

Project Title: Nitrogen use response of irrigated and dryland spring wheat

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Objective: To evaluate variety-specific nitrogen use response of irrigated spring wheat for agronomic performance.

Eight spring wheat cultivars were grown under four different nitrogen levels as a split plot, randomized complete block design, with four replications, where nitrogen levels represent the whole plot factor and the spring wheat varieties were the sub plot factor. The four nitrogen treatments included no added fertilizer and 150, 281, and 412 pounds/A, respectively, based on soil test N levels plus supplemental N fertilization. For the irrigated study, irrigation was applied when necessary to keep soil moisture from falling below 50% of the plant available water. Other agronomic management procedures are detailed in Table 1.

Table 1. Agronomic management for irrigated and dryland experiments

Seeding Date:	4/22/15	Herbicide:	5/20/15
Julian Date:	112		13.7 fl oz/A Huskie complete + 0.5 lb/A AMS
Seeding Rate:	20 plnts/sqft	Pesticide:	6/19/15
Previous Crop:	Canola		12 fl oz/A Quadris + 1.92 fl oz/A Warrior II
Tillage:	Conventional	Harvest Date:	8/5/2015 (Dryland)
Soil Type:	Fine sandy loam	Julian Date:	217
Soil Test:	19-6-111	Harvest Date:	8/12/2015 (Irrigated)
Fertilizer:	-48-115	Julian Date:	224

Irrigated

Nitrogen treatment had significant effect on physiological maturity, moisture content, yield, protein, and test weight (Table 2). Volt had the highest yield at 106.3 bu/A with 281 lbs N, while Cabernet had the least yield at 57.8 bu/A with 412 lbs N. The 150 lbs/A total N consistently showed yield response across varieties. Except for Volt and McNeal, the 281 lbs N/A reduced yield. The highest N at 412 lbs/A significantly reduced yields (Figure 2).

The known inverse relationship between yield and protein is evident (Figure 1 and 2). Increased N supply consistently increased protein across varieties with irrigation. For irrigated spring wheat, test weights has inverse relation with N supply. The lower the N supply the higher the test weight, as N supply increased, test weight decreased (Figure 3). Increased N beyond 150 lbs/A is not economically justifiable with this year's protein premium/discount. Plant height, seed size, thousand kernel weight and falling number were not influenced by the N treatment, but appeared strongly related to variety.

Table 2. Effect of N levels to agronomic performance of irrigated spring wheat — 2015

Variety	HT in	PM* days	SS seeds/lb	MC %	YLD bu/A	PRO %	TWT lb/bu	TKW g	FN sec
19 lbs N (no added fertilizer)									
Brennan	22.5	83	12484	4.4	64.8	14.4	63.4	36.4	424
Buck Pronto	26.5	82	10483	5.1	75.8	13.0	63.2	43.4	370
Cabernet	22.5	83	11525	5.3	79.5	12.2	63.6	39.5	317
Espresso	25.8	84	11270	5.1	75.2	13.8	63.2	40.3	303
McNeal	27.5	83	10863	5.3	78.5	11.8	62.6	41.9	508
Solano	22.5	84	10537	5.5	81.8	13.2	63.7	43.2	360
Volt	28.3	85	12015	5.9	87.6	12.0	64.4	37.9	390
WB Rockland	23.3	84	10468	4.6	68.3	14.6	62.8	43.4	307
150 lbs N (soil + fertilizer)									
Brennan	22.3	86	12059	5.3	78.5	15.0	63.4	37.6	398
Buck Pronto	26.5	85	10352	6.2	91.9	13.8	62.7	43.9	375
Cabernet	22.0	84	11521	6.0	88.5	12.6	63.6	39.5	316
Espresso	27.5	86	10879	7.0	104.4	13.9	62.5	41.9	306
McNeal	29.5	86	10796	6.8	101.8	13.2	62.5	42.2	457
Solano	25.3	86	10679	6.7	99.1	13.9	63.0	42.5	350
Volt	28.0	86	12150	6.8	101.2	12.7	64.0	37.5	369
WB Rockland	24.5	86	10357	6.3	93.4	15.0	62.3	43.8	341
281 lbs N (soil + fertilizer)									
Brennan	23.0	85	12025	4.9	72.2	16.0	62.2	37.8	383
Buck Pronto	26.8	85	9828	5.9	87.3	15.1	60.9	46.2	360
Cabernet	21.8	85	11415	5.7	85.2	13.9	62.5	39.8	319
Espresso	26.3	87	10931	6.9	102.3	15.0	60.7	41.5	301
McNeal	32.0	87	10387	6.9	102.8	14.2	60.5	43.8	461
Solano	25.5	87	10573	6.6	98.3	14.8	61.1	42.9	358
Volt	28.3	87	11780	7.2	106.3	13.8	62.4	38.6	366
WB Rockland	24.0	87	10213	6.2	92.2	16.1	60.1	44.5	328
412 lbs N (soil + fertilizer)									
Brennan	23.8	86	12113	4.2	62.4	16.3	61.4	37.5	409
Buck Pronto	26.0	84	10113	5.4	80.3	14.9	60.3	44.9	367
Cabernet	23.0	86	11384	3.9	57.8	14.2	61.8	40.0	331
Espresso	24.8	86	11081	5.7	84.4	15.3	59.9	41.0	295
McNeal	27.8	87	10246	6.4	94.2	14.6	60.1	44.3	461
Solano	24.8	86	10706	5.8	86.7	15.2	61.1	42.4	342
Volt	26.0	86	11926	6.4	95.3	14.1	62.8	38.1	361
WB Rockland	24.8	87	10149	5.3	79.1	16.7	59.8	44.7	315
C.V	12.3	2.2	8.0	16.1	17.0	9.6	2.7	7.8	15.5
LSD	ns	1.8	ns	0.8	11.8	0.8	2.0	ns	ns
Pr>F _{(0.05)-N}	0.107	0.003	0.088	0.002	0.002	<.0001	0.009	0.105	0.291
Pr>F _{(0.05)-Var}	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Pr>F _{(0.05)-N x Var}	0.168	0.936	0.801	0.121	0.127	0.134	0.843	0.607	0.002

HT: height, PM: physiological maturity *(duration from emergence), SS: seed size, MC: moisture content, YLD: yield, PRO: protein, TWT: test weight, TKW: thousand kernel weight, FN: falling number, ns: nonsignificant

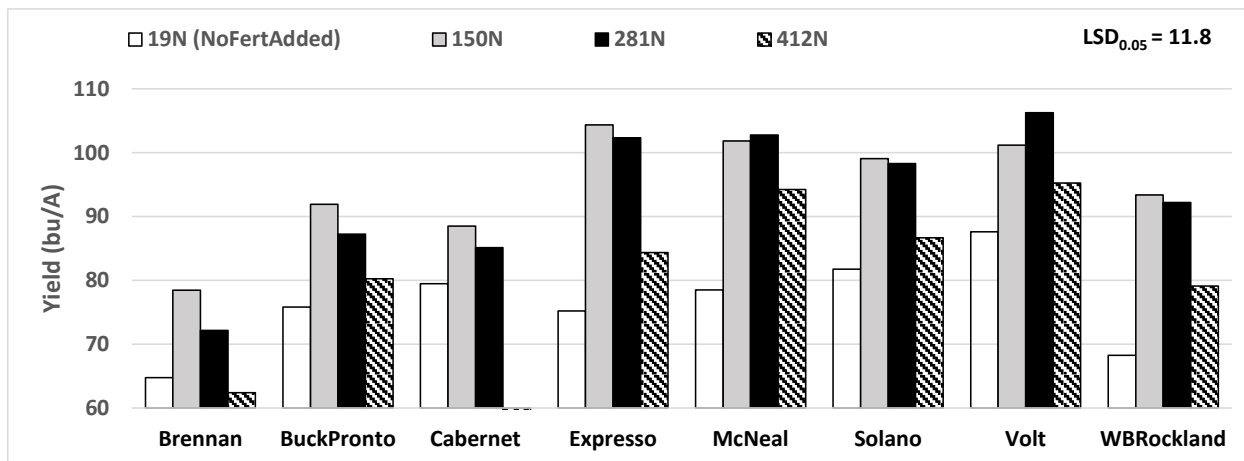


Figure 1. Yield response to N levels of an irrigated spring wheat on fine sandy loam soil, Creston, MT.

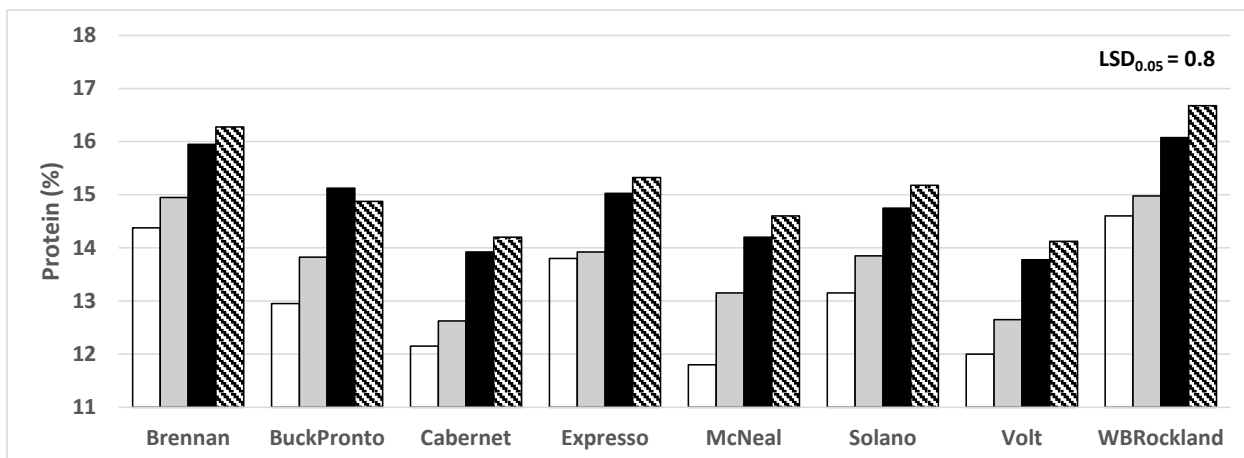


Figure 2. Protein response to N levels of an irrigated spring wheat, fine sandy loam soil, Creston, MT

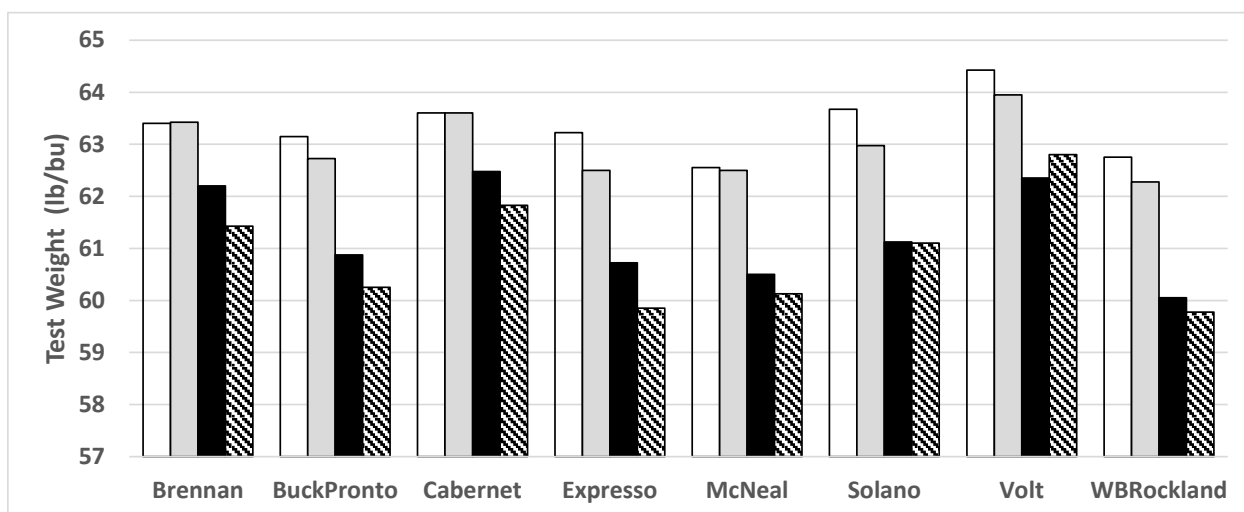


Figure 3. Test weight response to N levels of an irrigated spring wheat, fine sandy loam soil, Creston, MT

Dryland

No yield response for N application was observed due to extreme drought year. Volt had the highest yield and Brennan had the least. Nitrogen treatment had significant effect on increased protein up to 150 lbs N/A (Table 3). Despite protein advantage at 150 lbs N/A, application of N during such dry season on fine sandy loam soil with only 4.7 inches plant available water (PAW) cannot be justified (root zone 50% PAW at planting + rainfall, see Figure 5).

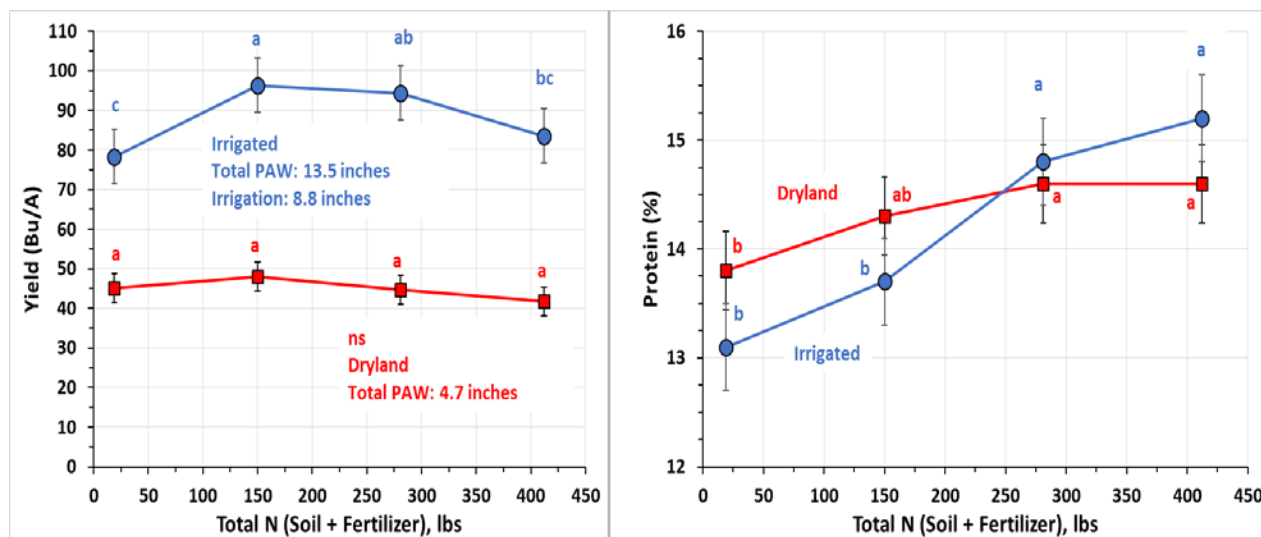


Figure 4. Spring wheat yield response to total N supply per water regime (left) and their corresponding protein quality (right). *Same letter assignment indicates that they are not significantly different.*

Adjusted Gross Return for Irrigated and Dryland N Study

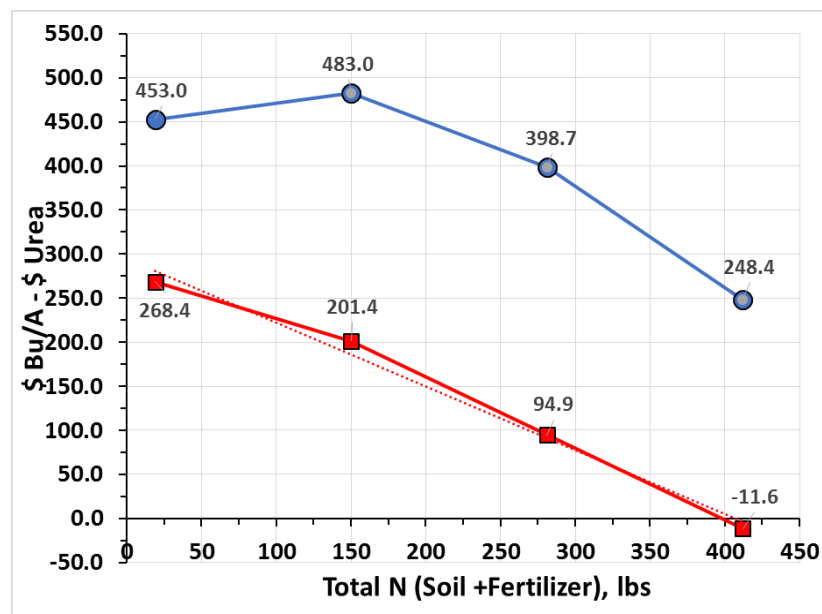


Figure 5. Adjusted gross return of N application for two water regimes.

For irrigated spring wheat in 2015, adjusted gross returns diminished with N application resulting to more than 150 lbs total N. For dryland spring, N application did not provide any economic advantage (Figure 5) despite the increased protein with N supply (Figure 4, right). Thus, for extreme drought like this year, reduction of N input should be considered.

Table 3. Effect of N levels to agronomic performance of dryland spring wheat — 2015

Variety	HT in	PM* days	SS seeds/lb	MC %	YLD bu/A	PRO %	TWT lb/bu	TKW g	FN sec
19 lbs N (no added fertilizer)									
Brennan	19.9	76	14800	9.5	40.7	14.1	62.5	30.9	459
Buck Pronto	22.2	77	13103	9.6	44.6	13.7	61.5	34.8	420
Cabernet	17.6	76	14134	10.0	43.9	13.3	62.2	32.4	343
Espresso	22.0	78	13250	11.0	47.5	14.3	61.6	34.3	307
McNeal	23.8	77	14031	10.3	45.2	13.0	60.8	32.4	537
Solano	21.8	77	12524	10.3	49.4	13.9	62.2	36.3	390
Volt	23.0	78	14717	11.5	49.9	12.7	62.8	30.9	418
WB Rockland	19.6	79	12311	10.6	39.8	15.0	61.5	36.9	315
150 lbs N (soil + fertilizer)									
Brennan	19.9	76	15644	9.4	41.9	14.5	62.3	29.0	455
Buck Pronto	22.1	76	13458	9.5	46.1	14.2	61.1	33.8	407
Cabernet	17.3	76	14841	9.5	42.6	13.8	61.6	30.6	348
Espresso	22.4	79	13283	10.2	52.8	15.1	62.0	34.2	322
McNeal	23.3	78	13821	9.9	49.4	13.7	60.7	32.8	507
Solano	21.2	77	12375	10.0	51.4	14.7	61.8	36.6	388
Volt	23.5	78	14128	9.9	53.9	13.0	63.6	32.6	433
WB Rockland	20.9	78	12481	9.8	45.7	15.5	61.7	36.4	341
281 lbs N (soil + fertilizer)									
Brennan	19.9	76	15313	10.1	37.7	15.0	61.9	29.7	424
Buck Pronto	21.9	76	12776	10.0	42.8	14.6	60.9	35.6	411
Cabernet	17.5	77	13493	10.6	40.2	14.1	61.6	33.9	338
Espresso	21.9	78	12864	11.4	48.0	15.1	61.2	35.4	301
McNeal	24.6	77	13728	11.8	46.4	14.1	59.9	33.1	507
Solano	20.8	79	12272	11.4	43.3	14.8	61.5	37.1	360
Volt	23.1	79	14320	12.0	55.9	13.3	62.5	31.7	388
WB Rockland	21.0	79	12042	11.1	43.5	15.8	61.2	37.8	314
412 lbs N (soil + fertilizer)									
Brennan	20.3	77	15098	9.8	35.8	15.1	62.0	30.1	415
Buck Pronto	23.0	76	12781	9.9	40.7	14.7	61.0	35.5	397
Cabernet	17.8	76	14032	10.1	37.5	14.0	61.8	32.4	326
Espresso	23.0	79	13032	12.1	44.0	15.4	60.5	34.8	276
McNeal	23.9	78	13280	11.7	45.5	14.3	60.5	34.2	523
Solano	21.0	78	12533	11.1	45.3	14.9	61.5	36.2	352
Volt	23.6	79	14635	10.8	47.4	13.3	63.0	31.0	404
WB Rockland	20.8	78	11963	12.4	37.3	15.1	60.7	38.0	301
C.V	10.5	1.8	8.9	12.6	15.5	6.4	1.6	8.9	18.3
LSD	ns	ns	ns	ns	ns	0.6	ns	ns	ns
Pr>F _{(0.05)-N}	0.699	0.450	0.259	0.275	0.357	0.007	0.247	0.262	0.123
Pr>F _{(0.05)-Var}	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Pr>F _{(0.05)-N x Var}	0.921	0.469	0.651	0.087	0.288	0.822	0.082	0.670	0.012

HT: height, PM: physiological maturity *(duration from emergence), SS: seed size, MC: moisture content, YLD: yield, PRO: protein, TWT: test weight, TKW: thousand kernel weight, FN: falling number, ns: nonsignificant