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Impact of Cover Crops on Soil N, Corn Yield and Economic Optimum N Rate

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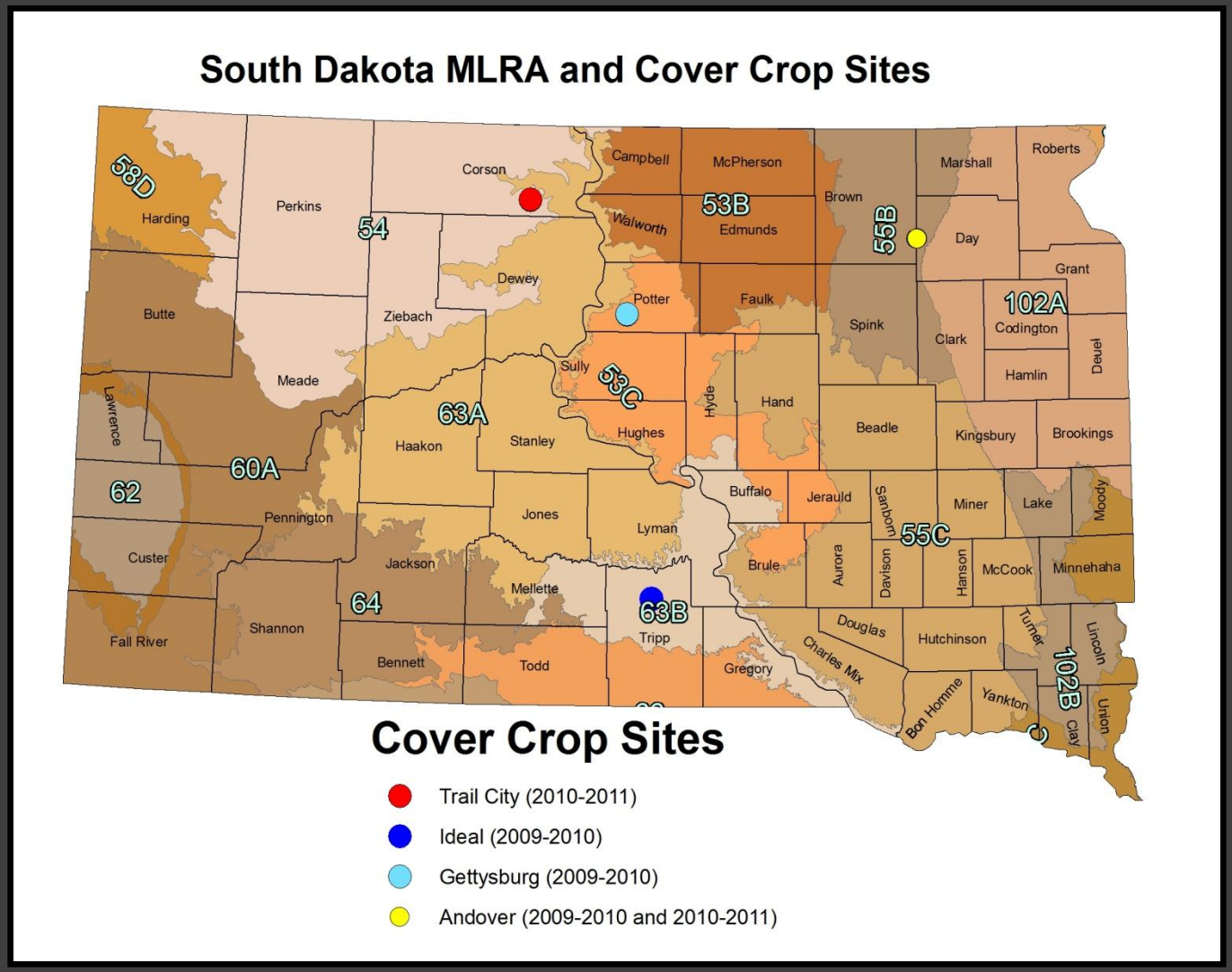
Rick Bieber, Trail City and Roger and Grant Rix, Andover

Outline

- Research background→ What we did.
- Soil moisture, cover crop biomass (fall)
- Soil N (spring)
- Corn yield (fall)
- NRCS CIG grant objective:
  - Evaluate fall seeded and summer seeded cover crops in a wheat/corn rotation

Field Sites


South Dakota MLRA and Cover Crop Sites
58D
Harding
Perkins
Corson
54
Campbell
McPherson
Walworth
53B
Edmunds
Brown
55B
Marshall
Roberts
Day
Grant
Dewey
Potter
Faulk
102A
Codington
Butte
Ziebach
Spink
Clark
Hamlin
Deuel
Sully
53C
Meade
Lawrence
63A
Haakon
Stanley
Hughes
Hyde
Hand
Beadle
Kingsbury
Brookings
60A
62
Buffalo
Jerauld
Sanborn
Miner
Lake
Moody
Pennington
Jones
Lyman
55C
Custer
Jackson
Brule
Aurora
Davison
Hanson
McCook
Minnehaha
Mellette
64
63B
Douglas
Turner
Lincoln
Fall River
Shannon
Tripp
Hutchinson
Bennett
Todd
Gregory
Charles Mix
102B
Bon Homme
Yankton
Clay
Union
Cover Crop Sites
Trail City (2010-2011)
Ideal (2009-2010)
Gettysburg (2009-2010)
Andover (2009-2010 and 2010-2011)

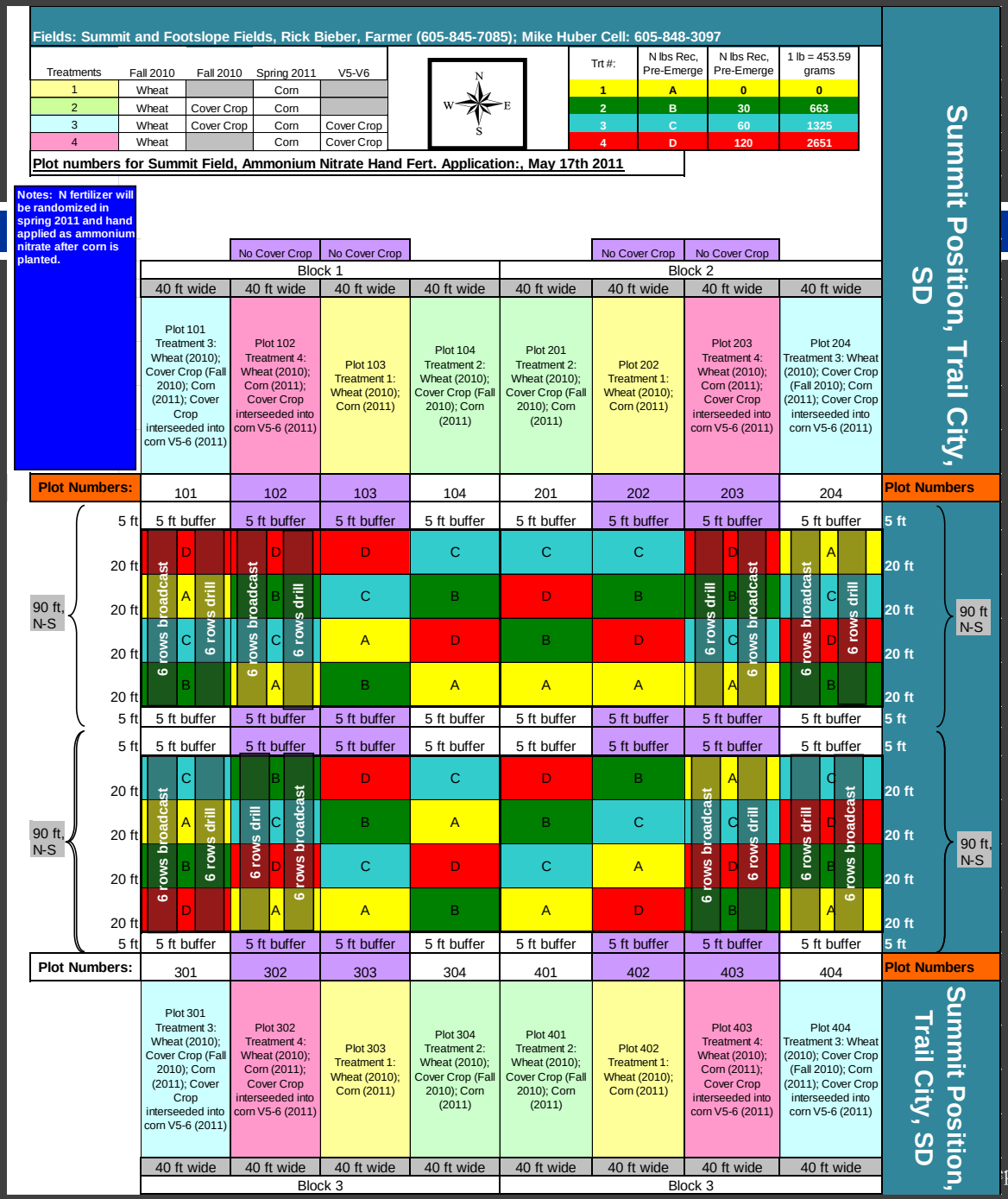
Timeline

- Fall 2010:
  - Plant cover crop into spring wheat stubble. (Est. Fall CC and NoCC Trt).
  - Soil sample for NO3, NH4, and PO4.
- Spring 2011:
  - Corn is planted.
  - Soil sample: spring NO3, NH4, and PO4.
  - Apply ammonium nitrate fertilizer rates to each plot.
- June 2011: Plant cover crop into corn at V5 (SDSU). (In-season CC planted)
- Fall 2011 (SDSU):
  - Harvest and soil sample.
  - Analysis: Soil– NO3, NH4, and PO4; aggregate stability, soil microbial activity and soil mycorrhizae activity.
  - Collect weed and cover crop biomass.

Cover Crop Treatments

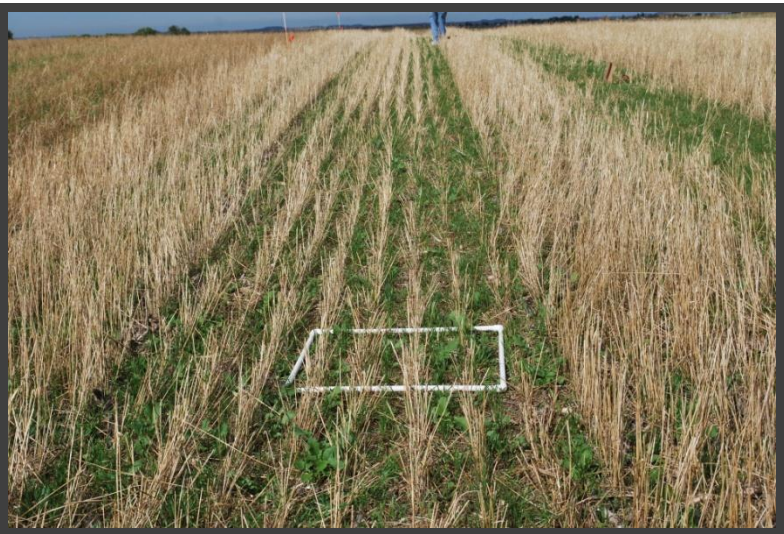
		Cover Crop Seeding Time	
Cover Crop Treatments	Number of Cover Crop Seeding Times	Fall, Seeded into Wheat	Following June, Seeded into Corn at V6
No Cover Crop	0		
FallCC	1	X	
FallCC and V5-6 (Broadcast seeded)	2	X	X
FallCC and V5-6 (Drilled)	2	X	X
V5-6 Broadcast	1		X
V5-6 Drill	1		X

Soil Map, Trail City, 2011, Summit



Trail City, Fall 2010

Summit



Footslope

Trail City CC Mix and Rates (Fall 2010)

Fall 2010 Cover Crops, Trail City									
		Purple Top Turnips	Diakon Radish	Indianhead Lentils	Peas	Proso Millet	German Millet	Volunteer Spring Wheat	Cost
					lbs/ A				US$
Site	Plant Date	Cool season broadleaf		Cool season legume		Warm season grass		Cool grass	
Trail City	8/16/10	1.75	1.75	8	8	1.5	1	NA	$22.33
Based on Purple Top Turnips, $2.50/lb; Diakon Radish, $3.75; Lentils, $0.90/lb; Peas, $0.40/lb; Proso Millet, $0.40/lb; and Golden German Millet, $0.40/lb.									

Trail City, Fall 2010 Biomass

Biomass, November, 2010, Trail City						
Treatments	**Broadleaf**		**Volunteer Wheat**		**Total Biomass**	
Field Position	**kg ha^{-1}**	**lb A^{-1}**	**kg ha^{-1}**	**lb A^{-1}**	**kg ha^{-1}**	**lb A^{-1}**
Summit	91^{a}	82^{a}	29^{b}	26^{b}	120^{b}	107^{b}
Toeslope	194^{b}	173^{b}	100^{a}	89^{a}	248^{a}	262^{a}
P value	<0.001		<0.001		<0.001	
Cover Crop						
No Fall Cover Crop	0^{b}	0^{b}	0^{b}	0^{b}	0^{b}	0^{b}
Fall Cover Crop	285^{a}	254^{a}	129^{a}	115^{a}	414^{a}	368^{a}
P Value	<0.001		<0.001		<0.001	

Trail City, Fall 2010, % Soil Moisture

Treatments	November 2010 Soil Moisture (%)			
Field Position	0-6 in. (0-15 cm)	6-12 in. (15-30 cm)	12-18 in. (30-45 cm)	12-24 in. (45-60 cm)
Summit	19.6[b]	19.5[b]	15.9[b]	18.5[b]
Toeslope	23.7[a]	22.5[a]	20.1[a]	24.1[a]
P value	<0.001	<0.001	<0.001	<0.001

Moisture greater at toeslope than summit

Cover Crop	No moisture difference between NoCC and FallCC			
No Fall Cover Crop	20.8	19.4	18.3	16.4
Fall Cover Crop	20.0	20.5	18.0	16.9
P Value	NS	NS	NS	NS

Trail City, May 2011, Soil N, 0-24 inches

Landscape Position	May 2011 Soil N, lbs / A		
Summit	**NO_3**	**NH_4**	**Total N**
No CC	23	30	53
Fall CC	18	31	50
P value	**0.005**	0.156	**0.100**
Footslope			
No CC	29	29	58
Fall CC	30	34	63
P Value	0.938	**0.027**	0.330

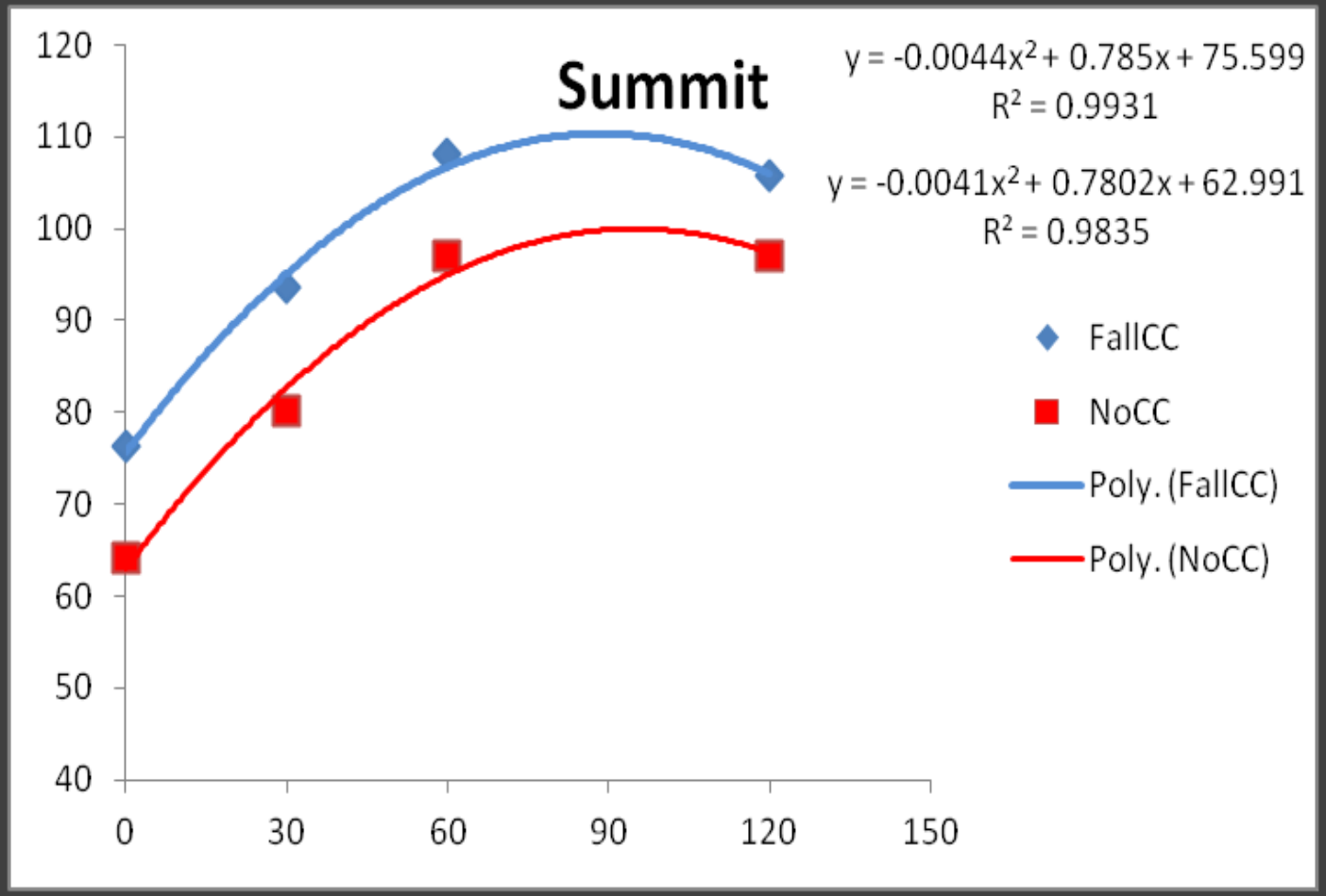
- Goal: Tie N in the organic matter for next year.
- Fall NO3 lower in Fall CC trt.
- NH4 higher in Fall CC

Trail City 2011 Yield

Field Location	Summit	Toeslope
	Yield	
CC Treatments	bu A^{-1}	bu A^{-1}
FallCC	85 a	160 a
FallCC and V5CC	79 ab	151 ab
V5CC	74 b	158 a
No CC	73 b	142 b
P Value	0.07	0.06

- Summit:
  - FallCC vs NoCC
  - 12 bu/A @ $6.02/ bu
  - $72.24/A
- Toeslope:
  - 18 bu/A @$6.02/bu
  - $108.36/A

Summit Yield Response (N Rates)



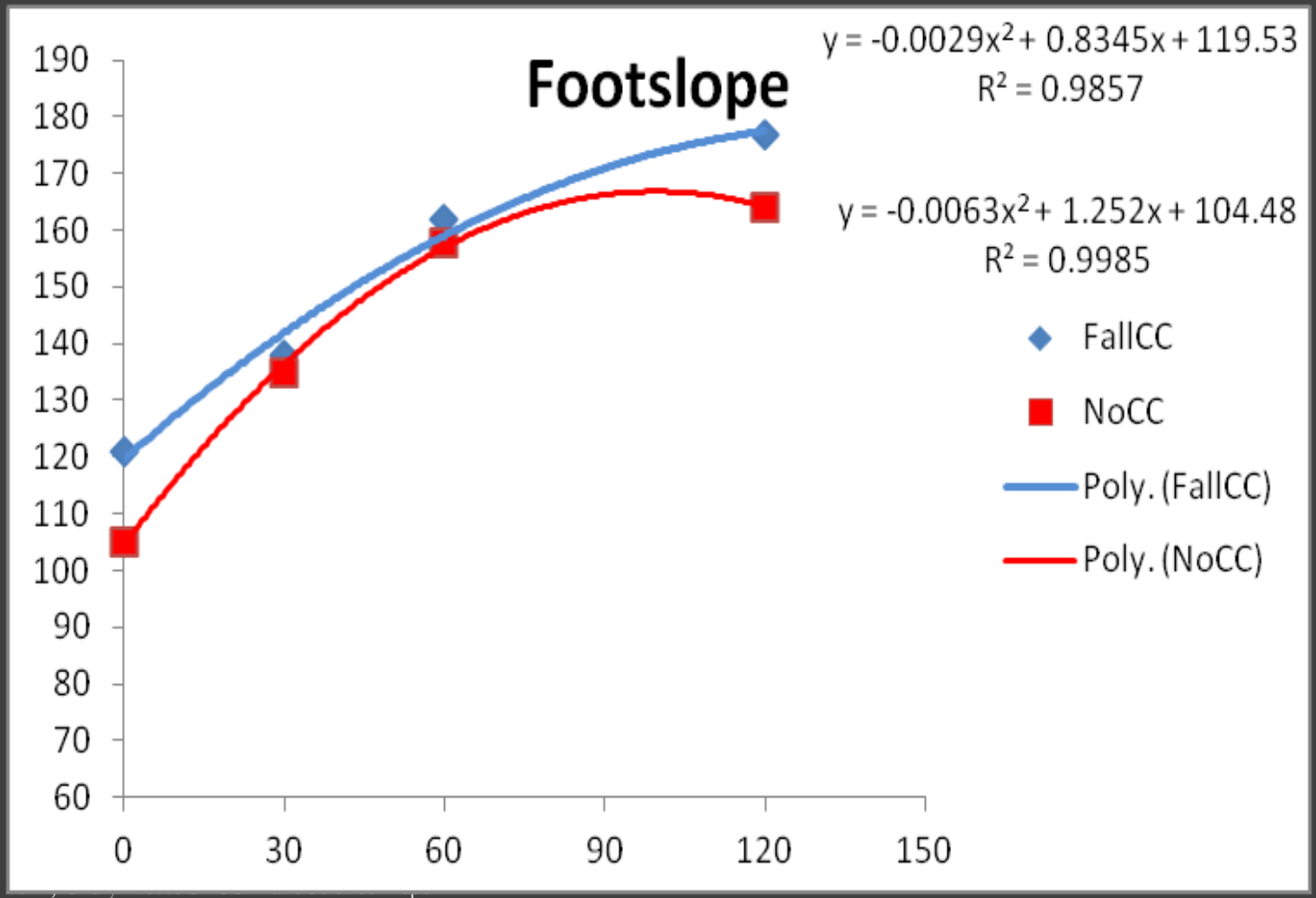
Summit EONR

	FallCC			Average yield 95%of time	
	regression coeffiecents			bu/A	alpha - 0.05
	c	b	a	85	
	-0.004436488	0.785031003	75.59916		
	Corn $ / bu	6.02			
	N $/ lb	0.65			
EONR	N Rate (lbs / A)	76	(this is determined at 1st derivative of regression line)		

	NoCC			Average yield 95%of time	
	regression coeffiecents			bu/A	alpha - 0.05
	c	b	a	73	
	-0.004190041	0.78794766	62.67701		
	Corn $ / bu	6.02			
	N $/ lb	0.65			
EONR	N Rate (lbs / A)	81	(this is determined at 1st derivative of regression line)		

- **5 lb N credit with Fall CC; 12 bu/A at summit**

Footslope Yield Response



Footslope EONR:

	FallCC			Average yield 95%of time	
	regression coeffiecents			bu/A	alpha - 0.05
	c	b	a	160	
	-0.00288136	0.82525	119.9267		
	Corn $ / bu	6.02			
	N $/ lb	0.58			
EONR	Rate (lbs / A)	126			

	NoCC			Average yield 95%of time	
	regression coeffiecents			bu/A	alpha - 0.05
	c	b	a	142	
	-0.00607095	1.223999	104.8692		
	Corn $ / bu	6.02			
	N $/ lb	0.58			
EONR	Rate (lbs / A)	93			

- **33 lbs N / A more with FallCC; Yield $ Diff: $108.54; N investment : $19.14 @$0.58/lb N**

2010 – 2011 Andover North Central South Dakota

Fall 2010 Cover Crops

Fall 2010 Cover Crop Rates and Seed Costs					
			Winter		
	Plant	Radish	Canola	Turnips	Cost
	Date		lbs/ A		US$
Andover Summit & Footslope	8/17/10	2	3	2	$16.03

Based on: Radish, $3.75/lb; Winter Canola, $1.21/lb; Turnips, $2.50

Andover, Fall 2010
Cover Crop

Andover
Fall 2010 Biomass

Treatments	Broadleaf		Volunteer Wheat		Total Biomass	
Field Position	**kg ha^{-1}**	**lb A^{-1}**	**kg ha^{-1}**	**lb A^{-1}**	**kg ha^{-1}**	**lb A^{-1}**
Summit	319	285	968	864	1286	1148
Footslope	653	583	506	452	1159	1034
P value	<0.001		<0.001		NS	
LSD (0.05)	199	178	156	139	208	186
Cover Crop						
No Fall Cover Crop	0	0	0	0	0	0
Fall Cover Crop	971	866	1476	1317	2445	2182
P Value	<0.001		<0.001		<0.001	
LSD (0.05)	199	178	156	139	208	186

Andover: Fall 2010 Soil Moisture

Treatments	Soil Moisture (%)		
Field Position	0-6 in. (0-15 cm)	6-12 in. (15-30 cm)	12-24 in. (30-60 cm)
Summit	19.6	19.5	20.7
Footslope	29.3	27.7	24.1
P value	<0.001	<0.001	<0.01
LSD (0.05)	1.8	1.8	2
Cover Crop			
No Fall Cover Crop	29.7	29.3	24.6
Fall Cover Crop	29.0	26.0	23.6
P Value	NS	<0.05	NS
LSD (0.05)		2.6	

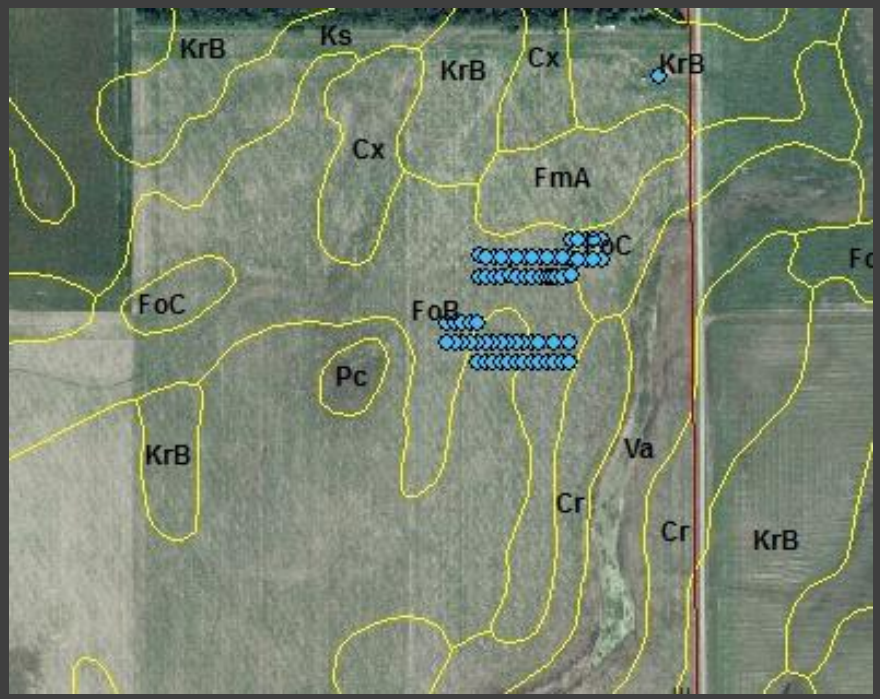
- 5.0 inches (12.7 cm) rainfall from 9/1/2010 to 11/17/2010.
- Normal for this period is about 3.5 inches.
- Average temp. = 48.2°F; 47.5°F is average.

Fall 2010 Root Depth, Purple Top Turnips and Grazing Radishes

Spring 2011 Andover, SD

Brassica regrowth on April 30th, 2011

Brassicas regrowth observed in plots at summit and footslope across field.



Beneficial insects decomposing brassicas

Isopods (beneficial) found in brassicas in footslope conditions and moist soil

Jonathan Lundgren, USDA-ARS, Research Entomologist

	Values	
Row Labels	Average of # mites	Average of # other arthropods
No Cover Crop	**323**	**62**
Footslope	421	89
Summit	226	35
Cover crop	**401**	**246**
Footslope	581	430
Summit	221	62
Grand Total	**362**	**154**

- In our experience, the more diversity you get in the soil, the more resistant it is to soil born pests.
- So the we would suspect that the arthropods in the "others" category to be a good thing.

Andover, May 2011, Soil N, 0-24 inches

Landscape Position	May 2011 Soil N, lbs / A		
Summit	**NO_3**	**NH_4**	**Total N**
No CC	32	20	52
Fall CC	15	19	34
P value	**0.003**	0.411	**0.006**
Difference	17		18
Footslope			
No CC	37	26	63
Fall CC	27	27	54
P Value	**0.013**	0.170	**0.016**
Difference	10		9

- Goal: Tie N in the organic matter for next year.
- Fall NO3 lower in Fall CC trt at both footslope and summit position

Summary

- **Yield:** Fall seeded cover **improved** corn yield the following year at Trail City (Andover still underway).
- **Moisture:** Fall soil moisture **decreased** at Andover footslope site in fall cover crop trt.
- **Soil N:** Spring soil NO3 **was lower** when fall CC planted, NO3 sequestered at Andover and Trail City sites.
- **EONR:** Mixed effect on EONR.
- Insect diversity **increased** at Andover site.

Working on

- Soil mycorrhiza analysis
  - Andover
  - Spore counts low but expected due to cropping systems
  - Trail City managed for soil quality longer period of time

- Soil diversity PLFA: identify microbial communities
  - Signature lipid biomarkers for different microbial communities

Thank you -- Questions