Dry Pea, Lentil, Chickpea, and Winter Legume Breeding

2014 Progress Report

Prepared by the

Grain Legume Genetics and Physiology Research Unit

U.S. Department of Agriculture

Agricultural Research Service

Pullman, WA 99164

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ARS Mission

ARS conducts research to develop and transfer solutions to agricultural problems of high national priority and provide information access and dissemination to:

- ensure high-quality, safe food, and other agricultural products
- assess the nutritional needs of Americans
- sustain a competitive agricultural economy
- enhance the natural resource base and the environment, and
- provide economic opportunities for rural citizens, communities, and society as a whole.

Acknowledgements

We would like to acknowledge the financial support of the USA Dry Pea and Lentil Council to the USDA-ARS Grain Legume Genetics and Physiology Research Unit.

We also would like to thank Washington State University for providing field space and support at the Spillman Agronomy Farm.

Personnel, Cooperators and Cooperating Growers

Personnel

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Cooperators

Stephen Guy, Washington State Univ.	Pullman, WA
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Cooperating Growers

Randy James	Dayton, WA
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Tim Stout	Genesee, ID
Todd Stout	Genesee, ID
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2014 PROGRESS REPORT

The 2014 Pacific Northwest growing season was significantly drier than average. Precipitation recorded at the WSU Spillman Research Farm from 1 October 2013to 31 September 2014 was approximately 13.9 inches, which is nearly 6.5 inches less than normal for that period. Late spring through summer was especially dry - May to October received only 48% of the historic precipitation. Summer time temperatures were moderate and it was very dry. On 23 July, a strong hail and wind storm swept through the region. Hail damage to the Pullman plots was moderate, but the plants were severely affected by the strong winds and most plots were flattened and did not recover before harvest. During the 2013-2014 winter, there was limited snow cover and moderate temperatures. Soil moisture levels were low going into the spring. The moderate summer temperatures allowed good pollination, seed set and pod fill. Monthly average high and low temperatures very closely paralleled the historical averages. Overall, seed yields were below average in our trials in 2014.

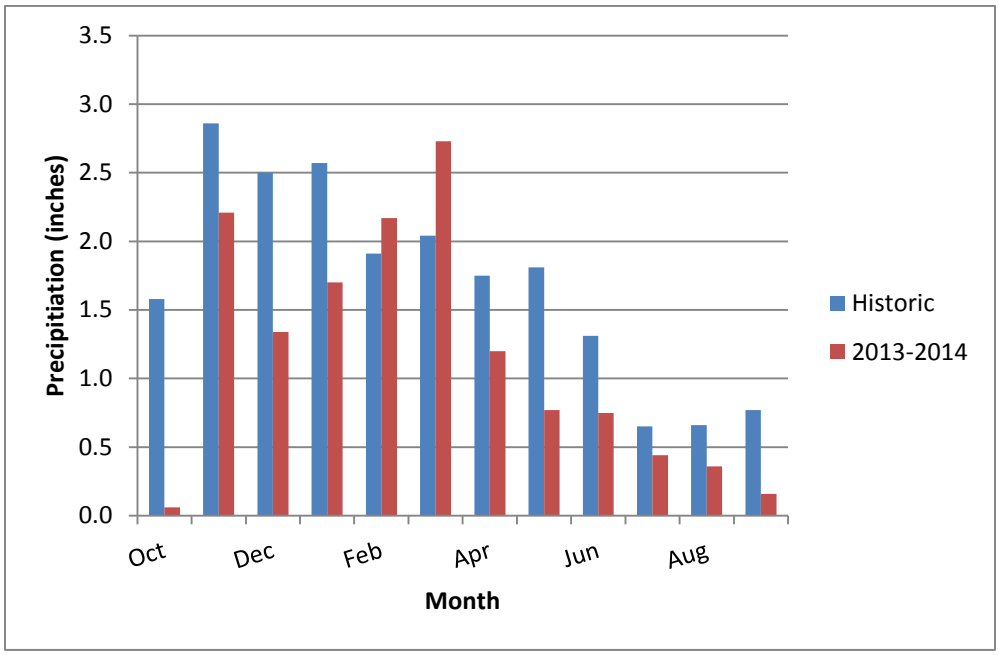

Figure 1. Monthly Precipitation at Pullman, WA. Historical (1940-2005) and 2013-2014 Averages. (Historical data from Western Regional Climate Center, www.wrcc.dri.edu; 2013-2014 data from WSU AgWeatherNet www.weather.wsu.edu).

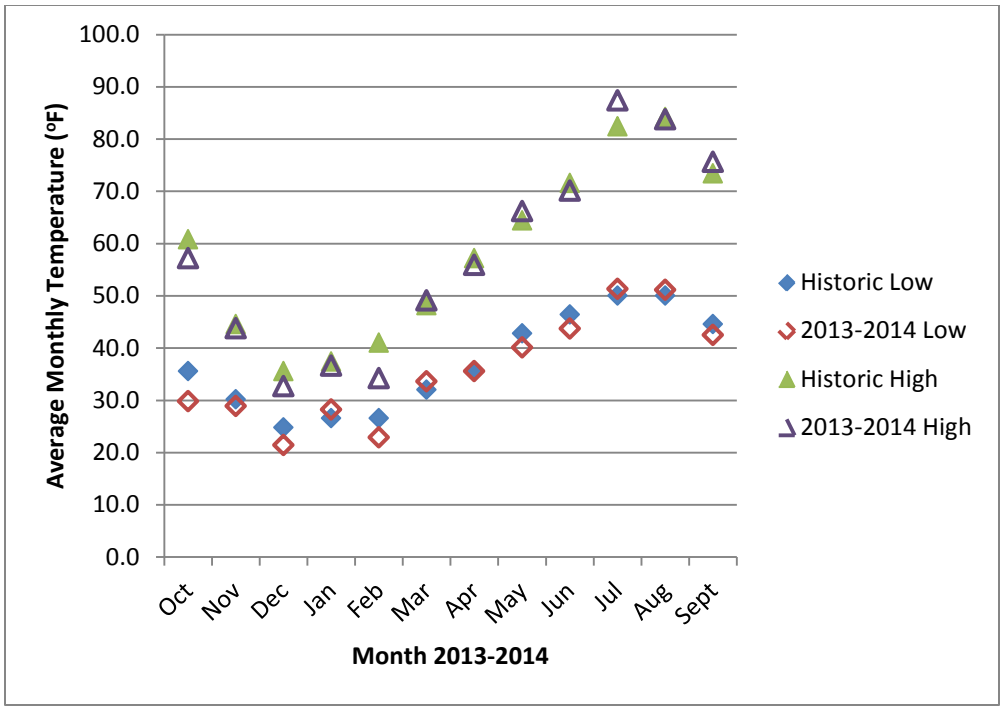

Figure 2. Monthly Temperatures at Pullman, WA. Historical (1940-2005) and2013- 2014 Averages. (Historical data from Western Regional Climate Center, www.wrcc.dri.edu; 2013-2014 data from WSU AgWeatherNet www.weather.wsu.edu).

Prior to planting, all seeds were treated with Maxim 4FS (0.9 oz/cwt), Apron XL LS (.61oz/cwt), Mertec LSP (3.0oz/cwt), Molybdenum (as sodium molybdate) (16g/cwt) and Cruiser (30ml/cwt). All advanced and preliminary yield trials were planted in a RCB design with plots 1.4 m x 4.9 m. Target population density for spring lentils was 8 sds/ft^2. Weed control in the spring planted fields was accomplished using Sencor (6 oz/acre) and Lorox (1.25lbs/acre) applied post-plant, pre-emergence. Due to the very dry spring, herbicides were not adequately activated and weed control was less than optimal. Insecticides, Mustang (4 oz/acre), Dimethoate (1 pt/acre) and Warrior (2 oz/ac) were applied as required to control aphids, pea leaf weevils and pea seed weevils. Data were analyzed with the Nearest Neighbours module of Agrobase (Agronomix Software, Inc., Winnipeg, MB).

SPRING PEA BREEDING UPDATE

In 2014, 19 advanced breeding lines and four check varieties (Aragorn, Ariel, Banner and Columbian) of green peas were evaluated in the advanced yield trials. Identical trials were planted at the Washington State University Spillman Research Farm (Pullman, WA) (6 May 2014), Fairfield, WA (2 May 2014) and Genesee, ID (3 May 2014) and Dayton, WA (16 April 2014). The Dayton trial was suffered from serious depredation by elk and deer. Results from the Dayton trial are presented, but not included in the annual mean calculations. Average yield was lower than usual at all locations, due primarily to the very dry conditions. Mean yields at the harvested locations were: Spillman 1399 kg/ha; Fairfield 2255 kg/ha; Genesee 1734 kg/ha; Dayton 697 kg/ha. Seed size of the checks ranged from 16.4g/100 seeds (Banner) to19.2g/100 seeds (Columbian). Seed size of the advanced lines ranged from 17.0 to 21.5g/100 seeds. The earliest check to flower, Columbian, flowered in 44 days; the earliest breeding line, PS05100840, flowered in 51 days. Banner and Columbian were the earliest checks in the trial to reach harvest maturity in 77 days. The earliest breeding line,PS09100052, reached harvest maturity in 76 days. The trials at Spillman were planted on ground that had moderate levels of Fusarium root rot (*Fusarium solani*). This was unexpected and we were able to score all entries in the advanced and preliminary trials for resistance. The wind storm on 23 July flattened most of the yield trial plots and the plants did not appreciably recover prior to harvest. Very notable exceptions were Hampton in trial 1401 and PS12100095, PS12100058 and PS12100011 all from trial 1403.

Seven breeding lines and four check varieties (Universal, DS Admiral, Delta and Carousel) of yellow peas were evaluated in the yellow pea advanced yield trials. Identical trials were planted at the Washington State University Spillman Farm (Pullman, WA) (6 May 2014), Fairfield, WA (2 May 2014) and Genesee, ID (3 May 2014). The mean yields were: Pullman 1298 kg/ha; Genesee 2326 kg/ha; and Fairfield 2567 kg/ha. Yields of the yellow peas were also much lower at all locations in 2014. Across all locations, yields of the checks were: DS Admiral 1748 kg/ha; Delta 1811 kg/ha; Universal 2178 kg/ha and Carousel 2136 kg/ha. The yields of the advanced lines ranged from 2408 kg/ha to 1985 kg/ha. As in 2013, in 2014 across all locations, the highest yielding breeding lines PS08101004, out-yielded Delta by 12%. Seed size of the check varieties ranged from 18.0g/100 seeds (Delta) to 21.0g/100 seeds (Carousel). Seed size of the advanced lines ranged from 20.4g/100 seeds (PS08101004) to 22.0g/100 seeds (PS08100950). Seed size and yield was less than 2013. There was not a significant difference in days to flower or days to maturity between the earliest check (Delta) and the earliest breeding line (PS08101022)

In response to interest from stakeholder groups, we have resumed the Marrowfat pea trials and breeding efforts. In 2014, 21 breeding lines and one check, Supra were planted in a preliminary trial at Pullman, WA. Yield of Supra was 2602 kg/ha. The yields of the breeding lines ranged from 1182 to 2640 kg/ha.

The breeding lines were evaluated for resistance to Fusarium wilt, Race 1 and for Aphanomyces root rot at the Spillman Farm Nurseries and Pea Enation Mosaic Virus, Powdery Mildew and Pea

Seed-borne Mosaic Virus in Corvallis, OR. Selected advanced breeding lines were also evaluated for reaction to Pea Enation Mosaic Virus and Bean Leaf Roll Virus using viruliferous aphids by Dr. Lyndon Porter (USDA-ARS, Prosser, WA).

Potential product quality of the green pea breeding lines was assessed visually. All entries in the green pea advanced yield trials were subjected to a simulated high temperature, high humidity bleach test. All entries in the green and yellow advanced yield trials were subjected to cooking quality tests and will be evaluated for nutritional quality by Dr. Dil Thavarajah Clemson University, Clemson, SC).

AN UPDATE ON HAMPTON

2014 was the fifth year in the advanced trials for the two sister lines PS05100735 and PS05100736. In 2014, PS05100736 was released as cv 'Hampton' , named in recognition of Dr. Richard Hampton, Professor (emeritus), Oregon State University. Dr. Hampton is a plant pathologist who did much early work on PEMV and BLRV in peas. These two lines have consistently had top yields in the USDA-ARS trials and the Washington State Variety Trials, the Idaho State Variety Trials and the Western Regional Trials. Both are resistant to both Pea Enation Mosaic Virus (PEMV) and Bean Leaf Roll Virus (BLRV). Resistance to PEMV and BLRV has previously not been available in field peas. Hampton has extremely high levels of resistance to BLRV. The data in Table 1 provide comparisons of the performance of Hampton with Aragorn, Ariel and Banner. In the 2013-2014 counter-season, foundation seed of Hampton was made jointly by the Washington State Crop Improvement Association (WSCIA) and USDA-ARS in New Zealand. Approximately 4 tonnes of seed was returned and was planted in the 2014 summer in Washington, Oregon, and Montana. Approximately 172,000 lbs of seed was harvested. The variety has been licensed to WSCIA and a PVP has been applied for.

Table 1. Comparison of the performance of Hampton with three commercial varieties in 29 location-years.

Entry	FW R1	PM	PEMV	BLRV	Days to Flr	Days to Mat	Vine Length (cm)	Plnt Ht (cm)	PHI	Sd Wt (g/100sd)	Yield (kg/ha)
Hampton	R	R	R	R	62	93	68	59	0.88	20.6	2281
Aragorn	R	R	S	S	60	90	72	66	0.92	20.2	2012
Ariel	R	S	S	S	61	90	70	64	0.91	17.7	2027
Banner	S?	S	S	S	59	91	82	70	0.86	20.3	2054

Location Yield Summary for the Advanced Green Pea Yield Trial (1401)

Entry	Dayton Seed Yield (kg/ha)	Fairfield Seed Yield (kg/ha)	Genesee Seed Yield (kg/ha)	Pullman Seed Yield (kg/ha)	Mean Seed Yield[§] (kg/ha)	% of Aragorn[§]
Pro 081-7161	894	2660	1691	1825	2059	127
Ginny	651	2783	1742	1458	1994	123
PS10100370	613	2409	1795	1770	1991	123
PS10100295	891	2377	1828	1707	1971	122
PS10100158	711	2545	1660	1664	1956	121
PS07100471	804	2423	1969	1468	1953	121
PS05100735	612	1757	2202	1737	1898	117
PS10100144	669	2413	1833	1403	1883	116
PS10100558	843	2116	1816	1711	1881	116
PS05100840	354	1925	2090	1541	1852	115
PS03101445	839	2286	1805	1451	1848	114
PS08100709	1176	2361	1597	1540	1833	113
Hampton	623	2145	1721	1546	1804	112
PS08100133	154	2337	1556	1426	1773	110
Greenwood	842	2081	1936	1203	1740	108
PS08100582	446	1950	1927	1303	1727	107
Ariel	918	2538	1497	1049	1695	105
Banner	939	2309	1846	772	1642	102
PS10100325	531	1903	1551	1452	1635	101
Aragorn	837	2326	1456	1047	1610	100
PS10100184	649	1967	1574	1230	1590	98
PS09100052	410	1863	1457	1369	1563	97
Columbian L1	632	2381	1340	502	1407	87
Grand Mean	697	2255	1734	1399	1796	111
CV	28	14	16	13	14	
LSD	382	501	457	359	203	12

[§] Mean seed yield and % of Morton does not include data from Dayton
Yield data are means of three replications at each location

Agronomic Data for the Advanced Green Pea Yield Trial (1401)

Name	FW 1	PM	PEMV	Days to Flower	Days to Maturity	Flower Node	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	# Repr Nodes	100 Seed Weight
								..cm..	..cm..		..cm..	..cm..			..g..
Aragorn	R	S	S	53.0	79.3	17.5	2.0	44.8	28.3	0.63	59.2	44.3	0.76	4.2	18.2
Ariel	R	S	S	54.0	81.3	16.3	2.0	46.3	27.2	0.59	64.0	46.8	0.75	5.3	16.6
Banner	S	S	S	48.3	77.3	13.8	2.0	49.7	30.7	0.64	72.0	48.3	0.67	4.3	16.4
Columbian L1	R	S	S	43.7	77.3	7.2	1.0	20.7	17.0	0.84	93.0	37.5	0.41	8.5	19.2
Ginny				54.0	83.0	17.2	2.0	40.5	34.2	0.85	62.5	49.7	0.80	5.5	18.5
Greenwood				52.3	81.3	16.8	2.0	40.2	28.3	0.72	61.3	43.8	0.72	5.5	17.0
PS03101445	R	R	S	53.0	83.0	16.2	2.0	39.2	19.2	0.50	59.5	33.5	0.56	4.3	17.8
PS05100735	R	R	R	56.3	86.3	15.2	2.0	48.8	16.2	0.34	70.0	28.7	0.42	4.8	18.0
Hampton	R	R	R	55.7	87.0	19.0	2.0	48.7	23.7	0.49	62.3	37.2	0.60	4.5	18.4
PS05100840	R	R	S	51.3	86.3	16.3	2.0	38.5	20.7	0.55	53.2	31.3	0.61	4.2	19.7
PS07100471	R	R	S	53.0	83.0	16.5	2.0	43.3	19.7	0.46	57.8	31.0	0.54	4.5	18.0
PS08100133	R	R	R	53.3	84.3	17.5	2.0	42.2	25.7	0.65	59.2	41.2	0.72	4.5	20.0
PS08100582	R	R	S	54.0	85.7	18.0	2.0	45.8	22.0	0.49	63.2	37.7	0.60	4.8	19.2
PS08100709			S	51.3	85.0	15.3	2.0	49.7	19.3	0.39	68.5	30.5	0.45	5.7	21.5
PS09100052		R	S	54.7	76.0	17.3	2.0	54.0	33.5	0.63	69.3	45.3	0.66	3.8	19.6
PS10100144				56.3	87.0	16.2	2.0	54.0	22.2	0.42	72.0	31.0	0.43	4.3	20.3
PS10100158				55.7	88.3	14.7	2.0	48.7	22.0	0.47	68.2	36.2	0.54	4.8	17.1
PS10100184				52.0	82.7	18.0	2.0	51.8	19.7	0.38	67.7	30.5	0.45	4.2	18.0
PS10100295				56.3	84.3	17.8	2.0	69.7	24.2	0.35	91.3	41.0	0.45	4.5	18.5
PS10100325				54.7	87.0	14.5	2.0	48.2	17.7	0.37	75.0	35.5	0.47	6.0	20.2
PS10100370				53.0	86.3	17.7	2.0	52.3	25.7	0.49	69.5	41.3	0.60	4.5	20.8
PS10100558				53.0	84.3	16.8	2.0	51.2	24.2	0.48	74.0	38.7	0.53	5.3	20.2
Pro 081-7161				53.0	83.0	16.5	2.0	50.3	29.5	0.60	67.2	47.3	0.71	4.3	17.0
GRAND MEAN				53.1	83.4	16.1	1.9	46.8	23.9	0.54	67.8	38.6	0.59	4.8	18.7
CV				2.8	4.4	8.0	6.2	9.4	13.8	16.59	6.6	10.8	12.53	17.1	2.1
LSD				2.5	6.0	2.1	0.2	7.3	5.4	0.15	7.4	6.8	0.12	1.3	0.6

FW 1 = Fusarium Wilt Race 1; R = resistant; S = susceptible. PM = Powdery Mildew; R = resistant; S = susceptible. PEMV = Pea Enation Mosiac Virus; R = resistant; S = susceptible,
Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.
Repr Nodes = average number of reproductive nodes on a plant. Agronomic data are means of three replications at Pullman, WA. Planting Date: 05/06/2014 Harvest Date: 08/01/2014

Name	Leaf Type	Vine Type	2014	2013	2012	2011	2010
			kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
Ariel	-	-	1476	2250	2073	2072	1474
Columbian L1	+	+	1259	1895	1734	1544	1254
PS03101445	-	-	1602	2479	2486	2190	1627
PS05100735	-	-	1622	2416	2606	2438	1669
Hampton	-	-	1531	2410	2668	2432	1746
PS05100840	-	-	1526	1875	2363	2147	1626
Aragorn	-	-	1397	2199	2206	2209	1416
Banner	-	-	1497	2223	2483	2096	1587
PS07100471	-	-	1730	2149	2545	2193	1760
PS08100582	-	-	1418	2362	2586	2380	
PS08100709	-	-	1653				
PS08100133	-	-	1403	2283	2703	2268	
PS09100052	-	-	1252	2241	2535		
PS10100144	-	-	1539	2149	2509		
PS10100158			1592	2397			
PS10100184			1248				
PS10100295	-		1681				
PS10100325	+		1363				
PS10100370	-		1583	2216			
PS10100558			1593				
Ginny	-	-	1652	2264	2637		
Greenwood	-	-	1502	2367	2513		
Pro 081-7161			1774	2255			

Leaf Type: + = normal leaf, - = afila or semi-leafless type.
Plant Type: + = tall plant type, - = short plant type.
Yield data are means of three reps per location, 4 locations per year.

Location Yield Summary for the Advanced Yellow Pea Yield Trial (1402)

Name	Leaf Type	Vine Type	Fairfield Seed Yield	Genesee Seed Yield	Garfield Seed Yield	Pullman Seed Yield	Mean Seed Yield	% of Carousel
			kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	
PS08101004	-	-	2714.2	2695.6	N/A	1812.9	2407.6	112
PS08100950	-	-	2632.7	2595.5	N/A	1426.1	2218.1	103
Universal	-	-	2948.4	2313.2	N/A	1271.9	2177.8	101
PS08101022	-	-	2687.4	2553.8	N/A	1256.1	2165.8	101
Carousel	-	-	2815.0	2182.9	N/A	1411.2	2136.4	100
PS07100925	-	-	2637.1	2247.8	N/A	1401.3	2095.4	98
Pro 793		-	2355.7	2516.2	N/A	1350.7	2074.2	97
PS10100207			2031.4	2504.0	N/A	1419.4	1984.9	92
Pro 103-7402			2324.1	2079.6	N/A	1248.5	1884.1	88
Delta	-	-	2796.4	1915.2	N/A	722.5	1811.4	84
DS ADMIRAL	-	-	2301.1	1988.5	N/A	953.8	1747.8	81
GRAND MEAN			2567.5	2326.5	N/A	1297.6	2063.9	
CV			13.9	13.6	N/A	9.3	13.8	
LSD			608.9	544.3	N/A	208.2	224.6	

Leaf Type: + = normal leaf; - = afila or semi-leafless.
Vine Type: + = tall vine; - = short vine.
Yield data are means of three replications at each location.

Agronomic Data for the Advanced Yellow Pea Yield Trial (1402)

Name	FW 1	PM	PEMV	Days to Flower	Days to Maturity	Flower Node	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	# Repr Nodes	100 Seed Weight
								..cm..	..cm..		..cm..	..cm..			..g..
Carousel	R	S	S	51.0	84.3	17.5	2.0	45.3	29.7	0.66	61.8	41.7	0.68	3.0	21.0
DS ADMIRAL	R	R	S	55.0	83.0	17.5	2.0	46.0	26.5	0.59	64.3	44.8	0.70	5.0	19.9
Delta	R	S	S	50.0	79.3	17.2	2.0	41.0	18.0	0.45	49.8	32.3	0.65	3.3	18.0
PS07100925	R	R	S	55.0	85.0	16.7	2.0	40.0	21.7	0.54	50.2	30.8	0.63	3.0	21.9
PS08100950				53.3	83.0	15.3	2.0	42.5	22.2	0.53	52.3	32.8	0.64	3.3	22.0
PS08101004	R	R	S	53.0	85.0	17.2	2.0	42.0	20.2	0.48	60.3	24.8	0.42	3.5	20.4
PS08101022	S	R	S	50.3	82.7	14.3	2.0	41.8	24.5	0.60	57.2	36.2	0.64	4.2	21.4
PS10100207				55.0	83.0	17.2	2.0	50.3	26.3	0.52	71.7	50.5	0.71	5.2	21.5
Pro 103-7402				55.0	83.7	16.3	2.0	48.8	24.0	0.50	69.2	46.7	0.69	5.7	20.3
Pro 793				51.3	79.7	15.3	2.0	44.7	25.7	0.57	67.7	42.0	0.63	4.5	22.9
Universal	R/S	S	S	51.7	78.0	15.0	2.0	44.3	29.5	0.66	68.5	44.0	0.66	4.8	18.6
GRAND MEAN				52.7	82.4	16.3	1.9	44.2	24.3	0.55	61.1	38.7	0.64	4.1	20.7
CV				3.1	1.5	6.6	8.8	13.8	23.3	16.00	6.4	9.1	10.24	14.1	2.2
LSD				2.8	2.1	1.8	0.3	10.4	9.6	0.15	6.7	6.0	0.11	1.0	0.7

FW 1 = Fusarium Wilt Race 1; R = resistant; S = susceptible. PM = Powdery Mildew; R = resistant; S = susceptible. PEMV = Pea Enation Mosiac Virus; R = resistant; S = susceptible.
Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.
Repr Nodes = average number of reproductive nodes on a plant. Agronomic data are means of three replications at Pullman, WA. Planting Date: 05/06/2014 Harvest Date: 08/01/2014

Name	Leaf Type	Vine Type	2014	2013	2012	2011	2010
			kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
Universal	-	-	2177	2946	2560	2571	1942
Delta	-	-	1811	2546	2430	2130	1568
Carousel	-	-	2136	2866	2847	2252	1629
DS ADMIRAL	-	-	1747	2634	2404	2033	1765
PS07100925	-	-	2095	2654	3005	2707	
PS08100950	-	-	2218	2864			
PS08101004	-	-	2407	2872	2915	2452	
PS08101022	-	-	2165	2623	2651	2318	
PS10100207			1984				
Pro 793		-	2074	2614	2974		
Pro 103-7402			1884	2679			

Leaf Type: + = normal leaf, - = afila or semi-leafless type.
Plant Type: + = tall plant type, - = short plant type
Yield data are means of three reps per location, 4 locations per year.

Agronomic and Yield Data for the Preliminary Green Dry Pea Yield Trial (1403)

Name	Days to Flower	Days to Maturity	Flower Node	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	# Repr Nodes	100 Seed Weight	Seed Yield	% of Aragorn
					..cm..	..cm..		..cm..	..cm..			..g..	kg/ha	
PS12100095	56.3	85.7	17.5	2.0	49.3	31.2	0.65	71.5	44.7	0.63	5.7	17.0	1903.8	206
PS12100058	57.0	89.0	19.0	2.0	48.0	34.3	0.72	63.3	47.0	0.75	5.0	17.4	1801.4	195
PS12100107	52.7	83.7	18.7	2.0	56.3	23.5	0.43	74.5	38.5	0.52	4.7	21.2	1761.6	191
PS12100096	51.3	82.7	17.8	2.0	56.2	22.2	0.40	77.5	36.8	0.49	6.2	18.1	1679.6	182
PS12100106	54.3	83.0	18.2	2.0	50.8	28.3	0.57	66.8	38.2	0.58	5.0	19.1	1613.3	175
PS12100035	55.0	83.7	17.8	2.0	52.7	32.0	0.62	72.7	51.5	0.73	5.2	19.6	1606.5	174
PS12100121	52.7	83.7	17.7	2.0	58.7	31.8	0.54	79.7	52.5	0.66	5.3	21.8	1600.5	173
PS10100280	57.0	87.7	16.2	2.0	49.3	20.7	0.43	66.7	37.0	0.56	4.3	20.0	1525.6	165
PS12100011	57.7	87.0	17.3	2.0	59.2	28.5	0.48	70.8	40.0	0.57	4.0	20.7	1495.7	162
PS12100057	50.7	83.7	14.8	2.0	43.5	25.0	0.58	54.8	34.5	0.64	3.8	20.7	1410.3	153
PS12100005	54.0	83.7	18.0	2.0	56.2	34.7	0.63	72.3	49.2	0.69	4.3	18.0	1407.4	152
PS10100131	51.3	81.3	18.0	2.0	51.7	33.3	0.65	68.5	47.8	0.70	3.7	20.1	1394.8	151
PS12100105	53.0	83.7	18.0	2.0	50.0	22.8	0.46	63.2	36.2	0.58	4.5	19.1	1390.4	150
PS12100001	49.7	81.3	14.0	2.0	48.0	27.5	0.58	65.2	43.7	0.68	4.7	20.4	1252.1	135
PS12100034	50.0	81.3	15.7	2.0	55.3	21.5	0.40	75.3	38.7	0.52	5.5	18.6	1100.0	119
PS12100120	45.0	81.3	13.8	2.0	40.2	20.0	0.52	59.7	39.0	0.66	5.5	18.1	1040.1	112
Aragorn	53.7	79.3	16.8	2.0	41.2	31.8	0.79	57.2	47.0	0.83	4.2	18.5	921.9	100
PS12100013	53.0	83.0	13.8	2.0	50.3	18.7	0.38	66.7	31.3	0.48	3.8	19.0	807.1	87
Banner	49.0	78.0	14.5	2.0	46.2	32.3	0.72	65.7	50.7	0.78	3.7	16.6	737.9	80
PS12100122	48.3	78.0	13.0	2.0	46.2	23.0	0.50	66.8	45.7	0.70	6.0	18.4	675.8	73
GRAND MEAN	52.5	83.0	16.5	1.9	50.4	27.1	0.55	67.9	42.4	0.64	4.7	19.1	1356.2	
CV	2.9	1.9	7.0	6.5	7.2	17.2	18.00	5.8	11.2	12.97	16.5	2.3	10.2	
LSD	2.5	2.6	1.9	0.2	6.0	7.7	0.16	6.5	7.8	0.14	1.3	0.7	276.1	

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.
Repr Nodes = average number of reproductive nodes on a plant. Agronomic data are means of three replications at Pullman, WA. Planting Date: 05/06/2014 Harvest Date: 08/01/2014

SPRING LENTILS

In 2014, identical advanced lentil yield trials were planted at Pullman, WA and Fairfield, WA. The green seed coat, yellow cotyledon market classes were divided into three groups: Eston Types: small seed size (mean seed size = 3.9g/100 seeds); Richlea Types: medium seed size (mean seed size = 6.0g/100 seeds); and Laird Types: large seed size (mean seed size = 7.3g/100 seeds. Pardina Types (Spanish Brown) have small seeds (mean seed size = 4.5g/100 seeds) with yellow cotyledons and brown seed coats. The Turkish Red Types have small seeds (mean seed size = 4.0g/100 seeds) with red/orange cotyledons and brown seed coats. The Zero Tannin Types have medium-large seeds (mean seed size = 5.3g/100 seeds) with any color cotyledon and clear seed coats. The 201 lentil yield trials were planted at the WSU Spillman Research Farm, Pullman, WA on 6 May 2014 and at Fairfield, WA on 2 May 2014. On 23 July, a strong wind and hail storm was centered at Spillman and the lentil yield trials were severely impacted by it. The combination of hail storm and very dry conditions, resulted in lentil yields at Spillman being very low in 2014. Due to the very dry conditions, seed size was also quite small in 2014. The wind storm also caused most of the lentils to lodge, therefore, measurements were not taken to determine the plant or pod height indices.

The 2014 small green seeded (Eston) advanced yield trial had four entries and three checks, CDC Viceroy, Athena and Eston. The mean yields at Pullman were 450 kg/ha, at Fairfield 2235 kg/ha. The best performing breeding line, LC09600066E has seed size of 3.1g/100 seeds compared to Eston and Athena seed sizes of 2.8g/100 and 3.9 g/100 seeds, respectively. Across all locations, it yielded 13% more than either Eston or Athena. LC01602273E, which has been presented to the USADPLC Variety Release Committee for consideration for release and registration, had an average yield of 1363 kg/ha across both locations. Its seed size in 2014 was 2.9 g/100 seeds.

The medium green seeded (Richlea) advanced yield trial had eight entries and two checks, Avondale and Richlea. The average yield at Pullman was 725 kg/ha and at Fairfield average yield was 2102 kg/ha. Avondale (the lentil previously known as LC01602300R) has performed well in previous years and performed very well in the Washington and Idaho state wide trials. It is broadly adapted to the Palouse region of Idaho and Washington and to NE Montana. It is highly resistant to Stemphylium Blight. It is slightly taller (38.7cm) than Richlea (37.4cm) at harvest and had similar days to maturity. Its seed size is 5.9g/100 seeds, compared to Richlea's 5.3g/100 seeds. Under the direction of the Washington State Crop Improvement Association, foundation seed of Avondale was made in Montana and Washington in 2014. Approximately 72,000 lbs (field run) of Avondale was harvested in 2014. A PVP has been granted: PVP #201400092.

The large green seeded (Laird) advanced yield trial had 20 entries and four checks, Pennell, Merrit, Riveland and Brewer. The average yields were: Pullman: 932 kg/ha and Fairfield: 1855 kg/ha. The yield of all of the breeding lines at Pullman and 12 of the breeding lines at Fairfield was greater than Merrit, the most widely grown check. Seed size of the breeding lines ranged from 4.7 to 8.1 g/100 seeds compared to Merrit 5.8 g/100 seeds. The breeding objectives of this class of lentils include improving seed shape to minimize seed damage during harvest and processing.

The Spanish Brown (Pardina) advanced yield trial had 11 entries and two checks, Pardina and Morena. Mean yield at Pullman was 822 kg/ha and 1970 kg/ha at Fairfield. Four new breeding lines were in the trials this year. Three of the four were the top three yielding enries. LC106000732P and LC10600231, the two highest yielding lines, out-yielded Pardina by 15% and 12%, respectively, across both locations. Their seed sizes are 4.4 g/100 seeds and 3.8 g/100seeds; Morena and Pardina had seed sizes of 3.5 and

3.3 g/100 seeds, respectively. Breeding objectives of this class of lentils continues to include improved height and standability and increased yield.

The 2014 Turkish Red advanced yield trials contained five entries and one check, Crimson. This trial was planted only at Pullman where the average seed yields were 632 kg/ha. All the retained breeding lines had seed size (3.3-3.9 g/100 seeds) larger than Crimson (2.8g/100 seeds). Acceptability of larger seed size is yet to be determined. We will continue to make improvements in yield and maintain taller, erect plant architecture.

The 2014 Zero Tannin advanced yield trials had six entries and two checks, Shasta and Cedar. This trial was also planted only at Pullman. Two entries, LC99602585RZ and Cedar, have red cotyledons, the others have yellow cotyledons. Average yield was 1025 kg/ha – approximately 600kg/ha less than 2012. The zero tannin lentils have relatively large seed size (average = 5.3g/100 seeds in 2014) and tend to be tall and have good lodging tolerance. They tend to be late maturing (average days to harvest = 88.9) and the pods tend to drop and shatter more readily than other lentil classes. Consequently, the primary breeding objectives for this class is to make them earlier maturing and to decrease the tendency for pod drop and shatter.

Avondale Update

Avondale (LC01602300R) has been a top performer in the medium green lentil advanced trials since 2004, the Western Regional Trials since 2006 and in the Washington and Idaho State Variety Trials since 2011. It has a seed size similar to Richlea (approximately 5g/100 seeds) and has yielded an average of 1320 kg/ha over more than 50 location years of advanced trials. This represents a yield increase of approximately 10% over Richlea (Table 4.). In the 2013-2014 counter-season, foundation seed of Avondale was made jointly by the Washington State Crop Improvement Association (WSCIA) and USDA-ARS in New Zealand. Approximately 1.5 tonnes of seed was returned. In 2014, Foundation Seed was made under the direction of WSCIA in Montana and Washington, approximately 72,000 lbs of field run seed was harvested. It has been licensed to WSCIA and sublicensed to Montec and Montana State University Foundation Seed Program. The table below (Table 1) presents comparisons of Avondale and Richlea.

Table 1. Comparison of the performance of Avondale (LC01602300R) with Richlea in 50 location-years.

Entry	Canopy Ht (cm)	Days to Mat	Plant Ht Index	Seed Size (g/100 sds)	Yield (kg/ha)
Avondale	34.4	97.5	0.95	4.9	1319
Richlea	33.4	96.5	0.91	5.2	1197

Location Yield Summary for the Eston Type Lentil Advanced Yield Trial (1451E)

Name	Pullman Seed Yield	Fairfield Seed Yield	Mean Seed Yield	% of Eston
	kg/ha	kg/ha	kg/ha	kg/ha
LC09600066E	438.8	2436.8	1437.8	113
LC09600054E	491.0	2372.4	1431.7	112
LC01602273E	410.5	2314.6	1362.6	107
LC08600005E	528.7	2154.2	1341.5	105
Athena	419.9	2171.3	1295.6	101
Eston	395.2	2149.4	1272.3	100
CDC Viceroy	465.8	2047.7	1256.8	98
GRAND MEAN	449.9	2235.2	1342.5	
CV	10.3	7.2	8.8	
LSD	83.8	288.4	117.8	

Yield data are means of three replications at each location.

Agronomic Data for the Eston Type Lentil Advanced Yield Trial (1451E)

Name	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight
				..cm..	..cm..		..cm..	..cm..		..g..
Athena	53.7	87.0	3.0	17.3			34.5			3.9
CDC Viceroy	55.7	90.0	3.0	17.7			31.8			2.8
Eston	58.3	84.0	2.0	13.2			27.7			2.8
LC01602273E	56.3	84.0	2.0	15.8			32.8			2.9
LC08600005E	59.0	86.0	3.0	19.0			37.2			4.3
LC09600054E	50.3	83.0	2.0	15.2			32.0			3.4
LC09600066E	49.3	86.0	2.0	15.3			31.2			3.1
GRAND MEAN	54.6	85.7	2.4	16.2			32.4			3.3
CV	2.1	1.7	21.2	17.1			6.1			3.4
LSD	2.0	2.7	0.9	4.9			3.5			0.2

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.
Agronomic data are means of three replications at Pullman, WA. Planting Date: 05/06/2014 Harvest Date: 08/08/2014

Name	2014	2013	2012	2011	2010
	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
Athena	1295	1610			
Eston	1272	1583	1083	1291	1350
LC01602273E	1362	1676	1319	1429	1676
LC08600005E	1341	1817	1316	1574	1622
LC09600054E	1431	1715	1206	1450	
LC09600066E	1437	1622	1204	1384	
CDC Viceroy	1256				

Yield data are means of three reps per location, 2 locations per year.

Location Yield Summary for the Richlea Type Lentil Advanced Yield Trial (1452R)

Name	Pullman Seed Yield	Fairfield Seed Yield	Mean Seed Yield	% of Richlea
	kg/ha	kg/ha	kg/ha	kg/ha
LC06601616R	813.9	2251.7	1532.8	123
Avondale	836.5	2205.6	1521.1	122
LC11600362R	574.4	2412.1	1493.3	120
LC11600361R	624.5	2321.7	1473.1	119
LC07600151R	832.9	2087.7	1460.3	118
LC09600183R	708.4	2183.5	1446.0	116
LC07600553R	713.8	2121.6	1417.7	114
LC11600370R	697.7	1960.4	1329.1	107
Richlea	862.0	1611.7	1236.9	100
LC11600369R	591.2	1862.9	1227.1	99
GRAND MEAN	725.5	2101.8	1413.7	114
CV	10.6	13.4	14.6	1
LSD	133.4	487.8	202.3	16

Yield data are means of three replications at each location.

Name	2014	2013	2012	2011	2010
	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
Richlea	1236	1555	1612	1641	1734
Avondale	1521	1574	1568	1804	1700
LC06601616R	1532	1586	1512	1632	1696
LC07600151R	1460	1843	1572	1754	1749
LC07600553R	1417	1829	1520	1487	1773
LC09600183R	1445	1545			
LC11600361R	1473				
LC11600362R	1493				
LC11600369R	1227				
LC11600370R	1329				

Yield data are means of three reps per location, 2 locations per year.

Agronomic Data for the Richlea Type Lentil Advanced Yield Trial (1452R)

Name	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight
				..cm..	..cm..		..cm..	..cm..		..g..
Avondale	55.7	88.0	3.0	19.5			36.5			4.5
Richlea	56.3	88.0	3.0	21.3			36.5			4.8
LC06601616R	56.3	87.0	3.0	19.7			34.8			4.9
LC07600151R	58.3	88.0	3.0	22.7			36.5			5.4
LC07600553R	57.0	83.0	2.0	19.7			35.3			4.6
LC09600183R	58.3	87.0	3.0	23.7			38.3			5.5
LC11600361R	56.3	85.0	3.0	21.8			39.2			4.0
LC11600362R	56.3	86.0	2.0	20.7			35.2			3.7
LC11600369R	57.0	86.0	3.0	20.8			36.3			4.4
LC11600370R	57.0	87.0	2.0	22.5			38.8			4.4
GRAND MEAN	56.8	86.5	2.6	21.2			36.7			4.6
CV	3.0	1.7	17.8	9.2			5.6			4.6
LSD	3.0	2.6	0.8	3.3			3.5			0.3

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the green plant height at the green pod stage.
Agronomic data are means of three replications at Pullman, WA. Planting Date: 05/06/2014 Harvest Date: 08/09/2014

Location Yield Summary for the Laird Type Lentil Advanced Yield Trial (1452L)

Name	Pullman Seed Yield	Garfield Seed Yield	Fairfield Seed Yield	Mean Seed Yield	% of Merrit
	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
LC09600410L	1133.6	N/A	2108.1	1620.9	133
LC0860B130L	1125.5	N/A	2090.1	1607.8	132
LC09600408L	1091.6	N/A	2073.5	1582.6	130
LC11600360L	971.4	N/A	2095.9	1533.7	126
LC11600380L	1146.3	N/A	1872.4	1509.4	124
LC06601734L	1186.5	N/A	1766.6	1476.6	121
LC11600298L	909.1	N/A	1973.5	1441.3	118
LC07600376L	1053.9	N/A	1808.3	1431.1	117
LC09600361L	949.3	N/A	1911.6	1430.5	117
LC07600541L	1001.2	N/A	1846.7	1424.0	117
LC07600524L	1039.9	N/A	1771.5	1405.7	115
LC07600536L	1055.9	N/A	1709.6	1382.8	113
Riveland	957.7	N/A	1793.7	1375.7	113
LC11600323L	826.9	N/A	1886.4	1356.7	111
LC11600342L	595.9	N/A	2102.2	1349.1	110
LC07600378L	978.8	N/A	1699.9	1339.4	110
LC11600330L	997.7	N/A	1668.4	1333.1	109
Brewer	578.6	N/A	2044.1	1311.4	107
LC09600476L	822.0	N/A	1773.3	1297.7	106
LC11600228L	776.0	N/A	1807.0	1291.5	106
LC09600481L	976.9	N/A	1556.8	1266.9	104
LC0860B123L	849.2	N/A	1630.4	1239.8	101
Pennell	720.3	N/A	1736.8	1228.6	101
Merrit	629.2	N/A	1803.1	1216.2	100
GRAND MEAN	932.2	N/A	1855.4	1393.8	
CV	14.7	N/A	8.2	10.4	
LSD	226.7	N/A	251.8	139.7	

Yield data are means of three replications at each location.

Agronomic Data for the Laird Type Lentil Advanced Yield Trial (1452L)

Name	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight
				..cm..	..cm..		..cm..	..cm..		..g..
Brewer	45.7	85.0	2.0	17.5			38.7			5.0
Merrit	46.0	86.0	2.0	20.3			39.7			5.8
Pennell	57.7	90.0	3.0	23.5			39.0			6.5
Riveland	52.0	87.0	2.0	20.5			38.5			6.8
LC06601734L	55.0	90.0	2.0	20.7			42.3			6.7
LC07600376L	59.0	93.0	3.0	23.0			40.7			7.4
LC07600378L	57.7	93.0	3.0	26.3			40.0			7.0
LC07600524L	56.3	89.0	2.0	19.5			37.8			6.8
LC07600536L	57.0	89.0	3.0	25.0			40.0			6.6
LC07600541L	57.0	90.0	2.0	21.3			39.2			6.6
LC0860B123L	50.0	89.0	2.0	21.5			38.2			8.1
LC0860B130L	52.0	87.0	2.0	20.5			40.3			6.5
LC09600361L	50.0	87.0	2.0	20.3			39.7			7.0
LC09600408L	52.7	87.0	2.0	19.2			37.3			6.7
LC09600410L	53.7	86.0	2.0	19.8			34.8			6.5
LC09600476L	50.0	86.0	2.0	17.8			34.8			6.2
LC09600481L	56.3	90.0	2.0	26.3			46.2			6.3
LC11600228L	50.0	87.0	2.0	21.3			40.3			6.0
LC11600298L	50.0	86.0	2.0	20.5			40.0			6.3
LC11600323L	57.7	93.0	3.0	21.0			36.2			6.0
LC11600330L	51.3	88.0	2.0	20.5			37.7			6.8
LC11600342L	48.0	83.0	2.0	16.5			40.0			4.7
LC11600360L	52.3	86.0	2.0	21.5			40.0			4.8
LC11600380L	56.3	87.0	2.0	21.3			41.7			6.4
GRAND MEAN	53.0	88.0	2.3	21.0			39.2			6.3
CV	3.9	1.6	16.8	9.7			7.1			3.2

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.
Agronomic data are means of three replications at Pullman, WA. Planting Date: 05/06/2014 Harvest Date: 08/09/2014

Agronomic Data for the Laird Type Lentil Advanced Yield Trial (1452L)

Name	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight
				..cm..	..cm..		..cm..	..cm..		..g..
LSD	3.4	2.3	0.6	3.3			4.6			0.3

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.
Agronomic data are means of three replications at Pullman, WA. Planting Date: 05/06/2014 Harvest Date: 08/09/2014

Name	2014	2013	2012	2011	2010
	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
Brewer	1311	1307	1395	923	1586
Merrit	1216	1435	1366	1091	1757
Pennell	1228	1581	1375	1174	
Riveland	1375	1566	1465	1045	1717
LC06601734L	1476	1294	1529	1223	1905
LC07600376L	1431	1529	1496	1479	1712
LC07600378L	1339	1644	1452		
LC07600524L	1405	1566	1468	1223	1682
LC07600536L	1382	1374	1404	1392	1643
LC07600541L	1423	1522	1502	1361	
LC0860B123L	1239	1349	1297	1169	
LC0860B130L	1607	1229	1554	1193	
LC09600361L	1430				
LC09600408L	1582	1463			
LC09600410L	1620	1567			
LC09600476L	1297	1334			
LC09600481L	1266				
LC11600228L	1291				
LC11600298L	1441				
LC11600323L	1356				
LC11600330L	1333				
LC11600342L	1349				
LC11600360L	1533				
LC11600380L	1509				

Yield data are means of three reps per location, 2 locations per year.

Location Yield Summary for the Pardina Type Lentil Advanced Yield Trial (1451P)

Name	Pullman Seed Yield	Fairfield Seed Yield	Mean Seed Yield	% of Pardina
	kg/ha	kg/ha	kg/ha	kg/ha
LC10600732P	1046.9	2054.4	1550.7	115
LC10600231P	810.2	2212.4	1511.3	112
LC10600494P	879.0	2043.7	1461.4	108
LC08600116P	907.2	1991.4	1449.3	107
LC08600113P	815.0	1996.2	1405.6	104
LC09600507P	761.7	2029.5	1395.6	103
Morena	851.0	1924.5	1387.8	103
LC10600260P	819.7	1946.0	1382.9	103
LC10600675P	875.7	1837.6	1356.7	101
Pardina	736.9	1947.9	1342.4	100
LC08600115P	844.3	1814.5	1329.4	99
LC08600109P	658.0	1993.8	1325.9	98
LC08600114P	677.9	1819.3	1248.6	93
GRAND MEAN	821.8	1970.0	1395.9	
CV	11.5	7.5	8.9	
LSD	160.4	250.1	120.4	

Yield data are means of three replications at each location.
Check variety = Pardina

Agronomic Data for the Pardina Type Lentil Advanced Yield Trial (1451P)

Name	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight
				..cm..	..cm..		..cm..	..cm..		..g..
Pardina	48.3	83.0	2.0	15.0			33.8			3.3
Morena	50.0	85.0	2.0	16.8			39.7			3.5
LC08600109P	47.3	78.0	2.0	19.3			35.5			3.9
LC08600113P	53.3	85.0	2.0	18.3			34.8			3.9
LC08600114P	48.0	83.0	3.0	18.3			37.5			4.1
LC08600115P	52.0	85.0	2.0	20.2			36.8			3.9
LC08600116P	55.0	86.0	2.0	25.8			40.8			4.1
LC09600507P	50.0	83.0	2.0	23.7			40.8			3.9
LC10600231P	50.0	86.0	2.0	17.0			36.0			3.8
LC10600260P	56.3	90.0	2.0	24.5			40.7			3.8
LC10600494P	50.0	85.0	2.0	19.2			37.2			3.6
LC10600675P	52.0	88.0	3.0	23.0			39.7			4.4
LC10600732P	56.3	89.0	3.0	23.8			40.3			4.4
GRAND MEAN	51.4	85.0	2.2	20.3			37.9			3.9
CV	3.3	1.0	19.3	14.5			7.5			3.6
LSD	2.9	1.4	0.7	5.0			4.8			0.2

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.
Agronomic data are means of three replications at Pullman, WA. Planting Date: 05/06/2014 Harvest Date: 08/08/2014

Name	2014	2013	2012	2011	2010
	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
Pardina	1342	1535	1407	1214	1399
Morena	1387	1649	1225	1196	1477
LC08600109P	1325	1807	1428	1223	1542
LC08600113P	1405	1908	1525	1374	1721
LC08600114P	1248	1679	1401	1221	1598
LC08600115P	1329	1846	1470	1373	1455
LC08600116P	1449	1982	1584	1434	1494
LC09600507P	1395	1894	1405	1319	
LC10600231P	1511	1849			
LC10600260P	1382	1826	1447		
LC10600675P	1356	1809			
LC10600732P	1550	1806			
LC10600494P	1461	1835			

Yield data are means of three reps per location, 4 locations per year.

Agronomic and Yield Data for the Turkish Type Lentil Yield Trail (1451T)

Name	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight	Seed Yield	% of Crimson
				..cm..	..cm..		..cm..	..cm..		..g..	kg/ha	
LC01602062T	49.3	83.0	2.0	16.8			33.5			3.8	740.7	130
LC09600037T	52.7	84.0	3.0	18.5			32.8			3.6	674.2	118
LC09600142T	50.3	83.0	2.0	14.8			31.3			3.6	671.0	118
LC09600545T	49.3	81.0	2.0	13.3			31.2			3.3	574.2	101
Crimson	57.7	85.0	3.0	20.0			32.7			2.8	567.7	100
LC05600043T	50.0	83.0	3.0	21.0			34.5			3.9	567.0	99
GRAND MEAN	51.5	83.1	2.3	17.4			32.6			3.5	632.4	
CV	3.4	1.4	21.1	9.2			6.7			4.9	14.6	
LSD	3.2	2.2	0.9	2.9			3.9			0.3	168.5	

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the green plant height at the green pod stage.
Agronomic data are means of three replications at Pullman, WA.
Planting Date: 05/06/2014 Harvest Date: 08/08/2014

Agronomic and Yield Data for the Zero Tannin Type Lentil Yield Trail (1461)

Name	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight	Seed Yield	% of Shasta
				..cm..	..cm..		..cm..	..cm..		..g..	kg/ha	
Cedar	50.0	87.0	2.0	21.7			38.8			4.2	1142.2	104
Shasta	50.3	90.0	2.0	23.3			41.7			5.6	1098.3	100
LC04600415YZ	54.7	89.0	2.0	23.2			42.2			6.1	1080.8	98
LC06600939YZ	57.0	90.0	2.0	23.5			44.2			5.1	1073.2	97
LC07600224YZ	50.0	89.0	2.0	22.0			42.7			6.0	1021.4	93
LC06600930YZ	55.7	90.0	2.0	22.7			43.3			5.3	996.6	90
LC04600389YZ	54.0	90.0	2.0	21.7			41.7			6.3	985.9	89
LC99602585RZ	56.3	87.0	2.0	19.2			35.0			3.8	799.7	72
GRAND MEAN	53.5	88.9	2.0	22.1			41.1			5.3	1024.7	
CV	4.2	1.7	10.0	8.8			10.5			3.7	4.1	
LSD	3.9	2.7	0.3	3.4			7.5			0.3	74.7	

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the green plant height at the green pod stage.
Agronomic data are means of three replications at Pullman, WA.
Planting Date: 05/06/2014 Harvest Date: 08/11/2014

AUTUMN-SOWN GRAIN LEGUMES

We have been ramping up the winter legume breeding program since 2010. Prior to 2010, the program was very small and the emphasis was on development of Turkish Red lentils and non-food quality peas. Significant advances were made in improving cold tolerance and plant habit. Since 2010, the programs have been expanded and now the objectives are more focused on development of food quality green and yellow peas and Spanish Brown and Small and Medium Green lentils. We continue to work on Austrian Winter Peas and have begun a small effort to breed autumn-sown peas for use as cover crops. We are systematically incorporating alleles from superior spring varieties and breeding lines into cold hardy backgrounds. The segregating nurseries have more tripled in size and the yield trials have also grown.

The main segregating nurseries and preliminary yield trials are grown at the Spillman Farm. The advanced yield trials are typically planted at four locations: Spillman Farm, Dayton, WA, Garfield, WA and Genesee, ID. In 2013-2014, there are approximately 1200 entries in the winter pea nursery, 450 entries in the winter lentil nursery and 200 entries in the winter chickpea nursery. There were 30 entries in the advanced winter pea and 15 entries in the winter lentil yield trials. The WSU and MSU Variety Testing Programs each have yield trials with elite pea and lentil varieties planted at Dusty, WA and Moccasin, MT, respectively

2013-2014 was a good year for the winter pulse variety trials and nurseries. On 23 July 2014 a brief, but intense hail and wind storm hit Spillman Farm. All the winter peas had been harvested except for 3 entries; however, none of the winter lentils had been harvested. The storm caused a lot of damage to the lentils and remaining peas and resulted in significant pod drop and shatter.

The winter pea and lentil advanced yield trials were planted at Garfield, Dayton and Pullman, Washington and Genesee, Idaho between 30 September and 15 October 2013. The trial at Garfield was lost due to lack of emergence and yields at Dayton were extremely low and variable due, in part, to significant deer and elk depredation (Figure 1). The food quality winter peas all have clear seed coats, a clear hilum and white flowers. The food quality trials had 19 breeding lines and two checks, Specter and Windham. The mean seed yields were: Pullman 3899 kg/ha; Dayton 1581kg/ha and Genesee 1939 kg/ha. Averaged across all locations (except Dayton), the highest yielding line was PS0017018W (4179 kg/ha), the same as in 2012-2013. PS0017018W had the highest yield in Genesee (3480 kg/ha). PS11300199W was the highest yielding (5032 kg/ha) experimental line in Pullman. Austrian Winter Peas have pigmented seed coats and are typically (although not always) characterized by very long vines and small seeds. The Austrian Winter Pea advanced yield trials contained nine entries and two checks, Granger and Melrose. The mean seed yields were: Dayton 1437 kg/ha; Genesee 2156 kg/ha and Pullman 3990 kg/ha.

The winter lentil advanced yield trials were planted at the same time and locations as the advanced winter pea yield trials. There were 19 entries and one check, Morton, in the trials. Average yield of the trials was: Genesee 1627 kg/ha; Dayton 512 kg/ha and Pullman 1952

kg/ha. The trial in Pullman suffered from herbicide drift when the plants were in full bloom and yields are about half of what they usually are.

The WSU and MSU Variety Testing Programs each have yield trials with elite winter pea and winter lentil varieties planted at Dusty, WA and Moccasin, MT, respectively. They also have segregating F_4 populations to evaluate and select for types well suited to the different regions. The bulk populations are typically spring x winter crosses that have been screened and selected only for cold tolerance.

AUTUMN-SOWN PEA GERMPLASM AND VARIETY RELEASES AND PVPS

The PVP application filed for Lynx was been accepted. Lynx was assigned PVP 201400093.

Figure 1. Elk depredation at the Dayton Advanced Winter legume yield trials. Right: The Problem; Left: The Solution.

Location Yield Summary for the Advanced Austrian Winter Pea Yield Trial (1421)

Entry	Dayton Seed Yield (kg/ha)	Genesee Seed Yield (kg/ha)	Pullman Seed Yield (kg/ha)	Mean Seed Yield [§] (kg/ha)	% of Granger[§]
PS07300092W	1728	2743	4812	3778	125
PS09300095W	922	2976	4165	3571	118
PS10300121W	1837	2971	3842	3407	113
PS10300120W	1985	2778	3957	3368	111
PS09300129W	1221	2052	3991	3022	100
Granger	1048	1851	4169	3010	100
PS10300134W	1444	1642	4284	2963	98
PS10300135W	1706	1802	3981	2891	96
PS10300031W	1472	1513	4163	2838	94
PS07300124W	933	1788	3722	2755	91
Melrose	1516	1606	2803	2205	73
Grand Mean	1437	2156	3990	3073	102
CV	46	20	9	13	
LSD	1368	726	586	377	12

[§] Mean seed yield and % of Morton does not include data from Dayton
Yield data are means of three replications at each location

Agronomic Data for the Advanced Austrian Winter Pea Yield Trial (1421)

Name	FW 1	PM	PEMV	Days to Flower	Days to Maturity	Flower Node	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	# Repr Nodes	100 Seed Weight
								..cm..	..cm..		..cm..	..cm..			..g..
Granger	R	S	S	232.7	277.7	14.5	2.0	53.5	31.0	0.60	95.7	55.2	0.61	6.2	13.9
Melrose	S	S	S	234.3	274.0	15.2	2.0	49.8	21.7	0.54	78.5	45.0	0.66	5.0	11.0
PS07300092W			S	234.3	272.0	13.5	2.0	63.3	26.8	0.46	115.7	40.3	0.36	5.2	17.1
PS07300124W		R	S	235.0	269.7	16.0	2.0	39.0	30.3	0.79	63.5	50.5	0.80	4.3	15.3
PS09300095W				232.7	272.7	14.5	2.0	50.2	31.7	0.70	88.3	56.5	0.68	5.7	14.5
PS09300129W				232.3	278.7	14.7	2.0	55.7	30.2	0.57	92.7	57.8	0.66	5.5	12.7
PS10300031W				233.3	280.0	14.7	2.0	68.5	27.0	0.41	116.8	53.3	0.46	5.5	15.1
PS10300120W				230.7	279.3	15.7	2.0	76.5	18.5	0.24	127.0	51.2	0.41	6.5	14.9
PS10300121W				235.3	278.7	17.2	2.0	84.5	17.3	0.22	140.8	41.3	0.30	5.7	12.8
PS10300134W				234.7	275.7	16.2	2.0	42.2	31.0	0.76	63.7	45.0	0.73	3.7	14.0
PS10300135W				235.3	267.7	15.3	2.0	38.0	27.5	0.73	61.3	42.8	0.70	5.7	14.9
GRAND MEAN				233.7	275.0	15.2	1.9	56.4	26.6	0.55	94.9	49.0	0.58	5.3	14.2
CV				0.8	1.1	13.4	13.0	21.9	27.5	26.33	17.9	13.4	18.84	23.4	3.8
LSD				3.4	5.5	3.4	0.4	21.1	12.5	0.25	28.9	11.2	0.19	2.1	0.9

FW 1 = Fusarium Wilt Race 1; R = resistant; S = susceptible. PM = Powdery Mildew; R = resistant; S = susceptible. PEMV = Pea Enation Mosiac Virus; R = resistant; S = susceptible,
Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.
Repr Nodes = average number of reproductive nodes on a plant. Agronomic data are means of three replications at Pullman, WA. Planting Date: 10/15/2013 Harvest Date: 07/17/2014

Location Yield Summary for the Advanced Winter Pea Yield Trial (1422)

Entry	Dayton Seed Yield (kg/ha)	Genesee Seed Yield (kg/ha)	Pullman Seed Yield (kg/ha)	Mean Seed Yield [§] (kg/ha)	% of Windham[§]
PS0017018W	2119	3480	4878	4179	120
PS11300289W	1396	2734	4530	3632	104
PS05300180W	1407	1738	5454	3596	103
Windham	901	1506	5446	3476	100
PS11300087W	2083	2991	3944	3468	99
PS11300287W	1806	3458	3199	3329	95
PS11300201W	973	1694	4814	3254	93
PS11300288W	1421	1898	4446	3172	91
PS11300199W	1016	1256	5032	3144	90
PS11300240W	2012	2435	3441	2938	84
PS06300024W	1339	2481	3256	2869	82
PS07300047W	1887	1730	3973	2852	82
PS07300125W	1654	1653	3677	2665	76
PS11300042W	738	1034	4153	2593	74
PS10300025W	1121	761	4355	2558	73
PS03101269W	1864	2187	2887	2537	72
Specter	1471	1443	3570	2506	72
PS06300028W	1966	2027	2983	2505	72
PS06300132W	1458	1229	3182	2205	63
PS11300039W	2137	1272	2611	1942	55
PS07300136W	2426	1708	2061	1884	54
Grand Mean	1581	1939	3899	2919	83
CV	34	26	17	20	
LSD	1052	819	1346	572	16

[§] Mean seed yield and % of Windham does not include data from Dayton
Yield data are means of three replications at each location

Agronomic Data for the Advanced Winter Pea Yield Trial (1422)

Name	FW 1	PM	PEMV	Days to Flower	Days to Maturity	Flower Node	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	# Repr Nodes	100 Seed Weight
								..cm..	..cm..		..cm..	..cm..			..g..
Specter	R	S	S	233	275	11.0	2.0	63.5	43.2	0.72	109.2	70.2	0.66	7.3	14.1
Windham	R	S	S	232	273	13.7	2.0	38.5	26.3	0.69	58.8	43.5	0.74	6.7	15.4
PS0017018W	R	S	S	235	273	11.8	2.0	68.3	21.5	0.33	121.3	45.7	0.39	6.7	13.7
PS03101269W	R	S	S	236	275	17.3	2.0	74.7	29.7	0.40	122.0	46.0	0.39	5.8	15.2
PS05300180W	R	S	S	235	281	14.7	2.0	32.7	25.2	0.79	66.5	52.7	0.80	6.7	14.9
PS06300024W			S	222	268	9.8	2.0	25.7	21.2	0.81	56.5	42.5	0.77	6.5	19.9
PS06300028W				237	279	15.0	2.0	46.2	30.2	0.66	76.8	52.0	0.69	5.8	18.1
PS06300132W				235	276	13.0	2.0	33.3	30.5	0.92	61.0	46.7	0.80	6.5	16.5
PS07300047W		R	S	233	276	14.2	2.0	34.8	26.7	0.78	63.3	43.7	0.71	7.7	15.3
PS07300125W			S	233	276	13.2	2.0	32.0	21.3	0.69	65.0	44.5	0.69	5.5	17.1
PS07300136W			S	238	281	14.3	2.0	37.3	29.0	0.79	68.0	53.0	0.78	6.3	16.8
PS10300025W				233	273	14.5	2.0	35.3	26.8	0.77	62.5	43.2	0.70	7.2	15.4
PS11300039W				233	276	13.8	2.0	32.3	22.8	0.73	56.2	43.2	0.78	6.5	13.3
PS11300042W				232	282	14.5	2.0	34.2	27.7	0.83	57.8	41.3	0.73	7.2	14.1
PS11300087W				232	271	14.8	2.0	41.5	33.2	0.81	72.8	48.8	0.69	6.7	17.8
PS11300199W				232	270	15.5	2.0	37.5	28.3	0.78	60.3	45.3	0.77	6.8	18.0
PS11300201W				232	271	14.7	2.0	35.7	30.3	0.87	62.7	45.2	0.74	7.0	18.7
PS11300240W				229	270	15.8	2.0	40.3	33.3	0.83	71.8	52.7	0.75	8.8	16.2
PS11300287W				243	280	17.5	3.0	41.2	29.2	0.72	60.2	43.3	0.72	4.5	15.8
PS11300288W				231	272	13.7	2.0	41.0	31.5	0.78	61.3	49.8	0.82	4.8	20.5
PS11300289W				235	273	12.2	2.0	35.2	25.5	0.75	56.2	39.7	0.72	5.2	19.9
GRAND MEAN				233	275	14.0	2.0	41.0	28.2	0.74	70.9	47.2	0.71	6.4	16.5
CV				0	0	12.8	10.7	13.2	10.4	13.49	10.2	7.6	11.50	16.2	2.1
LSD				1	4	2.9	0.3	8.9	4.8	0.16	12.0	5.9	0.13	1.7	0.7

FW 1 = Fusarium Wilt Race 1; R = resistant; S = susceptible. PM = Powdery Mildew; R = resistant; S = susceptible. PEMV = Pea Enation Mosiac Virus; R = resistant; S = susceptible,
Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.
Repr Nodes = average number of reproductive nodes on a plant. Agronomic data are means of three replications at Pullman, WA. Planting Date: 10/17/2014 Harvest Date: 07/18/14

Agronomic and Yield Data for the Winter Dry Pea Preliminary Yield Trial (1423)

Name	Leaf Type	Vine Type	FW 1	PM	PEMV	Days to Flower	Days to Maturity	Flower Node	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	# Repr Nodes	100 Seed Weight	Seed Yield	% of Windham
										..cm..	..cm..		..cm..	..cm..			..g..	kg/ha	
PS12300048W						233.7	275.0	11.2	2.0	37.0	31.0	0.84	69.0	53.5	0.78	8.0	15.1	4900.8	146
PS12300046W						231.3	275.0	14.0	2.0	33.8	25.8	0.75	67.8	49.2	0.74	7.3	13.2	4814.4	143
PS12300072W						231.7	267.7	13.5	2.0	33.0	29.0	0.88	59.3	45.3	0.78	6.8	14.8	4770.3	142
PS11300069W						224.3	273.3	13.3	2.0	41.7	23.7	0.61	80.7	47.2	0.61	7.2	17.4	4721.6	140
PS12300059W						234.3	270.0	14.3	2.0	42.7	33.0	0.81	64.7	51.5	0.81	5.5	15.4	4518.0	134
PS12300013W						228.7	269.0	12.3	2.0	33.8	26.0	0.78	61.7	47.5	0.78	7.2	16.7	4228.8	126
PS12300032W						229.7	275.0	14.2	2.0	36.8	19.3	0.53	60.8	37.5	0.63	6.8	18.6	4111.8	122
PS12300058W						235.0	276.3	17.2	2.0	47.0	33.8	0.74	66.8	51.3	0.78	6.0	13.4	4095.5	122
PS12300049W						234.3	275.0	13.5	2.0	42.0	34.5	0.82	70.2	50.7	0.73	5.5	14.4	4092.8	121
PS12300061W						240.3	278.0	15.5	2.0	44.0	37.2	0.85	64.3	53.3	0.84	5.2	15.1	4020.1	119
PS12300054W						237.3	277.3	14.7	2.0	39.7	30.7	0.78	64.8	47.5	0.74	5.7	13.8	3819.6	113
PS12300057W						235.3	273.3	13.5	2.0	53.5	30.5	0.62	78.8	49.7	0.67	5.0	14.2	3820.4	113
PS12300026W						228.7	269.0	13.2	2.0	39.0	27.7	0.79	78.3	49.7	0.66	7.7	14.5	3759.1	112
PS12300080W						235.0	278.0	13.8	2.0	55.8	21.8	0.39	106.5	41.3	0.40	7.3	16.7	3753.6	111
PS11300040W						234.3	277.3	14.0	2.0	41.2	24.0	0.66	73.0	40.3	0.63	7.3	12.8	3560.5	106
PS12300036W						229.0	270.3	13.3	2.0	32.7	24.3	0.75	59.7	39.5	0.67	6.7	15.4	3499.8	104
PS12300064W						238.3	276.3	15.5	2.0	37.7	31.8	0.86	56.7	44.7	0.80	6.3	15.7	3479.1	103
PS12300038W						233.3	273.3	13.0	2.0	30.8	23.3	0.77	55.8	37.7	0.69	7.2	17.6	3433.8	102
PS11300279W						234.3	278.0	15.3	2.0	40.3	26.0	0.66	72.5	48.3	0.67	7.3	16.7	3415.8	101
PS12300002W						232.3	278.0	12.3	2.0	33.2	20.0	0.61	56.8	41.5	0.74	7.3	12.8	3408.0	101
PS11300282W						232.3	276.3	14.5	2.0	35.8	29.3	0.83	63.2	51.8	0.83	6.8	17.8	3400.5	101
Windham	-	-	R	S	S	232.0	269.7	12.2	2.0	33.3	23.7	0.71	57.2	39.3	0.69	7.0	15.3	3356.8	100
PS12300065W						238.0	278.0	15.2	2.0	38.5	33.7	0.88	61.8	50.3	0.82	6.8	16.1	3338.5	99
PS12300010W	+/-	-				231.3	273.3	12.7	2.0	34.8	29.8	0.87	60.2	48.8	0.82	6.5	17.3	3262.5	97
PS12300052W						238.3	277.3	12.7	2.0	40.3	23.8	0.63	63.3	41.8	0.69	4.8	14.2	3212.4	95
Specter	-	+	R	S	S	233.3	279.7	13.8	2.0	64.0	36.3	0.60	122.0	67.3	0.57	7.5	11.0	3011.2	89
PS12300001W						231.0	275.0	13.3	2.0	32.7	23.0	0.72	58.7	41.3	0.72	6.0	11.7	3008.1	89

Leaf Type: + = normal leaf; - = afila or semi-leafless. Vine Type: + = tall vine; - = short vine.

FW 1 = Fusarium Wilt Race 1; R = resistant; S = susceptible. PM = Powdery Mildew; R = resistant; S = susceptible. PEMV = Pea Enation Mosiac Virus; R = resistant; S = susceptible.

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.

Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.

Repr Nodes = average number of reproductive nodes on a plant. Agronomic data are means of three replications at Pullman, WA. Planting Date: 10/17/2014 Harvest Date: 07/19/2014

Agronomic and Yield Data for the Winter Dry Pea Preliminary Yield Trial (1423)

Name	Leaf Type	Vine Type	FW 1	PM	PEMV	Days to Flower	Days to Maturity	Flower Node	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	# Repr Nodes	100 Seed Weight	Seed Yield	% of Windham
										..cm..	..cm..		..cm..	..cm..			..g..	kg/ha	
PS12300040W						229.0	272.7	12.3	2.0	32.0	25.7	0.80	57.2	43.7	0.78	6.5	16.4	2710.8	80
PS11300290W						235.3	276.3	14.5	2.0	61.2	28.8	0.47	109.2	57.7	0.53	6.0	19.0	2686.9	80
PS12300045W						241.0	278.0	16.0	2.0	52.0	40.3	0.79	84.3	63.7	0.77	5.7	14.4	2329.9	69
PS11300310W						234.7	280.0	12.7	2.0	76.7	23.2	0.32	125.8	46.3	0.39	7.7	11.4	1884.2	56
PS12300018W						239.7	281.3	20.2	2.0	46.2	23.3	0.52	64.2	39.2	0.61	4.5	12.9	518.3	15
GRAND MEAN						233.6	275.0	13.9	1.9	41.9	27.9	0.71	71.7	47.4	0.70	6.5	15.0	3529.5	
CV						0.9	1.1	14.8	13.8	17.8	18.7	18.53	14.5	15.0	15.06	20.6	7.3	12.6	
LSD						3.6	5.2	3.3	0.4	12.2	8.5	0.21	17.0	11.6	0.17	2.2	2.1	872.4	

Leaf Type: + = normal leaf; - = afila or semi-leafless. Vine Type: + = tall vine; - = short vine.

FW 1 = Fusarium Wilt Race 1; R = resistant; S = susceptible. PM = Powdery Mildew; R = resistant; S = susceptible. PEMV = Pea Enation Mosiac Virus; R = resistant; S = susceptible.

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.

Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.

Repr Nodes = average number of reproductive nodes on a plant. Agronomic data are means of three replications at Pullman, WA. Planting Date: 10/17/2014 Harvest Date: 07/19/2014

Agronomic and Yield Data for the Austrian Winter Dry Pea Preliminary Yield Trial (1424)

Name	Leaf Type	Vine Type	FW 1	PM	PEMV	Days to Flower	Days to Maturity	Flower Node	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	# Repr Nodes	100 Seed Weight	Seed Yield	% of Windham
										..cm..	..cm..		..cm..	..cm..			..g..	kg/ha	
PS09300104W						238.0	276.7	16.7	2	46.3	30.2	0.67	64.2	48.0	0.76	3.7	15.9	4146.0	101
Granger	-	+	R	S	S	232.3	274.0	14.3	2	65.3	27.3	0.44	118.8	54.8	0.47	5.8	14.0	4074.9	100
PS10300068W						238.0	277.3	15.2	2	55.2	31.5	0.59	88.2	55.5	0.66	5.0	14.4	4021.5	98
Melrose	+	+	S	S	S	234.3	276.7	15.3	2	61.8	20.5	0.35	109.5	43.7	0.43	5.7	11.1	3296.2	80
GRAND MEAN						235.6	276.1	15.3		57.1	27.3	0.51	95.1	50.5	0.58	5.0	13.8	3884.6	
CV						0.3	0.2	21.7		12.2	17.9	21.61	11.6	12.0	14.81	12.3	3.8	8.8	
LSD						1.6	1.3	6.6		13.9	9.8	0.22	22.2	12.1	0.17	1.2	1.0	722.6	

Leaf Type: + = normal leaf; - = afila or semi-leafless. Vine Type: + = tall vine; - = short vine.

FW 1 = Fusarium Wilt Race 1; R = resistant; S = susceptible. PM = Powdery Mildew; R = resistant; S = susceptible. PEMV = Pea Enation Mosiac Virus; R = resistant; S = susceptible.

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.

Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.

Repr Nodes = average number of reproductive nodes on a plant. Agronomic data are means of three replications at Pullman, WA. Planting Date: 10/17/2013 Harvest Date: 07/19/2014

Agronomic and Yield Data for the Winter Dry Pea Observation Nursery (1425)

Name	Leaf Type	Vine Type	FW 1	PM	PEMV	Days to Flower	Days to Maturity	Flower Node	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	# Repr Nodes	100 Seed Weight	Seed Yield	% of Windham
										..cm..	..cm..		..cm..	..cm..			..g..	kg/ha	
PS13300057W						216.0	267.0	11.0	2.0	27.0			47.0			7.0	20.2	2512.2	124
Specter	-	+		S		226.0	269.0	13.5	2.0	56.5	32.0	0.57	112.5	60.0	0.54	7.5	13.3	2463.8	121
PS13300033W						216.0	263.0	11.0	2.0	19.5			59.5			9.5	19.2	2148.5	106
PS13300064W						214.0	261.0	13.0	1.0	23.5			47.5			4.5	20.6	2049.0	101
Windham	-	-		S		227.0	263.0	13.0	2.0	32.5			59.0			6.5	15.9	2025.8	100
PS13300044W						214.0	270.0	12.0	2.0	20.5	17.0	0.88	50.5	41.0	0.82	7.0	21.5	1885.6	93
PS13300054W						230.0	272.0	15.5	2.0	30.0	19.0	0.65	68.5	39.5	0.58	8.5	17.6	1778.5	87
PS13300043W						214.0	265.0	13.0	2.0	29.0	20.0	0.71	60.5	38.5	0.64	8.0	21.6	1606.9	79
PS13300048W						219.0	265.0	7.0	2.0	25.5			58.5			7.5	25.5	1590.4	78
PS13300047W						223.0	263.0	9.5	2.0	17.0			52.5			5.5	25.6	1385.2	68
PS13300034W						216.0	263.0	10.5	2.0	21.5			51.5			8.5	19.4	1345.5	66
PS13300065W						214.0	265.0	6.5	1.0	13.5			31.0			4.5	24.5	1305.0	64
PS13300055W						221.0	274.0	9.5	2.0	22.0	15.0	0.65	51.0	42.0	0.83	8.0	17.1	1295.3	63
PS13300039W						214.0	261.0	13.0	1.0	28.0			50.5			6.5	19.5	1126.1	55
PS13300060W						214.0	261.0	10.0	2.0	27.0			59.5			8.0	19.5	992.8	49
PS13300042W						225.0	270.0	14.0	2.0	30.0	16.0	0.53	56.5	36.0	0.64	7.0	18.8	957.6	47
PS13300056W						230.0	272.0	9.0	2.0	22.5	17.5	0.80	50.0	38.5	0.77	9.5	18.5	826.9	40
PS13300061W						214.0	261.0	8.5	2.0	17.5			36.0			6.0	18.1	617.7	30
PS13300019W						214.0	267.0	8.5	1.0	20.5	16.0	0.78	39.0	30.0	0.78	5.0	21.6	502.7	24
PS13300051W						219.0	263.0	7.5	1.0	17.0	11.0	0.68	47.0	22.0	0.48	7.5	22.7	54.0	2
GRAND MEAN						219.0	265.7	10.7	1.7	25.0	18.1	0.69	54.4	38.6	0.68	7.1	20.0	1423.4	
CV						2.5	1.5	22.9	24.7	35.1	30.0	15.17	29.2	24.9	17.98	20.1	15.0	45.0	
LSD																			

Leaf Type: + = normal leaf; - = afila or semi-leafless. Vine Type: + = tall vine; - = short vine.
FW 1 = Fusarium Wilt Race 1: R = resistant; S = susceptible; PM = Powdery Mildew: R = resistant; S = susceptible; PEMV = Pea Enation Mosiac Virus: R = resistant; S = susceptible.
Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.
Repr Nodes = average number of reproductive nodes on a plant. Planting Date: 10/17/2014 Harvest Date: 08/04/2014

Location Yield Summary for the Advanced Winter Lentil Yield Trial (1441)

Entry	Dayton Seed Yield (kg/ha)	Genesee Seed Yield (kg/ha)	Pullman Seed Yield (kg/ha)	Mean Seed Yield [§] (kg/ha)	% of Morton[§]
LC1260W0004W	633	2852	3050	2951	115
LC1160W0071W	812	2182	2983	2582	101
Morton	667	2794	2314	2554	100
LC1160W0078W	672	1836	2985	2411	94
LC1260W0020W	862	2076	2538	2307	90
LC1260W0019W	712	2382	2209	2296	89
LC1160W0026W	550	1935	2200	2067	80
LC1160W0030W	668	1845	2274	2060	80
LC1260W0010W	725	1753	2077	1915	74
LC1260W0011W	433	1421	2372	1897	74
LC1260W0013W	436	1585	2083	1834	71
LC1160W0041W	563	1584	2044	1814	71
LC05600512WT	313	1913	1387	1650	64
LC1160W0031W	273	1537	1591	1564	61
LC1260W0006W	556	934	2077	1505	58
LC1160W0080W	289	1113	1877	1495	58
LC1160W0048W	470	1302	1629	1465	57
LC1260W0002W	471	1137	1694	1415	55
LC1260W0008W	529	1108	1669	1389	54
LC1160W0038W	113	1461	1167	1314	51
LC1260W0005W	332	847	1657	1252	49
LC1160W0020W	513	1251	1231	1241	48
LC1160W0017W	335	1203	1218	1210	47
LC1260W0018W	359	988	527	757	29
Grand Mean	512	1627	1952	1789	70
CV	36	15	22	19	
LSD	365	473	843	333	13

[§] Mean seed yield and % of Morton does not include data from Dayton
Yield data are means of three replications at each location

Agronomic Data for the Winter Lentil Advanced Yield Trial (1441)

Name	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight	Seed Yield	% of Morton
				..cm..	..cm..		..cm..	..cm..		..g..	kg/ha	
Morton	229.0	270.0	2.0	17.2	12.3	0.74	38.5	29.0	0.77	3.4	2314.0	100.0
LC05600512WT	225.0	277.0	2.0	14.2	10.5	0.74	39.0	30.8	0.81	4.1	1386.8	59.9
LC1160W0017W	238.3	279.0	2.0	21.3	16.3	0.77	45.0	34.2	0.78	2.9	1217.8	52.6
LC1160W0020W	239.0	281.0	2.0	27.8	14.7	0.57	46.3	27.8	0.64	2.7	1231.2	53.2
LC1160W0026W	235.7	277.0	2.0	20.5	15.8	0.78	44.3	32.8	0.76	3.4	2199.8	95.1
LC1160W0030W	235.0	278.0	2.0	19.8	16.8	0.84	42.8	36.5	0.86	3.5	2274.2	98.3
LC1160W0031W	237.3	278.0	2.0	24.3	18.8	0.80	40.8	34.5	0.86	3.5	1590.5	68.7
LC1160W0038W	235.0	282.0	2.0	20.8	18.2	0.88	45.2	37.0	0.83	4.3	1166.6	50.4
LC1160W0041W	233.0	278.0	2.0	18.2	12.5	0.70	41.7	34.7	0.83	3.8	2044.1	88.3
LC1160W0048W	235.7	282.0	2.0	21.8	16.2	0.75	44.7	33.7	0.77	4.0	1628.7	70.4
LC1160W0071W	230.7	275.0	2.0	18.0	14.0	0.80	39.0	31.3	0.81	3.4	2982.7	128.9
LC1160W0078W	233.7	275.0	3.0	18.2	15.3	0.84	44.7	35.8	0.81	3.4	2984.9	129.0
LC1160W0080W	237.7	280.0	2.0	24.0	16.8	0.71	44.3	33.2	0.76	3.1	1877.1	81.1
LC1260W0002W	238.0	280.0	2.0	24.0	16.0	0.71	40.2	28.7	0.74	3.0	1693.8	73.2
LC1260W0004W	227.7	272.0	3.0	14.7	12.7	0.89	36.2	29.0	0.82	3.1	3050.2	131.8
LC1260W0005W	238.3	280.0	2.0	23.8	17.7	0.76	40.5	32.3	0.81	3.2	1656.8	71.6
LC1260W0006W	237.3	278.0	3.0	27.0	15.0	0.57	46.0	26.0	0.57	3.2	2077.1	89.8
LC1260W0008W	239.7	280.0	2.0	23.0	16.7	0.74	41.0	29.3	0.73	3.1	1669.4	72.1
LC1260W0010W	229.3	274.0	2.0	18.3	15.0	0.81	39.5	33.2	0.86	3.7	2077.2	89.8
LC1260W0011W	236.7	277.0	3.0	22.5	17.8	0.81	42.0	35.2	0.84	3.4	2371.7	102.5
LC1260W0013W	237.3	277.0	2.0	21.8	17.0	0.79	40.7	33.3	0.82	3.3	2083.3	90.0
LC1260W0018W	237.7	285.0	2.0	21.0	16.7	0.80	39.5	32.7	0.83	3.5	526.8	22.8
LC1260W0019W	229.7	273.0	2.0	16.0	11.3	0.70	38.8	27.5	0.72	3.3	2209.1	95.5
LC1260W0020W	229.3	270.0	3.0	18.5	14.2	0.77	41.2	28.8	0.70	3.4	2537.8	109.7
GRAND MEAN	234.4	277.4	2.3	20.7	15.3	0.76	41.7	31.9	0.78	3.4	1952.1	
CV	1.1	1.0	21.3	12.5	18.4	17.25	10.2	10.4	13.79	8.8	21.9	
LSD	4.3	4.9	0.8	4.2	4.6	0.22	7.0	5.4	0.18	0.4	842.5	

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divded by pod height at the green pod stage.

Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.

Planting Date: 10/17/2013 Harvest Date: 07/29/2014

Agronomic and Yield Data for the Winter Lentil Observation Nursery (1445)

Name	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight	Seed Yield	% of Morton
				..cm..	..cm..		..cm..	..cm..		..g..	kg/ha	
LC1260W0001W	235.0	272.0	2.0	22.0	14.5	0.68	39.5	27.5	0.70	2.7	1251.7	188
LC1260W0022W	214.0	272.0	3.0	10.5	9.0	0.87	33.0	28.0	0.85	4.1	1015.5	152
LC1260W0003W	235.0	274.0	2.0	23.5	16.5	0.71	42.5	28.0	0.66	2.9	971.3	146
Morton	223.0	265.0	2.0	17.0	10.5	0.63	34.0	27.5	0.81	3.0	664.4	100
LC1260W0017W	229.0	279.0	2.0	19.0	15.0	0.79	38.5	36.0	0.94	3.6	631.3	95
LC1260W0021W	235.0	279.0	2.0	20.0	17.0	0.85	40.0	34.0	0.86	3.1	536.6	80
GRAND MEAN	228.5	273.5	2.1	18.6	13.7	0.76	37.9	30.1	0.80	3.2	845.1	
CV	3.4	1.7	17.2	22.5	21.6	11.69	8.8	11.5	11.95	14.6	29.9	

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.
Planting Date: 10/17/2013 Harvest Date:08/04/2014

CHICKPEA BREEDING

In 2014, 18 café kabuli chickpea breeding lines, two Spanish White chickpea breeding lines and four check cultivars were included in the Advanced Chickpea Yield Trials. The check cultivars were "Sawyer", "Sierra", "CDC-Frontier", and "Billybean". Trials were planted at four locations: Dayton, WA on 16 April 2014, Genesee, ID on 3 May 2014, at Pullman, WA on 6 May 2014, and at Kendrick, ID on 9 May 2014. Prior to planting all seeds received the seed coat treatment described previously in this report and *Mesorhizobium ciceri* inoculant was added to each seed lot prior to planting. Three replicated plots (1.5 m x 6.1 m) were planted at a density of 44 seeds/m^2 for each entry at each location. A post plant/pre-emergence application of metribuzin (Sencor; 6 oz/acre) and linuron (Lorox; 1.25 lb/acre) was applied for weed control at all location. Paraquat (Gramoxone; 2 pints/acre) was applied at each location approximately 14 d before harvest to promote desiccation.

The grand mean of all entries over all locations was 1423 kg ha^{-1} (1266 lb $acre^{-1}$). The highest yielding location was Kendrick, ID (1951 kg ha^{-1}) followed by Genesee, ID (1846 kg ha^{-1}), Pullman, WA (1486 kg ha^{-1}), and finally, Dayton, WA (410 kg ha^{-1}). The very low yields at Dayton were due to herbivory pressure from deer and elk feeding in the plots. Yields and seed size were compared between 2014 and 2013 for Pullman and Dayton, where data was collected in both years. The mean yields of the four check cultivars (Sawyer, Sierra, CDC-Frontier and Billybeans) in 2014 at Pullman (1429 kg ha^{-1}) was 40% less than in 2013 (2382 kg ha^{-1}). The mean yields of the four check cultivars in 2014 at Dayton (588 kg ha^{-1}) was 49% less than in 2013 (1429 kg ha^{-1}). These results, especially those based on data from Pullman, WA, where there was insignificant herbivore pressure during both years, suggest that overall growing conditions were better in 2013 than 2014. Seed size of entries was only determined for the Pullman, WA location. The mean weight of 100 seeds in 2014 for the four check cultivars (Sawyer, Sierra, CDC-Frontier and Billybean; mean = 40.25 g 100 $seeds^{-1}$) was almost exactly the same as observed in 2013 for these check cultivars (40. 18 g 100 $seeds^{-1}$). Since seed weight was similar in 2013 and 2014 but yields were much greater in 2013, this suggests that other components influenced plot yield in 2014. It is likely that greater yield in 2013 was primarily the result of more pods per plant and more seeds per pod than in 2014.

The ten entries with the highest mean yield across all locations included eight advanced kabuli café chickpea lines from the ARS breeding program, the small seeded landrace "Billybean", and the small café kabuli cultivar CDC-Frontier. Billybean was the highest yielding entry over all locations, averaging 1709kg ha^{-1}, which was 57% greater than that of the lowest yielding entry, Sierra (1083 kg ha^{-1}).The highest yielding breeding lines were CA11900028C (1616 kg ha^{-1}), CA0790B0043C (1525 kg ha^{-1}), and CA0790B0042C (1507 kg ha^{-1}). Yields at Pullman ranged from a low of 1099 kg ha^{-1} (Sierra) to a high of 1699 kg ha^{-1} (CA0790B0547C). Yields at Kendrick ranged from a low of 1545 kg ha^{-1} (Sierra) to a high of 2219 kg ha^{-1} (CA0890B0531C). Yields at Dayton ranged from a low of 110 kg ha^{-1} (CA0890B0628C) to a high of 942 kg ha^{-1} (Billybean). Yields at Genesee ranged from a low of 1375 kg ha^{-1} (Sierra) to a high of 2250 kg ha^{-1} (Sawyer).

Although yields varied across locations, several entries exhibited relatively stable yield rankings across locations. The three top yielding entries, Billybeans, CA11900028C, and CDC-Frontier, were ranked in the top ten across all locations, as was CA0790B0642C. CA0790B0733C was ranked in the top ten at Pullman, Dayton, and Genesee, while CA0790B0034 was ranked in the top ten at Pullman, Kendrick, and Dayton. CA04900843C, released as the cultivar "Nash" was ranked in the top ten at Pullman, Kendrick, and Genesee. Sierra, in contrast, was ranked last of all entries at Pullman, Kendrick, and Genesee. Among the 20 ARS breeding lines tested in 2014, 18 of these breeding lines had mean yields that were at least 20% greater than Sierra. There were 12 ARS breeding lines that had means yields that were at least 30% greater than Sierra. Two breeding lines, CA0790B0043C and CA11900028C had mean yields that were at least 40% greater than Sierra.

All entries in the Pullman, WA yield trial were also evaluated for other important traits including days to 50% flower, days to maturity, canopy height, plant height index (PHI), and 100 seed weight. Significant differences were observed among entries for all traits associated with morphological and developmental traits. At least 50% of the plants of each entry flowered within a range of 49-73 days. The earliest flowering entry was Billybean and the latest was CA07900042C. All entries matured within a range of 90-99 days, with Billybean maturing earliest and CA04900843C (Nash) maturing latest. Pod height at maturity, which may suggest ease of harvest, ranged from a low of approximately 20 cm (CA0890B0429C) to a high of more than 28 cm(CA0790B0043C). However, Sierra, which had the lowest yield of all entries at Pullman, had the second highest pod height at maturity (27 cm), which suggests that this trait may also identify genotypes that are especially erect at time of harvest due to a relatively low weight of pods and seeds. Plant Height Index (PHI), which is the ratio of the total length of the vine of the plant over canopy height, can range from 0-1. PHI is considered to be a measure of tolerance to lodging, with more tolerant lines having higher index scores. Nearly all breeding lines and check cultivars had PHI > 0.80, which suggests the entries were very tolerant to lodging under the field conditions encountered during the trial. The entries that were ranked in the top five for yield at Pullman had a mean PHI of 0.89.

The value of a chickpea crop is influenced by both yield and seed size. Larger seeds are more desirable in the whole seed markets and have a higher value than smaller seeds, which are typically processed into hummus. The USDA National Agricultural Statistics Service separates chickpeas into two size classes based on the diameter of seed: small (< 7.9 mm), and large (≥ 7.9 mm). Over a recent five year period (2009-2013), large chickpeas have received an average price of \$0.80 kg^{-1}, which is 48% higher than the average price of \$0.54 kg^{-1} received for small chickpeas. Consequently, there is considerable emphasis in the ARs breeding program to develop chickpea varieties that couple high yield with large seed size. The weight of 100 seeds of all entries ranged from a low of 30.6 g to a high of 62.3 g. 100 seed weight of the check cultivars ranged from 30.6 g (Billybean) to 52.3 g (Sierra). 100 seed weight seed of Sierra (52.3 g) was significantly greater than Sawyer (42.0 g), CDC-Frontier (36.1 g), and Billybeans (30.6 g). The 100 seed weight of Sierra was significantly greater than CDC-Frontier, which in turn was significantly greater than Billybean. 100 seed weight of breeding lines ranged from 46.8 g (CA0890B0581C) to 62.3 g (CA04900843C; Nash). The 100 seed weight of CA04900843C (Nash)

was significantly greater than all other entries. Six breeding lines had 100 seed weights that were significantly greater (≥ 54.1 g 100 seed^{-1}) than Sierra. The ten entries with the greatest 100 seed weight were all ARS breeding lines.

Recently selected chickpea breeding lines were evaluated in a preliminary yield trial conducted at the Washington State University Spillman Farm in Pullman, WA. A total of 23 entries were evaluated including ten café kabuli breeding lines, eleven Spanish White breeding lines, and two check cultivars; the café kabuli cultivar Sierra and the Spanish White cultivar Dylan. Trials were planted on 5 May 2014 and harvested on 20 August 2014. Three replicated plots (1.5 m x 6.1 m) were planted for each entry at a density of 44 seeds/m^2. Pre-plant seed treatment and herbicide applications were done as described above for the Advanced Yield Trial conducted at Pullman, WA.

The mean yield for all entries was 15832 kg ha^{-1}. The preliminary breeding lines ranged in yield from 1221-1833 kg ha^{-1}. Sierra had a yield of 1469 kg ha^{-1} and the yield of Troy was 1461 kg ha^{-1} kg/ha. The top ten yielding entries were all ARS breeding lines and included seven café kabuli breeding lines and three Spanish White breeding lines. These ten entries on average had yields that were 18% greater than Sierra.

All entries were also evaluated for other important traits including days to maturity, canopy height, plant height index, and 100 seed weight. The plant height index was greater than 0.80 for all entries except CA12900283C (PHI = 0.79), which indicates the entries have excellent tolerance to lodging. Significant differences were observed among entries for days until 50% flower and days to maturity. The entries reached 50% flower between 50-72 days and matured between 93 -101 days. The ten highest yielding lines matured in 93-98 days.

The weight of 100 seeds was determined for all entries in the preliminary yield trial. The breeding line CA12900153C had the smallest seed (40.7 g 100 seeds^{-1}) and the breeding line CA12900062W had the largest seed (66.5 g 100 seeds^{-1}). The100 seed weight of Sierra and Troy were 51.6 and 59.6 g, respectively. The ten highest yielding lines had 100 seed weights ranging from 40.7-63.4 g. Four of the top ten yielding breeding lines had seed weights that were significantly greater (≥ 53.7 g 100 seeds^{-1}) than Sierra.

Several of the higher yielding preliminary breeding lines will be included in advanced yield trials in 2015. Of particular interest are three lines, CA12900046W, CA0890B0435C, CA11900014C, and CA12900287C, all of which had yields that were at least 12% greater than Sierra and has seed weights that were significantly greater than Sierra.

PROMISING KABULI CHICKPEA BREEDING LINES

Several ARS breeding lines, evaluated for at least five years (2020-2013) across a total of 15 location-years in the Pacific Northwest, appear to be promising candidates for future release as improved germplasm or new cultivars. During 2014 we produced a second cycle of breeder

seed of both CA0790B0042C and CA0790B0043C, which have average yields over the five year period that are 21 and 20%, respectively, greater than the yield of Sierra. The most likely candidate among these two lines for release as a new cultivar is CA0790B0043C, based on it consistently having greater yields than Sierra while producing seed that is very similar in size to Sierra. The average weight of 100 seeds of Sierra across the two most recent years (2013-2014) is 51.1 g and the average for CA0790B0043C over the same period is 52.1 g. Other promising breeding lines based on multi-year performance in advanced yield trials in the Pacific Northwest include CA0690B0250C, CA0690B0427C, CA0790B0034C, and CA0790B0054C, all of which have had average yields over the last five years that are at least 9% greater than that of Sierra and produce seed that is at least as large as Sierra. Among these four breeding lines, the most likely to be released as a new cultivar is CA0790B0034C, which has an average yield over five years that is 19% greater than Sierra.

Other promising breeding lines have been identified based on their performance over three years of advanced yield trials (2012-2014). Among these, the most promising at present appears to be CA0790B0642C, which has an average yield over three years that is 19% greater than Sierra over the same period and has a two year average weight for 100 seeds of 57.7 g. Another promising breeding line is CA0890B0429C, which has an average yield over three years that is 16% greater than Sierra over the same period and has a two year average weight for 100 seeds of 56.4 g. Two other breeding lines appear promising based on two years (2013-2014) of field trials in Washington and Idaho over six location-years. CA0890B0531 has an average yield that is 17% greater than Sierra over the same period and has a two year average weight for 100 seeds of 52.3 g. CA0890B0551 has an average yield that is 10% greater than Sierra over the same period and has a two year average weight for 100 seeds of 57.7 g.

In 2014 we examined 130 preliminary kabuli breeding lines in an unreplicated (1 plot per entry) observation nursery at Pullman, WA. The observation plots are used to identify breeding lines that will be advanced to preliminary yield trials in which three plots for each entry are grown at a single location (Pullman, WA). Although it is difficult to assess yield accurately based on single plots, the observation nursery is useful for detecting differences between entries for seed size and maturity. There were 51 breeding lines that have 100 seed weight ≥ 50 g. In the preliminary nursery the weight of 100 seeds for Sierra was 53.9 g and there are 15 entries that had 100 seed weight greater than Sierra. Sierra matured in 104 days in the observation nursery. The breeding lines ranged in time to maturity from 87-108 days. There were 51 breeding lines that reached maturity at least 5 days earlier than Sierra. Most promising may be five breeding lines that had greater seed size and yield than Sierra, while also maturing at least five days earlier.

The 2014 observation nursery also included 24 breeding lines that produce mature seed that has green cotyledons. These breeding lines may be useful for growers that are interested in producing green chickpeas. Nearly all of these lines had yields and seed size that were smaller than Sierra. We are just beginning to identify factors that influence the amount of green color in mature chickpeas, which appear to include effects of the growing season environment along with storage time and the temperature at which the seeds are stored.

Location Yield Summary for the Large Kabuli Chickpea Advanced Yield Trial (1481)

Name	Leaf Type	Seed Type	Pullman Seed Yield	Kendrick Seed Yield	Dayton Seed Yield	Genesee Seed Yield	Mean Seed Yield	% of Sierra
			kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	
Billy Beans		C	1616	2067	942	2213	1709	157
CA11900028C		C	1677	2110	601	2077	1616	149
CDC Frontier	C	C	1664	2121	554	2051	1598	147
CA0790B0043C	C	C	1500	1970	542	2087	1525	140
CA0790B0042C	C	C	1496	2095	620	1820	1507	139
CA0790B0733C	C	C	1615	1856	478	2074	1506	139
CA0790B0642C	C	C	1614	2058	423	1920	1504	138
CA0790B0034C	C	C	1671	2086	422	1833	1503	138
CA11900031W		W	1508	1962	415	2076	1490	137
CA0790B0547C	C	C	1699	1962	304	1885	1462	135
CA0890B0531C	C	C	1407	2219	439	1762	1457	134
CA0690B0427C	C	C	1457	2039	365	1910	1443	133
Sawyer	S	C	1338	1632	542	2250	1441	133
CA0790B0549C	C	C	1541	2047	293	1866	1437	132
CA04900843C	C	C	1522	2072	254	1891	1435	132
CA0890B0429C	C	C	1421	2099	179	1825	1381	127
CA0690B0250C	C	C	1643	1939	294	1536	1353	124
CA0790B0054C	C	C	1342	1831	297	1797	1316	121
CA0790B0053C	C	C	1270	1922	339	1714	1311	121
CA0890B0551C	C	C	1437	1844	382	1554	1304	120
CA0890B0581C	C	C	1320	1787	355	1750	1303	120
CA0890B0434C	C	C	1423	1843	373	1546	1296	119
CA0890B0628W	C	W	1389	1710	110	1494	1176	108
Sierra	S	C	1099	1545	314	1375	1083	100
GRAND MEAN			1486	1951	410	1846	1423	
CV			9	7	30	11	11	
LSD			221	237	206	359	108	

Leaf Type: C = compound leaf, S = simple leaf type. Seed type; W = white seed type, C = cafe seed type
Yield data are means of three replications at each location.

Agronomic and Yield Data for the Large Kabuli Chickpea Advanced Yield Trial (1481)

Name	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight
				..cm..	..cm..		..cm..	..cm..		..g..
Sierra	50.7	96.0	1	30.8	27.3	0.89	48.8	41.5	0.86	52.3
Sawyer	52.0	91.0	1	27.7	25.7	0.93	46.5	41.0	0.89	42.0
CDC Frontier	57.7	93.0	1	24.3	22.7	0.94	46.5	40.7	0.88	36.1
Billy Beans	48.7	90.0	1	28.0	23.0	0.84	53.0	46.0	0.87	30.6
CA04900843C	60.3	99.0	1	24.8	21.5	0.86	44.2	39.5	0.90	62.3
CA0690B0250C	57.7	98.0	1	27.7	22.8	0.83	53.2	47.5	0.90	52.4
CA0690B0427C	55.7	98.0	1	24.8	22.2	0.90	47.8	39.3	0.83	53.2
CA0790B0034C	57.7	96.0	1	31.8	24.2	0.77	52.7	47.0	0.90	52.4
CA0790B0042C	72.7	94.0	1	30.0	23.2	0.78	51.2	44.5	0.87	44.7
CA0790B0043C	59.7	96.0	1	30.8	28.2	0.92	54.3	47.7	0.89	52.2
CA0790B0053C	58.3	97.0	1	29.2	26.2	0.91	54.7	47.8	0.88	56.0
CA0790B0054C	60.3	97.0	1	27.3	24.0	0.89	54.2	44.8	0.84	53.5
CA0790B0547C	55.7	95.0	1	28.8	25.3	0.88	45.8	41.0	0.90	52.3
CA0790B0549C	59.0	94.0	1	27.7	21.3	0.77	47.8	38.5	0.81	48.7
CA0790B0642C	57.7	96.0	1	24.0	22.2	0.92	50.2	41.5	0.84	56.2
CA0790B0733C	58.3	97.0	1	25.5	20.2	0.80	44.7	40.2	0.91	47.4
CA0890B0429C	72.0	96.0	1	26.3	19.8	0.77	50.3	41.2	0.83	56.1
CA0890B0434C	55.0	97.0	1	26.0	22.3	0.87	49.7	39.3	0.79	53.3
CA0890B0531C	60.3	95.0	1	25.8	22.0	0.86	48.2	38.7	0.81	51.8
CA0890B0551C	57.0	98.0	1	24.2	23.0	0.95	47.5	39.2	0.83	57.2
CA0890B0581C	61.0	96.0	1	25.0	22.7	0.91	46.2	38.2	0.83	46.8
CA0890B0628W	60.3	97.0	1	25.2	22.0	0.88	43.0	38.5	0.90	57.5
CA11900028C	57.7	91.0	1	24.7	22.3	0.91	47.3	40.2	0.85	51.2
CA11900031W	60.3	93.0	1	26.7	23.3	0.88	48.0	42.3	0.89	53.7
GRAND MEAN	58.5	95.4	1	26.9	23.2	0.87	48.9	41.9	0.86	50.8
CV	8.5	1.8	1	9.1	9.0	7.12	5.8	5.2	6.25	2.2
LSD	8.2	2.8	1	4.0	3.4	0.10	4.7	3.5	0.09	1.8

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.

Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.

Rep Nodes = average number of reproducing nodes to a plant. Agronomic data are means of three replications at Pullman, WA. Planting Date: 05/06/2014 Harvest Date: 08/19/2014

Name	Leaf Type	Seed Type	2014	2013	2012	2011	2010
			kg/ha	kg/ha	kg/ha	kg/ha	kg/ha
Sierra	S	C	1083	1722	1532	2090	767
Sawyer	S	C	1441	1913	1605	2380	908
CDC Frontier	C	C	1598	2090	1928	2216	
CA04900843C	C	C	1435	1927	1866	2434	978
CA0690B0250C	C	C	1353	1728	1725	2478	808
CA0690B0427C	C	C	1443	1836	1572	2324	693
CA0790B0034C	C	C	1503	1825	1978	2319	914
CA0790B0042C	C	C	1507	1769	1955	2520	984
CA0790B0043C	C	C	1525	1759	2012	2618	721
CA0790B0053C	C	C	1311	1600	1667	2242	651
CA0790B0054C	C	C	1316	1902	1766	2345	747
CA0790B0547C	C	C	1462	1956	2099		
CA0790B0549C	C	C	1437	1898	1907	2614	866
CA0790B0642C	C	C	1503	1799	1846		
CA0790B0733C	C	C	1506	1964	1917	2486	940
CA0890B0429C	C	C	1381	1770	1878		
CA0890B0434C	C	C	1296	1708			
CA0890B0531C	C	C	1457	1817			
CA0890B0551C	C	C	1304	1781			
CA0890B0581C	C	C	1303				
CA0890B0628W	C	W	1176	1698			
Billy Beans		C	1709	1949	2068	2473	
CA11900028C		C	1616				
CA11900031W		W	1490				

Leaf Type: C = Compound leaf, S = Simple leaf
Seed Type: C = Cafe seed type, W = White seed type
Yield data are means of three reps per location, 4 locations per year.

Agronomic and Yield Data for the Large Kabuli Chickpea Preliminary Yield Trial (1483)

Name	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight	Seed Yield	% of Sierra
				..cm..	..cm..		..cm..	..cm..		..g..	kg/ha	
CA12900117C	54.0	97.0	1	26.3	21.8	0.83	47.0	39.3	0.85	46.8	1833	124
CA12900153C	55.0	94.0	1	30.3	26.7	0.88	50.3	47.3	0.95	40.7	1824	124
CA11900139W	55.0	98.0	1	29.5	26.2	0.89	48.2	43.2	0.90	43.4	1817	123
CA12900413C	52.0	96.0	1	24.0	21.0	0.88	47.0	38.8	0.84	47.7	1806	122
CA11900127W	51.3	96.0	1	28.7	24.8	0.87	47.0	40.8	0.87	42.5	1768	120
CA11900088C	51.7	96.0	1	24.8	18.8	0.76	42.0	36.8	0.88	49.9	1739	118
CA12900046W	55.7	98.0	1	28.5	23.7	0.84	49.3	39.2	0.81	63.4	1696	115
CA0890B0435C	51.3	98.0	1	37.0	34.3	0.93	59.7	49.0	0.82	55.4	1666	113
CA11900014C	57.0	93.0	1	28.0	26.0	0.93	49.2	44.2	0.90	54.7	1661	113
CA12900287C	50.7	97.0	1	30.3	27.8	0.92	48.8	39.7	0.82	56.4	1652	112
CA11900036W	59.0	95.0	1	28.2	25.3	0.90	46.0	40.7	0.89	55.4	1614	109
CA12900168C	53.0	94.0	1	26.8	24.5	0.92	49.7	42.8	0.87	49.3	1608	109
CA11900064W	72.0	95.0	1	26.3	22.8	0.88	47.3	39.7	0.84	48.6	1546	105
CA11900113W	61.0	100.0	1	27.8	23.3	0.84	46.0	39.8	0.87	54.9	1529	104
CA12900283C	52.3	96.0	1	29.7	25.5	0.87	49.5	38.0	0.79	53.0	1515	103
CA12900072W	50.7	96.0	1	28.0	25.2	0.90	47.7	41.7	0.88	51.6	1492	101
Sierra	50.7	98.0	1	29.0	24.8	0.86	49.5	40.0	0.82	51.6	1469	100
Troy	51.0	98.0	1	28.7	22.5	0.79	43.2	37.2	0.87	59.6	1461	99
CA12900062W	53.0	100.0	1	23.7	16.5	0.69	45.8	36.0	0.80	66.5	1460	99
CA11900077W	52.7	97.0	1	24.3	21.2	0.88	47.8	40.0	0.85	63.7	1425	97
CA12900084C	50.0	100.0	1	29.7	26.5	0.90	51.8	43.3	0.84	52.3	1337	91
CA0890B0085W	50.7	101.0	1	36.0	33.0	0.92	54.3	47.7	0.89	59.2	1262	85
CA0890B0103W	58.3	100.0	1	29.3	25.8	0.88	49.0	41.5	0.85	53.3	1221	83
GRAND MEAN	54.2	96.9	1	28.4	24.7	0.87	48.5	41.1	0.86	53.0	1583	
CV	6.9	1.6	1	7.1	8.6	7.76	6.2	5.6	6.61	2.4	9	
LSD	6.2	2.6	1	3.3	3.5	0.11	5.0	3.8	0.09	2.1	242	

Pod height was measured at the green pod stage and at harvest maturity. Pod height index = pod height at harvest maturity divided by the pod height at the green pod stage.
Plant height was measured at the green pod stage and at harvest maturity. Plant height index = plant height at harvest maturity divided by the plant height at the green pod stage.
Rep Nodes = average number of reproducing nodes to a plant. Agronomic data are means of three replications at Pullman, WA. Planting Date 05/06/2014 Harvest Date: 08/20/2014

Agronomic and Yield Data for the Large Kabuli Chickpea Observation Nursery (1485K)

Name	Leaf Type	Seed Type	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight	Seed Yield	% of Sierra
						..cm..	..cm..		..cm..	..cm..		..g..	kg/ha	
CA13900049C			52.50	87.00	1	31.30	27.70	0.89	52.00	45.30	0.88	46.00	2569.	320
CA13900119C			51.80	97.00	1	37.20	27.90	0.75	49.00	46.20	0.96	46.80	2460.	306
CA13900051C			58.30	100.0	1	32.10	25.80	0.81	48.10	45.30	0.94	41.00	2275.	283
CA13900151C			53.80	93.00	1	28.60	25.50	0.91	49.50	41.80	0.85	37.40	2108.	262
CA13900129C			54.30	100.0	1	32.20	30.00	0.94	53.20	46.20	0.87	49.70	2108.	262
CA13900061C			49.50	98.00	1	26.30	25.30	0.97	50.60	41.60	0.84	51.60	2103.	262
CA13900032W			58.00	101.0	1	23.20	19.20	0.86	42.80	45.60	1.03	48.80	2100.	261
CA13900065C			53.50	95.00	1	26.40	16.90	0.64	44.60	37.20	0.85	52.50	2029.	252
CA13900139C			49.80	88.00	1	24.40	21.40	0.88	45.10	37.40	0.83	43.00	2021.	251
CA13900168C			53.50	98.00	1	28.70	23.00	0.81	48.00	46.60	0.97	42.50	2017.	251
CA13900062C			52.50	101.0	1	26.60	22.50	0.85	49.60	42.60	0.87	45.40	2013.	250
CA13900039C			52.30	94.00	1	35.10	33.40	0.96	58.80	50.20	0.86	49.10	2003.	249
CA13900002C			56.00	100.0	1	21.70	17.00	0.81	48.70	42.30	0.88	51.90	1987.	247
CA13900045C			54.00	94.00	1	28.10	22.00	0.79	48.30	43.30	0.91	44.40	1978.	246
CA13900008C			54.00	99.00	1	31.30	20.80	0.70	55.10	50.70	0.93	53.30	1975.	246
CA13900052C			51.30	87.00	1	27.80	25.80	0.93	47.80	38.30	0.81	43.40	1974.	246
CA13900034C			57.30	103.0	1	23.80	19.20	0.81	43.70	39.30	0.89	42.40	1973.	245
CA13900126C			50.00	99.00	1	26.70	22.20	0.83	48.10	41.40	0.87	48.60	1960.	244
CA13900113C			52.80	98.00	1	29.30	24.30	0.82	47.70	42.10	0.89	52.20	1951.	243
CA13900162C			56.50	101.0	1	20.60	19.40	0.93	45.70	39.60	0.86	53.60	1949.	242
CA13900076C			55.80	94.00	1	26.40	20.30	0.78	47.00	38.10	0.82	45.70	1946.	242
CA13900116C			49.80	94.00	1	24.30	18.30	0.77	43.00	38.60	0.89	38.80	1946.	242
CA13900115C			52.30	101.0	1	27.70	24.70	0.88	50.70	42.40	0.84	55.60	1942.	242
CA13900144C			52.30	95.00	1	24.20	22.00	0.91	48.00	42.30	0.88	41.40	1938.	241
CA13900033W			55.80	101.0	1	27.20	23.80	0.88	49.30	42.90	0.87	49.30	1935.	241

Pod height was measured at the green pod stage and at harvest maturity. Pod height index was determined by dividing pod height at harvest maturity by the green pod height.
Plant height was measured at the green plant stage and at harvest maturity. Plant height index was determined by dividing plant height at harvest maturity by the green plant height at the green plant stag
Planting Date 05/13/2014. Harvest Date: 09/05/2014

Agronomic and Yield Data for the Large Kabuli Chickpea Observation Nursery (1485K)

Name	Leaf Type	Seed Type	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight	Seed Yield	% of Sierra
						..cm..	..cm..		..cm..	..cm..		..g..	kg/ha	
CA13900154C			53.80	99.00	1	23.20	24.50	1.03	54.20	40.30	0.75	51.70	1933.	240
CA13900166C			51.80	98.00	1	18.20	17.70	0.95	43.70	42.10	0.97	54.40	1907.	237
CA13900131C			56.50	107.0	1	24.10	19.90	0.82	43.50	40.70	0.94	41.00	1905.	237
CA13900080C			48.80	101.0	1	22.40	19.90	0.89	44.80	39.90	0.90	50.60	1901.	237
CA13900055C			57.50	101.0	1	30.90	25.30	0.82	52.50	45.90	0.88	52.50	1893.	236
CA13900086C			74.80	89.00	1	23.90	15.20	0.74	42.10	33.30	0.82	38.80	1870.	233
CA13900125C			58.00	108.0	1	26.80	22.90	0.86	51.10	42.30	0.82	55.80	1860.	231
CA13900009C			56.50	101.0	1	27.20	24.80	0.90	42.60	29.20	0.72	35.00	1857.	231
CA13900068C			56.00	101.0	1	24.10	23.20	0.97	47.00	35.10	0.77	39.30	1835.	228
CA13900040C			52.80	92.00	1	25.20	23.80	0.93	47.00	41.70	0.89	50.80	1817.	226
CA13900070C			53.50	92.00	1	23.20	18.20	0.79	45.30	38.70	0.86	43.10	1812.	225
CA13900085C			50.50	96.00	1	27.60	23.90	0.92	44.60	39.60	0.87	47.00	1802.	224
CA13900138C			59.00	105.0	1	27.20	25.90	0.96	52.00	46.90	0.92	50.30	1793.	223
CA13900075C			58.30	95.00	1	29.20	24.00	0.83	52.30	40.40	0.79	47.10	1777.	221
CA13900077C			50.80	103.0	1	27.90	27.20	0.98	46.20	39.70	0.87	47.00	1766.	220
CA13900006C			56.50	98.00	1	29.30	27.90	0.93	53.80	42.80	0.82	47.60	1760.	219
CA13900148C			49.50	99.00	1	19.90	17.20	0.87	50.10	39.30	0.80	48.40	1752.	218
CA13900078C			52.50	101.0	1	30.20	25.50	0.85	48.10	36.80	0.77	46.20	1739.	216
CA13900046C			52.30	105.0	1	26.10	22.70	0.87	49.20	45.60	0.93	49.50	1733.	216
CA13900058C			57.50	101.0	1	23.60	22.30	0.94	45.10	38.80	0.87	46.40	1730.	215
CA13900160C			50.50	101.0	1	27.90	20.20	0.73	50.00	43.80	0.89	51.10	1728.	215
CA13900031C			55.50	103.0	1	28.10	25.30	0.90	48.10	41.10	0.85	53.70	1725.	215
CA13900142C			53.00	102.0	1	28.80	23.50	0.81	45.20	40.60	0.92	49.80	1715.	213
CA13900165C			54.30	101.0	1	33.40	30.90	0.91	50.80	43.80	0.86	45.80	1715.	213
CA13900157W			51.30	89.00	1	28.40	25.50	0.90	45.10	37.90	0.85	40.70	1711.	213

Pod height was measured at the green pod stage and at harvest maturity. Pod height index was determined by dividing pod height at harvest maturity by the green pod height.
Plant height was measured at the green plant stage and at harvest maturity. Plant height index was determined by dividing plant height at harvest maturity by the green plant height at the green plant stag
Planting Date 05/13/2014. Harvest Date: 09/05/2014

Agronomic and Yield Data for the Large Kabuli Chickpea Observation Nursery (1485K)

Name	Leaf Type	Seed Type	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight	Seed Yield	% of Sierra
						..cm..	..cm..		..cm..	..cm..		..g..	kg/ha	
CA13900023C			49.00	99.00	1	33.40	33.30	0.99	56.10	42.80	0.79	55.60	1693.	211
CA13900089C			51.50	96.00	1	28.60	26.80	0.96	45.60	41.90	0.92	45.40	1692.	210
CA13900158C			54.30	102.0	1	27.70	27.80	1.00	52.10	37.20	0.71	44.80	1682.	209
CA13900037C			54.00	104.0	1	19.70	20.30	0.99	44.20	39.90	0.90	44.40	1676.	208
CA13900067C			51.00	104.0	1	29.30	25.80	0.88	47.70	43.80	0.92	48.50	1670.	208
CA13900123C			56.50	97.00	1	29.90	25.20	0.84	45.70	39.10	0.85	51.90	1663.	207
CA13900001C			56.00	94.00	1	26.70	23.90	0.90	46.20	41.70	0.90	47.90	1639.	204
CA13900170C			53.00	99.00	1	29.30	26.90	0.92	49.60	43.60	0.88	47.90	1639.	204
CA13900152C			51.80	94.00	1	27.80	24.40	0.88	49.60	46.10	0.93	50.40	1635.	203
CA13900088C			49.80	100.0	1	29.30	27.40	0.97	47.00	39.40	0.82	48.00	1610.	200
CA13900044C			54.50	93.00	1	25.40	24.30	0.96	49.60	38.40	0.78	45.70	1608.	200
CA13900146C			56.00	104.0	1	24.60	23.40	0.94	49.20	39.10	0.80	49.50	1601.	199
CA13900147C			55.30	96.00	1	30.70	23.80	0.77	51.20	42.60	0.84	54.60	1600.	199
CA13900079C			61.30	101.0	1	30.70	24.00	0.79	53.10	41.20	0.78	45.50	1592.	198
CA13900069C			51.00	106.0	1	31.40	26.70	0.85	50.60	45.60	0.90	60.60	1585.	197
CA13900083W			53.00	96.00	1	29.20	23.50	0.82	54.30	40.20	0.74	49.80	1580.	197
CA13900087C			49.00	104.0	1	27.20	22.40	0.79	46.30	39.40	0.91	52.40	1579.	196
CA13900163C			55.30	101.0	1	25.60	20.40	0.81	54.80	40.90	0.76	48.70	1577.	196
CA13900124C			54.30	91.00	1	23.70	21.50	0.91	42.30	38.10	0.90	35.30	1573.	196
CA13900090C			55.30	105.0	1	20.90	18.20	0.87	55.80	41.90	0.75	56.90	1571.	195
CA13900004C			52.30	94.00	1	26.10	24.50	0.94	45.70	40.90	0.89	44.80	1564.	194
CA13900066C			56.00	101.0	1	27.60	25.00	0.92	51.00	46.10	0.91	47.70	1559.	194
CA13900111C			52.30	103.0	1	29.40	26.40	0.90	47.20	43.20	0.92	40.60	1555.	193
CA13900112C			51.50	103.0	1	24.70	22.70	0.93	45.00	39.90	0.89	46.90	1552.	193
CA13900057C			48.30	98.00	1	28.60	25.20	0.88	54.10	44.40	0.82	51.40	1547.	192

Pod height was measured at the green pod stage and at harvest maturity. Pod height index was determined by dividing pod height at harvest maturity by the green pod height.
Plant height was measured at the green plant stage and at harvest maturity. Plant height index was determined by dividing plant height at harvest maturity by the green plant height at the green plant stag
Planting Date 05/13/2014. Harvest Date: 09/05/2014

Agronomic and Yield Data for the Large Kabuli Chickpea Observation Nursery (1485K)

Name	Leaf Type	Seed Type	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight	Seed Yield	% of Sierra
						..cm..	..cm..		..cm..	..cm..		..g..	kg/ha	
CA13900054C			47.00	101.0	1	23.40	19.00	0.82	48.10	39.30	0.82	49.50	1539.	191
CA13900026C			52.50	103.0	1	19.80	17.40	0.90	44.80	41.80	0.93	53.50	1538.	191
CA13900122C			54.80	96.00	1	23.10	19.70	0.87	48.00	38.90	0.81	49.90	1531.	190
CA13900130W			51.00	93.00	1	24.90	21.50	0.89	47.50	38.70	0.82	51.80	1528.	190
CA13900155C			53.80	104.0	1	31.70	19.80	0.62	54.00	48.80	0.92	56.70	1525.	190
CA13900024C			55.30	99.00	1	31.20	26.20	0.84	48.50	45.60	0.94	42.90	1519.	189
CA13900038C			51.50	97.00	1	28.40	17.90	0.65	50.10	37.40	0.76	51.80	1516.	189
CA13900121C			54.30	107.0	1	24.30	22.70	0.91	48.20	44.20	0.93	49.30	1510.	188
CA13900072W			55.50	101.0	1	26.10	24.50	0.95	46.10	39.40	0.86	50.80	1508.	188
CA13900110C			52.80	93.00	1	26.60	18.90	0.69	49.10	41.20	0.85	52.60	1494.	186
CA13900114C			56.00	101.0	1	25.70	26.20	1.01	53.50	45.30	0.85	46.60	1490.	185
CA13900084C			51.00	108.0	1	28.60	25.80	0.91	52.80	48.30	0.92	52.90	1482.	184
CA13900149C			58.80	101.0	1	30.20	26.70	0.88	52.00	42.80	0.83	54.20	1482.	184
CA13900047C			54.80	106.0	1	22.90	19.90	0.86	43.70	40.30	0.92	48.80	1479.	184
CA13900071W			53.50	92.00	1	29.80	24.20	0.81	45.80	40.80	0.91	45.50	1478.	184
CA13900141C			48.00	103.0	1	24.40	22.90	0.95	50.30	42.40	0.84	42.50	1452.	181
CA13900022C			54.00	92.00	1	20.20	15.90	0.83	42.30	38.70	0.90	52.50	1439.	179
CA13900003C			52.30	107.0	1	30.20	22.70	0.74	50.60	41.10	0.82	48.80	1413.	176
CA13900150C			53.80	104.0	1	25.90	23.20	0.90	44.70	37.90	0.86	53.80	1411.	175
CA13900172C			60.00	99.00	1	21.80	19.70	0.89	40.30	34.60	0.88	46.90	1407.	175
CA13900036C			56.00	101.0	1	29.60	25.20	0.85	47.30	44.60	0.94	51.60	1400.	174
CA13900056W			56.00	101.0	1	26.20	23.30	0.89	42.50	39.20	0.93	49.60	1396.	174
CA13900030C			54.30	101.0	1	29.20	25.50	0.86	52.00	38.70	0.75	48.00	1391.	173
CA13900073C			47.50	106.0	1	19.20	16.40	0.86	45.80	37.20	0.82	48.80	1367.	170
CA13900081C			50.00	100.0	1	23.20	20.00	0.86	49.20	46.30	0.94	46.90	1363.	169

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Planting Date 05/13/2014. Harvest Date: 09/05/2014

Agronomic and Yield Data for the Large Kabuli Chickpea Observation Nursery (1485K)

Name	Leaf Type	Seed Type	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight	Seed Yield	% of Sierra
						..cm..	..cm..		..cm..	..cm..		..g..	kg/ha	
CA13900161C			52.30	99.00	1	28.60	26.40	0.92	51.20	47.20	0.93	46.00	1346.	167
CA13900082C			53.30	102.0	1	28.90	26.00	0.90	46.10	39.20	0.86	53.00	1342.	167
CA13900029C			54.00	93.00	1	23.70	20.00	0.84	46.00	41.80	0.91	46.00	1338.	166
CA13900132C			49.30	96.00	1	25.70	20.90	0.82	47.60	35.90	0.75	56.20	1321.	164
CA13900025C			51.00	104.0	1	29.80	23.30	0.79	50.30	37.90	0.76	45.20	1314.	163
CA13900007C			49.00	99.00	1	23.60	21.00	0.88	44.60	38.70	0.87	48.00	1274.	158
CA13900005C			51.00	106.0	1	26.90	24.50	0.92	50.80	43.10	0.85	54.10	1272.	158
CA13900048C			54.30	96.00	1	29.80	26.80	0.92	52.00	35.90	0.69	47.70	1267.	158
CA13900164C			49.00	99.00	1	32.40	24.70	0.77	45.00	39.80	0.89	48.30	1234.	153
CA13900063C			54.00	98.00	1	24.90	20.50	0.83	47.70	39.60	0.83	41.50	1233.	153
CA13900060W			59.30	103.0	1	26.80	22.00	0.83	46.30	42.10	0.91	53.80	1217.	151
CA13900118C			56.80	98.00	1	22.70	21.00	0.90	43.70	38.20	0.88	50.80	1216.	151
CA13900059W			57.00	102.0	1	29.10	24.70	0.85	51.10	41.60	0.82	47.30	1201.	149
CA13900120C			51.00	98.00	1	25.20	23.50	0.93	52.80	39.80	0.75	51.50	1197.	149
CA13900127C			50.00	98.00	1	23.60	20.00	0.86	46.10	41.60	0.92	49.50	1172.	146
CA13900074C			55.00	105.0	1	32.40	29.20	0.90	54.50	49.20	0.91	51.00	1155.	144
CA13900128C			57.50	101.0	1	27.70	24.00	0.87	51.30	42.80	0.84	46.80	1135.	141
CA13900171C			52.50	104.0	1	25.60	23.40	0.91	48.50	37.70	0.78	46.60	1131.	141
CA13900035C			48.00	96.00	1	28.60	25.90	0.90	50.10	39.80	0.80	52.20	1123.	140
CA13900140C			59.30	103.0	1	28.40	24.50	0.86	48.50	38.80	0.80	54.10	1088.	135
CA13900064C			52.80	97.00	1	28.30	27.70	0.99	48.60	38.60	0.80	54.10	1038.	129
CA13900117W			53.00	105.0	1	25.40	23.20	0.90	52.10	43.20	0.83	51.70	1014.	126
CA13900143W			56.00	102.0	1	27.20	21.80	0.81	47.30	40.70	0.88	54.00	996.5	124
CA13900053C			53.30	107.0	1	24.90	22.90	0.91	50.60	41.30	0.83	50.00	934.7	116
CA13900167C			59.30	103.0	1	25.20	21.90	0.87	47.60	36.30	0.76	41.90	895.4	111

Pod height was measured at the green pod stage and at harvest maturity. Pod height index was determined by dividing pod height at harvest maturity by the green pod height.
Plant height was measured at the green plant stage and at harvest maturity. Plant height index was determined by dividing plant height at harvest maturity by the green plant height at the green plant stag
Planting Date 05/13/2014. Harvest Date: 09/05/2014

Agronomic and Yield Data for the Large Kabuli Chickpea Observation Nursery (1485K)

Name	Leaf Type	Seed Type	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight	Seed Yield	% of Sierra
						..cm..	..cm..		..cm..	..cm..		..g..	kg/ha	
CA13900050C			54.50	111.0	1	23.30	17.50	0.77	46.10	41.70	0.91	50.20	803.7	100
Sierra	S	C	49.80	104.0	1	27.90	23.00	0.83	53.50	43.00	0.82	53.90	802.5	100
CA13900153W			52.50	110.0	1	24.30	18.50	0.76	44.20	37.30	0.85	51.30	760.1	94
CA13900041C			54.00	111.0	1	24.60	17.40	0.73	44.20	38.90	0.89	43.60	678.8	84
CA13900043C			49.50	103.0	1	31.90	28.80	0.90	51.30	39.90	0.78	65.20	334.9	41
CA13900042C			56.50	106.0	1	20.80	19.20	0.90	44.70	41.80	0.93			
GRAND MEAN			53.69	99.83	1	26.79	23.12	0.87	48.43	41.22	0.86	48.65	1585.	
CV			6.48	4.85	1	12.82	14.91	8.68	7.30	8.26	7.19	10.01	22.58	

Pod height was measured at the green pod stage and at harvest maturity. Pod height index was determined by dividing pod height at harvest maturity by the green pod height.
Plant height was measured at the green plant stage and at harvest maturity. Plant height index was determined by dividing plant height at harvest maturity by the green plant height at the green plant stag
Planting Date 05/13/2014. Harvest Date: 09/05/2014

Agronomic and Yield Data for the Green Type Chickpea Observation Nursery (1485G)

Name	Leaf Type	Seed Type	Days to Flower	Days to Maturity	Pods/ Peduncle	Pod Height	Pod Ht Maturity	Pod Ht Index	Vine Length	Canopy Height	Plant Ht Index	100 Seed Weight	Seed Yield	% of Myles
						..cm..	..cm..		..cm..	..cm..		..g..	kg/ha	
CA13900095G			53.90	93.00	1	23.20	21.20	0.93	42.00	39.80	0.95	50.10	2576.	142
CA13900099G			53.20	95.00	1	21.40	17.20	0.81	39.00	37.40	0.97	37.60	1926.	106
Sierra	S	C	49.90	101.0	1	33.70	28.80	0.86	50.90	46.30	0.92	53.80	1811.	100
CA13900137G			53.20	94.00	1	20.70	17.00	0.83	44.00	39.40	0.90	37.10	1780.	98
CA13900091G			54.40	104.0	1	21.70	19.50	0.89	42.50	37.80	0.88	43.70	1702.	94
CA13900109G			53.70	100.0	1	20.90	22.00	1.03	40.70	36.80	0.91	39.30	1645.	90
CA13900106G			54.40	98.00	1	24.10	22.20	0.94	45.90	38.40	0.84	45.00	1536.	84
CA13900104G			49.90	96.00	1	22.90	21.70	0.96	37.10	32.70	0.88	34.60	1505.	83
CA13900107G			51.20	93.00	1	16.30	13.50	0.81	34.20	30.40	0.89	27.50	1390.	76
CA13900135G			49.40	102.0	1	21.90	15.10	0.68	35.40	34.90	0.98	40.50	1389.	76
CA13900103G			54.90	102.0	1	24.70	19.10	0.78	45.20	38.40	0.86	37.90	1350.	74
CA13900101G			49.20	99.00	1	23.60	13.60	0.60	41.00	35.70	0.87	32.30	1332.	73
CA13900102G			54.90	94.00	1	17.90	15.80	0.87	35.50	31.40	0.89	34.10	1291.	71
CA13900096G			51.40	106.0	1	18.40	14.10	0.76	43.90	34.10	0.79	28.10	1270.	70
CA13900092G			48.20	89.00	1	14.80	14.50	0.96	35.00	30.90	0.90	28.60	1174.	64
CA13900134G			53.20	92.00	1	25.10	20.70	0.84	44.70	34.20	0.76	39.50	1170.	64
CA13900136G			53.20	100.0	1	14.40	13.80	0.96	30.90	27.60	0.90	24.00	1065.	58
CA13900133G			50.70	101.0	1	15.10	10.60	0.72	32.90	29.30	0.89	21.60	1008.	55
CA13900105G			48.20	96.00	1	20.10	14.70	0.74	38.00	35.30	0.93	32.60	965.1	53
CA13900097G			51.40	105.0	1	21.30	18.20	0.88	36.70	33.60	0.91	25.80	912.9	50
CA13900093G			53.70	108.0	1	21.30	13.70	0.65	38.20	31.40	0.83	24.50	900.2	49
CA13900100G			49.90	101.0	1	12.30	11.30	0.90	33.00	29.30	0.90	30.80	835.2	46
CA13900098G			50.20	94.00	1	15.30	10.70	0.75	36.20	28.80	0.80	34.70	707.6	39
CA13900094G			50.70	90.00	1	23.60	19.30	0.82	35.00	33.30	0.95	38.50	682.2	37
CA13900108G			53.70	99.00	1	14.80	9.00	0.68	31.40	29.10	0.92	29.40	377.0	20
GRAND MEAN			51.87	98.14	1	20.39	16.69	0.83	38.76	34.25	0.89	34.87	1292.	
CV			4.07	5.08	1	22.26	26.97	13.05	12.98	12.62	5.93	22.66	35.66	

Pod height was measured at the green pod stage and at harvest maturity. Pod height index was determined by dividing pod height at harvest maturity by the green pod height.

Plant height was measured at the green plant stage and at harvest maturity. Plant height index was determined by dividing plant height at harvest maturity by the green plant height at the green plant stag

Planting Date 05/13/2014. Harvest Date: 09/05/2014