

SUPPLEMENTAL FILE -- for “Assisted Migration of Sequoiadendron Genotypes for Conservation and Timber: Performance and Morphology in a Warmer Climate Outside of their Range” by Christopher M. Valness, William J. Libby, and John-Pascal Berrill

Table S1. Grove characteristics of 23 giant sequoia native grove samples planted at the Foresthill Seed Orchard study site (arranged from north to south in table).

Grove name	Area (ha)	Region	Lat (°)	Long (°)	Elev (m)	Adj Elev (m)
Foresthill Seed Orchard	-	-	39.08	120.73	1280	1284
Placer	1	North	39.05	120.57	1585	1585
North Calaveras	24	North	38.28	120.30	1400	1295
South Calaveras	184	North	38.25	120.23	1475	1365
Tuolumne	8	North	37.77	119.80	1705	1529
Merced	8	North	37.75	119.83	1675	1497
Mariposa	101	North	37.52	119.60	1890	1680
Nelder	195	North	37.45	119.58	1830	1611
McKinley	22	North	37.02	119.10	1950	1671
Cabin Creek	40	Central	36.80	118.95	1660	1352
Converse Basin	1498	Central	36.80	118.95	1755	1447
Lockwood	40	Central	36.80	118.85	1675	1367
Windy Gulch	405	Central	36.78	118.82	1980	1669
Grant	130	Central	36.75	118.98	1525	1210
Redwood Mountain	1271	Central	36.70	118.92	1905	1583
Giant Forest	855	Central	36.56	118.75	1905	1564
Atwell Mill	383	South	36.46	118.70	2135	1780
Cedar Flat/South Fork	97	South	36.36	118.70	1948	1579
Mountain Home	1620	South	36.23	118.68	1890	1504
Wheel Meadow	498	South	36.12	118.57	1950	1546
Black Mountain I	1333	South	36.10	118.65	1945	1543
Black Mountain II	1333	South	36.10	118.65	1950	1546
Packsaddle	137	South	35.93	118.58	1950	1523
Deer Creek	21	South	35.92	118.58	1830	1401

Table S2. Climate summary of the Foresthill study site and a subset of six native giant sequoia groves of 23 sampled at Foresthill Seed Orchard arranged by latitude from north to south for the period 1981-2009. Climate data generated from the Daymet database. Data are mean annual precipitation (Ann. Precip), mean monthly growing-season (GS = May-Sept) precipitation, mean May snow water equivalent (SWE kg m⁻²), mean monthly growing-season temperature (Temp), and mean monthly growing-season maximum (Max Temp) and minimum temperature (Min Temp).

Site	Ann. Precip. (mm)	Growing Season Precip. (mm)	May SWE (kg m ⁻²)	GS Avg. Temp (°C)	GS Max Temp (°C)	GS Min Temp (°C)
Foresthill Seed Orchard	1300	147.3	0	18.3	25.3	8.9
North Calaveras	1355	106.3	2.8	16.3	23.5	4.4
South Calaveras	1363	107.8	1.6	15.8	23.0	8.7
Converse Basin	990	91.6	28.5	15.2	22.5	8.0
Giant Forest*	1110	79.7	274.2	12.8	20.0	5.5
Atwell Mill*	1167	77.3	523.8	10.6	17.8	3.5
Mountain Home	929	55.4	125.2	13.7	19.0	7.5
Packsaddle*	883	55.7	170.8	12.9	21.1	4.8

*Daymet data estimates a higher elevation site than giant sequoia native grove data. Mean precipitation and SWE may be overestimated, while temperature data may be underestimated.

Table S3. Trial 1 SEGI steckling grove sample height (HT) in percent of within-trial steckling mean by grove sample in six measurement years from 1981 to 2009 at the Foresthill Seed Orchard. Coefficient of variation (CV) and grove sample rankings (R) included (1 = largest; 23 = smallest).

Grove	1981			1983			1988			1991			1997			2009			
	n	HT%	CV	R	HT%	CV	R												
Placer	8	75	31	23	68	22	21	67	21	22	69	28	22	69	34	22	63	33	22
North Calaveras	19	95	25	14	102	34	10	100	31	16	103	31	12	98	32	13	90	29	19
South Calaveras	13	85	31	20	101	30	12	104	23	11	105	22	8	104	27	8	102	23	11
Tuolumne	12	105	30	12	85	28	19	88	30	19	92	23	18	96	25	15	94	33	16
Merced	10	110	21	7	80	30	20	75	34	20	77	30	20	76	32	20	77	30	20
Mariposa	8	95	39	13	89	36	18	88	40	18	95	30	17	94	23	17	98	17	13
Nelder	6	110	34	4	94	22	16	100	15	13	97	18	15	91	24	18	91	20	18
McKinley	13	90	28	18	110	17	4	108	18	6	105	17	8	102	25	9	101	26	12
Cabin Creek	10	110	20	5	94	21	15	100	26	15	97	23	15	89	24	19	95	19	15
Converse Basin	14	105	22	9	116	30	2	117	25	1	118	21	1	115	19	1	118	16	2
Lockwood	11	115	31	1	96	20	14	104	15	9	108	21	7	104	23	7	105	28	9
Windy Gulch	5	110	36	2	111	36	3	100	22	13	90	21	19	98	22	14	104	17	10
Grant	7	90	30	19	90	33	17	92	29	17	97	25	14	94	31	16	93	28	17
Redwood Mtn	19	110	26	6	107	37	6	108	39	7	108	32	5	107	36	5	107	31	7
Giant Forest	11	105	34	11	105	36	8	108	30	5	113	27	3	109	31	4	112	28	3
Atwell Mill	10	110	19	2	98	36	13	100	30	12	100	25	13	98	29	12	97	33	14
Cedar Flat	3	80	44	22	59	45	23	71	36	21	69	36	21	74	51	21	73	44	21
Mountain Home	11	85	30	21	107	27	7	113	22	3	113	25	2	115	27	2	121	26	1
Wheel Meadow	13	105	31	10	117	26	1	113	25	2	110	25	4	111	28	3	107	29	6
Black Mountain I	13	95	24	17	101	31	11	104	30	10	105	24	10	104	25	6	109	26	4
Black Mountain II	8	95	19	15	105	19	9	108	19	8	108	17	6	102	23	10	108	19	5
Packsaddle	11	105	27	8	109	31	5	113	20	3	103	16	11	100	17	11	106	23	8
Deer Creek	2	95	7	16	68	0	22	58	10	23	59	22	23	57	23	23	63	55	23
All	237		28		31			30			27			29			29		

Table S4. Trial 1 SEGI steckling grove sample stem diameter (DBH) and volume (VOL) in percent of within-trial steckling mean by grove sample for three measurement periods from 1991 to 2009 at the Foresthill Seed Orchard. Coefficient of variation (CV) and grove sample rankings (R) included (1 = largest; 23 = smallest).

Grove	1991			1997			2009			1991			1997			2009			
	n	DBH%	CV	R	DBH%	CV	R	DBH%	CV	R	VOL%	CV	R	VOL%	CV	R	VOL%	CV	R
Placer	8	50	35	21	58	43	22	56	27	23	16	87	22	25	88	22	19	82	23
North Calaveras	19	107	39	7	95	35	17	88	22	20	112	76	8	92	93	12	71	63	19
South Calaveras	13	105	40	8	108	29	5	107	20	4	110	84	9	117	81	6	114	58	6
Tuolumne	12	89	46	19	94	32	18	93	28	18	75	88	18	83	88	16	86	85	17
Merced	10	67	60	20	87	36	20	91	26	19	42	116	20	61	92	20	67	73	20
Mariposa	8	93	51	17	98	29	12	102	18	11	90	106	15	85	76	14	95	46	13
Nelder	6	102	37	10	95	29	15	96	16	16	90	73	16	79	75	18	76	47	18
McKinley	13	124	27	1	105	21	8	101	13	13	131	52	3	101	69	8	95	49	12
Cabin Creek	10	98	44	13	91	30	19	100	14	14	90	74	14	70	60	19	86	45	16
Converse Basin	14	117	26	3	113	18	2	109	14	2	135	67	2	129	52	3	129	44	3
Lockwood	11	103	21	9	103	22	9	101	24	12	92	60	12	99	62	9	105	65	10
Windy Gulch	5	92	36	18	96	29	13	102	16	10	69	69	19	83	66	15	100	51	11
Grant	7	96	49	15	108	37	4	109	23	3	93	88	11	115	89	7	110	72	9
Redwood Mtn	19	101	44	11	107	31	6	104	22	8	116	105	7	128	89	4	114	63	5
Giant Forest	11	107	41	6	109	38	3	107	28	5	128	88	4	139	95	2	133	74	2
Atwell Mill	10	97	52	14	96	38	13	93	32	17	101	107	10	96	89	11	90	83	15
Cedar Flat	3	45	63	22	70	47	21	84	31	21	17	132	21	43	122	21	52	89	21
Mountain Home	11	122	33	2	128	25	1	128	20	1	149	74	1	175	69	1	195	66	1
Wheel Meadow	13	108	34	5	107	27	7	105	21	6	119	84	5	119	68	5	119	58	4
Black Mountain I	13	96	38	16	101	22	10	103	18	9	92	99	13	96	77	10	110	65	7
Black Mountain II	8	113	36	4	95	16	15	96	16	15	116	64	6	80	52	17	90	47	14
Packsaddle	11	99	32	12	101	18	11	104	17	7	85	68	17	86	44	13	110	53	8
Deer Creek	2	32	64	23	49	47	23	71	54	22	6	111	23	14	98	23	38	24	22
All	237	100	41		100	31		100	24		100	88		100	83		100	71	

Table S5. Descriptive statistics summarized for trial 2 SEGI stecklings by grove sample for height (m), diameter (cm), conic stem volume (m³), and height–diameter ratio (HDR) after 29 growing seasons at the Foresthill Seed Orchard. Grove sample rankings (R) included (1 = largest; 21 = smallest).

Grove	Height (m)						Diameter (cm)					Volume (m ³)					HDR				
	n	Mean	s.d.	Max	Min	R	Mean	s.d.	Max	Min	R	Mean	s.d.	Max	Min	R	Mean	s.d.	Max	Min	R
Placer	5	6.3	1.9	8.9	4.2	20	14.3	4.1	19.2	8.5	20	0.04	0.03	0.07	0.01	20	45	5.8	52	39	10
North Calaveras	11	10	2.9	13.6	5.7	16	22.3	4.2	28.2	15.6	18	0.15	0.08	0.28	0.04	18	44	6.7	57	34	11
South Calaveras	9	11.1	3.5	15.8	5.2	14	27.0	3.5	30.8	19.4	7	0.22	0.10	0.33	0.07	11	41	1.3	58	20	16
Tuolumne	4	9.9	4.3	15.0	4.6	17	21.1	7.0	25.6	10.7	19	0.14	0.09	0.24	0.01	19	47	0.7	61	36	5
Merced	2	10.6	1.2	9.7	11.4	16	28.5	2.2	26.9	30.0	5	0.23	0.06	0.18	0.27	11	37	1.4	36	38	20
Mariposa	3	11.4	2.2	13.0	8.9	12	27.4	3.2	29.3	23.7	6	0.23	0.09	0.29	0.13	10	41	3.5	44	38	15
Nelder	5	9.9	3.1	13.0	5.1	17	25.2	7.1	31.3	14.9	14	0.20	0.13	0.33	0.03	15	39	3.4	43	34	19
McKinley	6	11.8	2.3	14.7	7.9	8	25.2	5.1	32.4	17.4	14	0.21	0.11	0.40	0.06	12	47	4.5	53	40	4
Cabin Creek	4	12.2	3.9	15.7	7.6	7	30.3	9.0	38.0	19.8	3	0.35	0.26	0.58	0.08	3	40	1.5	42	38	17
Converse Basin	10	13.9	4.2	19.9	7.6	2	30.7	0.7	55.1	16.8	2	0.44	0.44	1.58	0.06	2	46	6.5	56	34	7
Lockwood	7	12.3	3.8	16.9	8.1	6	25.7	7.3	38.6	17.3	12	0.25	0.21	0.62	0.06	7	48	1.1	66	35	2
Windy Gulch	5	13.1	1.9	14.8	10.6	4	27.0	3.6	31.3	22.6	7	0.26	0.10	0.37	0.14	6	49	5.7	58	43	1
Redwood Mtn	8	13.2	2.2	16.7	10.4	3	27.8	5.0	35.6	20.7	5	0.29	0.14	0.53	0.13	5	48	6.9	58	38	3
Giant Forest	3	12.8	3.7	16.6	9.3	5	29.6	5.8	35.1	23.5	4	0.32	0.20	0.54	0.13	4	43	4.1	47	40	14
Atwell Mill	9	11.8	3.1	15.6	4.9	8	26.2	7.3	36.1	10.0	11	0.25	0.15	0.53	0.01	9	45	4.0	53	40	8
Cedar Flat	5	9.9	2.3	13.4	7.2	17	26.5	3.6	32.3	22.9	9	0.19	0.10	0.37	0.10	17	37	4.2	42	31	20
Mountain Home	4	14.3	3.9	19.7	10.9	1	35.5	5.9	42.9	28.5	1	0.51	0.31	0.95	0.23	1	40	4.4	46	36	18
Wheel Meadow	10	10.7	3.8	15.3	5.5	15	24.5	6.5	33.8	15.2	17	0.20	0.15	0.44	0.03	13	43	7.1	57	31	13
Black Mountain I	6	11.5	2.8	13.8	6.7	11	24.7	5.1	32.9	16.9	16	0.20	0.10	0.33	0.05	14	47	9.5	58	36	5
Black Mountain II	4	11.6	4.0	17.3	8.1	10	26.5	6.7	35.9	20.1	9	0.25	0.22	0.58	0.10	8	43	7.4	49	33	12
Packsaddle	3	11.3	1.2	12.6	10.3	13	25.3	3.2	28.1	21.9	13	0.19	0.07	0.26	0.13	16	45	2.4	47	42	9
All	123	11.5	3.4	19.9	4.2		26.1	6.9	55.1	8.5		0.24	0.20	1.58	0.01		44	7.2	66	20	

Table S6. Trial 2 SEGI steckling grove sample height (HT) in percent of within-trial steckling mean by grove sample in six measurement years from 1981 to 2009 at the Foresthill Seed Orchard. Coefficient of variation (CV) and grove sample rankings (R) included (1 = largest; 21 = smallest).

Grove	1981			1983			1988			1991			1997			2009			
	n	HT%	CV	R	HT%	CV	R												
Placer	5	68	22	21	63	42	21	63	35	21	62	29	21	56	31	21	55	30	21
North Calaveras	11	103	20	10	96	20	14	89	14	18	91	14	18	91	19	18	87	30	17
South Calaveras	9	107	22	8	88	40	18	94	27	15	97	24	14	98	29	13	97	32	14
Tuolumne	4	94	20	15	94	32	15	92	26	17	90	29	19	91	31	17	86	43	19
Merced	2	91	54	16	81	50	19	85	47	20	79	46	20	78	46	20	93	11	16
Mariposa	3	103	12	11	102	6	11	110	9	5	113	11	5	105	8	7	100	19	12
Nelder	5	91	19	16	105	28	8	101	30	12	94	26	17	90	30	19	87	31	18
McKinley	6	108	20	7	103	19	10	103	15	11	105	17	8	101	23	10	103	19	8
Cabin Creek	4	108	51	6	143	32	1	127	22	1	114	22	4	107	21	5	107	32	7
Converse Basin	10	104	33	9	105	32	9	109	22	6	116	23	3	123	31	2	121	30	2
Lockwood	7	89	34	18	78	38	20	86	29	19	95	23	15	100	26	11	107	31	6
Windy Gulch	5	117	34	2	116	38	3	107	35	7	103	23	10	102	19	8	115	15	4
Redwood Mtn	8	111	31	3	115	28	4	107	20	8	106	17	6	110	25	4	115	17	3
Giant Forest	3	110	8	4	109	43	6	123	35	2	119	32	2	114	37	3	111	31	5
Atwell Mill	9	102	41	12	89	21	17	94	18	16	98	19	12	99	26	12	103	32	9
Cedar Flat	5	86	29	20	91	16	16	98	18	14	94	14	16	95	24	15	86	16	19
Mountain Home	4	102	12	12	101	38	13	114	39	4	126	34	1	126	35	1	124	36	1
Wheel Meadow	10	95	49	14	112	28	5	103	23	10	97	24	13	96	28	14	93	33	15
Black Mountain I	6	86	24	19	102	28	11	100	22	13	103	16	9	105	19	6	100	25	11
Black Mountain II	4	118	64	1	105	30	7	106	25	9	105	31	7	101	40	9	101	35	10
Packsaddle	3	110	48	4	118	43	2	118	14	3	100	17	11	92	15	16	99	10	13
All	124		32		31			25			24			28			30		

Table S7. Trial 2 SEGI steckling grove sample stem diameter (DBH) and volume (VOL) in percent of within-trial steckling mean by grove sample for three measurement periods from 1991 to 2009 at the Foresthill Seed Orchard. Coefficient of variation (CV) and grove sample rankings (R) included (1 = largest; 21 = smallest).

Grove	1991			1997			2009			1991			1997			2009			
	n	DBH%	CV	R	DBH%	CV	R	DBH%	CV	R	VOL%	CV	R	VOL%	CV	R	VOL%	CV	R
Placer	5	45	51	21	48	42	21	55	29	21	14	100	21	15	79	21	16	73	21
North Calaveras	11	88	23	17	88	17	17	85	19	19	64	52	18	61	47	19	60	58	19
South Calaveras	9	101	37	11	105	33	7	103	13	9	100	81	10	110	76	8	90	43	12
Tuolumne	4	83	43	18	83	40	19	81	33	20	64	70	18	63	67	18	58	66	20
Merced	2	78	91	20	85	62	18	109	8	5	71	133	17	68	121	17	92	27	11
Mariposa	3	124	17	3	118	12	2	105	12	7	143	41	4	120	29	6	96	38	10
Nelder	5	91	48	16	99	32	11	97	28	16	86	82	13	88	78	13	80	65	16
McKinley	6	107	20	8	99	24	12	97	20	15	107	51	8	90	68	12	87	53	13
Cabin Creek	4	125	21	2	114	25	3	116	30	3	157	58	2	124	60	5	144	74	3
Converse Basin	10	113	33	5	113	33	6	118	35	2	143	67	4	161	83	2	180	99	2
Lockwood	7	79	45	19	92	32	16	98	28	13	64	115	18	85	84	14	102	82	7
Windy Gulch	5	109	34	6	102	23	9	104	13	8	121	72	6	95	54	10	106	37	6
Redwood Mtn	8	109	23	7	113	21	5	107	18	6	107	50	8	129	74	4	116	48	5
Giant Forest	3	119	27	4	113	30	4	113	20	4	150	66	3	139	69	3	131	63	4
Atwell Mill	9	99	33	12	101	33	10	100	28	12	93	55	12	100	76	9	101	60	9
Cedar Flat	5	99	30	13	95	28	15	101	14	11	86	70	13	83	79	15	79	53	18
Mountain Home	4	142	29	1	143	19	1	136	17	1	243	82	1	229	65	1	209	61	1
Wheel Meadow	10	101	33	10	99	31	12	94	27	18	100	71	10	93	70	11	83	74	14
Black Mountain I	6	95	17	15	97	16	14	95	21	17	79	48	15	83	37	15	81	48	15
Black Mountain II	4	106	38	9	104	35	8	102	25	10	121	88	6	112	99	7	102	90	7
Packsaddle	3	96	18	14	82	8	20	97	12	14	79	51	15	51	32	20	80	34	17
All	124		34		31			26			80			82			82		

Table S8. Descriptive statistics summarized for SEGI seedling tree height (m) in six measurement years from 1981–2009 by six SEGI seedling grove samples planted in trial 1 at the Foresthill Seed Orchard.

Grove	Height 1981					Height 1983				Height 1988			
	n	Mean	s.d.	Max	Min	Mean	s.d.	Max	Min	Mean	s.d.	Max	Min
North Calaveras	14	0.22	0.06	0.33	0.13	0.93	0.24	1.41	0.54	2.8	0.57	4.2	1.6
Redwood Mtn	13	0.22	0.07	0.36	0.14	1.08	0.38	1.98	0.59	3.1	0.75	4.5	1.6
Giant Forest	14	0.21	0.05	0.30	0.15	1.08	0.24	1.46	0.60	3.0	0.48	3.9	2.3
Cedar Flat	13	0.16	0.04	0.25	0.12	0.94	0.31	1.61	0.44	3.1	0.79	4.6	1.7
Garfield	11	0.20	0.05	0.31	0.14	0.94	0.25	1.38	0.62	2.8	0.64	3.9	1.8
Mountain Home	14	0.22	0.08	0.42	0.13	0.99	0.33	1.38	0.38	2.8	0.70	3.7	1.4
Overall Mean	79	0.21	0.06	0.42	0.12	0.99	0.29	1.98	0.38	2.9	0.65	4.6	1.4
Grove	Height 1991					Height 1997				Height 2009			
	n	Mean	s.d.	Max	Min	Mean	s.d.	Max	Min	Mean	s.d.	Max	Min
North Calaveras	14	4.7	0.88	6.4	2.8	6.9	1.6	10.0	4.3	11.8	2.5	16.7	8.2
Redwood Mtn	13	5.2	1.25	8.0	3.0	8.0	1.9	11.2	4.2	14.0	3.4	19.6	7.9
Giant Forest	14	4.8	0.58	6.0	4.2	7.3	1.3	9.5	5.7	13.1	2.4	17.5	9.9
Cedar Flat	13	5.0	1.22	6.6	2.9	7.2	1.9	9.8	4.3	12.7	2.9	16.7	7.8
Garfield	11	4.7	0.75	5.9	3.5	7.2	1.2	9.0	5.6	13.8	2.6	19.9	10.9
Mountain Home	14	4.5	0.85	5.1	2.3	7.0	1.3	8.5	3.8	12.8	2.4	15.3	7.8
All	79	4.8	0.95	8.0	2.3	7.2	1.5	11.2	3.8	13.0	2.7	19.9	7.8

Table S9. Descriptive statistics summarized for SEGI seedling diameter at breast height (cm) and volume (m³) in three measurement years from 1991–2009 by six SEGI seedling grove samples planted in trial 1 at the Foresthill Seed Orchard.

Grove	Diameter 1991					Diameter 1997				Diameter 2009			
	n	Mean	s.d.	Max	Min	Mean	s.d.	Max	Min	Mean	s.d.	Max	Min
North Calaveras	14	11.9	3.7	21.5	5.2	19.4	4.1	29.0	14.0	30.3	6.2	42.8	22.2
Redwood Mtn	13	13.6	3.9	21.0	5.5	22.7	4.6	29.0	11.0	34.9	7.5	43.5	18.7
Giant Forest	14	12.4	2.4	15.4	8.9	21.9	3.7	28.0	14.0	33.1	5.7	40.1	24.1
Cedar Flat	13	13.1	4.4	19.2	4.0	20.9	5.3	29.0	9.0	32.7	6.6	41.0	15.6
Garfield	11	12.2	3.4	17.3	7.3	20.0	3.5	26.0	16.0	32.0	5.6	41.1	24.2
Mountain Home	14	11.2	4.1	16.8	3.2	19.5	4.3	25.0	11.0	31.7	6.9	40.9	17.9
Overall Mean	79	12.4	3.7	21.5	3.2	20.7	4.4	29.0	9.0	32.4	6.4	43.5	15.6
Grove	Volume 1991					Volume 1997				Volume 2009			
	n	Mean	s.d.	Max	Min	Mean	s.d.	Max	Min	Mean	s.d.	Max	Min
North Calaveras	14	0.02	0.02	0.08	0.00	0.08	0.05	0.22	0.02	0.31	0.18	0.74	0.13
Redwood Mtn	13	0.03	0.02	0.09	0.00	0.12	0.06	0.25	0.01	0.50	0.27	0.91	0.07
Giant Forest	14	0.02	0.01	0.04	0.01	0.10	0.05	0.20	0.03	0.40	0.18	0.71	0.18
Cedar Flat	13	0.03	0.02	0.06	0.00	0.10	0.06	0.21	0.01	0.39	0.20	0.73	0.05
Garfield	11	0.02	0.01	0.04	0.00	0.08	0.04	0.15	0.04	0.40	0.22	0.88	0.19
Mountain Home	14	0.02	0.01	0.04	0.00	0.08	0.04	0.14	0.01	0.37	0.18	0.64	0.07
All	79	0.02	0.02	0.09	0.00	0.09	0.05	0.25	0.01	0.39	0.21	0.91	0.05

Table S10. Descriptive statistics summarized by six SEGI seedling grove samples in trial 1 for lower stem form traits fluting (FLUT), asymmetry (ASYM), and basal swelling (SWEL), plus crown fullness (FULL) and epicormic sprouting (EPI) after 29 growing seasons at the Foresthill Seed Orchard in 2009. Traits scored on a scale of 0–3.

Grove	FLUT					ASYM				SWEL			
	n	Mean	s.d.	Max	Min	Mean	s.d.	Max	Min	Mean	s.d.	Max	Min
North Calaveras	14	0.9	0.7	2	0	2.0	0.7	3	1	2.4	0.5	3	2
Redwood Mtn	13	1.4	1.1	3	0	2.0	1.2	3	0	1.9	0.8	3	1
Giant Forest	14	1.9	1.1	3	0	2.2	1.1	3	0	1.9	0.6	3	1
Cedar Flat	13	1.4	1.0	3	0	2.2	0.8	3	1	1.6	0.7	3	1
Garfield	11	1.1	1.1	3	0	1.8	1.0	3	0	1.4	0.5	2	1
Mountain Home	14	1.3	1.3	3	0	2.1	1.0	3	0	1.7	0.6	3	1
Overall Mean	79	1.3	1.1	3	0	2.1	0.9	3	0	1.8	0.7	3	1

Grove	FULL					EPI			
	n	Mean	s.d.	Max	Min	Mean	s.d.	Max	Min
North Calaveras	14	1.4	0.94	3	0	0.1	0.3	1	0
Redwood Mtn	13	1.2	0.73	2	0	0.2	0.6	2	0
Giant Forest	14	1.6	0.85	3	0	0.0	0.0	0	0
Cedar Flat	13	1.8	0.99	3	0	0.2	0.8	3	0
Garfield	11	0.9	0.70	2	0	0.3	0.5	1	0
Mountain Home	14	1.0	1.04	3	0	0.1	0.3	1	0
All	79	1.3	0.92	3	0	0.1	0.5	3	0

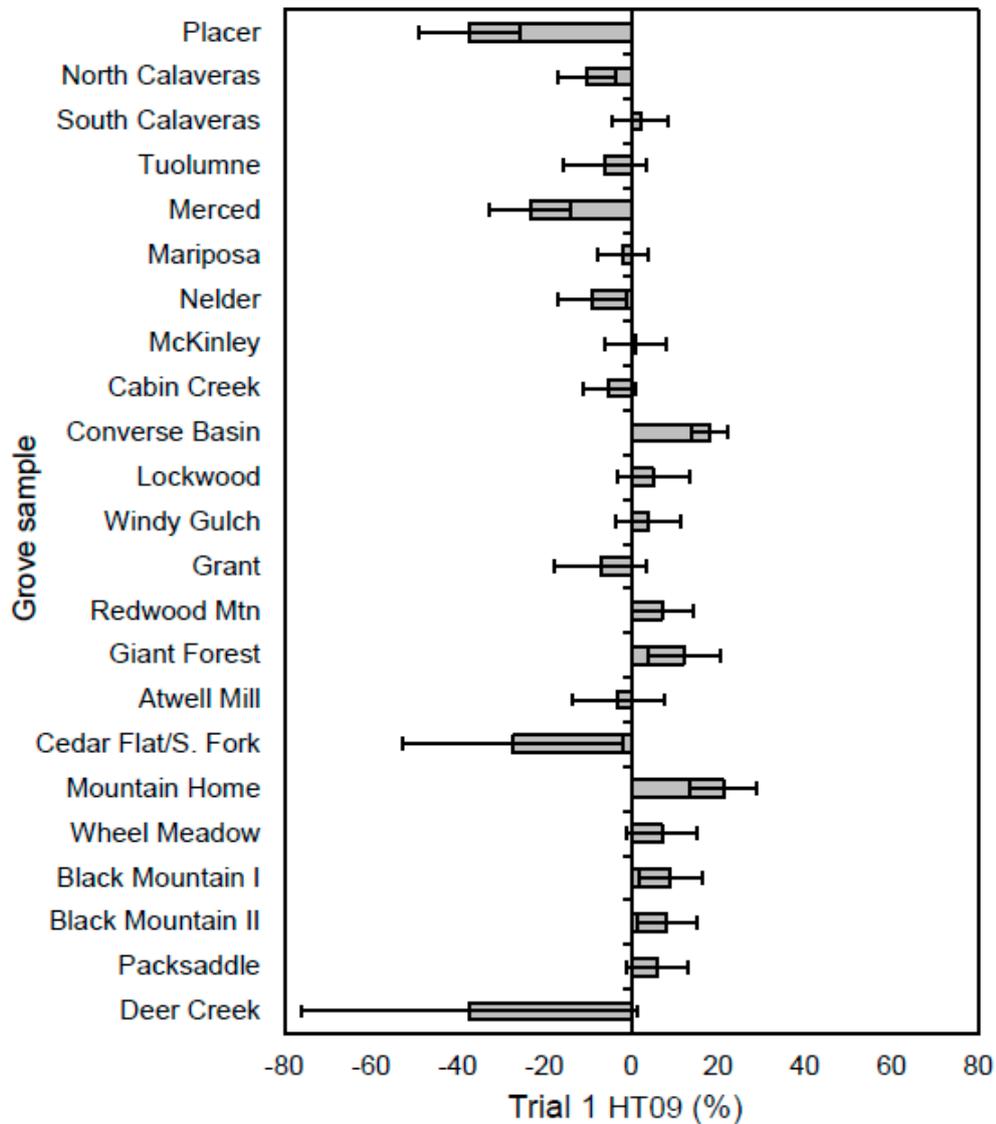


Figure S2. Trial 1 SEGI steckling grove sample mean height (HT09) in percent above or below the steckling mean after 29 growing seasons at the Foresthill Seed Orchard as of 2009. Among-grove differences were statistically significant ($p \leq 0.05$) in a Kruskal–Wallis test. Placer and Deer Creek grove samples were not included in the analysis. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

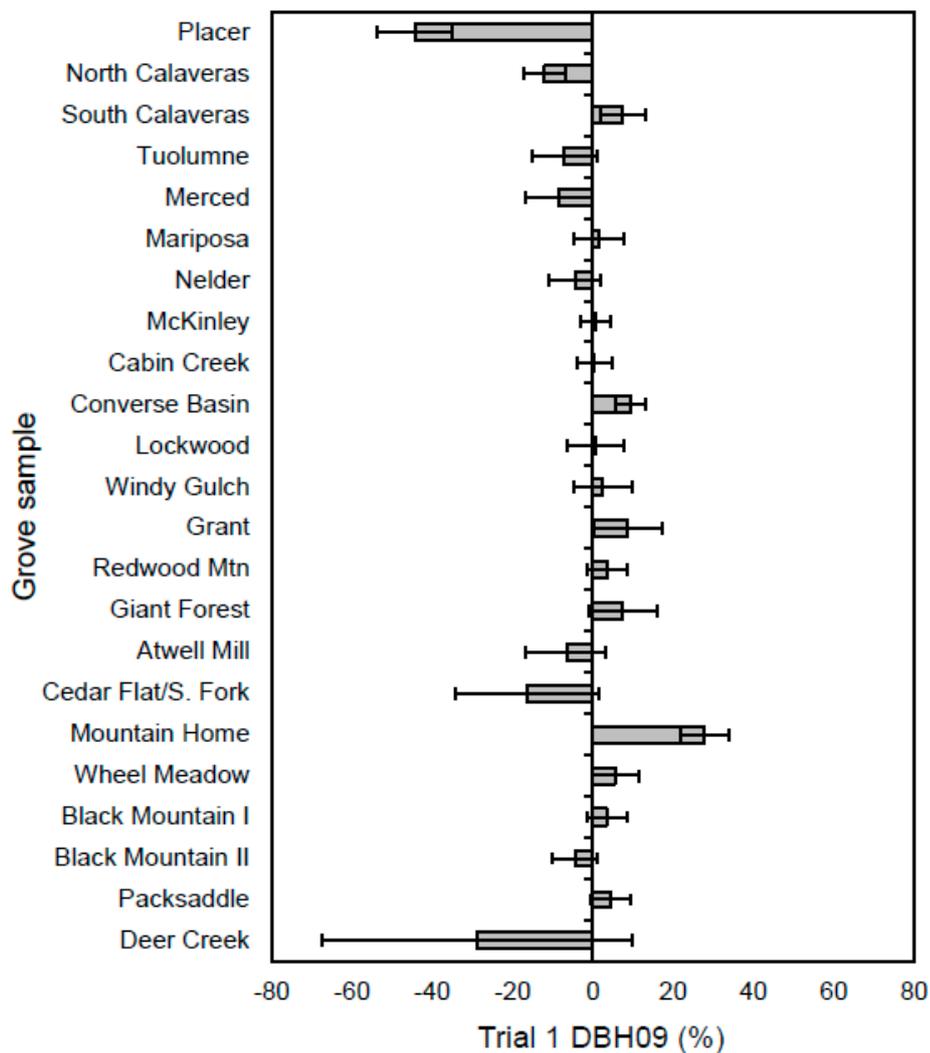


Figure S3. Trial 1 SEGI steckling grove sample mean diameter at breast height (DBH09) in percent above or below the steckling mean after 29 growing seasons at the Foresthill Seed Orchard as of 2009. Among-grove differences were statistically significant ($p \leq 0.1$) in a Kruskal–Wallis test at $\alpha = 0.1$. Placer and Deer Creek grove samples were not included in the analysis. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

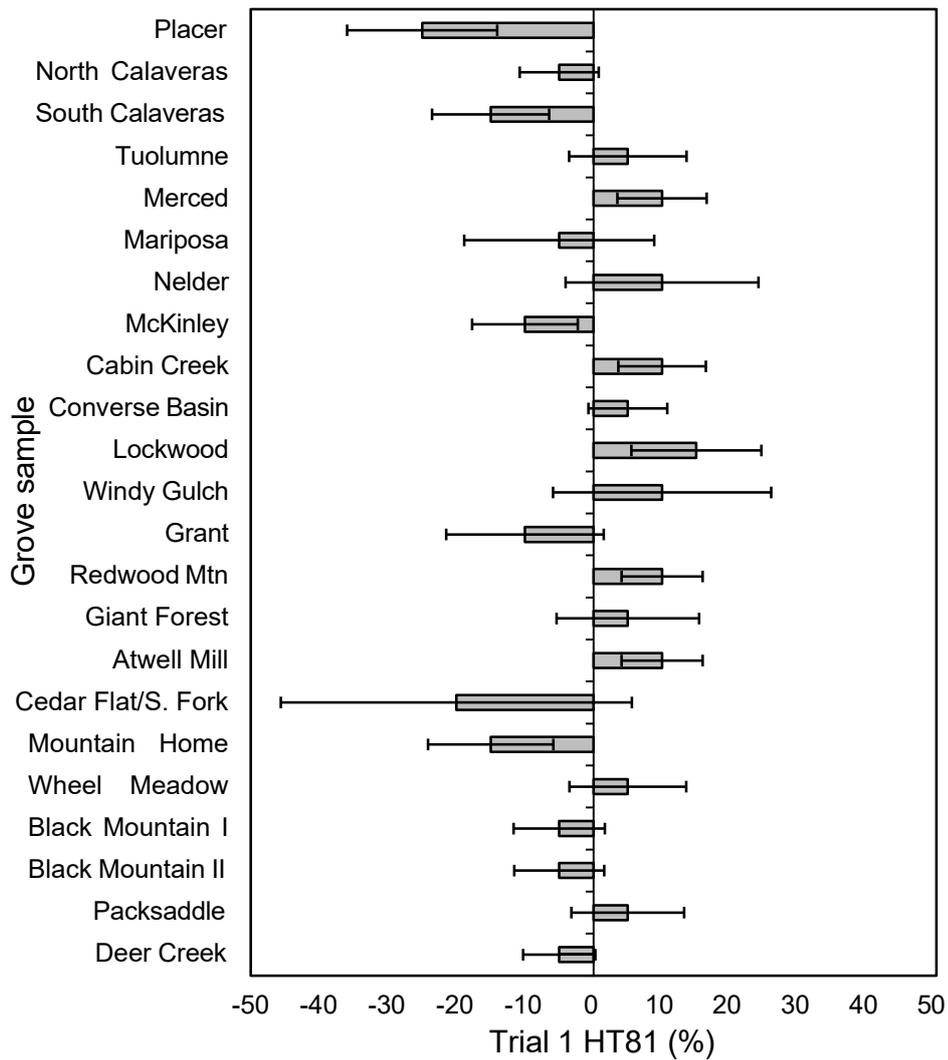


Figure S4. Trial 1 SEGI steckling grove sample mean height (HT81) in percent above or below the steckling mean after one growing season at the Foresthill Seed Orchard as of 1981. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

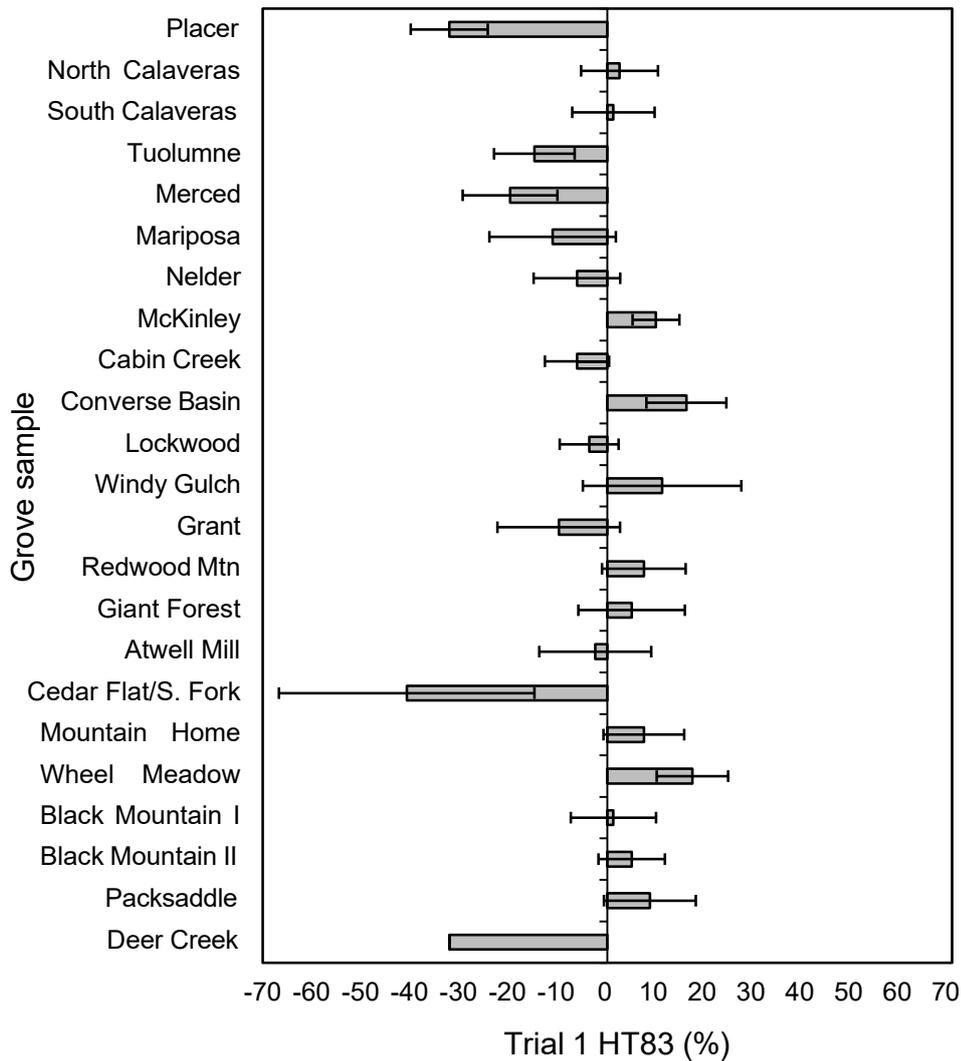


Figure S5. Trial 1 SEGI steckling grove sample mean height (HT83) in percent above or below the steckling mean after three growing seasons at the Foresthill Seed Orchard as of 1983. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

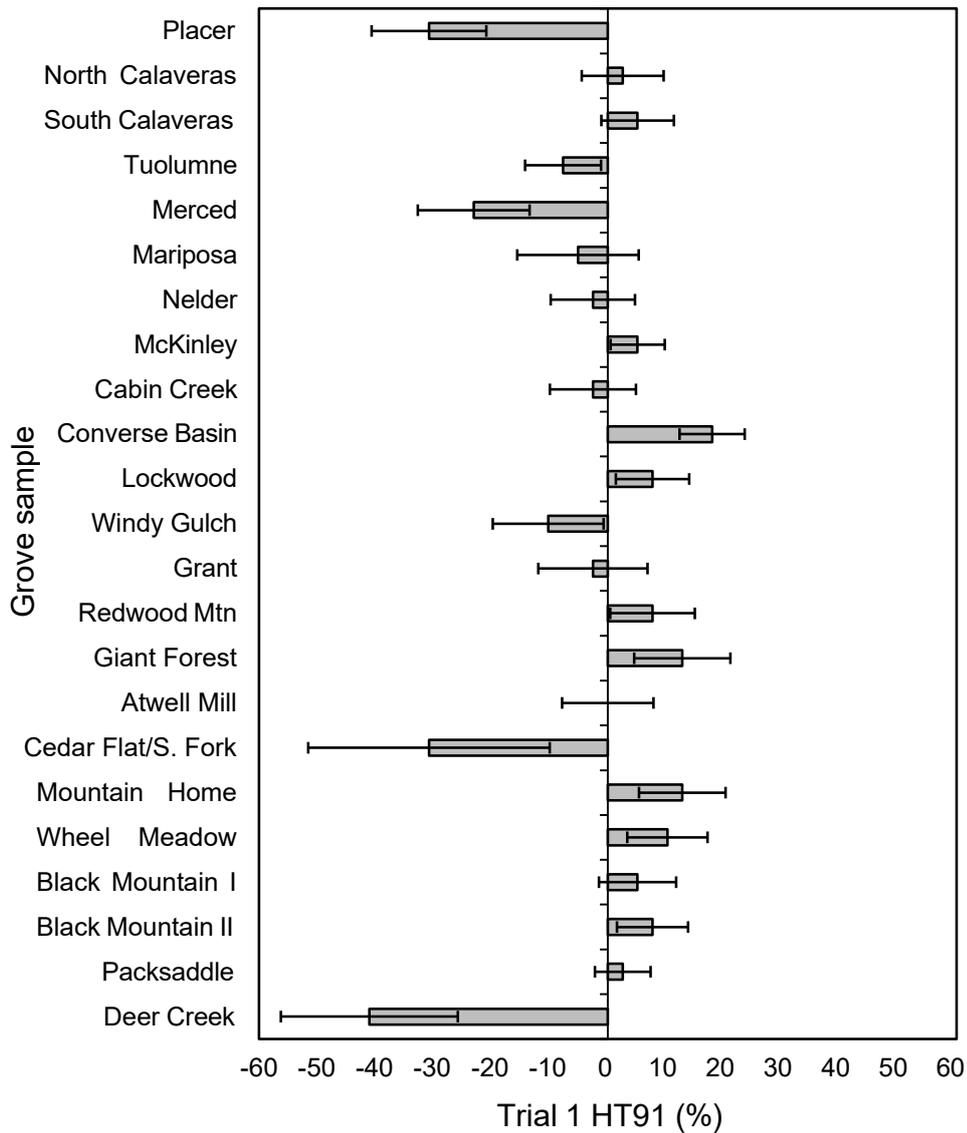


Figure S6. Trial 1 SEGI steckling grove sample mean height (HT91) in percent above or below the steckling mean after eleven growing seasons at the Foresthill Seed Orchard as of 1991. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

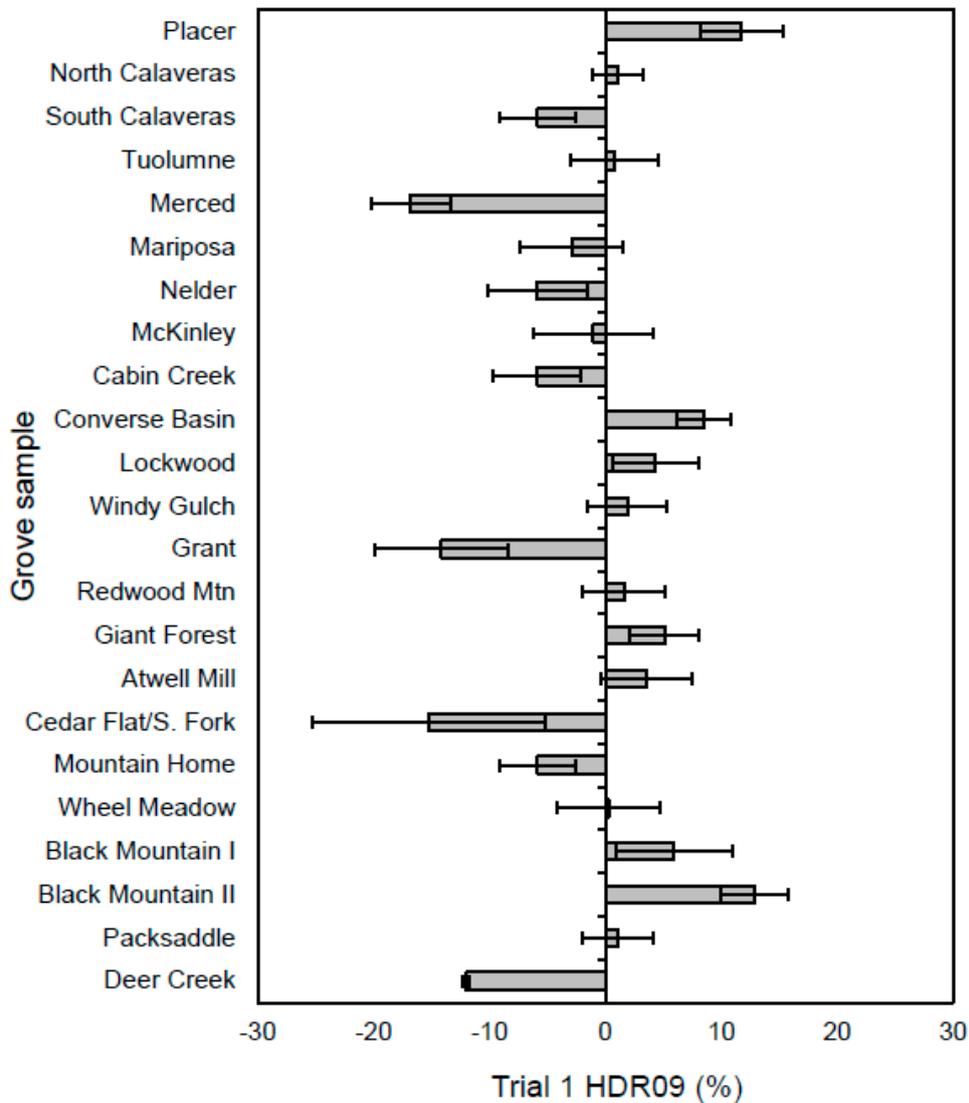


Figure S7. Trial 1 SEGI steckling grove sample mean height–diameter ratio (HDR) in percent above or below the within-trial steckling mean after 29 growing seasons at Foresthill Seed Orchard as of 2009. Among-grove differences were statistically significant ($p \leq 0.0001$) in a Kruskal–Wallis one-way ANOVA. Placer and Deer Creek grove samples were not included in the analysis. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

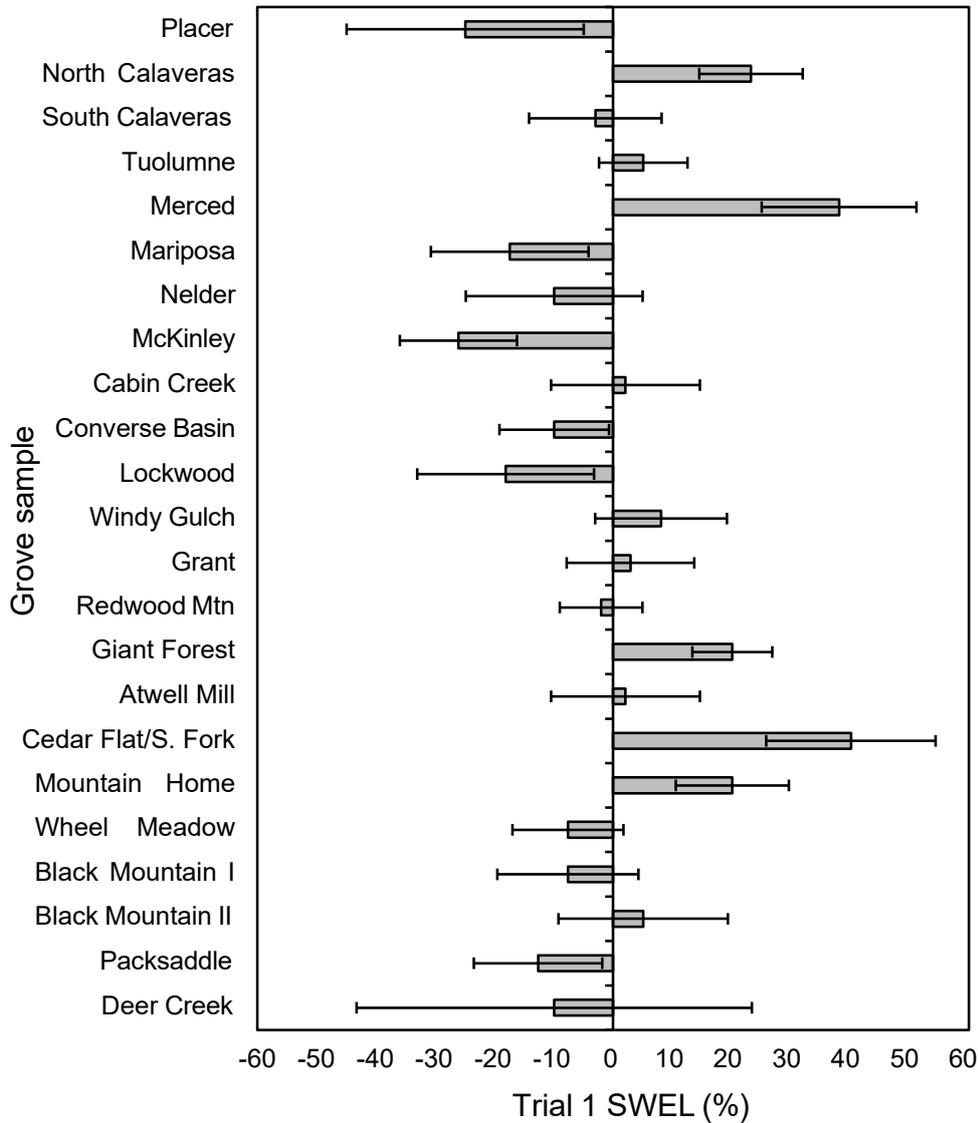


Figure S8. Trial 1 SEGI steckling grove sample basal swelling (SWEL) in percent above or below the steckling mean at the Foresthill Seed Orchard after 29 growing seasons. Among-grove differences were statistically significant ($p \leq 0.01$) in a Kruskal–Wallis one-way ANOVA. Placer and Deer Creek grove samples were not included in the analysis. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

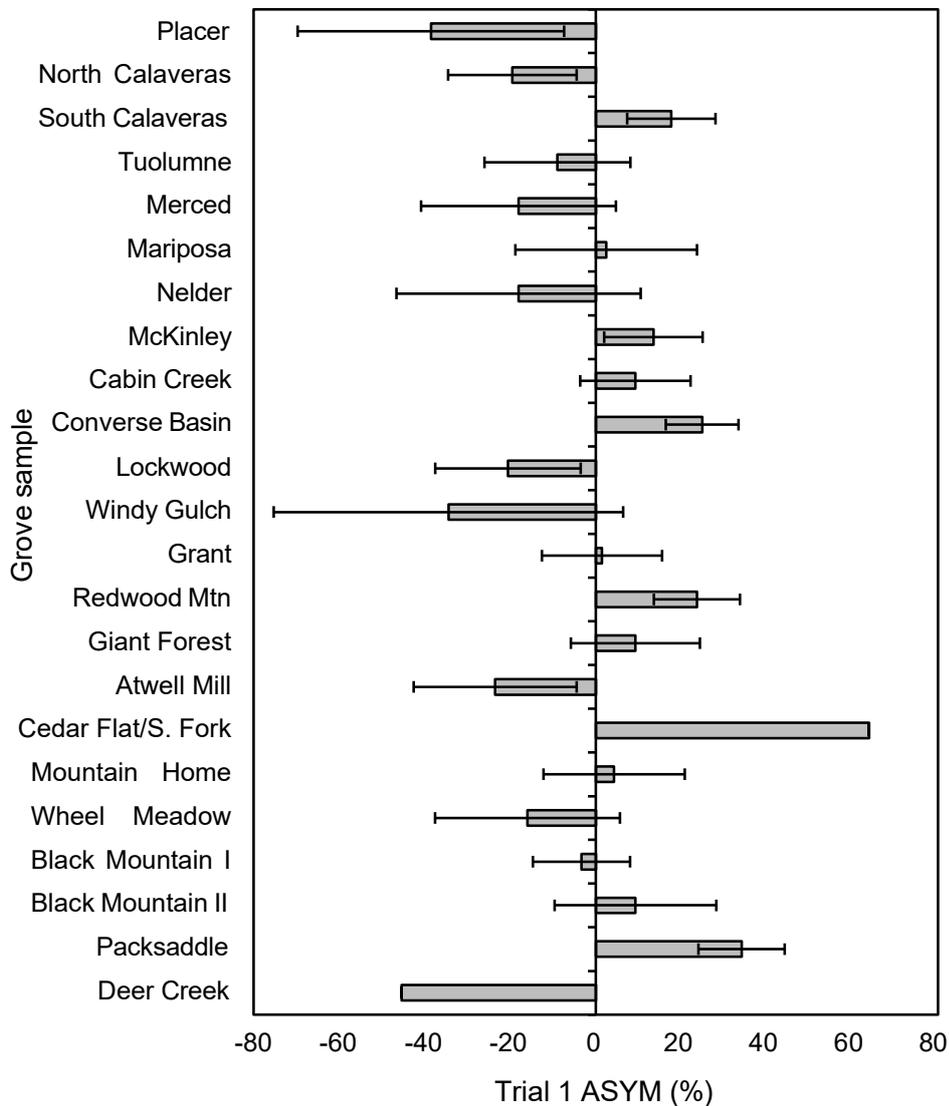


Figure S9. Trial 1 SEGI steckling grove sample lower stem asymmetry (ASYM) in percent above or below the overall mean at the Foresthill Seed Orchard after 29 growing seasons. Among-grove differences were moderately significant ($p \leq 0.1$) in a Kruskal–Wallis one-way ANOVA. Placer and Deer Creek grove samples were not included in the analysis. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

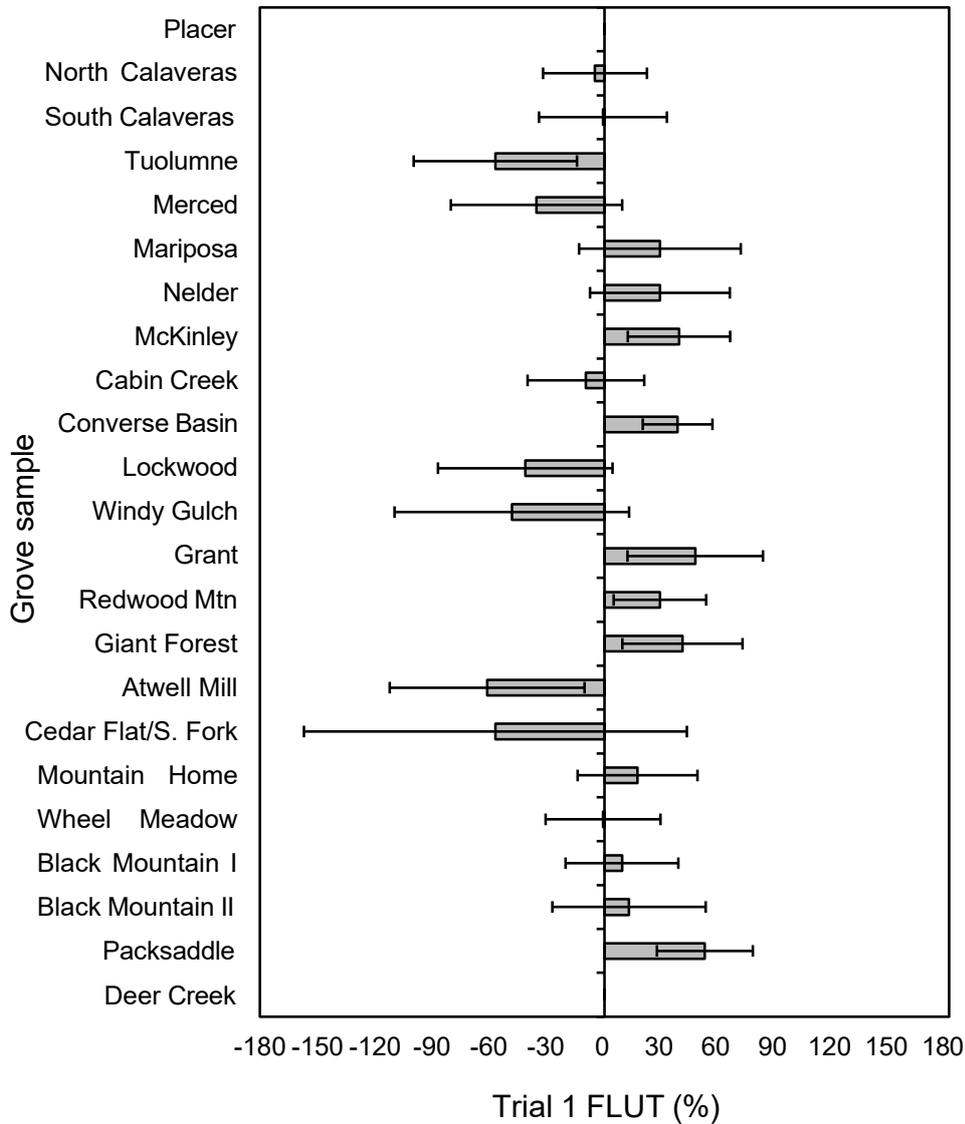


Figure S10. Trial 1 SEGI steckling grove sample lower stem fluting (FLUT) in percent above or below the overall mean at the Foresthill Seed Orchard after 29 growing seasons. There was no FLUT observed in Placer or Deer Creek grove samples. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

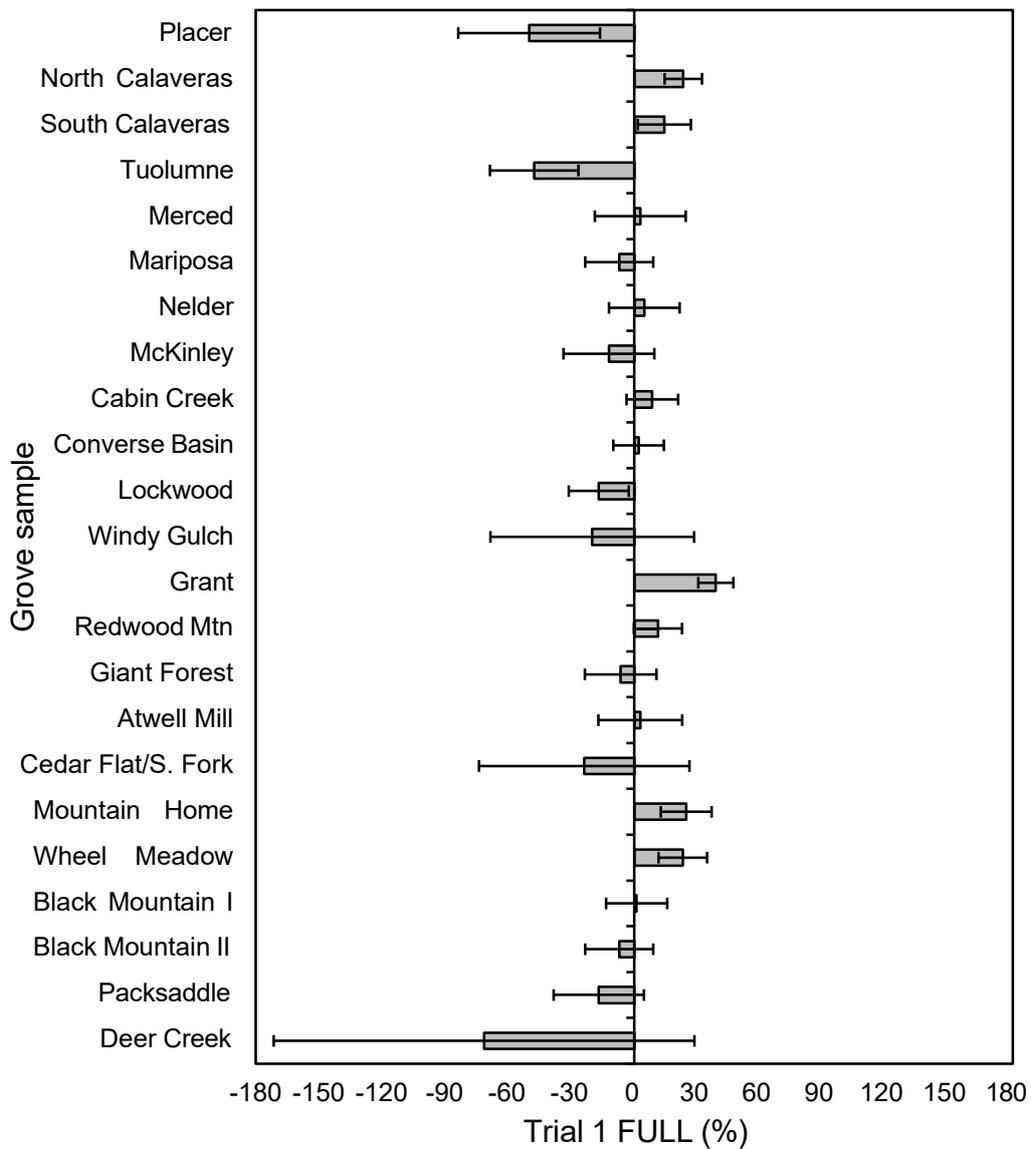


Figure S11. Trial 1 SEGI steckling grove sample crown fullness (FULL) in % above or below the overall steckling mean at the Foresthill Seed Orchard after 29 growing seasons. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

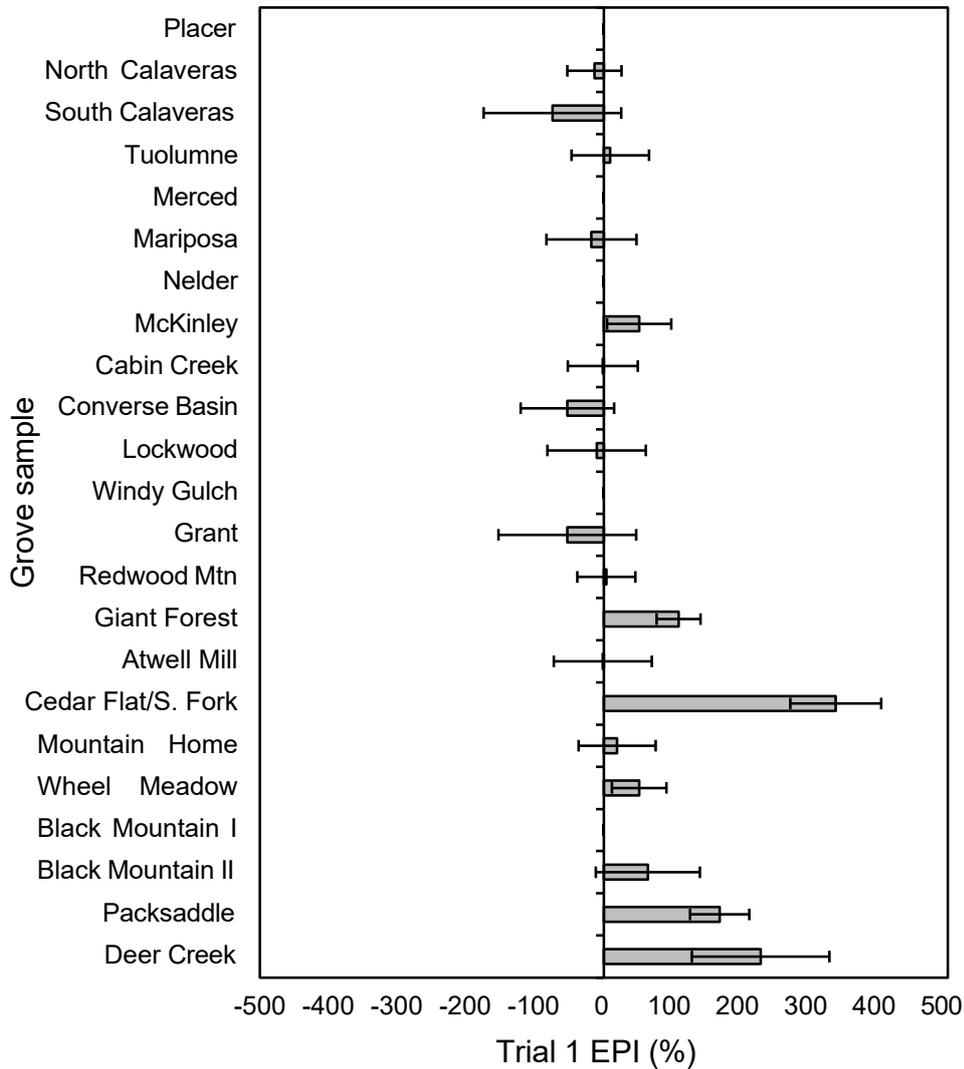


Figure S12. Trial 1 SEGI steckling grove sample epicormic sprouting abundance (EPI) in percent above or below the overall mean at the Foresthill Seed Orchard after 29 growing seasons. There were no epicormic sprouts recorded for Placer, Merced, Nelder, Windy Gulch, or Black Mountain I grove samples. Among-grove differences were statistically significant ($p \leq 0.1$) in a Kruskal–Wallis test at alpha = 0.1. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

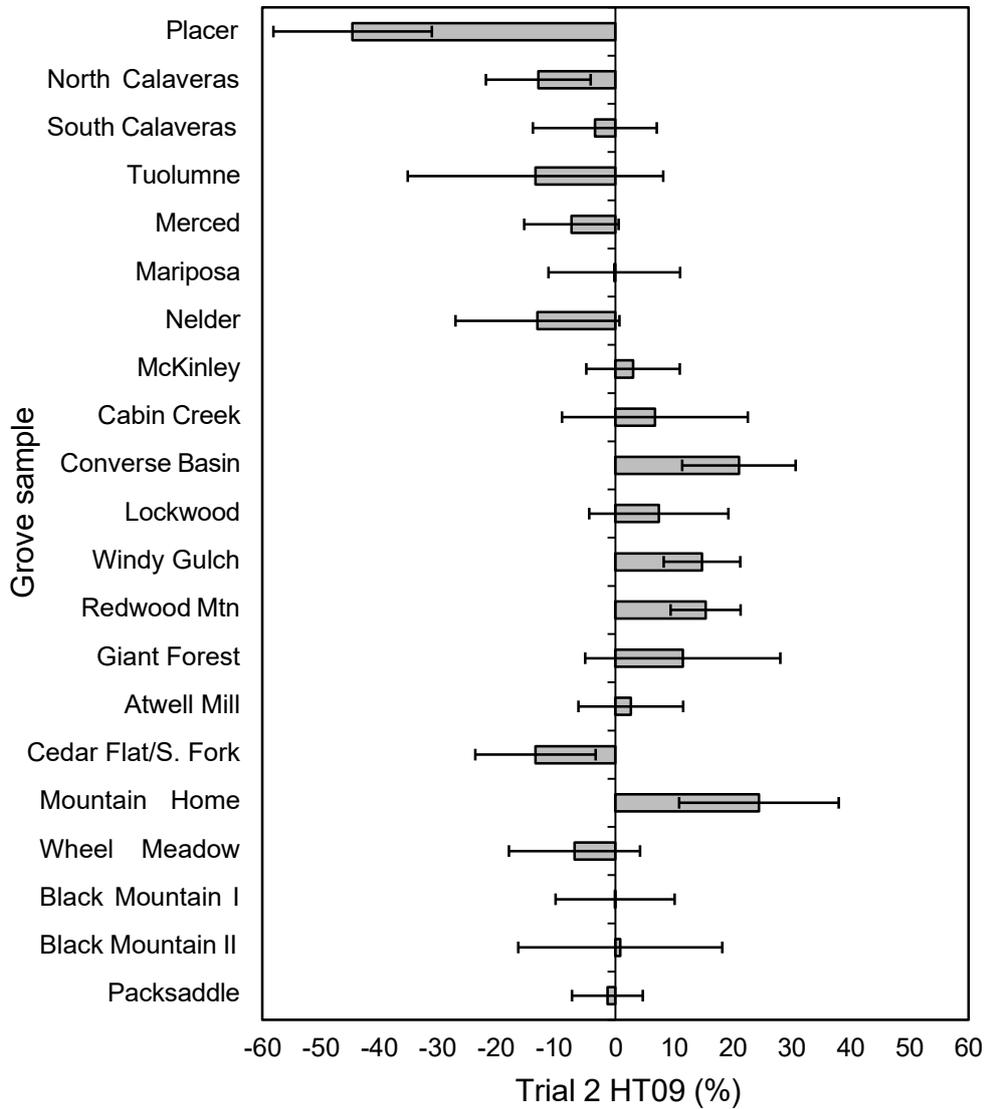


Figure S13. Trial 2 SEGI steckling grove sample mean height (HT09) in percent above or below the steckling mean after 29 growing seasons at the Foresthill Seed Orchard as of 2009. Error bars are relative standard errors (%). Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

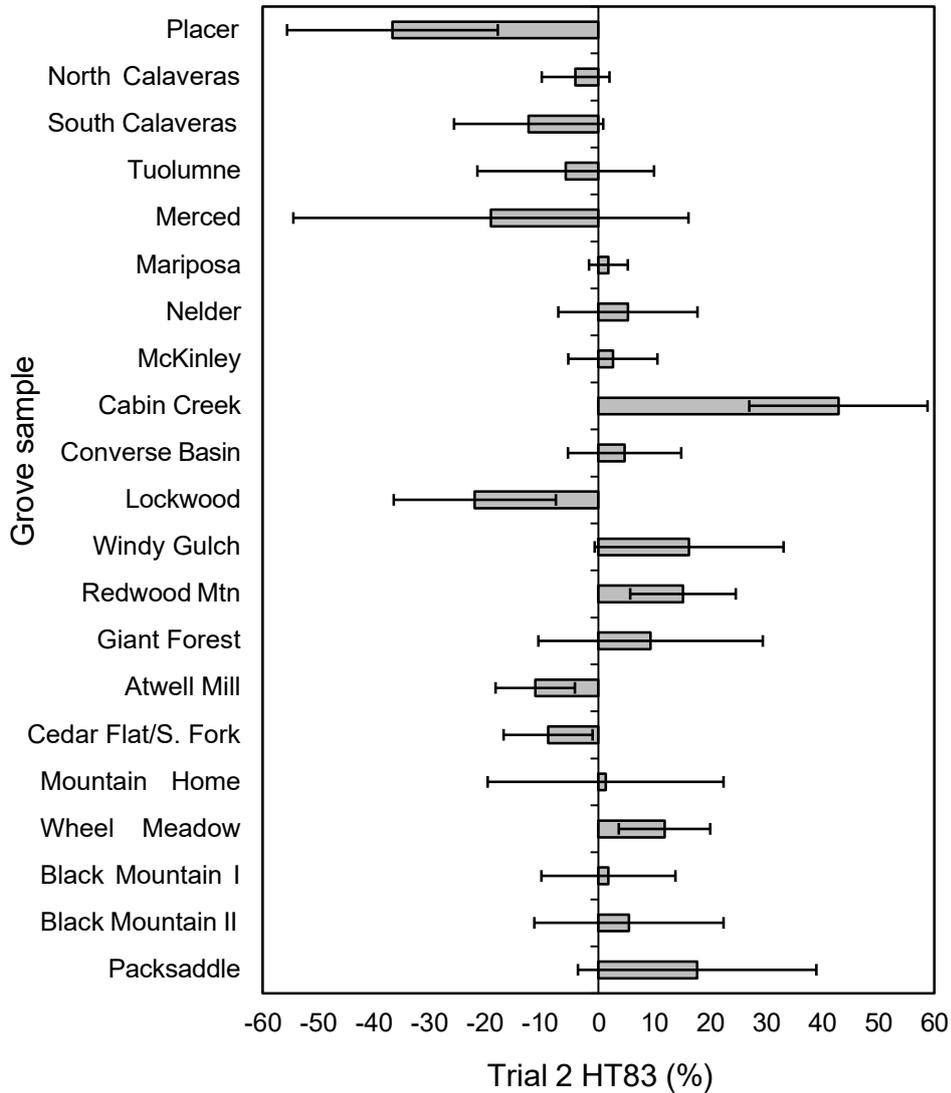


Figure S14. Trial 2 SEGI steckling grove sample mean height (HT83) in percent above or below the steckling mean after three growing seasons at the Foresthill Seed Orchard as of 1983. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

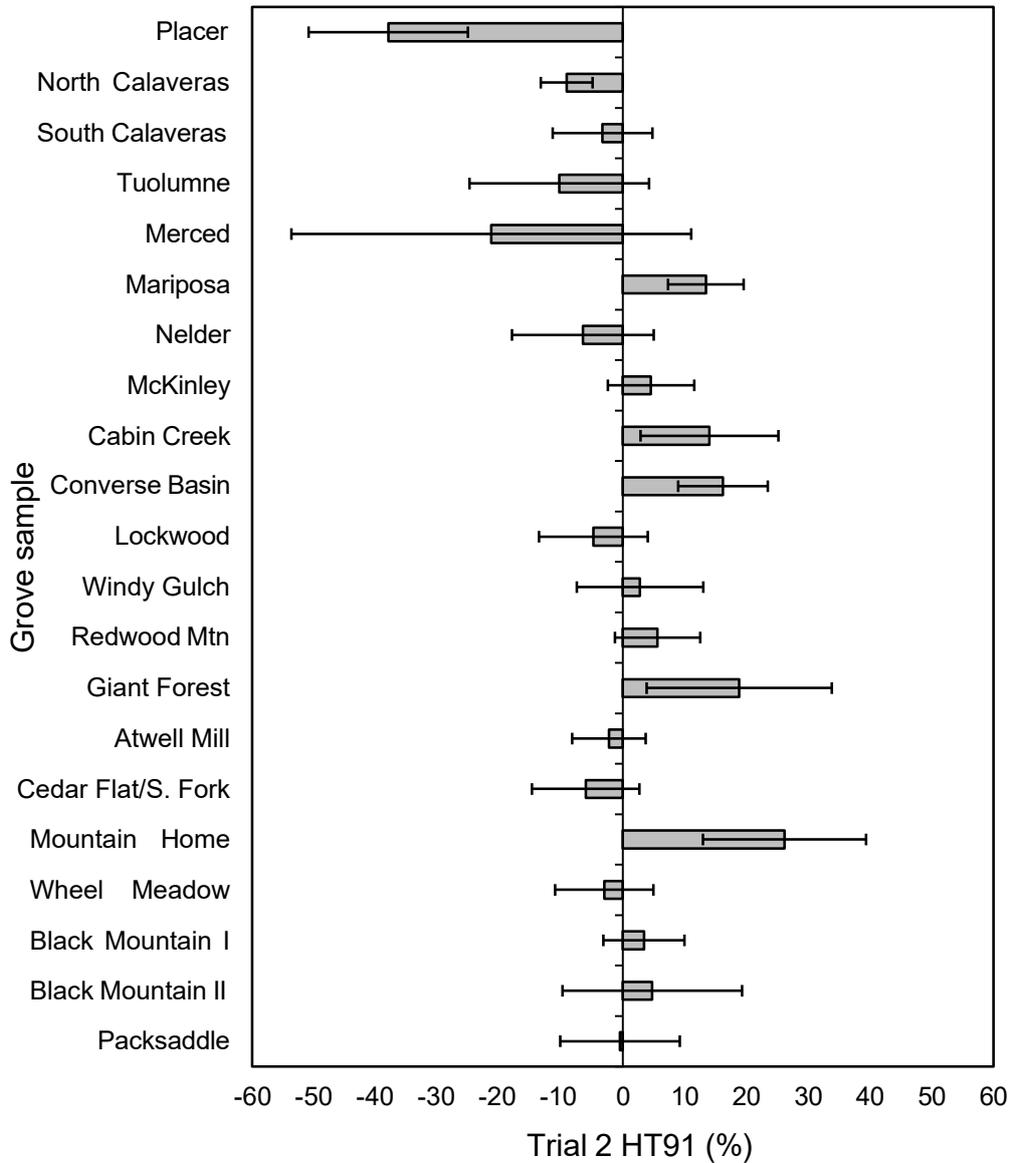


Figure S15. Trial 2 SEGI steckling grove sample mean height (HT91) in percent above or below the steckling mean after three growing seasons at the Foresthill Seed Orchard as of 1991. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

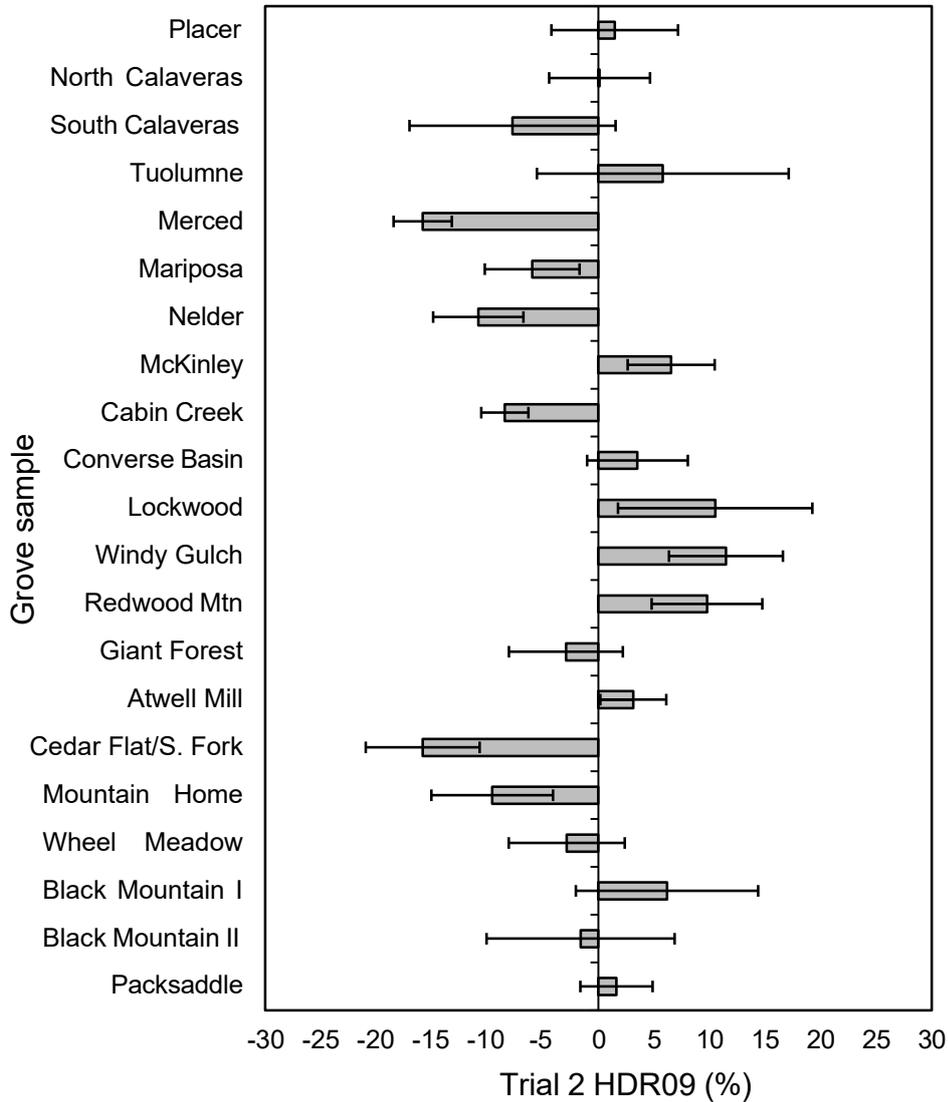


Figure S161. Trial 2 SEGI steckling grove sample mean height–diameter ratio (HDR09) in percent above or below the overall mean after 29 growing seasons at the Foresthill Seed Orchard. Error bars are relative standard errors (%). Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

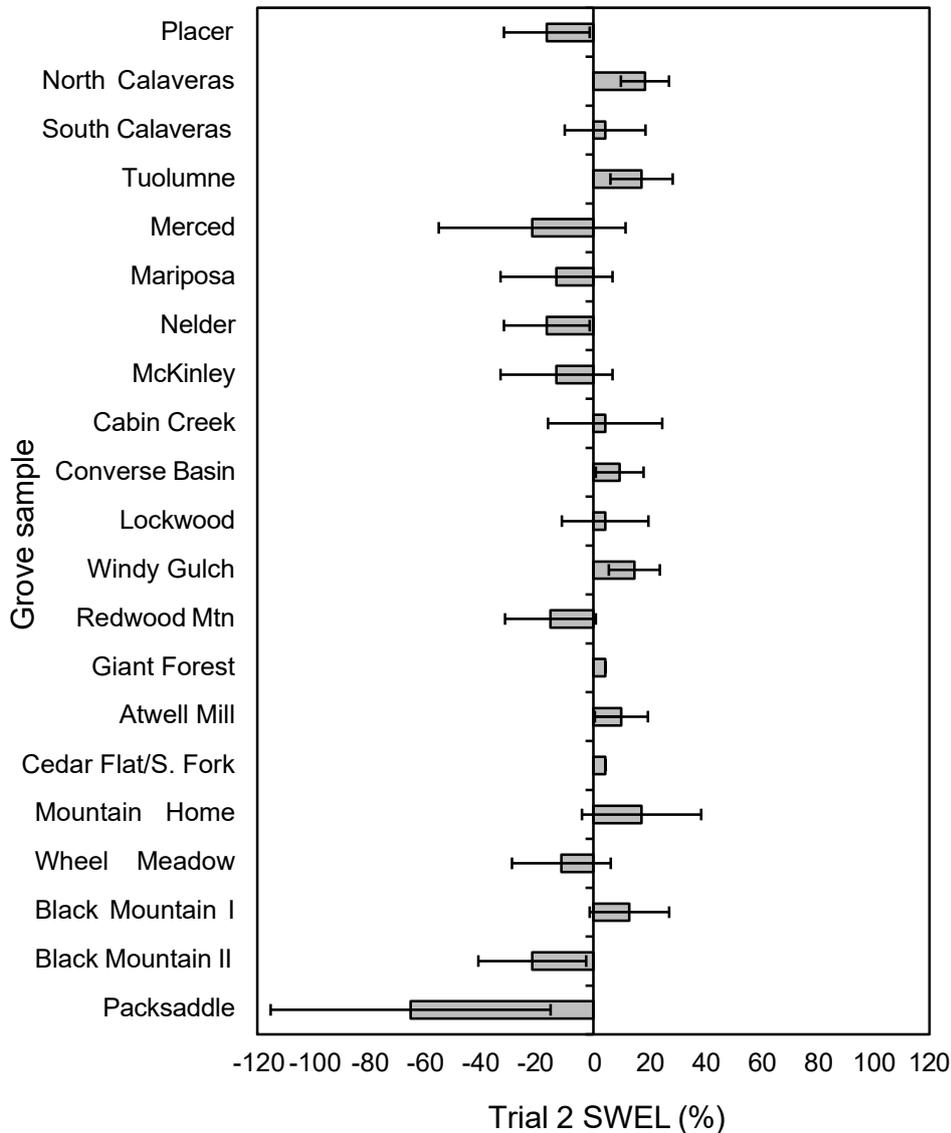


Figure S17. Trial 2 SEGI steckling grove sample mean basal swelling (SWEL) in percent above or below the within-trial steckling mean at Foresthill Seed Orchard. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

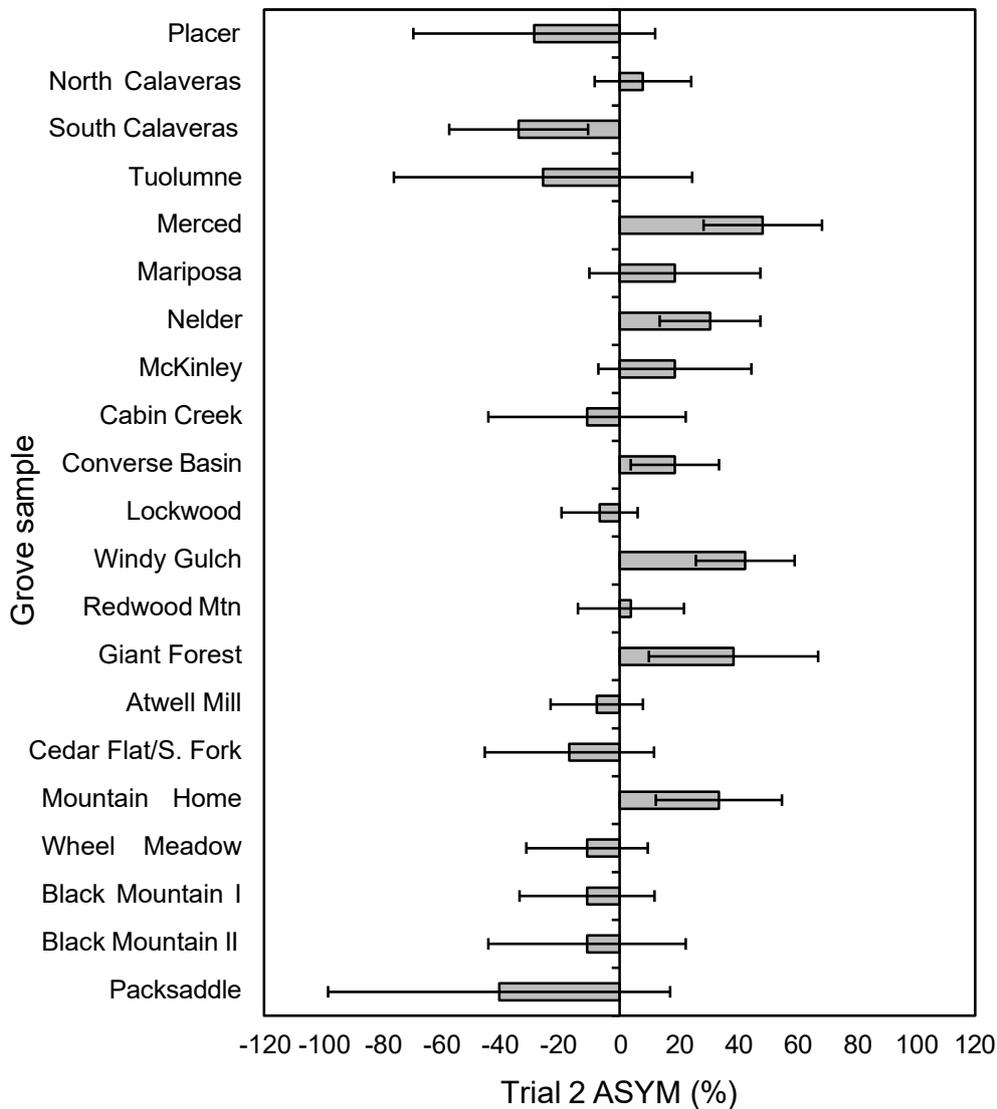


Figure S18. Trial 2 SEGI steckling grove sample mean lower stem asymmetry (ASYM) in percent above or below the within-trial steckling mean at the Foresthill Seed Orchard. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

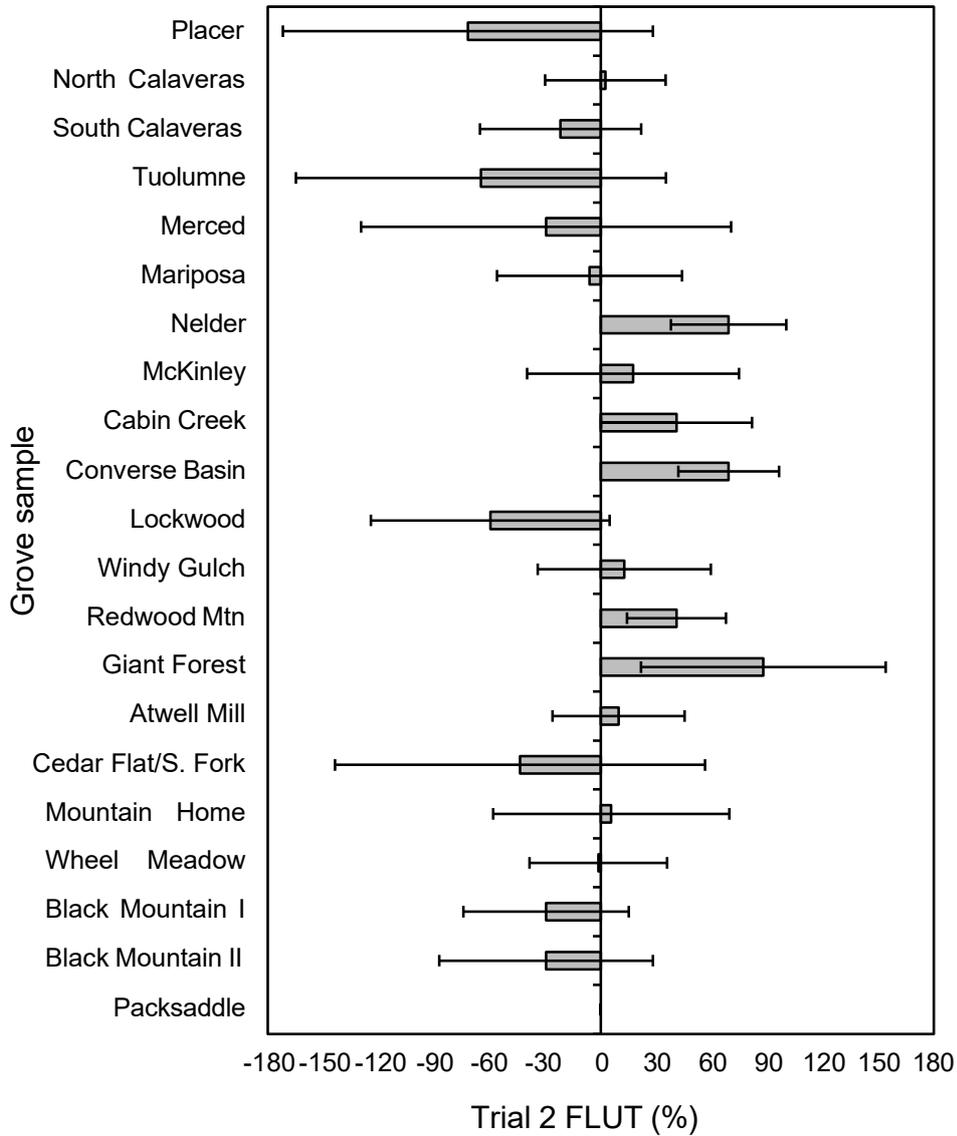


Figure S19. Trial 2 SEGI steckling grove sample mean lower stem fluting (FLUT) in percent above or below the within-trial steckling mean at the Foresthill Seed Orchard. Packsaddle had no observed fluting. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

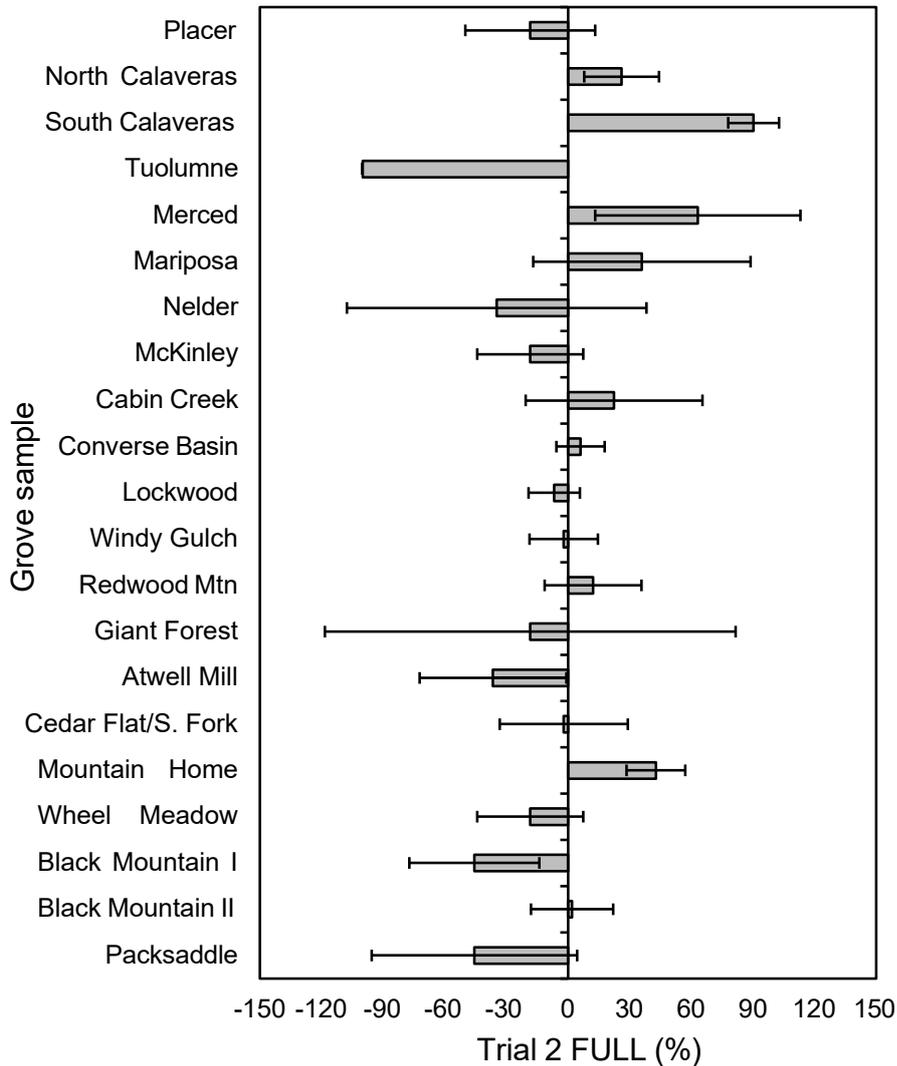


Figure S20. Trial 2 SEGI steckling grove sample mean crown fullness (FULL) in percent above or below the within-trial steckling mean at Foresthill Seed Orchard. Among-grove differences were statistically significant ($p \leq 0.05$) in a Kruskal–Wallis nonparametric test. Placer and Deer Creek grove samples were not included in the analysis. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

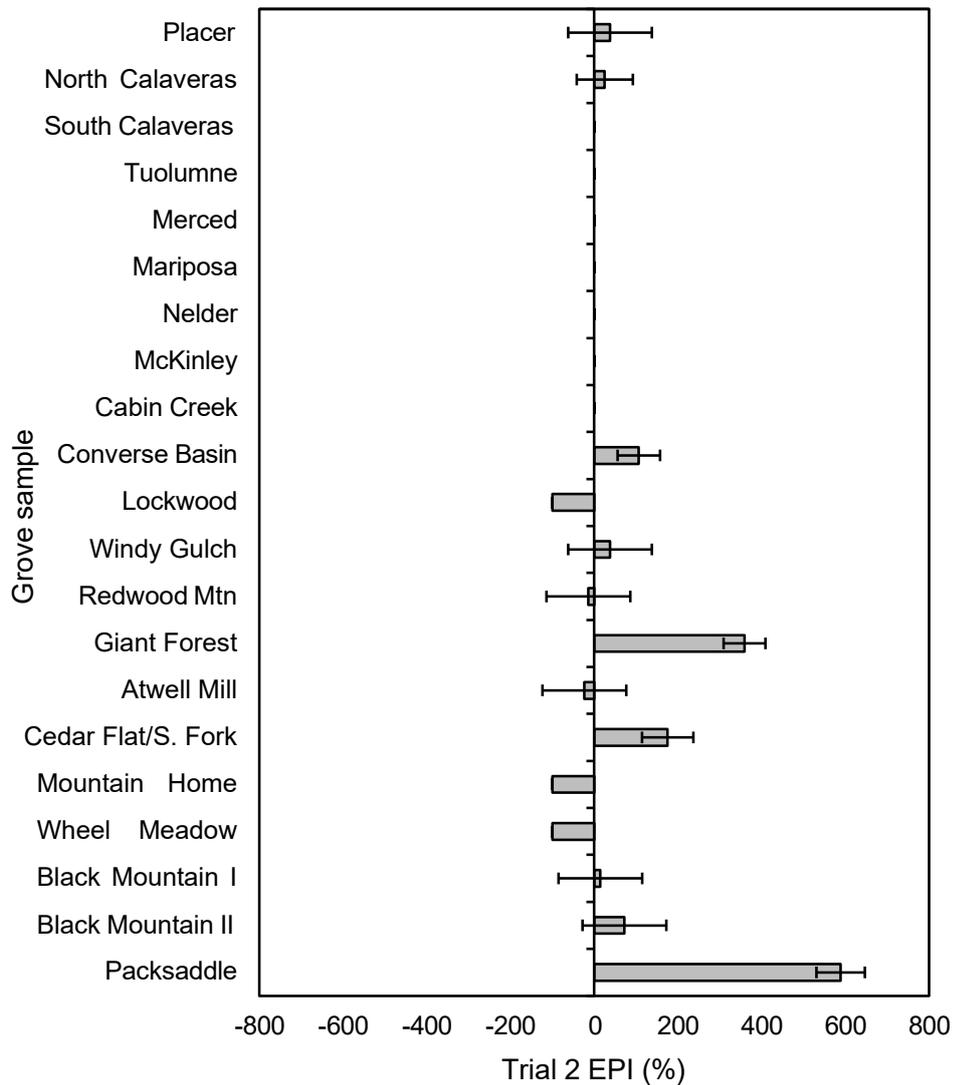


Figure S21. Trial 2 SEGI steckling grove sample mean epicormic sprout abundance (EPI) in percent above or below the within-trial steckling mean at the Foresthill Seed Orchard. Among-grove differences were statistically significant ($p \leq 0.1$) in a Kruskal–Wallis test at $\alpha = 0.1$. Error bars are relative standard errors of the grove sample mean, where the grove sample standard error is divided by the mean and expressed as a percent (%). Grove samples are arranged from north to south in the figure.

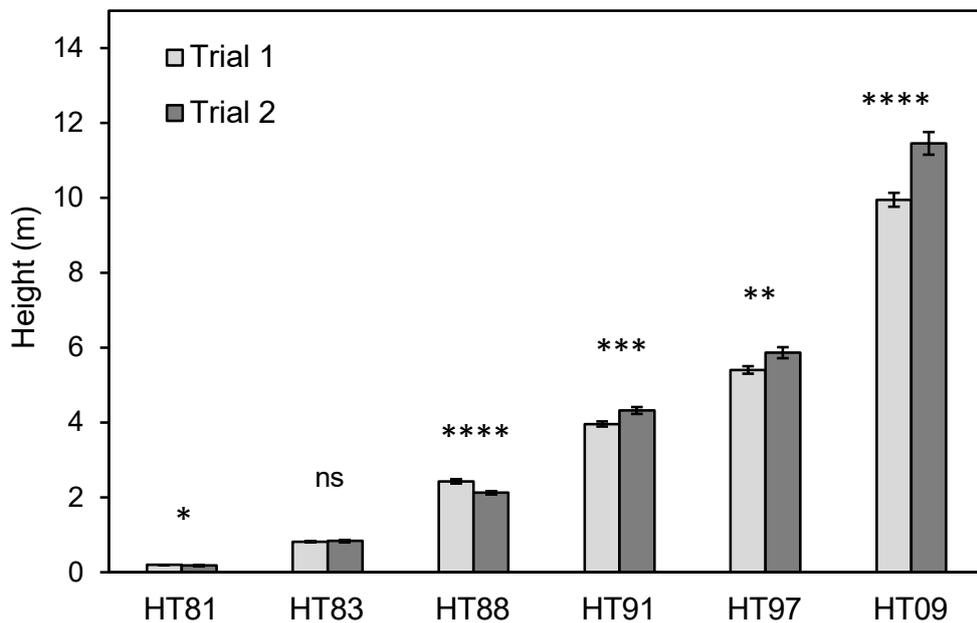


Figure S22. Mean height (HT) of SEGI stecklings in trial 1 (n = 235) and trial 2 (n = 124) in six measurement years over 29 growing seasons at the Foresthill Seed Orchard. Tests of significance were conducted using the nonparametric Kruskal–Wallis test. Trial 1 mean HT81 was significantly greater than trial 2. Levels of significance for each growth period are indicated by asterisks (ns = no significance, * p < 0.05; ** p < 0.001; ***p < 0.001; and **** p < 0.0001).

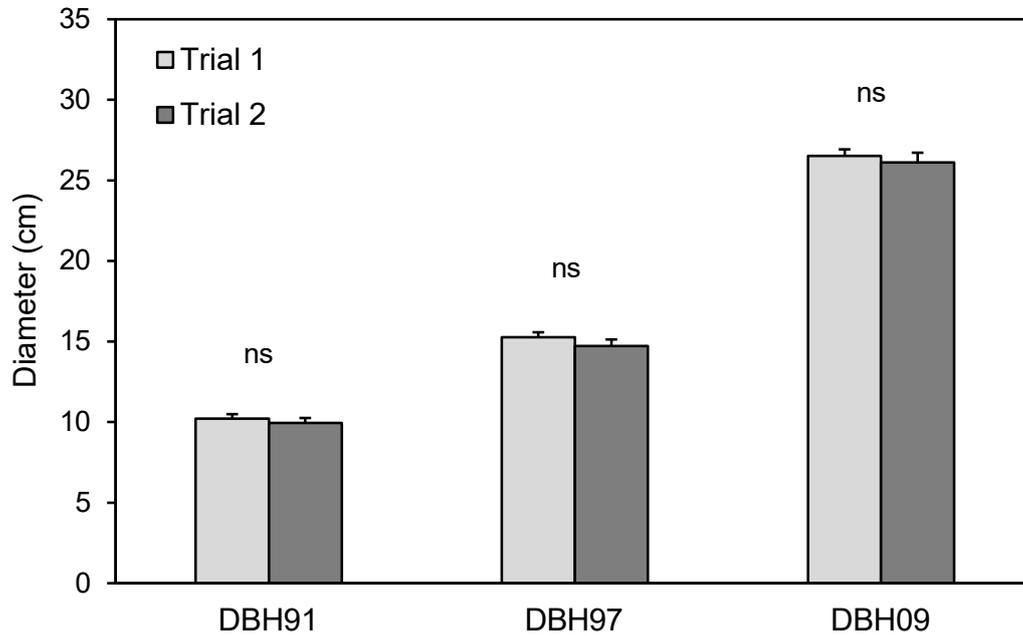


Figure S23. Mean diameter breast height (DBH) of SEGI stecklings in trial 1 and trial 2 in three measurement years over 29 growing seasons at the Foresthill Seed Orchard. Tests of significance were conducted using the nonparametric Kruskal–Wallis test, where ns = no significance at the 0.05 level.

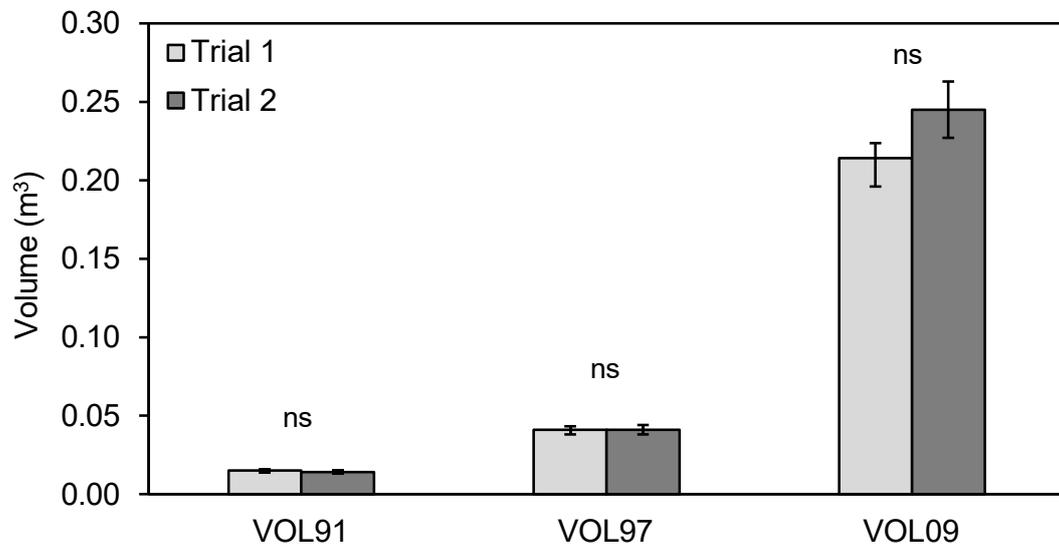


Figure S24. Mean conic stem volume (VOL) in SEGI stecklings in trial 1 and trial 2 in three measurement years over 29 growing seasons at the Foresthill Seed Orchard. Tests of significance were conducted using the nonparametric Kruskal–Wallis test, where ns = no significance at the 0.05 level.

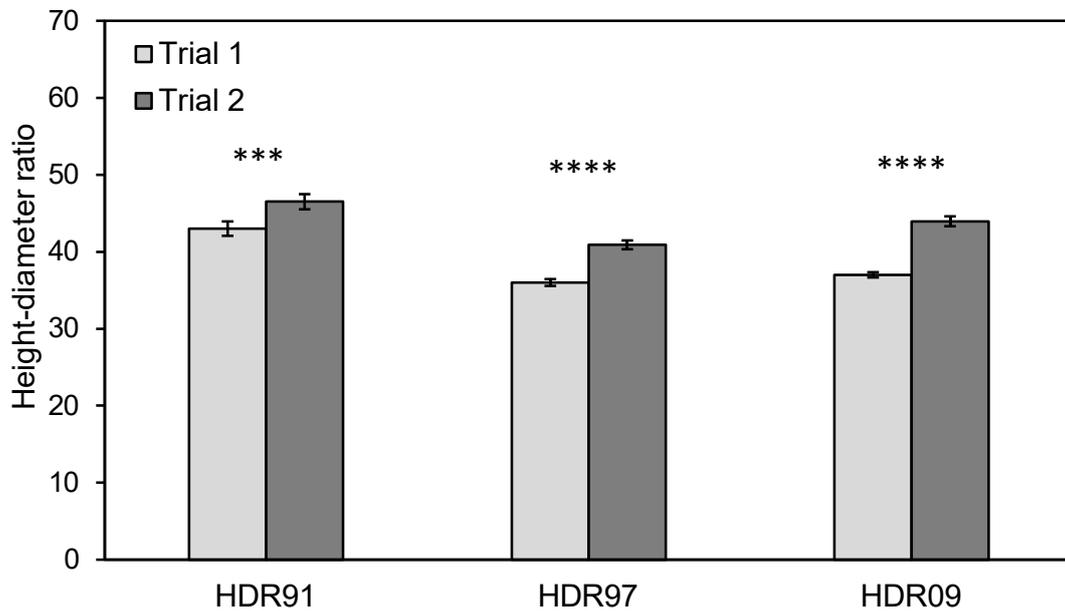


Figure S25. Mean height–diameter ratio (HDR) of SEGI stecklings in trial 1 and trial 2 in three measurement years over 29 growing seasons at the Foresthill Seed Orchard. Tests of significance were conducted using the nonparametric Kruskal–Wallis test. Levels of significance for each growth period are indicated by asterisks (ns = no significance; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; and **** $p < 0.0001$).

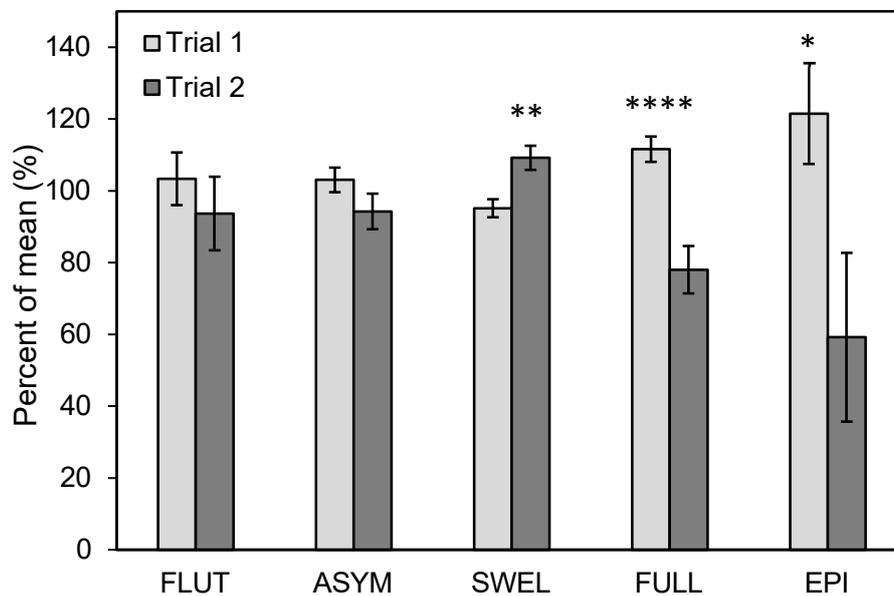


Figure S26. Comparison of trial 1 (n = 235) and trial 2 (n = 124) SEGI steckling form traits in percent of the mean after 29 growing seasons at the Foresthill Seed Orchard. Tests of significance were conducted using the non-parametric Kruskal–Wallis test. Error bars are relative standard errors of the trial mean where the trial standard error is divided by the mean and expressed as a percent. Levels of significance for each growth period are indicated by asterisks (* p < 0.05; ** p < 0.01; ***p < 0.001; and **** p < 0.0001).

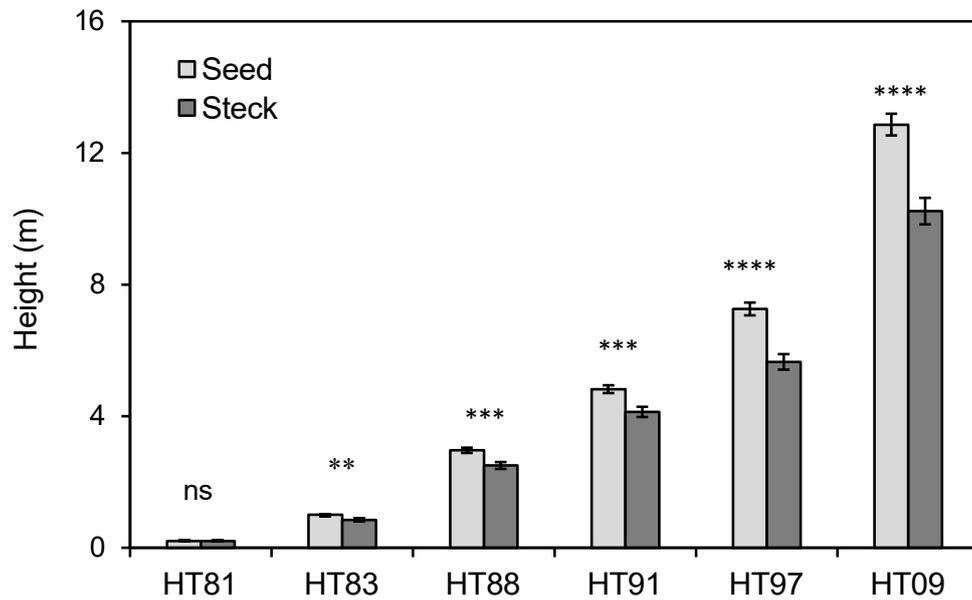


Figure S27. Trial 1 seedling (Seed; $n = 68$) and steckling (Steck; $n = 63$) height in six measurement years over 29 growing seasons at the Foresthill Seed Orchard. Only grove samples with both seedlings and stecklings planted in trial 1 were included in this analysis. Tests of significance were conducted using the nonparametric Kruskal–Wallis test. Levels of significance for each growth period are indicated by asterisks (ns = no significance; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; and **** $p < 0.0001$).

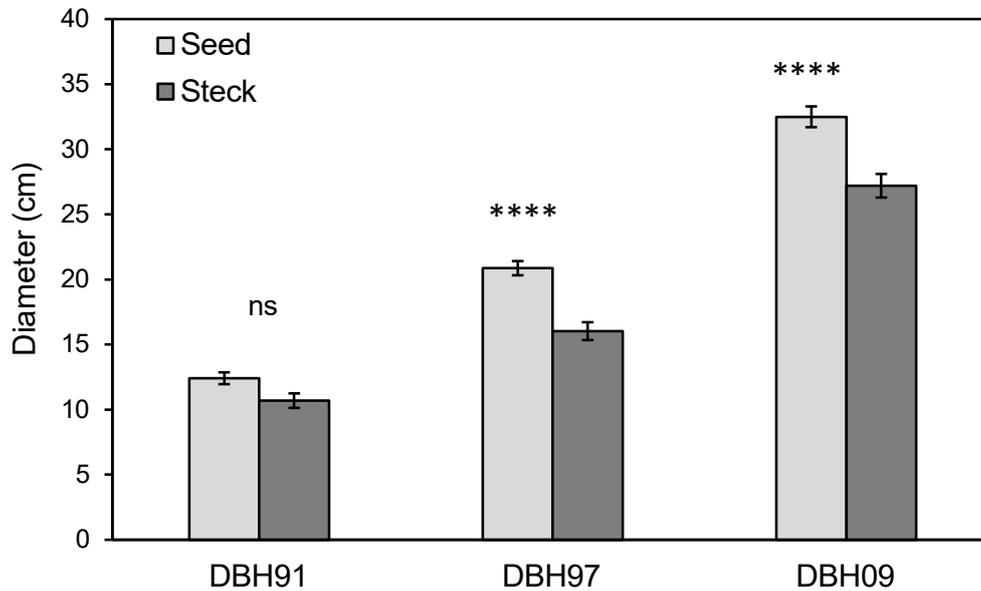


Figure S28. Trial 1 seedling (Seed; n = 68) and steckling (Steck; n = 63) stem diameter in six measurement years over 29 growing seasons at the Foresthill Seed Orchard. Only grove samples with both seedlings and stecklings planted in trial 1 were included in this analysis. Tests of significance were conducted using the nonparametric Kruskal–Wallis test. Levels of significance for each growth period are indicated by asterisks (ns = no significance; * p < 0.05; ** p < 0.01; ***p < 0.001; and **** p < 0.0001).

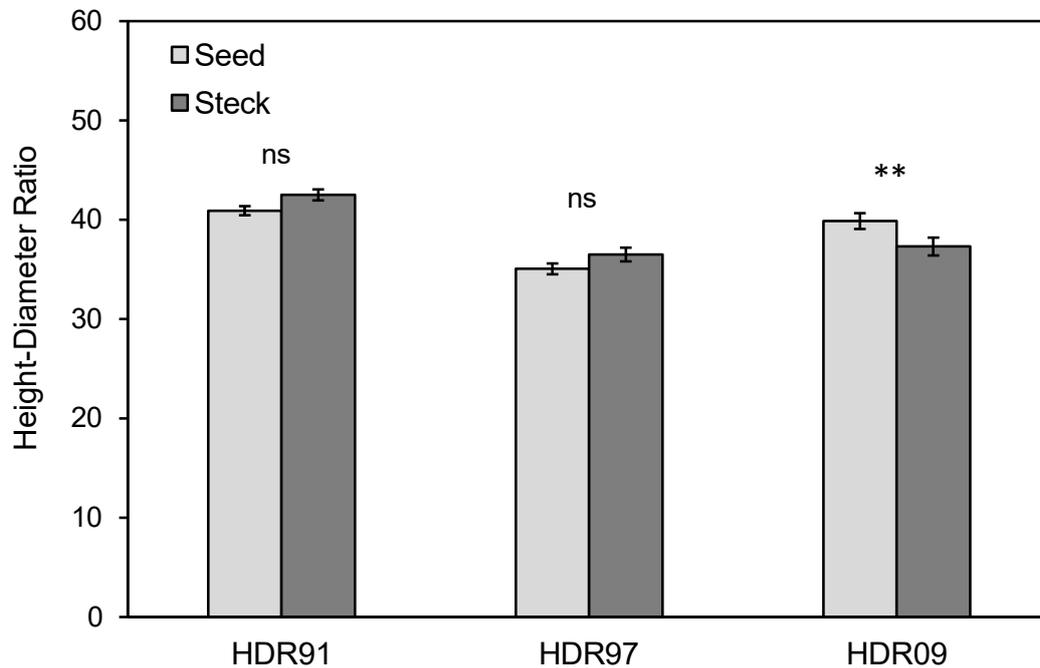


Figure S29. Trial 1 seedling (Seed; n = 68) and steckling (Steck; n = 63) height–diameter ratio for three measurement years from 1991 to 2009 at Foresthill Seed Orchard. Only grove samples with both seedlings and stecklings were included in this analysis. Tests of significance were conducted using the nonparametric Kruskal–Wallis test. Levels of significance for each growth period are indicated by asterisks (ns = no significance; * p < 0.05; ** p < 0.01; ***p < 0.001; and **** p < 0.0001).