Cover Crop Influence on Stored Soil Water Availability to Subsequent Crops

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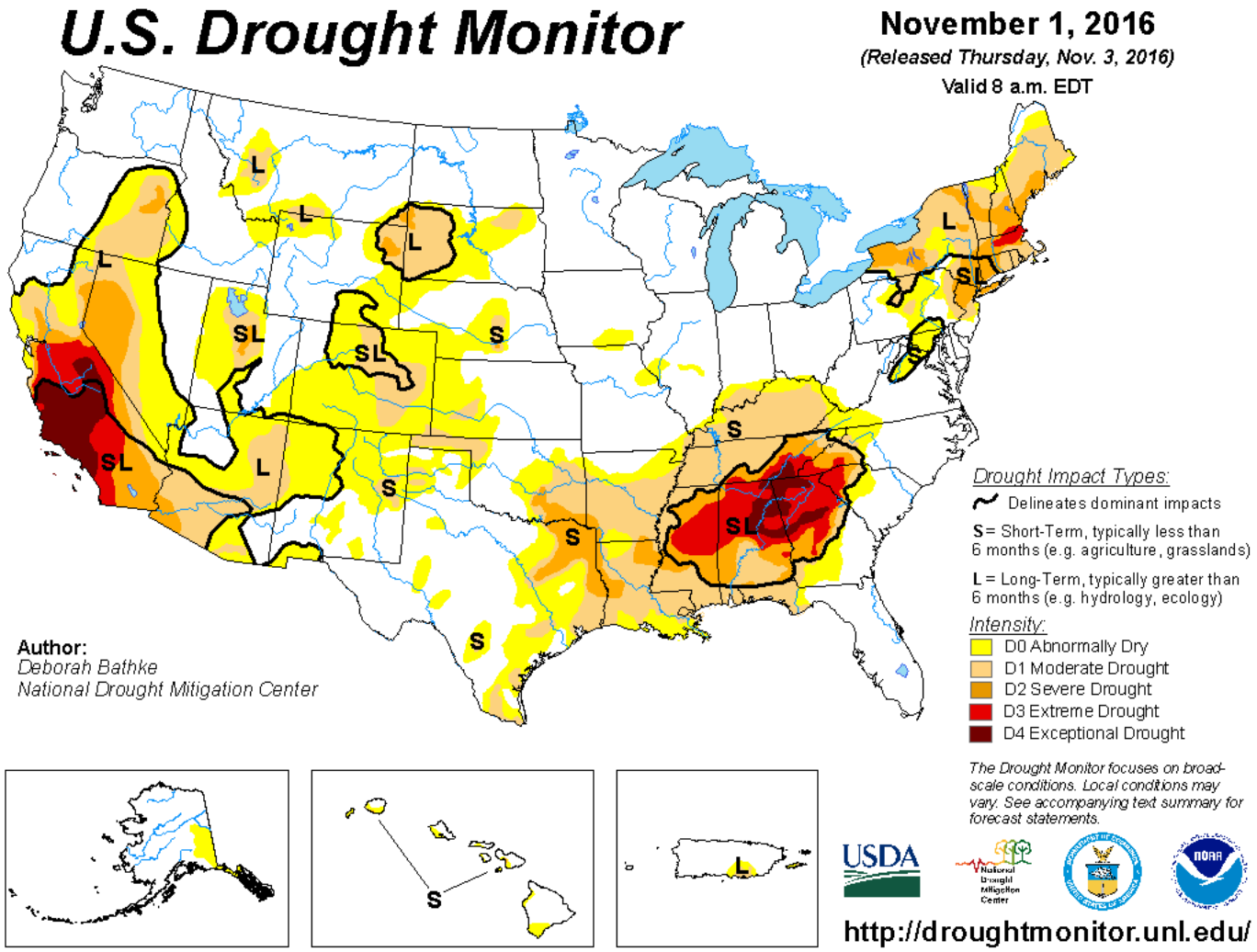
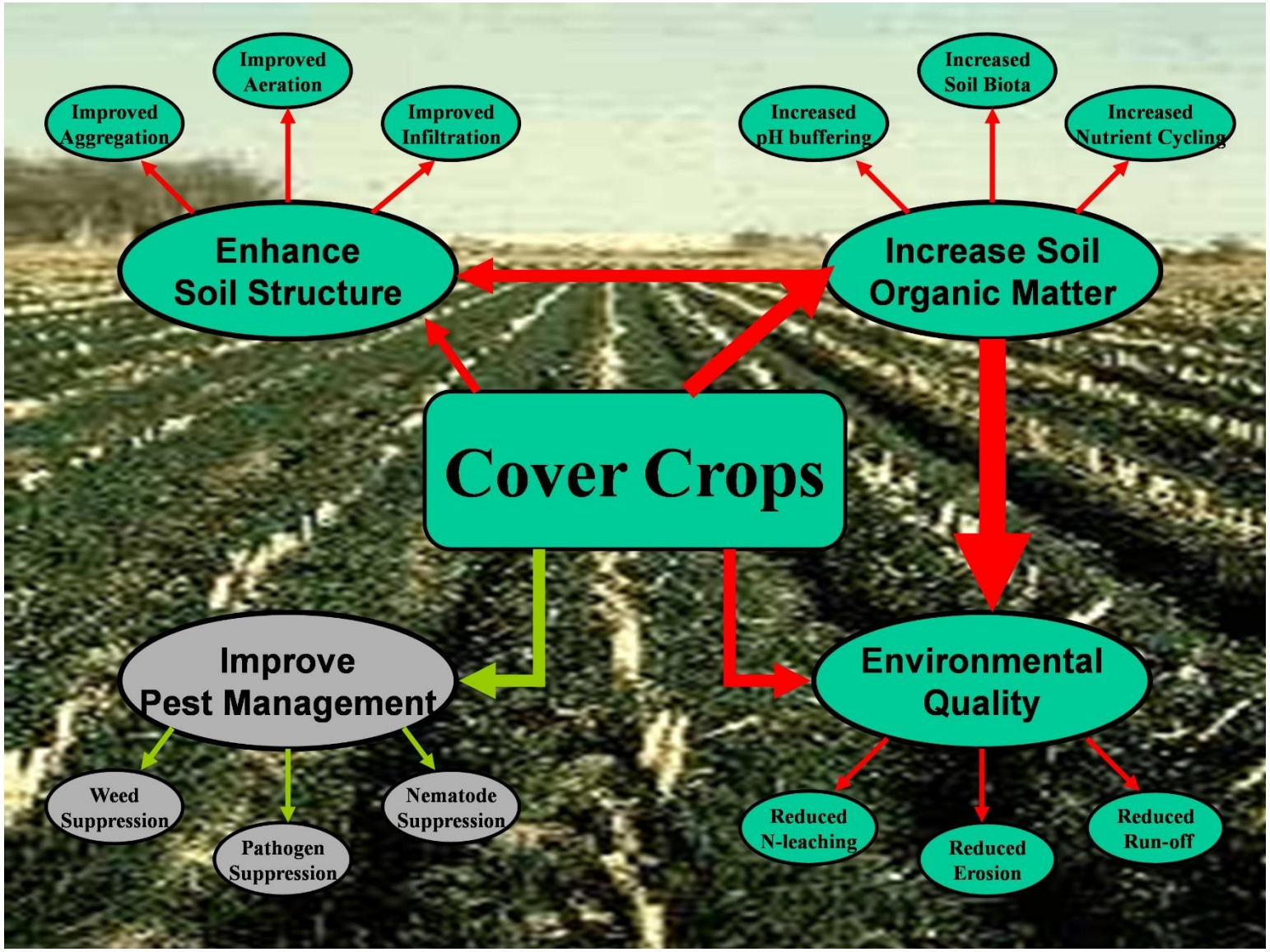
INTRODUCTION

DROUGHT IN THE UNITED STATES



BENEFITS OF COVER CROPS



Source: https://www.linkedin.com/in/Dr. Tohid Nooralvandi-7750978b/

FARMERS' HESITANCY FOR COVER CROPPING

Uncertainty of

- **Species to use**
- **Planting / Termination time**

- Additional Costs?

- Resource competition for the following cash crop
  - **Water**
  - **Nutrient**

RESEARCH QUESTION

If I plant a cover crop, how much soil water does it use and will it cause water stress to the subsequent cash crop?

OBJECTIVE

Evaluate common fall – winter cover crops (single species and mixtures) grown in South Carolina for:

- Biomass production
- Soil moisture content
- Water Use Efficiency (WUE)

APPROACH AND METHODS

Study Area (34°.60´1322´´, -82°.74´3332´´)

- On- farm trials on Milam farm in Anderson County, SC (fall - winter of 2016-2017)
- Study will be repeated in the fall - winter of 2017-2018

CRITERIA FOR TREATMENT SELECTION

- Combination of three functional groups (grass, legume, and brassica)
- Sustainable Agriculture Research and Education (SARE), Natural Resources Conservation Service (NRCS), or seed vendors' recommendations
- Commonly available fall-winter cover crops in SC

SINGLE SPECIES

Crimson clover

Single species of legume

Rye

Single species of grass

MIXTURE OF TWO SPECIES

Mixture of two
Oat and Radish
Grass-brassica combination

Mixture of two
Crimson clover and Turnip
Legume-brassica combination

Mixture of two
Crimson clover and Rye
Legume-grass combination

MIXTURE OF FIVE SPECIES

Mixture of 5a

(Austrian winter peas, Crimson clover, Hairy vetch, Rye, and Oats)

Legume- brassica-grass combination

Seed vendor (Adam-Brisco) recommendation

Mixture of 5b

Crimson clover, Radish, Turnip, Wheat, and Oats

Legume-brassica-grass combination

NRCS / SARE recommendation

CONTROLS

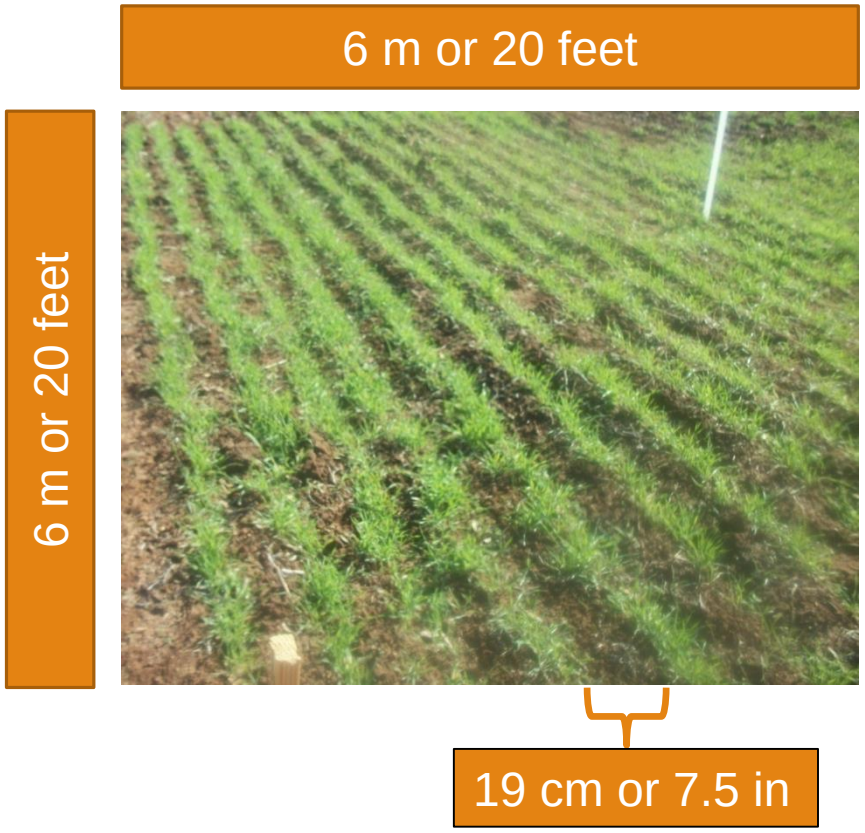
Control 1

Fallow with herbicide application

Control 2

Fallow without herbicide application

COVER CROP CULTURE



- Plot dimension - 6 m (20 feet) by 6 m.
- Row spacing – 19.05 cm (7.5 inches).
- Mechanized planting.

COVER CROP CULTURE

- Seeding rate of single species was based on the recommendations of the seed company (Adams Brisco), NRCS, or SARE.

- Seeding rate for multiple species was calculated as:

  seeding rate if used as a single species / number of species in the mixture

  (NRCS-USDA, 2007, National Plant Materials Manual, Fourth Edition, Beltsville, MD.)

- Termination by herbicide application and mechanical chopping one month prior to planting of soybean (variety: Pioneer)

MEASUREMENTS

Stand Count

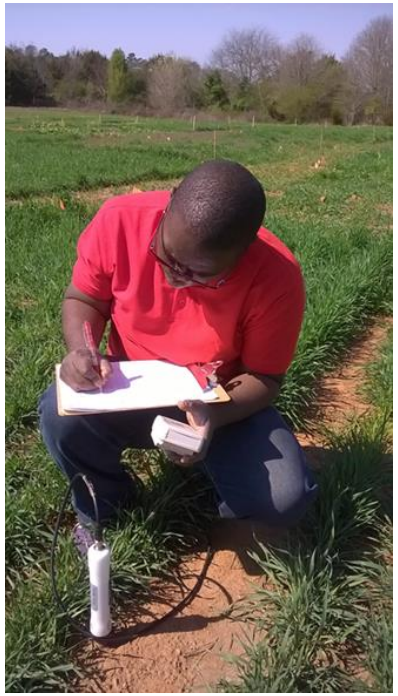
(Number of plants per meter square)

- **At 44 and 64 DAP (Days After Planting)**

MEASUREMENTS

PR2/6

100 cm



Soil Moisture Content

- At 74, 83, 97, 111, 130, and 137 DAP of cover crops and at one month after planting of next cash crop (soybean)
- Using a soil moisture probe (Delta T Devices PR2) at 10, 20, 30, 40, 60, and 100 cm (39 inch) depths (IP68 sensing connectors technology)
- Total stored soil moisture content was calculated up to 1 meter

MEASUREMENTS

Biomass Production

- Cover crop biomass was hand harvested ~monthly from 1 m^2 area within each plot

- At 83, 111, and 137 DAP

WATER USE EFFICIENCY

WUE = (biomass produced / water use)

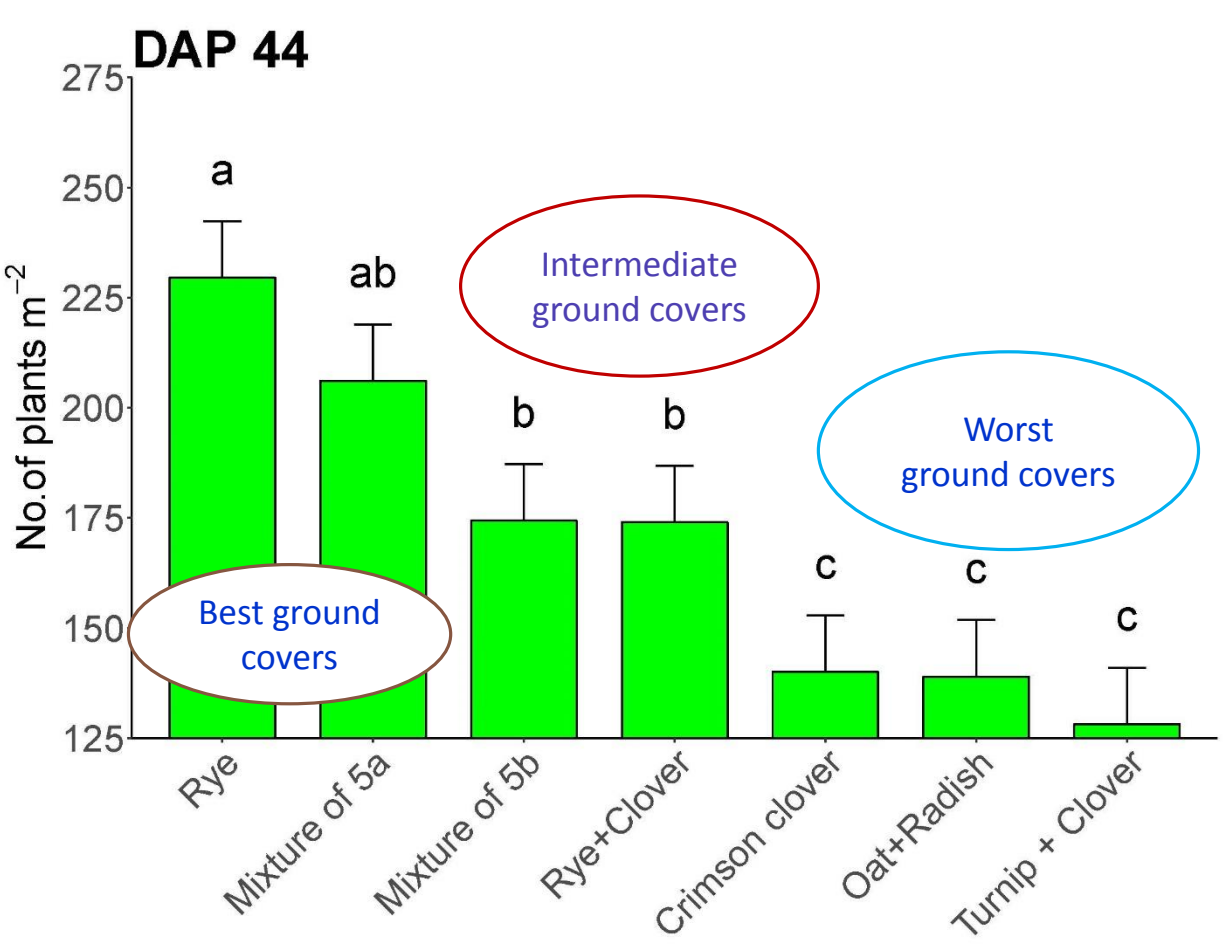
- Soil water depletion (ΔS) between two sampling dates was calculated as the difference between stored soil water between the sampling dates.
- Cover crop water use [Evapotranspiration (ET)] was determined by the soil water balance method (ET = ΔS + precipitation). No corrections were made for drainage and run-off. (Narayanan et al., 2013)
- WUE was estimated as the ratio between aboveground biomass and water use.

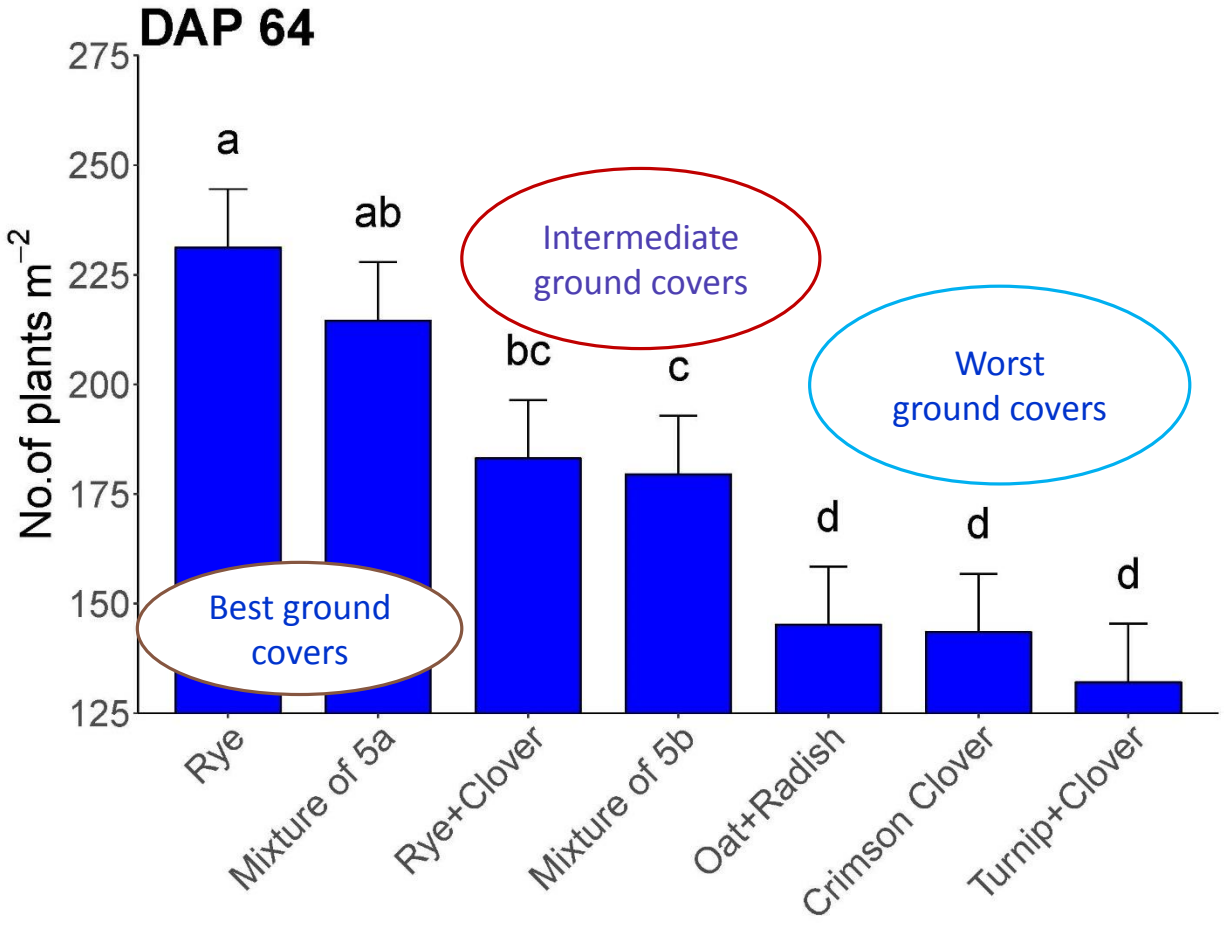
STATISTICAL ANALYSIS

- Experimental design was a randomized complete block with five replications.
- Cover crop treatments were considered as fixed effects and replications as random effects.
- Analysis of variance was performed using MIXED procedure in SAS 9.4.

RESULTS

STAND COUNT


DAP 44
No.of plants m^{-2}
275
250
225
200
175
150
125
a
ab
b
b
c
c
c
Intermediate ground covers
Worst ground covers
Best ground covers
Rye
Mixture of 5a
Mixture of 5b
Rye+Clover
Crimson clover
Oat+Radish
Turnip + Clover


DAP 64
No.of plants m^{-2}
275
250
225
200
175
150
125
a
ab
bc
c
d
d
d
Intermediate ground covers
Worst ground covers
Best ground covers
Rye
Mixture of 5a
Rye+Clover
Mixture of 5b
Oat+Radish
Crimson Clover
Turnip+Clover

Best ground covers

Mixture of 5a
Austrian winter pea, Rye, Clover, Hairy vetch, Oats

Intermediate ground covers

Mixture of 5b
Radish, Turnips, Wheat, Oats, Crimson Clover,

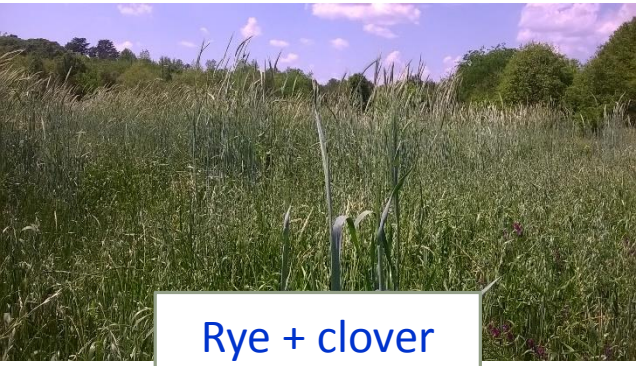
Worst ground covers

COVER CROPS AT TERMINATION


Mixture of 5a


Rye


Mixture of 5b


Rye + clover

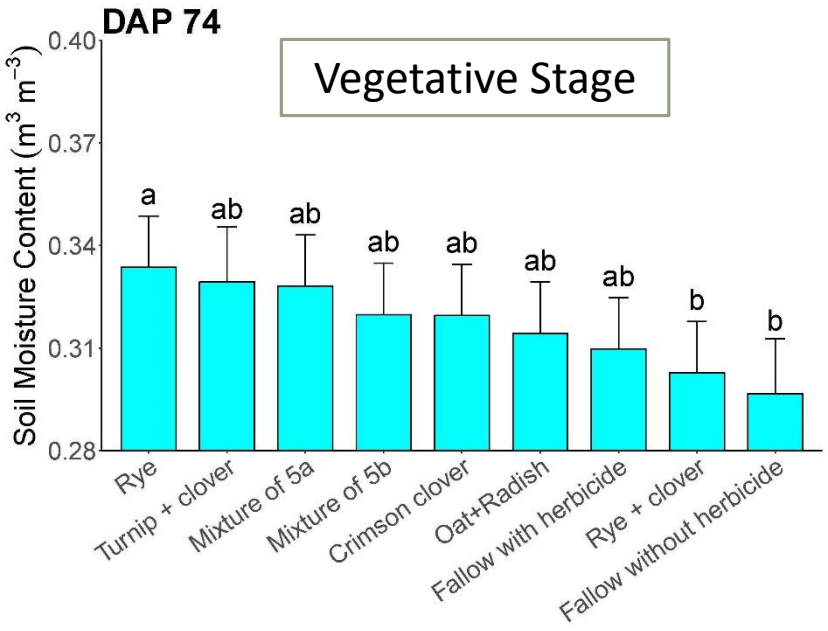

Oat + radish

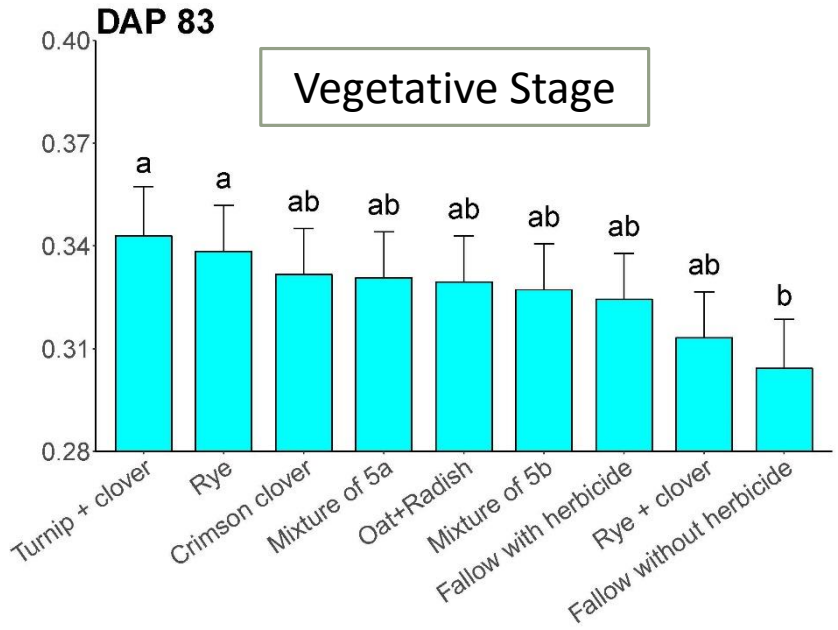

Turnip+ clover

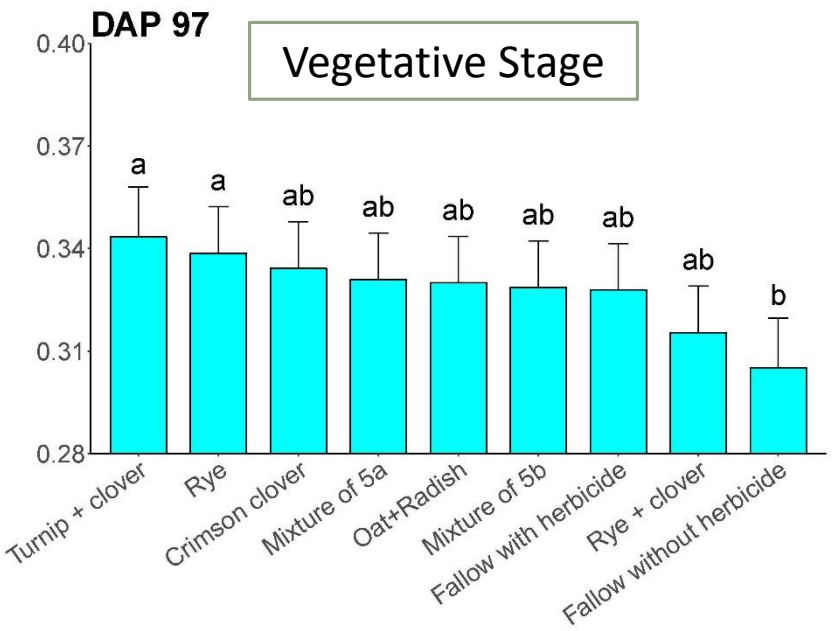

Crimson clover

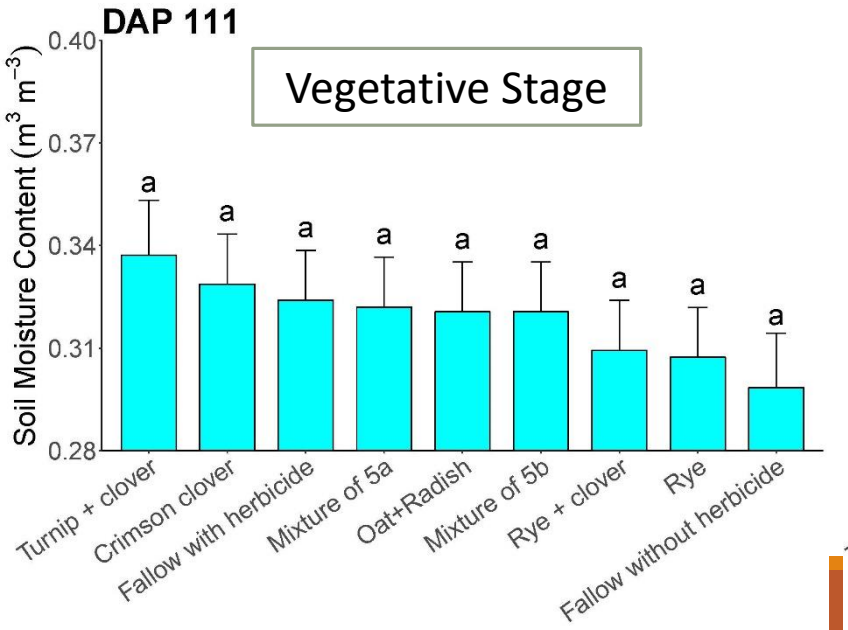
AERIAL VIEW OF THE RESEARCH FIELD

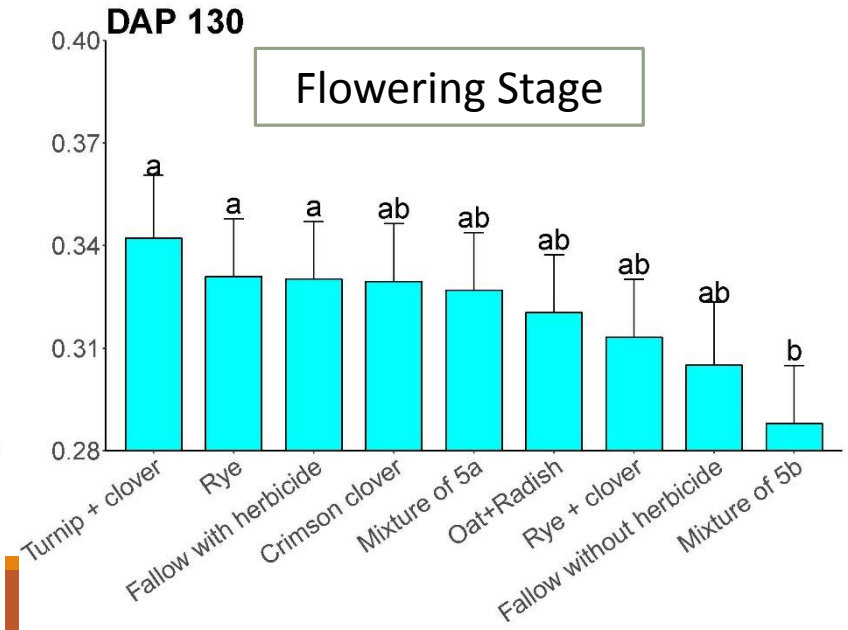
SOIL MOISTURE CONTENT

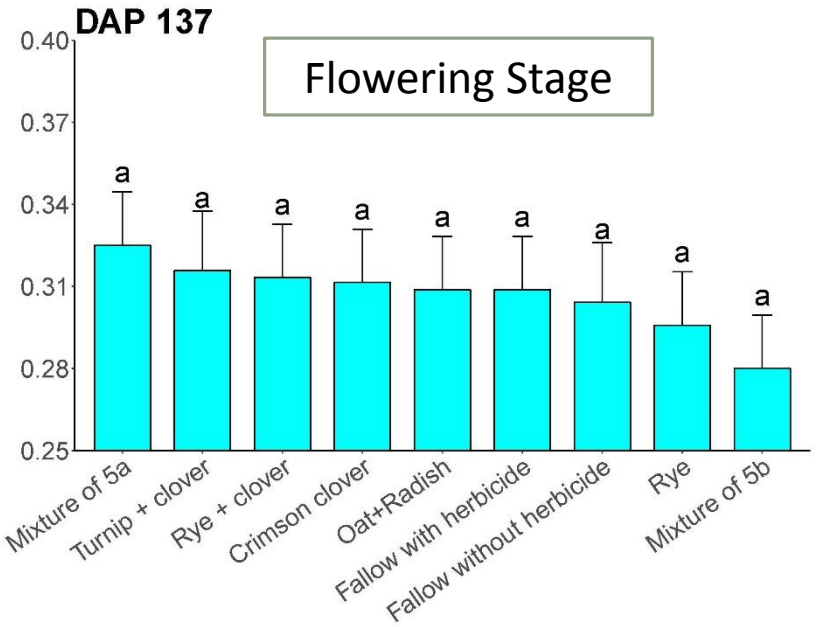




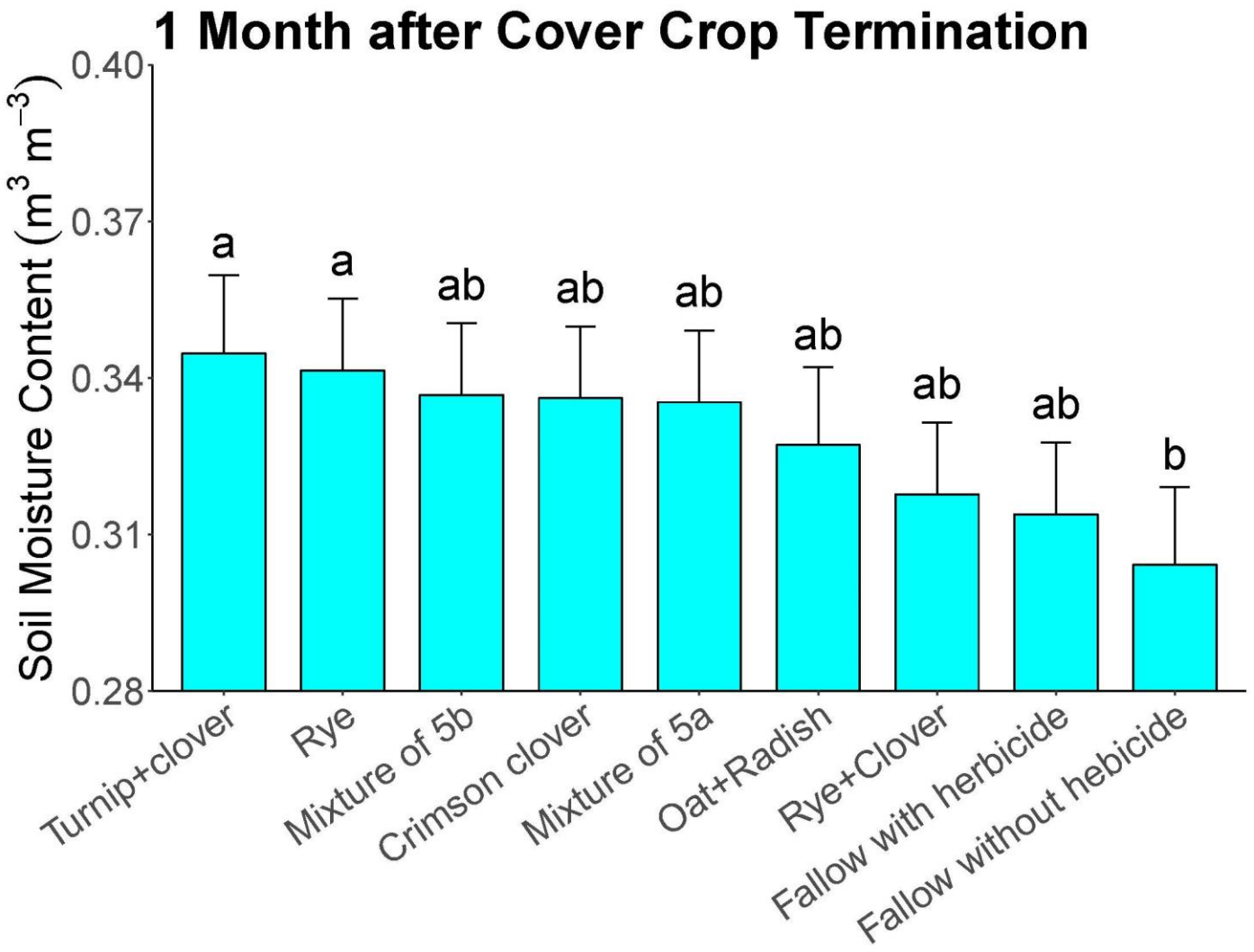




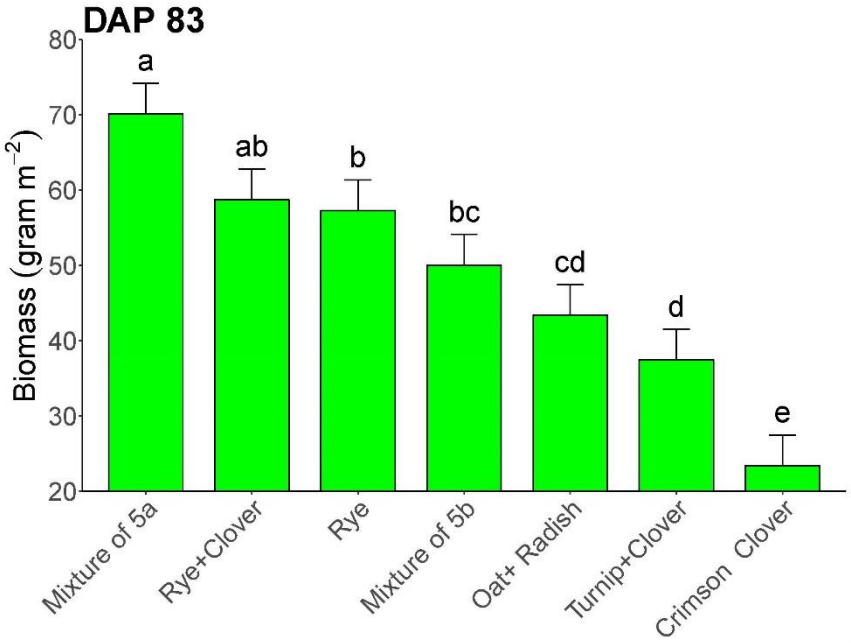


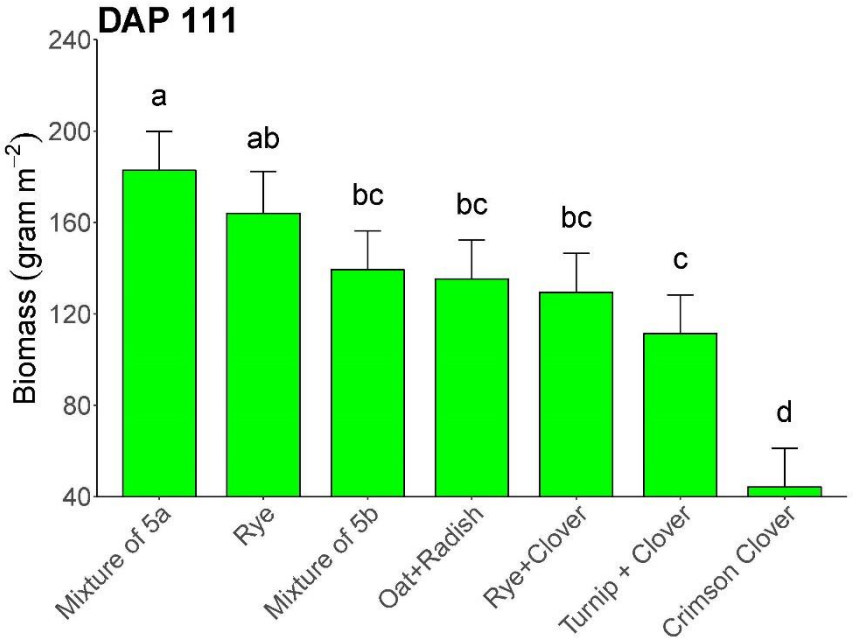


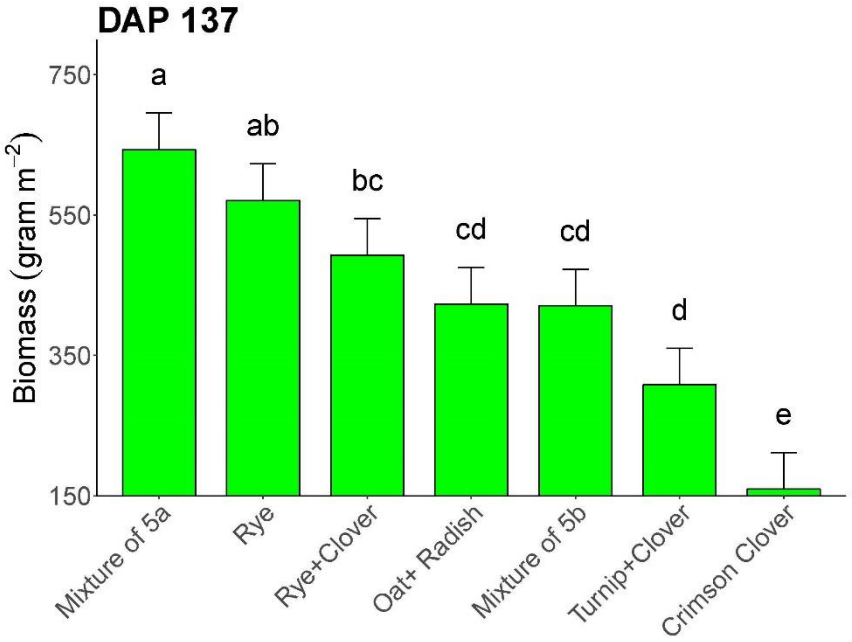
SOIL MOISTURE CONTENT



BIOMASS


DAP 83
Biomass (gram m^{-2})
80
70
60
50
40
30
20
a
ab
b
bc
cd
d
e
Mixture of 5a
Rye+Clover
Rye
Mixture of 5b
Oat+ Radish
Turnip+Clover
Crimson Clover


DAP 111
Biomass (gram m^{-2})
240
200
160
120
80
40
a
ab
bc
bc
bc
c
d
Mixture of 5a
Rye
Mixture of 5b
Oat+Radish
Rye+Clover
Turnip + Clover
Crimson Clover


DAP 137
Biomass (gram m^{-2})
750
550
350
150
a
ab
bc
cd
cd
d
e
Mixture of 5a
Rye
Rye+Clover
Oat+ Radish
Mixture of 5b
Turnip+Clover
Crimson Clover

WATER USE EFFICIENCY

Late vegetative stage

Treatment	Water use efficiency (g m^{-3})
Mixture of 5a	1700± 283 ^{a}
Oat+ Radish	1412± 283 ^{a}
Mixture of 5b	1364± 283 ^{a}
Rye	1221± 304 ^{a}
Rye + Clover	1131± 283 ^{a}
Turnip + Clover	1055± 304 ^{a}
Crimson Clover	338± 283 ^{b}

Late flowering stage

Treatment	Water use efficiency (g m^{-3})
Mixture of 5a	5039± 655 ^{a}
Rye + Clover	4300± 655 ^{ab}
Rye	3445± 655 ^{abc}
Oat+ Radish	2947± 655 ^{bc}
Mixture of 5b	2663± 655 ^{bcd}
Turnip + Clover	2080± 728^{cd}
Crimson Clover	1038± 655 ^{d}

CONCLUSIONS

- All cover crop treatments retained more or equal amount of soil moisture compared to controls (weed-free or weedy fallow).

- Rye and Mixture of 5a (Austrian winter pea + Crimson Clover + Hairy Vetch + Oat + Rye) were good ground covers in terms of number of plants per meter square, and had highest amount of biomass and water use efficiency values.

- Though turnip + crimson clover and crimson clover retained good amount of moisture in the soil, they were poor biomass producers and ground covers.

FUTURE WORKS

Effect of Cover crops on Soil Health and Soil Compaction

- How cover crops affect soil microbial activity and fertility?
- How cover crop root systems interact with compacted soil layers (hardpan)?

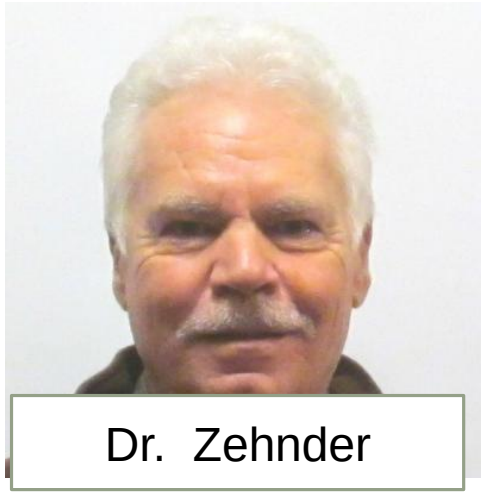
ACKNOWLEDGEMENTS

Mr. Milam
(Farmer cooperator)

Mr. **Talley**
(Extension Agent)

Lab mates

Dr. Narayanan



Dr. Zehnder

Dr. Suseela

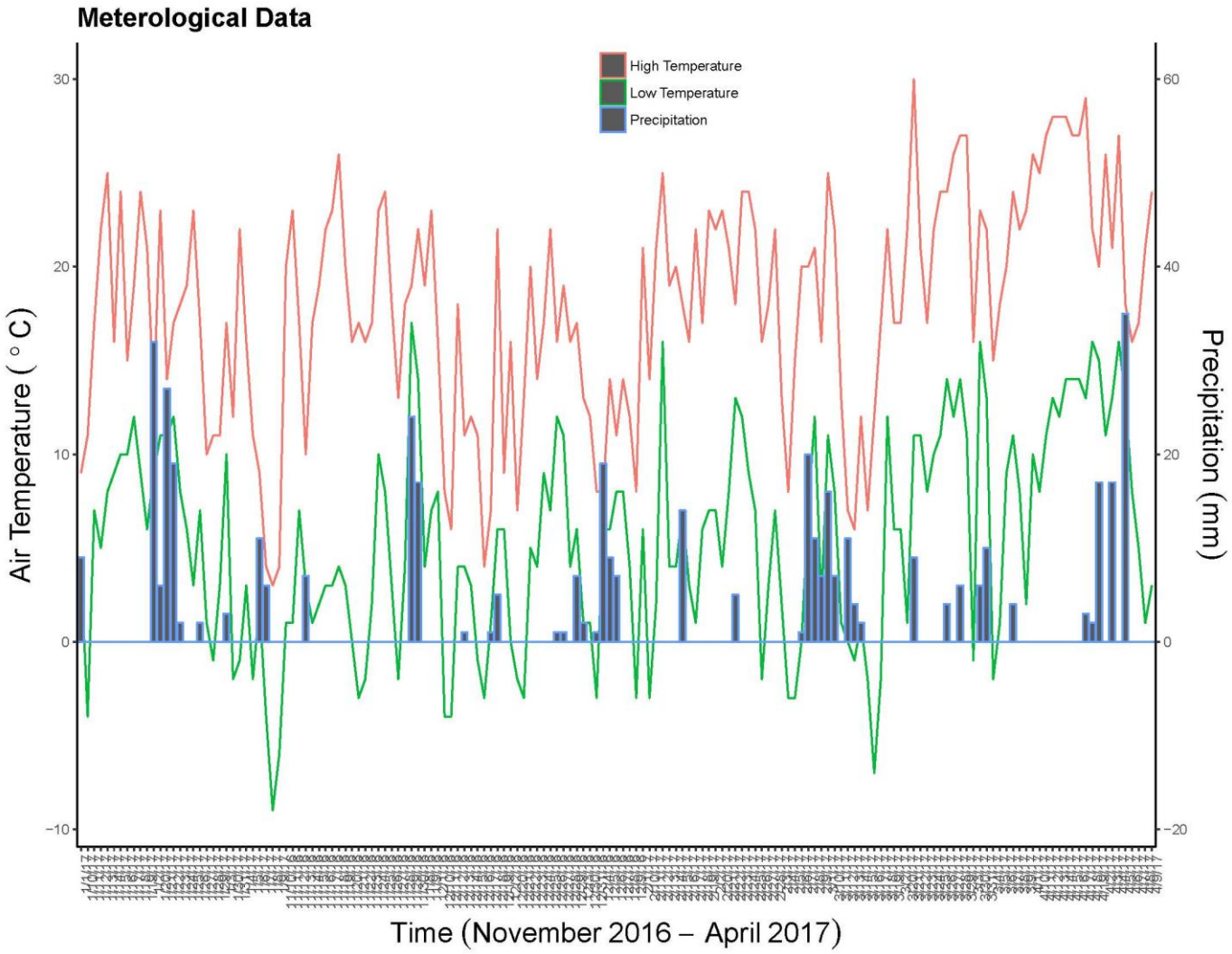
SOUTHERN SARE
Sustainable Agriculture Research & Education

FULBRIGHT

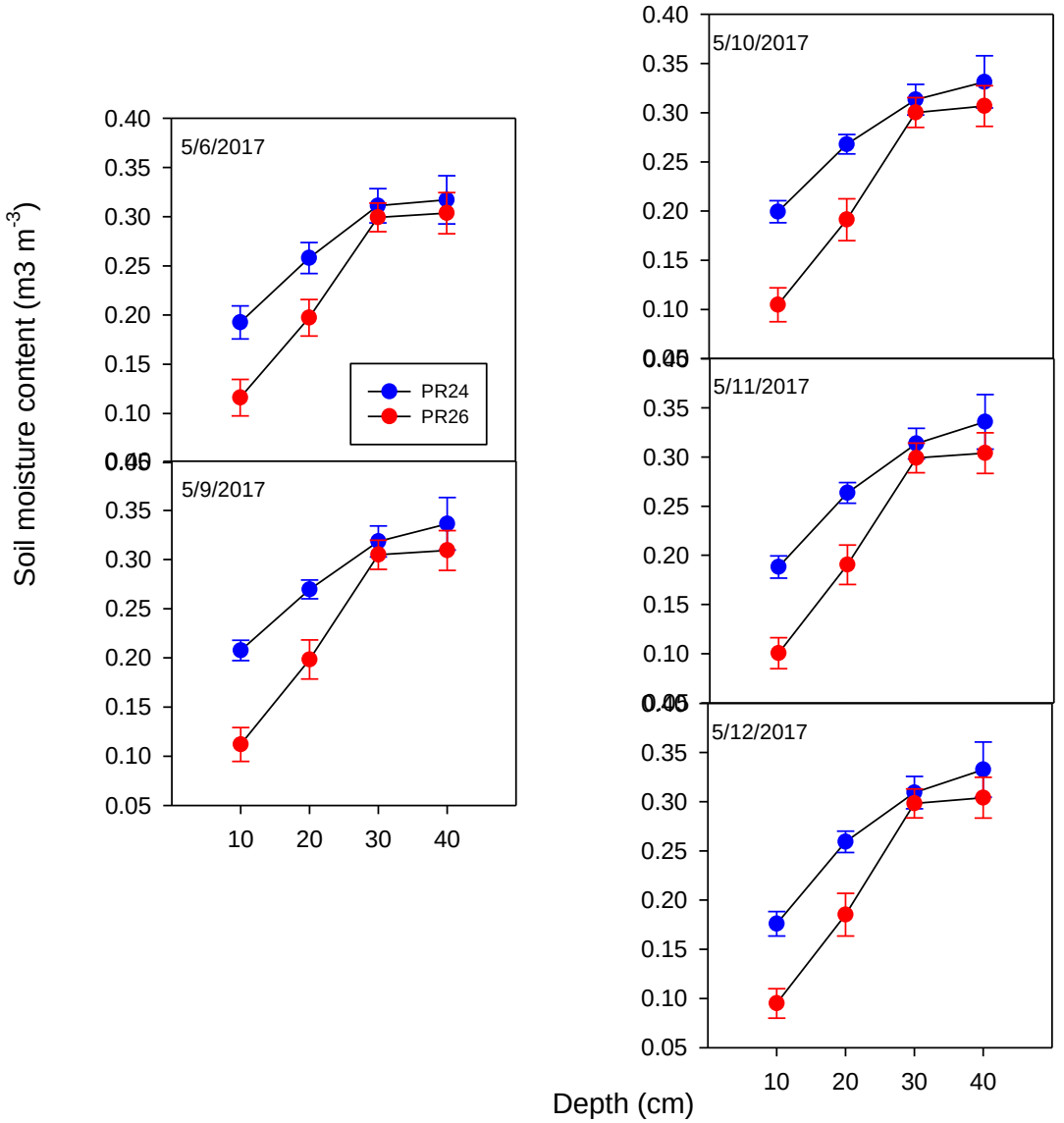
CLEMSON
PLANT AND ENVIRONMENTAL SCIENCES

"Increasing the proportion of agriculture that uses sustainable, organic methods of farming is not a choice, it's a necessity. We simply can't continue to produce food far into the future without taking care of our soils, water and biodiversity." Claire Kremen, University of California, Berkeley

METEOROLOGICAL DATA DURING COVER CROP SEASON



Comparison of 40 cm and 100 cm probe



Cover crop impacts on soybean