

Western Regional Cool Season Food
Legume Evaluation Trials
2015 Progress Report



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Introduction

The production of dry peas, lentils and chickpeas in Montana and North Dakota has increased considerably over the past 15-20 years. During 2011-2015 the average area of dry pea harvested in Montana and North Dakota was 362,650 acres per year, a 260 % increase over the average of 100,700 acres per year during 1998-2001⁽¹⁻²⁾. Similar trends are observed in changes in the area of lentils harvested in the Northern Great Plains. During 2011-2015 the average area harvested in Montana and North Dakota was 147,600 acres per year, a 182 % increase over the average of 52,300 acres per year during 1997-2000⁽¹⁻²⁾. However, compared to increases in the area of peas harvested over time, dry pea yields in Montana and North Dakota have decreased by over 1% per year since the mid 1980's⁽²⁾. Lentil yields in Montana and North Dakota have remained essentially unchanged, decreasing by less than 0.1% per year since the mid 1980's⁽²⁾. Although chickpeas in the USA are primarily grown in Washington and Idaho, their production is also increasing in Montana and North Dakota, which together accounted for approximately 23% of all chickpea production in the USA in 2015⁽¹⁾.

The varieties grown in Montana and North Dakota have been predominately developed in the US Pacific Northwest or Canada and likely are not ideally adapted for the Northern Great Plains. Varieties adapted to the Pacific Northwest often mature later in the Northern Great Plains and disease pressures from *Ascochyta*, *Mycosphaerella*, and *Stemphyllium* blight are typically more severe in the Northern Plains. Large genotype x environment interactions can be managed either by developing broadly adapted varieties or alternatively, varieties that are uniquely suited to specific target environments. Both approaches have limitations; rarely does the breeding process produce a variety that is ideally adapted across multiple environments, while breeding for very specific environments requires selection nurseries across many locations.

The Western Regional Cool Season Food Legume Trials serve as a venue for cooperation between the USDA-ARS, Montana State University, and North Dakota State University. The objective of these trials are to identify promising breeding lines and new varieties of cool season food legumes, which are then entered into state-wide trials conducted across several locations in Montana and North Dakota. This approach has led to the recent release of two new USDA-ARS varieties, the green pea "Hampton" and the Richlea-type lentil "Avondale", both of which have exhibited excellent performance in field trials in Montana and North Dakota.

In this report we summarize the results of the 2015 Western Regional Cool Season Food Legume Evaluation Trials, in which elite pea, lentil, and chickpea breeding lines and popular commercial varieties were evaluated at multiple locations in both Montana and North Dakota. Prior to planting, seed was treated with fungicides including fludioxinil and mefenoxam, and thiamethoxam insecticide as needed to control pea leaf weevil damage. Peas, lentils, and chickpeas were planted at densities of 8, 12, and 5 seeds per ft², respectively. Four replicated plots (5 x 20 ft) were planted for each entry at each location using a RCBD. Data were subjected to ANOVA to detect significant entry (genotype) effects and means comparisons between entries were performed using Fisher's Protected LSD. Field management practices, cropping histories, soil types, and climatic conditions varied considerably across locations. Additional

information on these variables can be found for each trial in Montana in the “2015 Montana Cool Season Spring Pulse Variety Evaluation Report (<http://agresearch.montana.edu/earc/reports-pdf/2015%20Montana%20Spring%20Pulse%20Evaluation%20Annual%20Report.pdf>).

Additional information on these variables can be found for each trial in North Dakota in the North Dakota State University Variety Trial Results webpage (<http://www.ag.ndsu.edu/varietytrials>).

Citations:

¹National Agricultural Statistics Service. 2015. www.nass.usda.gov.

² Vandemark, G., M. Brick, J. Osorno, J. Kelly and C. Urrea. 2014. Edible Grain Legumes. In; S. Smith, B. Diers, J. Specht, and B. Carver, eds. Yield Gains in Major U.S. Food Crops. CSSA Press, Madison, WI. P.87-123.

2015 Western Regional Cool Season Food Legume Evaluation Trials (Montana)

Peas:

In 2015, 18 pea entries were evaluated in Montana at Havre, Moccasin, and Richland. The entries included seven ARS green pea breeding lines, the green pea varieties CDC Striker, Majoret, Arcadia, and Hampton, three ARS yellow pea breeding lines and the yellow pea varieties Delta, DS Admiral, and CDC Treasure.

Yield was lowest at Moccasin (1358 lb/ac), followed by Richland (1722 lb/ac) and Havre (1964 lb/ac). Yield differences between entries at Moccasin were marginally significant ($F = 1.67$, $Prob = 0.08$). Yields at Moccasin ranged from 1100 lb/ac (Table 1, PS08100122) to 1602 lb/ac (PS05100840). The four highest yielding entries at Moccasin were ARS green pea breeding lines. The highest yielding green pea variety at Moccasin was CDC Striker (1410 lb/ac) and the highest yielding yellow pea variety was Delta (1404). 1000 seed weights at Moccasin were not significantly different between entries. Differences between entries for plant height at Moccasin were significant ($F = 2.81$, $Prob = 0.002$) and ranged from 46.0 cm (PS071000470) to 67.0 cm (PS08100950). Differences between entries at Moccasin for the number of days to flower were not significant.

Yield differences between entries at Richland were marginally significant ($F = 1.59$, $Prob = 0.10$). Yields at Richland ranged from 1461 lb/ac (Table 2, PS08100950) to 2035 lb/ac (Arcadia). The six highest yielding entries at Richland were all pea varieties, with the green pea varieties Arcadia and CDC-Striker having the highest yields. The highest yielding ARS breeding lines were the yellow pea lines PS0810004 and PS07100925, followed by the green pea lines PS08100133 and PS07100470. 1000 seed weights at Richland were significantly different ($F = 5.78$, $Prob < .0001$) and ranged from 625 g (Hampton) to 645 g (PS10100370). Differences between entries for plant height at Richland were significant ($F = 3.38$, $Prob = 0.003$) and ranged from 35.3 cm (PS0510-840) to 52.8 cm (Majoret and DS Admiral).

Yield differences between entries at Havre were significant ($F = 3.79$, $Prob < .0001$). Yields at Havre ranged from 1454 lb/ac (Table 3, CDC Striker) to 2304 lb/ac (PS08100122). The six highest yielding entries at Havre included five ARS breeding lines and the variety Arcadia. The two highest yielding entries were the ARS yellow pea breeding lines PS08100122 and PS08101004. The highest yielding ARS green pea breeding lines were PS10100370 and PS08100133. 1000 seed weights at Havre were significantly different ($F = 19.8$, $Prob < .0001$) and ranged from 603 g (PS07100470) to 627 g (CDC Treasure). Differences between entries for days to flower at Havre were significant ($F = 29.5$, $Prob < .0001$) and ranged from 61 d (PS08100122) to 66 d (Hampton).

Table 1. Means comparisons for yield and selected metric traits between pea entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Moccasin, MT.

Entry	Seed color	Yield (lb/ac)	1000 seed weight (g)	Plant height (cm)	Days to flower
PS05100840	Green	1602	642	56.8	78.5
PS03101445	Green	1595	638	47.0	78.5
PS08100582	Green	1532	644	56.8	78.0
PS08100133	Green	1509	638	57.0	78.0
CDC Striker	Green	1410	634	50.0	80.0
Delta	Yellow	1404	636	48.3	77.5
DS Admiral	Yellow	1363	641	55.3	77.8
PS08100950	Yellow	1354	643	67.0	77.3
PS07100925	Yellow	1344	643	53.3	77.8
Majoret	Green	1339	644	60.3	77.8
PS10100370	Green	1339	640	55.3	78.8
PS07100470	Green	1331	637	46.0	80.0
Arcadia	Green	1321	643	47.8	77.5
PS10100158	Green	1302	643	51.8	78.0
CDC Treasure	Yellow	1246	633	51.8	77.3
PS08101004	Yellow	1232	641	47.8	79.0
Hampton	Green	1131	638	51.3	77.8
PS08100122	Yellow	1100	644	54.8	79.0
Mean		1358	640	53.2	78.2
%CV		7.9	0.6	6.0	1.1
LSD (0.05)		304	1.1	9.0	2.3

¹Planted on 3/31/15 and harvested on 7/30/15. Yield is adjusted to 13% moisture.

Table 2. Means comparisons for yield and selected metric traits between pea entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Richland, MT.

Entry	Seed color	Yield (lb/ac)	1000 seed weight (g)	Plant height (cm)
Arcadia	Green	2035	634	45.5
CDC Striker	Green	2033	627	49.5
CDC Treasure	Yellow	2011	641	45.8
Majoret	Green	1960	631	52.8
DS Admiral	Yellow	1812	634	52.8
Delta	Yellow	1805	638	46.0
PS08101004	Yellow	1802	637	46.0
PS07100925	Yellow	1735	635	38.3
PS08100133	Green	1728	636	47.0
PS07100470	Green	1685	629	46.5
Hampton	Green	1653	625	47.3
PS10100370	Green	1651	645	45.0
PS10100158	Green	1606	630	43.5
PS03101445	Green	1565	632	41.8
PS05100840	Green	1509	624	35.3
PS08100582	Green	1472	630	39.5
PS08100122	Yellow	1467	642	37.5
PS08100950	Yellow	1461	642	35.8
Mean		1722	634	44.2
%CV		9.0	0.3	6.6
LSD (0.05)		439	7.0	8.1

¹Planted on 4/21/15 and harvested on 7/30/15. Yield is adjusted to 13% moisture.

Table 3. Means comparisons for yield and selected metric traits between pea entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Havre, MT.

Entry	Seed color	Yield (lb/ac)	1000 seed weight (g)	Days to flower
PS08100122	Yellow	2304	616	61.3
PS08101004	Yellow	2232	615	63.8
Arcadia	Green	2170	611	63.8
PS10100370	Green	2108	616	63.5
PS07100925	Yellow	2086	613	62.8
PS08100133	Green	2080	607	63.3
PS10100158	Green	2034	605	64.0
DS Admiral	Yellow	1962	611	63.5
PS07100470	Green	1955	603	65.0
Majoret	Green	1937	608	64.2
PS05100840	Green	1931	611	65.8
PS08100582	Green	1887	610	63.8
PS08100950	Yellow	1885	627	65.5
CDC Treasure	Yellow	1877	624	63.3
Hampton	Green	1835	611	66.3
PS03101445	Green	1820	613	62.0
Delta	Yellow	1807	620	61.8
CDC Striker	Green	1454	622	65.5
Mean		1964	613	63.8
%CV		5.0	0.2	0.4
LSD (0.05)		280	4.1	0.7

¹Planted on 4/9/15 and harvested on 8/4/15. Yield is adjusted to 13% moisture.

Lentils:

In 2015, 13 lentil entries were evaluated in Montana at Havre and Moccasin. The entries included nine ARS breeding lines and the varieties CDC Richlea, CDC Viceroy, CDC Redcoat, and Avondale. The mean yield of all entries was greater at Havre (930 lb/ac) than Moccasin (734 lb/ac). Differences between entries for yield at Moccasin were significant ($F = 2.36$, $Prob = 0.02$). Yields at Moccasin ranged from 521 lb/ac (Table 4, LC01602273E) to 1098 lb/ac (CDC Richlea). The three highest yielding entries at Moccasin were the varieties CDC Richlea, CDC Viceroy, and CDC Redcoat. The highest yielding ARS breeding lines were LC01600994P (Pardina type), LC01602062T (red cotyledon), and LC06601734L (Laird type). 1000 seed weights at Moccasin were significantly different ($F = 397.8$, $Prob < .0001$). Three Laird type ARS breeding lines (LC09600410L, LC11600380L, and LC06601734L) had 1000 seed weights greater than 700 g. The variety with the lowest 1000 seed weight was CDC Viceroy (325 g) and the highest was CDC Richlea (533 g). Differences between entries at Moccasin for plant height and number of days to flower were not significant.

At Havre, significant differences ($F = 5.68$, $Prob < .0001$) in yield were detected between entries. Yields ranged from 684 lb/ac (Table 5, LC01602062T) to 1191 lb/ac (CDC Richlea). The highest yielding ARS breeding lines were two large seeded Laird types, LC11600380L and LC06601734L. 1000 seed weights at Havre were significantly different ($F = 400.9$, $Prob < .0001$). Similar to results observed for Moccasin, three Laird type ARS breeding lines (LC09600410L, LC11600380L, and LC06601734L) had the highest 1000 seed weights. The lowest 1000 seed weight was CDC Viceroy (246 g) and the highest was LC09600410L (612 g). Differences between lentil entries at Havre for plant height were not significant.

Table 4. Means comparisons for yield and selected metric traits between lentil entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Richland, MT.

	Market class	Yield (lb/ac)	1000 seed weight (g)	Plant height (cm)	Days to flower
CDC Richlea	Richlea	1098	53.3	32.8	79.0
CDC Viceroy	Eston	975	32.5	32.0	79.8
CDC Redcoat	Red	870	39.1	29.5	79.3
LC10600994P	Pardina	777	42.3	28.5	81.3
LC01602062T	Red	759	45.6	34.3	80.0
LC08600113P	Pardina	683	47.1	32.5	78.8
LC06601734L	Laird	680	72.8	30.0	81.0
Avondale	Richlea	679	50.6	29.3	79.0
LC08600116P	Pardina	656	51.6	31.8	79.3
LC10600231P	Pardina	634	41.5	30.3	80.8
LC11600380L	Laird	604	73.7	31.5	81.3
LC09600410L	Laird	603	76.2	33.0	79.8
LC01602273E	Eston	521	38.9		79.5
Mean		734	51.5	31.1	79.9
%CV		14.4	1.4	7.6	1.1
LSD (0.05)		302	2.0	6.8	2.6

¹Planted on 4/22/15 and harvested on 9/18/15. Yield is adjusted to 13% moisture.

Table 5. Means comparisons for yield and selected metric traits between lentil entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Havre, MT.

	Market class	Yield (lb/ac)	1000 seed weight (g)	Plant height (cm)
CDC Richlea	Richlea	1191	40.3	27.9
CDC Viceroy	Eston	1000	24.6	30.3
LC11600380L	Laird	983	58.2	33.5
LC06601734L	Laird	980	60.9	28.0
CDC Redcoat	Red	976	29.2	27.7
LC1060494P	Pardina	956	34.7	28.4
LC08600113P	Pardina	953	35.3	26.2
LC08600116P	Pardina	947	39.8	27.8
LC09600410L	Laird	945	61.2	28.6
Avondale	Richlea	882	42.1	29.4
LC01602273E	Eston	776	30.1	26.4
LC01602062T	Red	775	35.7	29.6
LC01600231T	Red	684	34.8	23.7
Mean		930	40.5	28.3
%CV		5.6	1.5	7.4
LSD (0.05)		150	17	6.0

¹Planted on 4/8/15 and harvested on 7/14/15. Yield is adjusted to 13% moisture.

Chickpeas:

In 2015, 13 chickpea entries were evaluated in Montana at Moccasin and Richland. The entries included ten ARS breeding lines and the varieties CDC Frontier, Sierra, and Myles. The mean yields of all entries were similar at Richland (1178 lb/ac) and Moccasin (1122 lb/ac).

Differences between entries for yield at Moccasin were significant ($F = 4.27$, $Prob = 0.0001$). Yields at Moccasin ranged from 847 lb/ac (Table 6, Myles) to 1329 lb/ac (CA0790B0549C). All 10 ARS breeding lines had yields at least equal to Sierra. Five ARS lines, CA0790B0549C, CA0790B0043C, CA0790B0547C, CA0790B0733C, and CA0890B0531C had significantly greater yields than Sierra and produced seed similar in size to Sierra. 1000 seed weights at Moccasin were significantly different ($F = 447.8$, $Prob < .0001$). Myles had the lowest 1000 seed weight (174 g) and both CA0790B0043C and CA0790B0054C the highest (508 g). Differences between entries at Moccasin for plant height were significant ($F = 6.74$, $Prob < .0001$) and ranged from approximately 35 cm (Myles) to 46 cm (CA0790B0043C). No significant differences between entries for days to flower were detected at Moccasin.

Differences between chickpea entries for yield at Richland were significant ($F = 3.76$, $Prob = 0.0009$). Yields at Richland ranged from 543 lb/ac (Table 7, Myles) to 1583 lb/ac (CDC Frontier). Similar to results observed for Moccasin, all 10 ARS breeding lines had yields at least equal to Sierra. Two ARS lines, CA0790B0733C and CA0790B0043C, had significantly greater yields than Sierra and produced seed similar in size to Sierra. 1000 seed weights at Richland were significantly different ($F = 28.4$, $Prob < .0001$). Myles had the lowest 1000 seed weight (182 g) and CA0790B0429C the highest (578 g). Differences between entries for plant height at Richland were significant ($F = 5.36$, $Prob < .0001$) and ranged from approximately 30 cm (Myles) to 39 cm (CA0790B0043C).

Table 6. Means comparisons for yield and selected metric traits between chickpea entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Moccasin, MT.

Entry	Yield (lb/ac)	1000 seed weight (g)	Plant height (cm)	Days to flower
CA0790B0549C	1329	454	40.3	74.0
CA0790B0043C	1265	508	46.0	66.2
CA0790B0547C	1250	487	38.0	74.3
CA0790B0733C	1209	468	39.0	73.5
CDC Frontier	1195	359	37.3	75.0
CA0890B0531C	1192	480	40.3	71.5
CA0890B0429C	1096	507	42.5	71.5
CA0790B0042C	1089	474	42.5	72.5
CA0790B0642C	1057	492	39.5	73.0
CA0790B0054C	1041	508	44.8	68.5
CA0890B0551C	1028	497	36.5	72.0
Sierra	993	482	41.3	74.0
Myles	847	174	35.0	70.0
Mean	1122	453	40.2	72.0
%CV	5.7	0.9	3.0	4.4
LSD (0.05)	184	13.0	3.5	9.1

¹Planted on 4/9/15 and harvested on 8/7/15. Yield is adjusted to 13% moisture.

Table 7. Means comparisons for yield and selected metric traits between chickpea entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Richland, MT.

Entry	Yield (lb/ac)	1000 seed weight (g)	Plant height (cm)
CDC Frontier	1583	410	35.5
CA0790B0733C	1473	516	35.0
CA0790B0043C	1414	529	38.5
CA0790B0547C	1249	515	32.5
CA0790B0549C	1239	474	31.5
CA0790B0042C	1157	483	34.3
CA0890B0551C	1133	549	31.8
CA0790B0054C	1109	563	37.0
CA0790B0642C	1087	551	35.5
CA0890B0531C	1085	571	35.0
CA0890B0429C	1057	578	37.5
Sierra	1029	526	33.8
Myles	543	182	30.3
Mean	1178	502	34.5
%CV	10.4	3.5	3.2
LSD (0.05)	351	51	3.0

¹Planted on 4/22/15 and harvested on 9/11/15. Yield is adjusted to 13% moisture.

2015 Western Regional Cool Season Food Legume Evaluation Trials (North Dakota)

Peas:

In 2015, 17 pea entries were evaluated in North Dakota at Hettinger, Minot, and Williston. The entries included seven ARS green pea breeding lines, the green pea varieties CDC Striker, Cruiser, Hampton, and Majoret, three ARS yellow pea breeding lines and the yellow pea varieties Agassiz, CDC Meadow, and DS Admiral.

Mean yield across all entries was lowest at Williston (2373 lb/ac), followed by Minot (2915 lb/ac) and Hettinger (3281 lb/ac). Yields at Williston ranged from 1892 lb/ac (Table 8, Cruiser) to 2763 lb/ac (CDC Meadow). After CDC Meadow the three highest yielding entries were two yellow ARS breeding lines (PS08101022 and PS08101004) and a green ARS breeding line (PS10100158). The highest yielding green pea variety was Hampton (2538 lb/ac). 1000 seed weights at Williston ranged from 229 g (PS10100158) to 317 g (PS08100950). Seed protein content at Williston averaged 25.3 % and ranged from 23.7% (PS10100158) to 28.9 % (PS05100840). Pea entries at Williston on average flowered in approximately 58 d and ranged from 54 d (PS08101022) to 60 d (several entries).

Yields at Minot ranged from 2566 lb/ac (Table 9, PS10100370) to 3294 lb/ac (Agassiz). The six highest yielding entries were varieties. CDC Striker was the highest yielding green variety. The highest yielding ARS breeding lines were the green line PS10100158 followed by the yellow line PS08101022. 1000 seed weights at Minot ranged from 191 g (PS03101445) to 281 g (PS08100950). Seed protein content at Minot averaged 26.7 % and ranged from 25.7% (DS Admiral) to 28.3 % (PS05100840). Pea entries at Minot on average flowered in approximately 51 d and ranged from 50 d (several entries) to 63 d (several entries).

Yields at Hettinger ranged from 2867 lb/ac (Table 10, PS10100370) to 3719 lb/ac (CDC Meadow). Hampton was the highest yielding green variety. The highest yielding ARS breeding lines were the green line PS10100158 followed by the green line PS08100133. PS08101022 was the highest yielding ARS yellow line. 1000 seed weights at Hettinger ranged from 180 g (PS10100158) to 256 g (PS08100925). Seed protein content at Hettinger averaged 25.8 % and ranged from 24.9% (CDC Meadow) to 28.1 % (PS05100840). Pea entries at Hettinger on average flowered in approximately 69 d and ranged from 68 d (several entries) to 71 d (several entries).

Table 8. Means comparisons for yield and selected metric traits between pea entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Williston, ND.

	Market Class	Yield (lb/ac)	1000 seed weight (g)	% seed protein	Days to flower
CDC Meadow	Yellow	2763	237	24.9	60
PS08101022	Yellow	2664	261	24.0	54
PS08101004	Yellow	2652	267	25.2	58
PS10100158	Green	2578	229	23.7	60
DS Admiral	Yellow	2578	274	25.5	59
Hampton	Green	2538	259	23.4	60
PS05100840	Green	2475	258	28.9	60
Agassiz	Yellow	2466	280	25.0	59
PS08100925	Yellow	2363	264	26.0	57
PS08100582	Green	2359	260	24.7	60
PS03101445	Green	2288	239	24.9	57
PS08100950	Yellow	2189	317	26.3	59
PS08100133	Green	2184	260	25.4	57
CDC Striker	Green	2169	241	25.3	58
Majoret	Green	2143	259	27.2	60
PS10100370	Green	2076	266	24.4	57
Cruiser	Green	1892	251	26.1	59
Mean		2374	260	25.3	58.4
%CV			6.5	3.1	1.8
LSD (o.05)			24.2	1.1	1.5

¹Planted on 4/23/15 and harvested on 7/29/15. Yield is adjusted to 13.5 % moisture.

Table 9. Means comparisons for yield and selected metric traits between pea entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Minot, ND.

Entry	Market class	Yield (lb /ac)	1000 seed weight (g)	% seed protein	Days until flower
Agassiz	Yellow	3294	233	27.3	50
DS Admiral	Yellow	3250	226	25.7	50
CDC Striker	Green	3244	202	26.2	50
Cruiser	Green	3160	202	26.9	50
CDC Meadow	Yellow	3154	195	25.9	50
Majoret	Green	3117	225	27.3	50
PS10100158	Green	3110	194	27.3	51
Hampton	Green	3056	212	26.2	53
PS08101022	Yellow	2820	242	27.2	50
PS08100133	Green	2811	233	26.9	50
PS08101004	Yellow	2738	240	27.2	51
PS03101445	Green	2685	191	25.7	50
PS08100582	Green	2667	220	26.8	51
PS08100925	Yellow	2633	263	26.4	50
PS08100950	Yellow	2631	281	27.4	53
PS05100840	Green	2615	235	28.3	53
PS10100370	Green	2566	231	26.1	50
Mean		2915	225	26.7	51
%CV		8.9	2.7	1.9	0.9
LSD (0.05)		308	7	0.6	1

¹Planted on 5/10/15 and harvested on 8/25/15. Yield is adjusted to 13.5% moisture.

Table 10. Means comparisons for yield and selected metric traits between pea entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Hettinger, ND.

Entry	Market class	Yield (lb /ac)	1000 seed weight (g)	% seed protein	Days until flower
CDC Meadow	Yellow	3719	201	24.9	69
DS Admiral	Yellow	3581	219	25.4	69
PS10100158	Green	3506	180	26.5	69
Agassiz	Yellow	3464	222	25.2	71
Hampton	Green	3458	208	25.6	71
CDC Striker	Green	3422	205	25.4	68
PS08100133	Green	3369	208	26.6	70
PS08101022	Yellow	3345	246	25.6	67
PS08100950	Yellow	3260	271	25.9	71
PS08101004	Yellow	3210	238	26.0	69
PS08100925	Yellow	3194	256	25.5	68
PS03101445	Green	3167	210	24.9	69
PS05100840	Green	3162	234	28.1	70
PS08100582	Green	3077	209	26.4	70
Cruiser	Green	3042	193	25.4	70
Majoret	Green	2942	227	26.3	69
PS10100370	Green	2867	225	25.7	70
Mean		3281	221	25.8	69
%CV		7.7	3.4	1.4	0.6
LSD (0.05)		299	9	0.4	0.5

¹Planted on 4/15/15 and harvested on 8/3/15. Yield is adjusted to 13.5% moisture.

Lentils:

In 2015, 30 lentil entries were evaluated in North Dakota at Carrington, Hettinger, and Williston. The entries included 12 breeding lines from the USDA-ARS and NDSU and 18 varieties.

Mean yield across all entries was lowest at Williston (1533 lb/ac), followed by Carrington (1656 lb/ac) and Hettinger (2687 lb/ac). Yields at Williston ranged from 1170 lb/ac (Table 11, NDL080187L, Laird type) to 1869 lb/ac (LC10600494P, Pardina type). Among the top 10 yielding entries at Williston were seven varieties, two ARS Pardina breeding lines (LC10600494P and LC10600231P), and one Eston type line (LC07ND055E). The lowest yielding variety was CDC Greenland (1305 lb/ac) and the highest yielding variety was CDC Rosetown (1798 lb/ac). 1000 seed weights at Williston ranged from 28.0 g (CDC Rosetown) to 72.0 g (LC09600410L). Lentil seed protein content at Williston averaged 25.9 % and ranged from 22.8% (CDC Rouleau) to 28.4 % (CDC Rosetown). Lentil entries at Williston on average flowered in approximately 60 d and ranged from 58 d (several entries) to 64 d (LC11600380L).

Yields at Carrington ranged from 780 lb/ac (Table 12, Morena) to 2544 lb/ac (LC01602273E, Eston type). Among the top 10 yielding entries at Carrington were seven varieties, one ARS Pardina breeding line (LC08600116P), one Laird type breeding line (LC09600410L), and one Eston type line (LC07ND055E). The lowest yielding variety was Pennell (1245 lb/ac) and the highest yielding variety was CDC Redberry (2150 lb/ac). 1000 seed weights at Carrington ranged from 25.8 g (CDC Rosetown) to 68.4 g (LC09600410L). Lentil seed protein content at Carrington averaged 26.5% and ranged from 24.5% (Pardina) to 28.2% (Merritt). Lentil entries at Carrington on average flowered in approximately 55 d and ranged from 53 d (several entries) to 59 d (Crimson and CDC Lemay).

Yields at Hettinger ranged from 2075 lb/ac (Table 13, LC11600680L, Laird type) to 3409 lb/ac (LC07ND055E, Eston type). Among the top 10 yielding entries at Hettinger were seven varieties and three breeding lines, including the Eston type LC10602273E and the Pardina type LC08600116P. The lowest yielding variety was Morena (2213 lb/ac) and the highest yielding variety was CDC Redberry (3295 lb/ac). 1000 seed weights at Hettinger ranged from 27 g (CDC Rosetown) to 64 g (LC09600410L). Lentil seed protein content at Hettinger averaged 25.0% and ranged from 23.4% (Avondale) to 27.0% (CDC Viceroy). Lentil entries at Hettinger on average flowered in approximately 69 d, with all entries flowering within 68-69 d.

Table 11. Means comparisons for yield and selected metric traits between lentils entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Williston, ND.

Entry	Market class	Yield (lb/ac)	1000 seed weight (g)	% seed protein	Days to flower
LC10600494P	Pardina	1869	41	25.2	63
CDC Richlea	Richlea	1798	47	25.7	59
LC07ND055E	Eston	1782	37	25.8	62
Pardina	Pardina	1759	39	23.8	60
Essex	Eston	1757	44	25.9	60
Eston	Eston	1745	36	26.7	60
Avondale	Richlea	1730	49	25.0	59
CDC Red Rider	Red	1631	43	25.7	62
CDC Redcoat	Red	1620	39	24.1	58
LC10600231P	Pardina	1609	43	24.4	60
Pennell	Laird	1595	61	26.9	58
NDL090347T	Red	1583	37	23.8	60
CDC Rouleau	Red	1563	39	22.8	61
CDC Lemay	French Green	1561	31	25.8	59
LC09600410L	Laird	1554	72	27.2	62
LC08600113P	Pardina	1550	52	23.5	61
Crimson	Red	1538	35	26.3	58
Morena	Pardina	1536	40	25.1	61
LC08600113P	Pardina	1534	48	23.4	60
CDC Viceroy	Eston	1533	31	28.0	59
CDC Redberry	Red	1501	42	26.2	60
CDC Rosetown	Red	1478	28	28.4	61
LC06601734L	Laird	1452	67	27.1	62
Riveland	Laird	1368	68	26.8	62
LC01602273E	Eston	1348	36	26.6	61
CDC Greenland	Laird	1305	60	27.4	62
NDL090204R	Red	1254	64	27.6	62
Merrit	Laird	1219	66	27.6	62
NDL080187L	Laird	1170	67	27.6	59
LC11600380L	Laird	1043	66	27.1	64
Mean		1533	47.6	25.9	60.4
%CV		10.0	2.6	1.8	2.9
LSD (0.05)		215	1.7	0.7	2.4

¹Planted on 4/29/15 and harvested on 8/18/15. Yield is adjusted to 13.5% moisture.

Table 12. Means comparisons for yield and selected metric traits between lentil entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Carrington, ND.

Entry	Market class	Yield (lb/ac)	1000 seed weight (g)	% seed protein	Days to flower
LC01602273E	Eston	2544	37.3	25.9	55.3
LC07ND055E	Eston	2483	32.5	26.7	53.8
LC08600113P	Pardina	2283	38.0	25.4	55.3
LC09600410L	Laird	2151	68.4	27.1	53.3
CDC Redberry	Red	2150	34.7	27.5	57.0
Eston	Eston	2106	29.1	27.1	53.0
Avondale	Richlea	2088	41.8	25.1	54.0
CDC Greenland	Laird	1941	54.5	26.9	56.3
Riveland	Laird	1807	61.0	26.5	54.0
Merrit	Laird	1732	51.1	28.2	53.0
CDC Viceroy	Eston	1721	27.5	28.1	57.5
LC10600231P	Pardina	1694	36.9	25.6	53.8
CDC Rosetown	Red	1658	25.8	27.0	57.0
Pardina	Pardina	1638	33.1	25.8	53.5
CDC Lemay	French Green	1604	28.6	25.4	59.0
CDC Red Rider	Red	1597	36.5	27.4	55.8
CDC Richlea	Richlea	1591	38.3	26.0	56.3
NDL090347T	Red	1579	30.2	24.5	53.0
CDC Redcoat	Red	1562	31.5	25.6	58.5
LC08600113P	Pardina	1552	34.8	27.2	55.3
NDL080187L	Laird	1470	54.5	26.0	55.0
CDC Rouleau	Red	1434	29.8	25.9	56.0
LC10600494P	Pardina	1371	32.2	26.2	54.8
NDL090204R	Red	1335	52.8	27.4	53.3
Crimson	Red	1321	30.9	27.0	59.0
Pennell	Laird	1245	48.8	27.2	55.3
Essex	Eston	1225	35.1	25.2	57.8
LC06601734L	Laird	1189	54.6	26.7	54.3
LC11600380L	Laird	1058	55.3	26.6	55.5
Morena	Pardina	780	31.9	27.0	54.0
Mean		1656	39.9	26.5	55.3
%CV		22.5	4.8	2.0	1.8
LSD (0.05)		524	2.7	0.7	1.4

¹Planted on 4/22/15 and harvested on 8/10/15. Yield is adjusted to 13.5% moisture.

Table 13. Means comparisons for yield and selected metric traits between lentils entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Hettinger, ND.

Entry	Market class	Yield (lb/ac)	1000 seed weight (g)	% seed protein	Days to flower
LC07ND055E	Eston	3409	35	25.9	69
CDC Redberry	Red	3295	39	26.6	68
LC08600116P	Pardina	3266	49	23.5	68
CDC Rouleau	Red	3154	35	23.7	69
LC10602273E	Eston	3085	36	25.5	68
CDC Redcoat	Red	3057	38	24.5	69
CDC Lemay	French	3005	32	24.7	69
CDC Red Rider	Green	2974	42	24.5	69
CDC Viceroy	Red	2951	31	27.0	69
Avondale	Eston	2844	44	23.4	68
CDC Greenland	Richlea	2823	50	24.9	69
Eston	Laird	2823	32	26.3	69
CDC Richlea	Eston	2804	44	24.8	69
LC08600113P	Richlea	2786	43	24.2	68
CDC Rosetown	Pardina	2768	27	25.5	69
NDL090347T	Red	2633	35	23.3	68
Crimson	Red	2534	34	25.2	68
Pennell	Red	2527	51	25.7	69
NDL080187L	Laird	2516	55	24.5	69
Pardina	Pardina	2499	36	23.6	69
LC10600231P	Pardina	2452	40	23.9	69
Merrit	Laird	2407	58	26.7	68
LC09600410L	Laird	2401	64	25.7	68
Essex	Eston	2388	41	24.6	68
Riveland	Laird	2374	57	25.0	68
LC06601734L	Laird	2281	53	25.1	69
Morena	Pardina	2213	38	25.3	69
LC10600494P	Pardina	2149	38	25.8	69
NDL090204R	Richlea	2116	57	25.6	69
LC11600380L	Laird	2075	59	25.5	69
Mean		2687	43	25.0	68.5
%CV		7.0	4.7	1.8	0.5
LSD (0.05)		221	2	0.5	0.4

¹Planted on 4/15/15 and harvested on 8/5/15. Yield is adjusted to 13.5% moisture.

Chickpeas:

In 2015, 22 chickpea entries were evaluated in North Dakota at Hettinger and Williston. The entries comprised ten ARS breeding lines, other breeding lines and several varieties including Sierra, CDC Alma, CDC Orion, CDC Frontier, CDC Xena, CDC Luna, CDC Anna, and Sawyer. The mean yield of all entries at Williston (1801 lb/ac) was less than half of the mean yield of entries at Hettinger (3858 lb/ac). Yields at Williston ranged from 1280 lb/ac (Table 14, BGC090024) to 2243 lb/ac (CDC Alma). The top 10 yielding entries at Williston included five varieties and five ARS breeding lines. The lowest yielding variety was Sierra (1527 lb/ac). 1000 seed weights at Williston ranged from 255 g (B-90) to 576 g (CA0890B0429C). Three ARS breeding lines (CA0790B0042C, CA0790B0043C, and CA0890B0551C) had significantly greater yields than Sierra and also produced seed that was at least as large as Sierra. Entries flowered in approximately 54 d in Williston, and ranged from 53 d (CDC Anna and CDC Orion) to 59 d (B-90).

Yields at Hettinger ranged from 2606 lb/ac (Table 15, CA0890B0531C) to 4555 lb/ac (CA0790B0547C). The top 10 yielding entries at Hettinger included five ARS breeding lines. The lowest yielding variety was CDC Frontier (2688 lb/ac) and the highest yielding variety was Sierra (4192 lb/ac). 1000 seed weights at Hettinger ranged from 255 g (B-90) to 576 g (CA0890B0429C). Three ARS breeding lines (CA0790B0043C, CA0790B0547C and CA0790B0549C) had yields that were at least equal to Sierra and produced a percent of seed greater than 10 mm diameter that was not significantly different than Sierra. Entries flowered in approximately 70 d in Hettinger, with all entries flowering in between 69-71 d.

Table 14. Means comparisons for yield and selected metric traits between chickpea entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Williston, ND.

Entry	Yield (lb/ac)	1000 seed weight (g)	% seed 9-10 mm	Days to flower
CDC Alma	2243	404	9	55
CA0790B0733C	2169	497	42	54
CDC Anna	2113	206	0	53
CDC Frontier	2094	374	3	55
CA0890B0531C	1977	564	47	53
CA0790B0042C	1974	500	46	54
CA0790B0547C	1954	498	27	55
CDC Orion	1951	443	29	53
CA0790B0043C	1890	550	47	54
CDC Luna	1879	406	15	54
CA0790B0054C	1788	564	53	56
CA0890B0429C	1777	576	56	54
Sawyer	1758	451	27	54
B-90	1739	255	0	59
CA0790B0549C	1656	453	29	57
BGC090018	1586	429	26	55
Sierra	1527	499	45	55
BGC090017	1523	412	23	54
CA0890B0551C	1474	543	45	54
CA0790B0642C	1446	507	41	54
BGC090024	1280	426	30	55
Mean	1801	455	30.4	54.4
%CV	10.1	3.6	13.7	2.6
LSD (0.05)	258	23	5.9	2.0

¹Planted on 5/1/15 and harvested on 9/15/15. Yield is adjusted to 13.5% moisture.

Table 15. Means comparisons for yield and selected metric traits between chickpea entries tested in 2015 Western Regional Cool Season Food Legume Evaluation Trials¹ at Hettinger, ND.

Entry	Yield (lb/ac)	% seed 9-10 mm	% seed > 10mm	Days to flower
CA0790B0547C	4555	35	32	70
CA0790B0549C	4526	32	22	69
BGC090024	4363	19	34	70
CA0790B0043C	4358	35	43	69
BGC090018	4288	19	14	70
CA0890B0551C	4230	32	19	70
Sierra	4192	27	47	70
CDC Alma	4164	33	26	70
CA0790B0054C	4146	29	37	70
CDC Orion	4112	33	37	70
CA0890B0429C	4043	41	37	69
CA0790B0042C	4030	37	21	70
CA0790B0733C	3885	37	39	69
CDC Anna	3763	34	48	70
Sawyer	3757	26	38	70
CA0790B0642C	3675	29	29	70
BGC090017	3599	23	44	70
CDC Xena	3555	32	48	69
B-90	3192	25	27	70
CDC Luna	3156	32	40	70
CDC Frontier	2688	31	52	71
CA0890B0531C	2606	33	46	70
Mean	3858	31	35	70
%CV	22.2	37.0	66.0	1.0
LSD (0.05)	1011	13	28	1

¹Planted on 5/8/15 and harvested on 9/16/15. Yield is adjusted to 13% moisture.

Multi-year analysis of Western Regional Cool Season Food Legume Evaluation Trials

The primary functions of these field trials are to evaluate ARS breeding lines of peas, lentils, and chickpeas in selected environments in Montana and North Dakota and identify promising breeding lines that should be considered for entry in 'statewide' evaluation trials. Given the preliminary nature of the Western Regional trials relative to statewide cool season food legume trials conducted in Montana and North Dakota, breeding lines should only be evaluated across a few location-years before being either dropped or advanced to statewide trials. It may be possible to identify exceptional breeding lines based on a minimum of two environments, and decisions regarding the suitability of ARS breeding lines for statewide trials can generally be made after two years of trials in at least two environments. Below we present a two-year analysis of head to head comparisons between check varieties and ARS breeding lines of peas, lentils, and chickpeas.

Peas:

Available head to head comparisons over two years among pea entries are presented for Montana (Table 16) and North Dakota (Table 17). For Montana, six entries can be compared over two years, 2014 and 2015, at Moccasin and Richland. The entries include the yellow variety Delta, two yellow ARS breeding lines, PS08101004 and PS07100925, and three green ARS breeding lines, PS05100840, PS08100582, and PS03101445. The location mean for yield among the six entries was much higher at Moccasin than Richland but the mean among all entries for 1000 seed weights were identical between the two locations (Table 16). The highest yielding entry over both years at Moccasin was Delta (2018 lb/ac), followed by three ARS green pea breeding lines (PS05100840, PS08100582, and PS03101445). At Richland the yellow breeding line PS08101004 had the highest yield (1472 lb/ac) over both years followed by Delta and the green breeding line PS05100840.

For North Dakota, nine entries can be compared over two years, 2014 and 2015, at Hettinger, Minot, and Williston. The entries include three yellow pea varieties, Agassiz, CDC Meadow, and DS Admiral, the green pea variety CDC Striker, four green pea breeding lines (PS03101445, PS05100840, PS08100133, and PS08100582), and the yellow pea breeding line PS08101004. The location mean for yield among the nine entries was highest at Hettinger followed by Minot and Williston (Table 17). At Hettinger and Minot the highest yielding entry was the yellow variety Agassiz, while at Williston the highest yielding entry was the yellow breeding line PS08101004. The highest yielding green pea breeding line at Hettinger and Minot was PS08100133, while at Williston the highest yielding breeding line was PS05100840.

Table 16. Performance summary of pea entries¹ tested for two years (2014-2015) at Western Regional Cool Season Food Legume Evaluation Trials in Montana.

Entry	Moccasin		Richland		Both Locations	
	Yield (lb/ac)	1000 seed weight (g)	Yield (lb/ac)	1000 seed weight (g)	Yield (lb/ac)	1000 seed weight (g)
Delta ^Y	2018	239	1371	230	1695	235
PS08101004 ^Y	1826	234	1472	240	1649	237
PS07100925 ^Y	1733	245	1247	246	1490	246
PS05100840 ^G	1962	229	1253	237	1608	233
PS08100582 ^G	1942	219	1157	224	1550	228
PS03101445 ^G	1879	229	1177	220	1528	225
Location Mean	1893	233	1280	233		

¹Market Classes. Y = Yellow, G = Green

Table 17. Performance summary of pea entries¹ tested for two years (2014-2015) at Western Regional Cool Season Food Legume Evaluation Trials in North Dakota.

Entry	Hettinger		Minot		Williston	All locations
	Yield (lb/ac)	1000 seed weight (g)	Yield (lb/ac)	1000 seed weight (g)	Yield (lb/ac)	Yield (lb/ac)
Agassiz ^Y	3444	223	3181	237	2589	3071
CDC Meadow ^Y	3410	195	3133	207	2636	3060
CDC Striker ^G	3106	200	3144	214	2235	2828
DS Admiral ^Y	3234	220	3085	229	2550	2956
PS03101445 ^G	2782	205	2371	202	1998	2384
PS05100840 ^G	2889	222	2377	230	2499	2588
PS08100133 ^G	2946	202	2690	229	2297	2644
PS08100582 ^G	2839	204	2644	214	2292	2592
PS08101004 ^Y	3095	234	2715	241	2664	2825
Location Mean	3083	212	2816	223	2418	

¹Market Classes. Y = Yellow, G = Green

Lentils:

Available head to head comparisons over two years among lentil entries are presented for Montana (Table 18) and North Dakota (Table 19). For Montana, six entries can be compared at Moccasin over 2014 and 2015 and at Richland over 2013 and 2015. The entries include two varieties, CDC Richlea and Avondale (Richlea type), and four breeding lines LC06601734L (Laird type), LC01602062T (Red type), LC08600113P (Pardina type) and LC08600116P (Pardina type). CDC Richlea had the highest yield over two years at both locations and the yield of Avondale was similar to CDC Richlea at Richland (Table 18). A lack of consistent check varieties for other market classes makes it difficult to interpret the results for the other breeding lines.

For North Dakota, 22 entries can be compared over two years, 2014 and 2015, at Hettinger, Carrington, and Williston (Table 19). The entries included 18 varieties and four breeding lines. The location mean for yield across all entries and both years was greatest at Hettinger, followed by Carrington and Williston. The breeding line LC07ND055E (Eston type) had the highest mean yield (2445 lb/ac) of all entries across all locations. The mean yield across locations of LC07ND055E was 13.9% greater than the mean yield of Eston (2145 lb/ac). The Pardina type breeding lines LC08600113P and LC08600116P both had two year mean yields greater than Pardina at Hettinger and Carrington, but less than Pardina at Williston. Mean yields of LC08600116P and LC0860113P at Carrington were 37.7 and 20.4% greater, respectively, than Pardina. The Laird type breeding line LC06601734L had considerably lower mean yields than the large seeded Laird type varieties CDC Greenland and Riveland at Hettinger and Carrington, although differences between these three entries were less pronounced at Williston.

Table 18. Performance summary of lentil entries tested for two years at Western Regional Cool Season Food Legume Evaluation Trials in Montana.

Entry	Market class	Moccasin (2014,2015)		Richland (2013,2015)	
		Yield (lb/ac)	1000 seed weight (g)	Yield (lb/ac)	1000 seed weight (g)
Richlea	Richlea	1308	54.9	1334	52.2
Avondale	Richlea	1105	51.6	1328	47.0
LC06601734L	Laird	1041	67.4	997	66.0
LC01602062T	Red	985	44.2	1135	42.5
LC08600113P	Pardina	967	49.0	1200	49.4
LC08600116P	Pardina	978	50.0		
Location Mean		1064	52.9	1199	57.4

Table 19. Performance summary of lentil entries¹ tested for two years (2014-2015) at Western Regional Cool Season Food Legume Evaluation Trials in North Dakota.

Entry	Hettinger		Carrington		Williston	All locations
Entry	Yield (lb/ac)	1000 seed weight (g)	Yield (lb/ac)	1000 seed weight (g)	Yield (lb/ac)	Yield (lb/ac)
CDC Redberry ^R	3013	40.5	2427	37.4	1343	2261
CDC Rouleau ^R	2998	37.5	2034	32.4	1437	2156
LC07ND055E ^E	2993	38.5	2752	34.3	1590	2445
CDC Redcoat ^R	2952	40.0	2092	34.3	1442	2162
LC08600116P ^P	2910	50.0	2307	43.0	1321	2179
LC08600113P ^P	2817	45.0	2018	37.9	1359	2065
CDC Lemay ^{FG}	2804	34.0	1972	30.3	1366	2047
Avondale ^R	2772	51.0	2360	44.9	1460	2197
CDC Red Rider ^R	2725	46.0	1889	37.8	1467	2027
Eston ^E	2712	34.5	2283	30.1	1440	2145
Viceroy ^E	2670	32.5	2144	29.3	1322	2045
Pardina ^P	2551	38.5	1675	32.6	1486	1904
CDCRosetown ^R	2544	32.0	2064	26.9	1288	1965
CDCGreenland ^L	2503	60.5	1902	57.3	1264	1890
Crimson ^R	2500	34.5	1667	30.0	1255	1807
CDC Richlea ^R	2444	51.5	1957	44.2	1514	1972
Pennell ^L	2398	57.5	1574	51.9	1405	1792
Merrit ^L	2326	62.5	1731	54.6	1095	1717
Riveland ^L	2225	66.5	1694	62.0	1243	1721
Essex ^E	2210	45.0	1462	38.6	1556	1743
Morena ^P	2071	38.5	1451	34.5	1382	1635
LC06601734L ^L	1996	61.5	1507	58.3	1210	1571
Location Mean	2597	45.4	1953	40.1	1375	

¹Market Classes. R = Red; E = Eston; P = Pardina ; FG = French Green, and L = Laird.

Chickpeas:

Available head to head comparisons over two years among chickpea entries are presented for Montana (Table 20) and North Dakota (Table 21). For Montana, six entries can be compared over 2014 and 2015 at Moccasin and Richland. The entries include two varieties, Myles and CDC Frontier and four breeding lines. The location mean for yield and 1000 seed weight across all entries and both years were greater at Moccasin than Richland. CDC Frontier had the highest mean yield (1159 lb/ac) over all locations and years. CA0790B0549C was the highest yielding breeding line at both Moccasin and Richland. CA0790B0043C had the second highest mean yield and 1000 seed weight among the four breeding lines at both Moccasin and Richland.

For North Dakota, six entries can be compared over 2013 and 2015, at Hettinger and Williston (Table 21). The entries included the varieties CDC Frontier, CDC Luna, Sierra, and Sawyer and two breeding lines CA0790B0549C and CA0790B0547C. The mean yield over both years for all entries was greater at Williston than Hettinger. CDC Frontier had the highest yield (2139 lb/ac) across both locations. Interestingly, the relative performances of the sibling breeding lines CA0790B0549C and CA0790B0547C were different in North Dakota and Montana, with CA0790B0547C having higher yields than CA0790B0549C in North Dakota (Table 21) while CA0790B0549C had higher yields in Montana (Table 20).

Table 20. Performance summary of chickpea entries tested for two years (2014-2015) at Western Regional Cool Season Food Legume Evaluation Trials in Montana.

Entry	Moccasin		Richland		Both Locations	
	Yield (lb/ac)	1000 seed weight (g)	Yield (lb/ac)	1000 seed weight (g)	Yield (lb/ac)	1000 seed weight (g)
Myles	1207	183	733	150	970	167
CDC Frontier	1108	356	1210	319	1159	338
CA0790B0549C	1015	444	917	342	966	393
CA0790B0043C	930	485	853	385	892	435
CA0790B0547C	889	474	818	376	854	425
CA0890B0429C	829	505	725	430	777	468
Location Mean	996	408	876	334	936	371

Table 21. Performance summary of chickpea entries tested for two years at Western Regional Cool Season Food Legume Evaluation Trials in North Dakota.

Entry	Williston (2013,2015)		Hettinger (2013,2015)		Both locations
	Yield (lb/ac)	1000 seed weight (2015)	Yield (lb/ac)	% Seed larger than 9 mm	Yield (lb/ac)
CDC Frontier	2044	206	2363	83	2204
CDC Luna	1905	406	2372	72	2139
Sawyer	1615	451	2479	64	2047
Sierra	1528	499	2279	74	1904
CA0790B0547C	1597	498	2349	67	1973
CA0790B0549C	1413	453	2366	54	1890
Location Mean	1684	479	2368	69	2026

Conclusions

The results of the 2015 Western Regional Cool Season Food Legume Evaluation Trials taken together with available head to head comparisons over 2014 and 2015 indicate that the yellow pea breeding line PS08101004 and the green pea breeding line PS05100840 should be considered for advancement to statewide pea evaluation trials in Montana and North Dakota. PS08101004 was one of the top three yielding pea entries in 2015 at Richland (Table 2), Havre, (Table 3) and Williston (Table 8). Results across multiple years and locations suggest that PS08101004 may be especially well adapted to Montana (Table 16) and Williston (Table 17). The green pea breeding line PS05100840 was the highest yielding entry in 2015 at Moccasin (Table 1). It has consistently had high yields at Moccasin and Richland compared to other green pea entries (Table 16). PS05100840 yields comparable to CDC Striker at Hettinger and Williston (Table 17). Of special note regarding the performance of PS05100840 is that it had the highest protein content of all pea entries in 2015 at Williston (Table 8), Minot (Table 9) and Hettinger (Table 10). These results suggest that PS05100840 may have value for both its high yield and high seed protein content.

The Eston type lentil breeding line LC07ND055E is an example of how the Western Regional Cool Season Food Legume Evaluation Trials can be used to develop plant materials that are adapted to the USA Northern Plains. This line was derived from a population developed by the USDA-ARS breeding program but the line itself was originally selected based on its performance in a lentil nursery in North Dakota. Over two years of trials (2014 and 2015), LC07ND055E had the highest mean yield (2445 lb/ac) of all 22 entries over three locations in North Dakota (Table 19). The yield of LC07ND055E was 13.9% greater than Eston over these trials in North Dakota. In 2015 LC07ND055E had the highest yield of all entries at Hettinger (Table 13), the second highest yield at Carrington (Table 12) and the third highest yield among all 30 entries tested at Williston (Table 11). It is recommended that LC07ND055E be advanced to statewide evaluation trials in Montana and North Dakota.

Two Pardina type lentil breeding lines, LC08600116P and LC08600113P, appear to have promise in Montana and North Dakota based on their performance relative to the variety Pardina. In 2015 LC08600113P was the third highest yielding entry at Carrington (Table 12), while LC08600116P was the third highest yielding entry at Hettinger (Table 13). Over trials conducted in 2014 and 2015 at Hettinger, Carrington, and Williston, the mean yields of LC08600116P (2179 lb/ac, Table 19) and LC08600113P (2065 lb/ac) were 37.7 and 20.4% greater, respectively, than the yield of Pardina (1904 lb/ac). Both LC08600116P and LC08600113P produce seed that is larger than Pardina (Table 19). The 1000 seed weight of LC0860113P is closer in size to Pardina, so it is recommended that this line be considered for advancement to statewide lentil yield trials in Montana and North Dakota.

Results indicate that the chickpea breeding line CA0790B0043C should be considered for advancement to statewide chickpea evaluation trials in Montana and North Dakota. In 2015 CA0790B0043C was the second highest yielding entry at Moccasin (Table 6) and the third highest yielding entry at Richland (Table 7). In both of these trials CA0790B0043C had 1000 seed weights that were significantly greater than CDC Frontier. In the trial conducted at Williston in 2015 both the yield and 1000 seed weight of CA0790B0043C were significantly greater than Sierra (Table 14).

Results also indicate that CA0790B0547C should be considered for advancement to statewide lentil yield trials in Montana and North Dakota. CA0790B0547C had the third highest yield among all chickpea entries tested at Moccasin in 2015 (Table 6) and the fourth highest yield at Richland in 2015 (Table 7). CA0790B0547C was the highest yielding entry in 2015 at Hettinger (Table 15). CA0790B0547C consistently produces seed that has a 1000 seed weight similar to Sierra.