Effects of Cropping Sequence on Pipeline Reclamation in Western North Dakota

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Introduction

- May 15th, 2015, installation of a **36 in. wide pipeline** was completed at the Williston-REC.
- The pipeline **extended 1.5 mi. length**, entirely across cropland.
- Soil disturbance **extended 200 ft. wide.**
- Three specific disturbance areas were identified as having unique soil characteristics.
  - Undisturbed
  - Roadway
  - Pipeline
- We took advantage of this research opportunity by selecting several cropping sequences and perennial covers to evaluate as **long-term reclamation practices.**

Motivation for Study

- Common Barriers to Successful Reclamation on **cropland.**
  - Improper backfilling and topsoil placement
  - Areas of extreme compaction
  - Severely reduced infiltration
  - Destruction of soil structure
  - Reduced water holding capacity
  - Erosion
  - Subsidence within the trench
  - Reduction of soil microbes
  - Reduced nutrient cycling
  - Reduced soil fertility
- Returning cropland to sustainable production can be challenging.
  - Are there specific cropping systems, tillage practices, or amendments that can mitigate these barriers?

Agronomic vs. Engineering Soil Profile Definitions

Figure 1. Profile of a Williams Soil(USDA-NRCS Soil Survey Staff). Credit: Smithsonian Institution's Forces of Change.

Williams-Bowbells Loam (Pre-Disturbance)

Ap - 0 to 6 in: loam

Bt1 - 6 to 10 in: clay loam
Bt2 - 10 to 15 in: clay loam

Btk - 15 to 24 in: clay loam
Bk - 24 to 36 in: clay loam
C - 36 to 60 in: clay loam

Soil Removal and Placement Standards During Reclamation

Topsoil – >12 in
Subsoil – <12 in

- **Current Policy states scrape *NO MORE* than top 12 inches to represent topsoil**
  - This is **often misinterpreted** – with some contractors pushing up 12 inches, creating a mixing of top and subsoil

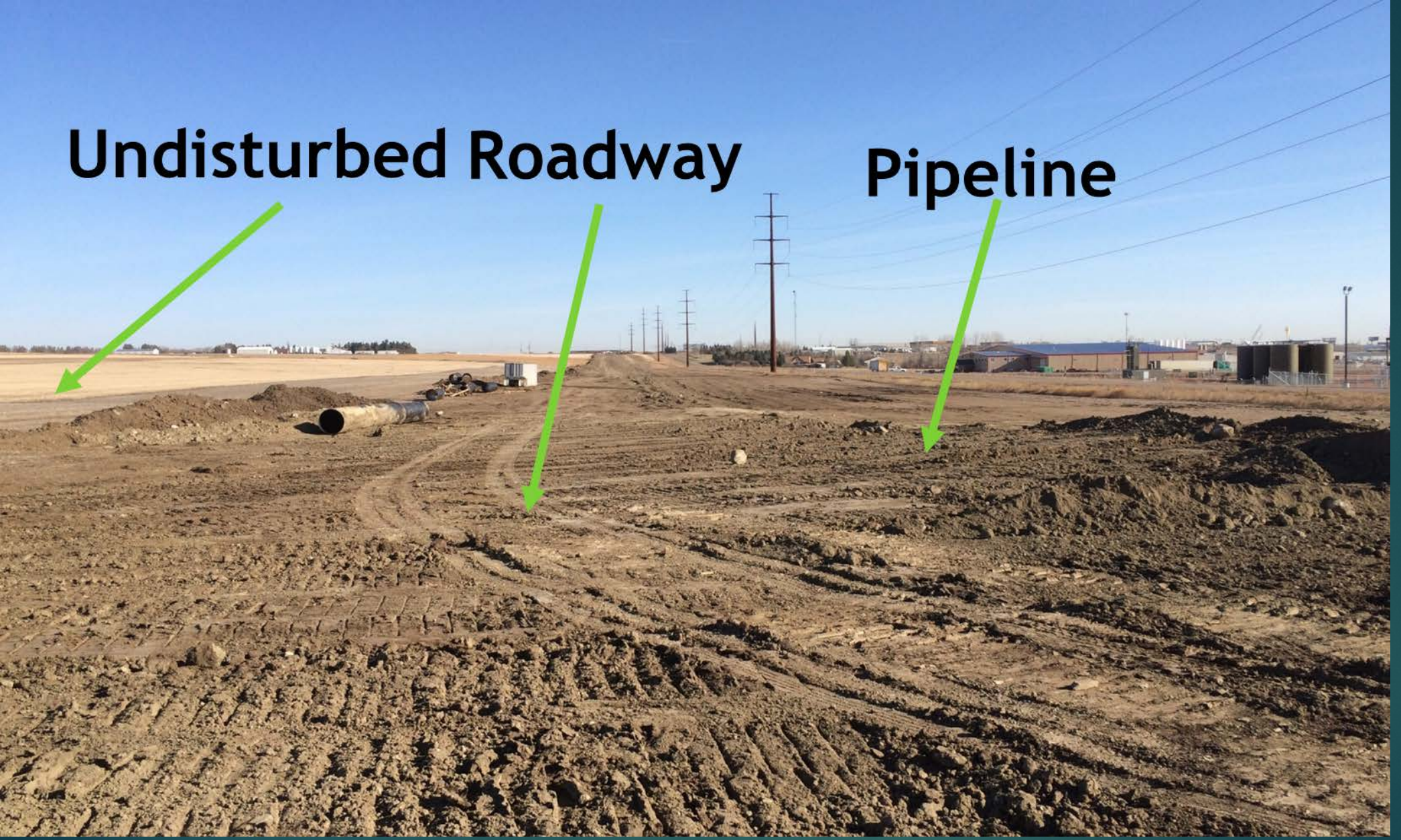


Figure 2. Areas of disturbance being studied.

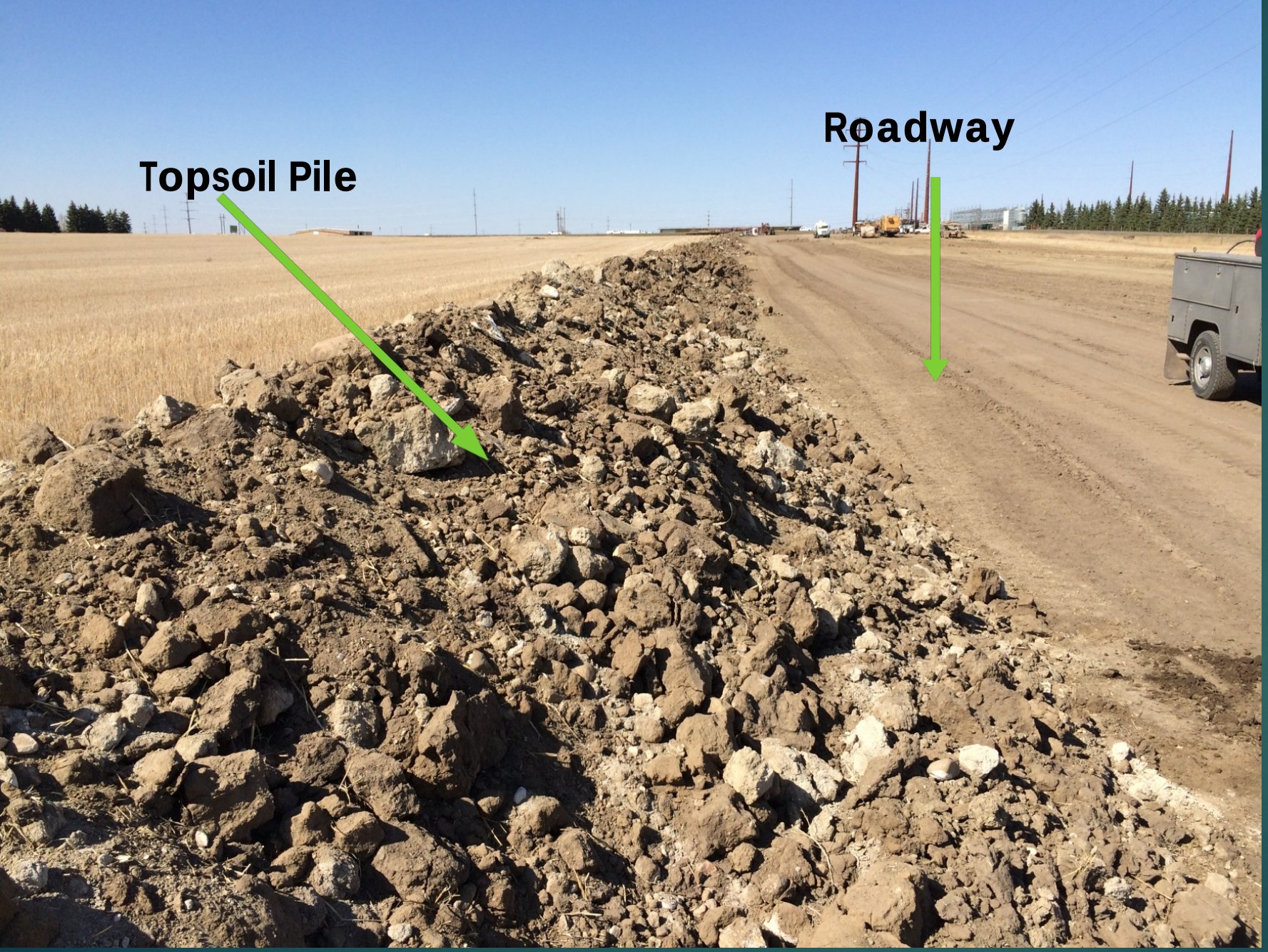


Figure 3. Poor Topsoil Placement/Compacted Access Road.

Objectives

1) Define the reclamation success of a long-term control (no action/continued mono-cropping of wheat.

2) Evaluate the effects of five annual and two perennial cropping sequences on soil health and crop performance in three disturbance areas (pipeline, road, undisturbed).

3) Determine the effects of ripping with and without manure application across severely compacted areas.

Design

Sequences are based on the most commonly grown crops in western North Dakota

Sequence	2015	2016	2017	2018	2019	2020
	Min. till	**Min. till**	**Spring Ripping/Manure**	**Min. till**	**Min. till (N/SM Reset)**	**Min. till (Final comp.)**
1	Durum	Durum	Durum	Durum	Flax	Wheat
2	Durum	Peas	Barley	Safflower	Flax	Wheat
3	Peas	Barley	Safflower	Durum	Flax	Wheat
4	CC Mix	Durum	CC Mix	Durum	Flax	Wheat
5	Durum	CC Mix	Durum	CC Mix	Flax	Wheat
6	Alfalfa	Alfalfa	Alfalfa	Alfalfa	Flax	Wheat
7	Per. Grass	Per. Grass	Per. Grass	Per. Grass	Flax	Wheat

Table 1. Cropping schedule. (N=Nitrogen, SM=Soil Moisture)

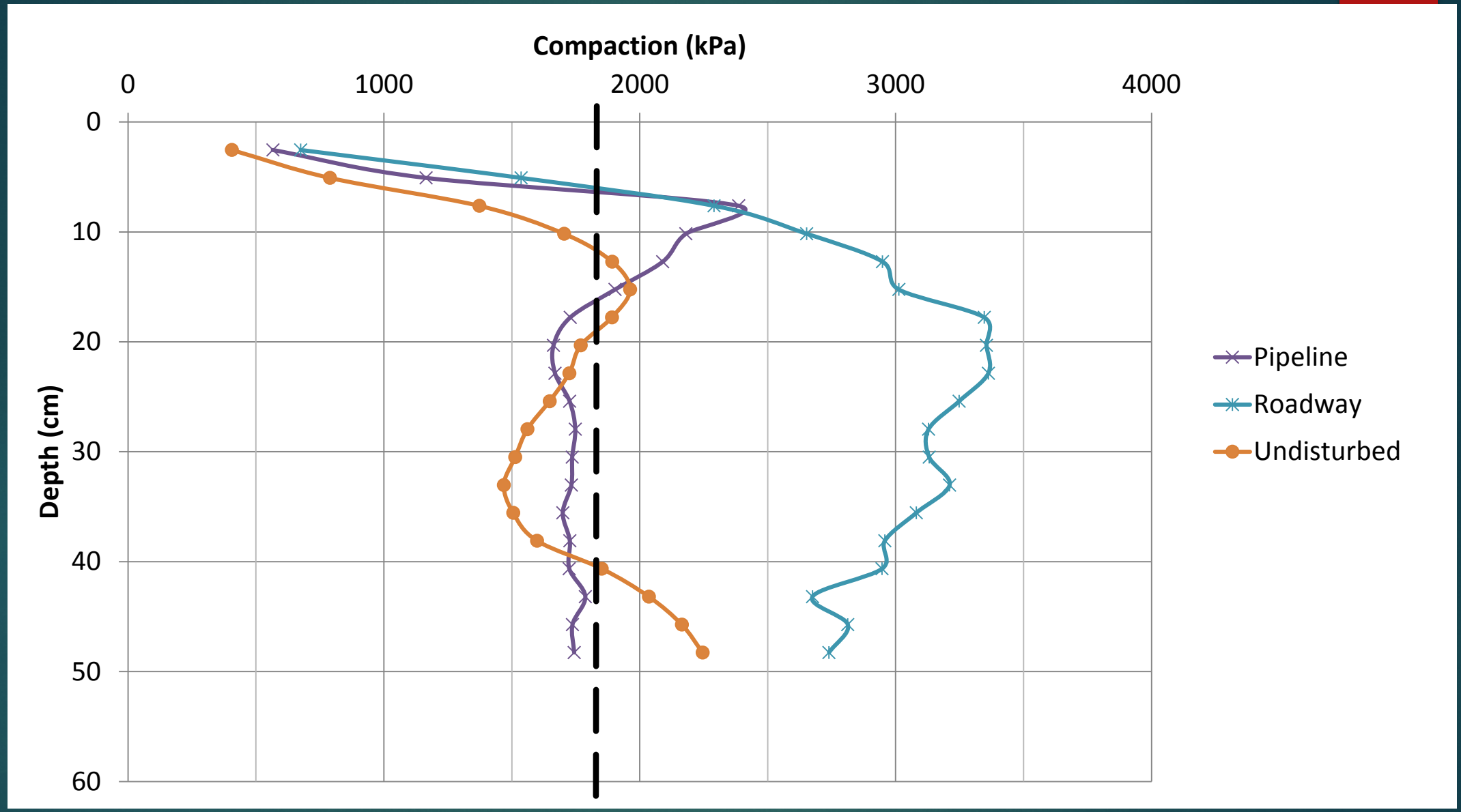


Figure 4. Compaction > 1724 kPa restricts root growth and compaction > 2069 kPa ceases root growth and development.

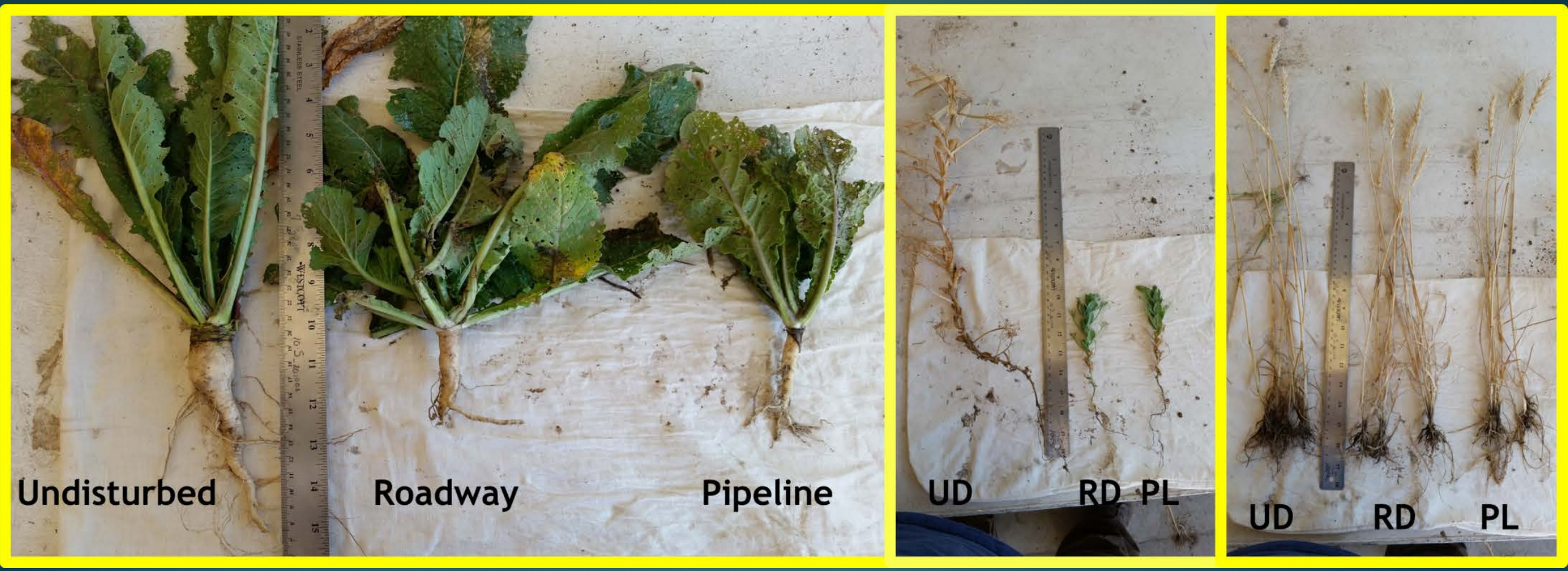
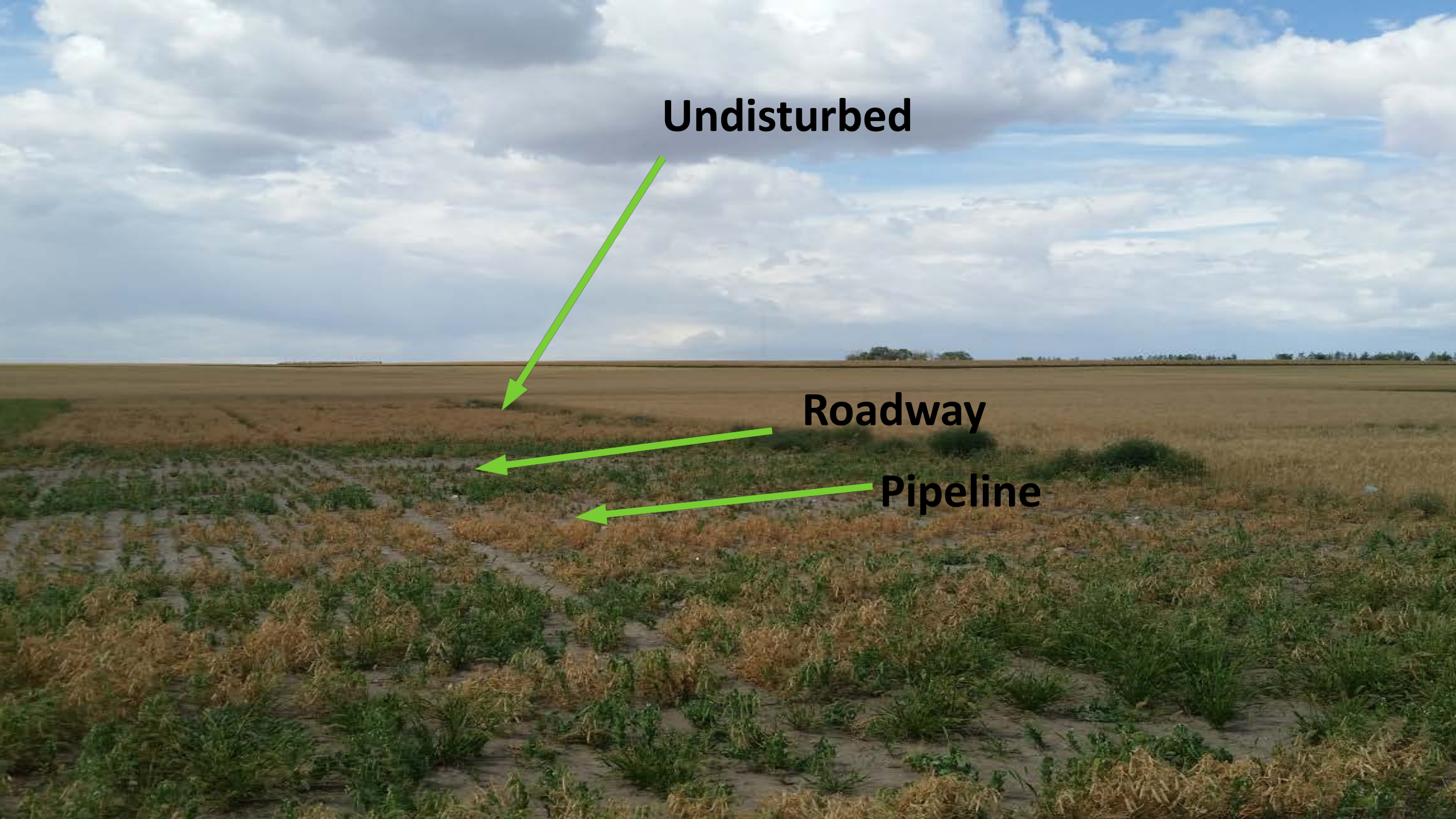
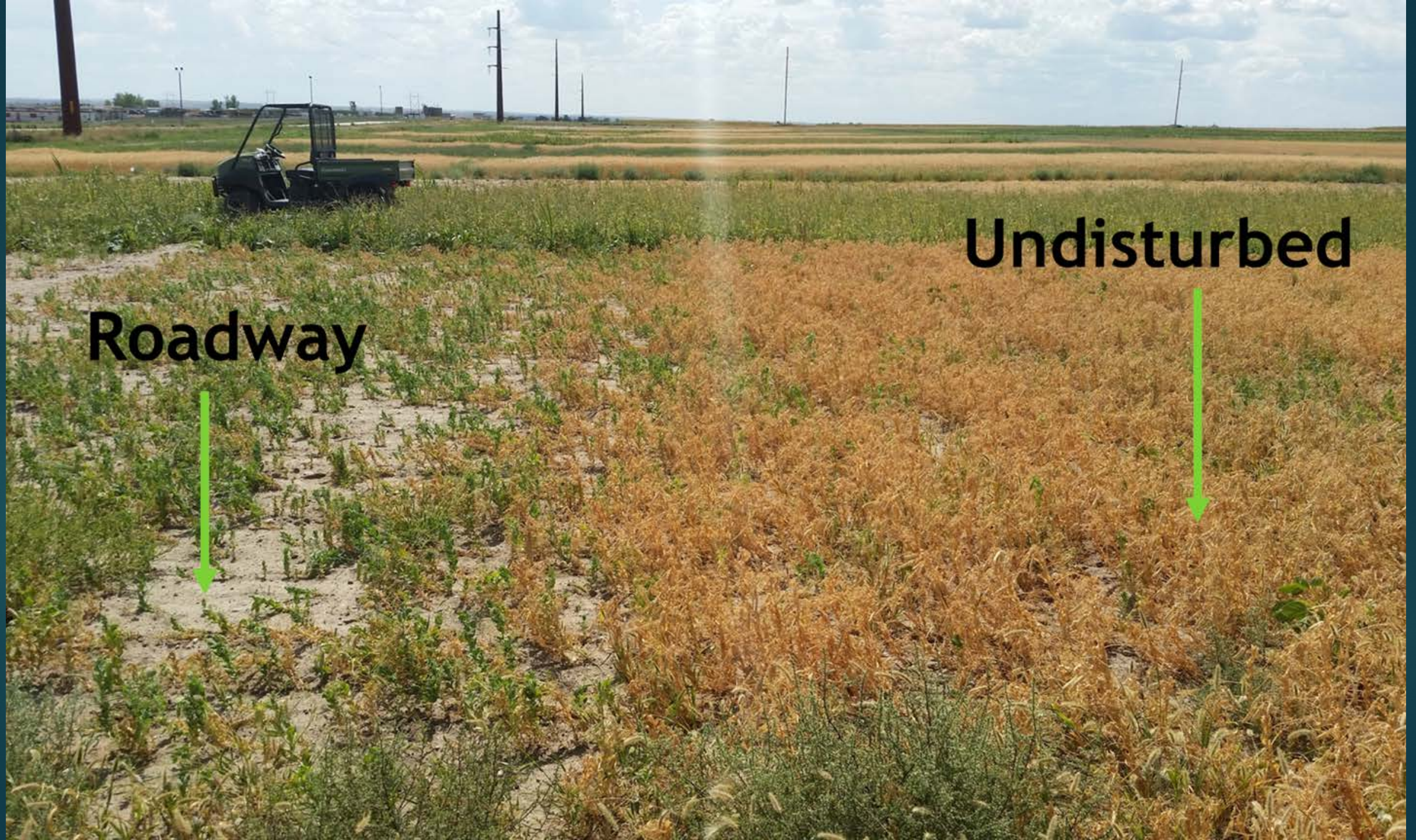


Figure 5. Differences in root development of turnip, peas, and durum seen in 2016.


Undisturbed
Roadway
Pipeline


Undisturbed
Roadway

Economic Impacts – Year One

Crop	Variety	Disturbance	Protein %	Yield (bu/a)	Market Price w/prem. ($/bu)	Gross Return ($/a)	+ or – Undisturbed ($/a)
HRSW	Elgin	Undisturbed	17.4	24.5	6.15	150.68	0.00
HRSW	Elgin	Roadway	16.6	9.0	5.77	51.93	(98.75)
HRSW	Elgin	Pipeline	16.1	15.2	5.53	84.06	(66.62)
Field Peas	Cruiser	Undisturbed	23.7	21.2	6.00	127.20	0.00
Field Peas	Cruiser	Roadway	20.2	4.4	6.00	26.40	(124.28)
Field Peas	Cruiser	Pipeline	21.7	6.0	6.00	36.00	(114.68)

Table 2. Economic impacts of reduced crop performance in HRSW and Field Peas.

HRSW Planting Date: 6/1/2015
Field Pea Planting Date:6/10/2015

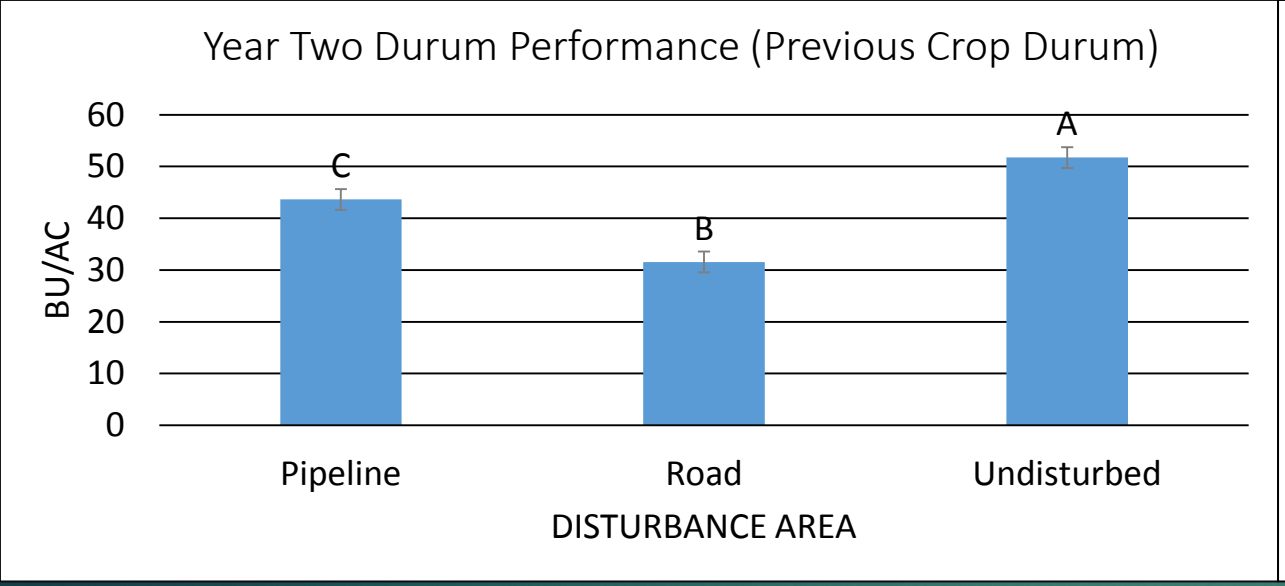


Figure 6. Durum yields were significantly lower in the Pipeline and Road areas than in the Undisturbed area, and yields in the Road area were significantly lower than the Pipleline area (P ≤ .05).

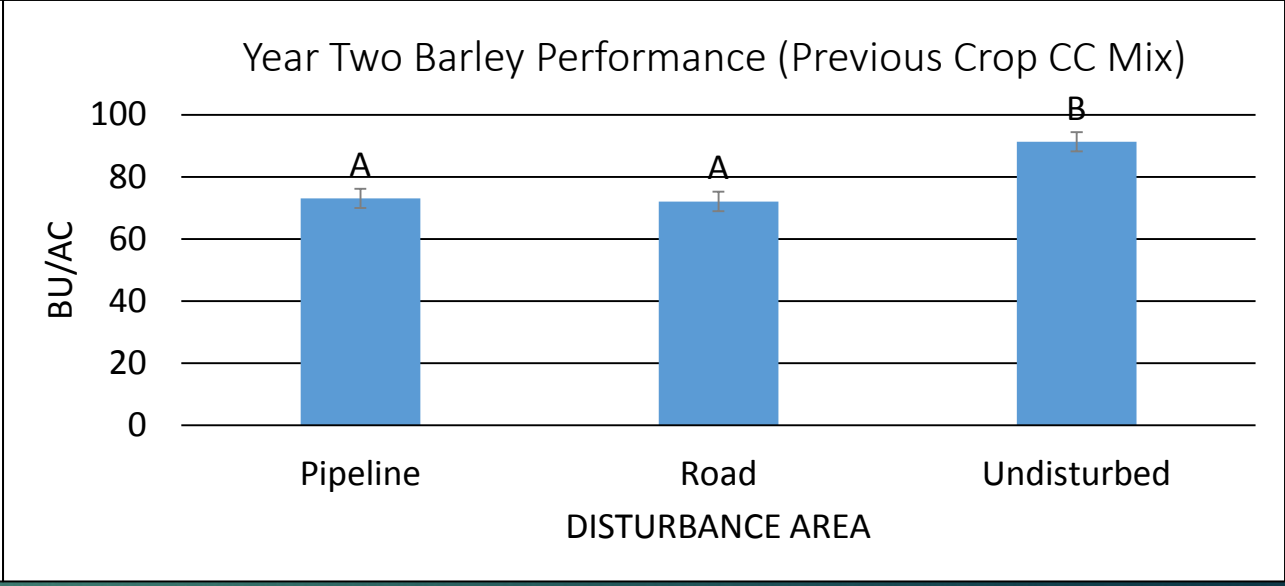


Figure 7. Barley yields were significantly lower in the Pipeline and Road areas than in Undisturbed area (P ≤ .05).

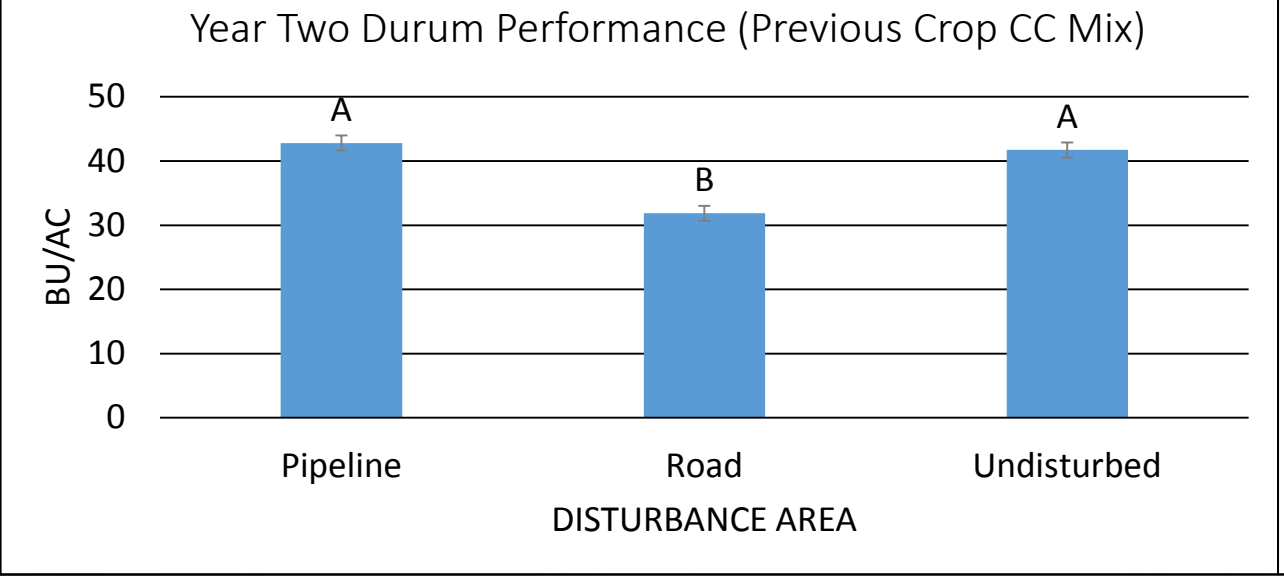


Figure 8. Durum yields were significantly lower in the Road area than in the Pipeline and Undisturbed areas. (P ≤ .05)

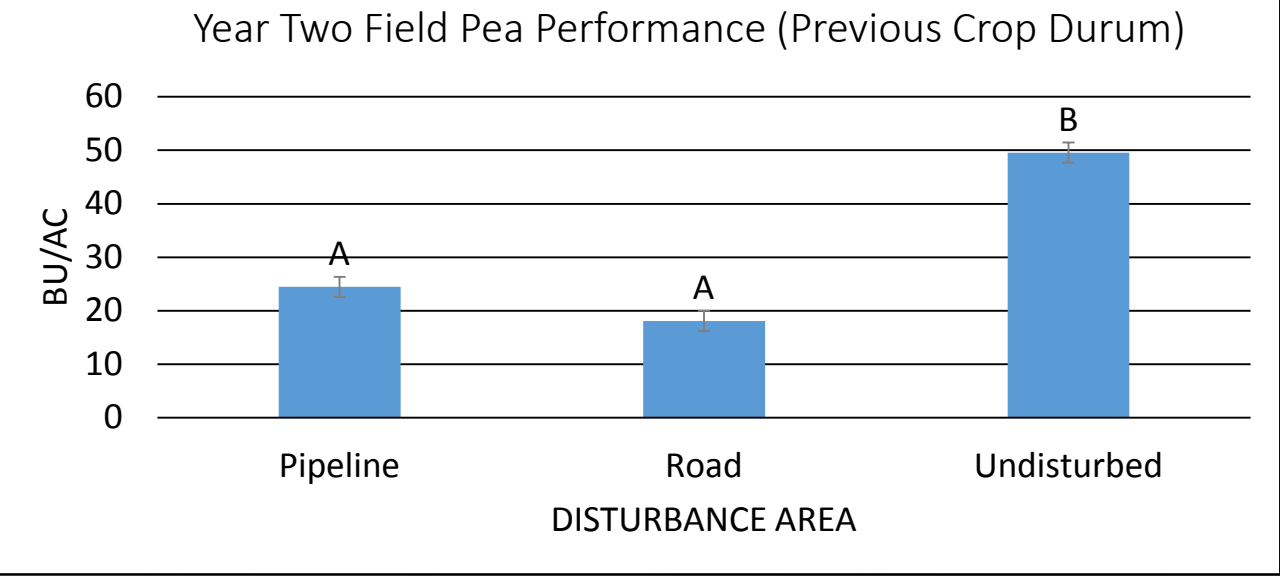


Figure 9. Pea yields were significantly lower in the Pipeline and Road areas than in Undisturbed area. (P ≤ .05)

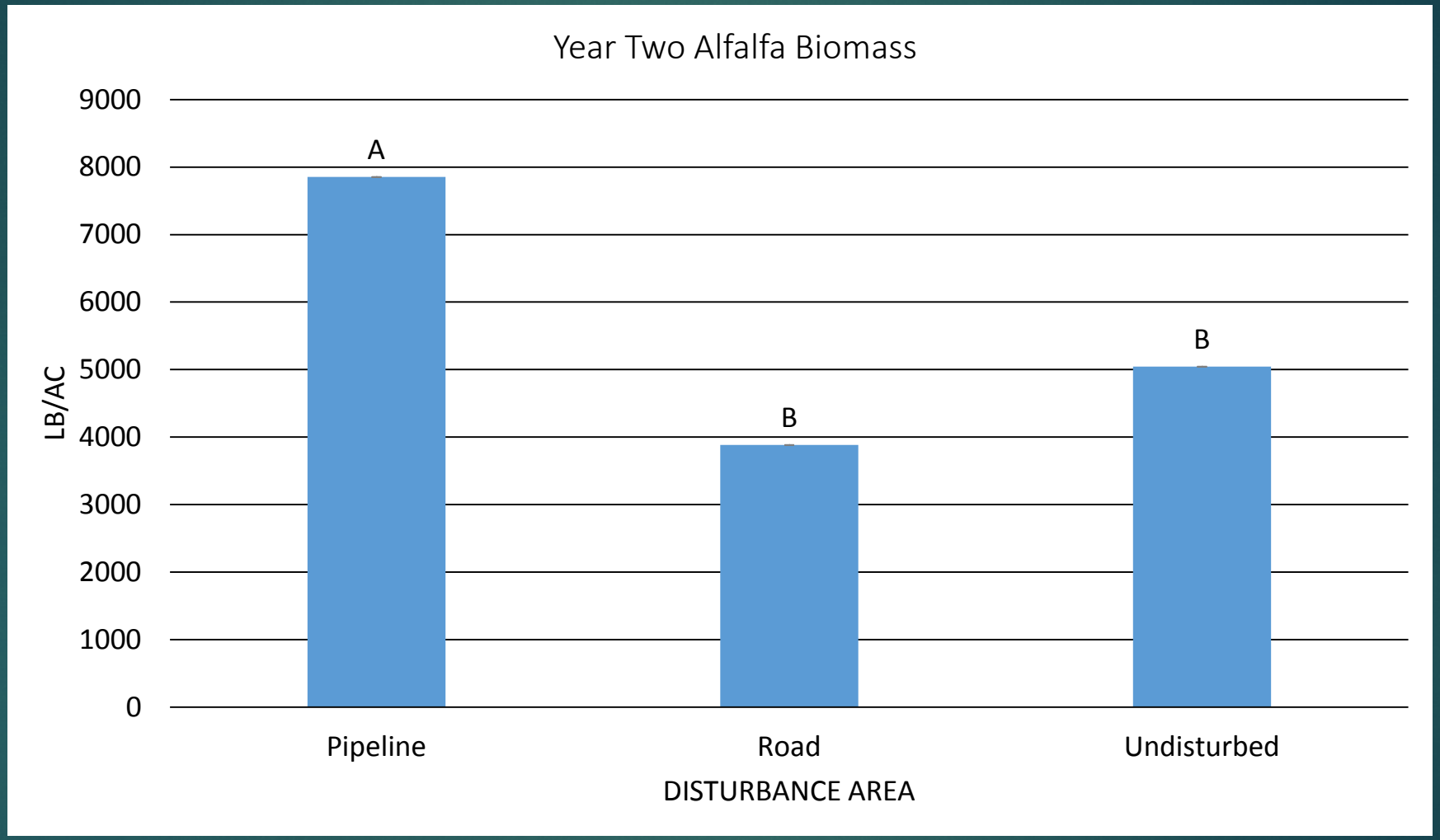


Figure 10. Alfalfa biomass was significantly higher in the Pipeline area than in the Road and Undisturbed areas. ($P \leq .05$)

If cropping systems can't improve production over time, what are other options?

- In reclaimed mine land deep tillage has been shown to increase infiltration (Chong & Cowsert).

- In cropland, manure and tillage treatments have been shown to effect soil organic matter and soil aggregation (Mikha & Rice).

If cropping systems can't improve production over time, what are other options?

- Is it beneficial and economical to apply one-time treatments of deep ripping and/or manure?
  - Each 45 ft. wide plot will be split to create three 15 ft. wide plots with the following treatments applied to all cropping rotations:
    - Ripping (tillage @ 24 in. deep)
    - Manure/Ripping
    - Continued minimum tillage

Undisturbed - Ripped	Road - Ripped	Pipeline - Ripped
Undisturbed - Ripped/Manure	Road - Ripped/Manure	Pipeline - Ripped/Manure
Undisturbed - Min. Tillage	Road - Min. Tillage	Pipeline- Min. Tillage

Figure 11. Design of each sequence.

Additional Data Collection

- Soil Health Analysis Package
  - Soil pH, Organic Matter, P, K, micronutrients
  - Soil Texture
  - Active Carbon
  - Wet Aggregate Stability
  - Soil Respiration
  - Autoclave-Citrate Extractable (ACE) Protein Test
  - Available Water Capacity
  - Surface, sub-surface hardness interpretation
- Vegetation Sampling
  - Grain yield
    - Protein
    - Test Weight
    - Bu/ac
  - Plant biomass
  - Plant Physiology

Management Implications

- This study is designed to address barriers to successful pipeline reclamation. More specifically, this study aims to provide short-term and long-term management strategies for landowners to restore productivity to cropland.

- If economical reclamation options are available to landowners, more effective reclamation plans can be composed and more efficient pipeline installations will be possible.

Research Team

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- Mikha, M. M., and C. W. Rice. 2004. Tillage and Manure Effects on Soil and Aggregate-Associated Carbon and Nitrogen. Contribution No. 03-86-J of Kansas Agric. Exp. Stn. . Soil Sci. Soc. Am. J. 68:809-816. doi:10.2136/sssaj2004.8090

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Questions?

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