The Effects of Cover Crops on Nitrogen, Soil Moisture, and Carbon in Wheat/Fallow Systems

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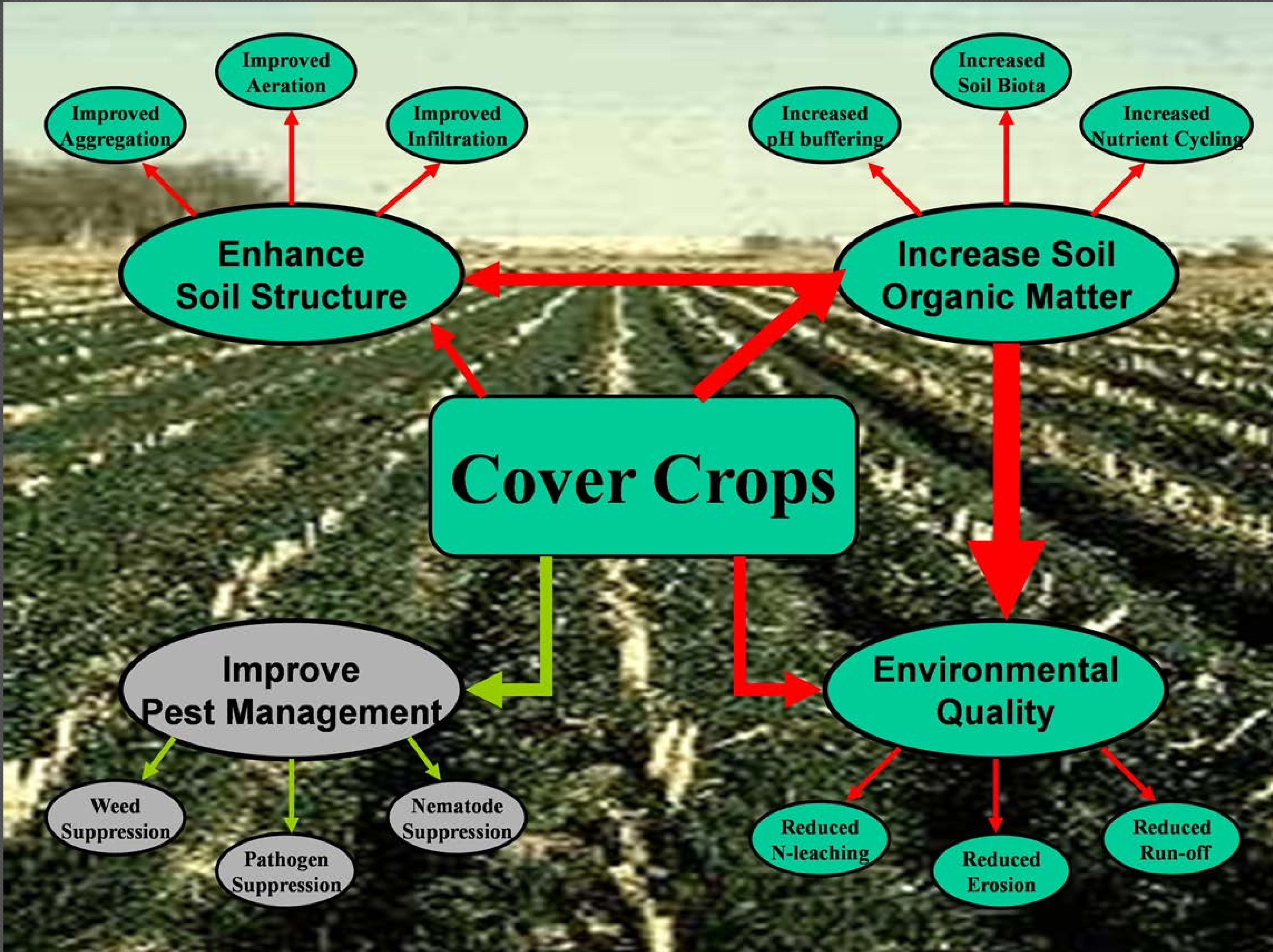
What's the Problem?

- In recent years dry-land farmers have been noticing significantly lower crop yields
- Some believe that traditional winter wheat-summer fallow cropping system have led to a decrease in soil health specifically moisture loss and decreasing Nitrogen amounts
- If the soil continues to be degraded it will be detrimental to the wheat, farmers, and consumers

What's the Point?

- This area is one of the largest dry-land wheat producers in the world!
- Cover crops are not well understood in the PNW
- Hope to understand the relationship cover crops have with various soil factors in comparison to conventional farming


Improved Aeration
Improved Aggregation
Improved Infiltration
Increased Soil Biota
Increased pH buffering
Increased Nutrient Cycling
Enhance Soil Structure
Increase Soil Organic Matter
Cover Crops
Improve Pest Management
Environmental Quality
Weed Suppression
Pathogen Suppression
Nematode Suppression
Reduced N-leaching
Reduced Erosion
Reduced Run-off

(USDA 2012.)

Summer CC Fix N, Increase Crop Yield, and Improve Soil-Crop Relationship

- Study done from 1995-2009 in south central Kansas
- Assessed crop yield and its relationship with CC-induced changes in soil properties
- Used 3 CC treatments and 4 Nitrogen rates at 0, 33, 66, and 100 kg/ha^{-1}

- Found cover crops increased crop yields at low rates of N application
- Results suggested that CC decreased soil compactibility and most likely favored root growth and nutrient uptake

(Blanco-Canqui 2012.)

Cover Crop Study

- Experiment began October 2014 when Winter Wheat was planted
- 4 treatments, 1 control, and 3 replications
- Two sets of soil samples collected at a depth of 0-10 cm and 10-20 cm
- March 19, 2015
  - Collected before CCs were planted
- May 29, 2015
  - Collected after CCs were harvested

Goals/Objectives

- My main objective this summer was to analyze a variety of soil components and to focus on the relationship between soil moisture and Nitrogen (Nitrate)

- The overarching goal is to not only improve profit and long-term wheat yields, but to also improve the overall health of the soil

Questions

- How will cover crops affect soil quality (moisture, N, C) if they are integrated in wheat/fallow systems?
- Is there a correlation between soil moisture and Nitrate amounts found in the soil?
- Which CC treatment will be the most effective?

Treatments

- Summer Fallow
  - Control
- Spring Barley
  - Adds biomass and soil organic matter
  - (81 lb/ac)

- Spring Pea
  - Fixes N
  - (68 lb/ac)

- Yellow Mustard
  - Aerates soil
  - (11.4 lb/ac)

- Mixed (SP + SB + YM)
  - Provides a little bit of everything
  - (72 lb/ac)

	Phase	Plots (90ft x 20 ft. plots) (27.4 mx 6.09m)	Treatment
Rep 1	P2(CC)	1	T1
		2	T2
		3	T5
		4	T3
		5	T4
	P1(Wheat)	6	T4
		7	T5
		8	T3
		9	T2
		10	T1
Rep 2	P1	11	T5
		12	T4
		13	T2
		14	T3
		15	T1
	P2	16	T1
		17	T4
		18	T2
		19	T3
		20	T5
Rep 3	P1	21	T4
		22	T2
		23	T3
		24	T1
		25	T5
	P2	26	T1
		27	T3
		28	T2
		29	T5
		30	T4

Treatments

1. Winter wheat - Summer Fallow
2. Winter wheat - Spring Pea
3. Winter wheat - Spring Barely
4. Winter wheat - Yellow Mustard
5. Winter wheat - SP + SB+ YM

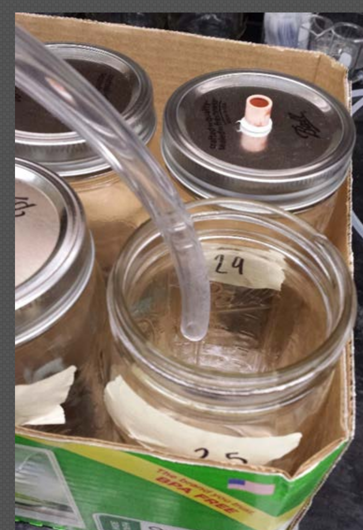
NO3 Analysis

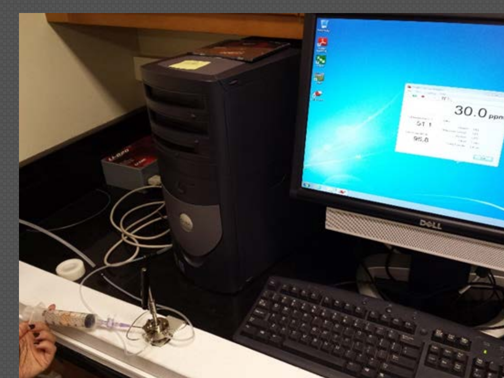
- ~10g of soil were extracted in 50ml 1M KCL
- Measured the total mineralizable Nitrogen (Nitrate) found in soil
- Analyzed them using a flow injection Nitrogen analyzer



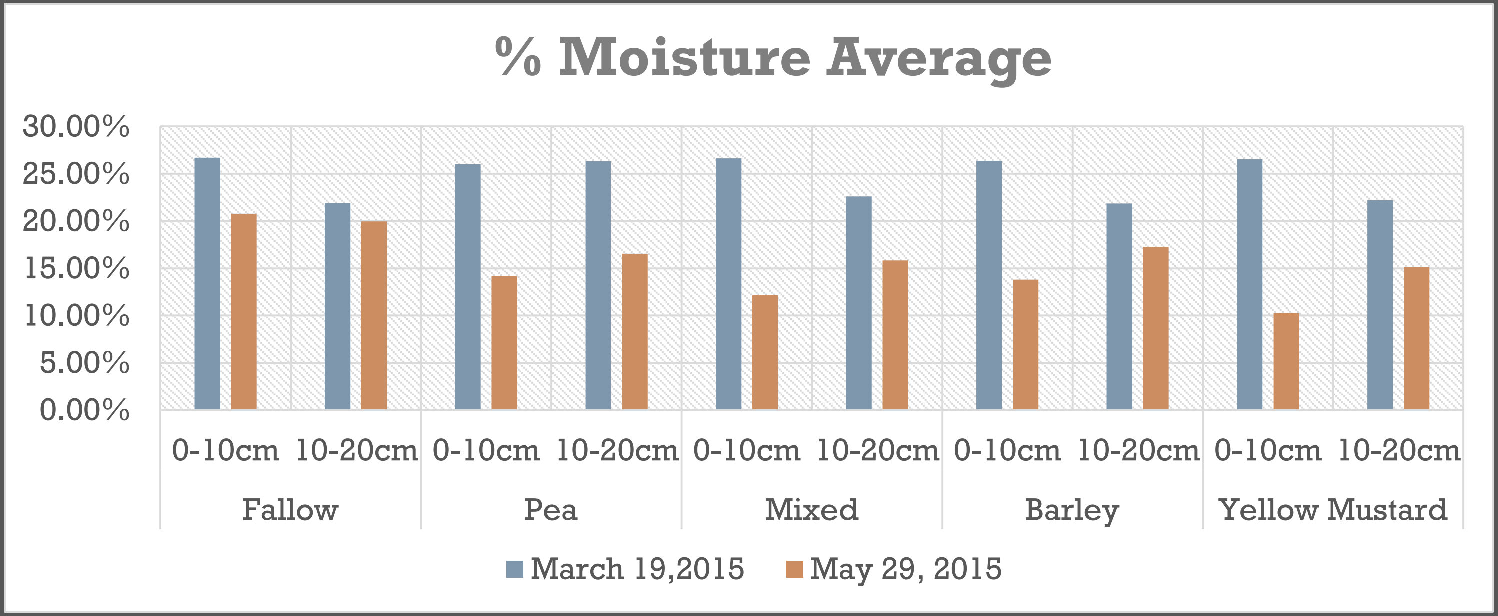
CO_2 Analysis

- ~22g soil at field capacity incubated in mason jars at 23˚c
  - Took readings after 24hrs, 72hrs, 1 week, and 2 weeks
- Extracted CO_2 in order to measure the potential mineralizable carbon (PMC)

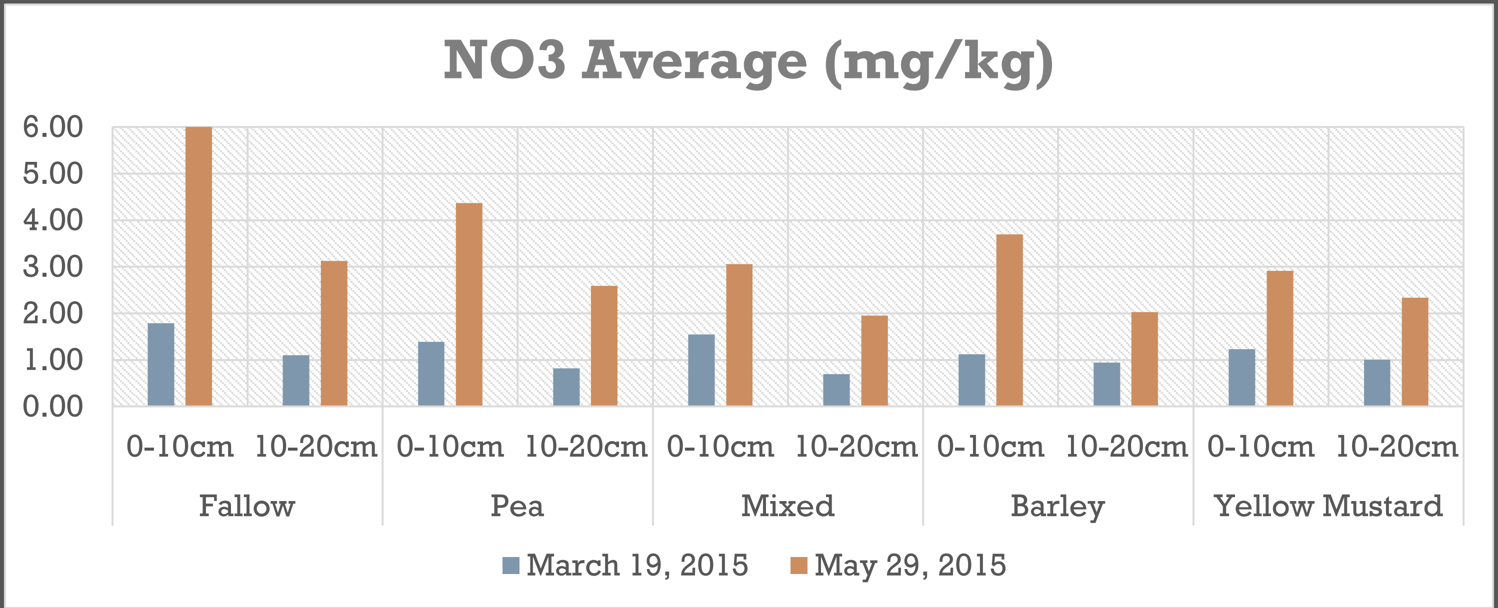





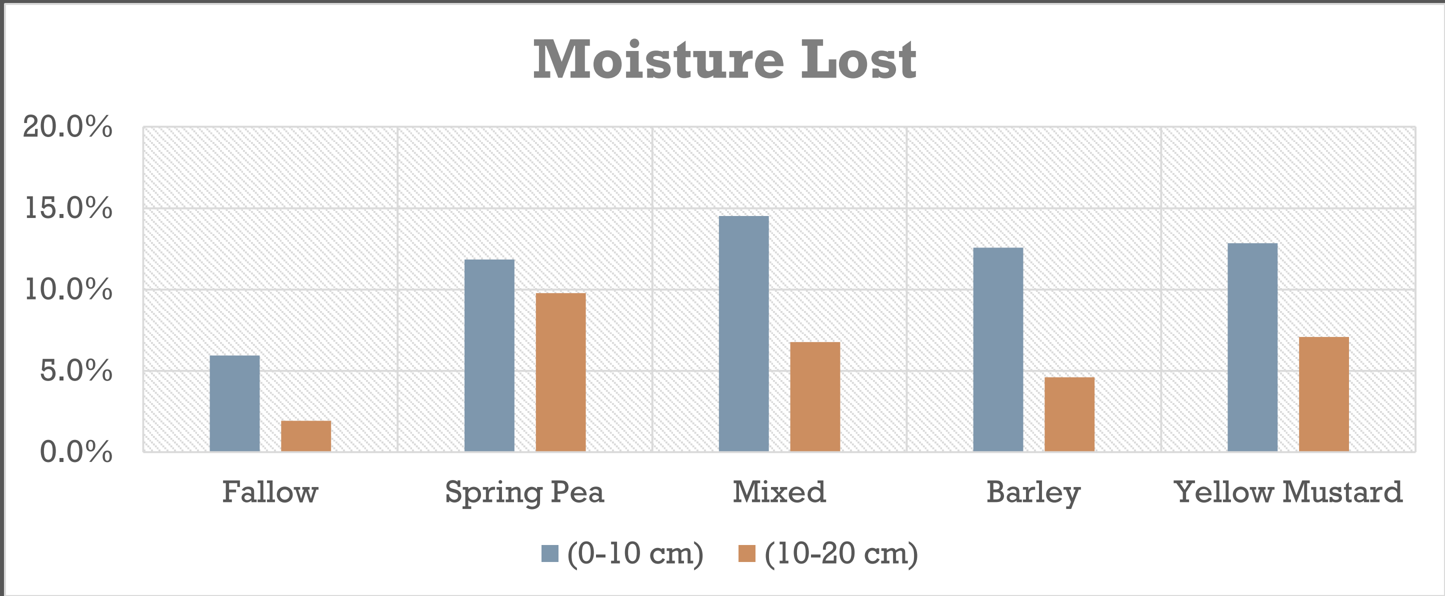
Results



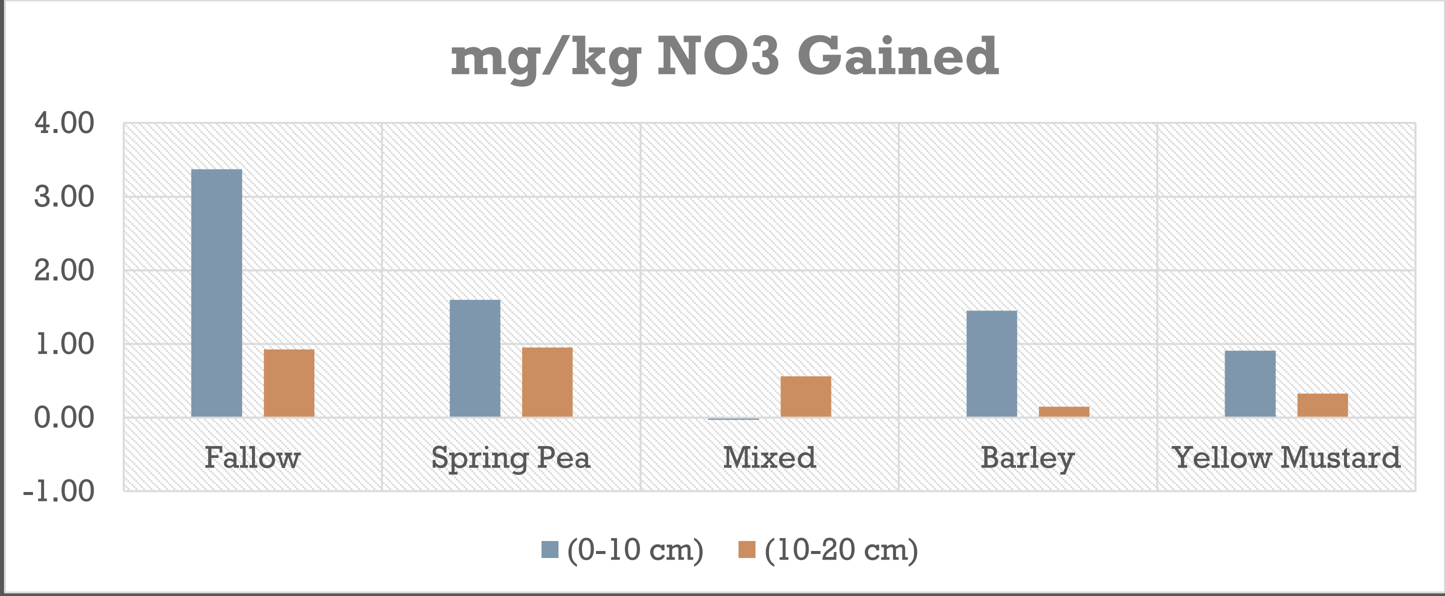
% Moisture Average
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
0-10cm
10-20cm
Fallow
Pea
Mixed
Barley
Yellow Mustard
March 19,2015
May 29, 2015



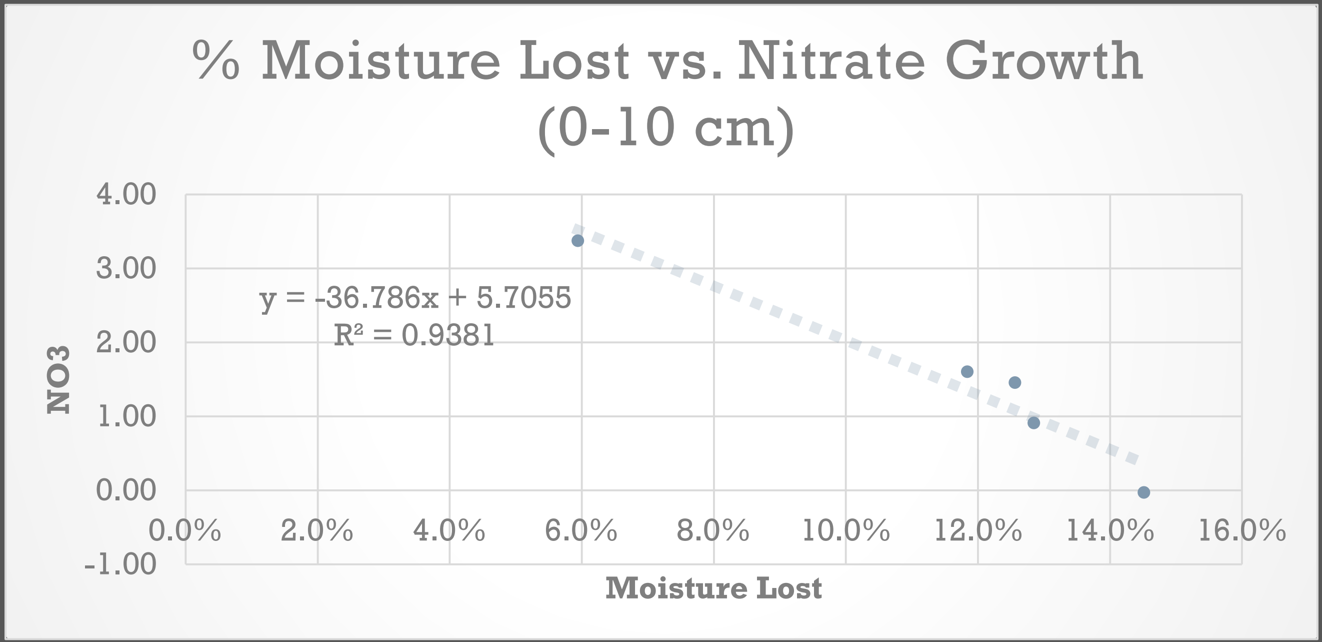
NO3 Average (mg/kg)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0-10cm
10-20cm
Fallow
Pea
Mixed
Barley
Yellow Mustard
March 19, 2015
May 29, 2015



March 19 – May 29

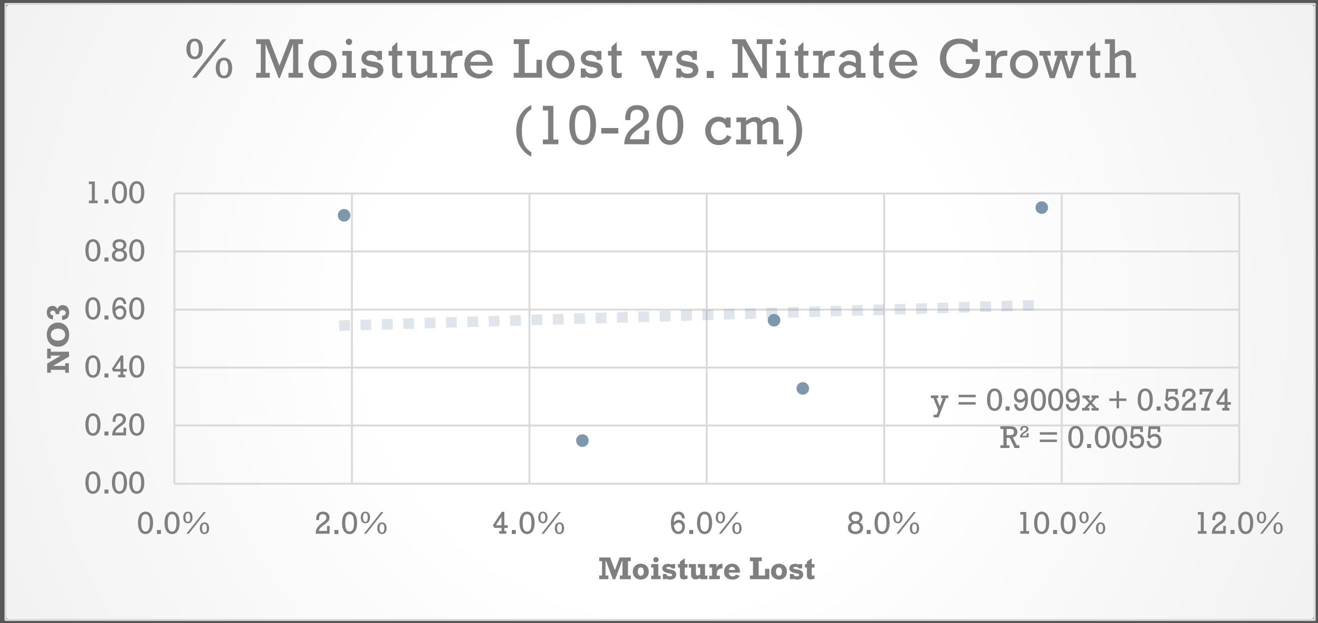


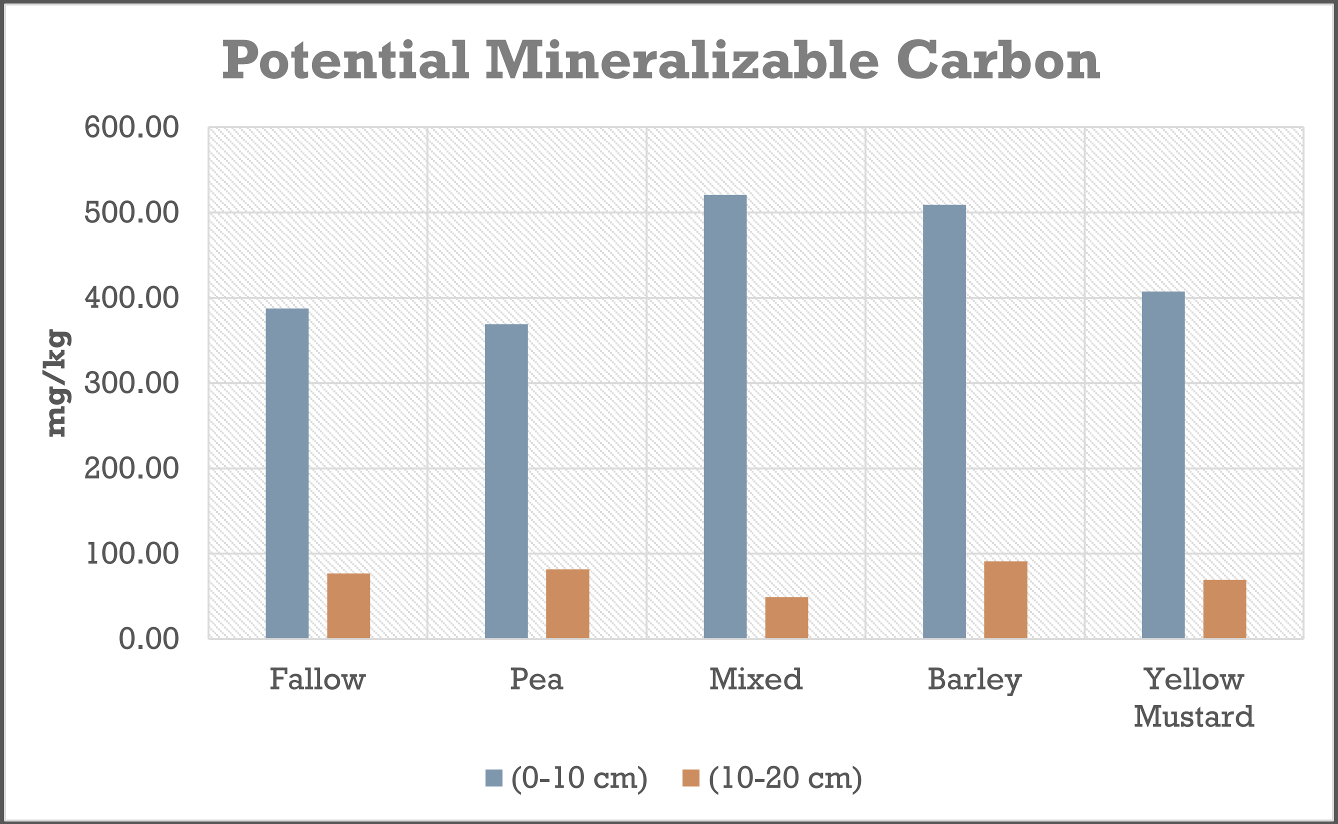
May 29 – March 19



- Found a high correlation between moisture and Nitrate in a 0-10 cm soil depth

- Found no correlation between moisture and Nitrate in the 10-20 cm soil depth





- Potentially Mineralizable Carbon (PMC) is the amount of active C that can be potentially held in the soil under constant conditions
- Mixed has the highest followed by Barley and Yellow Mustard

Conclusion

- According to the data analyzed, fallow had the greatest increase in NO3 amounts in two months
- When you compare the CC data to each other the data shows Barley and Spring Pea as the most effective CC treatments

	PMC	Moist Lost	NO3 Gained
Fallow	387.41	5.95%	3.37
Spring Pea	368.91	11.84%	1.60
Mixed	520.67	14.52%	-0.03
Barley	508.96	12.57%	1.45
Yellow Mustard	407.50	12.85%	0.91

What's Next?

- Stakeholders:
  - Farmers, scientists, community members, educators, potential funders (USDA, OSU, NSF)

- Potential Extension Program:
  - Create a program that has a website, organized events, scientific literature, and possibly YouTube videos providing cover crop information to anybody whose interested

Additional Work

- Analyzed soil for a local farmer
- Tested pH
- Assisted in a Biochar experiment
  - Washed roots
  - Ground plant and soil samples
  - Prepared Nitrogen extractions

References

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Questions?