

PROJECT TITLE: Statewide evaluation of lentil variety performance
(Montana Statewide Lentil Performance Trial).

EXPERIMENT NO: #85

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OBJECTIVES:

To evaluate the performance of lentil varieties under different cropping conditions across Montana.

METHODS:

The 2001 Montana Statewide Lentil Variety Performance Trial (SLPT) included ten lentil varieties, established at five dryland sites (Sidney, Moccasin, Huntley, Conrad, and Bozeman) and one irrigated site (Corvallis). Lentil entries ranged in seed kernel size, maturity and color (**Tables 10**). The trial was seeded during the last two weeks of April (May 3rd at Sidney) into a range of cropping conditions and harvested from the end of July through the end of August (**Table 11**). Other pertinent production methods for each testing site are summarized in **Table 11**.

RESULTS:

Drought-like conditions persisted into the 2001 cropping year across much of Montana. Below normal growing season precipitation was recorded at all sites, with the Sidney site being the exception. The Sidney site had below normal moisture conditions at seeding and received much above normal precipitation in June. The Conrad site received only 2.28 inches of precipitation during the growing season (April 26th - July 25th), of which 1.53 inches fell in June.

Lentil Grain Yields: Statewide, dryland lentil grain production averaged 923 pounds per acre (15.4 bu/acre) with CDC Richlea medium green lentil having the highest production (1,091 lbs/acre; **Table 12**). However, CDC Richlea's yield was not significantly better than Laird large green lentil (the check variety). French Green small green and Red Chief medium red lentils were the top lentil grain producers at Corvallis - irrigated site. Due to its late maturity, Toni small red winter lentil had the lowest grain production and was significantly lower than Laird under both dryland and irrigated environments, the only exception being at the Conrad site, where Toni was the top producing lentil. This is attributed to a late June precipitation event (0.47") which benefited the late maturing lentils.

Seed Weights: Kernel sizes measured at three sites ranged from 19.2 grams (Indianhead - Bozeman) to 71.5 grams (Laird - Moccasin) per 1,000 kernels with Laird large green consistently having the largest kernel size (**Table 13**). Kernel sizes were subdivided into large, medium and small lentil fractions and a representative "check" variety was selected for each subdivision, whereby a comparative analysis of lentil weights for each subdivision could be accomplished. Differences were seen among lentil sizes within each subdivision from site to site. However, in the three-site average, only Indianhead small black lentil showed a consistently smaller seed size (compared to Eston small green) in its size division. Differences were seen in lentil test weights where Indianhead lentil having the highest test weight (66.6 lbs/bushel).

Flower and Pod-fill Dates: Red Chief red and Brewer yellow lentils were the earliest lentils to flower, averaging a flowering date 57 days from seeding date and were significantly earlier than Laird (**Table 14**). Both Indianhead and Toni were on average six (6) and 10 days, respectively, later than Laird among the four locations that recorded growth stage data.

Plant Canopy Heights: Indianhead, Laird and the small red winter, Toni, lentils were the tallest lentils across all locations, with grain harvest canopy heights of 16.1, 15.9 and 15.2 inches, respectively (**Table 14**). Over the four site locations, the average canopy height was 13.7 inches.

Quality Data: Since 1999, the green-manure type lentil, Indianhead, has had the highest grain protein content (29.7%) and has averaged 26.0% statewide (**Table 15**). However, with a two location average grain protein content of 32.3%, Toni winter lentil contained a higher grain protein content than Indianhead in the 2001 trial.

SLPT Multi-year (1998 - 2001) Summary: Looking at multi-year variety yields compared to Laird green lentil at all locations, indicated that most varieties perform equal to or better than Laird, except for at the Huntley site, where Laird tended to do better than the majority of the other lentils evaluated (**Table 16**). By comparing yields from the 2001 field season to the statewide four-year (1998-2001) average (**Tables 12 and 16**, respectively), lentil production, under dryland environments, in 2001 was 91% of the four-year statewide trial average (923 lbs/acre and 1,019 lbs/acre, respectively). With an average dryland grain production of 1,159 pounds per acre, CDC Richlea green lentil has been the highest statewide grain yielding lentil over four years of testing. Moccasin lentil yields were the only dryland site where 2001 lentil production was greater than that sites four-year average (1,137 and 1,114 lbs/acre, respectively). Lentil yields in the 2001 season at Corvallis were 166% of that sites two-year average (2,255 and 1,361 lbs/acre, respectively) and over 700 pounds more production than the four site-year irrigated average of 1,512 pounds per acre. Over the four years of statewide lentil evaluations, the dryland grain yields averaged 1,019 pounds per acre, with Sidney, Bozeman and Moccasin having the highest average yields. Under irrigation, lentil production averaged 1,512 pounds per acre in from 1998 through 2001.

FUTURE RESEARCH:

Variety trials will continue on a statewide basis to evaluate lentil varieties for adaptation in different Montana climates and to provide a more comprehensive statewide lentil grain database.

Table 10. 2001Montan Statewide Lentil Performance Trial - Lentil variety characteristics summary.
- Exp. 850001. Central Agricultural Research Center, Moccasin, MT. **{File: 850001- Character}**

Variety	Seed Source	Usage	Seed Color	Cotyledon Color	Size Class ^{1/}	Maturity
CDC Richlea	Timeless Seeds	Food	Green	Yellow	Medium	Medium
Red Chief	Timeless Seeds	Food/Specialty	Red	Red	Medium	Early
Indianhead	Timeless Seeds	Green Manure	Black	Yellow	Small	Late
Pardina	Spokane Seeds	Food/Specialty	Brown	Yellow	Small	Medium
Laird	Timeless Seeds	Food	Green	Yellow	Large	Late
French Green	Timeless Seeds	Food/Specialty	Blue-Green	Yellow	Small	Medium
Brewer	USDA-ARS	Food	Green	Yellow	Medium	Early
Crimson	Timeless Seeds	Food/Specialty	Red	Red	Small	Medium
Eston	Spokane Seeds	Food	Green	Yellow	Small	Medium

^{1/} - Size Classes (g/1000 seeds): Large >60-65; Medium = 40-60; Small <40

Table 11. 2001 Montana Statewide Lentil Performance Trial - Testing site trial production summary.

- Exp. 850001. Central Agricultural Research Center, Moccasin, Montana. **{File: 850001-SiteInfo}**

Testing Site:	Sidney	Moccasin	Huntley	Conrad	Bozeman	Corvallis
Field Summary						
Environment:	Dryland	Dryland	Dryland	Dryland	Dryland	Irrigated
Tillage History:	Conventional	No-Till	Conventional	Conventional	No-Till	Conventional
Previous Crop:	Fallow	Barley	Fallow	Barley	Barley	Rape+Pea
Trial Management						
Seeding Date:	5/03	4/17	4/19	4/26	4/30	4/24
Harvest Date:	8/09 - 8/15	7/30 - 8/07	8/15	7/23 - 7/30	8/13 & 8/28	8/30
Timing: ^{1/}	Maturity	Maturity	All	Maturity	All & Toni	All ^{4/}
Fertilizer: (lbs/ac)	None	None	18-46-0 (100)	11-52-0 + potash (58)	0-18-31-11 (100)	11-52-0 (100) + potash (60)
Method: ^{2/}			Pr-P Incorp	Top-dress @ seeding	W/ seed	Pr-P Incorp.
Pesticides: (rates)	Hand Weed	Sonolan (8lbs/a) Assurell (8oz/a) Malathion (2pt/a) {Cut Worms}	Prowl (2pt/ac) RoundUp (1pt/ac)	None	Sonolan (8lbs/a) RoundUp (12oz/a) Assure II (8oz/a)	Hand Weed
Method: ^{2/}		Pr-P Incorp Po-E	Pr-E		Pre-P; Pr-E; Po-E	
Precipitation: ^{3/}	16.43"	7.47"	7.95"	2.28"	6.72"	5.87" + 7.00" (irrig.)
Elevation:	2200'	4300'	2990'	3700'	4780'	3590'

^{1/} - Harvest was conducted at variety maturity ("Maturity"), or all varieties at same time ("All").

^{2/} - Pr-P = Pre-Plant; Pr-E = Pre-Emergence; Po-E = Post-Emergence; Incorp = Incorporated.

^{3/} - Precipitation from seeding to grain maturity (Apr-Aug - Sidney; Apr-swath - Conrad).

Table 12. 2001 Montana Statewide Lentil Performance Trial - Lentil grain yield summary.

- Exp. 850001. Central Agricultural Research Center, Moccasin, MT. **{File: 850001- GrainYield}**

Selection		----- Dryland Sites -----					Average	Irrigated Corvallis
		Sidney	Moccasin	Huntley	Conrad ^{1/}	Bozeman		
		----- (lbs/acre) -----						
Laird (check)	Lrg. Green	926	1,211	650	635	1,211	927	2,390
CDC Richlea	Med. Green	1,193	1,237	940^a	704	1,379	1,091	2,906
Red Chief	Med. Red	787	1,324	558	590	1,479 ^a	1,055	1,248 ^a
Brewer	Med. Green	1,005	1,234	587	530	1,403	952	2,053
French Green	Sm. Green	1,148	1,053	743	386	1,368	1,004	3,093^a
Eston	Sm. Green	1,307 ^a	1,151	873 ^a	600	1,346	948	2,646
Indianhead	Sm. Black	1,481^a	1,309	421 ^a	446	652 ^a	940	2,423
Pardina	Sm. Brown	915	1,013	768	599	1,344	928	2,695
Crimson	Sm. Red	904	1,153	831 ^a	605	1,529^a	862	1,910
Toni	Sm. Red-winter	961	681 ^a	56 ^a	734	180 ^a	522 ^a	1,183 ^a
Site Means		1,063	1,137	643	583	1,191	923	2,255
LSD (0.05 by t)		279	224	120	259	224	304	553
C.V. % (s / means)		18.1	11.50	12.87	30.59	13.0	25.67	16.91
F-Value (variety; df = 9)		**	6.26 **	29.6 **	1.42 ^{ns}	31.3 **	2.16 **	11.75 **

^{ns} - Indicates no statistical significance at 0.10 level. ** - Indicates statistical significance at 0.05 level.

^a - Denotes values significantly different from Laird green lentil (check) based on LSD_(0.05).

^{1/} - Conrad testing site encountered severe drought-like conditions.

Table 13. 2001 Montana Statewide Lentil Performance Trial - Lentil grain size and test weight summary.
 - Exp. 850001. Central Agricultural Research Center, Moccasin, MT. {File: 850001- SeedWts}

Entry	Kernel Weight				Test Weight			
	Moccasin	Huntley	Bozeman	Average	Sidney	Moccasin	Huntley	Average
	----- (g / 1,000 seeds) -----				----- (lbs / bushel) -----			
Large (>60)								
Laird	71.5	59.0	58.6	63.0	59.4	60.3	59.6	59.8
Medium (40-60)								
Brewer	58.8	47.3	53.3	53.1	59.0	60.3	59.5	59.6
CDC Richlea	61.8 ^a	42.0 ^a	43.1 ^a	49.0	60.2	61.8 ^a	61.2 ^a	61.1 ^a
Red Chief	52.2 ^a	45.5	50.7 ^a	49.5	57.0 ^a	60.4	58.2 ^a	58.5 ^a
Small (<40)								
Eston	32.5	27.3	28.8	29.5	64.0	64.8	65.3	64.7 ^b
Crimson	35.5 ^b	29.3 ^b	30.9 ^b	31.9	62.0 ^b	64.1 ^b	63.6 ^b	63.2 ^b
Pardina	38.1 ^b	32.0 ^b	35.0 ^b	35.0	63.0	66.0 ^b	64.9	64.6
French Green	31.1	24.0 ^b	27.0	27.4	63.6	65.0	64.6	64.4
Indianhead	21.5 ^b	24.3 ^b	19.2 ^b	21.6 ^b	66.0^b	67.2^b	66.6^b	66.6^b
Toni	28.5 ^b	32.3 ^b	24.3 ^b	29.6	62.7 ^b	65.0	---- ^{1/}	63.9
Site Means	42.6	36.3	37.1	39.0	61.7	63.5	62.6	62.6
LSD (0.05 by t)	2.1	2.0	2.1	7.0	1.3	0.6	0.9	0.9
C.V.% (s/means)	2.87	3.80	3.82	10.41	1.5	0.53	0.95	0.82
F-value (df = 9)	517.4 ^{**}	284.4 ^{**}	364.4 ^{**}	33.8 ^{**}	^{**}	170.62 ^{**}	103.2 ^{**}	82.80 ^{**}

** - Statistically significant at 0.05 level.

^a - Denotes values significantly different from Brewer medium green lentil based on LSD_(0.05).

^b - Denotes values significantly different from Eston small green lentil based on LSD_(0.05).

^{1/} - Insufficient seed quantity to perform test weight analysis.

Table 14. 2001 Statewide Lentil Performance Trial - Summary of flowering days and plant canopy height.
 - Exp. 850001. Central Agricultural Research Center, Moccasin, MT. {File: 850001 - Dates}

Entry	Days to Flower						Plant Canopy Height ^{1/}				
	Sidney	Mocc.	Huntley	Boze.	Corv.	Ave	Sidney	Mocc.	Huntley	Corv.	Ave.
	-----						----- Inches -----				
Laird	62	71	65	64	66	66	15.4	13.0	10.7	20.5	15.9
Red Chief	53^a	63^a	53	56	62	57^a	13.8	11.0	12.4	16.5	13.4
Brewer	53^a	64 ^a	52	56	62	57^a	14.2	10.2	14.7	17.7	13.3
Pardina	57 ^a	65 ^a	58	59	62	60	9.8	9.2	12.0	16.5	11.4
Eston	56 ^a	69 ^a	62	61	66	63	12.6	9.3	11.0	17.3	12.8
CDC Richlea	60 ^a	68 ^a	62	63	62	63	13.8	11.3	9.8	21.1	14.7
Crimson	59 ^a	68 ^a	63	61	66	63	10.2	9.2	9.9	15.1	11.2
French Green	60 ^a	67 ^a	63	63	72	65	12.2	9.5	14.4	19.0	12.9
Indianhead	62	77 ^a	71	69	72	70 ^a	16.9	10.3	10.2	22.6	16.1
Toni	69 ^a	85 ^a	79	78	76	77 ^a	14.2	10.3	14.3	22.1	15.2
Site Means	56	70	63	63	67	64	13.3	10.3	12.0	18.8	13.7
LSD _{0.05}	1	1	1	1		3	2.2	1.3	2.3	3.2	1.8
C.V.% (s/mean)	1.5	0.99	0.55	2.3		3.4	11.5	7.52	13.11	11.65	9.17
F-Value (df = 9)	^{**}	286.8 ^{**}	289	308		38.7 ^{**}	^{**}	7.09 ^{**}	5.90 ^{**}	5.66 ^{**}	7.67 ^{**}

** - Indicates statistical significance at 0.05 level.

^{1/} - Plant canopy height at grain harvest.

Table 15. 2001 Statewide Lentil Performance Trial - Multiyear (1999-2001) lentil grain protein summary.
 - Exp. 850001. Central Agricultural Research Center, Moccasin, MT. **{File: 850001 – Quality}**

Variety	Sidney	Conrad	Moccasin				Huntley			Multi-yr
	1999	1999	1999	2000	2001	Ave. (3)	2000	2001	Ave. (2)	Ave. (7)
----- (% Protein, dmb) -----										
Indianhead	24.1	25.5	31.1^a	31.1^a	28.4	30.2^{a(3)}	36.7	31.0	33.9^{a(2)}	29.7^{a(7)}
Brewer	24.8	25.9	29.6 ^a	27.8	26.6	28.0 ⁽³⁾	32.1	25.2	28.7 ⁽²⁾	27.4 ⁽⁷⁾
French Green	-----	-----	-----	28.0	26.5	27.6 ⁽²⁾	32.5	24.6	28.6 ⁽²⁾	26.8 ⁽⁴⁾
Red Chief	22.5	24.8	28.6 ^a	27.7	27.0	27.8 ⁽³⁾	29.9	26.0	28.0 ⁽²⁾	26.6 ⁽⁷⁾
Crimson	-----	-----	-----	25.5	25.9	26.1 ⁽²⁾	32.6	23.6	28.1 ⁽²⁾	25.8 ⁽⁴⁾
Eston	-----	-----	-----	26.3	24.5	25.8 ⁽²⁾	32.4	22.6	27.5 ⁽²⁾	25.3 ⁽⁴⁾
Laird	22.2	22.7	26.8	27.2	25.4	26.5 ⁽³⁾	33.1	24.2	25.4 ⁽²⁾	25.0 ⁽⁷⁾
CDC Richlea	20.0	22.6	24.9	24.7	23.7	24.4 ⁽³⁾	29.8	21.2	25.5 ⁽²⁾	23.8 ⁽⁷⁾
Pardina	19.9	21.4	23.9	24.6	23.1	23.9 ⁽³⁾	29.6	23.4	26.5 ⁽²⁾	23.7 ⁽⁷⁾
Toni	-----	-----	-----	-----	31.8^a	-----	-----	32.8	-----	-----
Means (n)	22.2 ⁽⁶⁾	23.8 ⁽⁶⁾	27.5 ⁽¹²⁾	27.0 ⁽¹⁸⁾	26.3 ⁽³⁰⁾	26.7 ⁽²⁷⁾	32.1 ⁽⁹⁾	25.5 ⁽¹⁰⁾	28.0 ⁽¹⁸⁾	26.0 ⁽⁶³⁾
LSD _{0.05}			2.0	1.4	1.6	1.1			4.0	1.4
CV% (s/means)			2.88	2.27	3.47	2.37			6.16	4.87
F-Value (variety)			25.1 ^{**}	21.6 ^{**}	22.8 ^{**}	28.6 ^{**}			4.24 ^{**}	15.4 ^{**}

** - Indicates statistical significance at 0.05 level.

^{1/} - Letters in parentheses indicate number of site-years variety in trials.

Table 16. 2001 Lentil Trial - Multiyear ('98-'01) summary; A-variety/Laird comparative; B-average grain yields.
 - Exp. 850001. Central Agricultural Research Center, Moccasin, MT. **{File: 850001-Multiyear}**

A: Variety	----- Dryland Sites -----							----- Irrigated Sties -----				
	Havre	Sidney	Mocc.	Hunt.	Conrad	Boze.	Denton	Ave	Crest.	Corv.	Conrad	Ave
Site-Years:	2	4	4	2	4	1	3	20	1	2	1	4
----- (% of Laird Yield) -----												
Laird	100	100	100	100	100	100	100	100	100	100	100	100
CDC Richlea	163	125	123	134	145	114	149	136	105	228	124	172
Pardina	199	108	112	86	143	111	173	133	128	280	151	169
Red Chief	153	119	124	57	135	122	190	131	125	181	164	163
Crimson	181	102	106	90	130	126	163	124		178	107	131
Eston	195	114	109	107	119	111	130	123		208	99	142
Brewer	154	112	117	64	125	116	162	121		184	147	154
French Green	129	114	107	80	111	113	140	114	148	311	162	233
Indianhead	125	113	88	59	72	54	84	88	78	104	96	95
Means (n)	155 ⁽¹⁸⁾	112 ⁽³⁶⁾	110 ⁽³⁶⁾	86 ⁽¹⁸⁾	120 ⁽³⁶⁾	108 ⁽⁹⁾	143 ⁽²⁷⁾	120 ⁽¹⁸⁰⁾	125 ⁽⁹⁾	197 ⁽¹⁸⁾	128 ⁽⁹⁾	151 ⁽³⁶⁾
LSD _{0.05}	ns	ns	ns	44	33		58	16		ns		ns
CV% (s/means)	18.4	18.8	16.0	22.0	18.9		22.9	21.1		56.6		42.8
F-value (df = 9)	2.70 ^{ns}	0.54 ^{ns}	1.68 ^{ns}	3.5 ^{**}	4.1 ^{**}		3.29 ^{**}	7.99 ^{**}		0.79 ^{ns}		1.66 ^{ns}
B: Variety	----- Average Lentil Grain Yields -----											
----- (lbs / acre) -----												
Laird	642 ⁽²⁾	1,234 ⁽⁴⁾	1,027 ⁽⁴⁾	792 ⁽²⁾	864 ⁽⁴⁾	1,211 ⁽¹⁾	507 ⁽³⁾	905 ⁽²⁰⁾	880 ⁽¹⁾	1,268 ⁽²⁾	1,891 ⁽¹⁾	1,326 ⁽⁴⁾
CDC Richlea	1,041 ⁽²⁾	1,521⁽⁴⁾	1,244 ⁽⁴⁾	1,048⁽²⁾	1,119 ⁽⁴⁾	1,379 ⁽¹⁾	699 ⁽³⁾	1,159⁽²⁰⁾	926 ⁽¹⁾	1,696 ⁽²⁾	2,350 ⁽¹⁾	1,667 ⁽⁴⁾
Red Chief	956 ⁽²⁾	1,458 ⁽⁴⁾	1,256⁽⁴⁾	414 ⁽²⁾	1,128 ⁽⁴⁾	1,479 ⁽¹⁾	861⁽³⁾	1,108 ⁽²⁰⁾	1,101 ⁽¹⁾	849 ⁽²⁾	3,093⁽¹⁾	1,473 ⁽⁴⁾
Pardina	1,209 ⁽²⁾	1,341 ⁽⁴⁾	1,125 ⁽⁴⁾	640 ⁽²⁾	1,167⁽⁴⁾	1,344 ⁽¹⁾	782 ⁽³⁾	1,096 ⁽²⁰⁾	1,123 ⁽¹⁾	1,672 ⁽²⁾	2,858 ⁽¹⁾	1,837 ⁽⁴⁾
Crimson	1,177 ⁽¹⁾	1,284 ⁽³⁾	1,082 ⁽³⁾	658 ⁽²⁾	1,076 ⁽³⁾	1,529⁽¹⁾	760 ⁽²⁾	1,056 ⁽¹⁵⁾	-----	897 ⁽¹⁾	2,024 ⁽¹⁾	1,084 ⁽²⁾
Brewer	974 ⁽¹⁾	1,355 ⁽³⁾	1,193 ⁽³⁾	467 ⁽²⁾	1,055 ⁽³⁾	1,403 ⁽¹⁾	777 ⁽²⁾	1,043 ⁽¹⁵⁾	-----	1,040 ⁽¹⁾	2,775 ⁽¹⁾	1,531 ⁽²⁾
Eston	1,283⁽¹⁾	1,390 ⁽³⁾	1,124 ⁽³⁾	811 ⁽²⁾	875 ⁽³⁾	1,346 ⁽¹⁾	614 ⁽²⁾	1,041 ⁽¹⁵⁾	-----	1,633 ⁽¹⁾	1,876 ⁽¹⁾	1,378 ⁽²⁾
French Grn.	801 ⁽²⁾	1,386 ⁽⁴⁾	1,073 ⁽⁴⁾	589 ⁽²⁾	921 ⁽⁴⁾	1,368 ⁽¹⁾	611 ⁽³⁾	975 ⁽²⁰⁾	1,303⁽¹⁾	1,903⁽²⁾	3,066 ⁽¹⁾	2,044⁽⁴⁾
Indianhead	788 ⁽²⁾	1,329 ⁽⁴⁾	902 ⁽⁴⁾	455 ⁽²⁾	614 ⁽⁴⁾	652 ⁽¹⁾	378 ⁽³⁾	783 ⁽²⁰⁾	683 ⁽¹⁾	1,289 ⁽²⁾	1,811 ⁽¹⁾	1,268 ⁽⁴⁾
Means ^{2/} (n =)	985 ⁽¹⁸⁾	1,367 ⁽³⁶⁾	1,114 ⁽³⁶⁾	652 ⁽¹⁸⁾	980 ⁽³⁶⁾	1,301 ⁽⁹⁾	665 ⁽²⁷⁾	1,019 ⁽¹⁸⁰⁾	1,102 ⁽⁶⁾	1,361 ⁽¹⁸⁾	2,415 ⁽⁹⁾	1,512 ⁽³⁶⁾
LSD _{0.05} by t	368	ns	ns	391	278		203	116		ns		ns
C.V.%(s/mean)	14.5	16.4	15.5	26.0	19.3		17.3	18.3		32.0		28.1

^{ns} - Indicates no statistical significance at 0.10 level.

^{**} - Statistical significance at 0.05 level.

^{1/} - Numbers in parenthesis indicate number of site-years varieties tested at each location.

^{2/} - Site means account for missing values.