Bean CAP – Snap Beans

2012 update

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United States Department of Agriculture
National Institute of Food and Agriculture

Snap beans – focus on “green” pods

- Phenotypic data collection is focused on this organ
- Traits of interest include:
  - Morphology (length, thickness, cross-sectional shape, height, width, fiber and suture strings)
  - Nutritional qualities (flavonoids and phenolics, minerals, vitamin C and carotenoids)

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150 cultivars & breeding lines selected

- 11 pole (vining) as well as 139 bush types
- Range from heirlooms to contemporary commercial types
- Represent both Andean and Mesoamerican centers of domestication
- Flat-podded Romanos, round-podded fresh market and processing, wax, bush blue lake and extra fine European type

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Activities in 2012

- (None planned in 3rd yr)
- Finished carotenoid analysis
- Conducted white mold (*Sclerotinia sclerotiorum*) trial of 134 bush types in the snap bean panel

Standard (β-, α-carotene) | Gold Mine | Contender | Renegade | Contender (Unsaponified)

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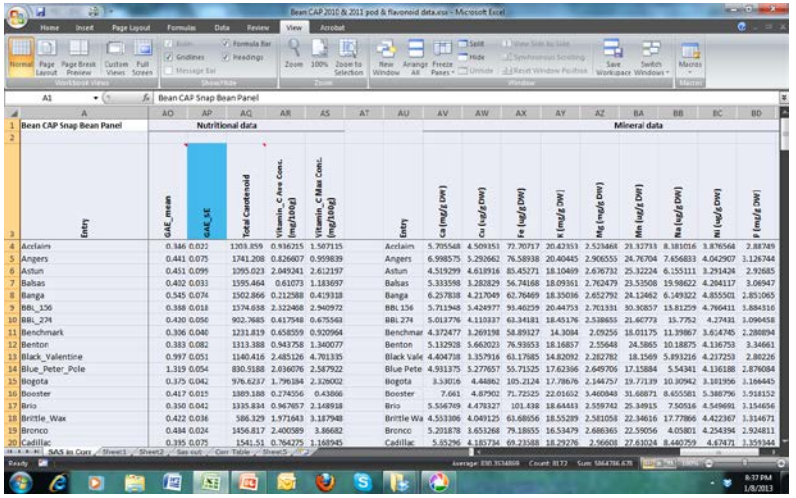
Nutritional analysis complete

- **Total Flavonoids**
  - Done
- **Vitamin C**
  - Done
- **Total Carotenoids**
  - Done
- **Pod mineral analysis**
  - Done



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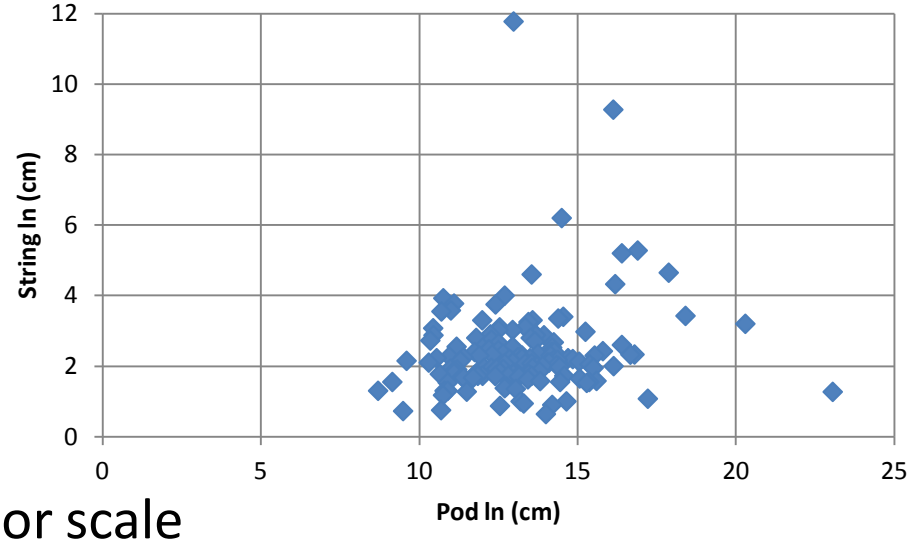
Phenotypic data collected

- Flower color (V, v, v^{lae})
- Days to physiological maturity
- Growth habit
- Plant height
- 3^{rd} internode length
- Lodging
- Fresh and frozen pod L*,a*,b* color scale
- Brix
- Flavor (4 parameters, frozen pods)
- Pod & string length
- Pod dimensions
- Pod fiber



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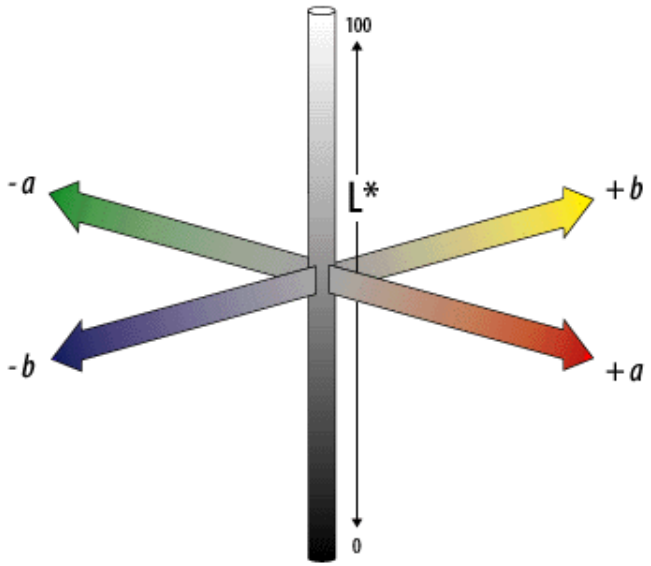
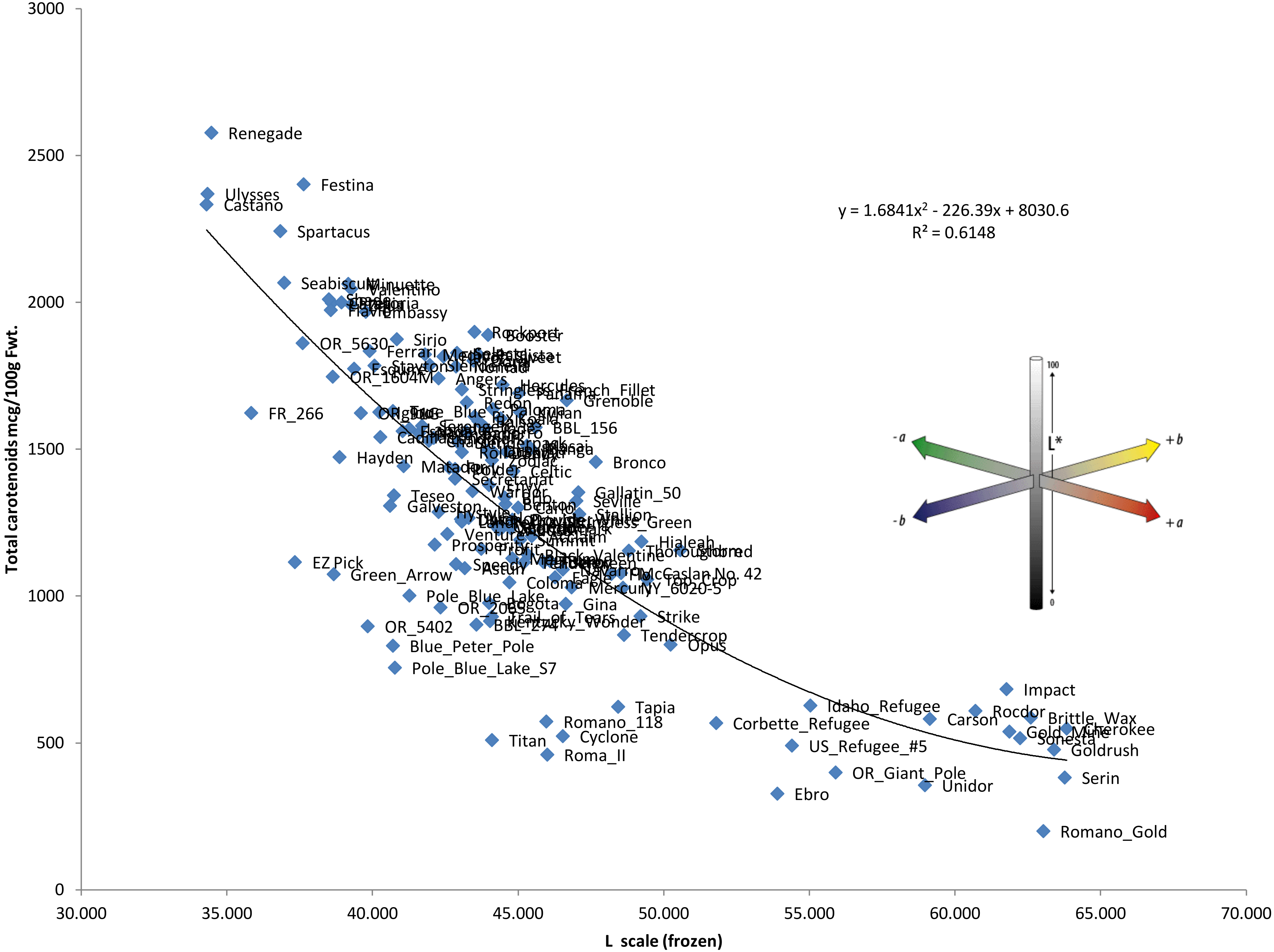
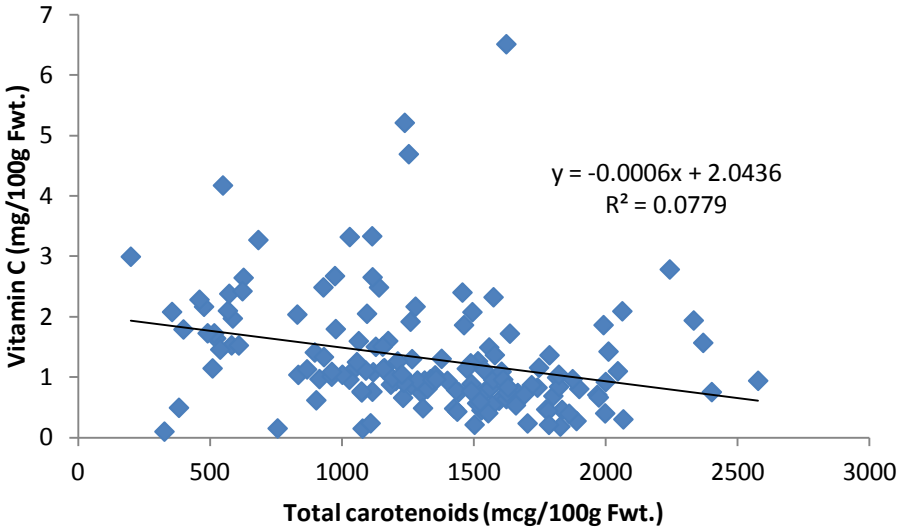
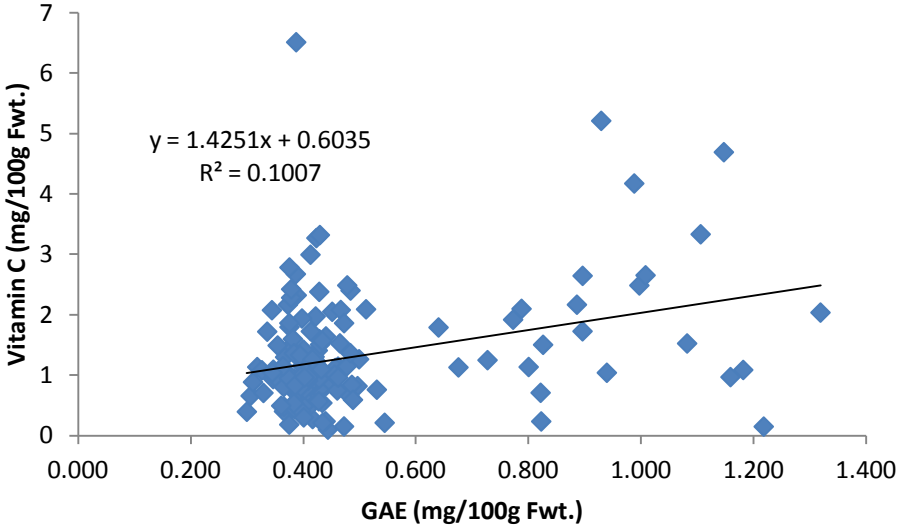
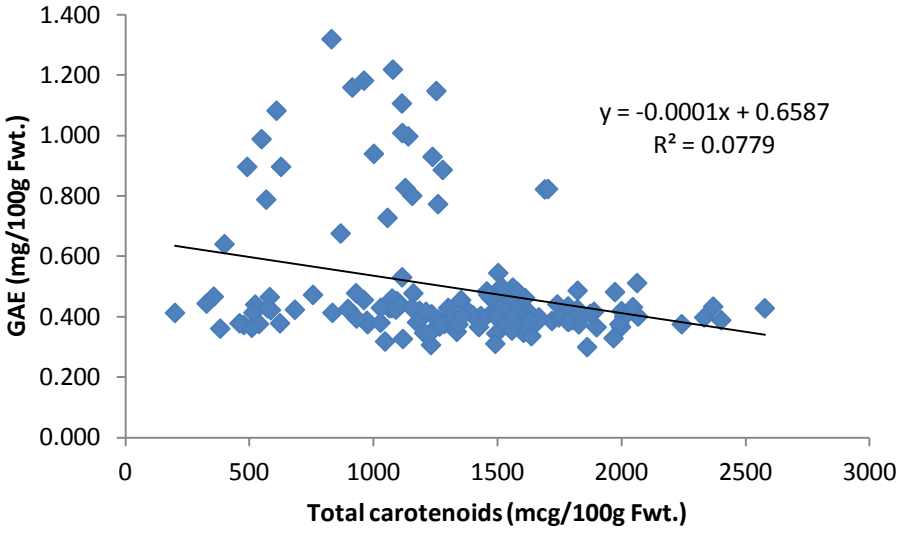
	Fresh a*	Fresh b*	Frozen L	Frozen a*	Frozen b*	Brix pct	Flavor floral	Flavor beany	Flavor sweet	Flavor sour	Pod fiber	GAE	Carotenoids	Vitamin C	Flower color
Fresh L	0.10	0.44	0.78	0.46	0.49	0.03	-0.02	0.09	-0.10	-0.13	0.08	-0.04	-0.62	0.30	-0.01
	0.206	<.0001	<.0001	<.0001	<.0001	0.677	0.807	0.269	0.217	0.122	0.362	0.612	<.0001	0.000	0.897
Fresh a*		-0.63	0.59	0.74	0.00	-0.12	0.03	0.06	-0.10	-0.10	-0.17	0.40	-0.44	0.23	0.43
		<.0001	<.0001	<.0001	0.975	0.139	0.751	0.455	0.255	0.245	0.044	<.0001	<.0001	0.005	<.0001
Fresh b*			0.00	-0.27	0.35	0.13	0.00	-0.01	0.11	-0.03	0.09	-0.34	-0.05	-0.02	-0.42
			0.970	0.001	<.0001	0.114	0.997	0.879	0.194	0.702	0.292	<.0001	0.588	0.811	<.0001
Frozen L				0.67	0.49	-0.02	-0.06	0.06	-0.10	-0.16	-0.08	0.20	-0.76	0.27	0.24
				<.0001	<.0001	0.824	0.492	0.471	0.251	0.051	0.331	0.017	<.0001	0.001	0.004
Frozen a*					-0.08	-0.07	-0.10	0.12	-0.17	-0.15	-0.11	0.14	-0.41	0.25	0.16
					0.348	0.430	0.252	0.159	0.043	0.078	0.170	0.089	<.0001	0.003	0.047
Frozen b*						0.01	-0.01	-0.04	0.11	-0.08	-0.01	0.07	-0.48	0.05	0.02
						0.889	0.919	0.658	0.202	0.347	0.863	0.402	<.0001	0.538	0.833
Brix pct							-0.04	0.06	0.19	0.28	-0.07	0.01	-0.14	-0.13	-0.11
							0.612	0.463	0.023	0.001	0.376	0.935	0.099	0.108	0.174
Flavor floral								-0.21	-0.03	-0.12	-0.08	-0.05	-0.04	0.03	-0.10
								0.010	0.714	0.158	0.316	0.512	0.614	0.725	0.232
Flavor beany									0.10	0.08	-0.01	0.14	-0.15	0.18	-0.05
									0.210	0.339	0.919	0.088	0.077	0.033	0.560
Flavor sweet										0.40	-0.07	0.06	-0.07	0.10	-0.10
										<.0001	0.375	0.473	0.396	0.207	0.229
Flavor sour											-0.11	0.03	0.07	0.02	-0.14
											0.184	0.741	0.375	0.811	0.096
Pod fiber												-0.03	0.15	-0.17	0.06
												0.702	0.064	0.037	0.444
GAE													-0.28	0.32	0.65
													0.001	<.0001	<.0001
Carotenoids														-0.28	-0.28
														0.001	0.001
Vitamin C															0.39
															<.0001




Total carotenoids mcg/100g Fwt.
L scale (frozen)
y = 1.6841x² - 226.39x + 8030.6
R² = 0.6148
3000
2500
2000
1500
1000
500
0
30.000
35.000
40.000
45.000
50.000
55.000
60.000
65.000
70.000
100
0
L*
-a
+b
-b
+a
Renegade
Festina
Ulysses
Castano
Spartacus
OR_5630
Sirio
Ferrari
OR_1604M
Angers
FR_266
Hayden
Bronco
Gallatin_50
Seville
Teseo
Galveston
Hialeah
EZ Pick
Green_Arrow
Pole_Blue_Lake
Gina
OR_5402
Strike
Blue_Peter_Pole
Pole_Blue_Lake_S7
Tendercrop
Opus
Impact
Tapia
Idaho_Refugee
Carson
Rocdor
Romano_118
Corbette_Refugee
Cyclone
Titan
US_Refugee_#5
Roma_II
Goldrush
OR_Giant_Pole
Unidor
Serin
Ebro
Romano_Gold


y = -0.0006x + 2.0436
R² = 0.0779
Vitamin C (mg/100g Fwt.)
Total carotenoids (mcg/100g Fwt.)
0
1
2
3
4
5
6
7
0
500
1000
1500
2000
2500
3000


y = 1.4251x + 0.6035
R² = 0.1007
Vitamin C (mg/100g Fwt.)
GAE (mg/100g Fwt.)
0
1
2
3
4
5
6
7
0.000
0.200
0.400
0.600
0.800
1.000
1.200
1.400


y = -0.0001x + 0.6587
R² = 0.0779
GAE (mg/100g Fwt.)
Total carotenoids (mcg/100g Fwt.)
0.000
0.200
0.400
0.600
0.800
1.000
1.200
1.400
0
500
1000
1500
2000
2500
3000

	Ca	Cu	Fe	K	Mg	Mn	Na	Ni	P	S	Zn	Fresh L	Fresh a*	Fresh b*	Flower color
Pod fiber	0.19	-0.01	0.06	0.04	0.18	0.11	-0.01	0.01	0.04	0.09	0.06	0.08	-0.17	0.09	0.06
	0.020	0.871	0.484	0.630	0.031	0.191	0.904	0.866	0.658	0.266	0.449	0.362	0.044	0.292	0.444
GAE	-0.10	0.00	-0.23	-0.21	-0.11	-0.21	0.04	-0.12	-0.15	-0.14	0.06	-0.04	0.40	-0.34	0.65
	0.241	0.953	0.004	0.009	0.166	0.010	0.640	0.156	0.062	0.092	0.440	0.612	<.0001	<.0001	<.0001
Carotenoids	0.26	0.13	0.35	0.25	0.33	0.38	0.00	0.30	0.29	0.38	0.28	-0.65	-0.47	-0.04	-0.30
	0.002	0.125	<.0001	0.003	<.0001	<.0001	0.980	0.000	0.000	<.0001	0.001	<.0001	<.0001	0.591	0.000
Vitamin C	-0.20	-0.11	-0.01	-0.06	-0.18	-0.18	0.18	-0.13	-0.02	-0.22	-0.12	0.30	0.23	-0.02	0.39
	0.017	0.173	0.860	0.463	0.029	0.029	0.028	0.108	0.845	0.006	0.147	0.000	0.005	0.811	<.0001
Ca		0.43	0.17	0.41	0.75	0.56	0.13	0.16	0.41	0.48	0.45	-0.06	0.03	-0.16	-0.01
		<.0001	0.042	<.0001	<.0001	<.0001	0.106	0.056	<.0001	<.0001	<.0001	0.500	0.728	0.053	0.915
Cu			0.43	0.52	0.51	0.40	0.03	0.29	0.66	0.55	0.67	-0.09	-0.05	0.02	-0.06
			<.0001	<.0001	<.0001	<.0001	0.748	0.000	<.0001	<.0001	<.0001	0.260	0.568	0.852	0.474
Fe				0.38	0.29	0.34	0.12	0.24	0.51	0.44	0.48	-0.21	-0.18	0.12	-0.15
				<.0001	0.000	<.0001	0.161	0.004	<.0001	<.0001	<.0001	0.011	0.026	0.148	0.065
K					0.48	0.52	0.28	0.38	0.76	0.67	0.51	-0.03	-0.10	0.02	-0.09
					<.0001	<.0001	0.001	<.0001	<.0001	<.0001	<.0001	0.718	0.237	0.795	0.264
Mg						0.56	0.10	0.19	0.52	0.60	0.58	-0.10	-0.08	-0.02	-0.08
						<.0001	0.218	0.019	<.0001	<.0001	<.0001	0.208	0.326	0.765	0.363
Mn							0.11	0.31	0.55	0.54	0.48	-0.11	-0.12	0.02	-0.19
							0.190	0.000	<.0001	<.0001	<.0001	0.186	0.132	0.805	0.020
Na								0.05	0.23	0.22	0.06	0.06	0.04	-0.01	0.11
								0.549	0.004	0.008	0.494	0.502	0.588	0.938	0.197
Ni									0.47	0.41	0.37	-0.16	-0.10	-0.05	-0.06
									<.0001	<.0001	<.0001	0.054	0.244	0.582	0.454
P										0.74	0.71	-0.04	-0.16	0.11	-0.10
										<.0001	<.0001	0.627	0.057	0.190	0.241
S											0.70	-0.28	-0.15	-0.06	-0.08
											<.0001	0.001	0.062	0.498	0.335
Zn												-0.19	-0.06	-0.06	0.03
												0.019	0.472	0.453	0.755

Bean CAP in 2012

- 134 bush snap beans screened for white mold
- Several lines appear to have resistance similar to checks
- Repeat next year; conduct association mapping study

Entry	Incidence (%)	Severity (%)	WM score (%)[z]	Est. Yield[y]	Entry	Incidence (%)	Severity (%)	WM score (%)[z]	Est. Yield[y]
Corbette Refugee	0	0	0	3	Ferrari	43.3	16.7	26.9	2.3
Unidor	0.3	0.3	0.3	1.7	Serin	40	20	27.2	2
5122	0.7	0.3	0.5	3	Festina	43.3	18.3	28	1.7
Selecta	0.7	0.7	0.7	1.3	Prosperity	38.3	21.7	28.5	2
Montcalm	2.3	0.7	1.2	2.7	Igloo	38.3	21.7	28.5	1.3
Idaho Refugee	2	1	1.4	2.7	Landreth's Stringless Green	40	21.7	28.7	3
Angers	3.7	0.7	1.4	1.3	Summit	36.7	23.3	29.1	1.7
Sirio	3.3	0.7	1.5	1.3	Valentino	41.7	21.7	29.5	2
Cadillac	5.3	1	2.1	1.7	Jade	35	25.3	29.6	2
JS Refugee #5	16.7	0.3	2.4	2.7	Palati	41.7	21.7	29.9	2.3
MO162	3.3	1.7	2.4	3	Top Crop	31.7	28.3	30	2.3
Nomad	6.7	1.3	2.9	1.7	Bogota	40	23.3	30.2	2.3
Koala	4	2.7	3.1	2	Esquire	40	23.3	30.2	2.3
NY6020-5	5	2	3.1	3	Dusky	38.3	25	30.9	1.3
Redon	6.7	1.7	3.3	1	Gallatin 50	50	20	31.1	2.7
FR 266	10	1.7	4.1	2.3	Profit	37	27	31.5	2.3
Pretoria	6.7	3.3	4.7	1.3	Oregon 1604M	43.3	23.3	31.6	2
Royal Burgundy	6.7	3.3	4.7	2.7	Tendercrop	43.3	23.3	31.6	2.3
Banga	7	3.7	5	1.7	Oregon 2065	40	26.7	32.2	2.3
Rocdor	7.3	4.3	5.1	1.7	Cyclone	48.3	23.3	33.3	2.7
Gina	10	3.3	5.8	2.7	Grenoble	46.7	25	33.3	1.7
Panama	8.3	5	6.4	1.7	Storm	43.3	26.7	33.6	1.7
Green Arrow	12.3	4.3	7.2	1.7	OR 5630	43.3	26.7	33.9	1
Flavio	16.7	3.3	7.5	1.7	Galveston	48.3	24	34	1.7
Impact	14	4.3	7.5	1.7	Romano 118	43.3	28.3	35	3
Black Valentine	13.3	4.3	7.6	2.3	Gold Mine	46.7	26.7	35.2	1.7
Saporro	17	3.7	7.8	1	OR 91G	46.7	26.7	35.2	1
NY 6020-5	15	5.3	8.5	3	Ebro	45.7	27.3	35.3	2.3
Stayton	20.3	3.7	8.5	1.3	True Blue	45	28.3	35.7	2.3
Widusa	16.7	5	9.1	1.7	Goldrush	46.7	30	37.3	2
Normandie	20	5	10	1.7	Charon	45	31.7	37.4	2.3
Serengeti	15.3	7.3	10.5	1.3	Seville	46.7	31.7	38.2	2.3
Teseo	13.3	10	11.5	2.3	Stallion	50	30	38.6	2
Booster	26.7	5.7	12.2	1	Titan	56.7	30	39.7	1.3
Acclaim	23.3	8.3	13.5	1.7	Scorpio	53.3	30	39.7	1
Navarro	20	10	13.9	3	Contender	46.7	36.7	40.7	2
Kylian	23.7	8.7	14.2	1.3	Fury	48.3	37	41.6	2
Dandy	23.3	10.3	15.4	2.3	Derby	50	36.7	42.1	1
Carson	26.7	10	15.9	1.7	Espada	50	36.7	42.5	2
Paulista	26.7	10.3	16.3	1.3	Bronco	53.3	35	43.2	2
Slenderella	31.7	12	17.6	1.7	Carlo	56.7	33.3	43.3	2
Masai	36.7	10.3	18.4	2	Speedy	56.7	33.3	43.4	2.3
Tendergreen	26.7	13.3	18.6	2.7	Landmark	56.7	36.7	43.9	1
Doral	30	11.7	18.7	2.3	Opus	53.3	36.7	44.1	1.3
Nicelo	26.7	13.3	18.7	1.7	Ulysses	53.3	36.7	44.2	2
Celtic	30	13.7	19.7	2	Benchmark	60	33.3	44.7	2
Roller	30.3	15.3	20.7	1	Matador	63.3	36.7	47.5	1.7
Brio	25	20	21	1.3	Provider	58.3	43.3	47.6	2.3
Calgreen	33.3	13.7	21	2.7	Secretariat	63.3	36.7	47.8	2.3
BBL 156	26.7	16.7	21	1.7	Slenderpack	63.3	36.7	48	1.7
Balsas	30	15.3	21	1.7	EZ Pick	63.3	36.7	48.1	2
Tapia	30	16.7	21.3	2.3	Labrador	60	40	48.5	1.7
Catania	30	16.7	21.9	1.3	Strike	58.3	43.3	49.5	1.3
Seabiscuit	30	16.7	22.2	1.7	Renegade	63.3	40	50.1	1.3
Eagle	30	16.7	22.3	1.7	Hayden	66.7	40	51.6	2.7
Oregon 5402	33.3	15	22.3	1.7	Sonesta	60	46.7	52.8	1.7
Cherokee	28.3	18.3	22.3	2.3	Astun	66.7	43.3	53.7	3
Paloma	28.3	18.7	22.4	2.3	Zodiac	58.3	50	53.9	1.7
Warrior	31.7	18.3	23.2	2.3	Romano Gold	70	43.3	54.9	2.7
Brittle Wax	33.3	16.7	23.4	2	Magnum	65	46.7	55	3
Hystyle	34	17	23.9	2	Coloma	68.3	46.7	55.5	2.3
Flavor Sweet	33.3	18.3	24.4	1.3	Embassy	71.7	43.3	55.7	2
Roma II	30	20	24.4	3	Hialeah	70	46.7	56.6	2
OSU 5613	31.7	20	25.1	1.7	Spartacus	70	46.7	56.7	1.3
Hercules	36.7	18.3	25.4	1.7	Benton	66.7	53.3	59.2	1.7
Zeus	33.3	20	25.6	2	Mercury	73.3	56.7	64.1	2.3
Envy	33.3	20	25.7	2.3	Venture	80	70	74.5	2.3
OR 5402	43.3	16.7	26.3	1.3					
LSD 0.05	34.7	26.7	29.3	1.1		34.7	26.7	29.3	1.1

[z]Geometric mean of incidence and severity. [y]Visual estimate of yield on a 1-3 scale where 1 is highest yield.

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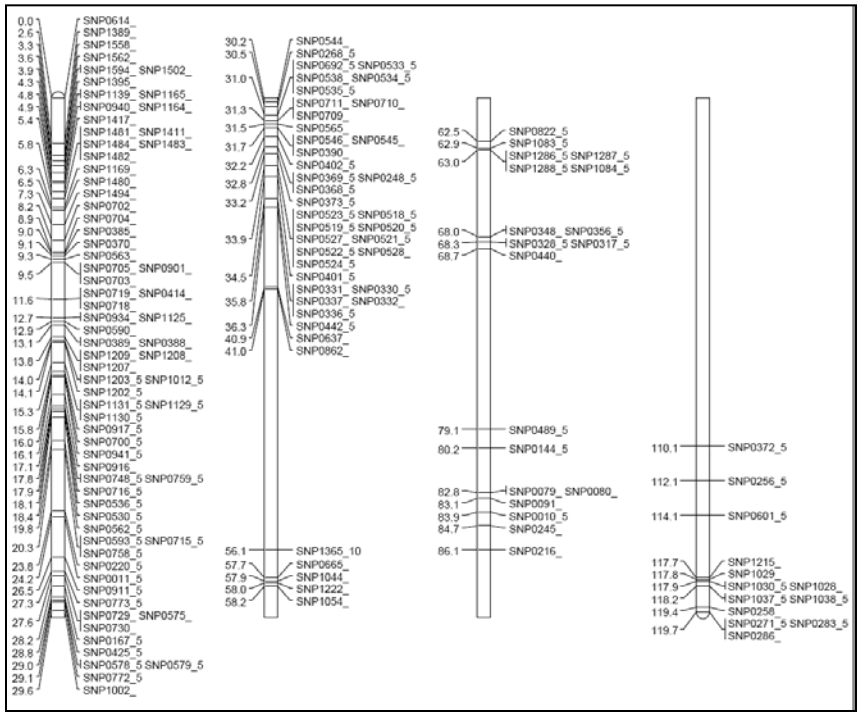
Bean CAP

Bean root rot population

- RR 6950 x OSU 5446
- Small black type III by BBL type I cross
- 169 RILs + 6 cks (4 reps)
- Screened 3 years in OR for Fusarium RR
- Screened 2 years in WI for Aphanomyces RR
- Segregating for snap bean traits

PV05



1,808 of 2,077 markers mapped;
14 linkage groups; 1,373 cM

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More snap bean populations to genotype with the Illumina SNP chip

RIL populations	No. of lines
RR6590/OSU5446 RI	169
Min/5630 RI	90
91G/PI 255956 BCIB	115
91G/PI 433251B BCIB	262
M0162/PI 433251B BCIB	120

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Summary

- Phenotypic data collection of the original grant has been completed for the snap bean panel
- Move on to data analysis and combining phenotypic data with genotypic data to understand genomic architecture
- Snap bean panel will be useful for further phenotypic characterization (diseases, yield, quality)

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