Crop Water Use & Rooting Depth - Crop Rotation for a Dry Cycle

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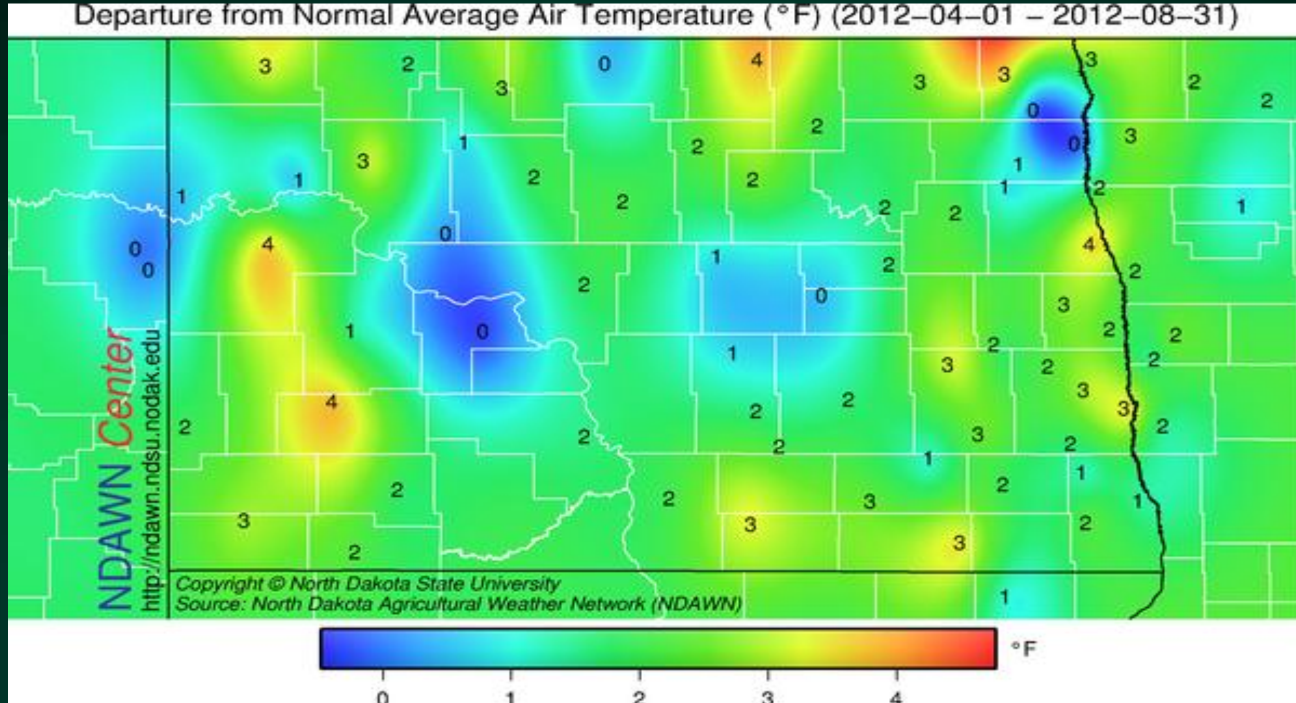
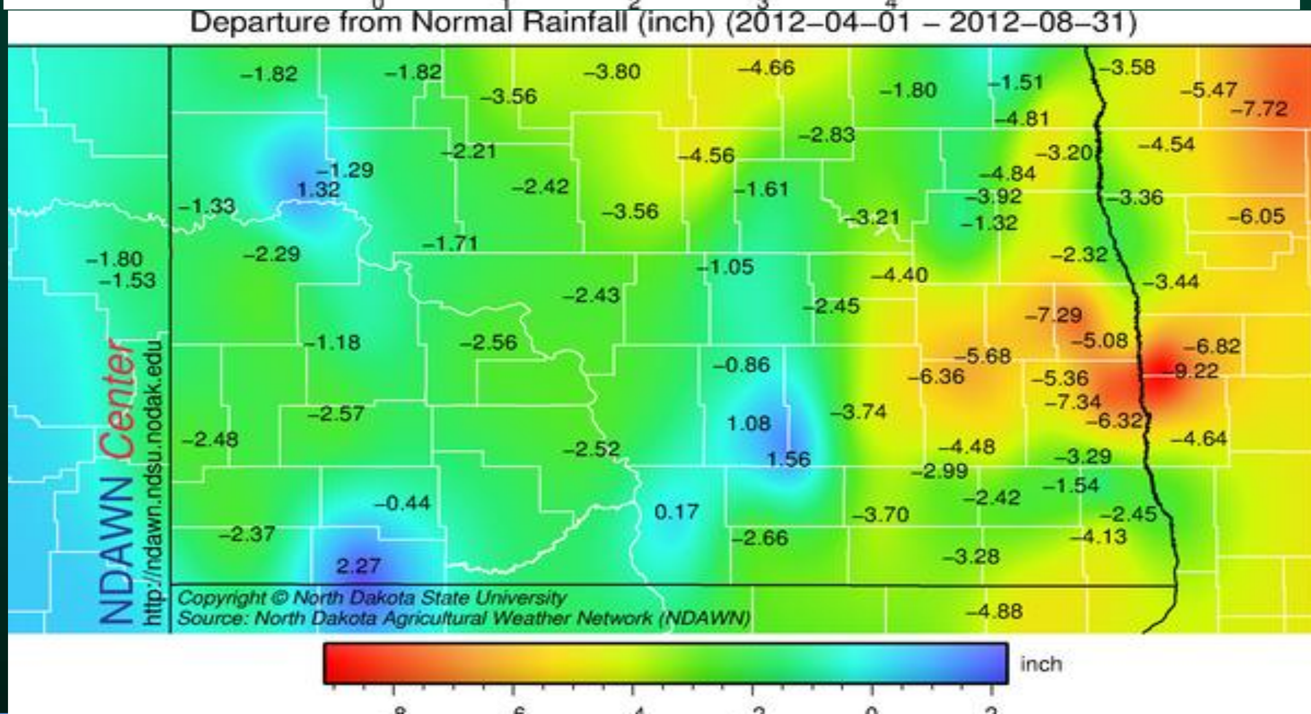

Departure from Normal Average Air Temperature (°F) (2012–04–01 – 2012–08–31)
NDAWN Center
http://ndawn.ndsu.nodak.edu
Copyright © North Dakota State University
Source: North Dakota Agricultural Weather Network (NDAWN)
°F
0
1
2
3
4


Departure from Normal Rainfall (inch) (2012–04–01 – 2012–08–31)
NDAWN Center
http://ndawn.ndsu.nodak.edu
Copyright © North Dakota State University
Source: North Dakota Agricultural Weather Network (NDAWN)
inch

The data cutoff for Drought Monitor maps is Tuesday at 7 a.m. Eastern Time. The maps, which are based on analysis of the data, are released each Thursday at 8:30 a.m. Eastern Time.

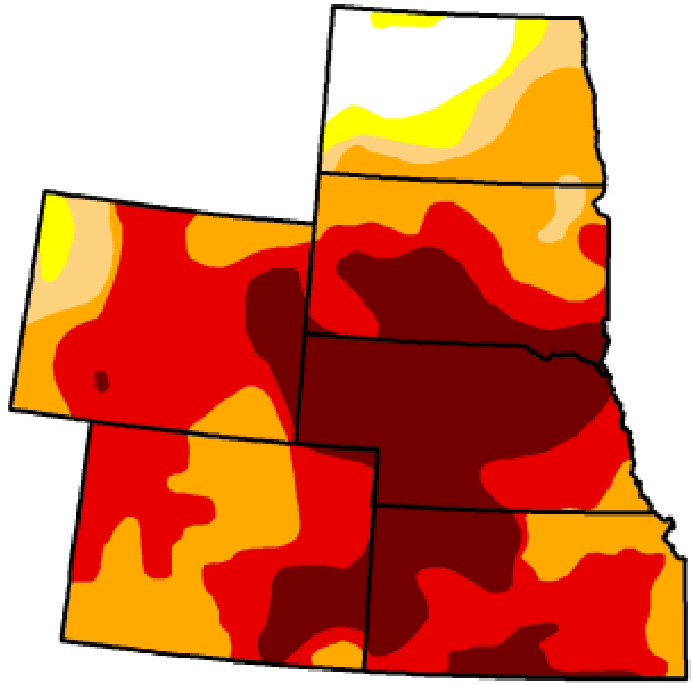
U.S. Drought Monitor

High Plains

January 29, 2013
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	4.79	95.21	92.08	87.25	61.29	27.02
Last Week (01/22/2013 map)	4.79	95.21	92.08	87.25	61.30	27.02
3 Months Ago (10/30/2012 map)	0.00	100.00	98.20	83.87	57.02	27.44
Start of Calendar Year (01/01/2013 map)	1.54	98.46	93.01	86.20	60.25	26.99
Start of Water Year (09/25/2012 map)	0.00	100.00	98.91	83.80	61.28	24.35
One Year Ago (01/24/2012 map)	40.03	59.97	22.86	6.33	2.22	0.04



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu

Released Thursday, January 31, 2013
Mark Svoboda, National Drought Mitigation Center

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Presentation overview

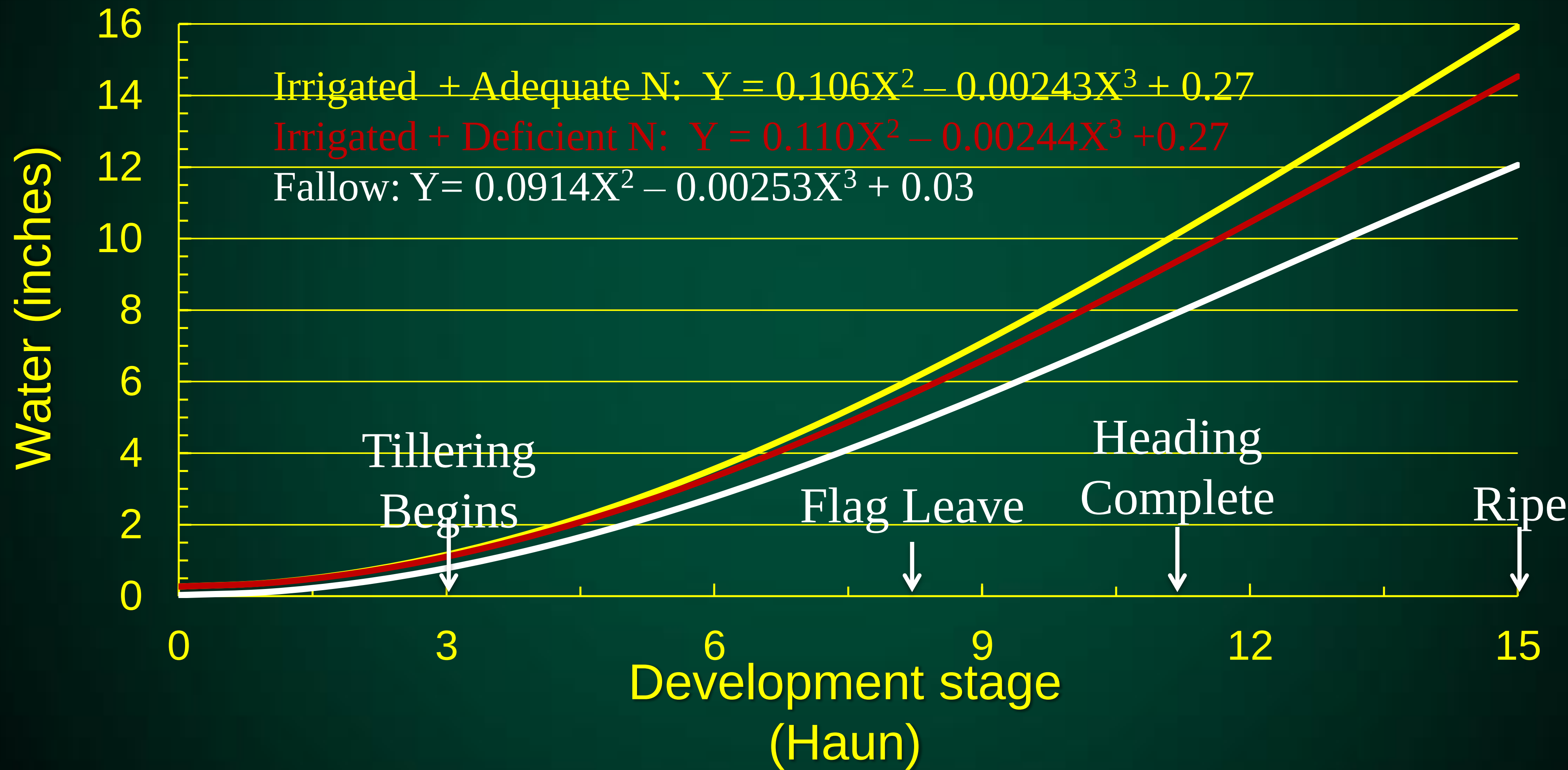
- Topics to be covered:
  - Crop water requirements
  - Soil water holding capacity
  - Rooting depth
  - Water balance calculations

How much water does a crop need?

- Alfalfa = 22 – 24 inches
- Sunflower = 18 -21 inches
- Corn = 19 – 20 inches
- Soybean = 16-17 inches
- Spring wheat = 12 - 16 inches
- Barley = 11 – 16 inches

Scherer

Cumulative water-use by ET, HRSW, 1979-1987 Mandan



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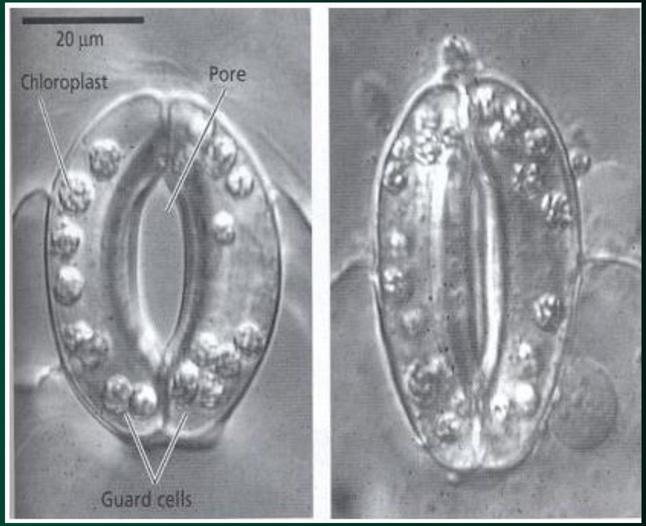
Bauer, Black, Frank, 1989

Water use and drought

- Metabolism
- Structure
- Transpiration
  - Moves nutrients from the roots
  - Regulated by stomatal opening
    - Cooling of plant
    - Movement of water through the plant
    - Movement of CO_2 into the leaves
    - Water use correlates to yield
    - Challenges are to maximize available water for transpiration and maximize efficiency of water use



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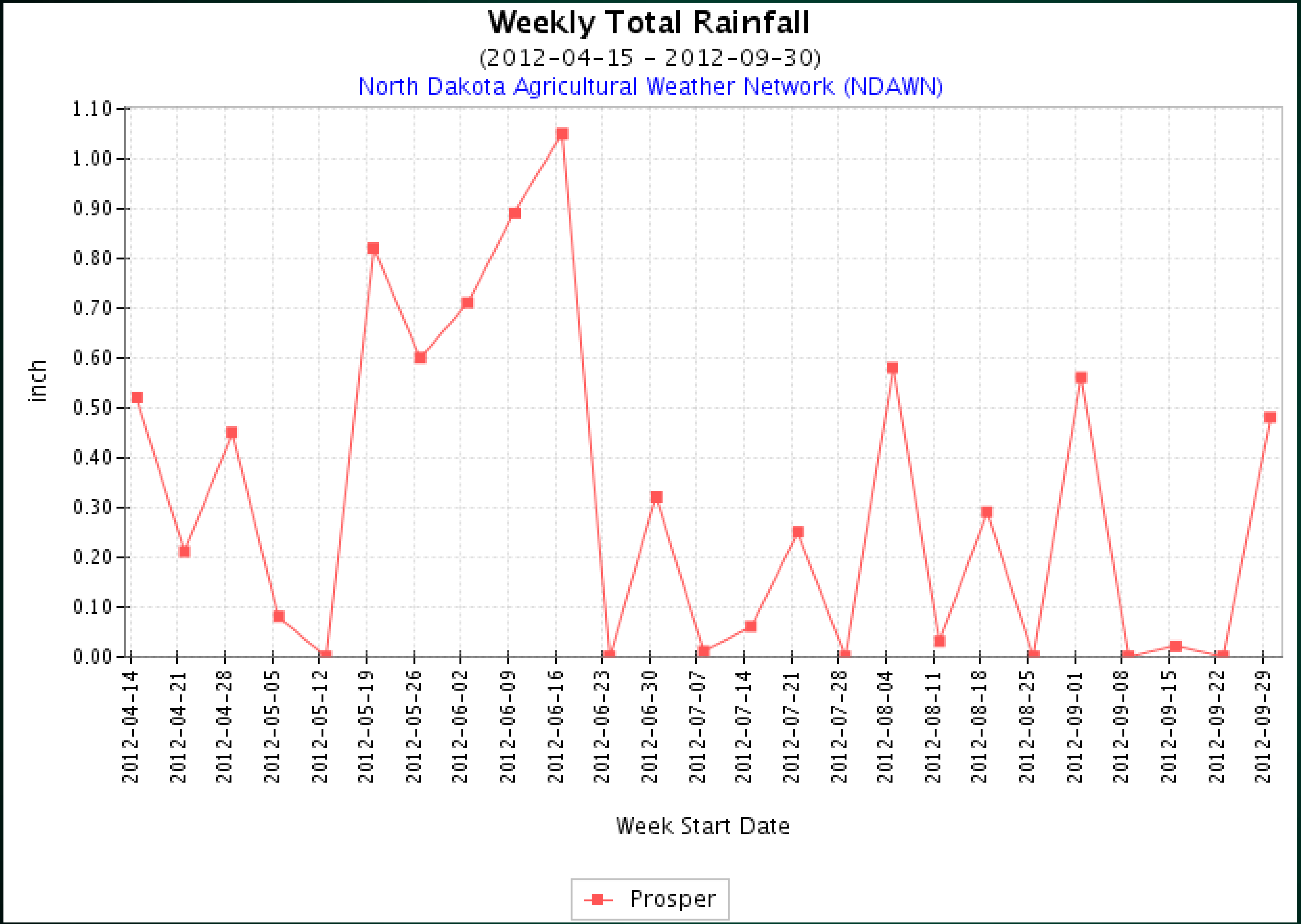
Soil water availability in 2013

- Carryover from the end of the 2012 growing season
  - Soil type
  - Crop type:
    - rooting depth
    - water requirement
    - productivity of the crop
- Recharge during the fall and winter
- Rainfall during the growing season
- Rooting depth of crop



Total rainfall for the period = 7.9 inches

Safe to assume that soil was depleted to the rooting depth of the crop grown (16” needed minus 8” rainfall, 8 removed from the soil or all that it could hold)

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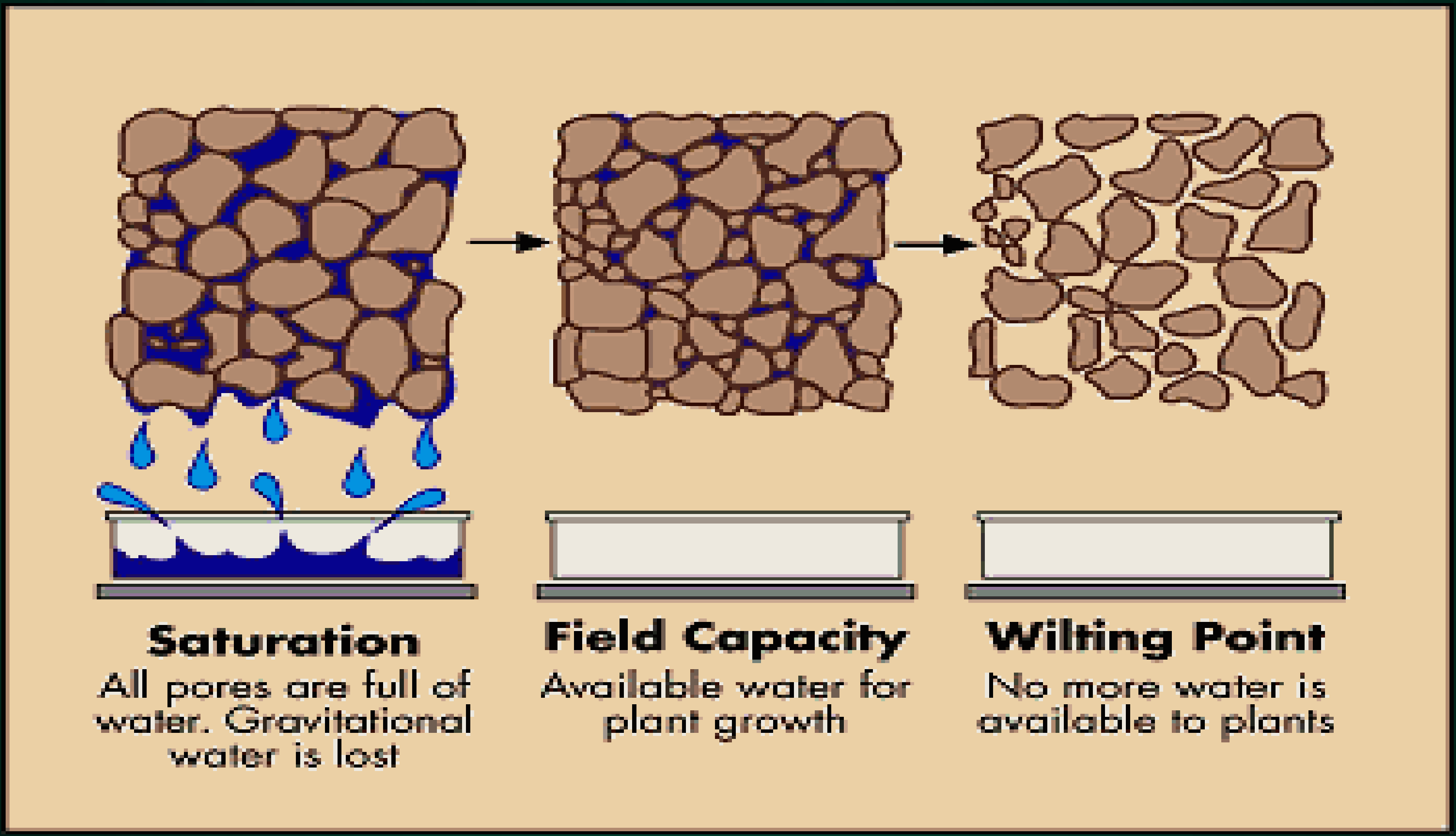
Soil water holding basics



Source: Dept of Agriculture Bulletin 462, 1960

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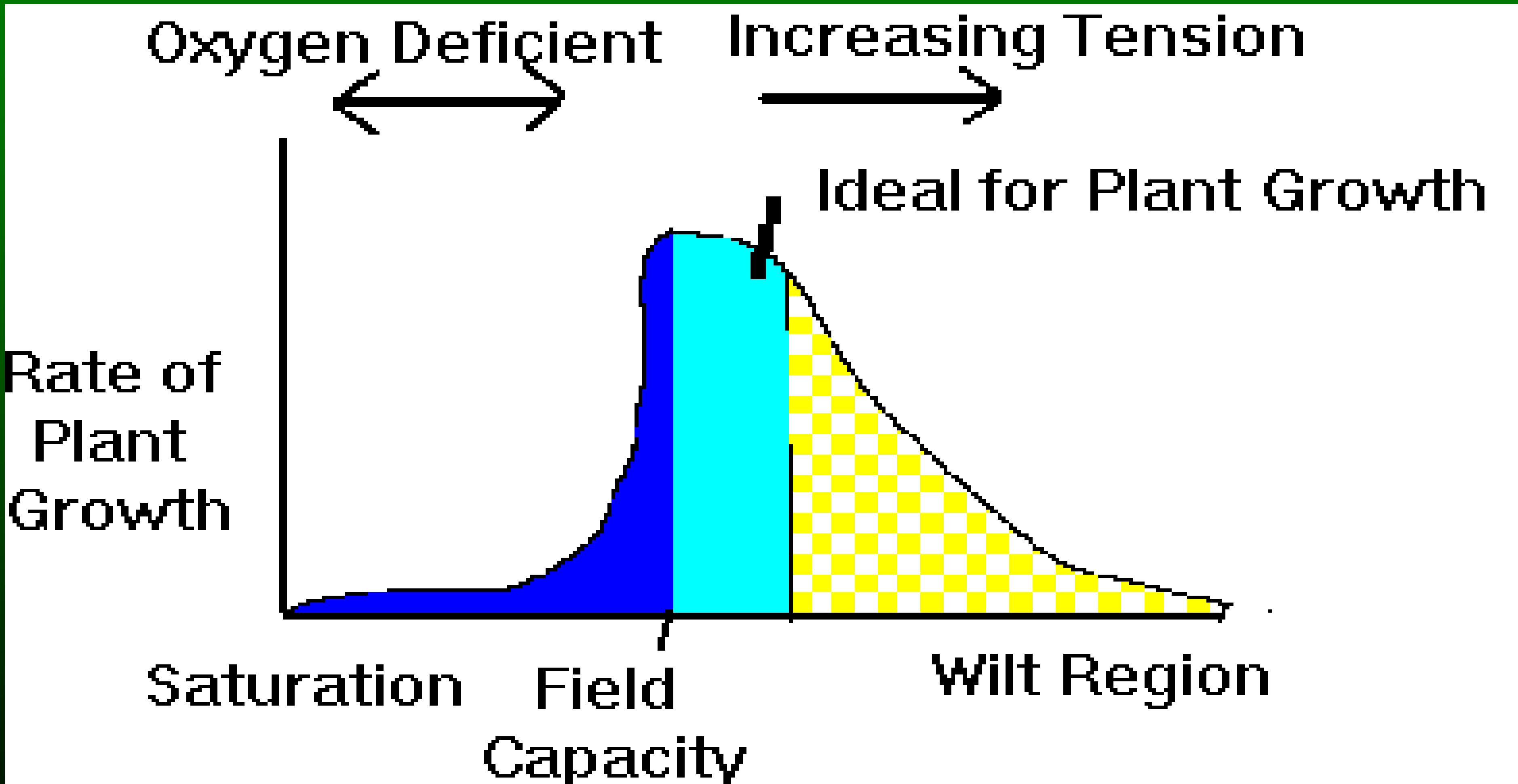
Soil Water and Plant Use



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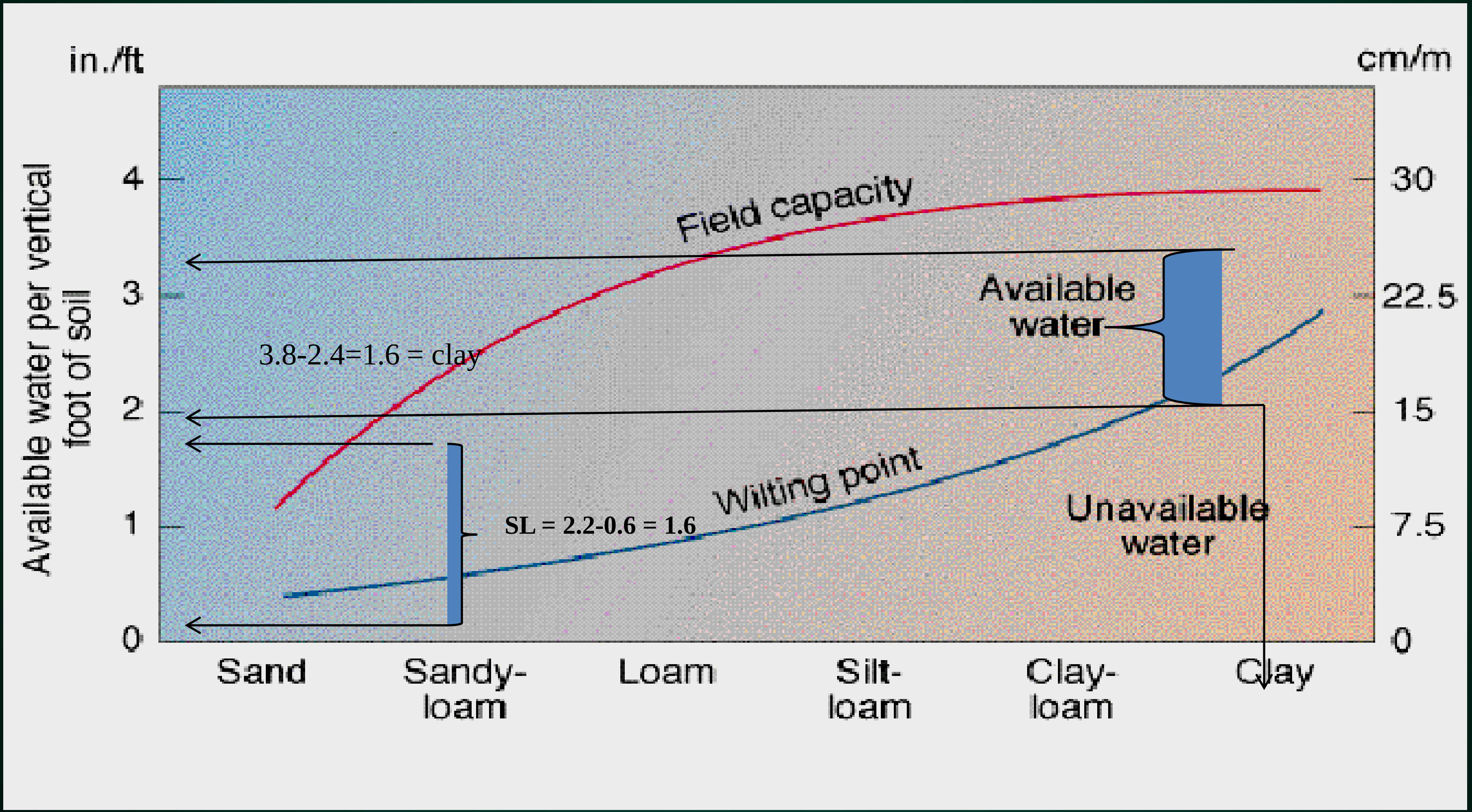
Relationship between soil texture and soil water availability.

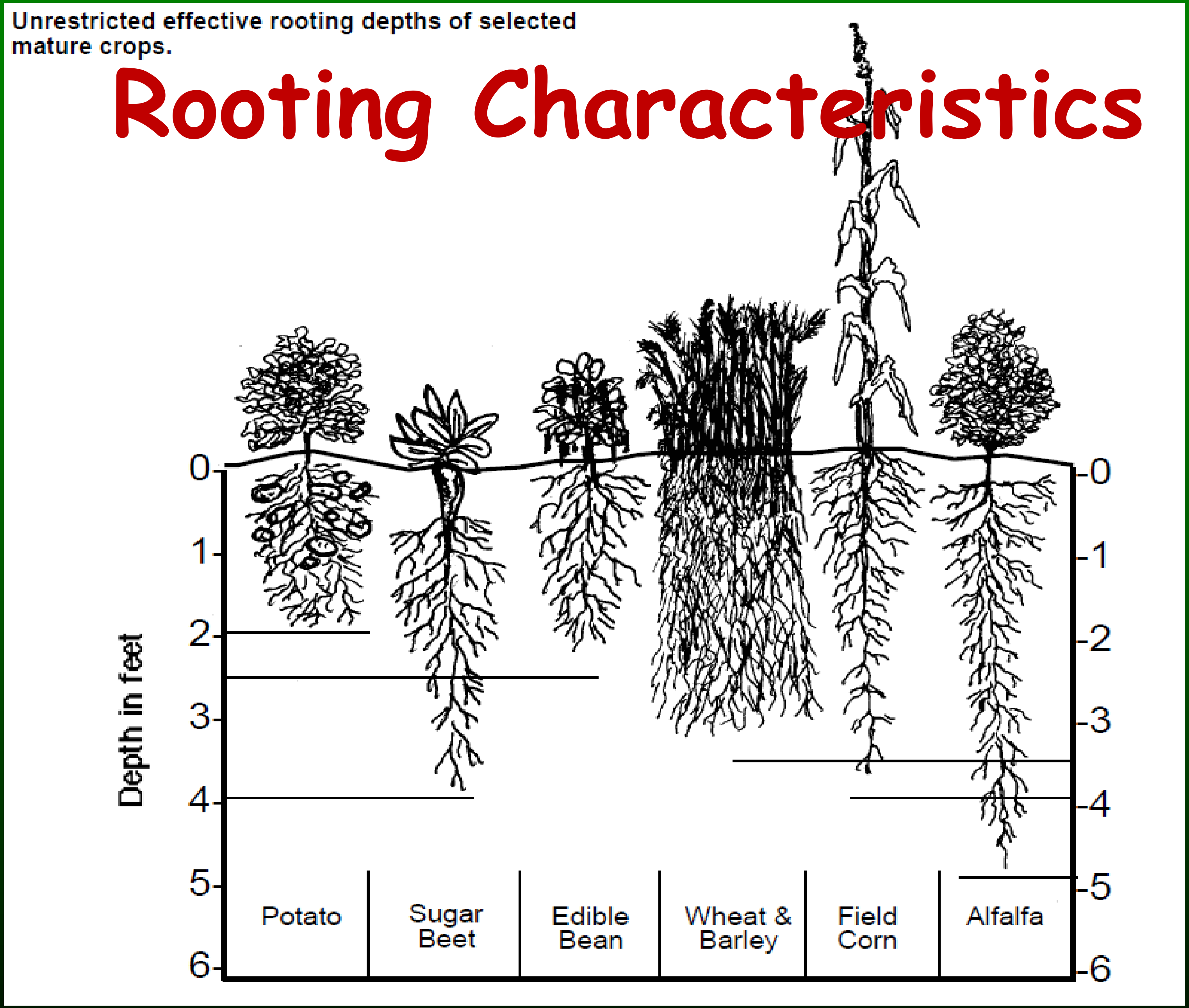


Water holding capacity (inches/ft) of different soil types

Coarse Sands	0.25 - 0.75
Fine Sands	0.75 - 1.00
Loamy Sand	1.10 - 1.20
Sandy Loams	1.25 - 1.40
Fine Sandy Loam	1.50 - 2.00
Loam	1.80 - 2.00
Silt Loams	2.00 - 2.50
Clay Loam	1.80 - 2.00
Silty Clay Loams	1.80 - 2.00
Silty Clay	1.50 - 1.70
Clay	1.20 - 1.50

Rooting depth and crop water use characteristics

Rooting Characteristics



Lundstrom, 1988

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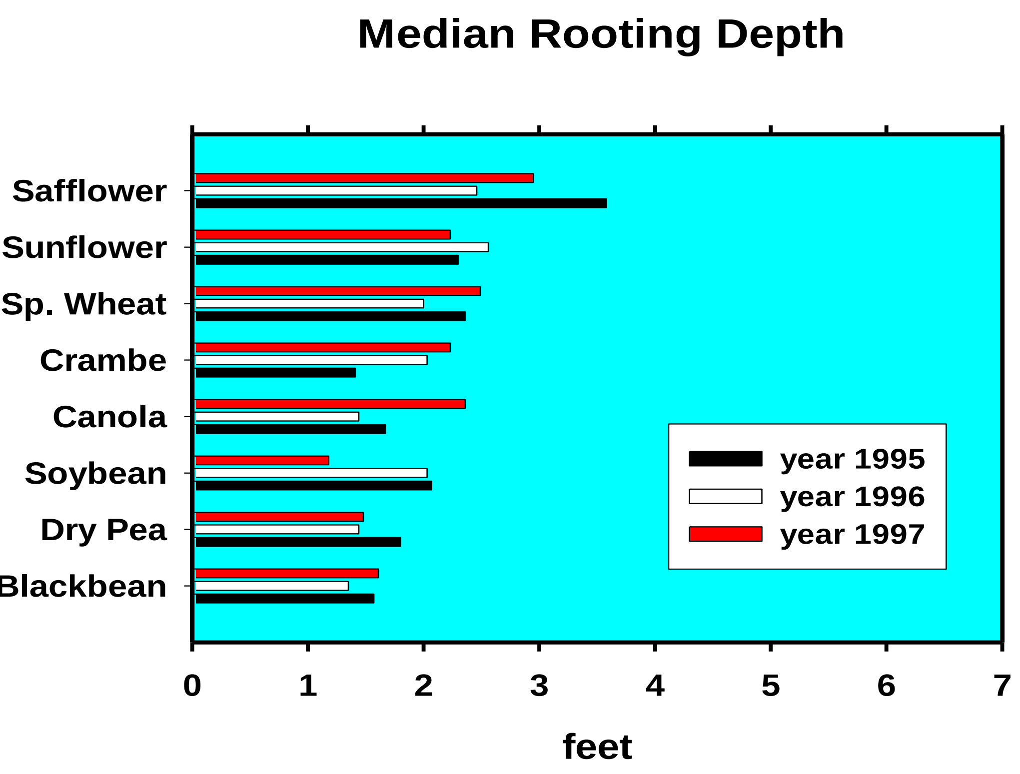
Rooting Depths - Mandan



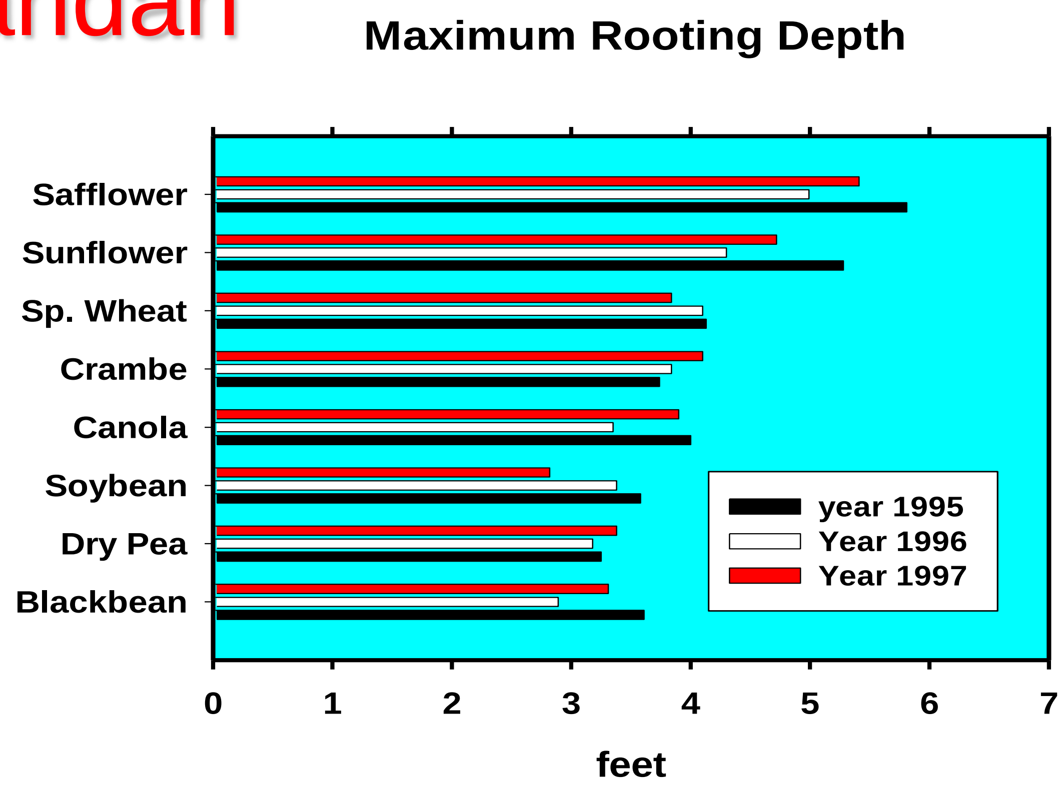


Fig. C. Maximum and median depths of root length growth measured with minirhizotron technology in Phase I Alternate Crops Experiment, 1995-1997. Median depth is that at which half of root length growth is above, half below.

Source: Crop sequence calculator

Crop characteristics with regards to soil water use

Length of active growing season is the best overall guide to the relative amount of soil water depletion. Rooting depth is also an indicator of depletion.

	WATER DEPLETION	SEASON LENGTH	ROOTING DEPTH
SUNFLOWER	heavy	long	deep
CORN	heavy	long	mod. deep
SOYBEAN*	mod. heavy	mod. long	mod. shallow
SP. WHEAT	medium to mod. Light	mod. short	medium
CANOLA	mod. heavy to mod.light	medium but variable	medium
DRY PEA	light	short	mod. shallow

* Soybean was grown in the Phase II crop sequence experiment.

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Soil water depletion to six feet, Mandan, 2002

SUNFLOWER	8.2
CORN	7.0
SPRING WHEAT	5.0
CANOLA	7.2
Chickpea	5.2
Lentil	4.0
DRY PEA	3.9

Crop Sequence calculator,
USDA-Mandan

What about recharge during the winter

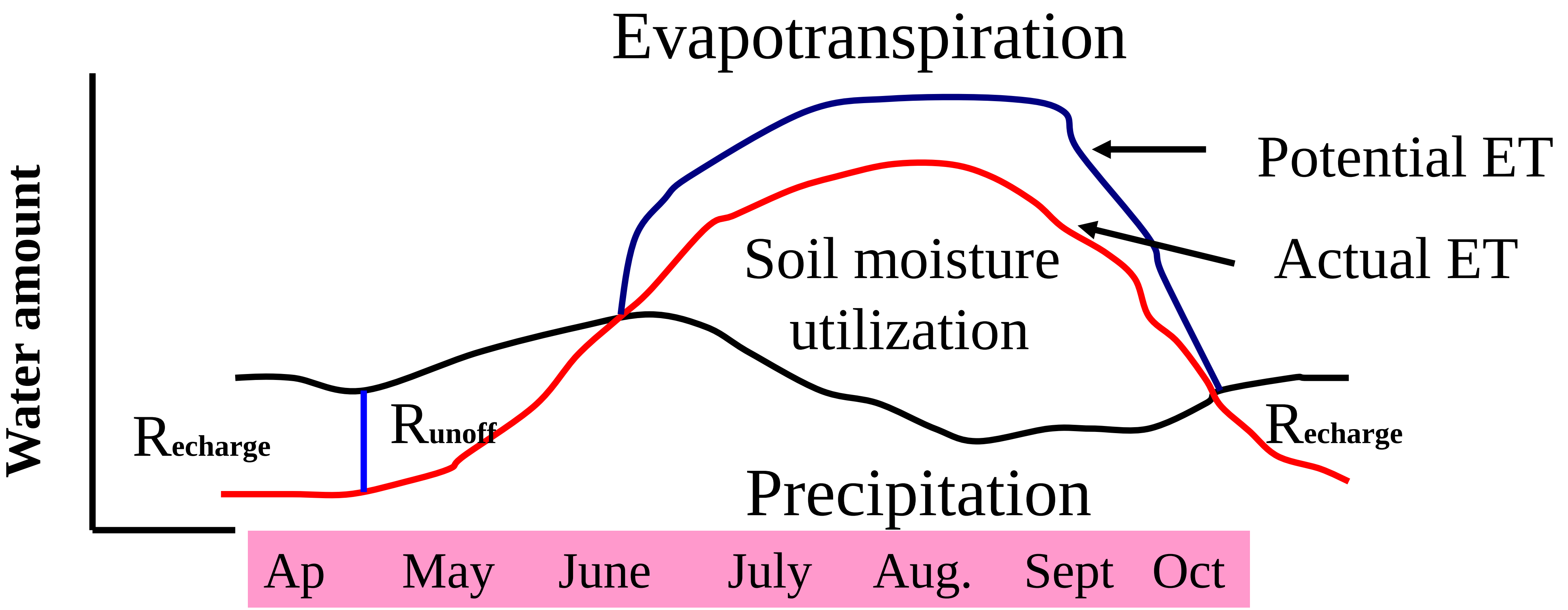
Crop	Depletion	Recharge	Rank Avg Recharge
	-------- inches --------		
Sunflower	5.3	1.2	10
Corn	5.0	2.1	6
Spring wheat	4.2	2.4	1,2
Canola	3.9	2.1	5
Millet	3.8	2.2	3,4
Buckwheat	3.7	2.2	3,4
Chickpea	3.3	1.4	9
Lentil	3.2	1.5	8
Dry pea	2.0	1.5	7

Merrill, Tanka, Krupinsky, Liebig and Hanson, 2007

How deep will an inch of moisture move during recharge

- **Depends on the moisture status of the soil**
  - One inch rain that fully infiltrates into the soil moves:
  - Fine sand: 12 inches
  - Loam: 6 inches
  - Clay: 8 inches
- **Heavy rain events usually mean surface runoff**
- **Frozen soils in the spring will not allow infiltration**

Water Balance Diagram



ET > Precip = Soil moisture utilization

Precip > ET = Recharge, surplus, and runoff

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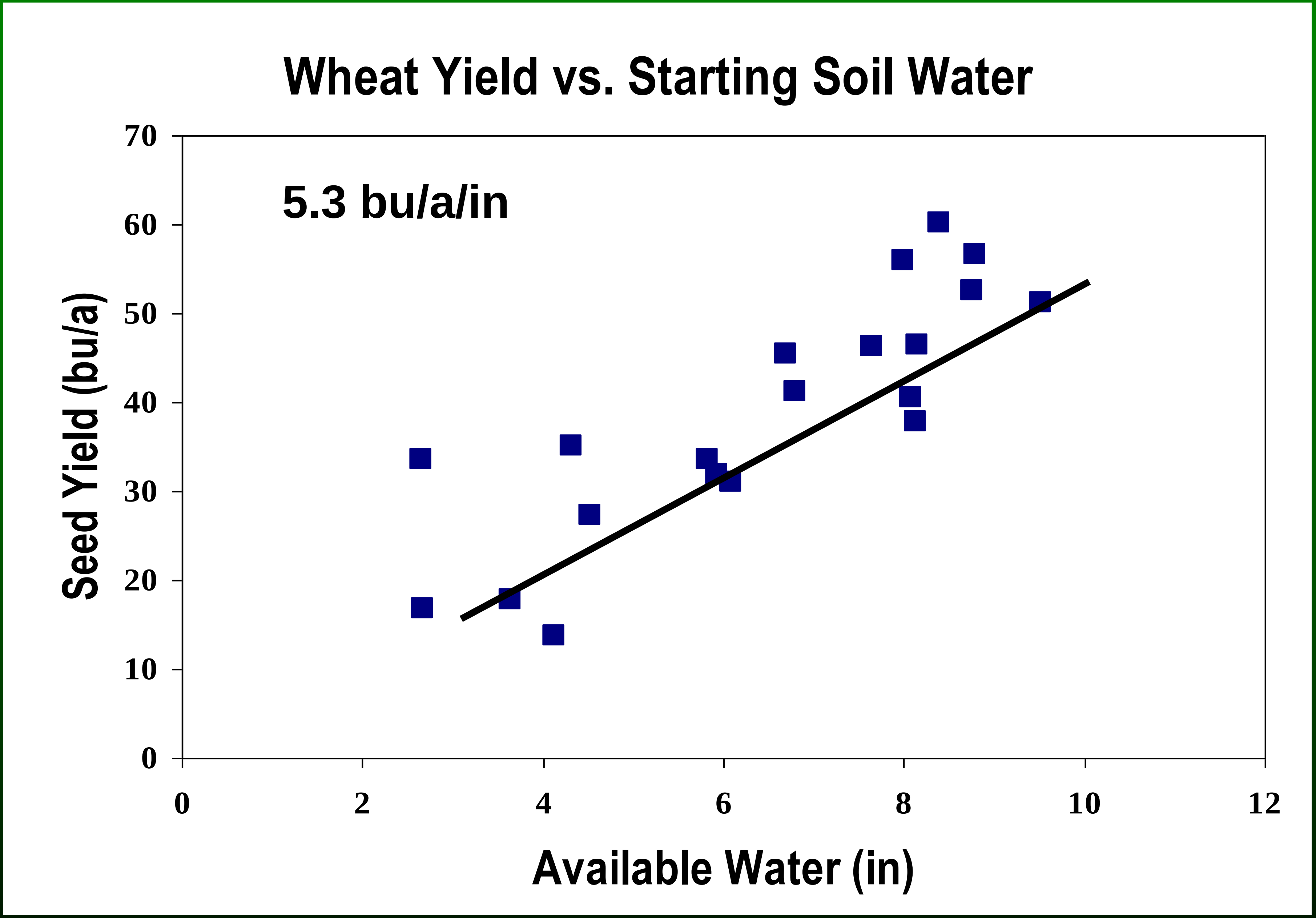
Some practical numbers

- **A full profile shortly after planting 2012 (2 inches per foot of soil available water)**
- **Depleted root zone by harvest**
  - Spring wheat 8 inches (down to four feet)
  - Corn 10 inches (down to five feet)
- **Fall/winter recharge (1.2 inches) (top 8 inches at field capacity)**
- **Roots grow to water, but can’t grow through a dry zone and are impeded by compaction.**
- **We need additional 6.8 (following wheat) and 8.8 inches (following corn) to fill the profile**



Wheat Yield vs. Starting Soil Water
5.3 bu/a/in
Seed Yield (bu/a)
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
Available Water (in)

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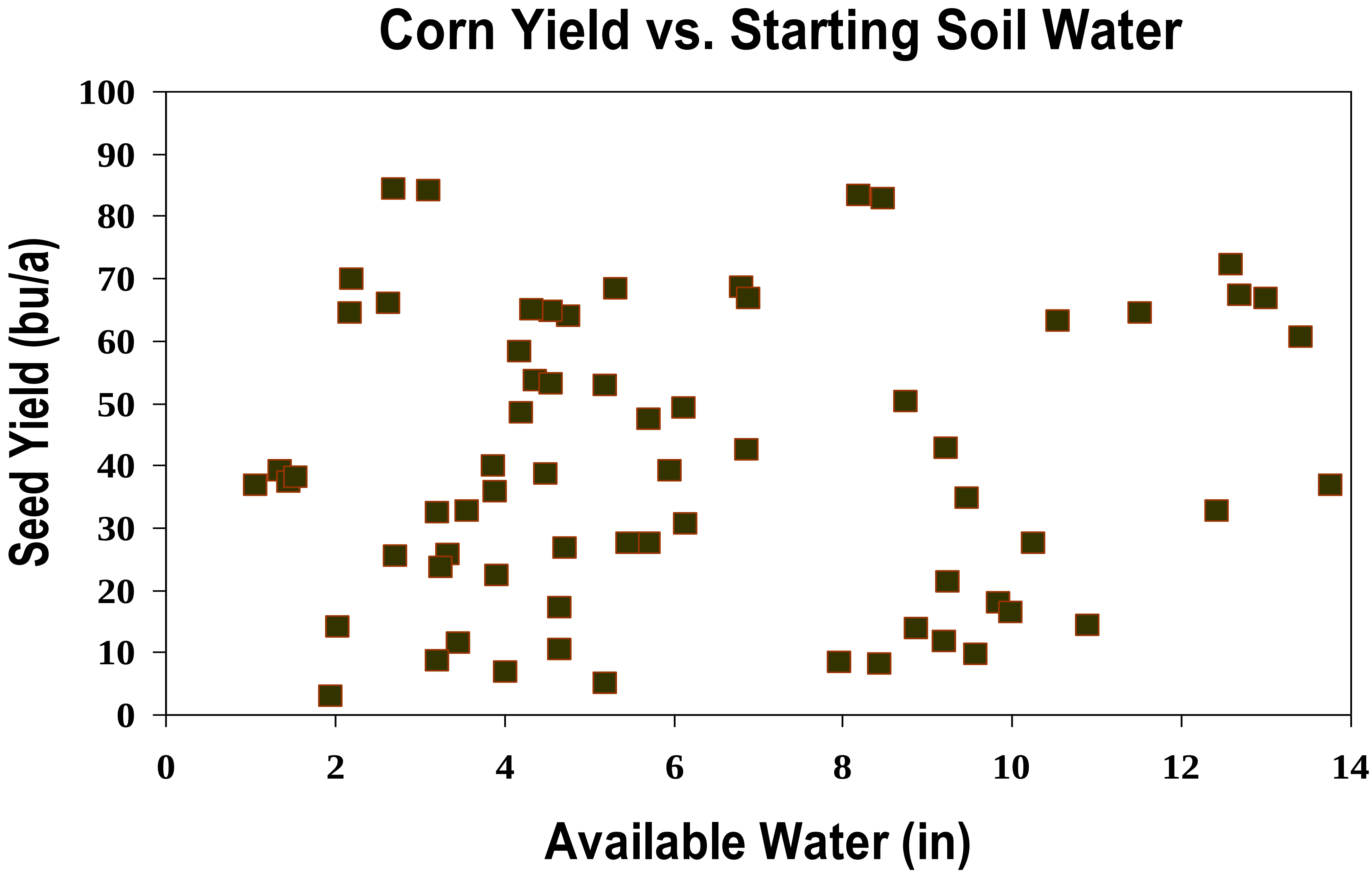
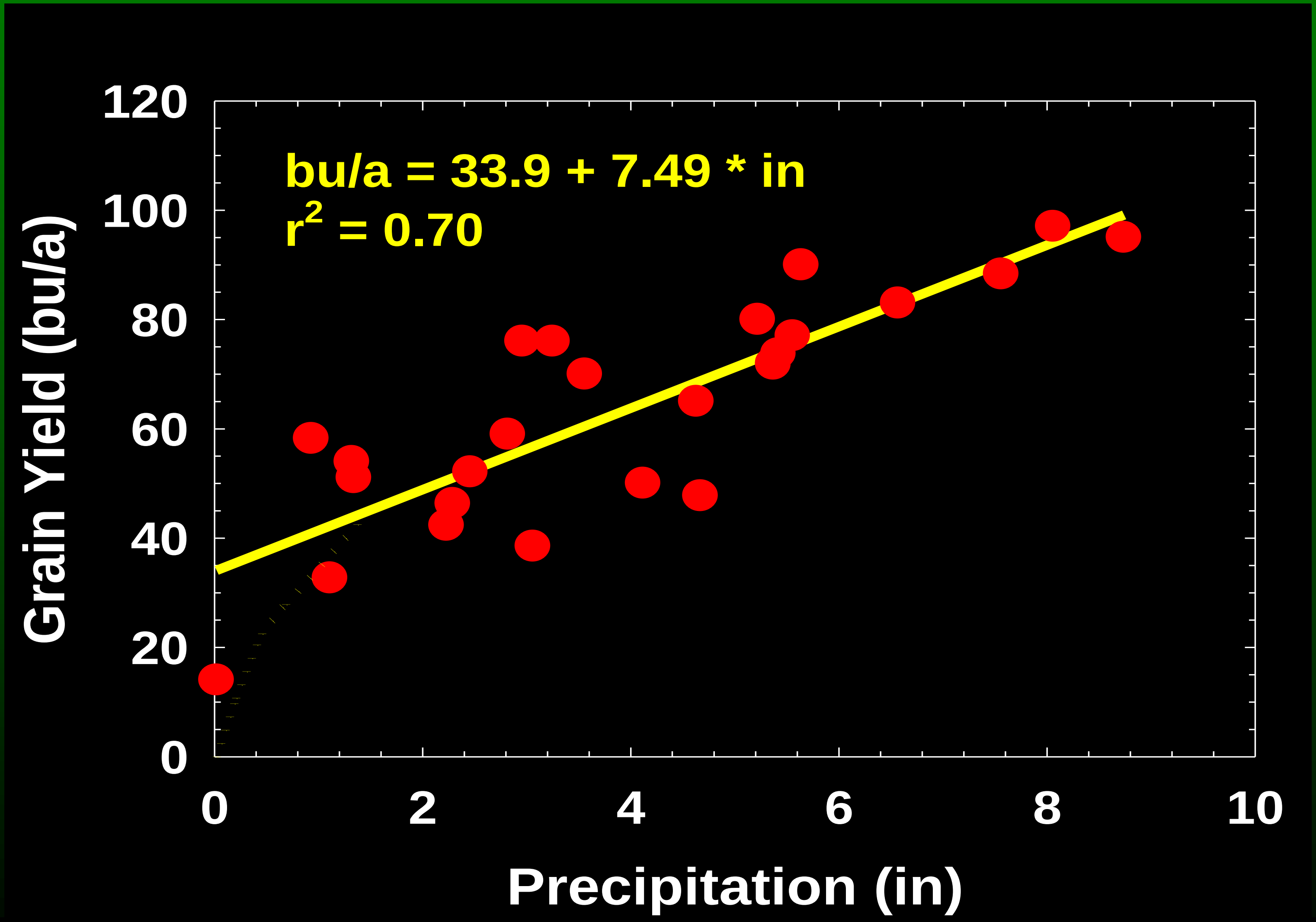

Corn Yield vs. Starting Soil Water
Seed Yield (bu/a)
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
Available Water (in)

Corn Yield vs Precipitation, CO
(15 July – 25 August)



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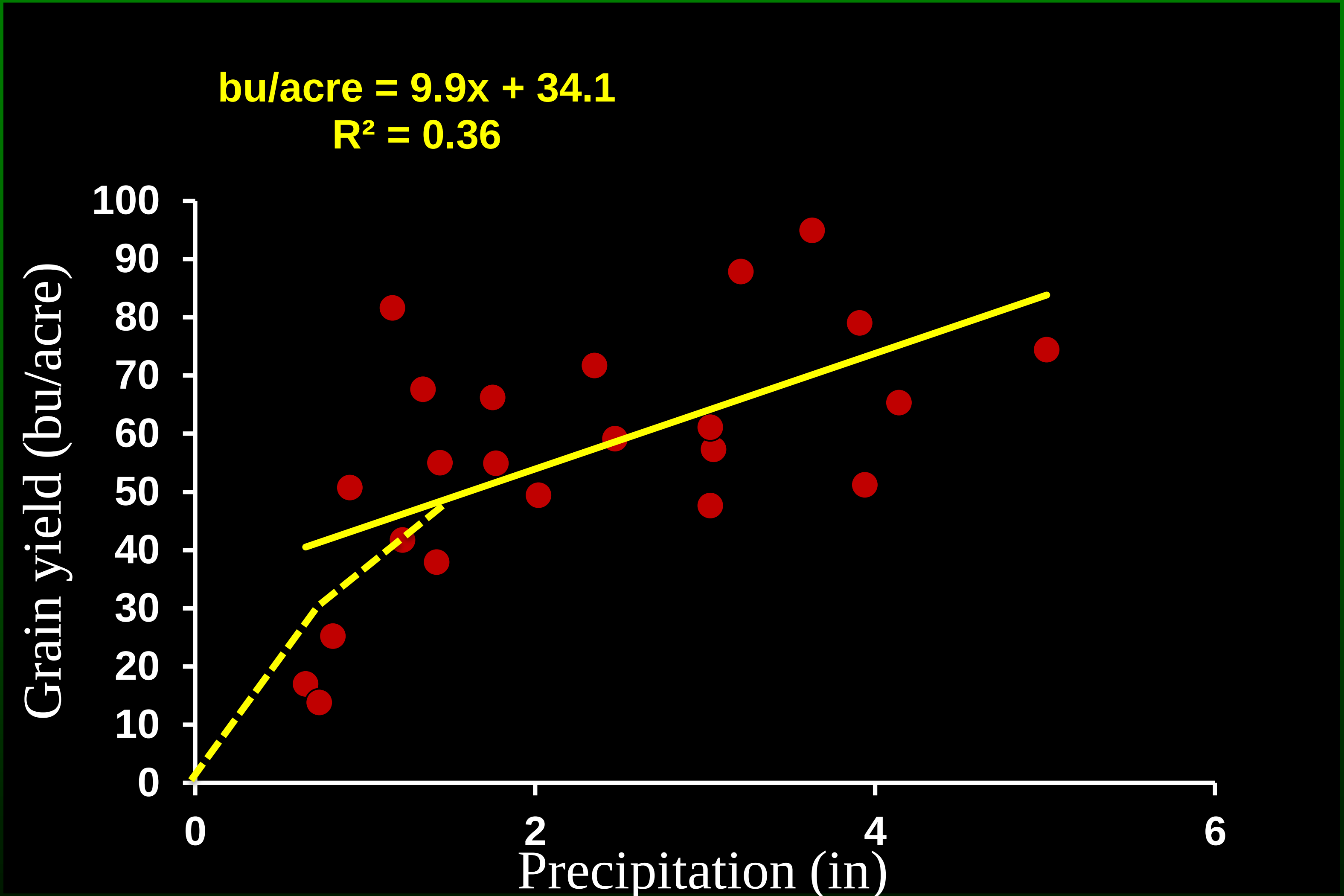
Corn Yield vs Precipitation Western ND (15 July – 25 August)



Ashley, 2013

Practices to increase water availability

- **Tillage**
  - Minimize or eliminate tillage
- **Residue management**
  - Snow catch is good
  - Reduced surface evaporation
  - Excessive residue can delay emergence and increase frost risks in the spring

A couple of suggestions for 2013

- **Growing deeper rooting and high water requiring crops after barley, spring wheat, or soybeans may provide ~>2 inch of moisture**
  - Avoid corn after corn or after sunflower!
- **Small grains will be less risky than corn or soybeans in soils with little or no stored moisture**
  - If winter recharge is good and early spring rains refill the profile, a good crop would be likely
  - Corn and soybeans will need July and August rains regardless of spring recharge.