



Straw Management and Crop Rotation Alternatives to Stubble Burning: Assessing Economic and Environmental Trade-offs

DOE Presentation – Feb. 12, 2013

by Gerard Birkhauser

Co-Principle Investigators

Dave Huggins, Soil Scientist

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Field Studies and Lab Analyses

DOE-1 Field Study (12 x 12 ft plots)

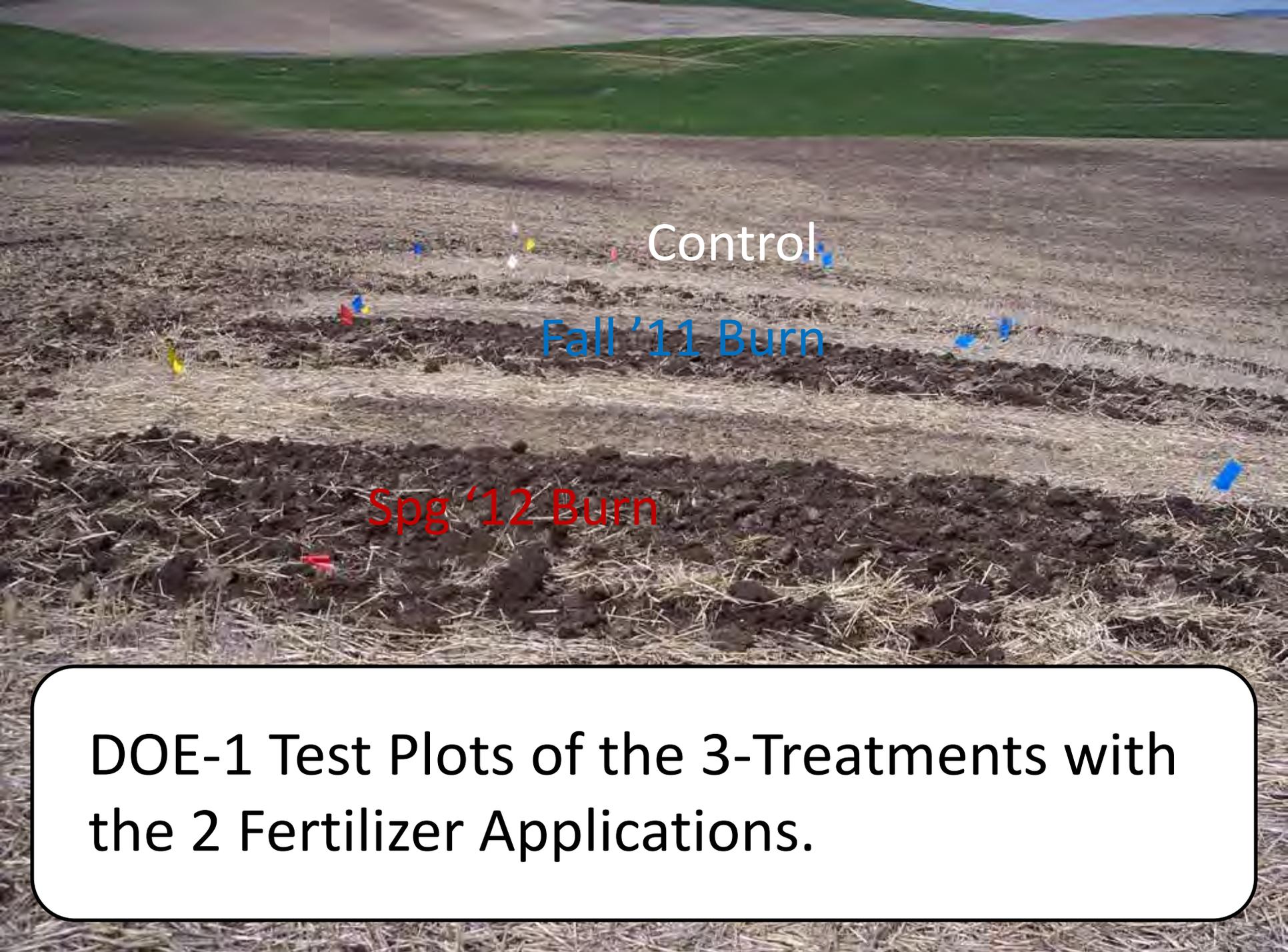
- 15 sites with 6 treatments (Fall '11 Burn, Spg. '12 Burn, Control, Fertilized/Nonfert.)

DOE-2 Field Study (12 x 12 ft plots)

- Rotations after Fall Burn: (1) ww-sb-sw; (2) ww-cp-sw; (3) ww-ww-sw.

DOE-3 Field Study (10 x 50 ft plots)

- 2 rotations (ww and ww-l) and 3 tillage



Control

Fall '11 Burn

Spg '12 Burn

DOE-1 Test Plots of the 3-Treatments with
the 2 Fertilizer Applications.

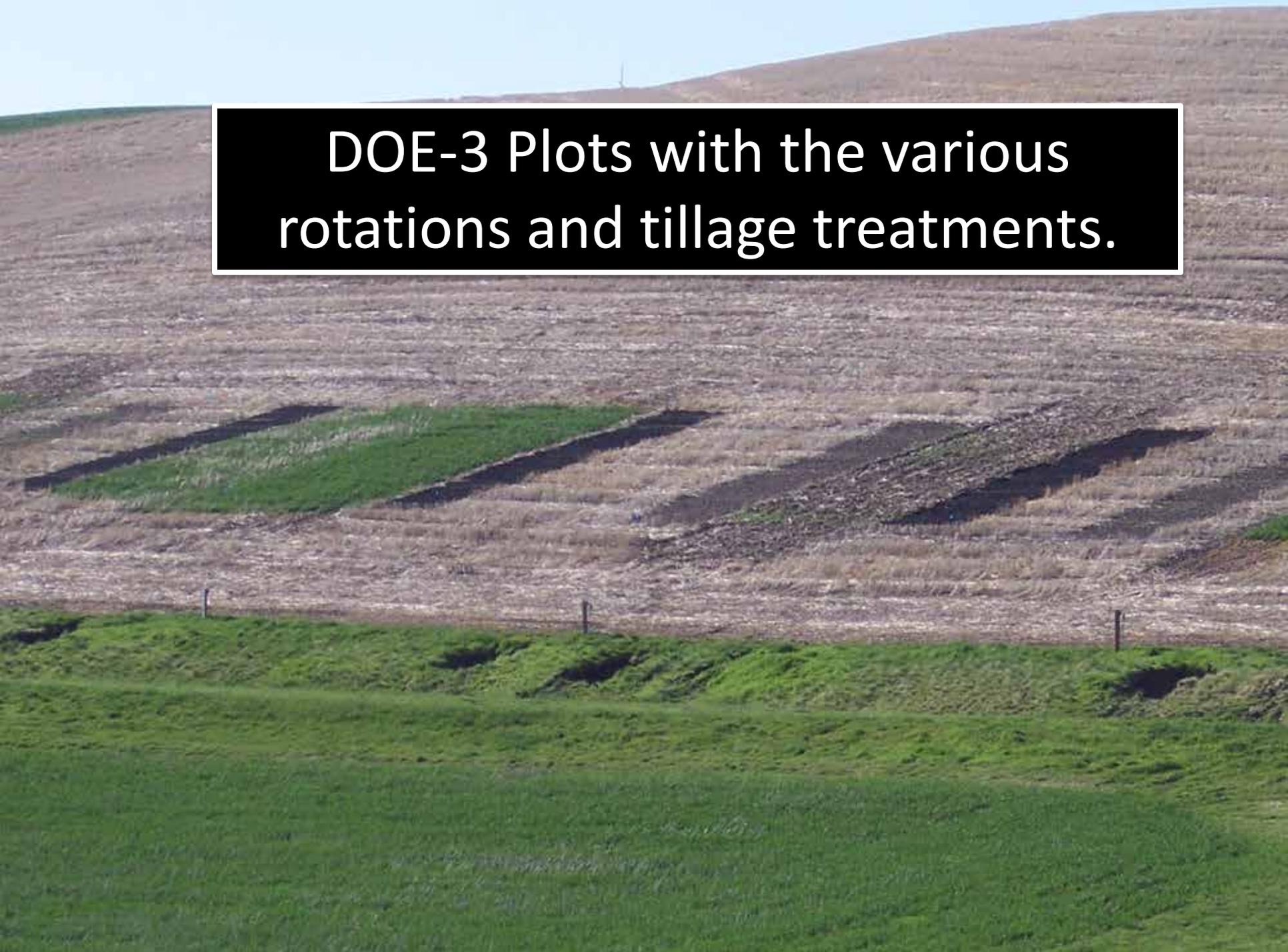
DOE-1 Field



DOE-2 Fields

DOE-1 and DOE-2 Test Plots
(Fall 2011 Burn is shown)

DOE-3 Plots with the various rotations and tillage treatments.



Project Objectives

2011-2012 study documenting:

- (1) Wheat stubble burning impacts (SOM; C, N, P losses)
- (2) Crop rotations and sequences that benefit from retaining winter wheat residues in DS systems
- (3) Effects of wheat straw management and rotation alternatives on root pathogens
- (4) An economic analysis

Methodology Used to Accomplish the Objectives

- Measure soil chemical and physical characteristics (soil pH, POM, bulk density, water content, nutrient contents).
- Assess the residue loads (biomass, yields, C and N contents, net collected weights).
- Compute C, N, and P losses (mass balance on soil, plants, and residue).
- Evaluate micronutrient fluxes (PRS probes).

Progress Made Since June Meeting

- Process the collected residue from Spg burn.
- Assessed the Spg 2012 burn residue loads.
- Harvested and threshed crops to determine yields for all three DOE fields.
- Collected post-harvest soil samples (90).

Progress Being Made (... continued)

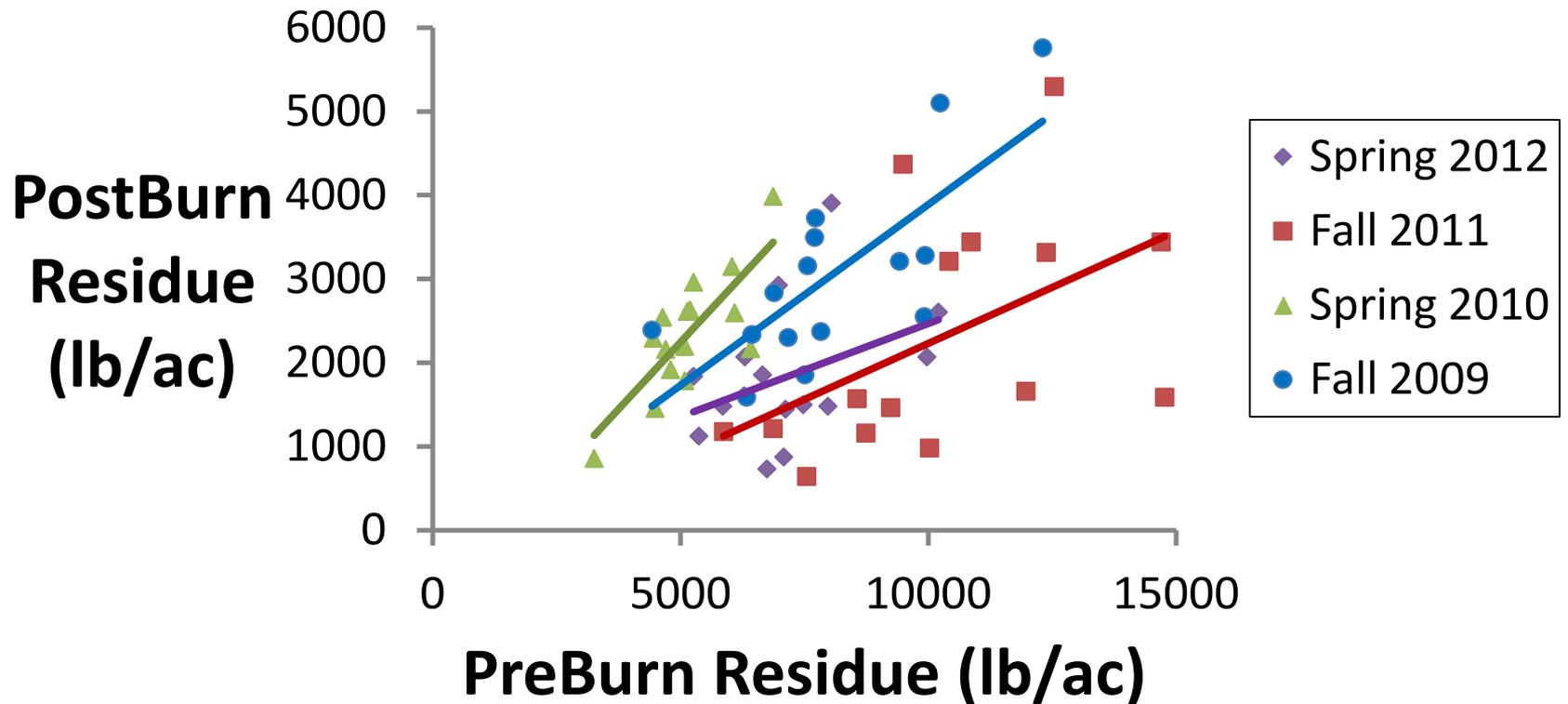
- Prepared residue samples of Spg 2012 burn for nutrient analysis.
- Reviewing and summarizing nutrient flux data from PRS probes.
- Performing physical and chemical testing on soil samples.
- Computing C, N, and P losses (mass balance on soil, plants, and residue) of Spg burn.

Residue Loss from Spg 2012 Burn

- 7,152 lb/ac (preBurn) vs. 1,832 lb/ac (postBurn)
- Residue mass lost to burning ranged 51 – 89%
- Average residue lost to burning for 15 sites was 74% compared to:
 - § 78% - **fall 2011** 10,264 (PreB) 2,302 (PostB) lb/ac
 - § 55% - **spg 2010** 5,166 (PreB) 2,353 (PostB) lb/ac
 - § 62% - **fall 2009** 8,092 (PreB) 3,064 (PostB) lb/ac
- Plotting residue consumed from burning, slope correlation were lower than previous burn data.

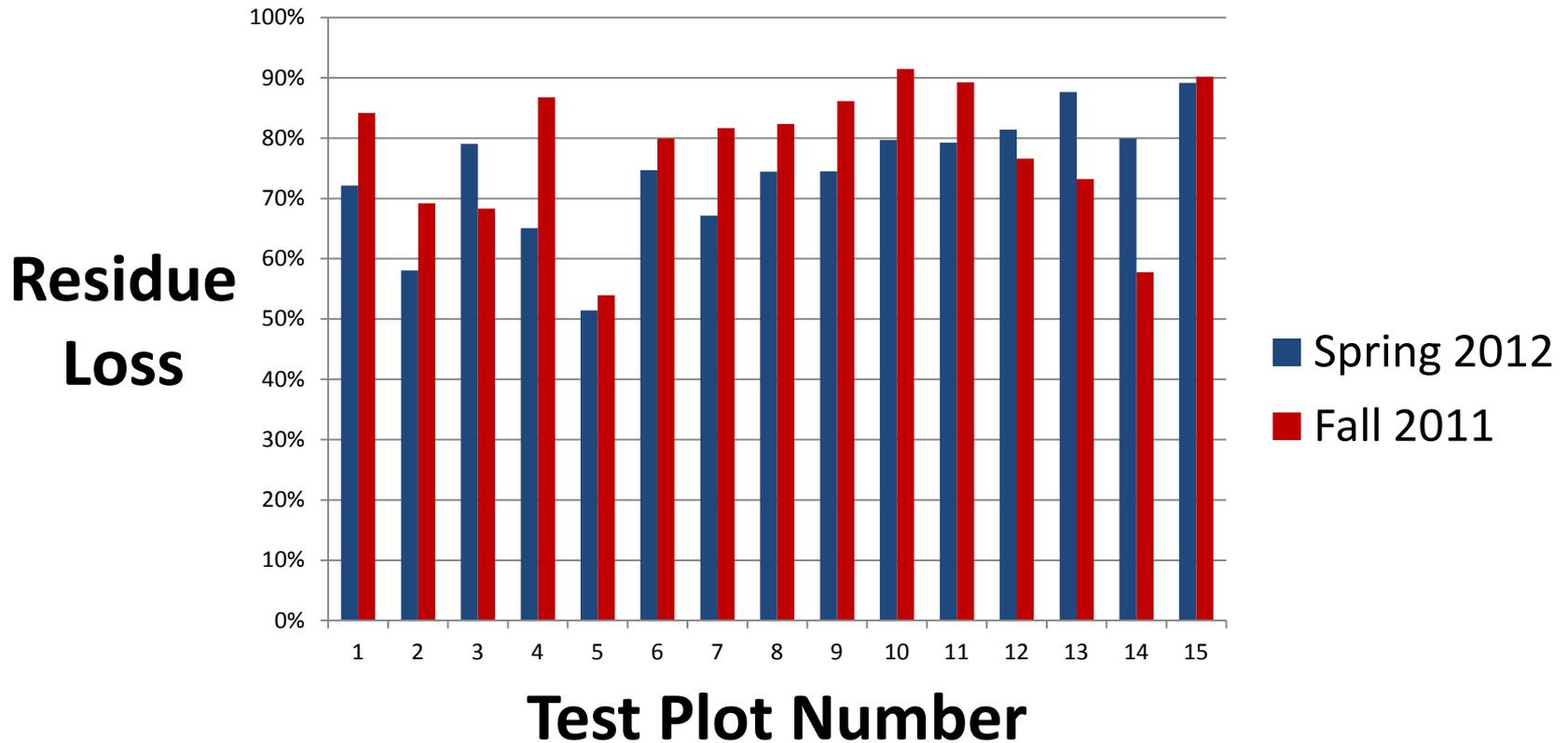
Residue Loads for 4 Burn Seasons

Residue Remaining after Burning



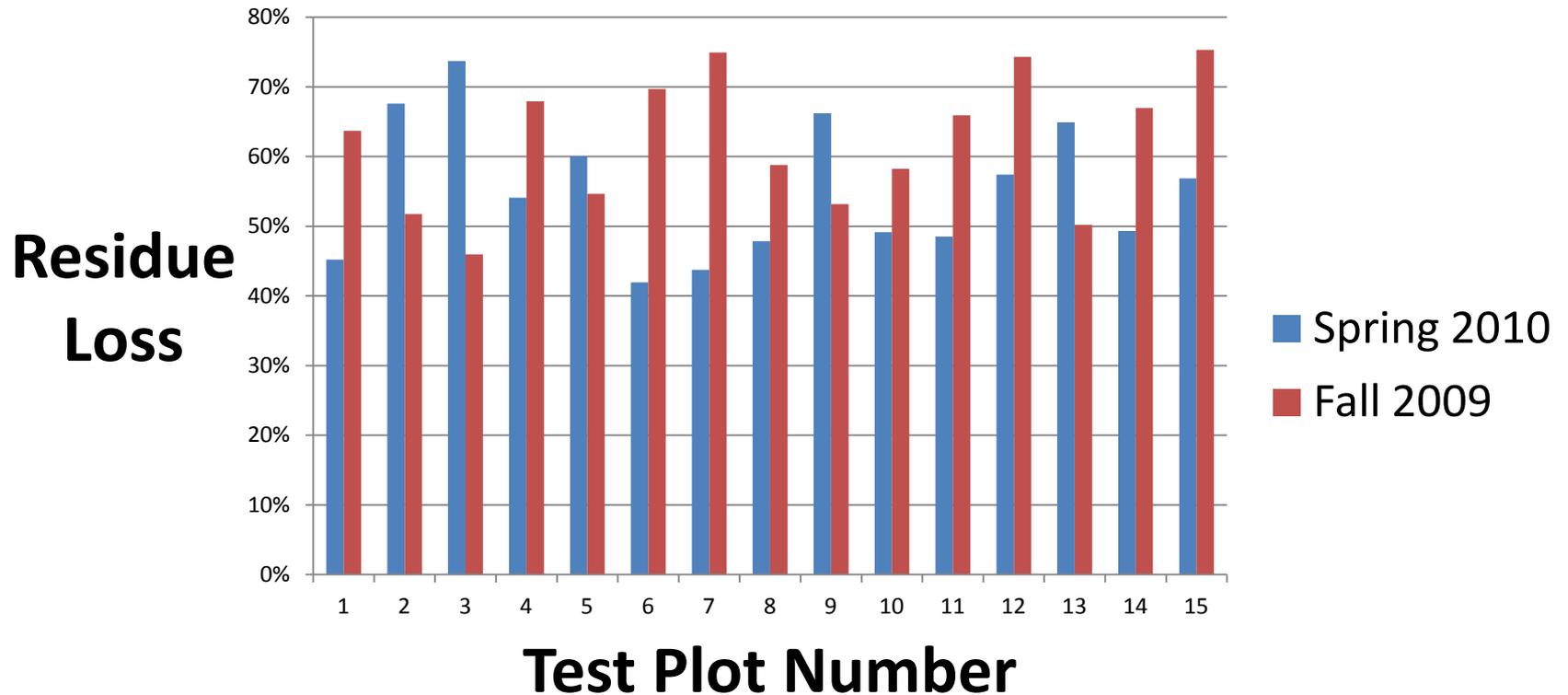
Residue Loss from Recent Burns

Percentage Residue Loss to Burning



Residue Loss from Prior Burns

Percentage Residue Loss to Burning



Comparison of Crop Yields for Various Treatments

In comparing Burning to Control (non-burn):

Fertilized Plots

Non-Fertilized

2011-2012 Harvest

Fall Burn 18% ↑ yield

25% ↑ yield

Spring Burn 4% ↑ yield

3% ↓ yield

2009-2010 Harvest

Fall Burn 3% ↓ in yield

13% ↑ in yield

Spring Burn 10% ↓ in yield

4% ↓ in yield

Crop Yields for DOE-1

| Spring Wheat | Control | | Fall Burn | | Spring Burn | |
|---------------------|--------------|--------------|--------------------|--------------|--------------|--------------|
| | N Applied | No N Applied | N Applied | No N Applied | N Applied | No N Applied |
| | | | 2009 - 2010 | | | |
| Grain Yield (bu/ac) | 59a | 47b | 57a | 53a | 53a | 45b |
| Grain Protein (%) | 11.0a | 9.1b | 11.4a | 8.9b | 11.4a | 8.8b |
| | | | 2011 - 2012 | | | |
| Grain Yield (bu/ac) | 51 | 36 | 60 | 45 | 53 | 35 |
| Grain Protein (%) | 8.3 | 8.2 | 8.3 | 8.6 | 8.0 | 8.3 |

Crop Yields for DOE-2

| Crop | 2010 Harvest | | 2012 Harvest | |
|--|--------------|-----------|--------------|-----------|
| | Control | Fall Burn | Control | Fall Burn |
| Winter Wheat Yield following Winter Wheat, (bu/ac) | 82a | 82a | 72 | 82 |
| Garbanzo Bean Yield following Winter Wheat, (lbs/ac) | 1624a | 1634a | 1934 | 2008 |
| Spring Barley Yield following Winter Wheat, (lbs/ac) | 4733b | 5234a | 4059 | 4415 |

Outreach Efforts to get the word out about DOE-funded Project

- ASSS Conference
- Stakeholder Presentations
- Field Day Presentations to Local Growers and Scientific Researchers
- “Subcontractor” Technical Presentations

Straw Management and Crop Rotation Alternatives to Stubble Burning

Gerard Birkhauser
WSU

DOE Study results – Aug. 2012

Cook Farm Field Day

Growers & Researchers Presentation

Straw Management and Crop Rotation Alternatives to Stubble Burning

Gerard Birkhauser & Dave Huggins

WSU - USDA

DOE Study results – Oct. 2012

American Society of Soil Science Annual
Meeting

Poster Session

Straw Management and Crop Rotation Alternatives to Stubble Burning

Dave Huggins
USDA - WSU

DOE Study results – Jan. 2013

Columbia Conservation District Annual Meeting

Dynamics of Ion Sorption by Synthetic Resin Membranes (PRS Probes)

**Eric Bremer and Troy Radtke
Western Ag Innovations**

**Dave Huggins and Gerard Birkhauser
USDA - WSU**

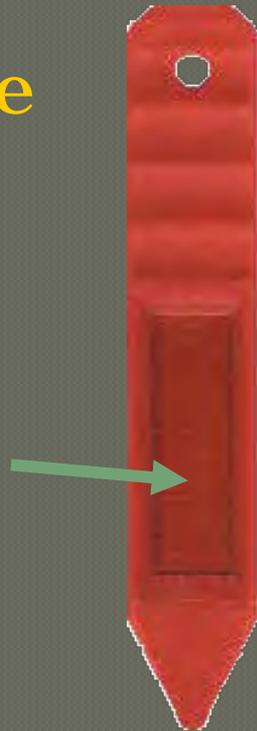
**DOE PRS Study results – Feb. 2013
Alberta Soil Science Workshop**



Plant Root Simulator (PRS™) Probes

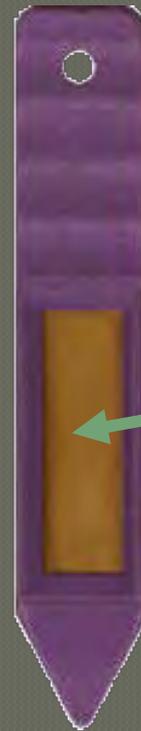
Anion probe

- Anion Membrane
- quaternary $R-NH_3^+$



Cation probe

- Cation Membrane
- sulfonic acid $R-SO_3^-$



Field Deployment & Lab Incubation Studies



Nutrient Flux Measurements using the PRS Probes for Lab Incubation study.



14 Nutrients are collected on probes that simulate what a plant would take-up during the burial period.

Week-3 Plot #8
Fall Burn w/ PRS





Probes deployed between rows Spg. Wht.

Summary of PRS probe data for Field Deployment

Installed in FB & CON plots (unfertilized subplot)

Burial periods: 1-day and 1, 2, 3, 4-week

Spring 2012

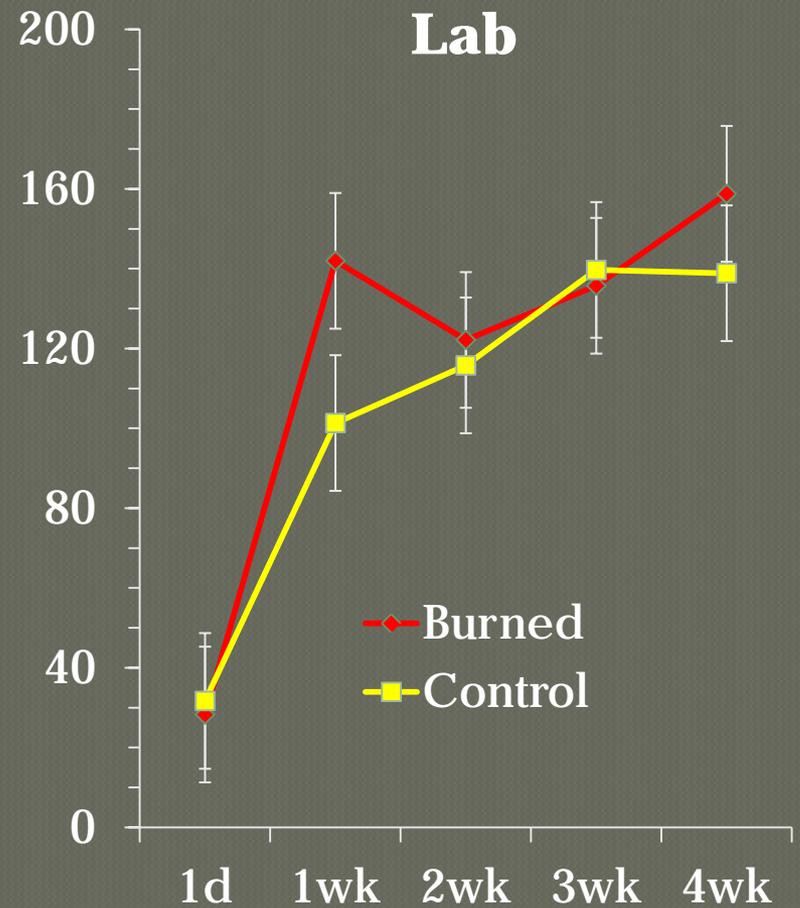
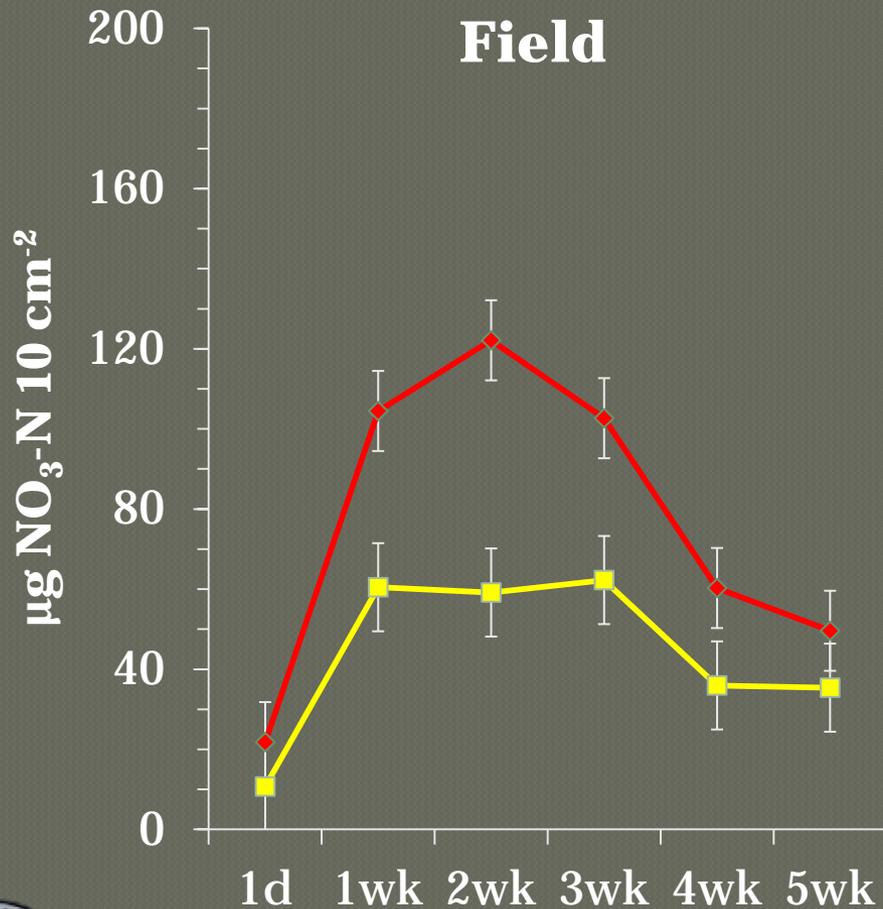
- May 10th (started 24-hr period) – June 15th
- Prior Precpt.: 19.2 in (actual) – 16.1 (normal)
- Test time rainfall: 3.3 in (act.) – 3.1 (norm.)

Spring 2010

- April 14th – May 20th
- Prior Precpt.: 9.5 in (actual) – 14.5 (normal)
- Test time rainfall: 4.6 in (act.) – 3.5 (norm.)

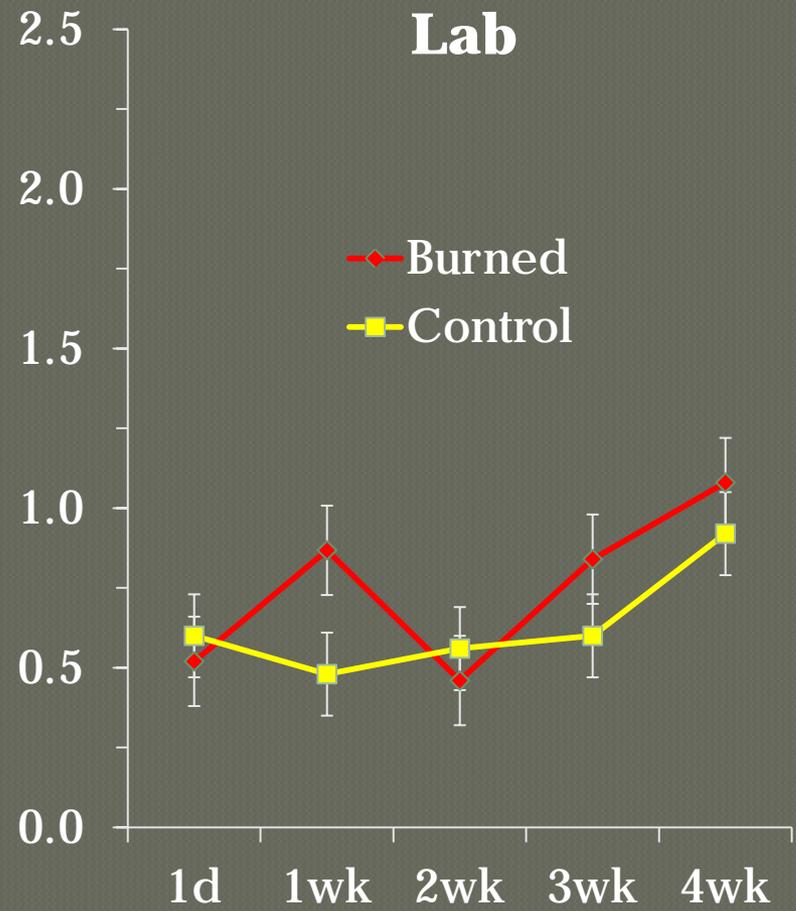
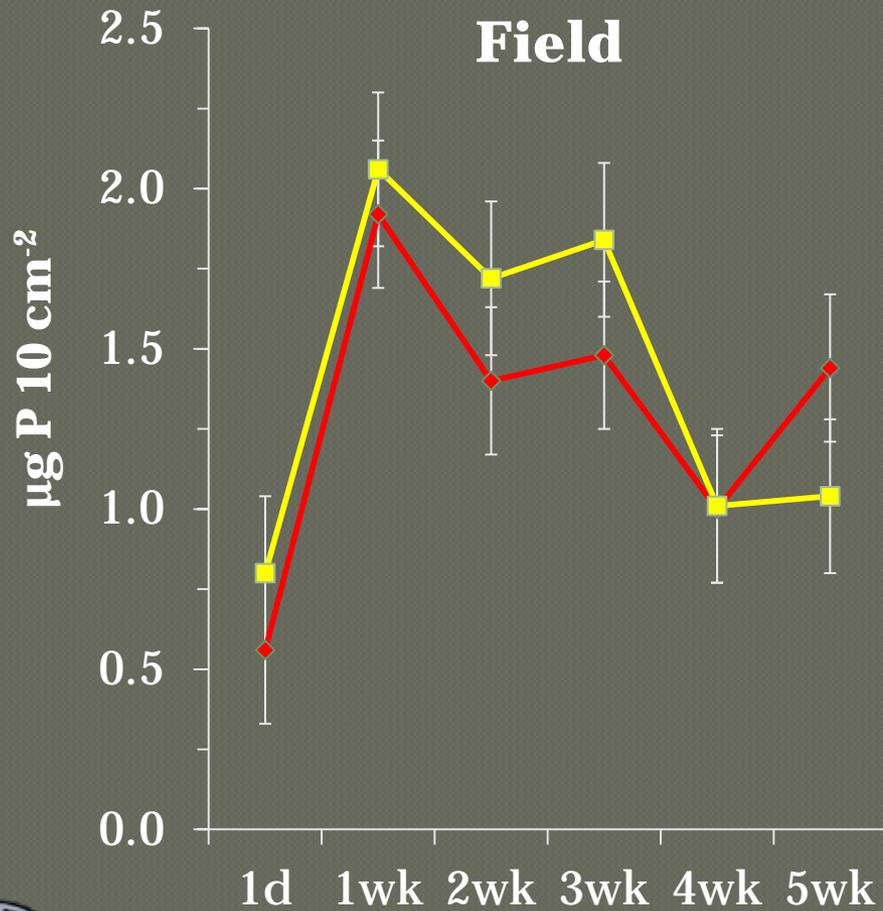
NO₃-N

Spring 2010



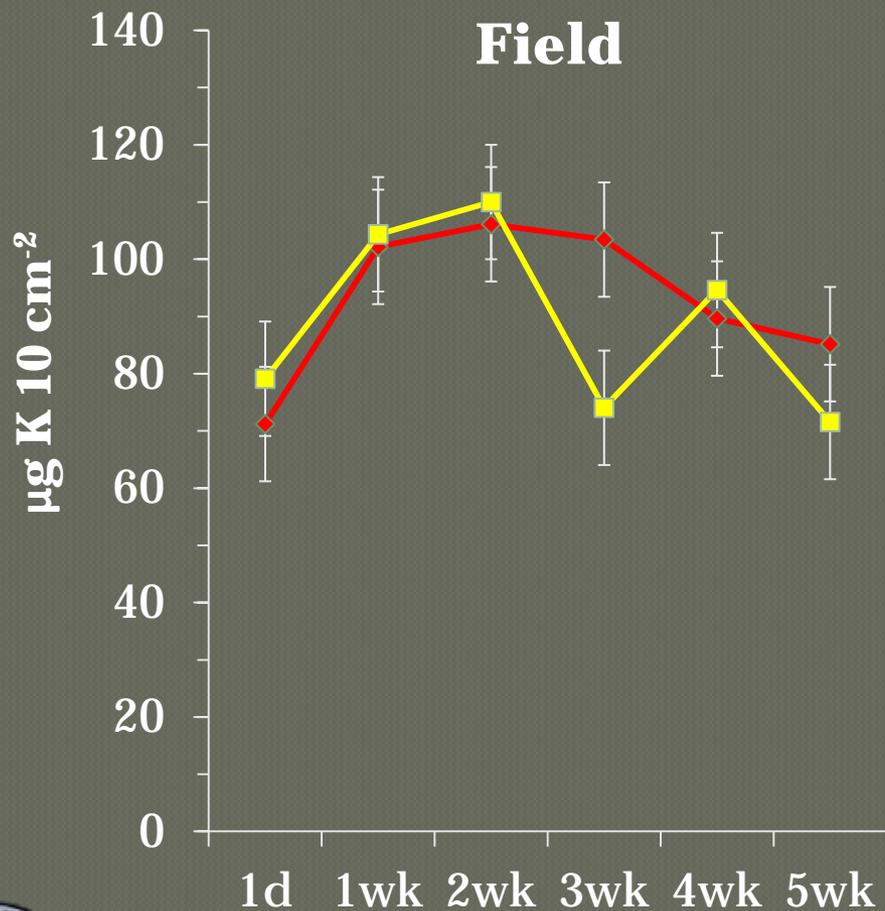
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Spring 2010



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Spring 2010



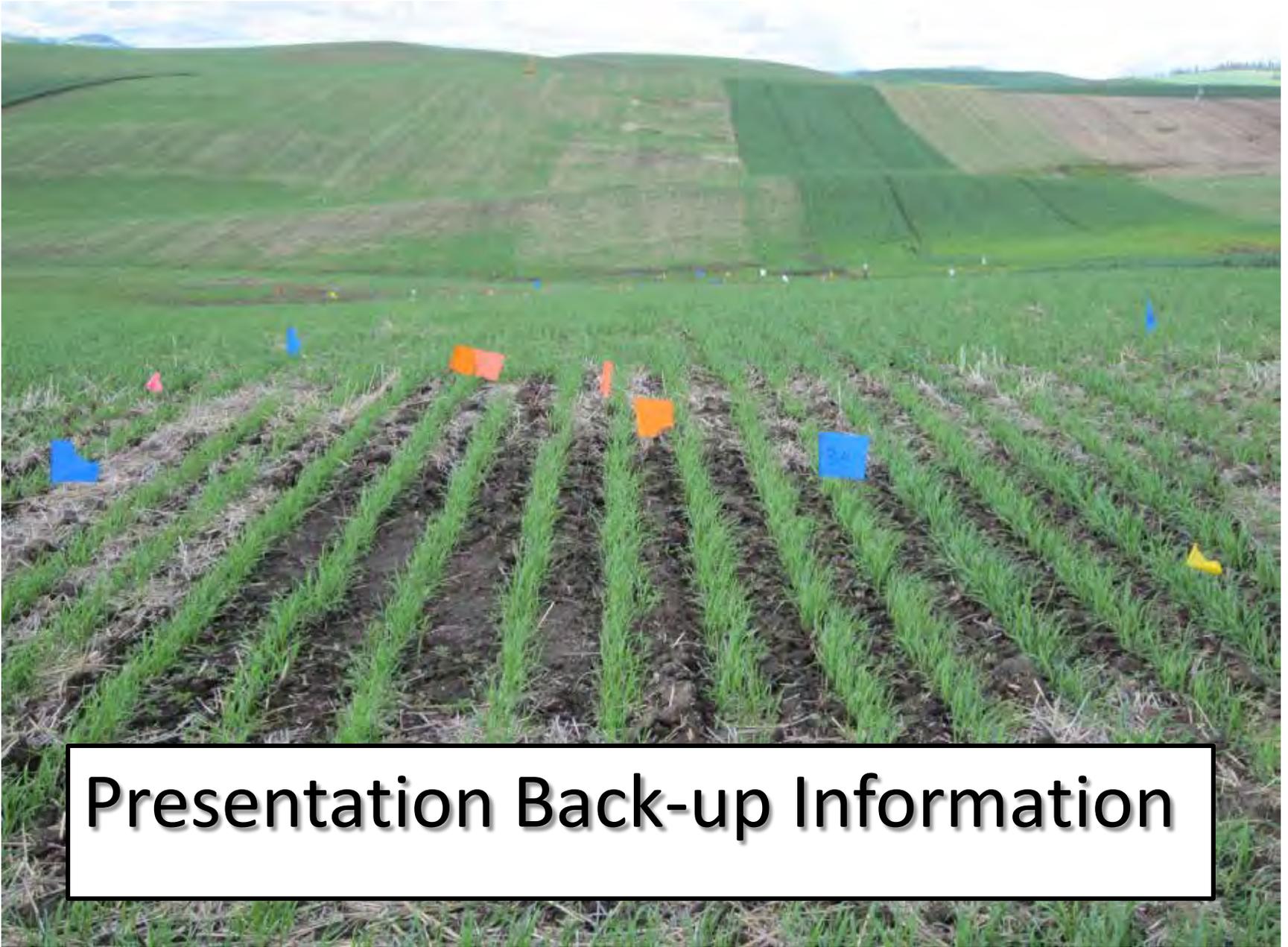
Items to Complete (next 6 mon.)

- Physical analyses of soil (45 samples).
- Nutrient analyses of plants (12 samples).
- Nutrient analyses of residue (12 samples).
- C & N contents of soil and residue for spring 2012 Burn (30 samples each).
- N mineralization incubations 28-day cycle.
- Evaluation of PRS probe data.

Items to Complete (continued)

- Soil erosion and condition index estimates.
- Economic assessment of lost residue.
- Completion of Final Report.
- Continue outreach efforts to communicate the project findings.
- Compile a manuscript of results for the 2-growing seasons (2009 – 2012).

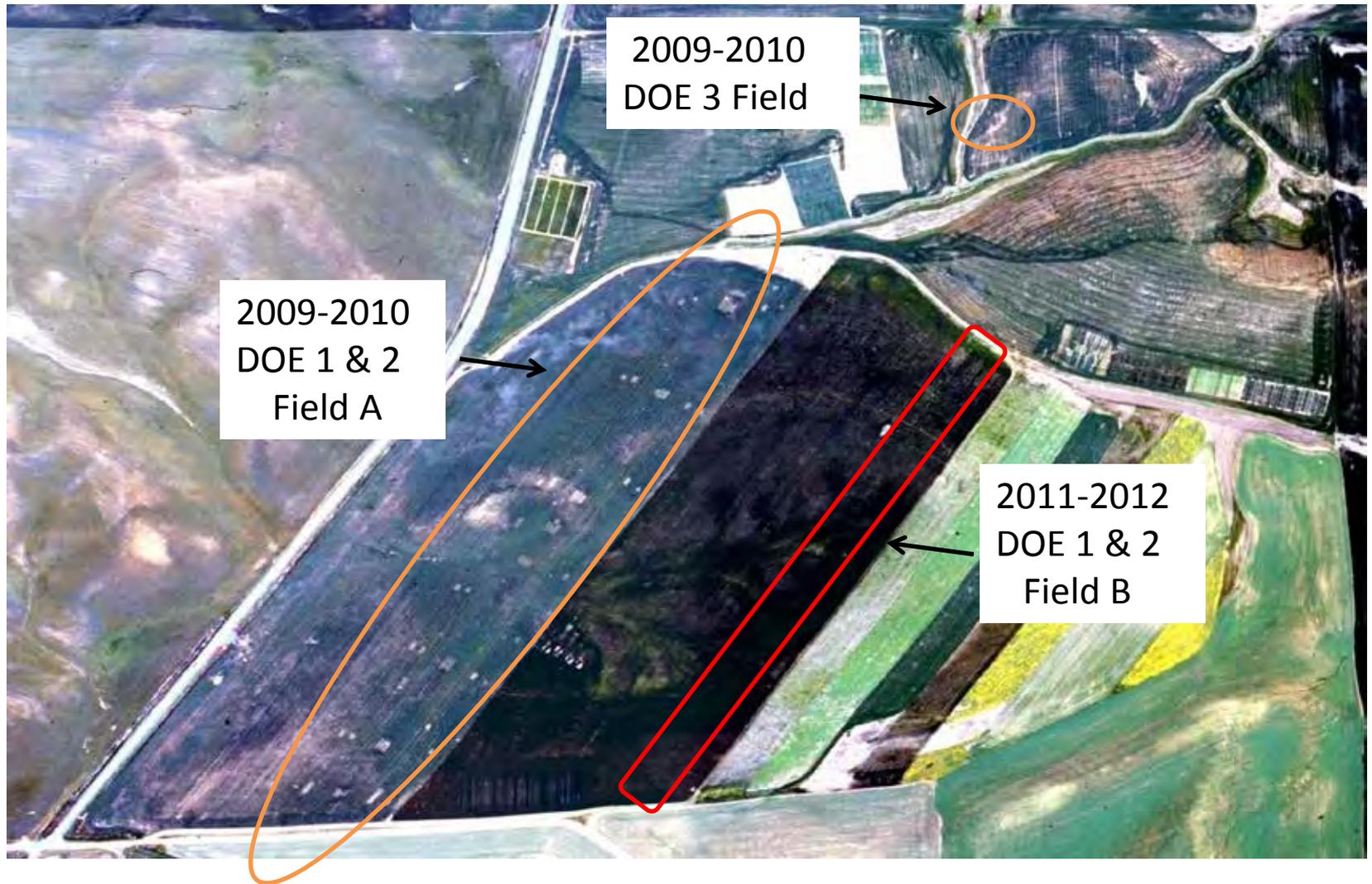




Presentation Back-up Information

Cook Agronomy Farm

Direct Seed and Precision Farming Systems

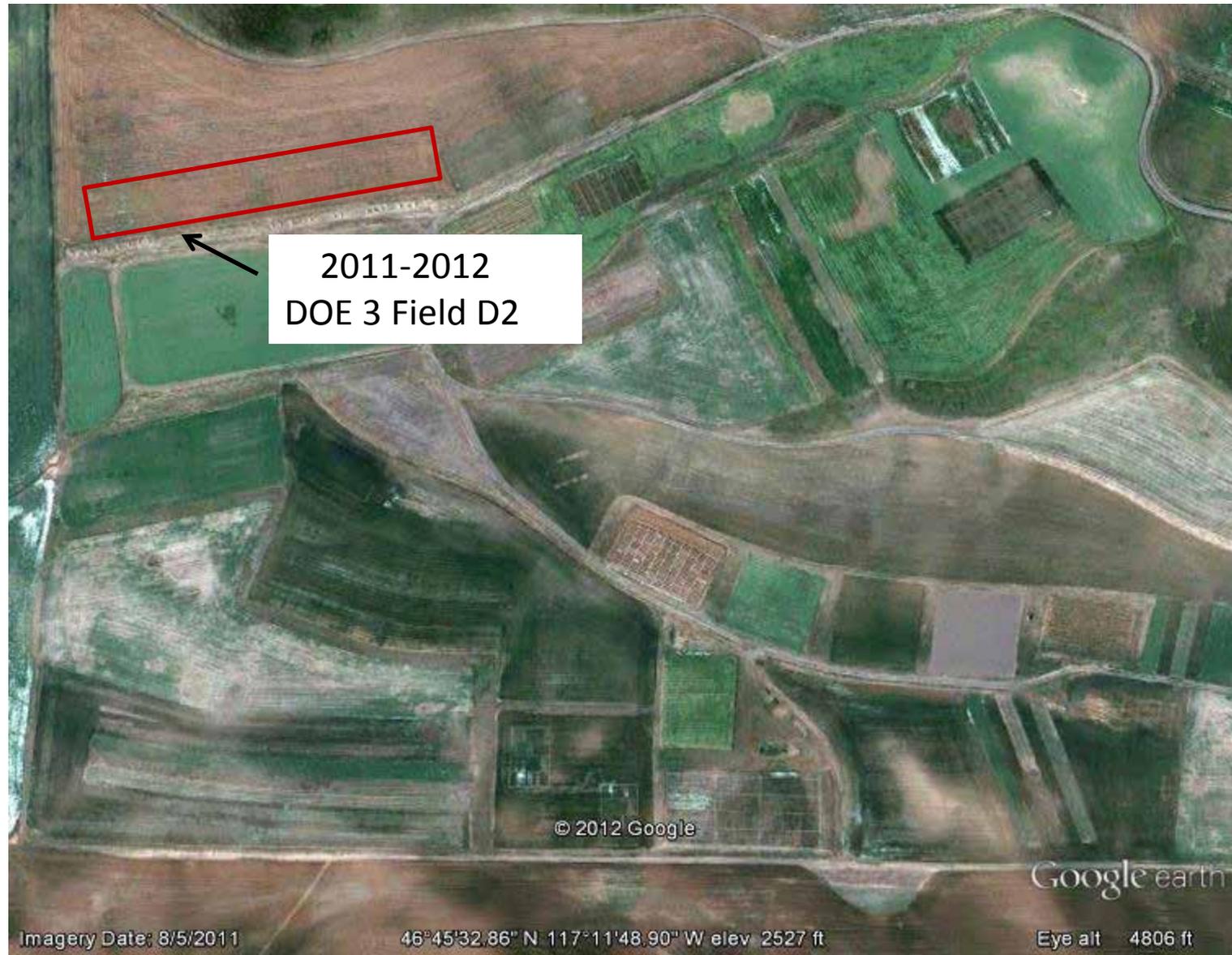


Location of Field Studies based on the 3 Objectives

DOE-1 Burn Plots: Fall 2011 and Spring 2012



USDA Palouse Conservation Field Station



DOE 3 Plot Map SY2011-HY2012, PCFS Field

| 100' | | | | | | | | | | North |
|--------------|---|-----------------------|---------------|---------------|---------------|---|-------------------------|---------------|---------------|---|
| | 10' | 10' | 10' | 10' | 15' | 15' | 10' | 10' | 10' |  |
| Rep 1 | W-L-3 SBCS | W-L-4 NBCS | W-L-2 FBCS | W-L-1 CT | W-L-5 NBH | W-4 NBH | W-2 FBCS | W-1 CT | W-3 NBCS | |
| | 10' | 10' | 10' | 15' | 10' | 10' | 10' | 15' | 10' | |
| Rep 2 | W-1 CT | W-2 FBCS | W-3 NBCS | W-4 NBH | W-L-1 CT | W-L-4 NBCS | W-L-2 FBCS | W-L-5 NBH | W-L-3 SBCS | |
| | 10' | 15' | 10' | 10' | 10' | 10' | 15' | 10' | 10' | |
| Rep 3 | W-3 NBCS | W-4 NBH | W-2 FBCS | W-1 CT | W-L-3 SBCS | W-L-4 NBCS | W-L-5 NBH | W-L-2 FBCS | W-L-1 CT | |
| | 10' | 10' | 15' | 10' | 10' | 10' | 10' | 15' | 10' | |
| Rep 4 | W-L-1 CT | W-L-3 SBCS | W-L-5 NBH | W-L-2 FBCS | W-L-4 NBCS | W-1 CT | W-3 NBCS | W-4 NBH | W-2 FBCS | |
| | Rotation W - continuous winter wheat | | | | | Rotation W-L - winter wheat-legume | | | | |
| | W-1 CT | Conventional Tillage | | | | W-L-1 CT | Conventional Tillage | | | |
| | W-2 FBCS | Fall Burn, Cross Slot | | | | W-L-2 FBCS | Fall Burn, Cross Slot | | | |
| | W-3 NBCS | No Burn, Cross Slot | | | | W-L-3 SBCS | Spring Burn, Cross Slot | | | |
| | W-4 NBH | No Burn, Horsh | | | | W-L-4 NBCS | No Burn, Cross Slot | | | |
| | | | | | | W-L-5 NBH | No Burn, Horsh | | | |

Residue Load Impacts from Burn Treatments

| Winter Wheat Residue | Fall 2009 Burn | | Spring 2010 Burn | |
|-----------------------|----------------|-----------|------------------|-----------|
| | Pre-burn | Post-burn | Pre-burn | Post-burn |
| Residue Load (lbs/ac) | 8093a | 3059c | 5168b | 2354c |
| Residue N (%) | 0.44d | 0.78a | 0.52c | 0.69b |
| Residue C (%) | 39.9b | 39.9b | 43.0a | 40.5b |
| Residue C/N | 92.0a | 54.5b | 84.6a | 59.5b |
| Residue N (lbs/ac) | 35.9a | 24.2c | 27.3b | 16.3d |
| Residue C (lbs/ac) | 3228a | 1218c | 2226b | 955c |