Project Title:	Evaluation of water use efficiency of spring wheat on fine sandy loam
Project Leaders:	Jessica Torrion (PI), Bob Stougaard (Co-PI)
Project Personnel:	John Garner, Brooke Bohannon
Objective:	To evaluate water use response of spring wheat varieties on yield and quality

Methods:

Eight spring wheat cultivars were grown under six irrigation levels as a split plot, randomized complete block design with four replications, where irrigation levels represent the whole plot and the eight spring wheat varieties were the sub plot factor. The irrigation levels were full irrigation (100ET, FullIrr), deficit irrigation (66ET, 2/3FullIrr), various levels of early irrigation termination events (FullIrr-1, FullIrr-2 FullIrr-3) and a rainfed check. The daily potential evapotranspiration was monitored (Creston Weather Station) and daily crop water use was determined using a crop coefficient approach. To trigger irrigation, daily soil water balance was calculated and plant water availability was maintained above 50% in treatment 100ET and irrigated 1.25 inches each irrigation event. The deficit irrigation followed the same schedule with 100ET, except 0.85 inch was applied for each irrigation event. The FullIrr-3, FullIrr-2, and FullIrr-1 were terminated on June 23, July 6, and July 13, respectively. Details of agronomic management is shown in Table 1. The cumulative amount of water in the dryland and irrigated treatments is shown in Figure 1.

Table 1: Material and Methods – Water use efficiency in spring wheat — 2015

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		
Irrigation:	Yes		
Soil Type:	Fine sandy loam	Harvest Date:	8/13/15
Soil Test:	19-6-111	Julian Date:	225
Fertilizer:	281-48-115		

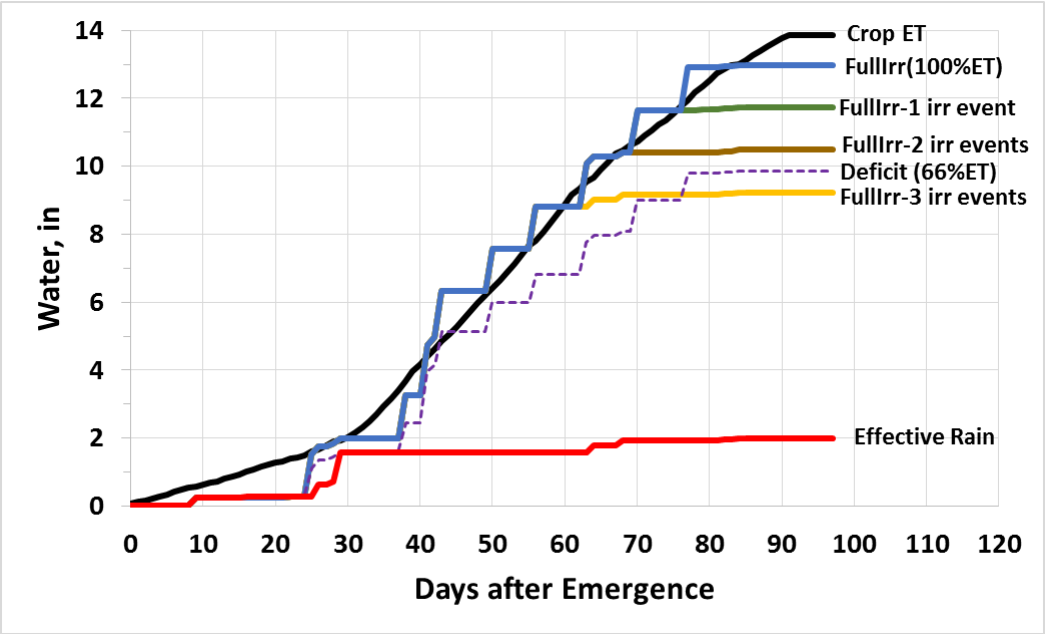

Figure 1. Cumulative rain and irrigation treatments relative to crop water use (Crop ET).

Summary:

The irrigation main effect was significant among all agronomic traits except protein, still the expected relationship between yield and protein was observed. Volt had the highest yield response while Brennan yielded the least consistently across all water regimes (Figure 2). The maximum yield response was when total plant available water was at 11 inches (Figure 3).

Among varieties, Volt had the highest yield but with the lowest protein due to dilution effect of these two factors. Test weight increased with irrigation, but late season irrigation events that occurred during milk and early dough (FullIrr-1 and FullIrr, respectively) on average decreased test weights, Expresso was the exception.

Heights ranged from 19.8 inches for Cabernet under dryland treatment to 29.4 inches for McNeal under FullIrrig-2 treatment. An interaction between irrigation and varieties was observed for falling number. All varieties had falling number greater than 250 seconds. McNeal had highest falling number for all treatments. Late season rainfall that would have triggered preharvest sprout was lacking. No visible plant lodging was observed.

A significant interaction between irrigation and variety for protein was observed. Late season irrigation appears to increase protein selectively with varieties. An expected relationship between seed size and yield was observed (compare TKW or SS with yield in Table 2). As yield increased with irrigation, seed size decreased due to increased number of seeds per unit area, whereas seed size increased when number of seeds per unit area decreased for low yield.

Table 2. Spring wheat water use effects on agronomic performance — 2015

Cultivar	HT in	PM* days	SS seeds/lb	MC %	YLD bu/A	PRO %	TWT lb/bu	TKW g	FN sec
				Full Irrigation (FullIrrig)					
Brennan	21.3	84	12517	11.1	58.5	15.8	62.5	36.3	411
Buck Pronto	26.2	84	11295	10.6	68.5	14.4	62.0	40.8	366
Cabernet	20.7	84	12446	11.4	64.6	13.8	62.7	36.6	311
Expresso	26.5	86	11354	11.1	85.0	14.9	62.8	40.0	305
McNeal	28.2	87	11003	11.3	81.4	14.3	61.7	41.6	470
Solano	22.1	86	10975	11.9	77.2	14.3	62.4	41.4	334
Volt	26.8	86	12503	13.0	87.8	13.5	62.4	36.3	349
WB Rockland	23.1	88	10735	13.6	71.5	15.7	60.3	42.3	300
				Deficit Irrigation (2/3FullIrrig)					
Brennan	21.2	83	12755	10.6	52.4	16.1	62.7	35.6	402
Buck Pronto	25.8	83	10778	10.5	73.4	14.8	61.8	42.1	382
Cabernet	20.2	82	12951	10.4	61.0	13.6	63.0	35.1	316
Expresso	24.7	83	12027	11.2	78.1	14.2	62.6	37.8	301
McNeal	28.4	85	11286	10.6	79.1	14.1	61.9	40.4	504
Solano	22.8	85	11316	10.6	77.3	14.2	62.8	40.2	356
Volt	25.9	85	12622	11.4	80.7	13.0	63.5	36.0	385
WB Rockland	23.0	85	10882	12.4	66.5	15.8	60.9	41.8	292
				One Irrigation Event terminated Early (FullIrrig-1)					
Brennan	21.3	84	12322	10.6	58.8	15.9	62.9	36.9	421
Buck Pronto	25.6	84	10959	10.6	70.5	14.6	62.1	41.5	367
Cabernet	21.3	83	12539	10.6	70.2	13.7	63.3	36.4	320
Expresso	25.0	85	11854	11.5	78.6	14.6	62.3	38.4	277
McNeal	28.4	87	11390	11.2	84.0	13.9	61.7	40.1	517
Solano	23.0	85	11356	12.7	76.1	14.6	61.3	40.1	323
Volt	27.2	86	12550	12.2	90.4	13.4	62.9	36.2	371
WBRockla	22.8	87	10977	11.0	67.9	15.2	61.5	41.4	290
				Two Irrigation Events Terminated Early (FullIrrig-2)					
Brennan	21.1	83	12553	10.5	57.4	15.7	62.7	36.2	425
Buck Pronto	25.6	83	11519	10.3	68.4	14.0	62.1	39.6	376
Cabernet	21.3	82	12337	10.5	70.3	13.7	62.8	36.9	321
Expresso	25.4	86	12049	11.5	76.5	14.6	61.9	37.7	349
McNeal	29.4	87	11271	11.0	86.7	13.7	61.8	40.3	521
Solano	23.3	86	11556	10.6	79.8	14.2	62.9	39.3	355
Volt	26.9	87	13754	11.2	80.9	13.0	63.5	33.1	393
WB Rockland	22.9	87	11966	12.3	70.8	16.0	61.0	38.2	313
				Three Irrigation Events Terminated Early (FullIrrig-3)					
Brennan	21.2	79	12597	10.7	49.7	15.3	62.6	36.2	413
Buck Pronto	25.3	81	11510	10.3	63.4	14.9	61.3	39.5	384
Cabernet	20.6	81	12609	10.6	63.4	13.5	62.6	36.1	359
Expresso	23.8	83	12428	10.7	69.6	14.6	62.0	36.7	310
McNeal	26.2	81	12270	11.5	70.0	13.9	60.7	37.4	471
Solano	23.3	83	12419	10.7	68.3	14.2	62.3	36.7	354
Volt	25.2	82	13204	10.8	78.8	13.1	63.4	34.6	400
WB Rockland	21.1	83	11556	11.7	65.7	15.3	61.4	39.4	324
				Dryland					
Brennan	20.5	76	14993	10.3	25.5	15.4	61.8	30.3	449
Buck Pronto	22.7	78	12645	10.0	36.2	14.8	61.2	36.0	399
Cabernet	16.7	76	14765	10.3	25.6	14.3	61.2	30.7	361
Expresso	20.8	79	12451	10.1	33.0	15.5	61.3	36.6	298
McNeal	25.1	80	13343	10.2	34.4	14.5	60.7	34.2	535
Solano	20.1	77	12455	10.0	34.6	15.4	61.6	36.5	381
Volt	22.0	79	14479	10.1	40.7	13.3	63.1	31.4	416
WB Rockland	19.8	79	11860	9.8	29.2	16.1	61.3	38.3	323
C.V	13.4	4.3	10.0	11.1	28.3	6.7	1.8	9.7	18.9
LSD	1.4	2.8	715.8	0.8	6.3	ns	0.6	2.4	27.0
$Pr>F_{(0.05)-Irr}$	<.0001	<.0001	<.0001	0.0002	<.0001	0.3347	0.0056	<.0001	0.0026
$Pr>F_{(0.05)-Var}$	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
$Pr>F_{(0.05)-Irr\ x\ Var}$	0.8163	0.7680	0.0115	0.2475	0.3060	0.0035	0.2655	0.0972	0.6269

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

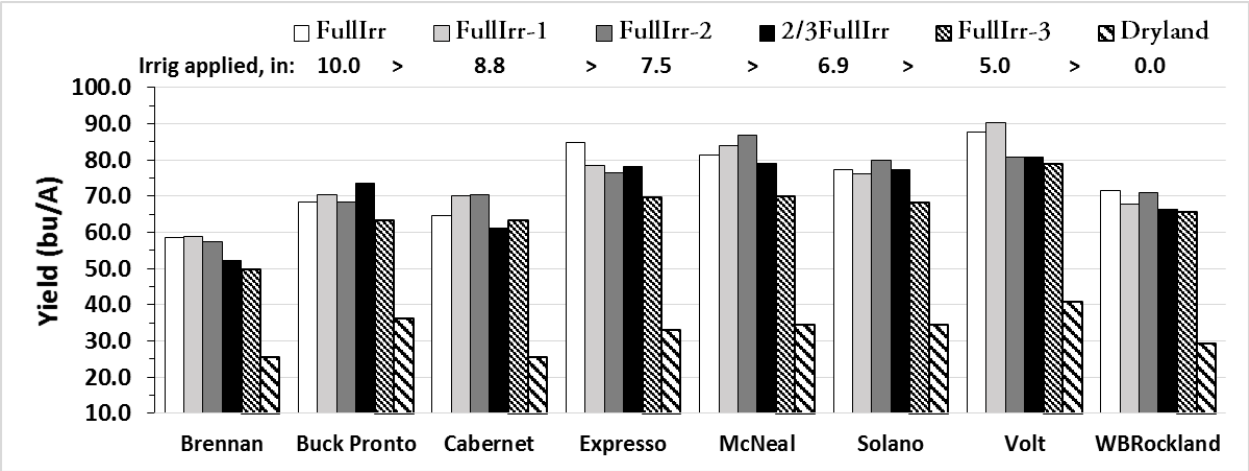

Figure 2. Yield response to water use efficiency of spring wheat on fine sandy loam soil, Creston, MT.

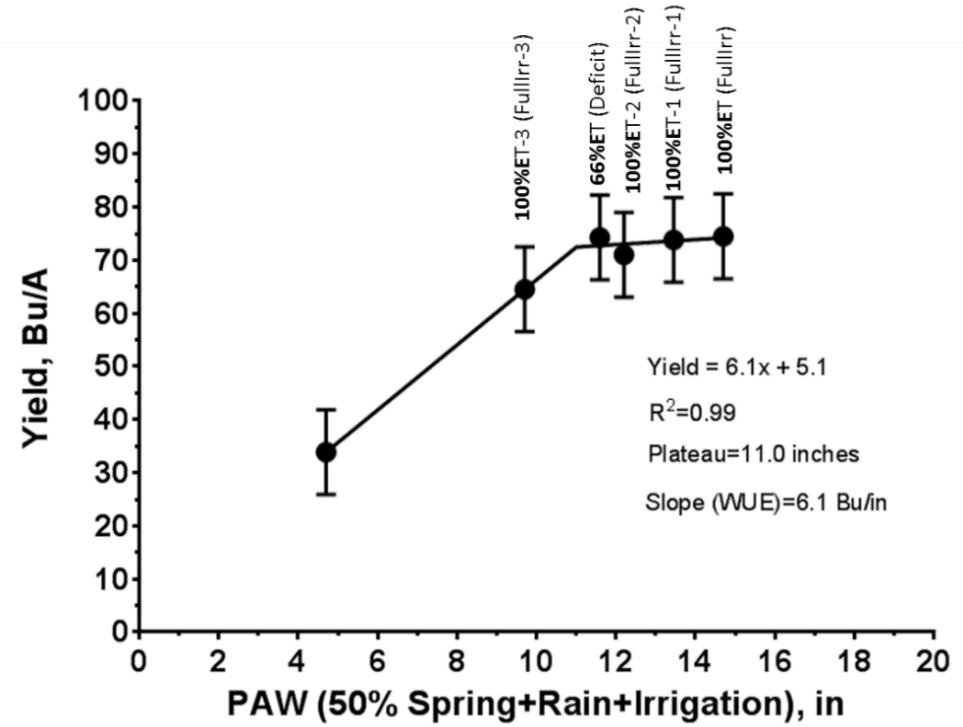

Figure 3. Yield response of spring wheat to water regimes on fine sandy loam soil, Creston, MT.