Cotton population and yield following rye and crimson clover termination with roller/crimper and herbicides in an Alabama no-till system

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Presentation Outline

- Conservation tillage information
- Cover crops benefits
- Roller/crimper design background
- Research Objectives
- Materials and Methods
- Results
- Summary
- Other roller designs

Conservation tillage

- Conservation Tillage: >30% of residue cover on soil surface
- Reduced Tillage: (15-30% residue)
- Conventional Tillage: (<15% residue)

Important factors in conservation tillage:

1. Minimizing soil disruption, and
2. Maximizing soil coverage using cover crops

Cover crops

- Cover crops are a vital part of conservation agriculture and they need to produce maximum biomass to provide most benefits.

Cereal Rye: 3,000 to 7,000 lbs./acre

Crimson Clover: 3,500 to 5,500 lbs./acre,
N production: 150 lbs. N/acre

Hairy Vetch: 4,000 to 7,000 lbs./acre,
N production: 90-200 lbs. N/acre

Sunn Hemp: 5,000 lbs./acre,
N production: 120 lbs. N/acre

Benefits from cover crops

- ✓ Reduced soil erosion
- ✓ Reduced soil compaction
- ✓ Increased soil organic carbon and nitrogen source
- ✓ Reduced weed pressure (mulch and allelopathy)

➢ Improving soil quality and plant growth

- ✓ Reduced runoff
- ✓ Reduced evaporation
- ✓ Increased water infiltration
- ✓ Increased available moisture

➢ Providing better water utilization by plants

Maintain soil sustainability and farm profitability

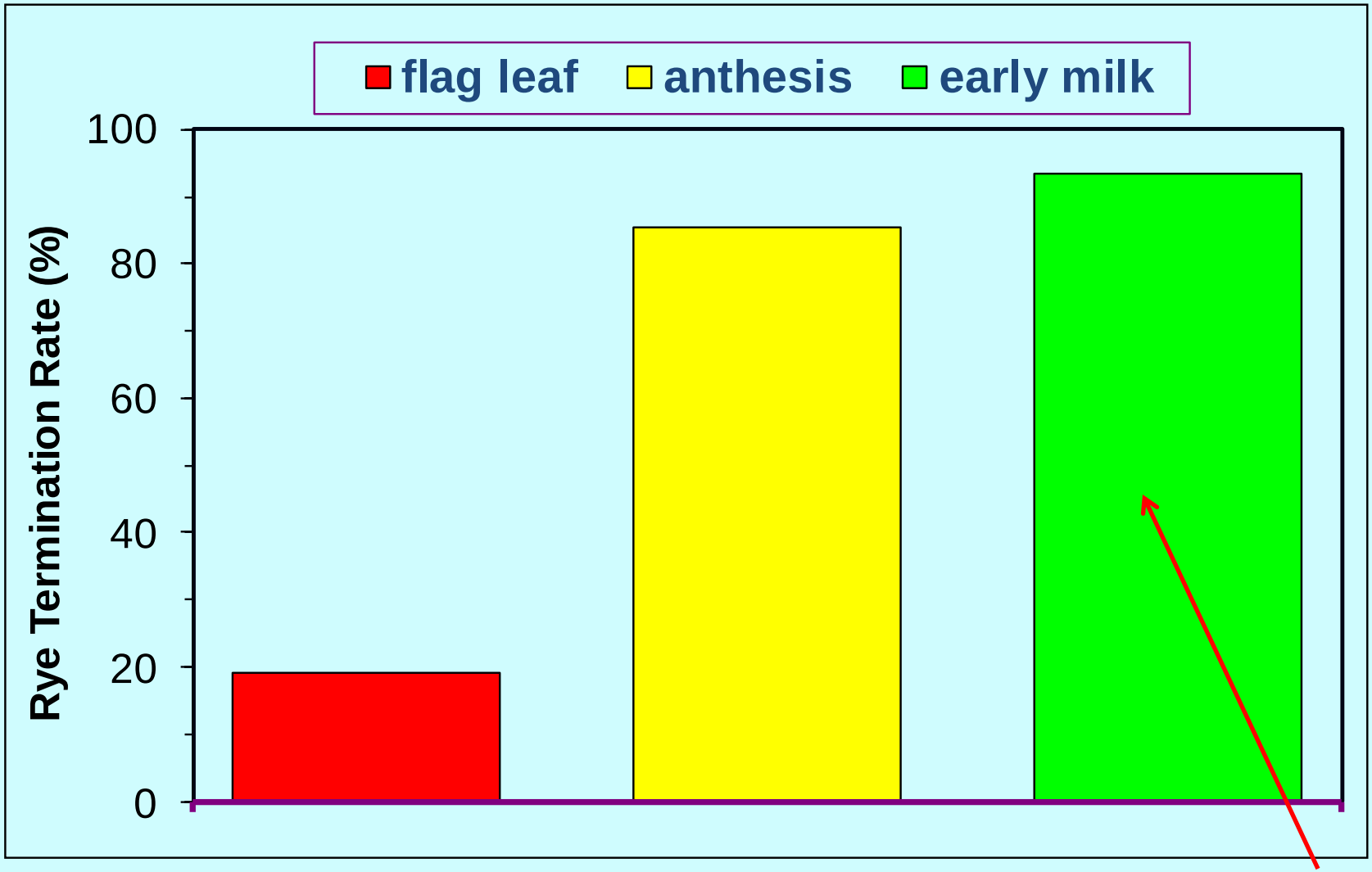
When we terminate cover crops?

Recommended termination of cover crop (rye) is three weeks before planting a cash crop

Period of three weeks allows to effectively terminate cover crop mechanically >90% using roller/crimper and to eliminate cover crop competition with cash crop for nutrients and water. After that period cash crop can be planted in parallel direction to rolled cover crop.

(Ashford and Reeves, 2003; Kornecki et al., 2006)

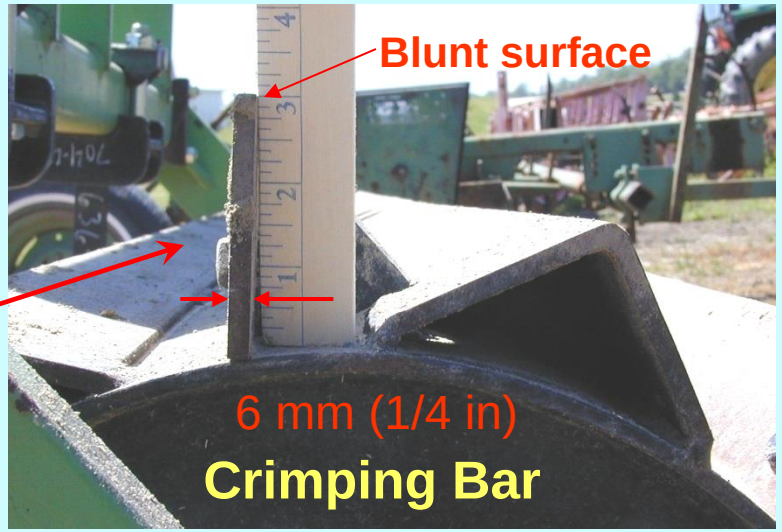
Termination and cover crop growth stage



Effectiveness of roller alone 3 weeks after rolling

Ashford and Reeves, 2003

Principle of rolling crimping



Crimping action injures cover crop by crashing plant's tissue against a firm soil surface thus restricting nutrients flow and causing plant death.

To improve rolling effectiveness and shorten time between cover termination and planting cash crop, spraying herbicides may be required as a supplement to roller/crimper.

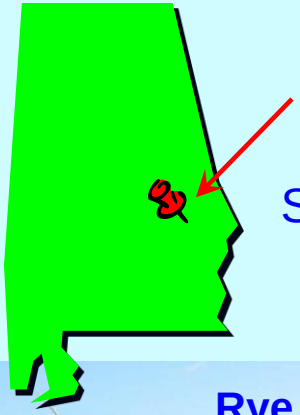
Research Objectives:

- Determine effectiveness of two-stage roller/crimper and three herbicides: (1) glyphosate, (2) Vinegar (organic), (3) Weed-Zap (organic) applied with rolling at 3 different rates in terminating rye and Crimson clover.

- Determine effect of rye and clover covers on volumetric soil moisture content (VMC).

- Determine effect of rye and clover covers on cotton population and yield.

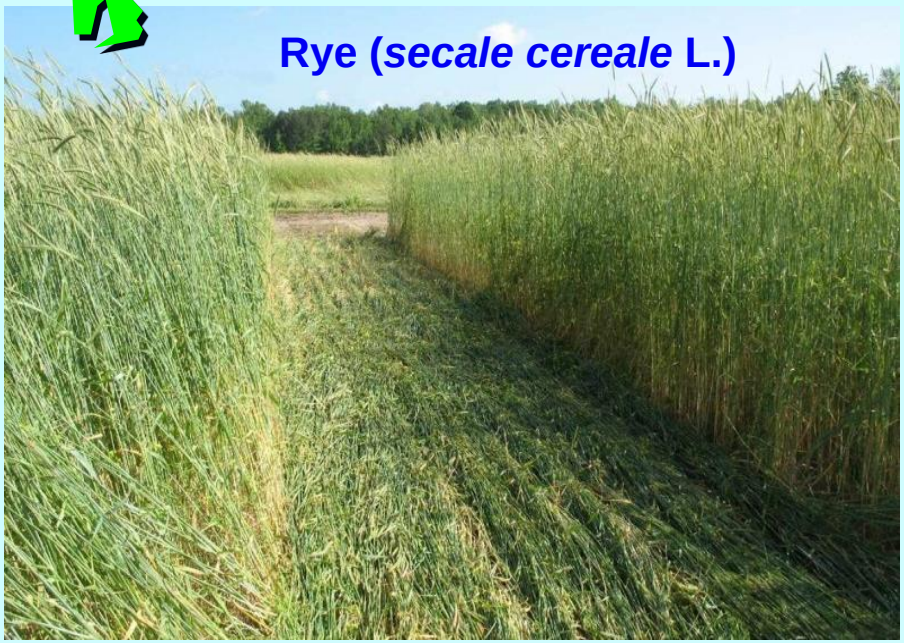
Materials and Methods



Experiment Location: EV. Smith Research Station, Alabama

Soil Type: Cowarts fine sandy loam thermic Typic Kanhapludults

COVER CROPS:



Rye Variety: ELBON,
Planting rate 90 Lbs./Acre

Clover Variety: Dixie Crimson Clover
Planting rate: 25 Lbs./acre

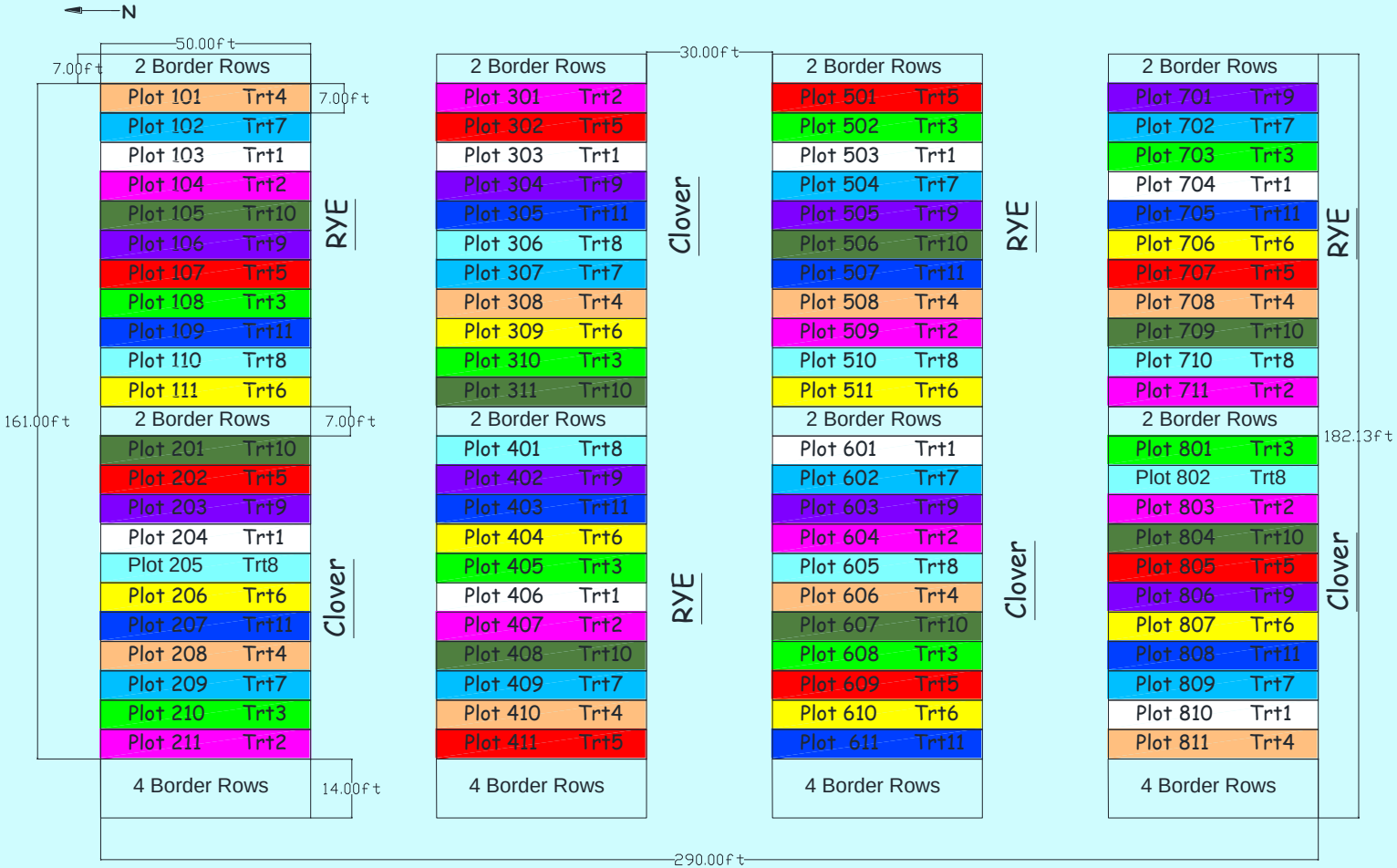
Rye and clover received 30.0 Units(Lbs.)N/acre: January 27, 2009 and February 26, 2010

Cotton Variety: Stoneville 4427B2RF, planting rate: 73,000 seeds/acre

Split Plot Experimental Design

Main plots: Rye and Clover, Sub plots: Eleven treatments randomly assigned to each cover crop (with four replicates):

1 No Roller
2 Roller only
3 Roller+Weed Zap continuous spray
4 Roller+Weed Zap every 2nd crimp
5 Roller+Weed Zap every 3th crimp
6 Roller+Vinegar continuous spray
7 Roller+Vinegar every 2nd crimp
8 Roller+Vinegar every 3th crimp
9 Roller+Roundup continuous spray
10 Roller+Roundup every 2nd crimp
11 Roller+Roundup every 3th crimp



Roller type: Two-stage roller/crimper
Cover Crops: Rye and Crimson Clover

Herbicides: Glyphosate and Organic herbicide
Rates: Continuous, every 2nd crimp and every 3th crimp

Materials and Methods

Events	2009	2010
Cover crops planted	11/10/08	11/4/09
Rolling treatments performed	4/27/09	4/29/10
Cotton planted	5/21/09	5/20/10
Cotton harvested	10/26/09	9/30/10

Termination rate was evaluated using a Greenseeker and a procedure described in Kornecki et al, (2012) at one, two, and three weeks after rolling.

Volumetric moisture content was measured one, two, and three weeks after rolling using TDR meter.

TDR soil moisture meter 12 cm long rods from Spectrum Technologies

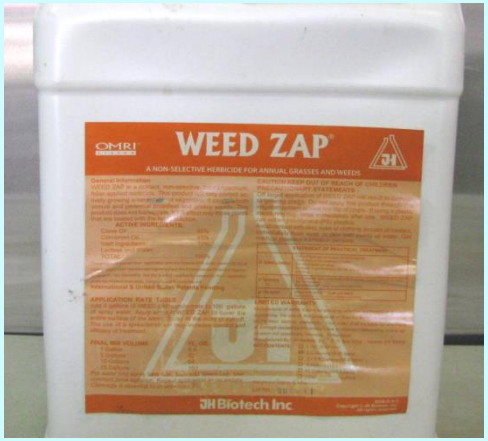
Cover crop termination rates assessment using Normalized Difference Vegetation Index (NDVI): Hand-held Greenseeker from NTech

Herbicides used in the experiment: Continuous application rates

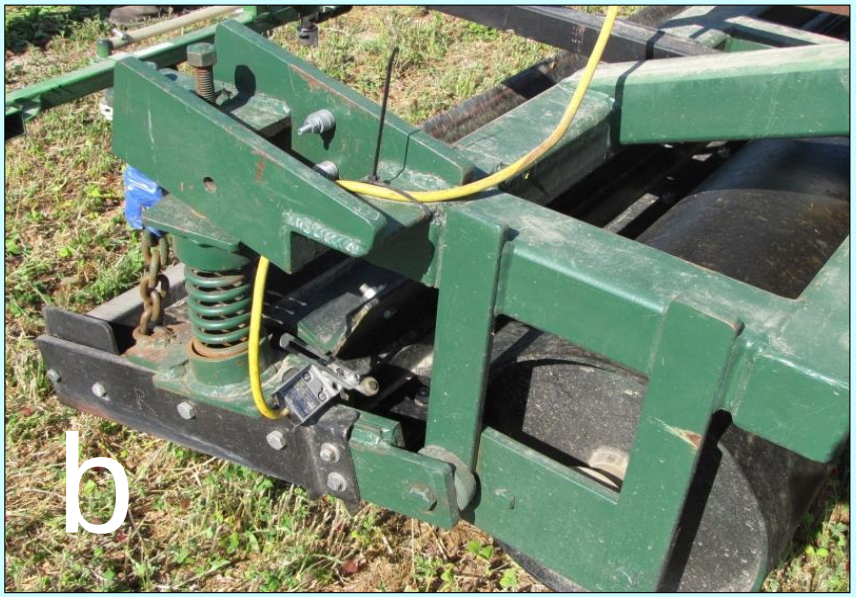
- Roundup Powermax—325mL/7.5gallons
  (22 ounces/acre) ($70-75.00/2.5gallon)

- VINEGAR—20% No Dilution
  (15 gallons/acre) ($16.10-21.49/gallon)

- WEED ZAP—Mix 64oz/per 10 gallons H2O
  (96 ounces/acre) ($75.60-79.99/gallon)



Equipment used: Two-stage roller/crimper



a. Rear view

b. Side View

(Kornecki, 2011, U.S. Patent #7,987,917 B1).

Calibration of herbicide discharge

Rear view of the 2-stage roller and herbicide applicator

Cotton was harvested with two–row JD cotton picker

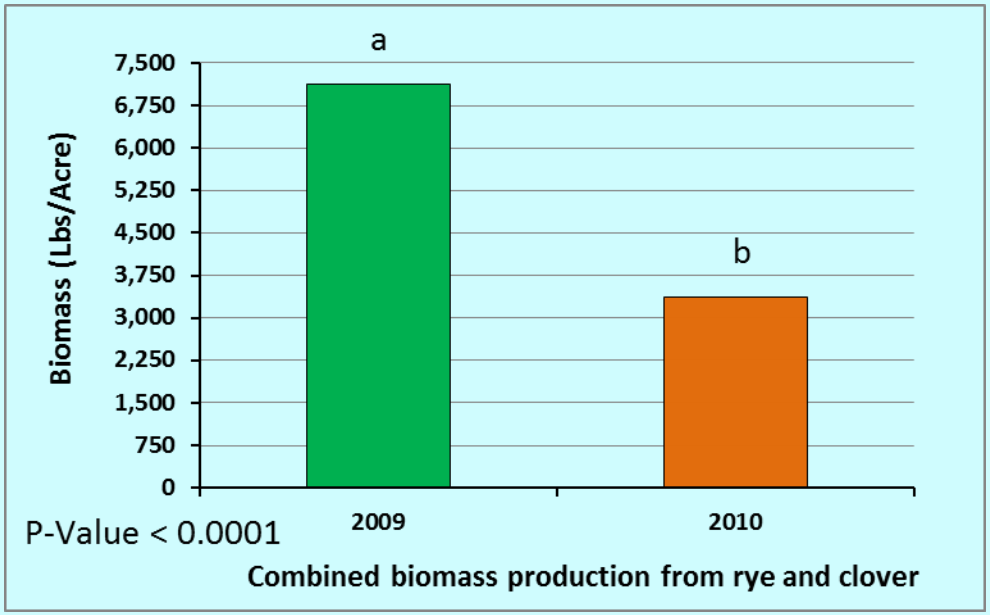
RESULTS

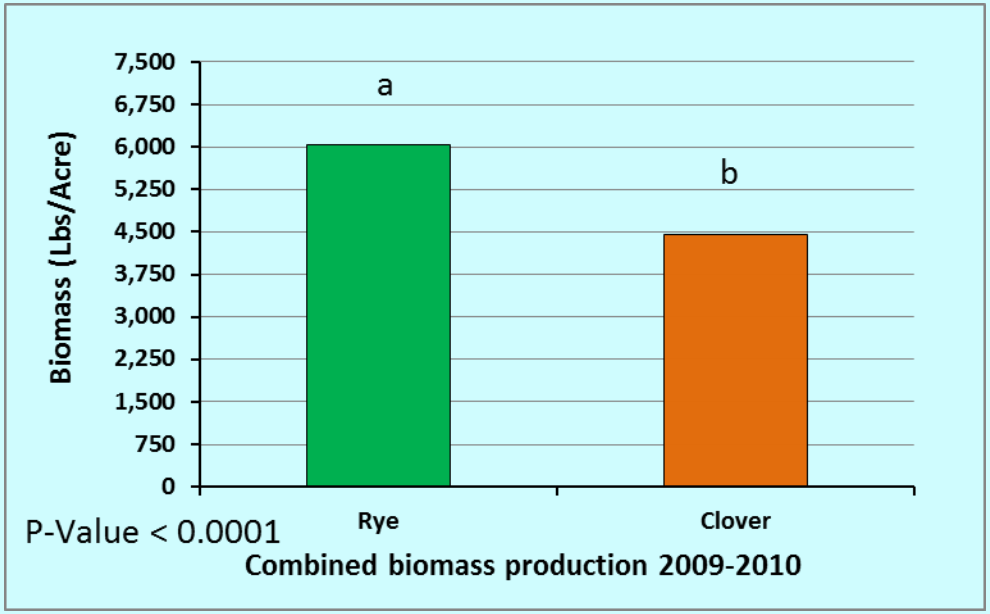
Cover crop biomass production

Cereal Rye

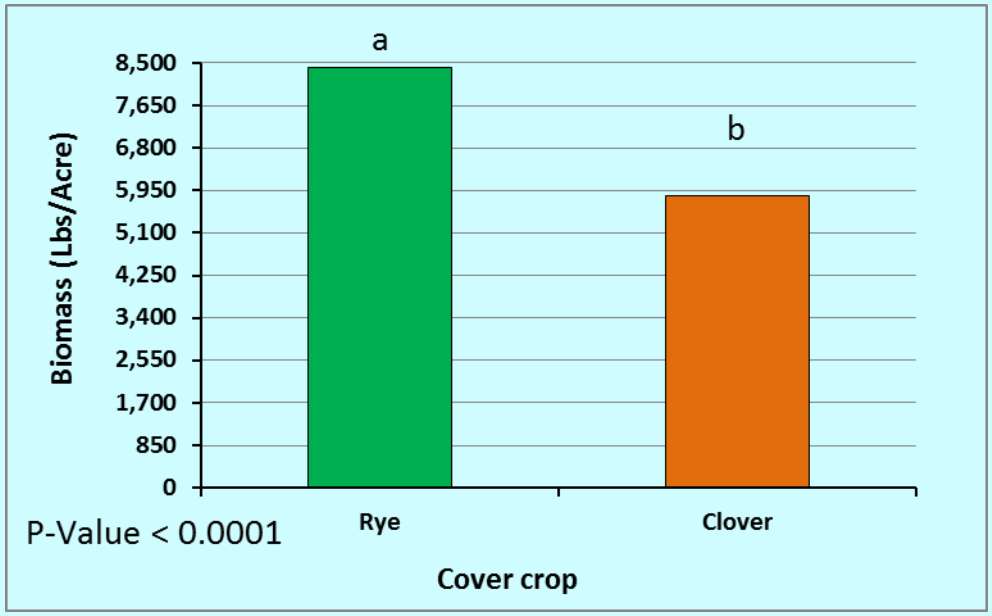
Crimson Clover

Combined cover crop biomass production

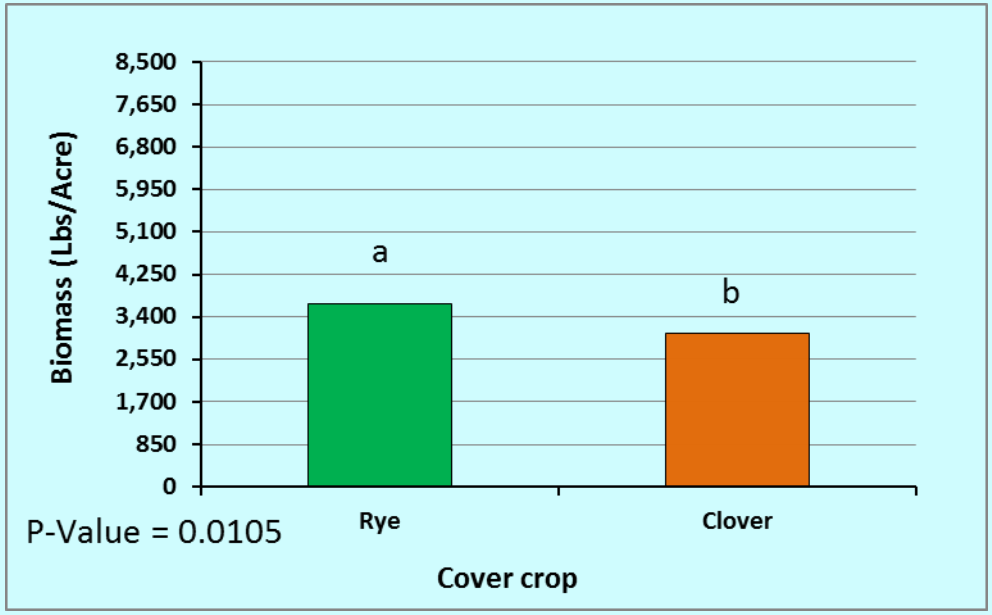




Cover crop biomass production each year

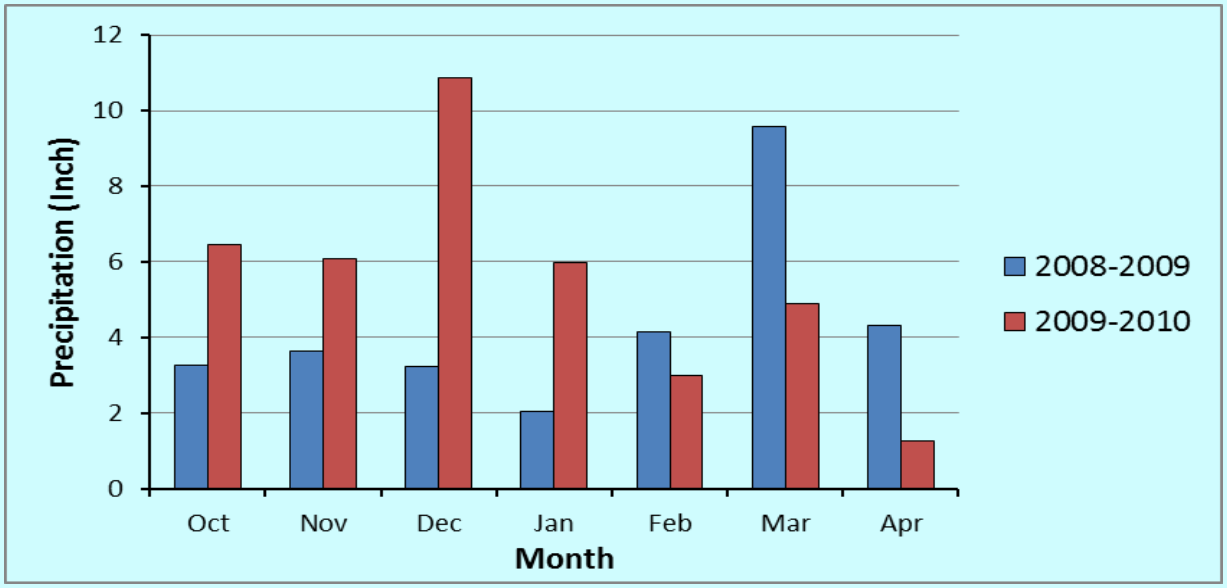


2009

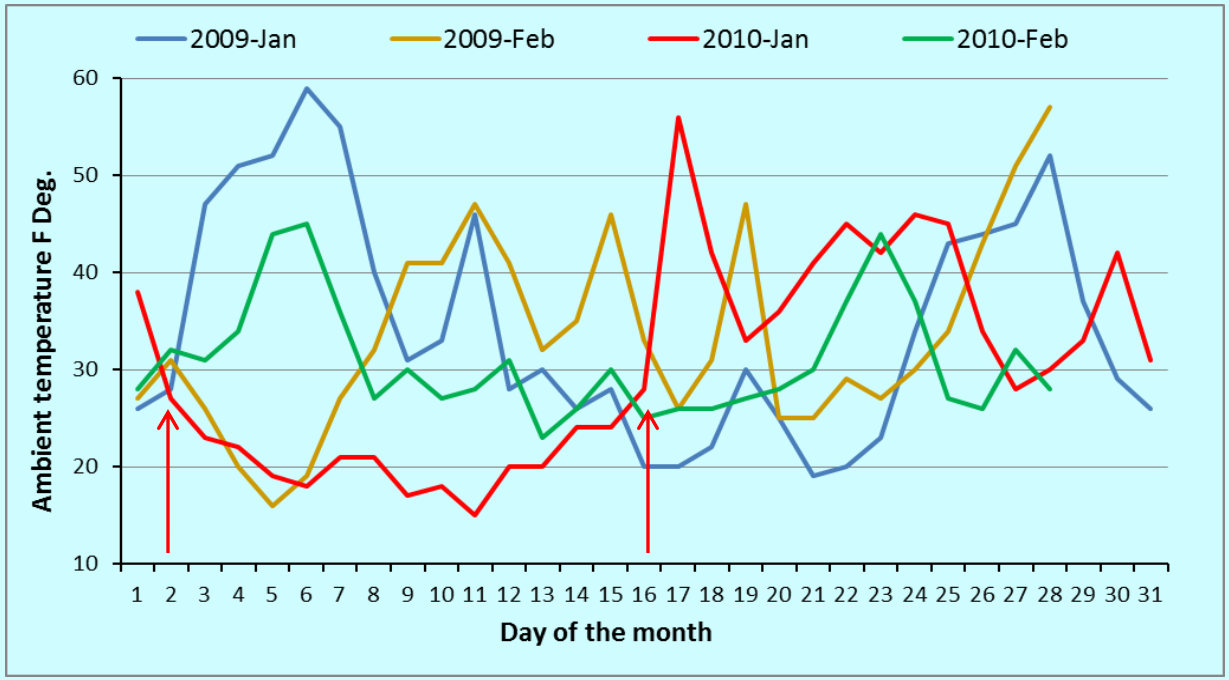


2010

Rainfall and minimum temperatures during cover crops growth



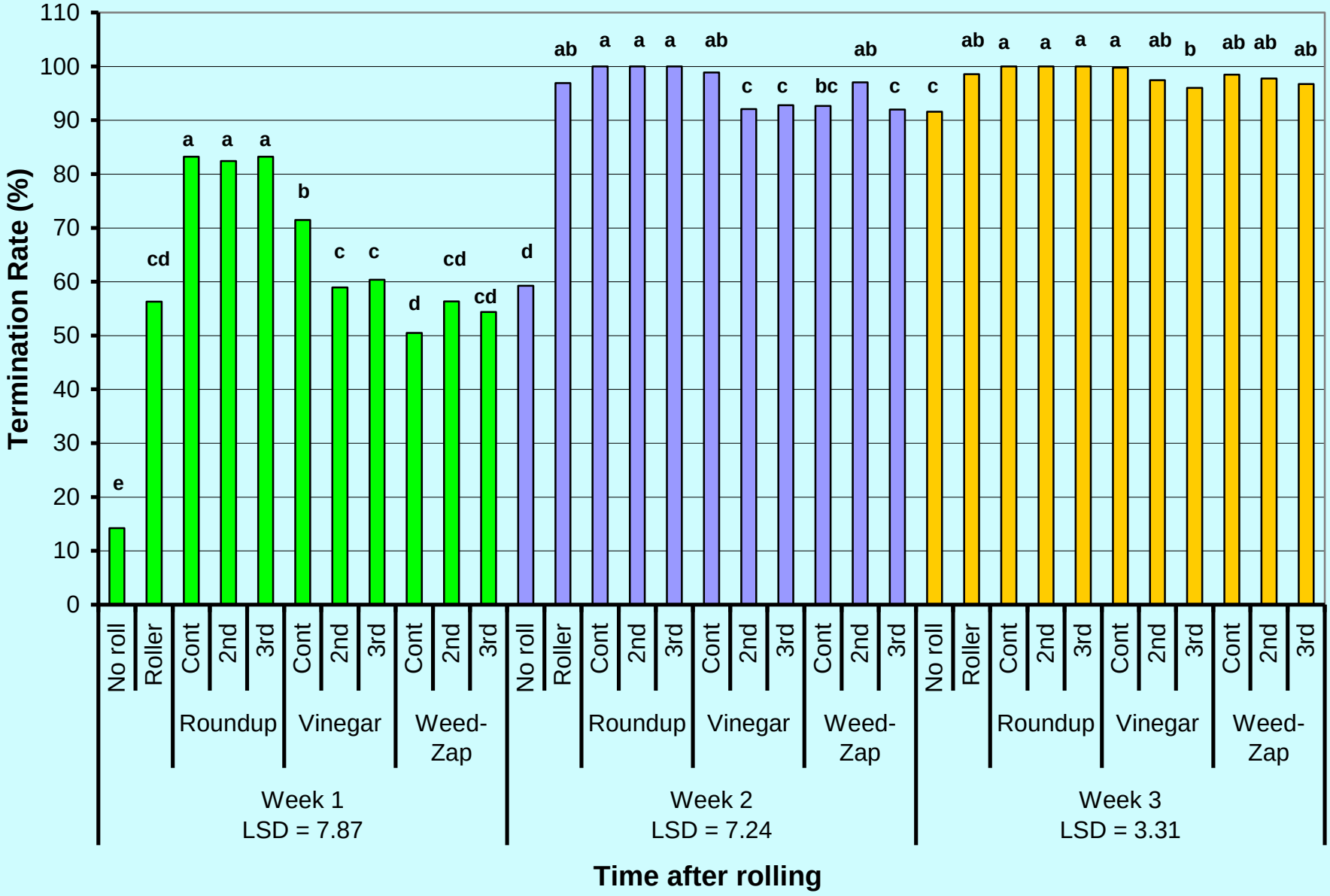
Rainfall



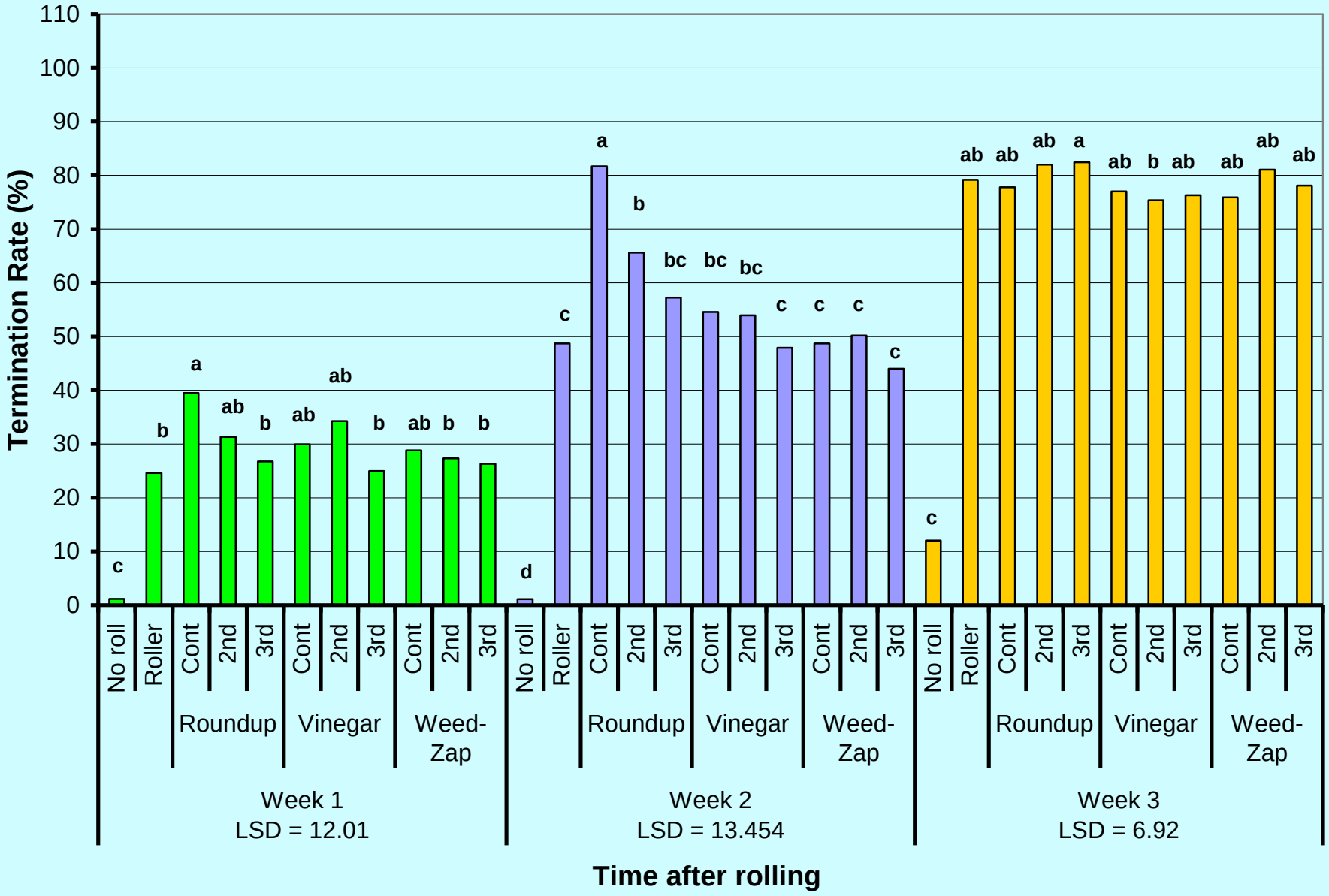
Min. temp.

Rye and Crimson Clover termination results

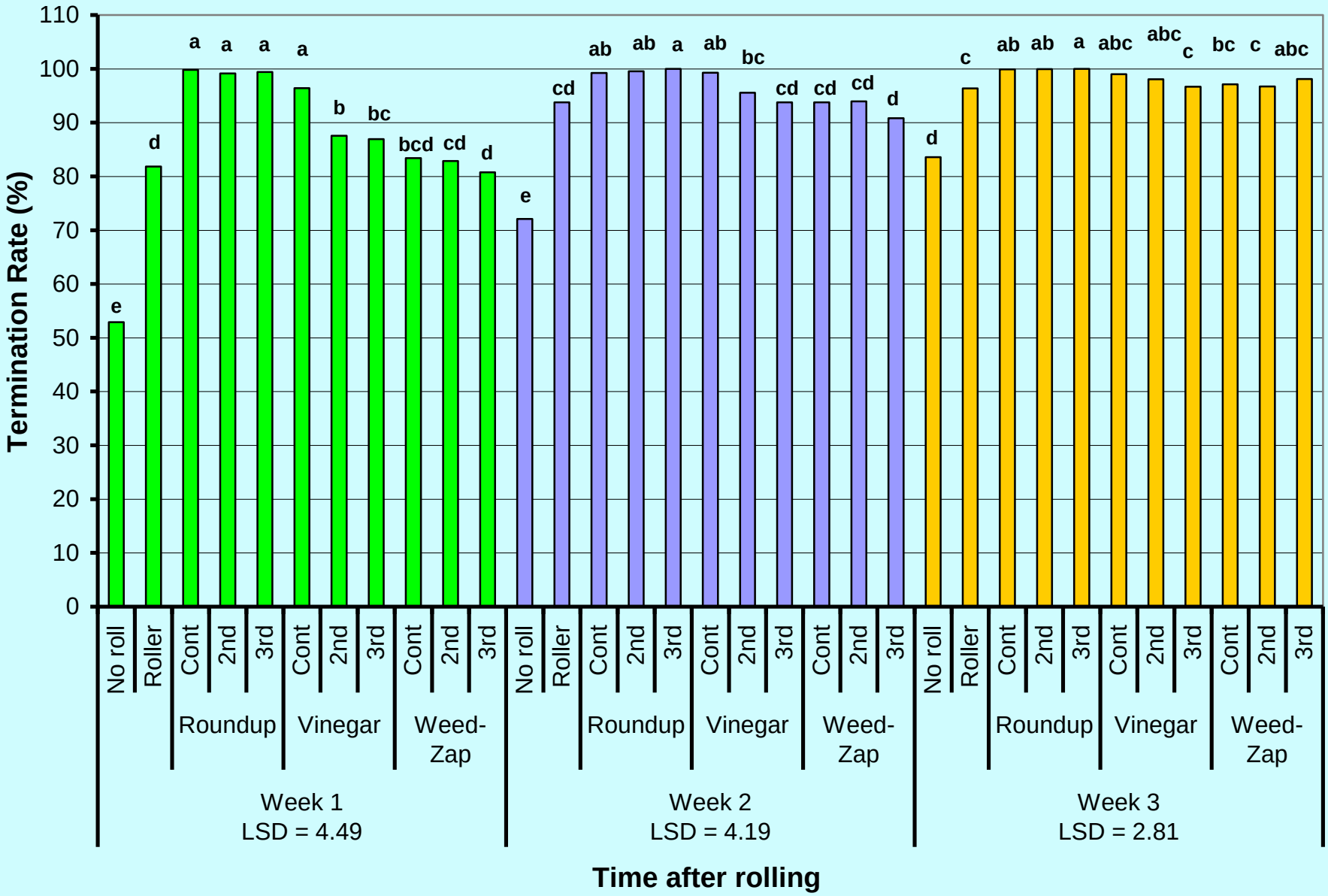
2009 termination Rates for Rye



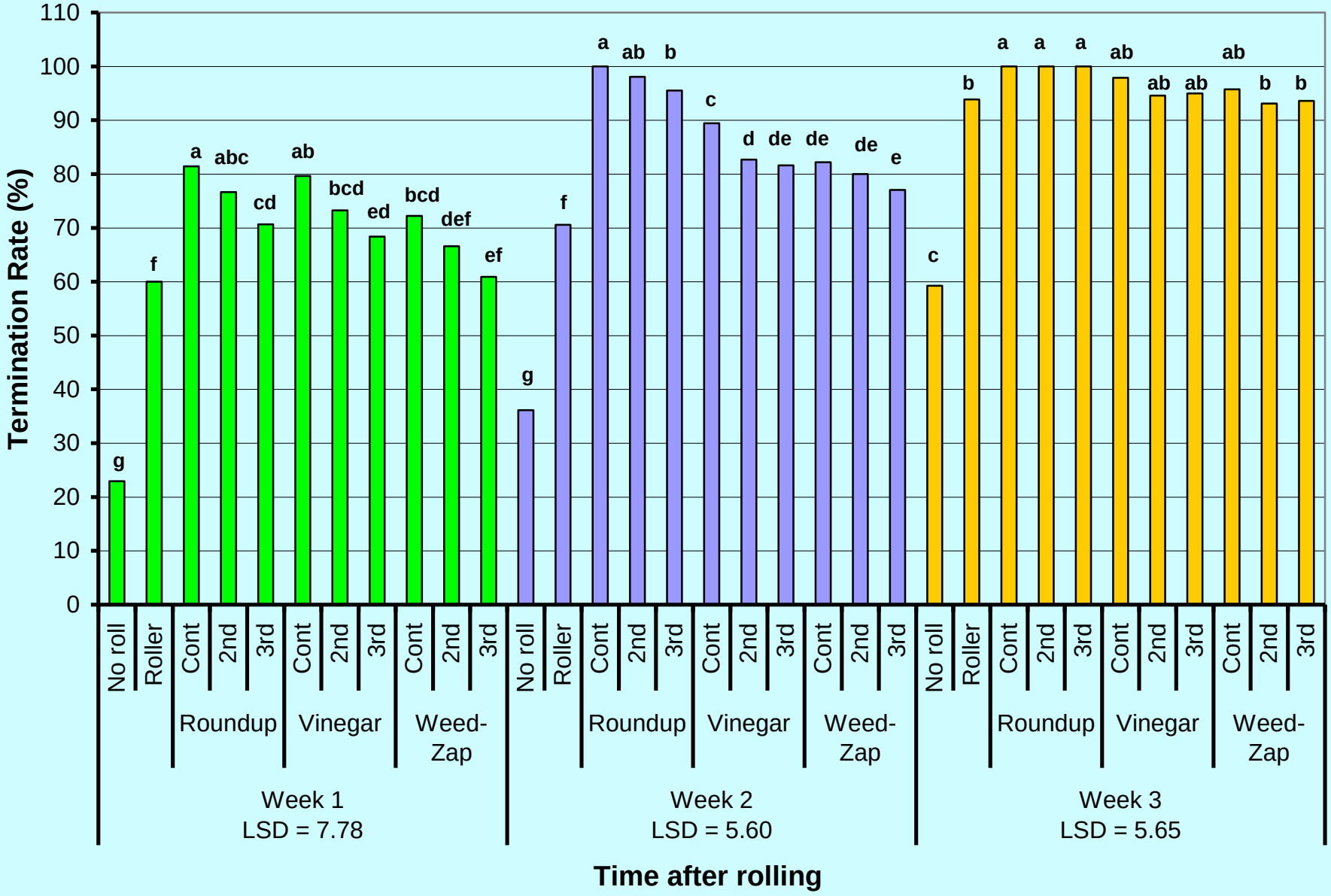
2009 termination rates for Crimson Clover



2010 termination Rates for Rye



2010 termination rates for Crimson Clover

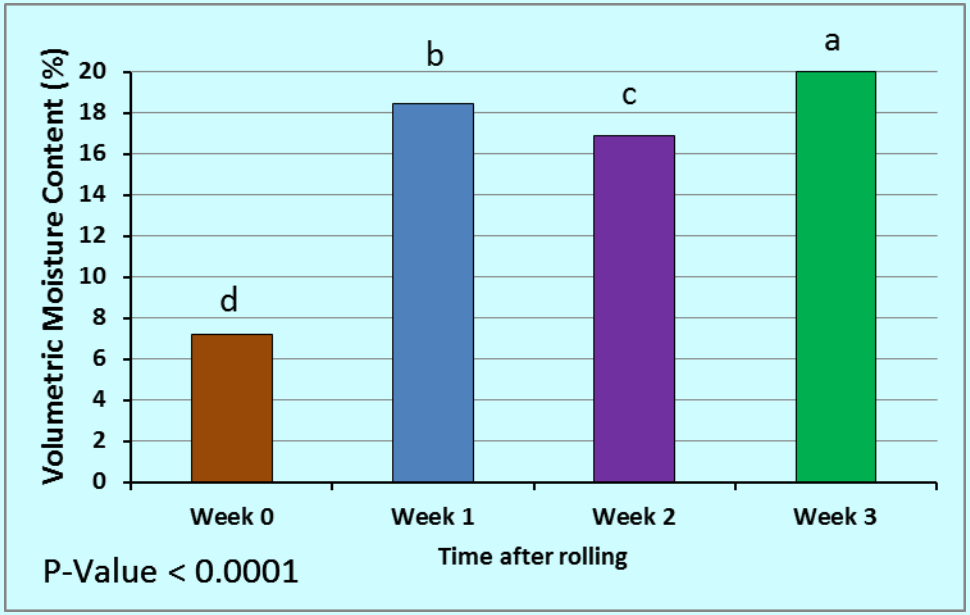


2-stage Roller/crimper

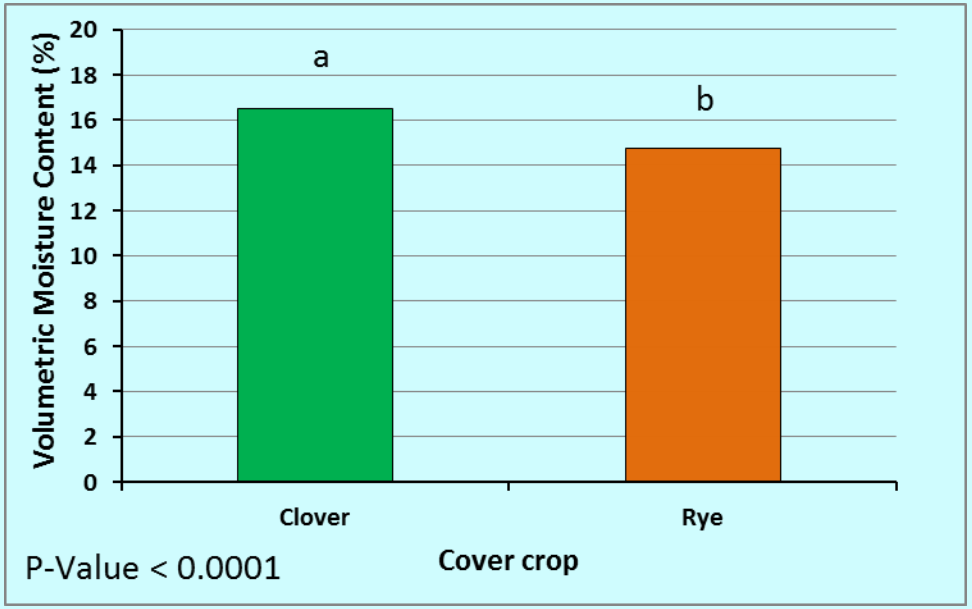
Amount of herbicides used

Treatment	Herbicide	Herbicide solution applied (gal/ac)	% Herbicide amount of continuous spray and cost	
Continuous spray	Roundup	0.17 (22 Oz)	100	$5.00
	Vinegar	15.0		$270.00
	Weed Zap	0.75 (96 Oz)		$58.00
Spray every 2nd (every other) crimp	Roundup	0.12 (15 Oz)	69	$3.45
	Vinegar	10.35		$186.30
	Weed Zap	0.52 (66 Oz)		$40.00
Spray every 3rd crimp	Roundup	**0.10 (12 Oz)**	**59**	**$2.95**
	Vinegar	**8.85**		**$159.30**
	Weed Zap	**0.44 (56 Oz)**		**$34.22**

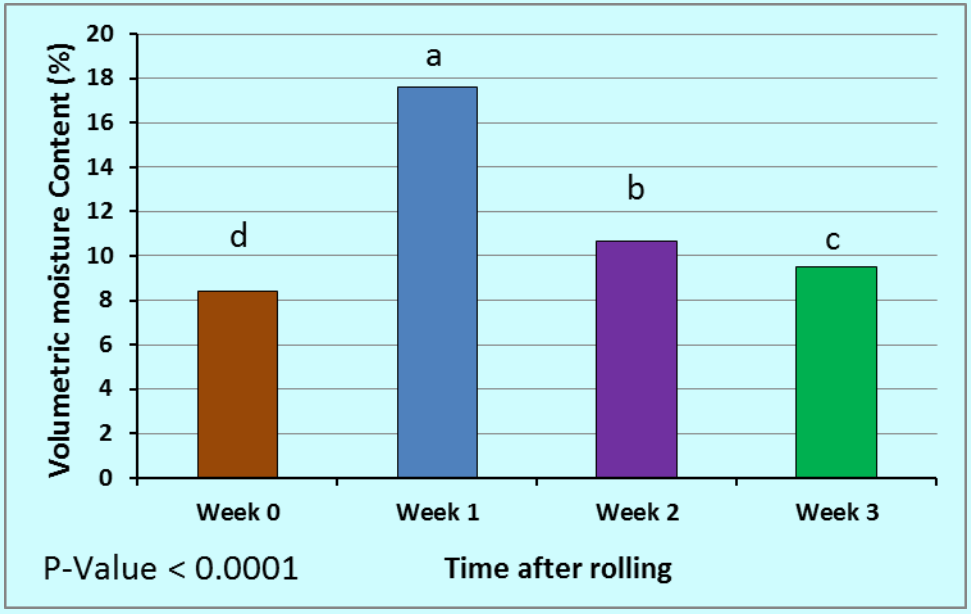
Volumetric Moisture Content 2009

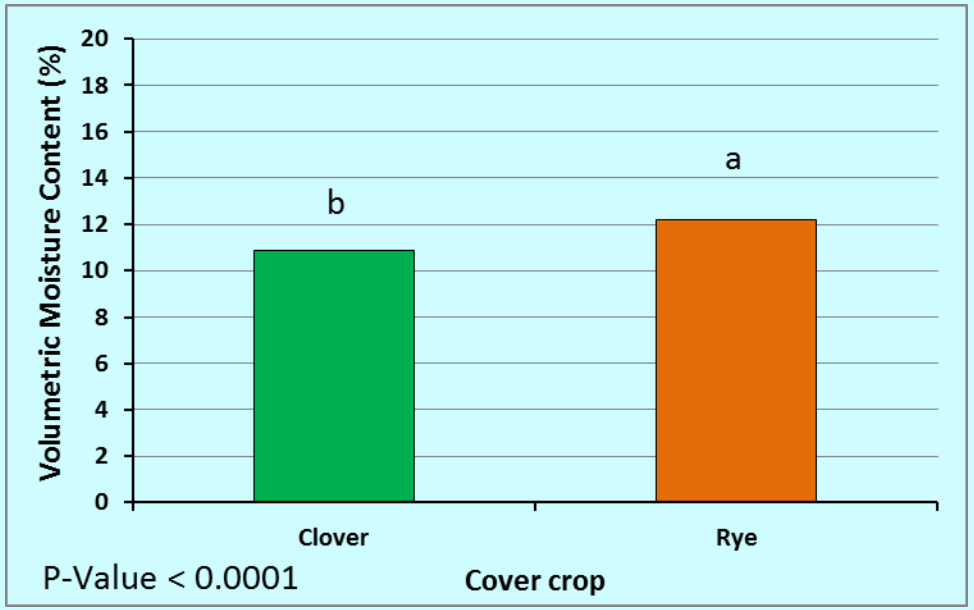


Higher VMC in 2009 affected clover termination rates (80%) 3 weeks after rolling

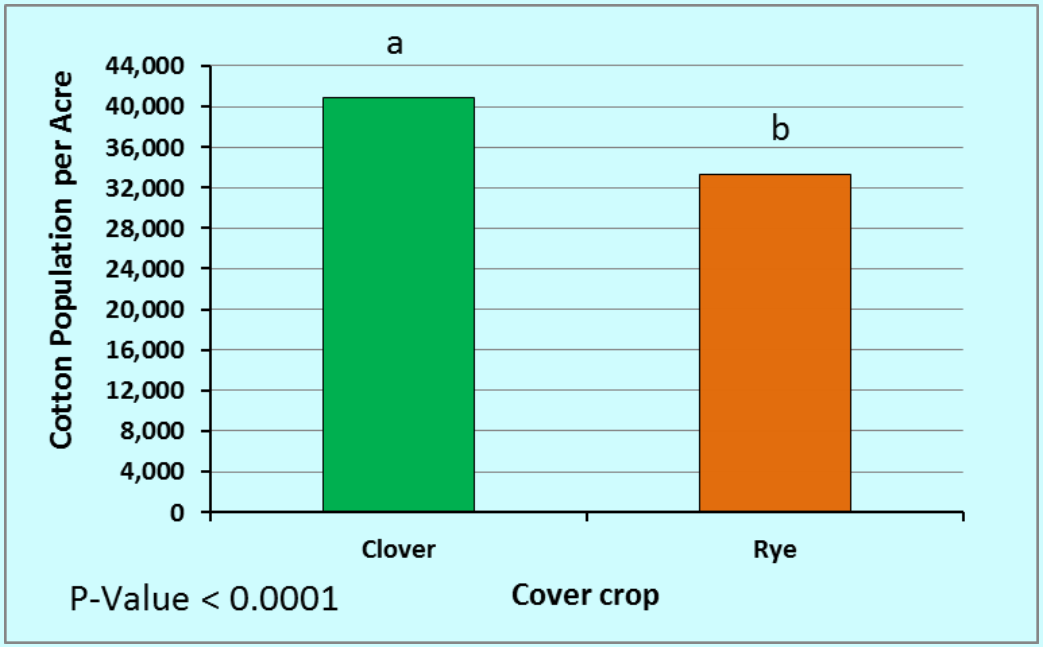


Volumetric Moisture Content 2010

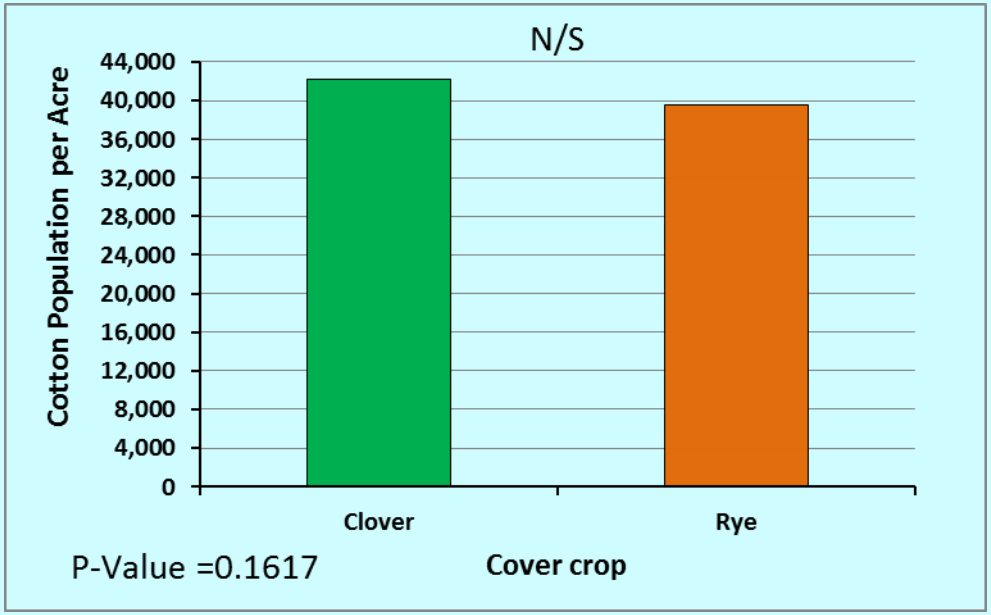




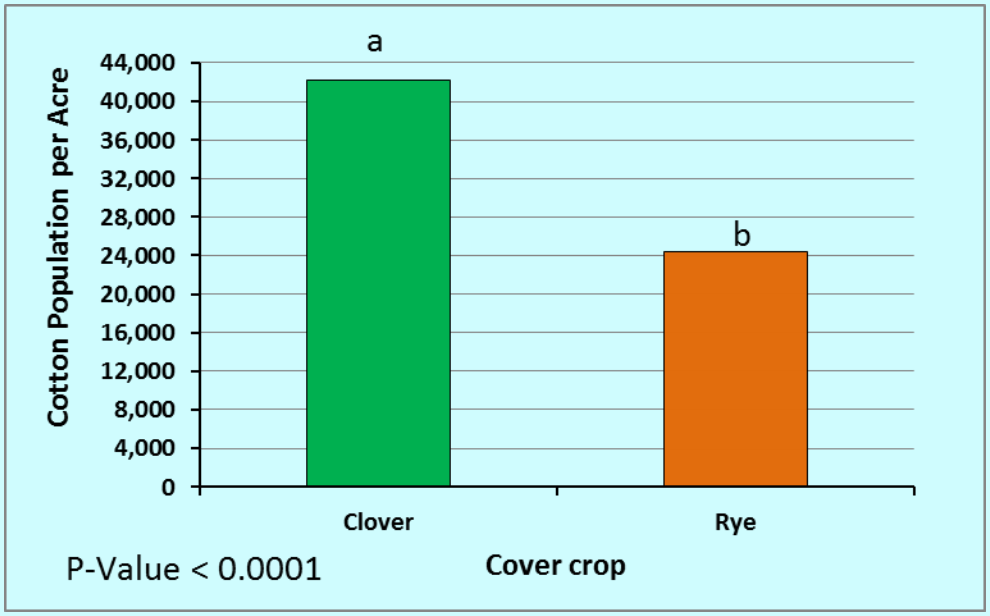
Cotton population 2009-2010



Cotton Population based on 40 inch row spacing



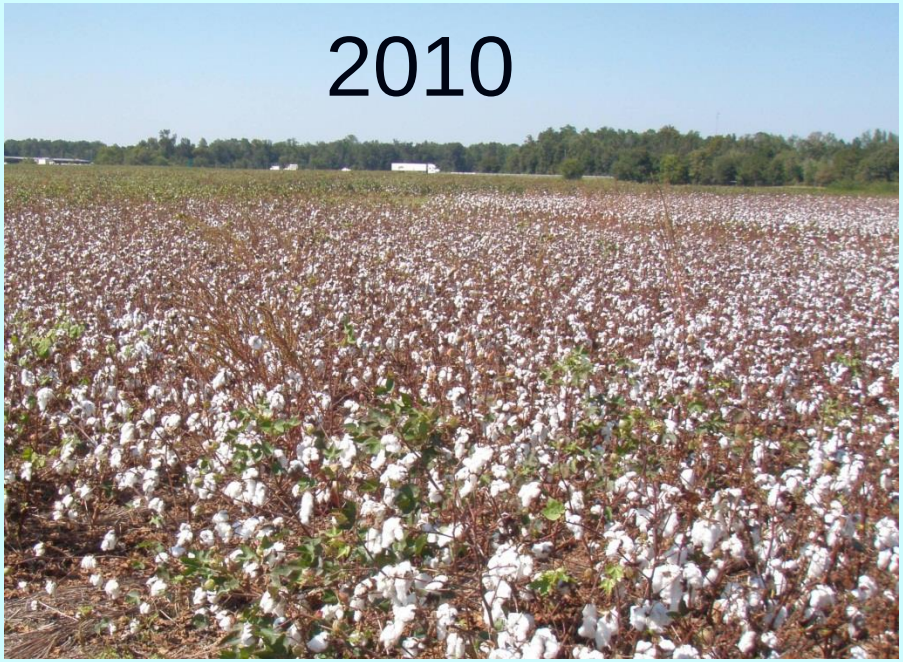
2009



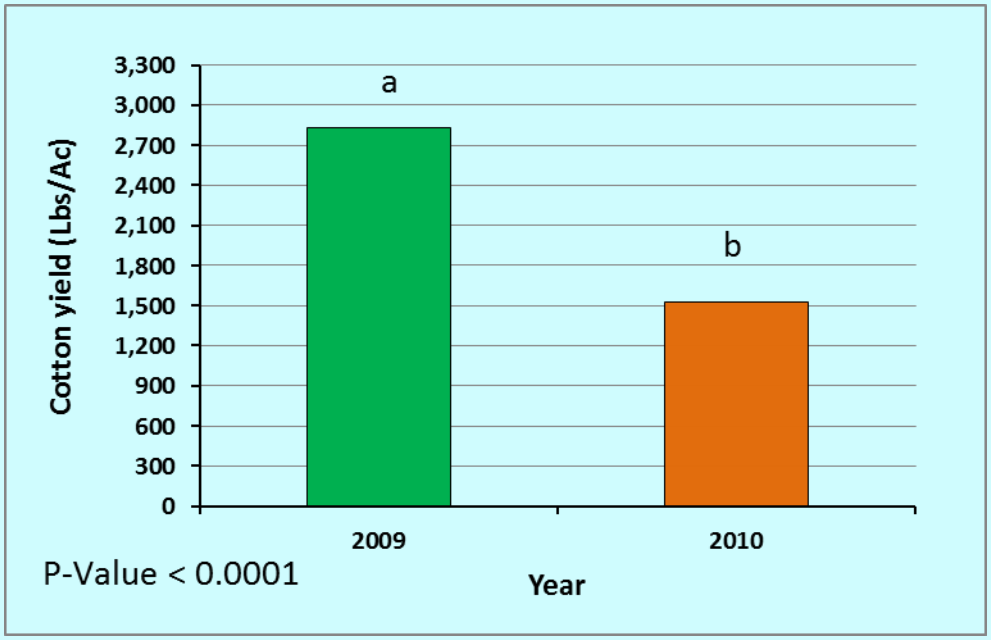
2010

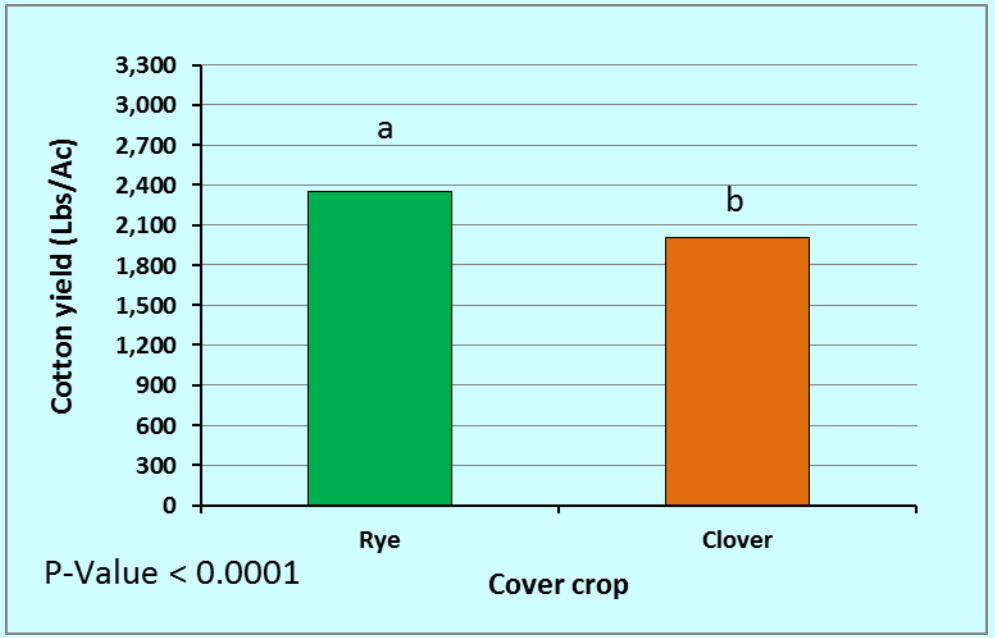
Seed Cotton Yield

2009

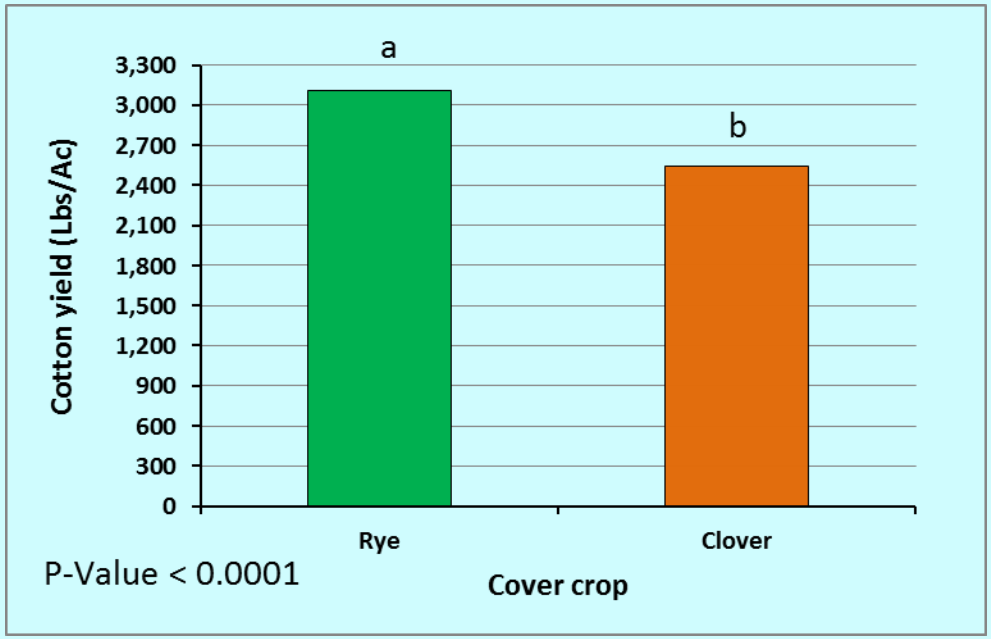


Seed Cotton yield 2009-2010

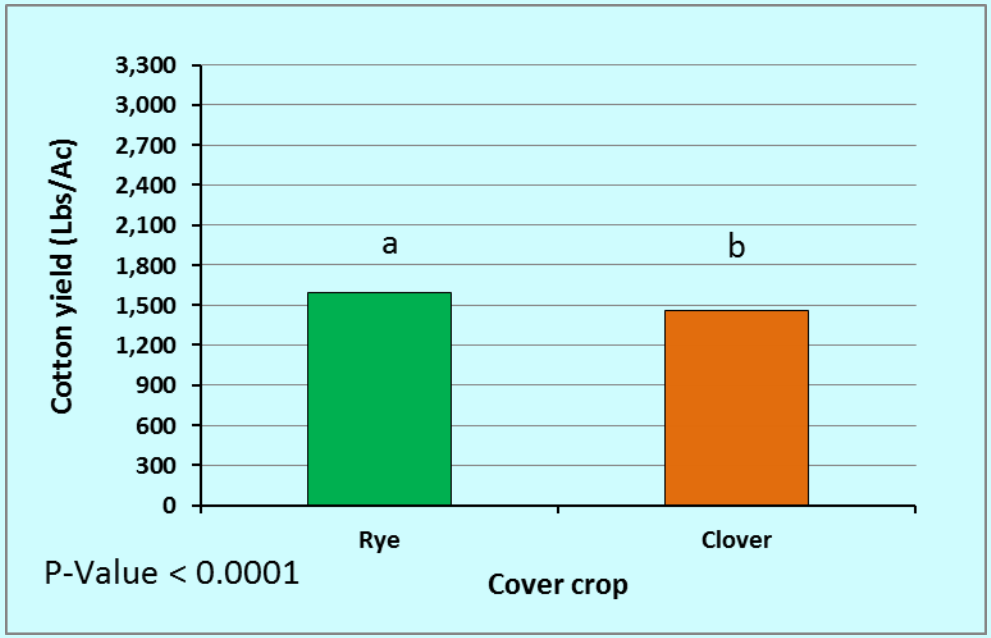




Seed cotton yield

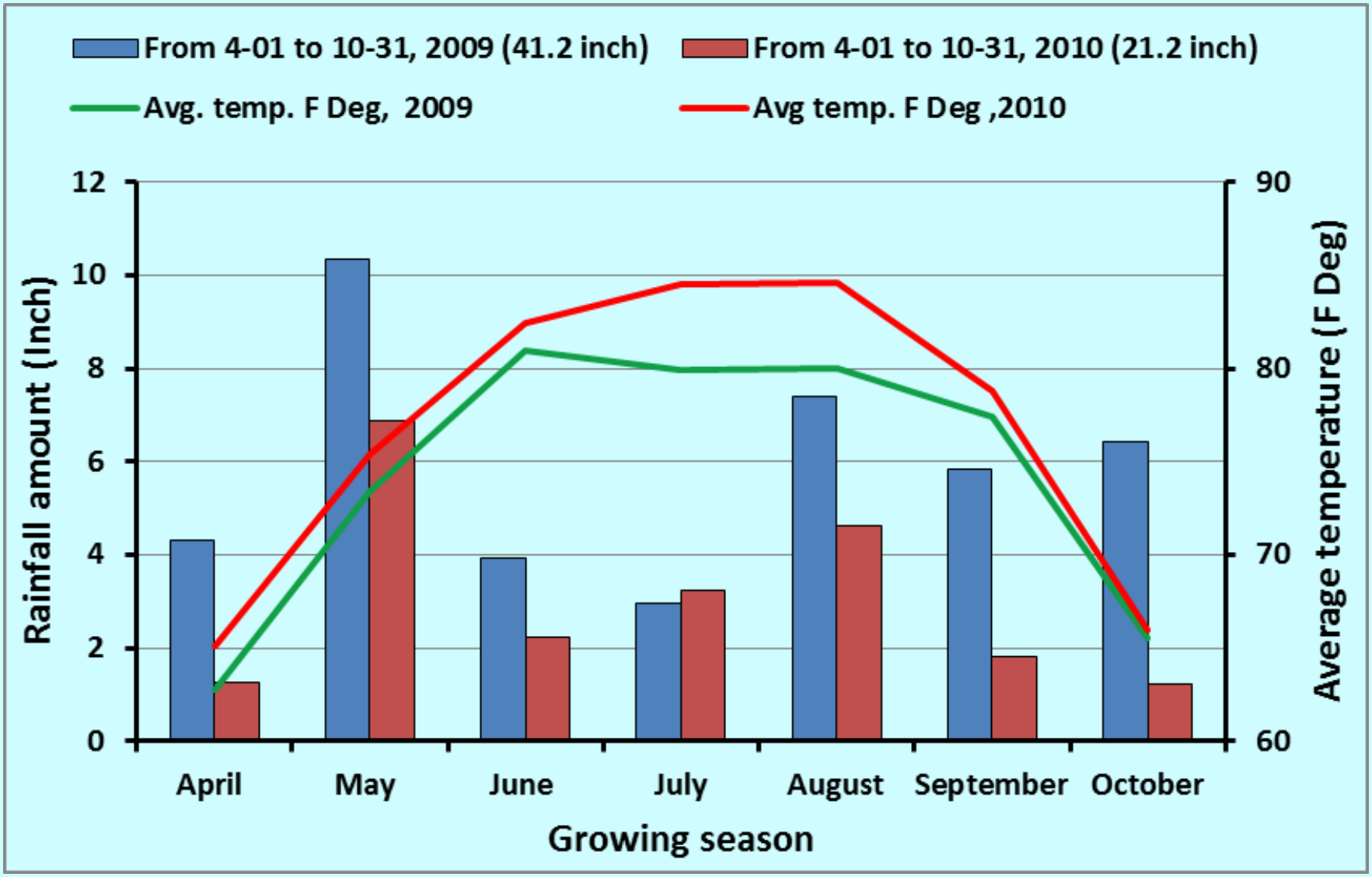


2009

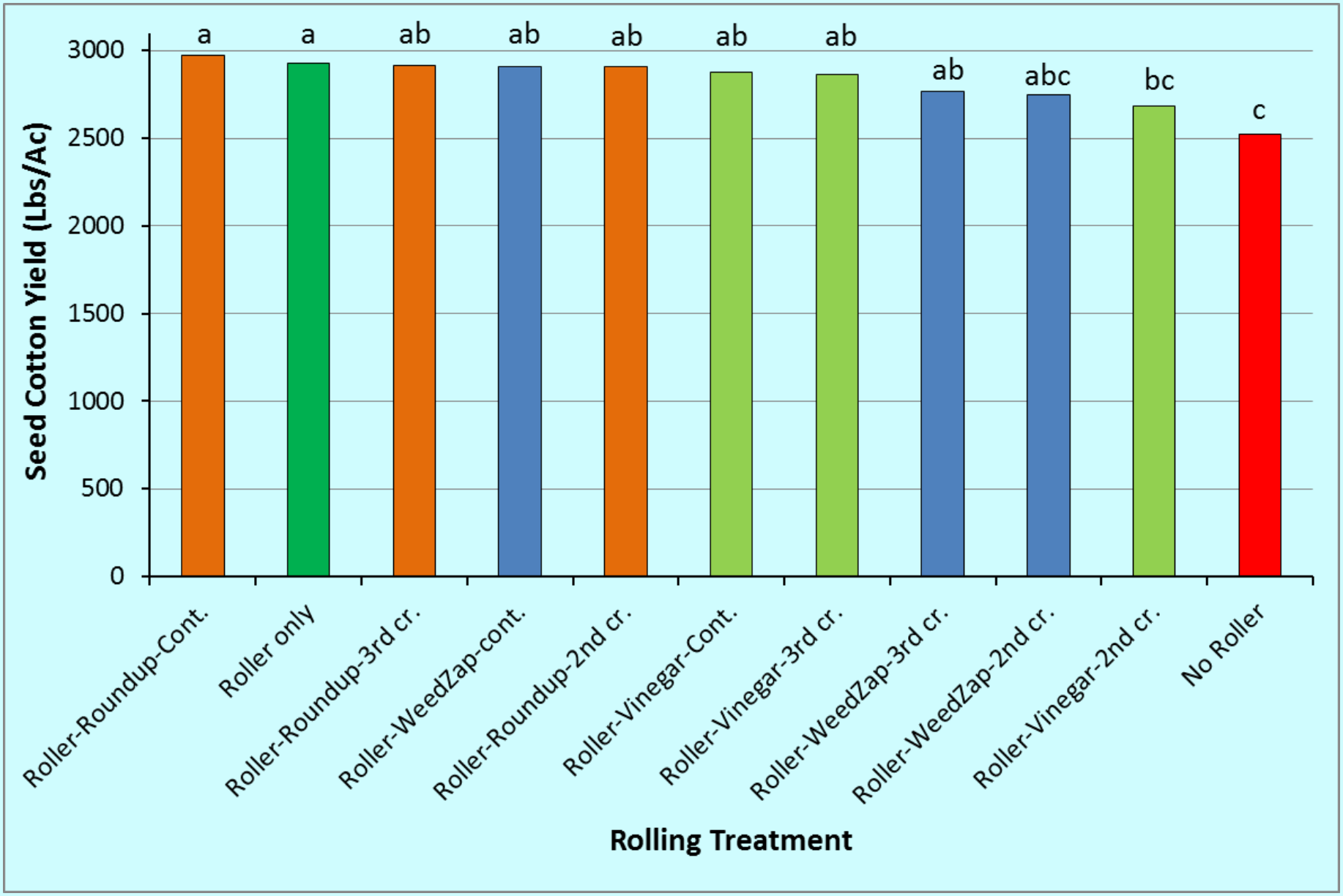


2010

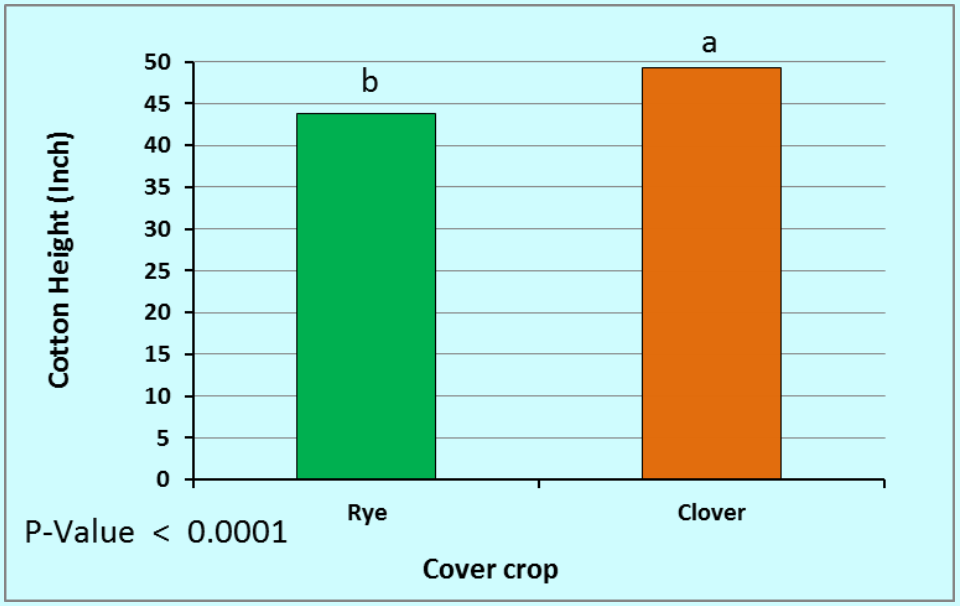
Rainfall and ambient temperatures for 2009-2010



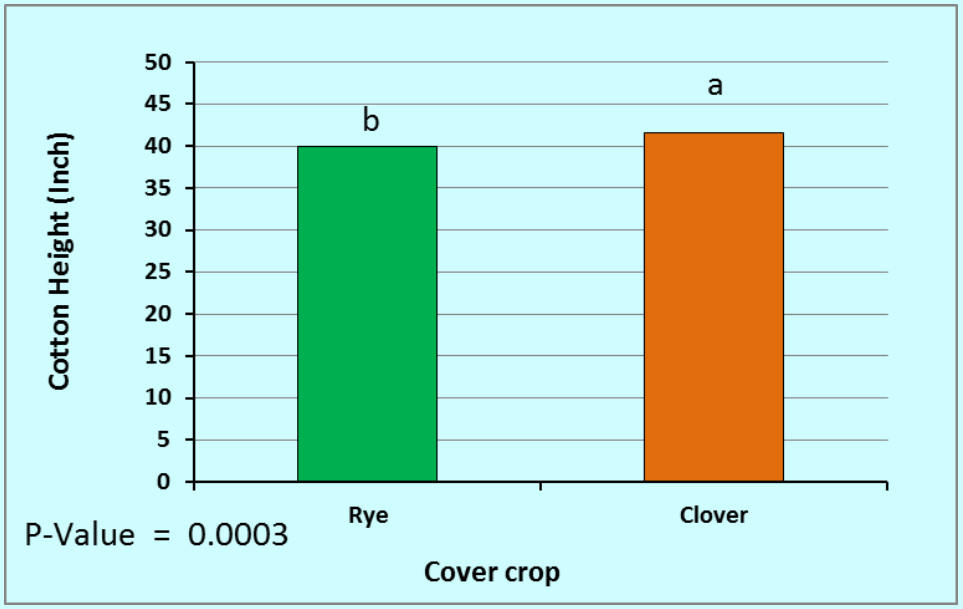
Treatment effect on cotton yield in 2009



2009-2010 Cotton plant height

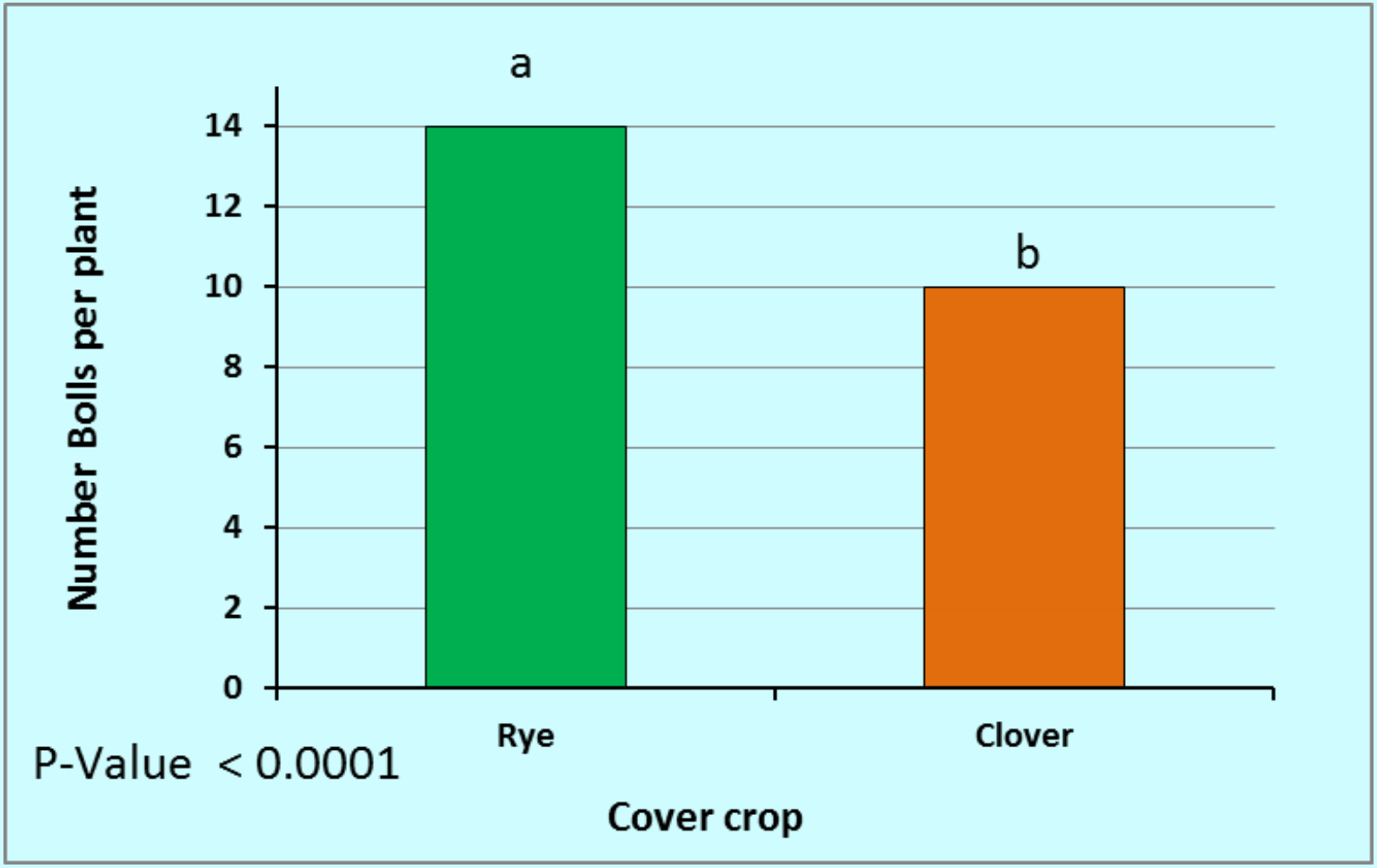


2009



2010

Average number bolls per plant in 2010



Summary

✓Based on 2009 and 2010 results, three weeks after rolling, rye termination rate was above 95% for all rolling treatments.

✓ In 2009, three weeks after rolling termination rates for Crimson clover was lower (80%) due to higher soil available moisture during evaluation period.

✓Compared to roller alone, termination process can be faster with continuous or reduced supplemental applications of Glyphosate but not with organic herbicides.

Summary cont.

✓Applying organic herbicides (Vinegar 20% and Weed Zap) did not speedup termination process compared with roller/crimper alone.

✓Herbicide reduction of discharge was 31.3% for every second crimp and 41.5% for every third crimp discharge compared with the continuous discharge rates.

✓During two growing seasons cover crops biomass, cotton population and yield were affected by different weather conditions in 2009 and 2010.

Other roller Developments

Roller/crimper for elevated beds;
Kornecki, U.S. Patent #7,662,517 B1

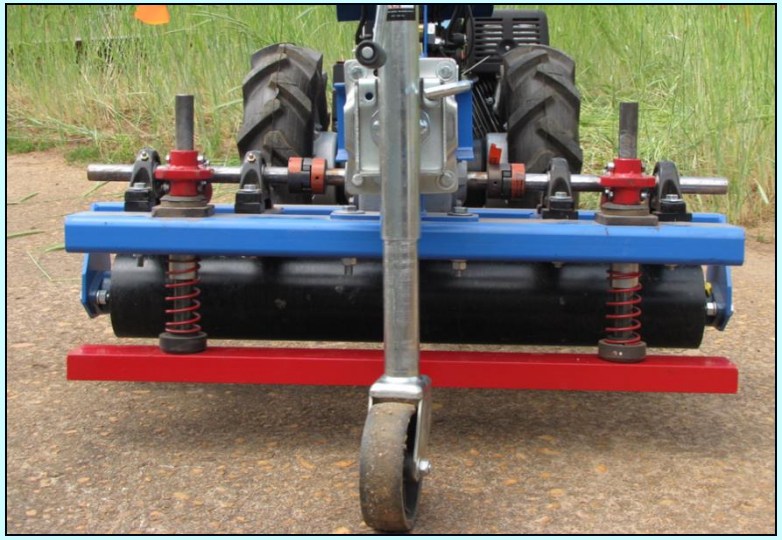
Powered roller/crimper for walk-behind
Tractor. Kornecki, Patent #8,176,991 B1

Elevated beds roller/crimper

Powered roller/crimper for walk behind tractors

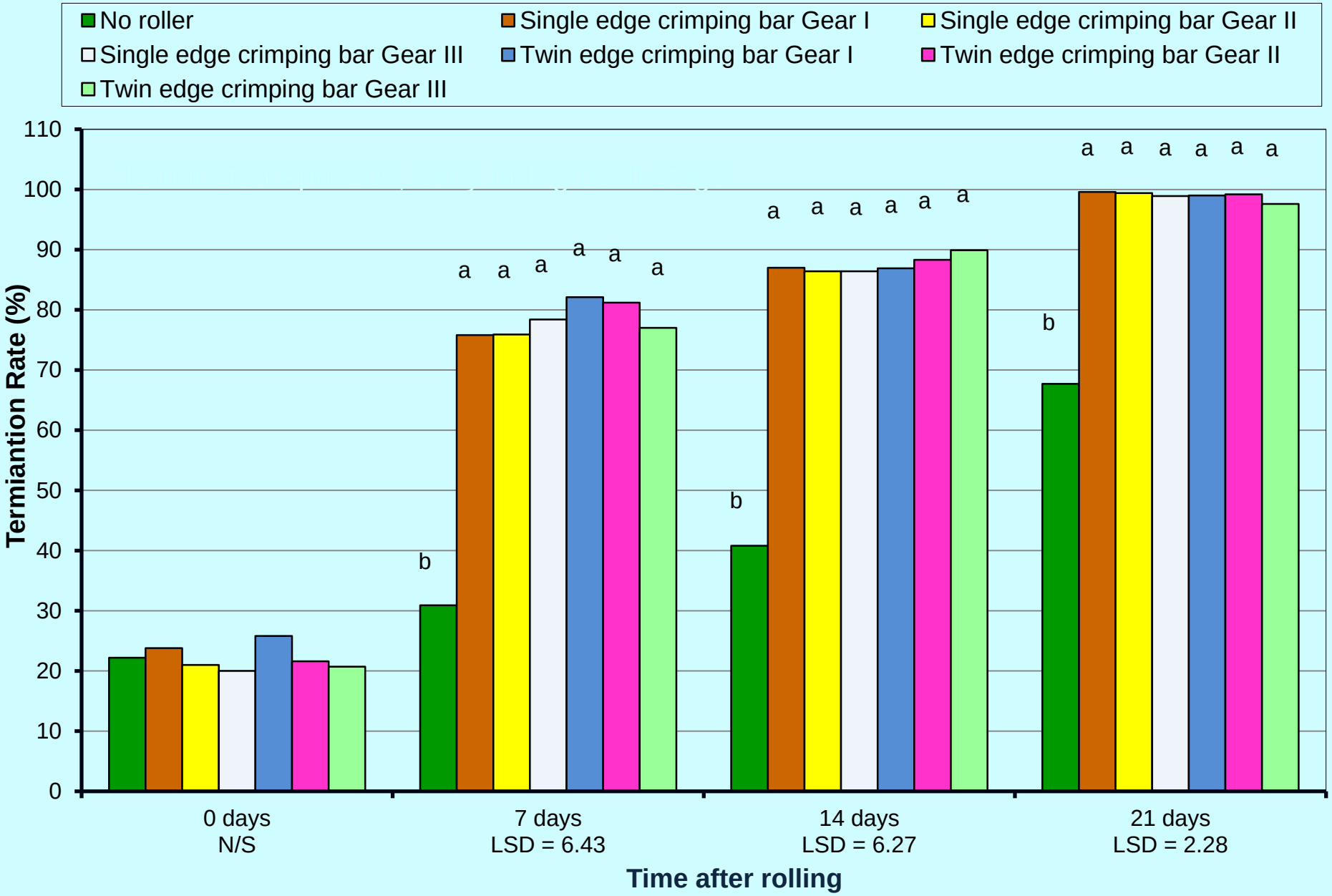
Single-edge crimping bar

Double-edge crimping bar



(Kornecki, 2012, U.S. Patent #8,176,991 B1).

2010 Rye Termination rates by powered roller/crimper



New roller/crimper designs

- Two-stage roller can effectively terminate dense and tall cover crops. Applicable for different tractor sizes/farm scales.
- Roller/crimper for elevated beds can effectively terminate cover crops grown on elevated bed culture.
- Powered roller/crimper for walk behind tractors gives small farms effective solution to terminate cover crops using limited power source.


Thank you. Questions?