genotyping-by-sequencing (GBS). A set of all the available rootstocks that are currently being used, those under testing, and novel hybrids produced at the Davis repository (National Clonal Germplasm Repository) have been included in the GBS approach.

Materials and Methods:

The **Three-Steps** approach described below are being currently implemented to develop commercially viable Almond rootstocks with durable resistance (resistance that is long-lasting under variable growing conditions) to one or more of the key soil borne diseases/syndromes.

Step 1. Identify disease resistant rootstock genotypes

A set of 45 almond rootstocks currently used in the industry and some under experimental trials, along with 46 recently produced interspecific hybrids (**Table 1**) are being evaluated for two major soil borne diseases, crown gall and *Phytophthora*. The new hybrids have been clonally propagated (**Figure 1**) through rooting cuttings to conduct replicated disease evaluation. The evaluation trials are currently underway.

Step 2. Genetic mapping of genes which mediate disease resistance

We have produced 615 embryo rescued clonally propagated hybrids from 47 different cross combinations involving nine different species of Prunus that are potential donors of resistance to soil borne diseases. Clonal hybrid plants from 13 different crosses involving 'Nemaguard', *P. argentea*, *P. fenzliana, P. cerasifera, P. dulcis*, and *P. kansuensis* are currently being evaluated for resistance to crown gall and phytophthora. Currently first year soil borne diseases evaluation data from the field and greenhouse trials are available and second year data is being collected.

Genome resequencing of a dozen genotypes of cultivated and wild *Prunus* spp. (*P. dulcis, P. argentea, P. kansuensis, P. davidiana, P. bucharica, P. kuramica, P. arabica, P. persica*, and *P. fenzliana*) that have been used in hybrid production is currently being performed at the Beijing Genome Institute using Illumina HiSeq 2000 platform. The sequence data equivalent to 30x the average size of the *Prunus* genome is expected soon and will be analyzed to discover SNPs.

A second approach to discover SNPs and genotype concurrently has also been undertaken using a new method called genotyping-by-sequencing (GBS). A set of all the available rootstocks that are currently being used or under test along with our novel hybrids have been included in the GBS approach.

Step 3. Identify SNPs associated with resistance

Association analysis of molecular and disease data will be performed later in 2013 when the sequence and GBS data are available. Markers identified as linked to disease resistance will have to be validated in greenhouse and field tests. Once confirmed, these SNPs will be used to develop juvenile selection strategies for rootstock improvement. We anticipate performing *Step 3* in late 2013.

Research Activities Planned for 2013/2014

We will continue to produce many more interspecific hybrids involving diverse *Prunus* species that are potential donors of resistance to soil borne diseases. We believe in large scale evaluation of diverse hybrids to indentify durable resistance that the industry is looking for.

Upon receiving the sequences from the Beijing Genome Institute in late 2013, we will analyze the sequences to identify useful SNPs cross compatible across species used in sequencing. We will be performing bioinformatic analysis of the GBS data to enumerate SNPs and genotypes for various hybrids used in the study. The data will be analyzed to identify markers linked to disease traits.

Results and Discussion:

Prunus hybrids

One hundred-ninety hybrid genotypes are included in either disease testing or genotyping using GBS approach or both. These form the basic genetic resources for association analysis. The National Clonal Germplasm Repository (NCGR) interspecific hybrids are being clonally propagated (**Figure 1**) for replicated disease testing. More hybrids are being embryo rescued at the California Seed and Plant Laboratory (**Table 2**) which will be further increased though rooting cuttings to achieve numbers sufficient for replicated testing.

Molecular Data Development

Genome resequencing of a dozen genotypes of cultivated and wild *Prunus* spp. that have been used in hybrid generation (*P. dulcis, P. argentea, P. kansuensis, P. davidiana, P. bucharica, P. kuramica, P. arabica, P. persica*, and *P. fenzliana*) is currently beingperformed at the Beijing Genome Institute using Illumina HiSeq 2000 platform. The sequence data equivalent of 30x the average size of Prunus genome is expected soon and will be aligned to discover SNPs.

A second approach to discover SNPs and genotype concurrently has also been undertaken using a new method called genotyping-by-sequencing (GBS). A set of all the available rootstocks that are currently being used or under testing, along with our novel hybrids, have been included in the GBS approach.

Research Effort Recent Publications:

None at this time.

Table 1. Rootstocks that are under disease testing and genotyping using GBS approach.

Sample	Code	Name	Parentage/Type	Disease Testing
1	BB106	BB106	dulcis x persica	CG/Phytophthora
2	BH106	Bright Hybrid 106	dulcis x persica	CG/Phytophthora
3	BH5	Bright Hybrid 5	dulcis x persica	CG/Phytophthora
4	Citation	Citation	salicina 'Red Beaut' x persica	CG/Phytophthora
5	17_C5	Controller 5	salicina x persica	CG/Phytophthora
6	Controller 9	Controller 9	salicina x persica	CG/Phytophthora
7	Empyrean 1	Empyrean 1	persica x davidiana	CG/Phytophthora
8	Flordaguard	Flordaguard		CG/Phytophthora
9	Fortuna sdlg	Fortuna*	cerasifera x (salicina x persica)	CG/Phytophthora
10	Y119-109-98	Y119-109-98	Flordaguard x Alnem	CG/Phytophthora
11	GF677	GF677		CG/Phytophthora
12	G15	GxN 15		CG/Phytophthora
13	Halford	Halford		CG/Phytophthora
14	Hansen 2168	Hansen 2168	dulcis x persica	CG/Phytophthora
15	Hansen 536	Hansen 536	dulcis x persica	CG/Phytophthora
16	1_HB1	HBOK 1	Harrow Blood x Okinawa derived	CG/Phytophthora
17	HB10	HBOK 10	Harrow Blood x Okinawa derived	CG/Phytophthora
18	HBOK 27	HBOK 27	Harrow Blood x Okinawa derived	CG/Phytophthora
19	HB28	HBOK 28	Harrow Blood x Okinawa derived	CG/Phytophthora
20	HB32	HBOK 32	Harrow Blood x Okinawa derived	CG/Phytophthora
21	HB50	HBOK 50	Harrow Blood x Okinawa derived	CG/Phytophthora
22	Hiawatha	Hiawatha	(besseyi x salicina) x OP	CG/Phytophthora
23	HM2	HM2		CG/Phytophthora
24	Ishtara	Ishtara		CG/Phytophthora
25	Ramming K119-50	K-119-50	salicina x dulcis	CG/Phytophthora
26	Ramming K146-44	K-146-44	salicina x persica	CG/Phytophthora
27	14_K1	Krymsk 1	tomentosa x cerasifera	CG/Phytophthora
28	**K2**	**Krymsk 2**		CG/Phytophthora
30	**Krymsk 86**	**Krymsk 86**	**cerasifera x persica**	CG/Phytophthora
31	19_K9	Krymsk 9		CG/Phytophthora
32	Lovell	Lovell	persica	CG/Phytophthora
33	M40	M40	Marianna 26-24 sel.	CG/Phytophthora
34	M58	M58	Marianna 26-24 sel.	CG/Phytophthora
35	Marianna 2624	Marianna 26-24		CG/Phytophthora
36	16_MYR	Myrobalan	P. cerasifera	CG/Phytophthora
37	Myrobalan-04	Myrobalan-04	P. cerasifera	CG/Phytophthora
38	Myrobalan-05	Myrobalan-05	P. cerasifera	CG/Phytophthora
39	**Myrobalan 29C**	**Myrobalan 29C**	**P. cerasifera**	CG/Phytophthora
40	Nemaguard	Nemaguard	persica or persica x davidiana	CG/Phytophthora
41	Nemaguard sdlg	Nemaguard*	persica or persica x davidiana; PG 7-16	CG/Phytophthora
42	Nickels	Nickels	dulcis 'Sel. 5-33' x Nemaguard	CG/Phytophthora
43	P58-25	P58-25	P. japonica x Marianna 2624	CG/Phytophthora
44	PAC 0301-05	PAC 0301-05		CG/Phytophthora
45	PAC 9908-02	PAC 9908-02	(dulcis x persica) x persica	CG/Phytophthora
46	Puente	Puente	plum	CG/Phytophthora
47	Rootpac-R	Rootpac-R	dulcis x cerasifera	CG/Phytophthora
50	SPM	SPM		CG/Phytophthora
51	Sharpe	Sharpe	angustifolia hybrid	CG/Phytophthora
52	Speaker	Speaker		CG/Phytophthora
53	TPAC	Tempropac		CG/Phytophthora
54	DPRU 2429 plum	Vesennee Plamia	unknown, in plum collection	CG/Phytophthora
55	Y105-208-95	Y105-208-95	P. davidiana x Flordaguard	CG/Phytophthora
56	Y112-225-96	Y112-225-96	P. persica x P. arabica	CG/Phytophthora
57	P248-139	P248-139	Harrow Blood x Okinawa F1	CG/Phytophthora
58	Harrow Blood	Harrow Blood	persica	CG/Phytophthora
59	Nemared sdlg	Nemared*	PG 7-3	CG/Phytophthora
60	Okinawa	Okinawa	persica	CG/Phytophthora
61	P. fenzliana	P. fenzliana		CG/Phytophthora
62	Sunpeal	Sunpeal		CG/Phytophthora
63	Tardy Nonpareil	Tardy Nonpareil		CG/Phytophthora
64	12R1E1	12R1E1		CG/Phytophthora
65	12R1E8	12R1E8		CG/Phytophthora
66	3-3	3-3	includes P. davidiana	CG/Phytophthora
67	3-4	3-4	includes P. davidiana	CG/Phytophthora
68	6-1	6-1		CG/Phytophthora
69	6-2	6-2		CG/Phytophthora
70	6-3	6-3		CG/Phytophthora
71	8	8	includes P. davidiana	CG/Phytophthora
72	DR-11CH	DR-11CH-2	cerasifera x (OP, self?)	CG/Phytophthora
73	DR-11DK	DR-11DK-4	Tardy Nonpareil (dulcis) x DPRU1467.x (kuramica)	
74	DR-11DK	DR-11DK-5	Tardy Nonpareil (dulcis) x DPRU1467.x (kuramica)	
75	DR-11DK	DR-11DK-9	Tardy Nonpareil (dulcis) x DPRU1467.x (kuramica)	
76	DR-11DR	DR-11DR-1	Tardy Nonpareil (dulcis) x DPRU0194 (argentea)	
77	DR-11DR	DR-11DR-4	Tardy Nonpareil (dulcis) x DPRU0194 (argentea)	
78	DR-11NF	DR-11NF-1	Nemared x fenzliana	CG/Phytophthora
79	DR-11NF	DR-11NF-10	Nemared x fenzliana	CG/Phytophthora
80	DR-11NF	DR-11NF-12	Nemared x fenzliana	
81	DR-11NF	DR-11NF-13	Nemared x fenzliana	
82	DR-11NF	DR-11NF-14	Nemared x fenzliana	
83	DR-11NF	DR-11NF-15	Nemared x fenzliana	
84	DR-11NF	DR-11NF-16	Nemared x fenzliana	
85	DR-11NF	DR-11NF-18	Nemared x fenzliana	
86	DR-11NF	DR-11NF-2	Nemared x fenzliana	
87	DR-11NF	DR-11NF-20	Nemared x fenzliana	
88	DR-11NF	DR-11NF-25	Nemared x fenzliana	CG/Phytophthora
89	DR-11NF	DR-11NF-4	Nemared x fenzliana	
90	DR-11NF	DR-11NF-7	Nemared x fenzliana	
91	DR-11NF	DR-11NF-8	Nemared x fenzliana	
92	DR-11NR	DR-11NR-1	Nemared x DPRU0194 (argentea)	CG/Phytophthora
93	DR-11NR	DR-11NR-10	Nemared x DPRU0194 (argentea)	
94	DR-11NR	DR-11NR-11	Nemared x DPRU0194 (argentea)	CG/Phytophthora
95	DR-11NR	DR-11NR-2	Nemared x DPRU0194 (argentea)	CG/Phytophthora

96	DR-11NR	DR-11NR-3	Nemared x DPRU0194 (argentea)	
97	DR-11NR	DR-11NR-4	Nemared x DPRU0194 (argentea)	CG/Phytophthora
98	DR-11NR	DR-11NR-8	Nemared x DPRU0194 (argentea)	
99	DR10-P014.1	DR10-P014.1	Nemaguard x DPRU0582 (kansuensis)	CG/Phytophthora
100	DR-12PD2	DR-12PD2-1	DPRU2544A (persica) x DPRU2578.2 (dulcis)	
101	DR-12PD2	DR-12PD2-2	DPRU2544A (persica) x DPRU2578.2 (dulcis)	
102	DR-12PD2	DR-12PD2-3	DPRU2544A (persica) x DPRU2578.2 (dulcis)	
103	DR-12PD2	DR-12PD2-5	DPRU2544A (persica) x DPRU2578.2 (dulcis)	
104	DR-12PD2	DR-12PD2-8	DPRU2544A (persica) x DPRU2578.2 (dulcis)	
105	DR-12PK1	DR-12PK1-2	DPRU2655.1 (persica) x DPRU1467.9 (kuramica)	
106	DR-12PK1	DR-12PK1-3	DPRU2655.1 (persica) x DPRU1467.9 (kuramica)	
107	DR-12PK2-1	DR-12PK2-1	DPRU2499.4 (persica) x DPRU1467.9 (kuramica)	
108	DR-12PR	DR-12PR-10	DPRU2546.3 (persica) x DPRU0194 (argentea)	
109	DR-12PR	DR-12PR-12	DPRU2546.3 (persica) x DPRU0194 (argentea)	
110	DR-12PR	DR-12PR-13	DPRU2546.3 (persica) x DPRU0194 (argentea)	
111	DR-12PR	DR-12PR-14	DPRU2546.3 (persica) x DPRU0194 (argentea)	
112	DR-12PR	DR-12PR-17	DPRU2546.3 (persica) x DPRU0194 (argentea)	
113	DR-12PR	DR-12PR-2	DPRU2546.3 (persica) x DPRU0194 (argentea)	
114	DR-12PR	DR-12PR-22	DPRU2546.3 (persica) x DPRU0194 (argentea)	
115	DR-12PR	DR-12PR-4	DPRU2546.3 (persica) x DPRU0194 (argentea)	
116	DR-12PR	DR-12PR-5	DPRU2546.3 (persica) x DPRU0194 (argentea)	
117	DR-12PR	DR-12PR-6	DPRU2546.3 (persica) x DPRU0194 (argentea)	
118	DR-12PR	DR-12PR-7	DPRU2546.3 (persica) x DPRU0194 (argentea)	
119	DR-12PR	DR-12PR-8	DPRU2546.3 (persica) x DPRU0194 (argentea)	
120	DR-12PR	DR-12PR-9	DPRU2546.3 (persica) x DPRU0194 (argentea)	
121	DR-12PS	DR-12PS-1	DPRU2631B (persica) x DPRU0582 (kansuensis)	
122	DR-12PS	DR-12PS-2	DPRU2631B (persica) x DPRU0582 (kansuensis)	
123	DR-12PS	DR-12PS-3	DPRU2631B (persica) x DPRU0582 (kansuensis)	
124	DR-12PS	DR-12PS-4	DPRU2631B (persica) x DPRU0582 (kansuensis)	
125	DR-12PT	DR-12PT-AA4	DPRU2651.2 (persica) x DPRU2327.x (tangutica)	
126	DR-12PT	DR-12PT-AE4	DPRU2651.2 (persica) x DPRU2327.x (tangutica)	
127	DR-12PT	DR-12PT-AQ4	DPRU2651.2 (persica) x DPRU2327.x (tangutica)	
128	DR-12PT	DR-12PT-BA3	DPRU2651.2 (persica) x DPRU2327.x (tangutica)	
129	DR-12PT	DR-12PT-BC1	DPRU2651.2 (persica) x DPRU2327.x (tangutica)	
130	DR-12PT	DR-12PT-BD1	DPRU2651.2 (persica) x DPRU2327.x (tangutica)	
131	DR-12PT	DR-12PT-BF3	DPRU2651.2 (persica) x DPRU2327.x (tangutica)	
132	DR-12PT	DR-12PT-BH2	DPRU2651.2 (persica) x DPRU2327.x (tangutica)	
133	DR-12PT	DR-12PT-BL1	DPRU2651.2 (persica) x DPRU2327.x (tangutica)	
134	DR-12PT	DR-12PT-BL2	DPRU2651.2 (persica) x DPRU2327.x (tangutica)	
135	DR-12PT	DR-12PT-BM4	DPRU2651.2 (persica) x DPRU2327.x (tangutica)	
136	DR-12PU1	DR-12PU1-1	DPRU2499.5 (persica) x DPRU1871.1 (bucharica)	
137	DR-12PV	DR-12PV-2	DPRU2466.17 (persica) x DPRU2493.x (davidiana)	
138	DR-12PV	DR-12PV-3	DPRU2466.17 (persica) x DPRU2493.x (davidiana)	
139	DR-12PV	DR-12PV-4	DPRU2466.17 (persica) x DPRU2493.x (davidiana)	
140	DR10-OT16.06	DR10-OT16.06	DPRU2327.16 (tangutica) x OP	CG/Phytophthora
141	DR10-P019.3	DR10-P019.3	Tardy Nonpareil (dulcis) x argentea	
142	DR11-OR.01	DR11-OR.01	DPRU0194 (argentea) x OP	
143	DR11-OR.02	DR11-OR.02	DPRU0194 (argentea) x OP	
144	DR11-OR.03	DR11-OR.03	DPRU0194 (argentea) x OP	CG/Phytophthora
145	DR11-OR.04	DR11-OR.04	DPRU0194 (argentea) x OP	
146	DR11-OR.10	DR11-OR.10	DPRU0194 (argentea) x OP	
147	DR11-OR.11	DR11-OR.11	DPRU0194 (argentea) x OP	
148	DR11-OR.14	DR11-OR.14	DPRU0194 (argentea) x OP	
149	DR11-OW8.01	DR11-OW8.01	DPRU0198 (webbii) x OP	CG/Phytophthora
150	DR11-OW8.04	DR11-OW8.04	DPRU0198 (webbii) x OP	
151	DPRU 2203 besseyi x armeniaca	DPRU 2203 besseyi x armeniaca	besseyi x armeniaca	
152	DPRU 192.3 bucharica	DPRU 192.3 bucharica	bucharica	
153	DPRU 2733.4 fenzliana	DPRU 2733.4 fenzliana	fenzliana	
154	DPRU 2316.12 tomentosa	DPRU 2316.12 tomentosa	tomentosa	
155	DPRU 506.7 tomentosa	DPRU 506.7 tomentosa	tomentosa	
156	DPRU 544 americana	DPRU 544 americana	armericana	
157	DPRU 546 munsoniana	DPRU 546 munsoniana	munsoniana	
158	DPRU 823 bokhariensis	DPRU 823 bokhariensis	bokhariensis	
159	DPRU 843 americana	DPRU 843 americana	americana	
160	DPRU 853 bokhariensis	DPRU 853 bokhariensis	bokhariensis	
161	DPRU 1911 angustifolia	DPRU 1911 angustifolia	angustifolia	
162	DPRU 1916 angustifolia	DPRU 1916 angustifolia	angustifolia	
163	DPRU 2464 salicina	DPRU 2464 salicina	salicina	
164	DPRU 581 davidiana	DPRU 581 davidiana	davidiana	
165	DPRU 2495.1 ferganensis	DPRU 2495.1 ferganensis	ferganensis	
166	DPRU 2583.4 mira	DPRU 2583.4 mira	mira	
167	DPRU 2561.18 mira	DPRU 2561.18 mira	mira	
168	DPRU 1467.4 kuramica	DPRU 1467.4 kuramica	kuramica	
169	DPRU 1467.9 kuramica	DPRU 1467.9 kuramica	kuramica	
170	DPRU 1511 cerasifera	DPRU 1511 cerasifera	cerasifera	
171	DPRU 1871.1 bucharica	DPRU 1871.1 bucharica	bucharica	
172	DPRU 194 argentea	DPRU 194 argentea	argentea	
173	DPRU 198 webbii	DPRU 198 webbii	webbii	
174	DPRU 2151 B persica	DPRU 2151 B persica	persica	
175	DPRU 2327.17 tangutica	DPRU 2327.17 tangutica	tangutica	
176	DPRU 2327.7 tangutica	DPRU 2327.7 tangutica	tangutica	
177	DPRU 2327.8 tangutica	DPRU 2327.8 tangutica	tangutica	
178	DPRU 2466.17 persica	DPRU 2466.17 persica	persica	
179	DPRU 2493.1 davidiana	DPRU 2493.1 davidiana	davidiana	
180	DPRU 2493.3 davidiana	DPRU 2493.3 davidiana	davidiana	
181	T4xF	Tsukuba No. 4 x Flordaguard	Tsukuba No. 4 x Flordaguard	
182	DPRU 2499.4 persica	DPRU 2499.4 persica	persica	
183	DPRU 2499.5 persica	DPRU 2499.5 persica	persica	
184	DPRU 2544 A persica	DPRU 2544 A persica	persica	
185	DPRU 2546.3 persica	DPRU 2546.3 persica	persica	
186	DPRU 2578.2 dulcis	DPRU 2578.2 dulcis	dulcis	
188	DPRU 2631 B persica	DPRU 2631 B persica	persica	
189	DPRU 2651.2 persica	DPRU 2651.2 persica	persica	
190	DPRU 2655.1 persica	DPRU 2655.1 persica	persica	
191	DPRU 582 kansuensis	DPRU 582 kansuensis	kansuensis	
192	P. davidiana-CL	P. davidiana-CL	davidiana	

Table 2. Additional interspecific hybrids in embryo rescue and clonal multiplication.

Cross Year	Repository	Full lab code	Pistil parent	Pollen parent
2012	DR-12PR	197-2-2	peach	P. argentea
2012	DR-12PR	197-2-4	peach	P. argentea
2012	DR-12PR	197-2-5	peach	P. argentea
2012	DR-12PR	197-2-6	peach	P. argentea
2012	DR-12PR	197-2-7	peach	P. argentea
2012	DR-12PR	197-2-8	peach	P. argentea
2012	DR-12PR	197-2-9	peach	P. argentea
2012	DR-12PR	197-2-10	peach	P. argentea
2012	DR-12PR	197-2-11	peach	P. argentea
2012	DR-12PR	197-2-12	peach	P. argentea
2012	DR-12PR	197-2-13	peach	P. argentea
2012	DR-12PR	197-2-14	peach	P. argentea
2012	DR-12PR	197-2-17	peach	P. argentea
2012	DR-12PR	197-2-22	peach	P. argentea
2012	DR-12PT	197-3-AA-4	peach	P. tangutica
2012	DR-12PT	197-3-AE-4	peach	P. tangutica
2012	DR-12PT	197-3-AQ-4	peach	P. tangutica
2012	DR-12PT	197-3-BA-3	peach	P. tangutica
2012	DR-12PT	197-3-BC-1	peach	P. tangutica
2012	DR-12PT	197-3-BD-1	peach	P. tangutica
2012	DR-12PT	197-3-BF-3	peach	P. tangutica
2012	DR-12PT	197-3-BH-2	peach	P. tangutica
2012	DR-12PT	197-3-BL-1	peach	P. tangutica
2012	DR-12PT	197-3-BM-4	peach	P. tangutica
2012	DR-12PD2	197-4-1	peach	P. dulcis
2012	DR-12PD2	197-4-2	peach	P. dulcis
2012	DR-12PD2	197-4-3	peach	P. dulcis
2012	DR-12PD2	197-4-5	peach	P. dulcis
2012	DR-12PD2	197-4-8	peach	P. dulcis
2012	DR-12PV	197-5-2	peach	P. davidiana
2012	DR-12PV	197-5-3	peach	P. davidiana
2012	DR-12PV	197-5-4	peach	P. davidiana
2012	DR-12PS	197-10-1	peach	P. kansuensis
2012	DR-12PS	197-10-2	peach	P. kansuensis
2012	DR-12PS	197-10-3	peach	P. kansuensis
2012	DR-12PS	197-10-4	peach	P. kansuensis
2012	DR-12PK1	197-11-2	peach	P. kuramica
2012	DR-12PK1	197-11-3	peach	P. kuramica
2012	DR-12PD1	197-18-1	peach	P. dulcis
2012	DR-12PU1	197-19-1	peach	P. bucharica
2012	DR-12PU1	197-19-3	peach	P. bucharica
2012	DR-12PK2-1	197-20-1	peach	P. kuramica
2012	DR-12PK2-2	197-20-2	peach	P. kuramica

Figure 1. Samples of clonal propagation of interspecific hybrids for replicated disease testing.