Spring Wheat Productivity in dryland and irrigated environments

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Mountains & Minds

Montana Wheat and Barley

Goal

Optimal productivity with the rainfall received and applied irrigation

"more crop per drop"(Water for Food Inst)

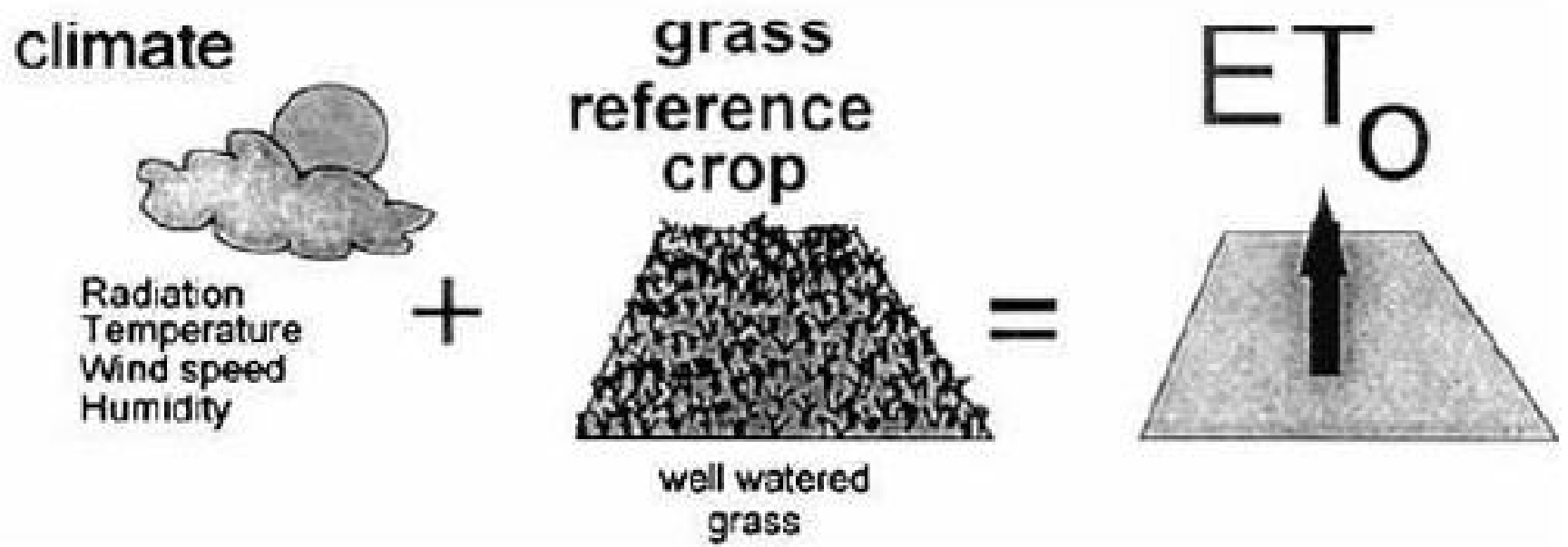
Specific objectives

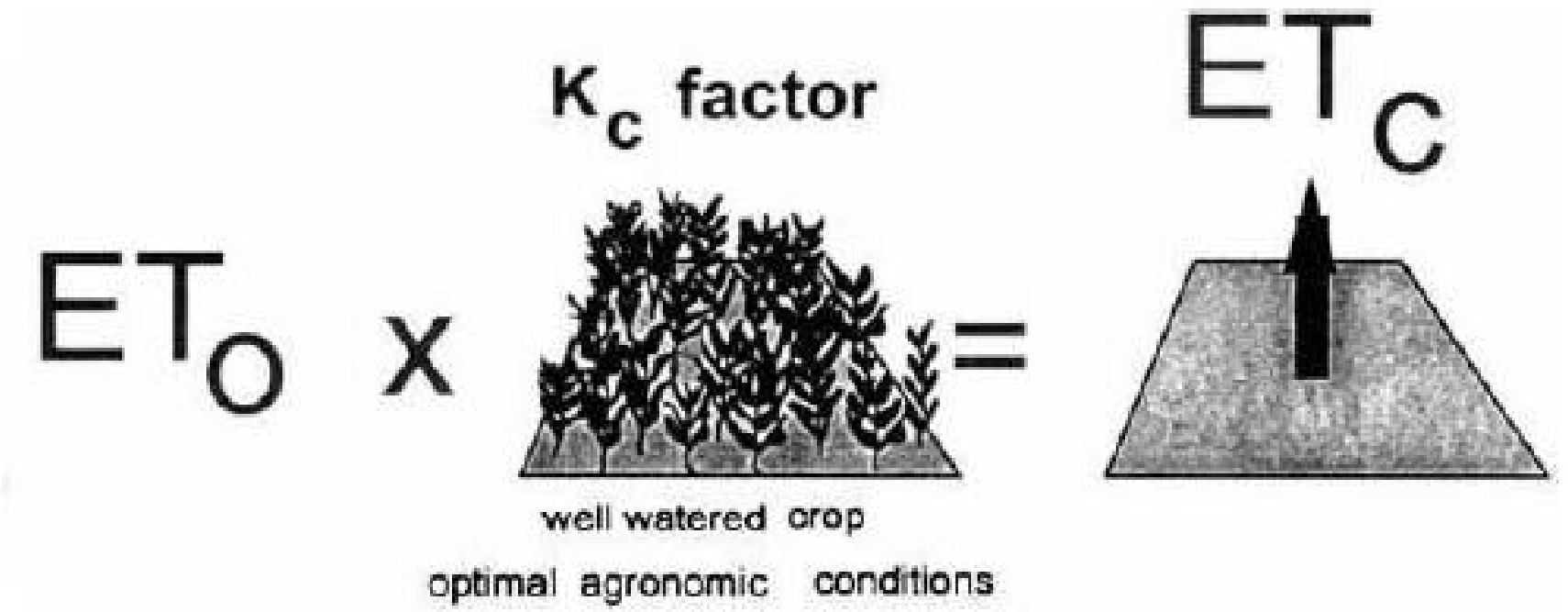
Characterize spring wheat variety response to water regimes – in yield and quality

Creston, Montana AgriMet Weather Station (CRSM)

Latitude: 48.1875 N
Longitude: 114.12777 W
Elevation: 2950'
Installation Date: 4/1/1988

http://www.usbr.gov/pn/agrimet/agrimetmap/crsmda.html





Daily Crop Water Use (Crop ET)

ETc = ETo x Kc

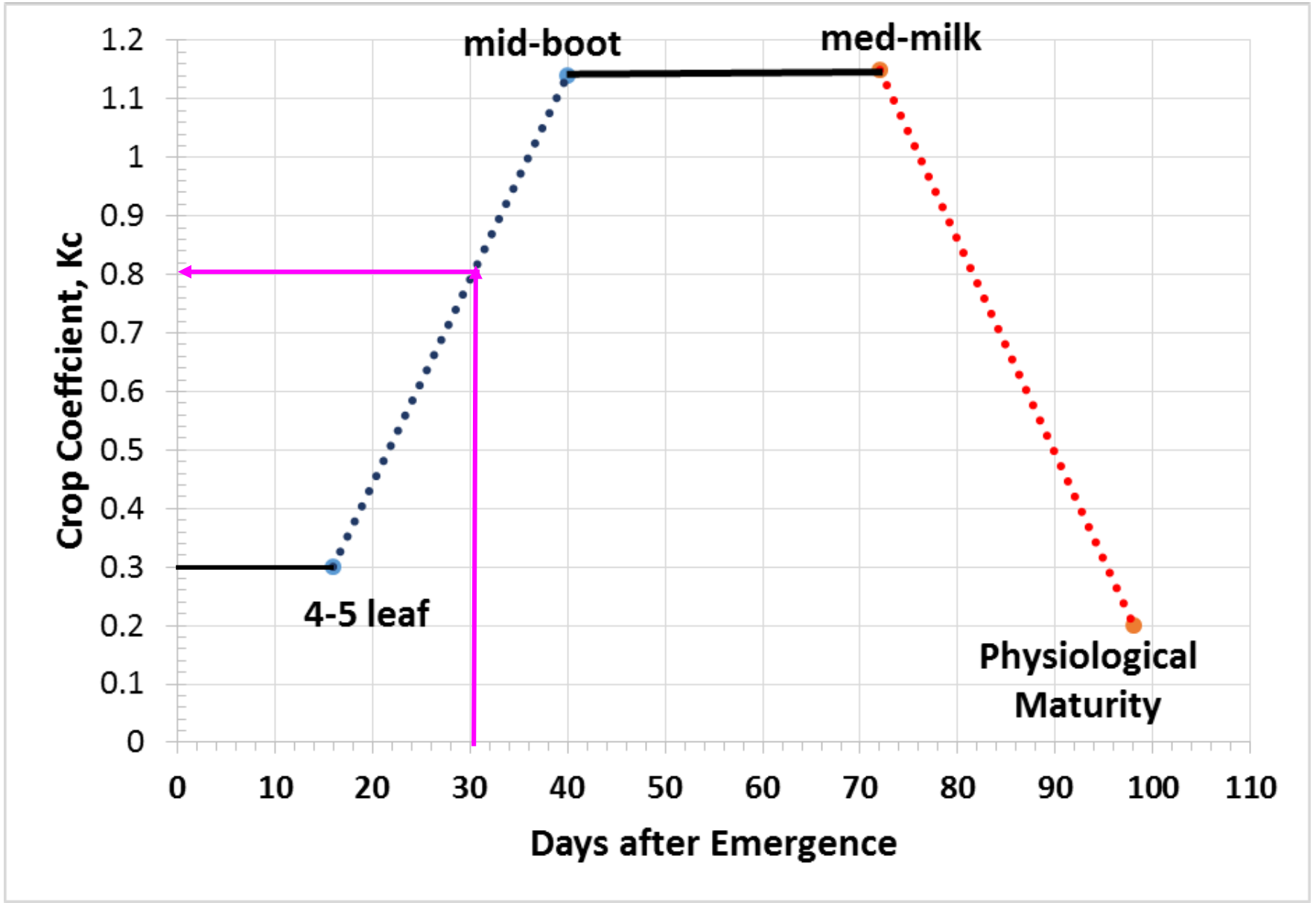
For example:

<u>Creston Weather Station</u>

ETo: <u>0.4</u>

Current Kc: 0.8

ETc= 0.4 x 0.8 = 0.32 inch



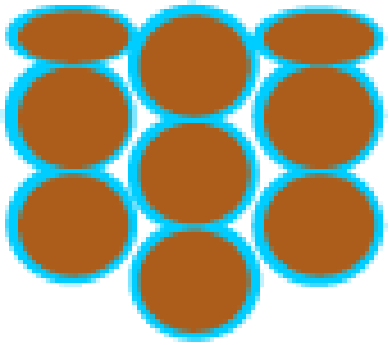
http://www.usbr.gov/pn/agrimet/cropcurves/crop_curves.html

Permanent Wilting Point

Field Capacity

Saturated Water Content

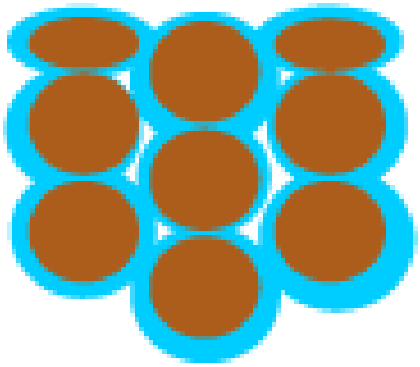
Hygroscopic water



Remaining water adheres to soil particles and is unavailable to plants

Wilting point →

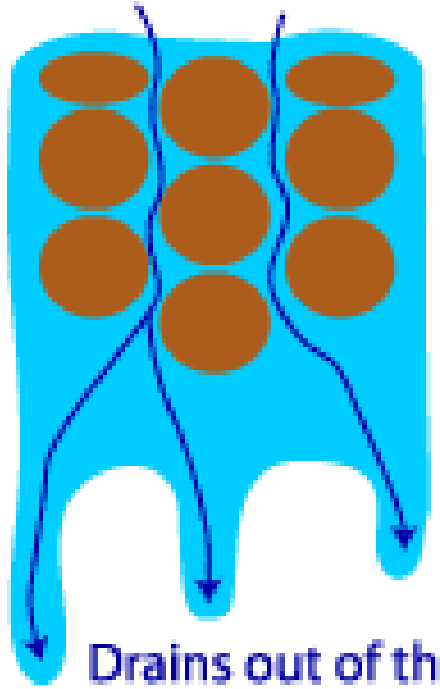
Capillary water



Water held in micropores

Available water- plant roots **can** absorb this

Gravitational water

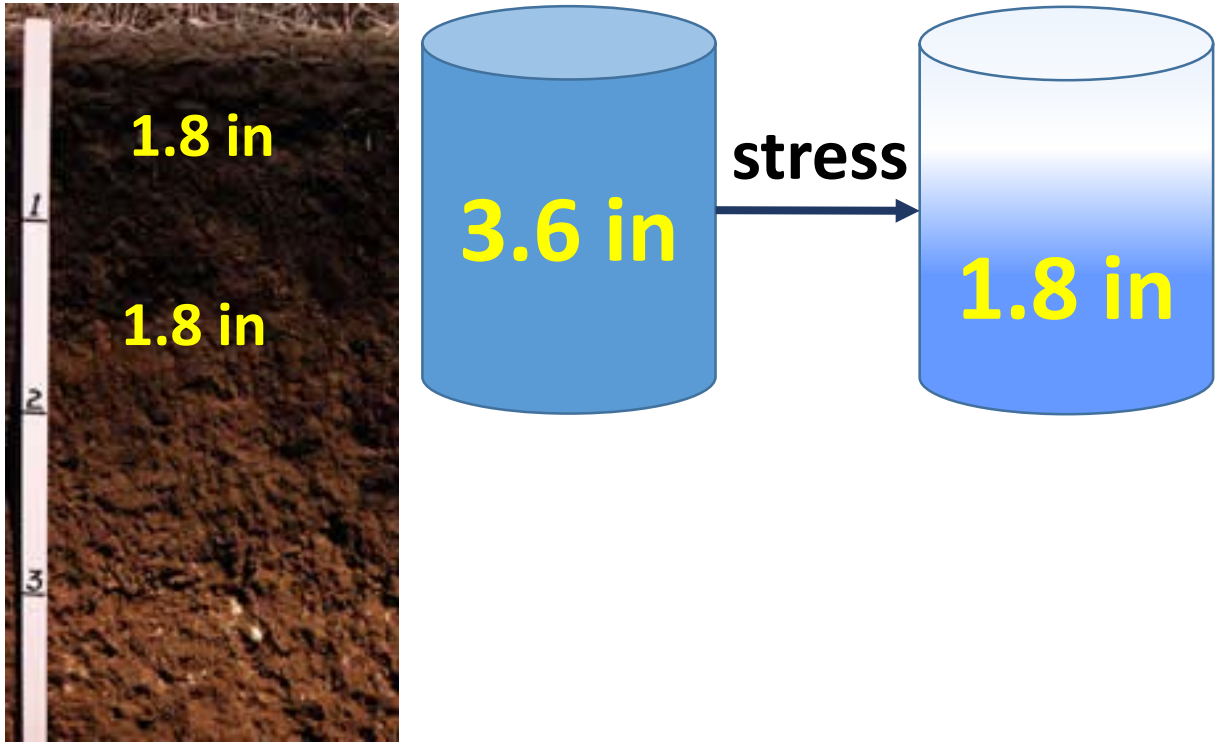


Drains out of the root zone

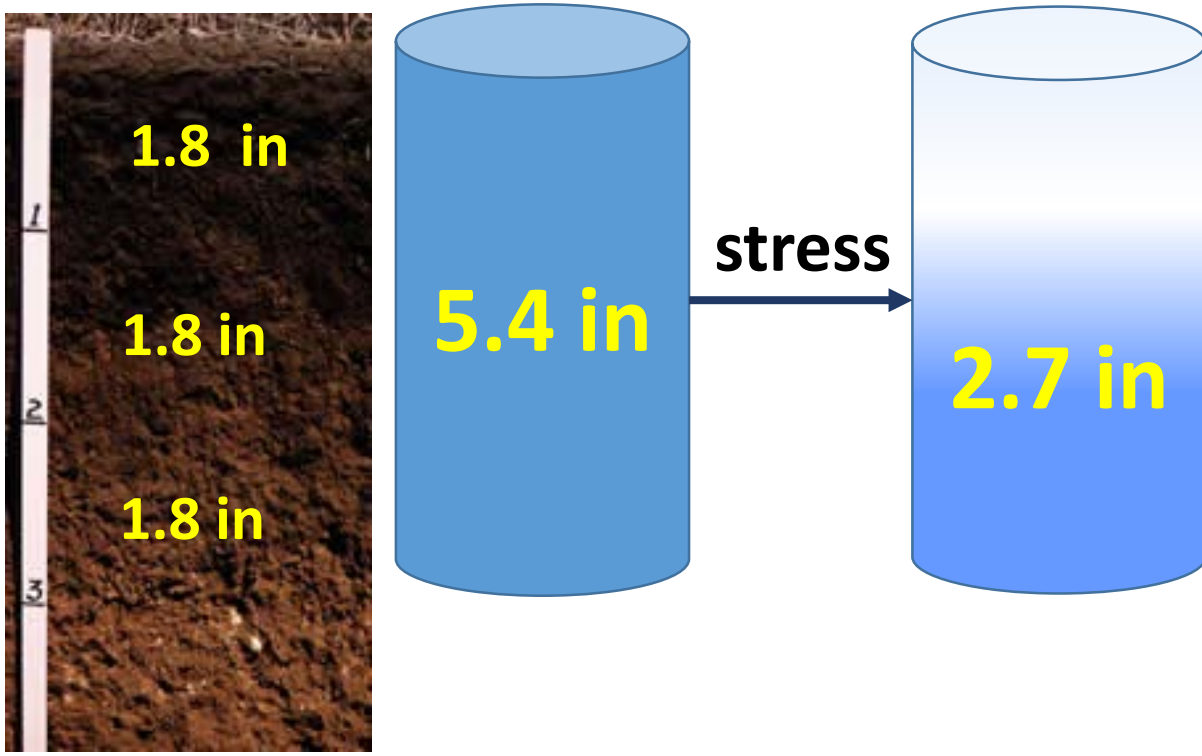
← Field capacity

Available water for plant growth

Water Holding Capacity of a Fine Sandy Loam Soil



1.5 or 2 ft Soil Depth to Consider: early vegetative



3 ft Soil Depth to Consider: ~Boot

$PAW_{Today} = PAW_{yesterday} - CropET - Other\ Losses + Rainfall + Irrigation$

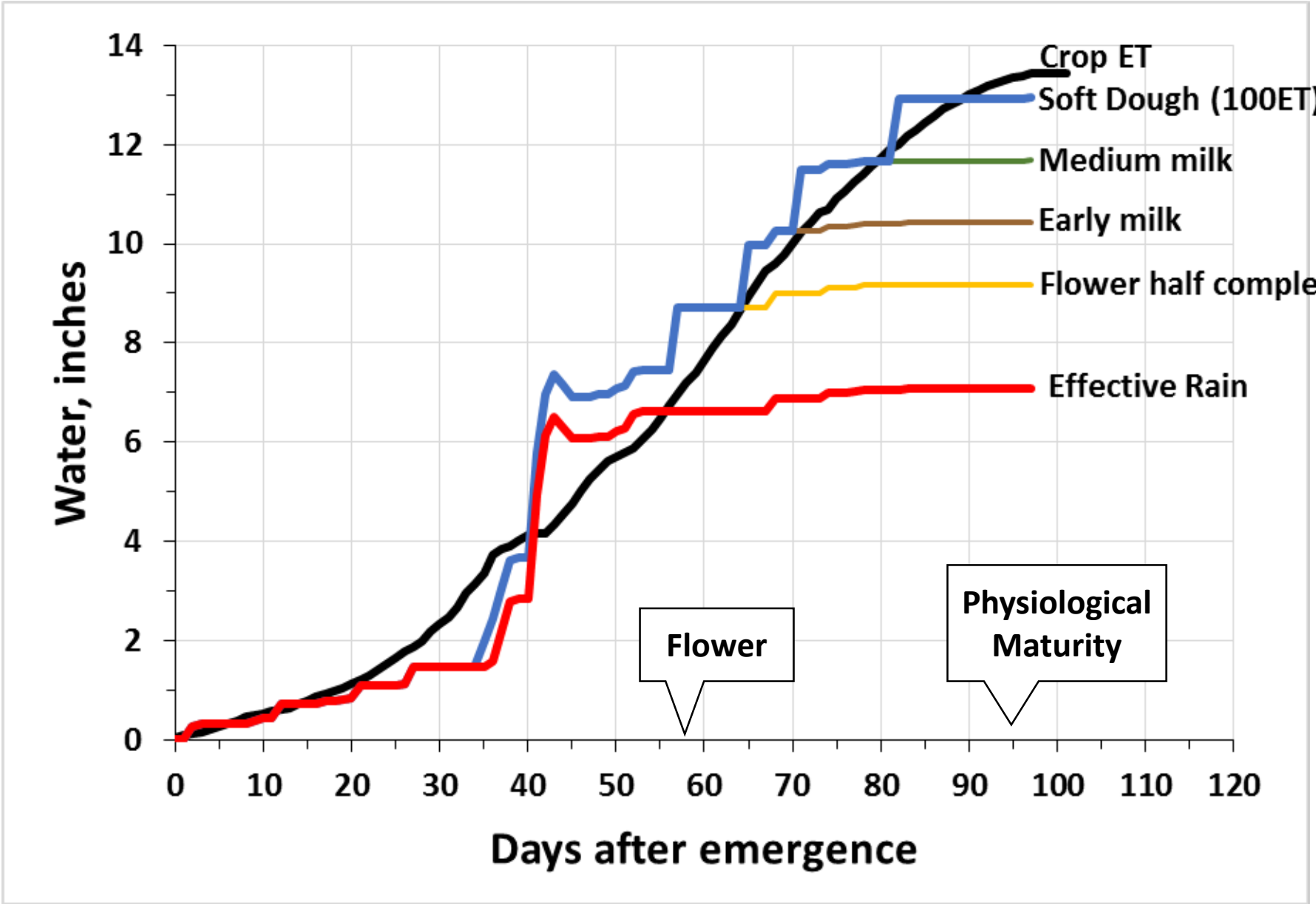
Field Research Set-Up

Water Treatment: 1) Soft dough (100ET), 2) early milk, 3) medium milk, 4) dough and, 5) Rainfed check

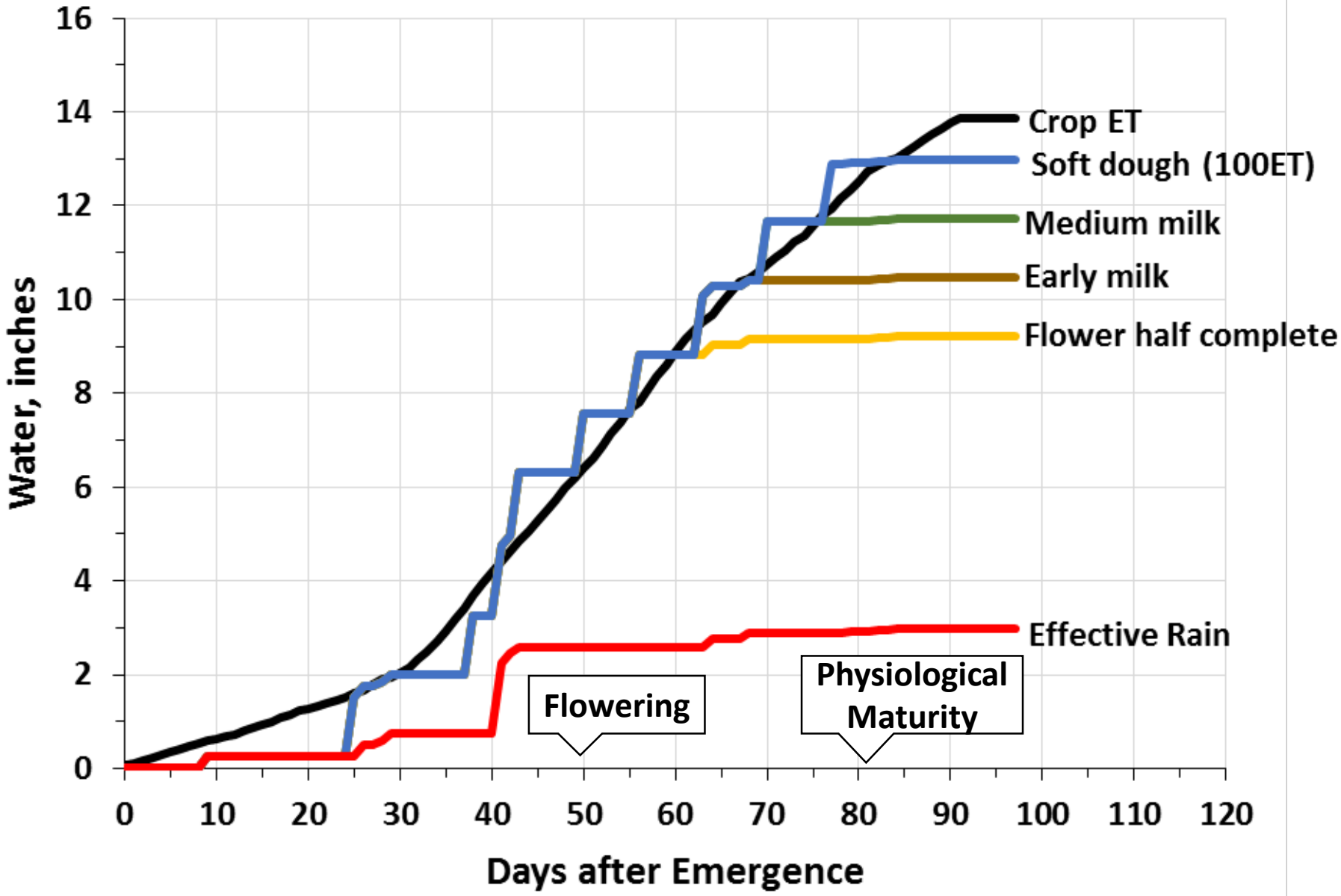
Varieties: Brennan, Buck Pronto, Cabernet, Expresso, McNeal, Solano Volt and WB Rockland

Year	April	May	June	July	August	April-Aug
	Mean Temperature, F					
2014	44.5	53.3	56.9	67.5	64.9	57.4
2015	44.8	54.7	65.1	66.3	65.2	59.2
1989-2015	43.9	52.4	58.4	66.0	64.4	57.0
	Precipitation, in					
2014	0.84	1.6	6.05	0.46	1.88	10.8
2015	0.6	0.62	0.97	0.35	0.16	2.7
1989-2015	1.48	2.04	3.19	1.15	0.95	8.8
	Total Irrigation Applied					
	Soft Dough		Medium milk	Early milk	Flower half complete	
2014	5.8		4.6	3.3	2.1	
2015	10.0		8.8	7.5	5.0	

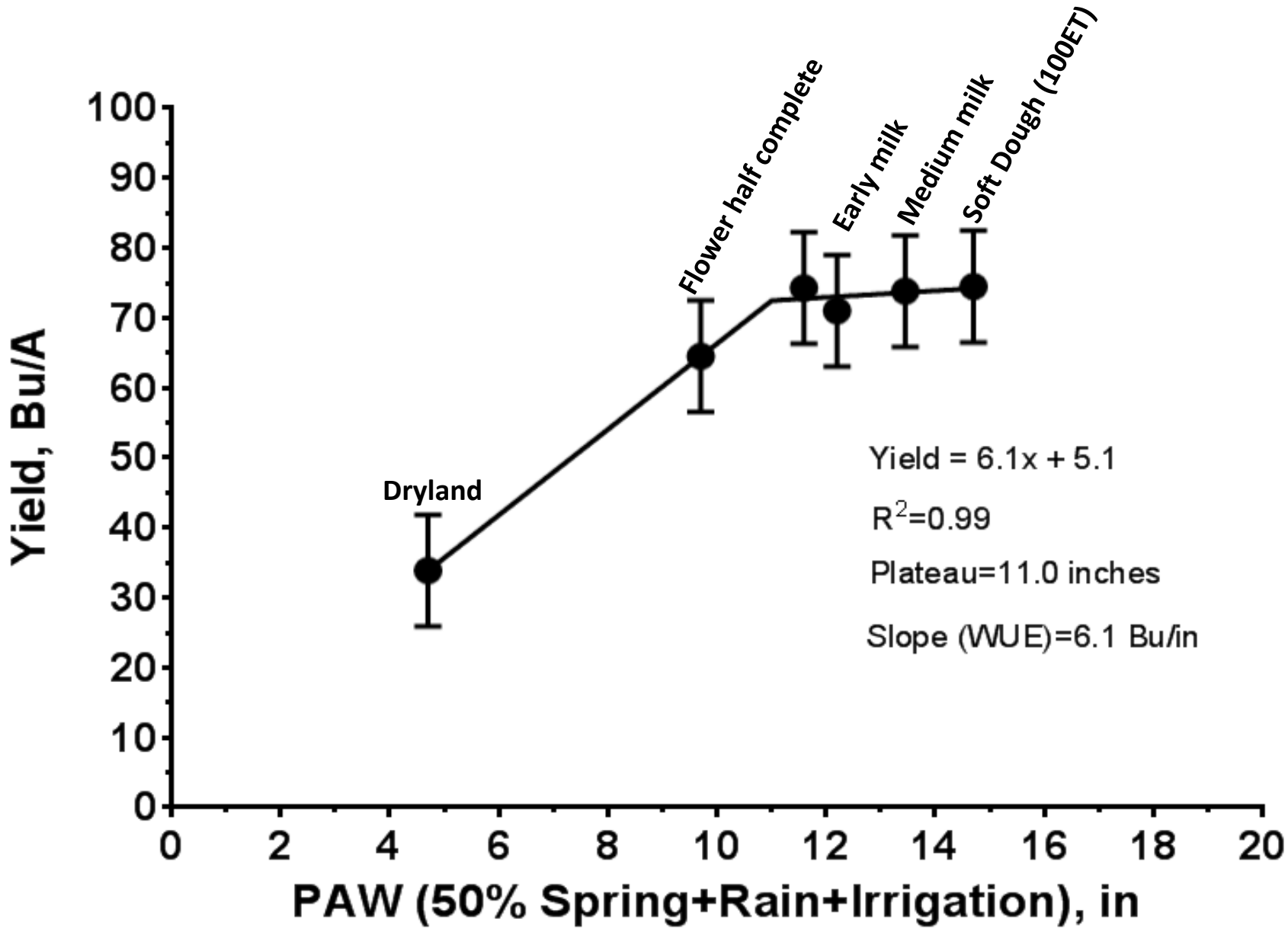
Water Regimes: 2014

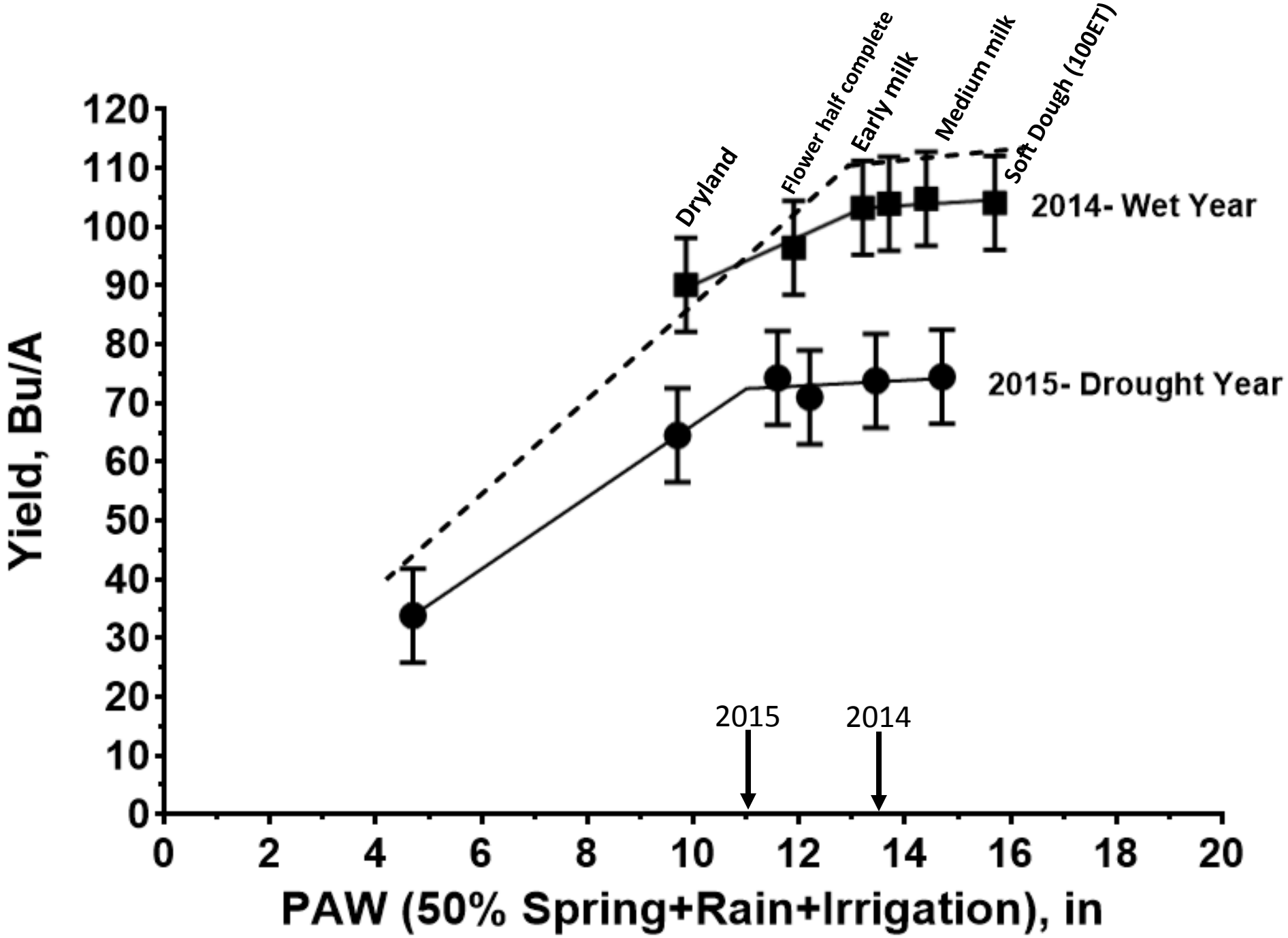


Water Regimes: 2015



Water Productivity and UnProductivity




Dryland
Flower half complete
Early milk
Medium milk
Soft Dough (100ET)
2014- Wet Year
2015- Drought Year
2015
2014
Yield, Bu/A
PAW (50% Spring+Rain+Irrigation), in
0
10
20
30
40
50
60
70
80
90
100
110
120
0
2
4
6
8
10
12
14
16
18
20

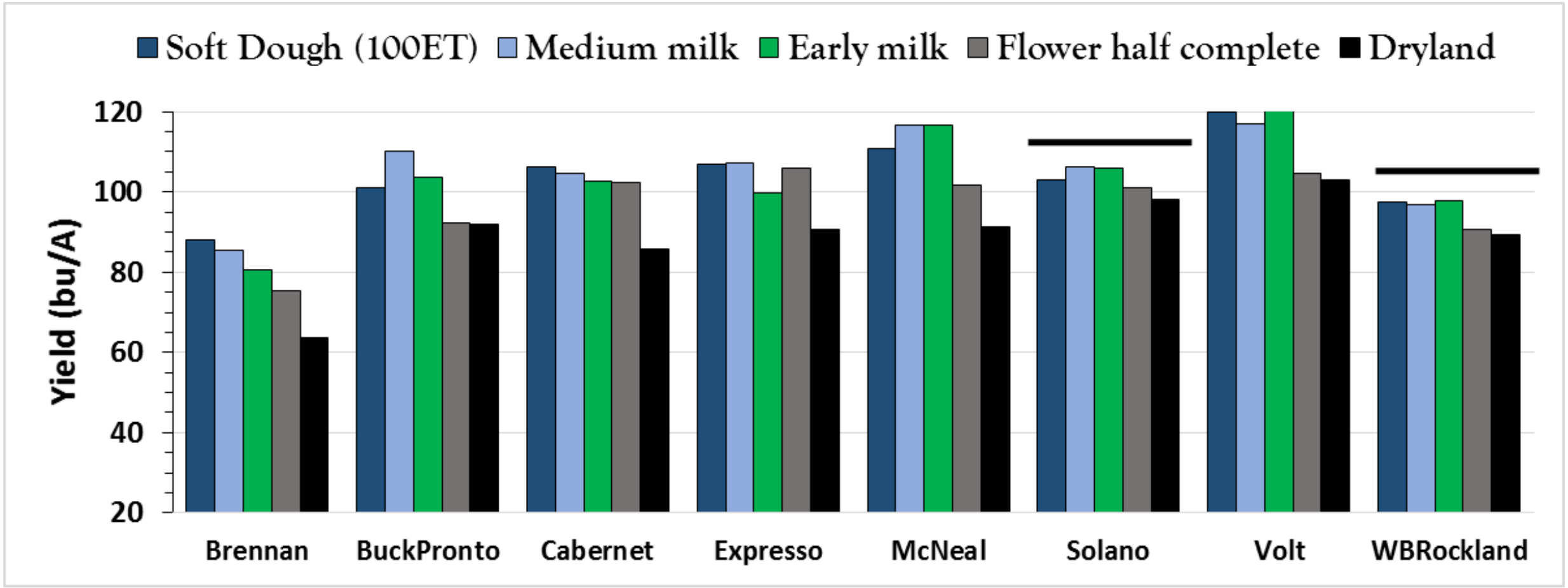
What does this yield plateau mean?

In terms of water, time, and energy cost?

In terms of more crop per drop?
WP= Produce/total water

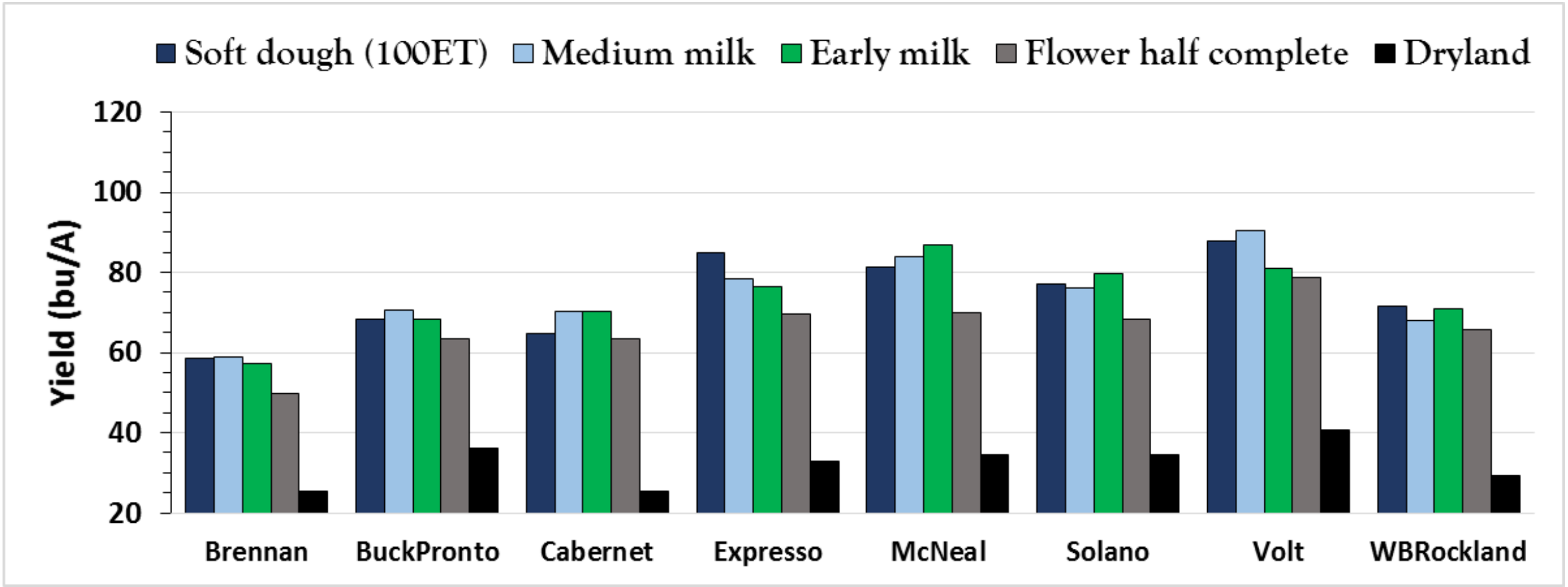
1 acre-inch = 27,154 gallons; 140 acres: 3.8 million gal
~average pumping cost for 1 acre-inch: $5/acre; $700 (140 Acres); x2 $1,400

2014 Yields



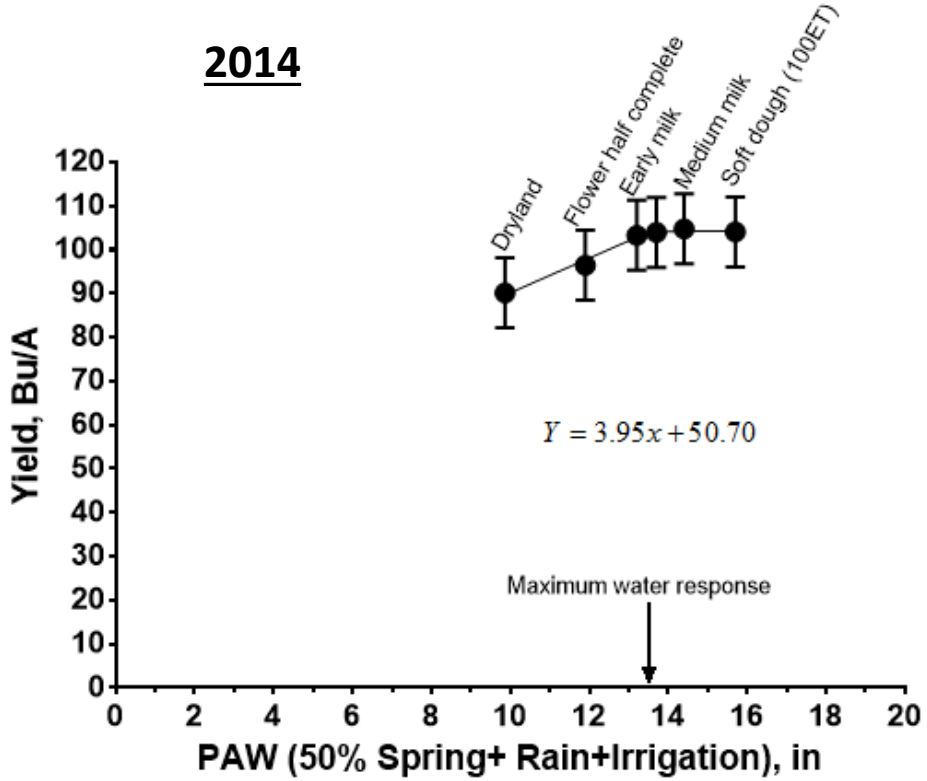
Nonsignificant yield response with water regimes

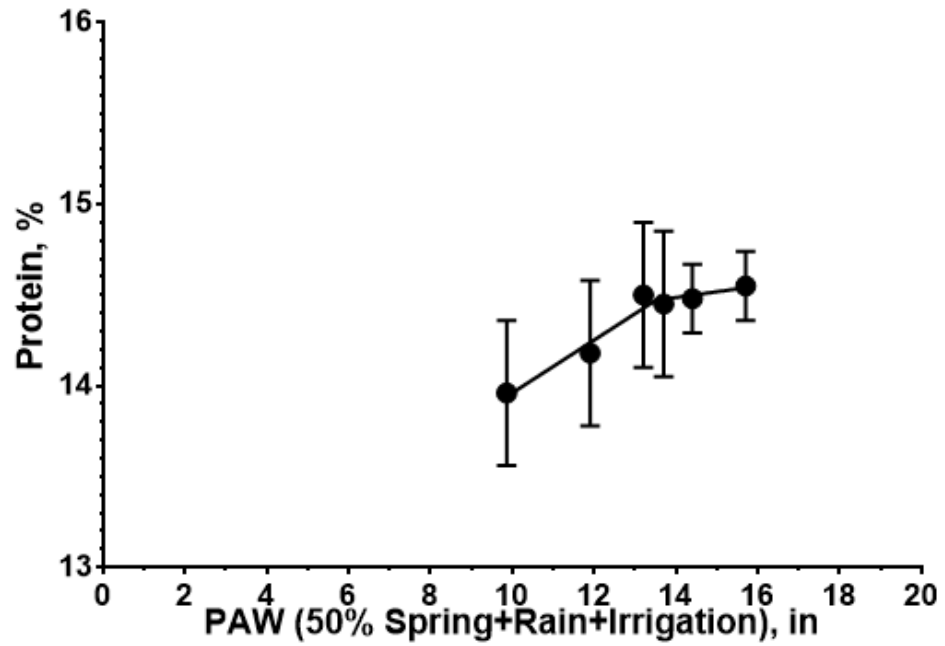
2015 Yields


Soft dough (100ET)
Medium milk
Early milk
Flower half complete
Dryland
Yield (bu/A)
120
100
80
60
40
20
Brennan
BuckPronto
Cabernet
Expresso
McNeal
Solano
Volt
WBRockland

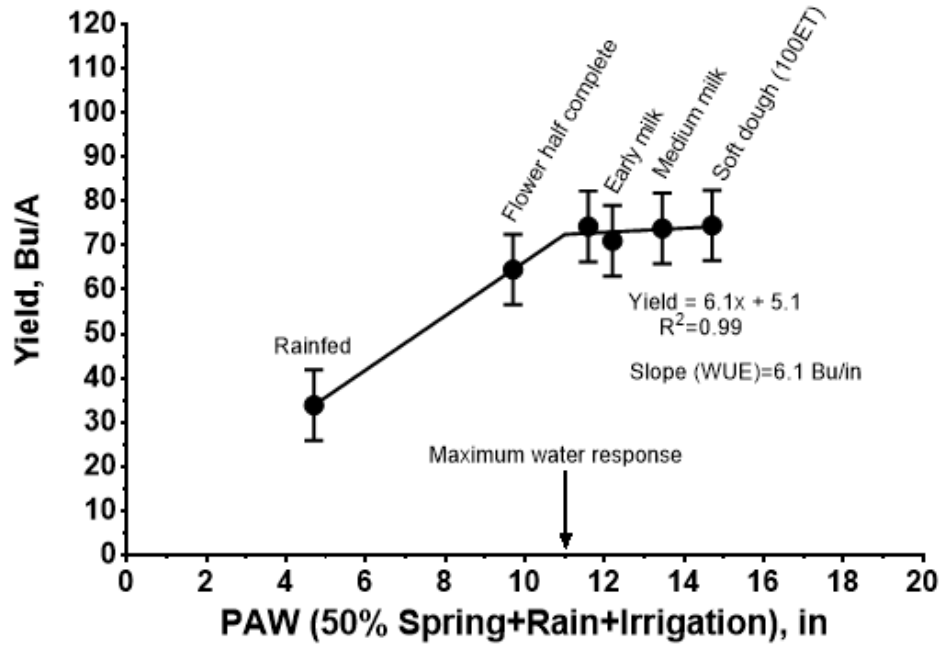
Protein Response: Year x Irrigation x Variety*

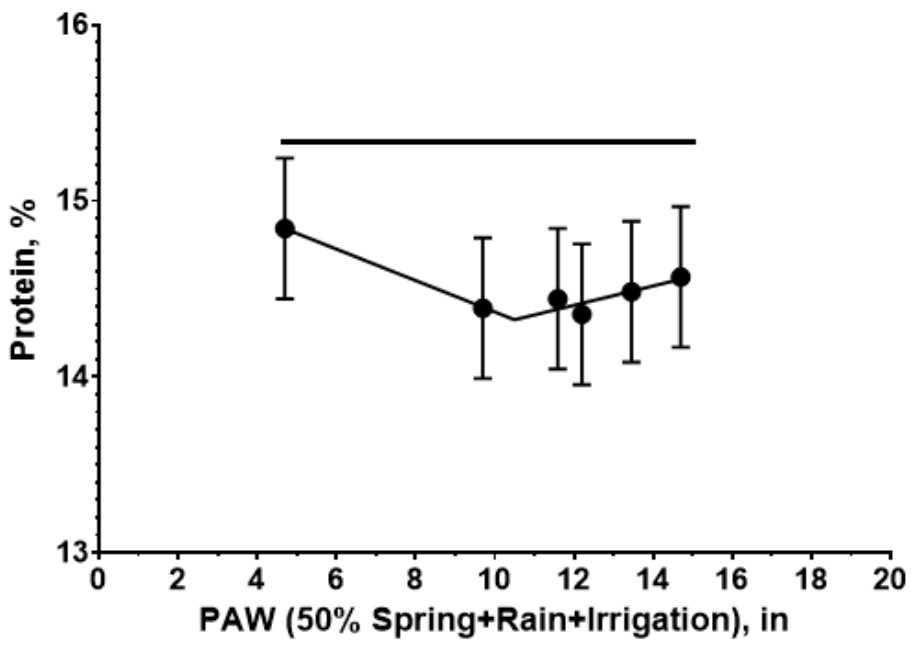
2014



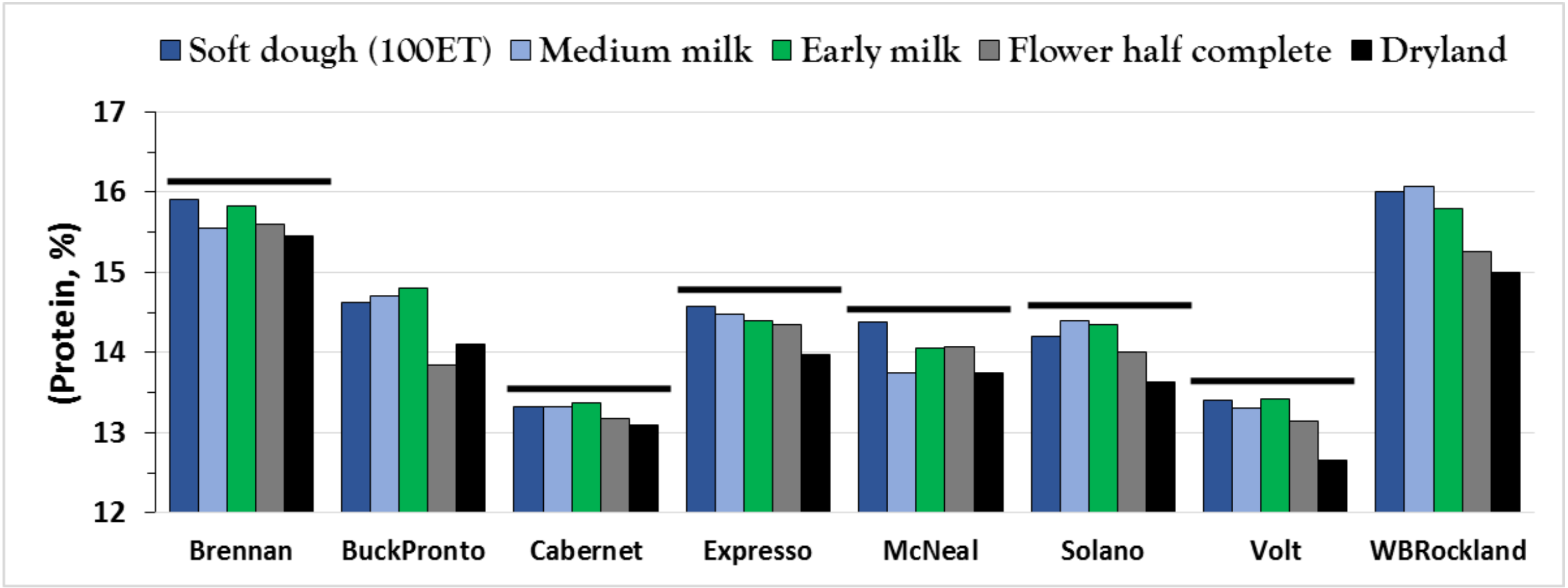


2015





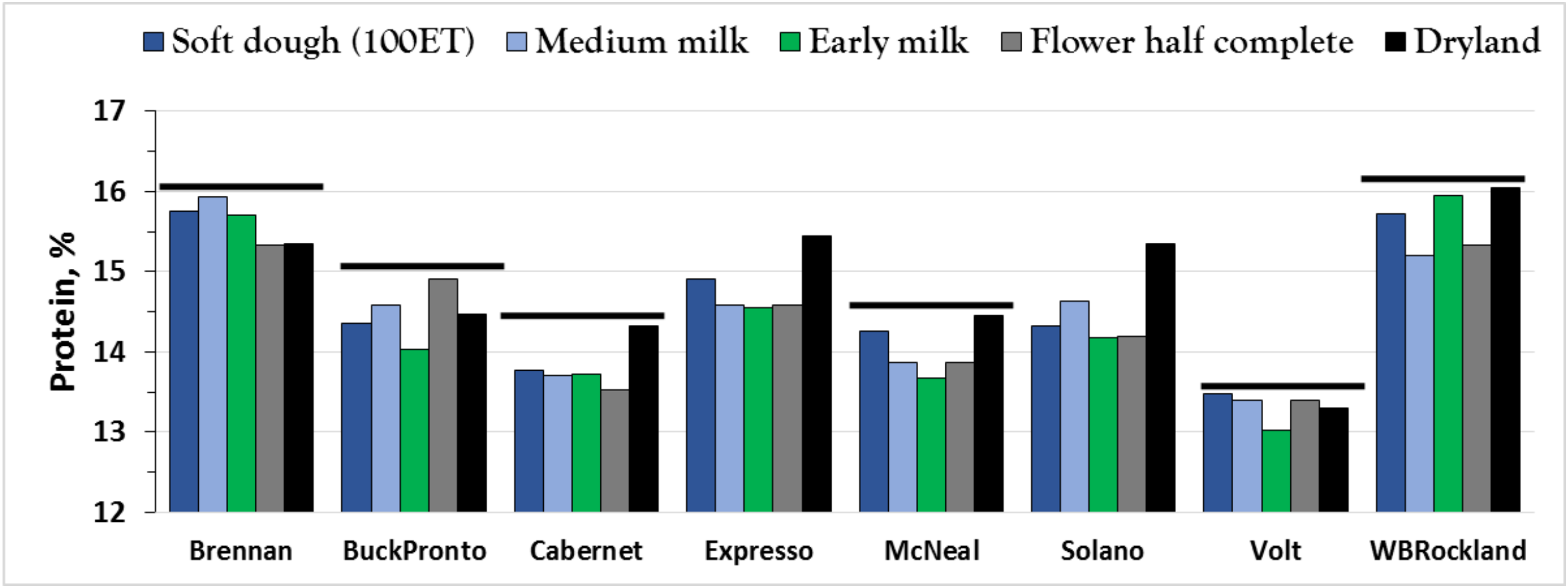
Protein, 2014



Nonsignificant protein response with water regimes

I (*), V (*), I x V (ns)

Protein, 2015

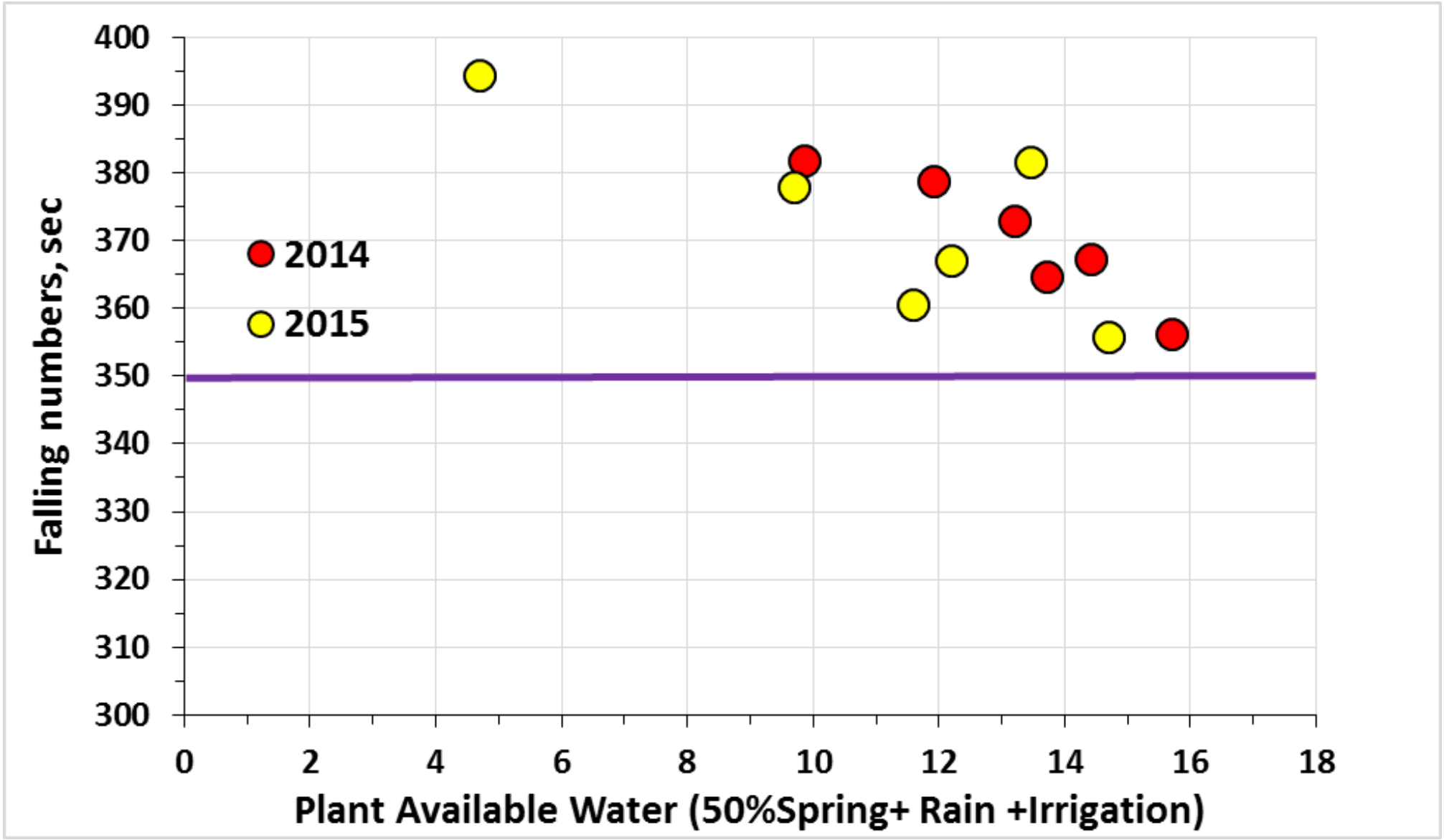


Nonsignificant protein response with water regimes

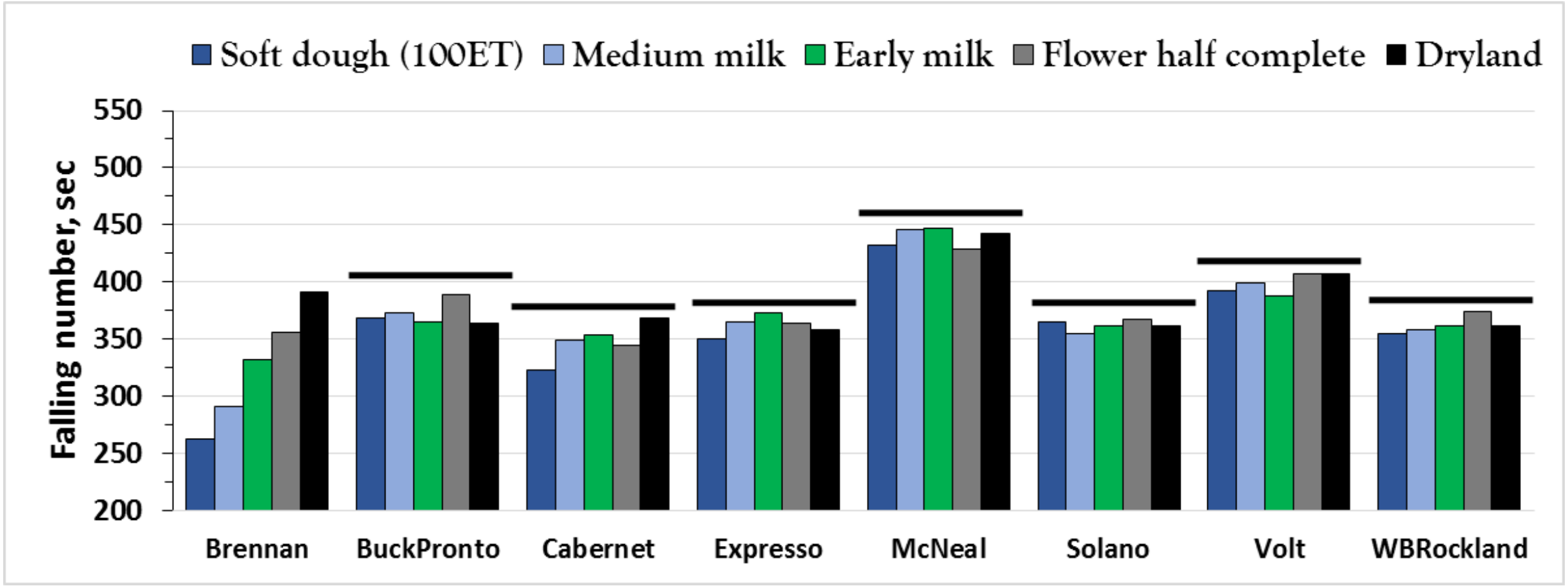
I (ns), V (*), I x V (*)

WUE- STUDY: Fine Sandy Loam

Falling Number



Falling Number, 2014



——— Nonsignificant FN response with water regimes

I (*), V (*), I x V (*)

In Summary:

Water-critical stage in spring wheat:

From seedling establishment to early milk.

- **Consider the water holding capacity of soil, ‘bucket’ size, and make room for storing rain.**

Non-Water Critical stage in spring wheat:

Late milk to dough

- **Schedule Final Irrigation of the season starting early to medium-milk stages**

Yield:

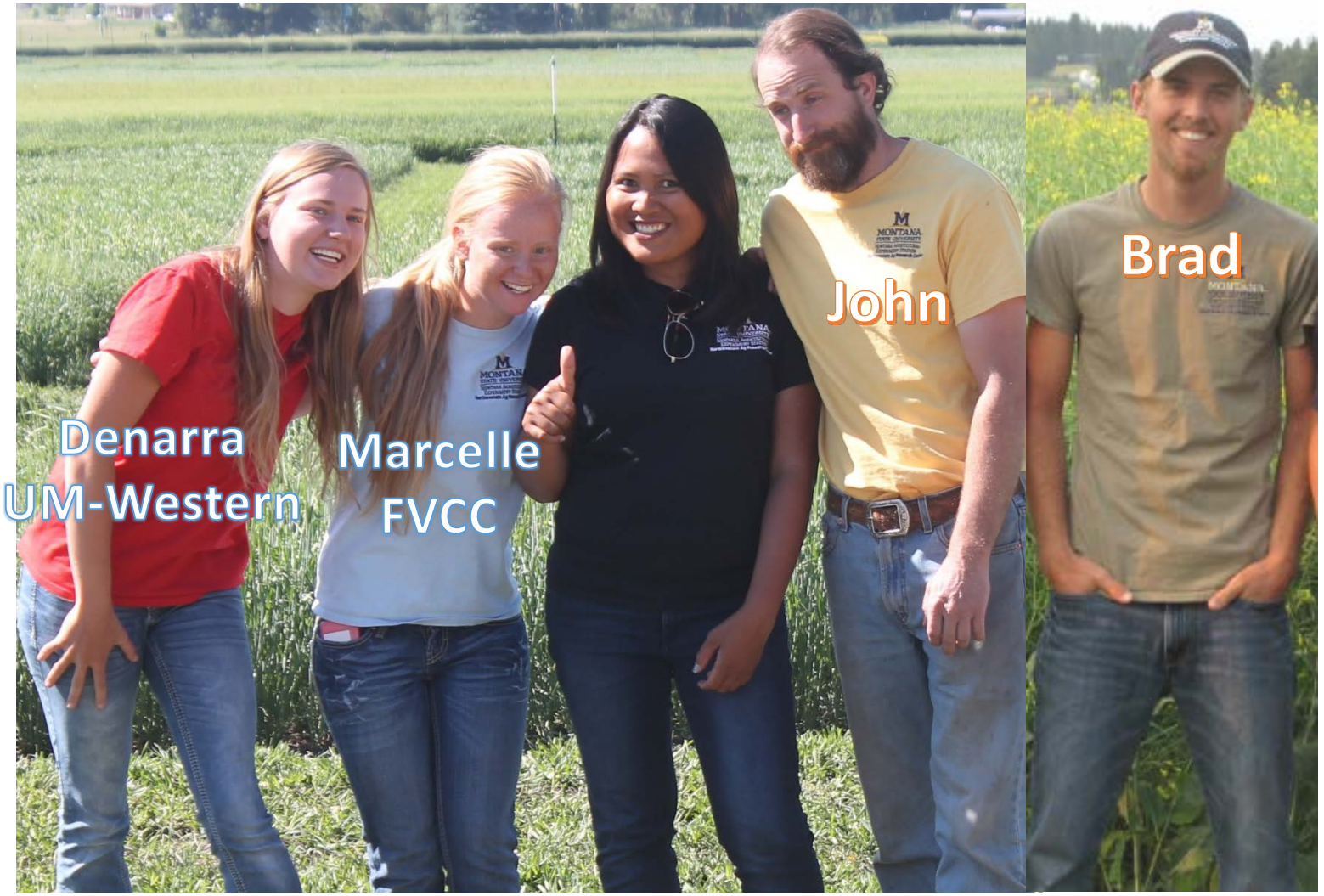
- Yield increased with irrigation (6 Bu per inch water).
- Plateau indicates the limits of water productivity (insensitivity of spring wheat to water at seed-fill).
- Temperature stress limited yield potential of irrigated wheat in 2015

Protein:

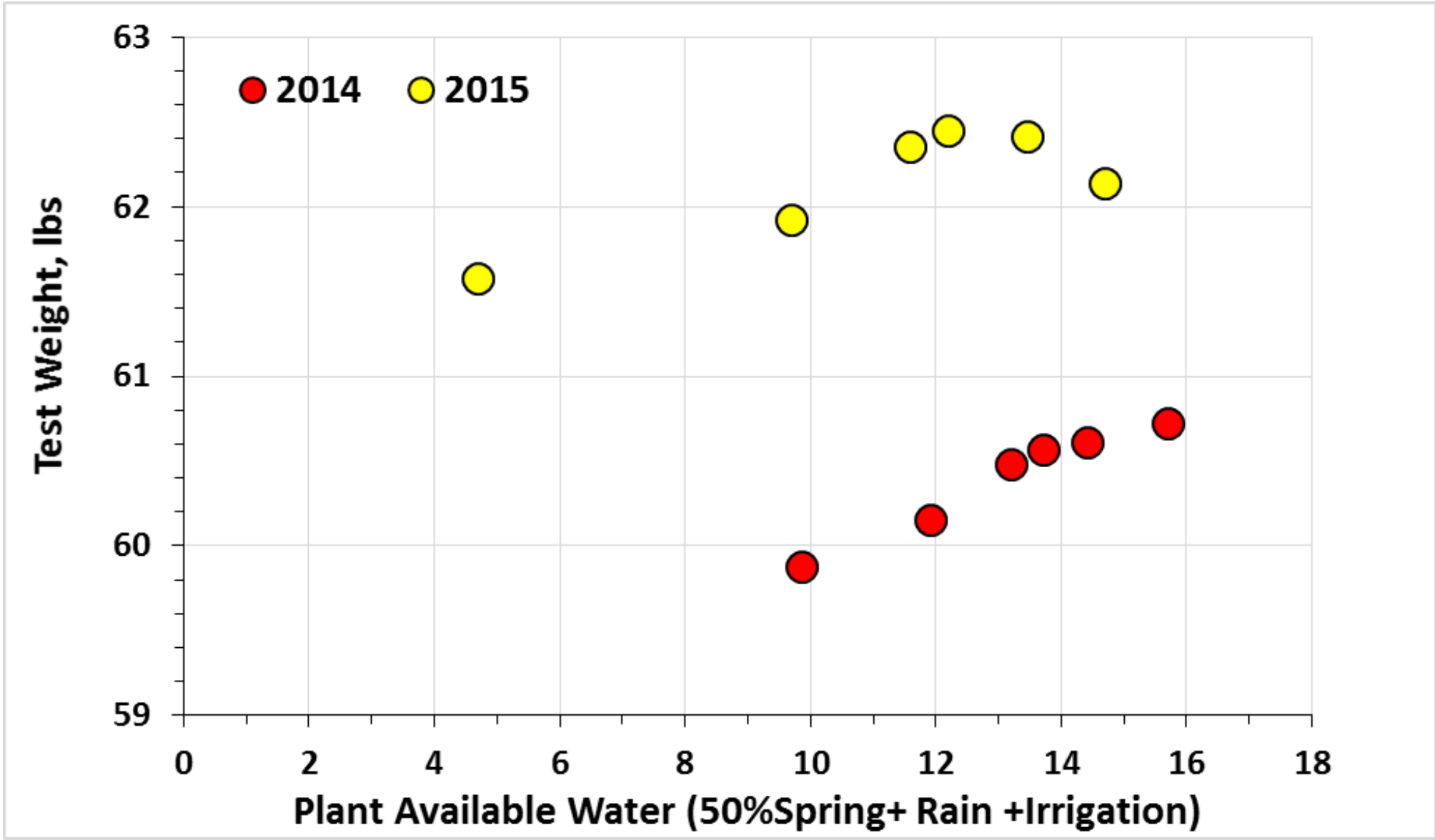
Protein improvement at early milk irrigation is possible in case of 2014 weather- at least 80% of the yield potential was already achieved prior to this irrigation event.

Falling Number:

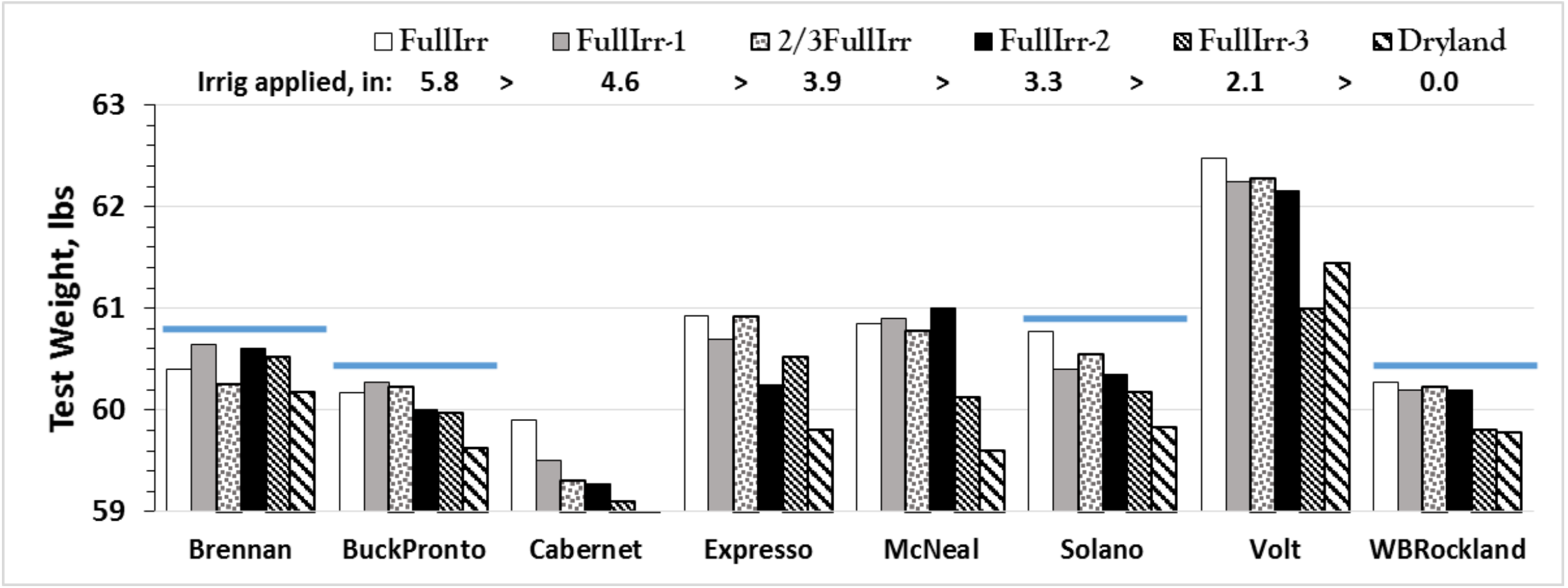
Brennan is the most susceptible to the decrease in falling number with irrigation



Thank you

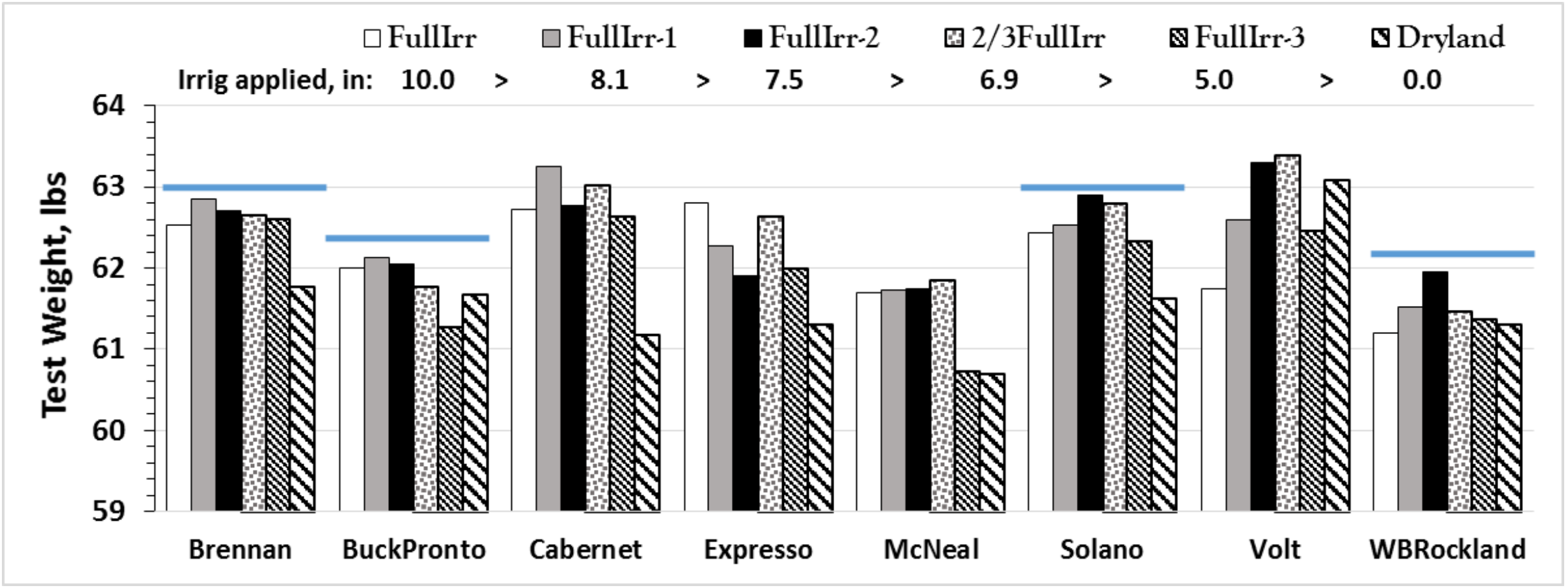

2014
2015
Test Weight, lbs
63
62
61
60
59
0
2
4
6
8
10
12
14
16
18
Plant Available Water (50%Spring+ Rain +Irrigation)

Test Weight, 2014



Nonsignificant TWT response with water regimes

Test Weight, 2015



Nonsignificant TWT response with water regimes