Estimating Nitrogen Release from Cover Crops

Miguel Cabrera, Julia Gaskin,Rick Hitchcock

David Kissel, Lisa Woodruff, Carson Dann (UGA)

Resham Thapa, Steven Mirsky (USDA-ARS)

Kate Tully (Univ. of Maryland)

Chris Reberg-Horton (NCSU)

Crop and Soil Sciences

University of Georgia

Overview

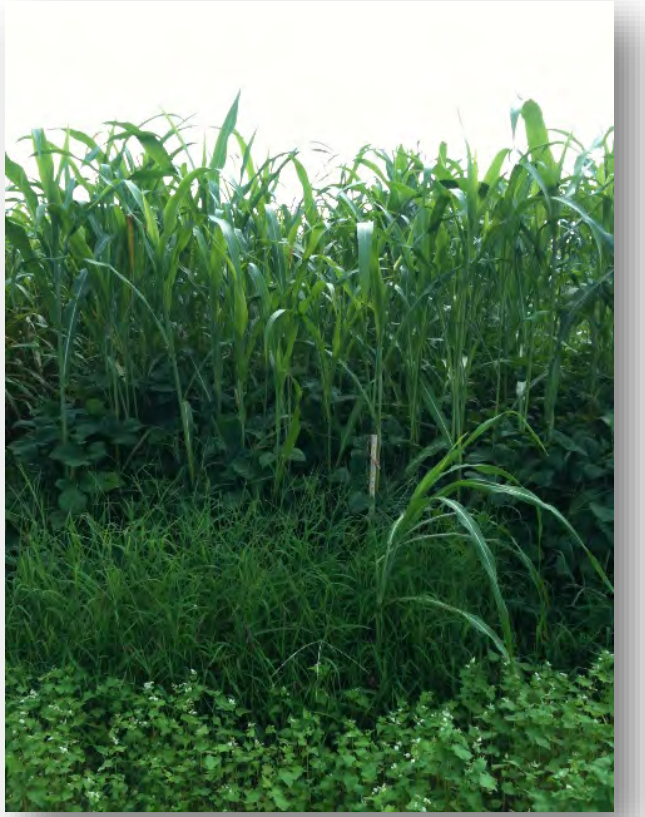
- *Amount of N released from cover crop residues*
- Factors affecting N release from crop residues
- A calculator to estimate N release from incorporated residues
- Diurnal change in water content of surface residues
- A model of water content of surface residues
- A calculator to estimate N release from surface residues
- A calculator to estimate N release form organic fertilizers

Why Use Cover Crops?

- Increase organic matter
- Reduce nutrient loss
- Reduce erosion
- Reduce weed pressure
- Protect water quality
- Provide beneficial insect habitat
- Supply nitrogen to the following crop

Which Cover Crops can Release N?

- Legumes (crimson clover, cowpea, sunn hemp, lablab …)
- Cereals at early stage (rye, oats, wheat ..)
- But, cereals at late stage immobilize N
- N immobilization example
  - Sorghum-sudangrass/cowpea cover crop
    - Biomass = 15,800 lb/a
    - % N = 1.06
    - Total N = 168 lb/a
    - Available N = 0 lb/a



Example - Nitrogen from Cowpea

(*Vigna unguiculata*-warm season cover crop)

Available N (lb N/a)	
60 days	34 to 70
70 days	40 to 85
80 days	50 to 110

Example – Nitrogen from Sunn hemp

(*Crotalaria juncea* - warm season cover crop)

Available N (lb N/a)

60 days	50 to 75
90 days	75 to 140

Oat Cover Crop Quality at two Growth Stages

	2015	2016
Growth stage	Headed	Soft dough
Biomass (lb/ac)	7,300	11,000
N (%)	2.3	1.4
Carbohydrates (%)	41	38
Cellulose (%)	54	53
Lignin (%)	5	9
Total N (lb/a)	165	152
Avail. N (lb/a)	60	25

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Main Factors Affecting Nitrogen Release from Cover Crops

- Temperature and moisture
- Cover crop quality
  - ✓*Carbohydrates (speed decomposition)*
  - ✓*Cellulose/hemicellulose*
  - ✓*Lignin (resistant to decomposition)*
  - ✓*Nitrogen content*
  - ✓Affected by species, growth stage

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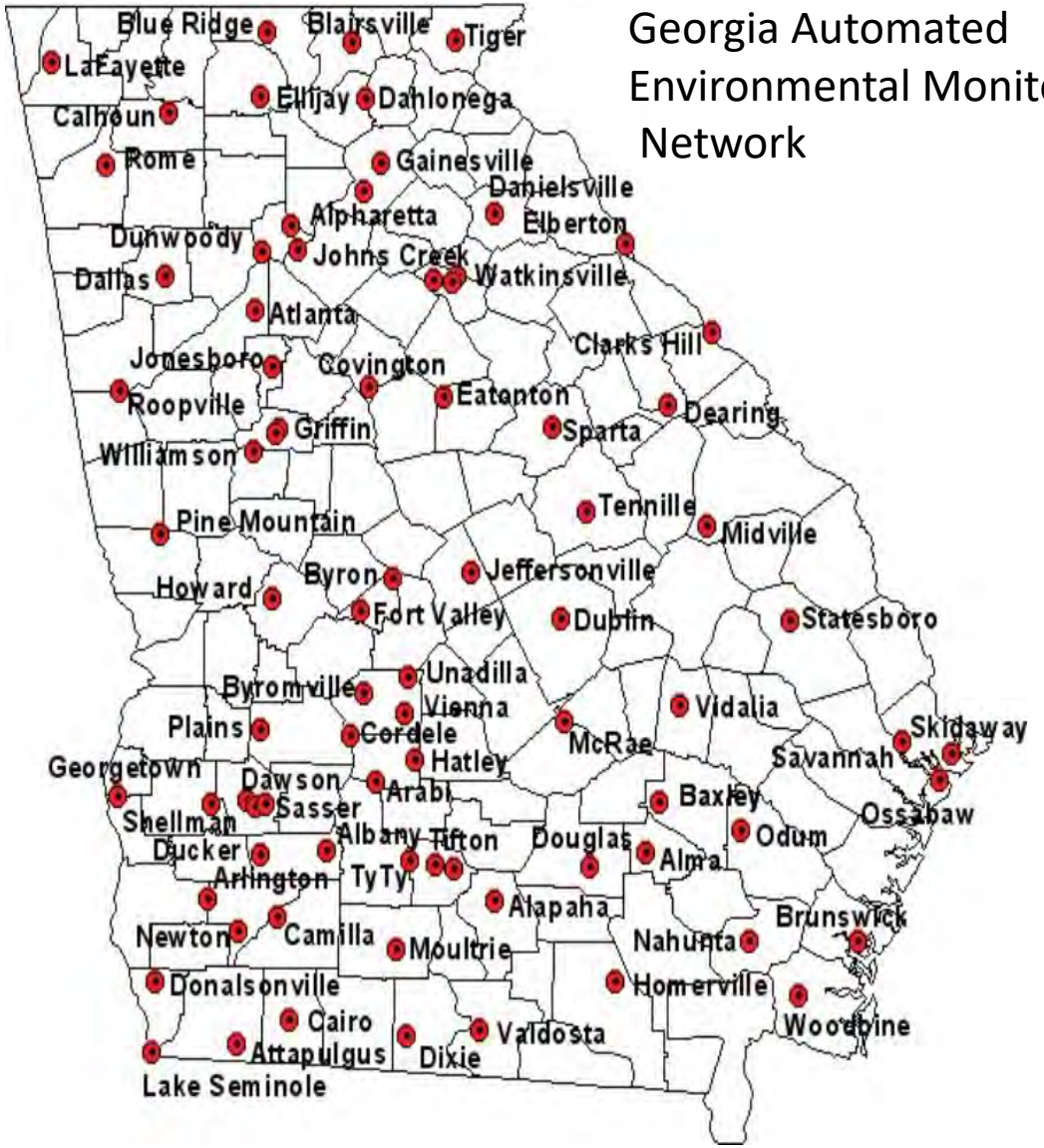
Advances that Make N Estimation Possible

- Network of weather stations
- Available weather data:
  - Soil water content
  - Soil temperature



Georgia Automated Environmental Monitoring Network

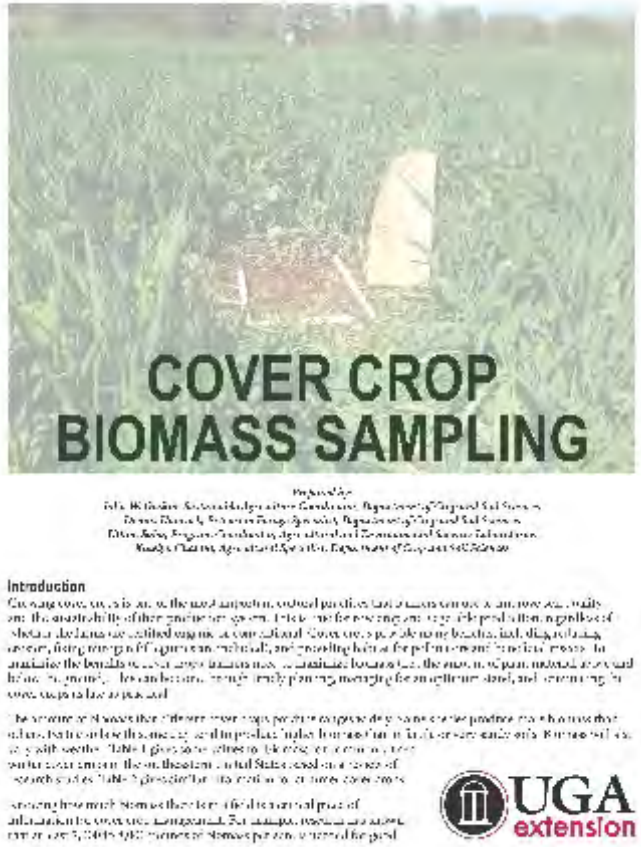
Advances that make N Estimation Possible

(Near-infrared spectroscopy (NIRS))

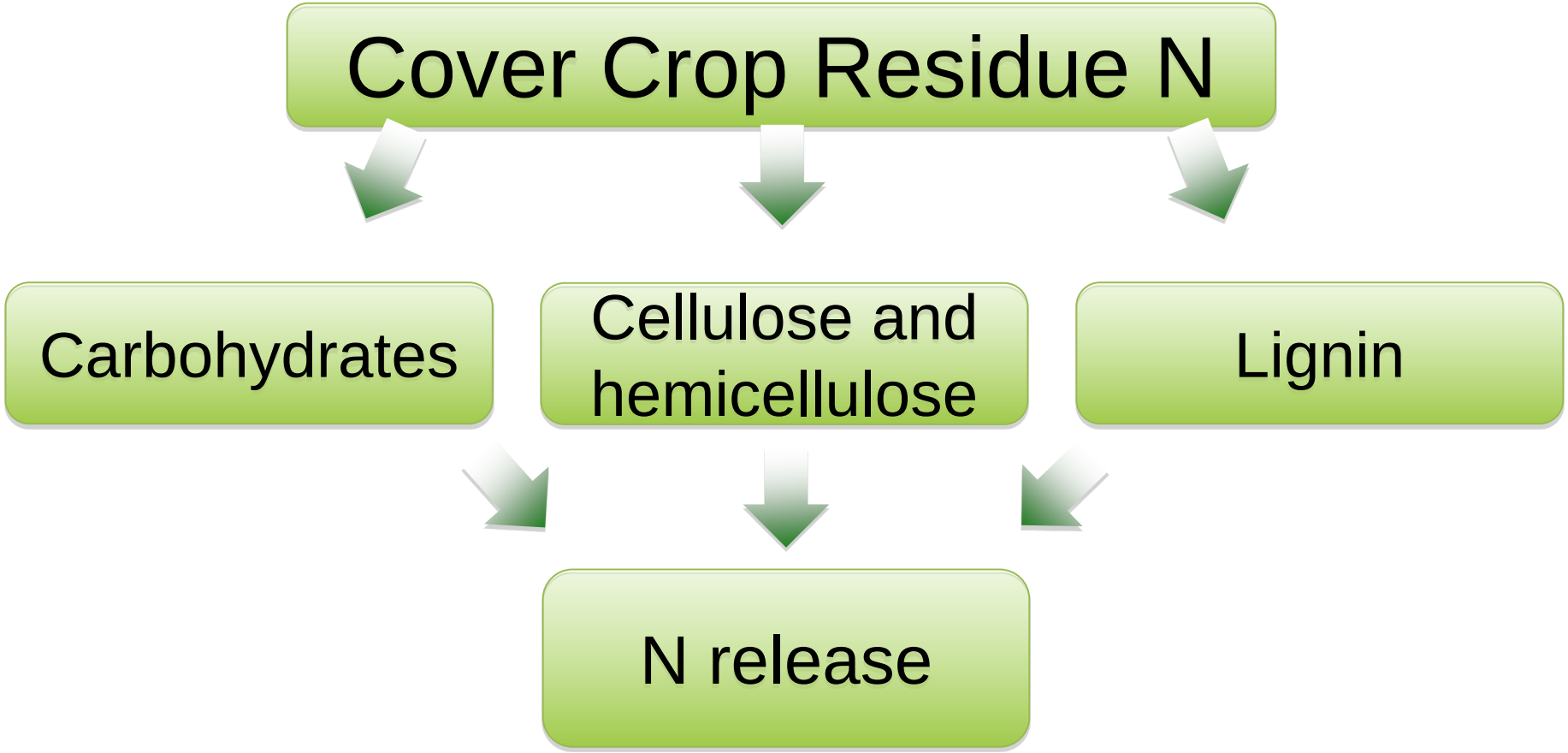
- Quick turnaround and cheaper than wet chemistry
- Estimates cover crop quality:
  - Nitrogen
  - Non-structural carbohydrates
  - Cellulose-hemicellulose
  - Lignin

Our General Procedure

- User measures wet cover crop biomass in field
  - "*Cover Crop Biomass Sampling*"
  - Sends subsample for analysis of:
    - Total nitrogen
    - Carbohydrates, cellulose, and lignin
- Use data from nearby weather station for soil moisture and temperature
- Cover Crop N Availability Calculator predicts N mineralization/immobilization from *cover crop residue*
- Predicts nitrogen credit or debit for the season



Estimating N Mineralization from Cover Crops



http://aesl.ces.uga.edu/mineralization

COVER CROP NITROGEN AVAILABILITY CALCULATOR

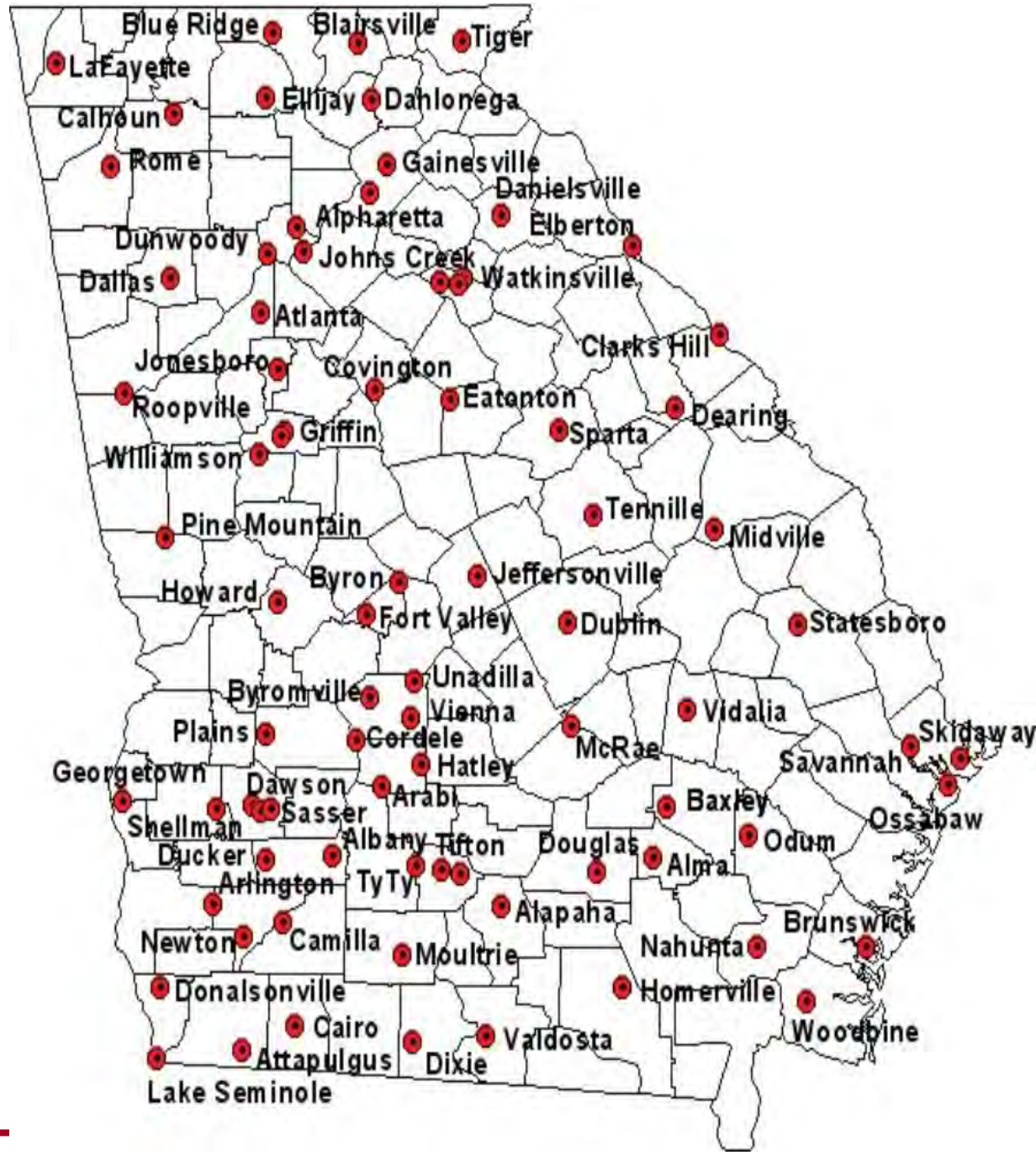
CALCULATOR | INSTRUCTIONS | CONTACT

If you need instructions, click the **Instructions** tab above.

Please answer the questions below and click "Next Page" when complete.

Background

Was the cover crop residue analyzed by the Agricultural and Environmental Services Labs? • If so, please enter the Lab Number. • IF NOT, leave blank and enter data from another laboratory in the section below.	1567 Lab No.
Please enter the field name	Front Field
Enter the sample ID	1
To choose the closest weather station, what county is your farm located in? (OR Choose from interactive map.)	Clarke Using weather station at: **Horticulture Research Farm**
What is the CASH crop?	Select a crop Broccoli
What is your target nitrogen fertilizer rate?	150 lbs N/acre
What is the planting date?	08/24/2015 mm/dd/yyyy
What is the COVER CROP?	Select one or more cover crops Cowpeas
When was the cover crop killed or incorporated?	08/01/2015 mm/dd/yyyy



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COVER CROP NITROGEN AVAILABILITY CALCULATOR

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Please answer the questions below and click "Next Page" when complete.

Background

Is this a high organic matter soil? (High organic matter soils are usually those that have been managed using conservation tillage with cover crops or organically for at least three years.)	☐ Yes ◉ No
Cover crop residue will be	◉ Incorporated ○ Left on the surface
Dry cover crop biomass	7,583

Nitrogen in cover crop	2.9	0.3-5.0%
Carbohydrates in cover crop	43	0-100%
Cellulose in cover crop	52	0-100%
Lignin in cover crop	5	0-100%

Carbohydrates + Cellulose + Lignin should equal 100%

COVER CROP NITROGEN AVAILABILITY CALCULATOR

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RESULTS: Wide Bottom Farm — Front Field - 1

Your cover crop Cowpeas was terminated on 08/01/2015.

The cover crop is predicted to release 78 lbs of N per acre from the aboveground biomass over three months. This is a N credit.

The cover crop is predicted to release:

- 29 lbs of N per acre in the first **two** weeks after termination.
- 59 lbs of N per acre in the first **four** weeks after termination.

Your target nitrogen fertilizer rate was 150 lbs N/ac.

Your recommended N after the cover crop is 72 lbs N/ac.

The available N reported above from the cover crop decompositions is considered a N credit if positive or a debit if negative. The amount of N fertilizer recommended may be reduced by a credit or increased by a debit. Here are examples:

N Credit Example:	N Debit Example:
Recommended or Target N = 150 lbs N/ac	Recommended or Target N = 150 lbs N/ac
Predicted Cover Crop N = 50 lbs N/ac	Predicted Cover Crop N = - 20 lbs N/ac
Recommended N after Credit = 150 - 50 = **100** lbs N/ac	Recommended N after Debit = 150 - (-20) = 150 +20 = **170** lbs N/ac

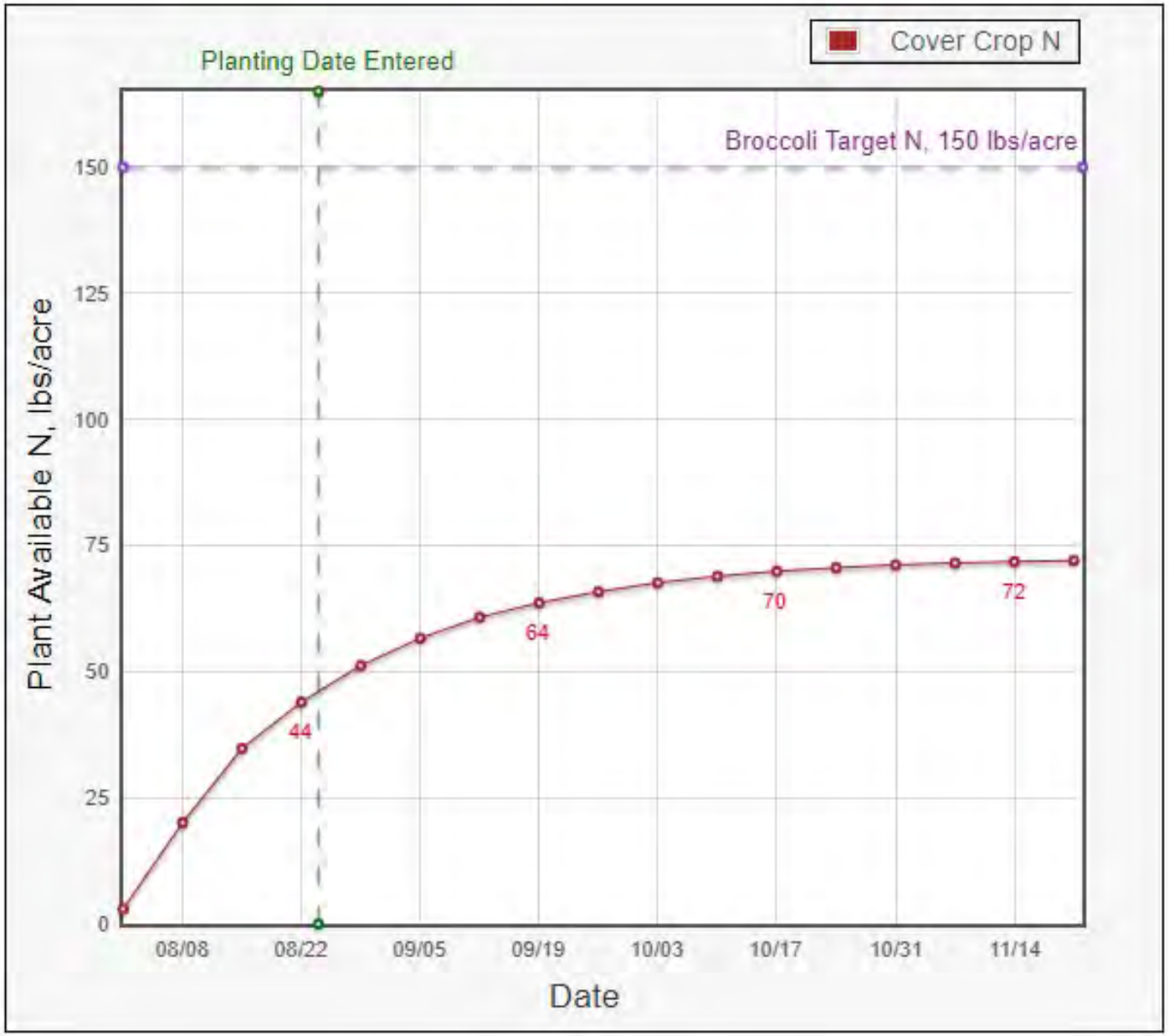
In addition to the amount of available N released from your cover crop, when it is released is important to guide your N management.

Wide Bottom Farm | Front Field - 1

This graph will give you an idea about when the N is being released. Days after cover crop termination is on the horizontal axis and amount of available N on the vertical axis. To determine how much available N will be available at a given time, follow a vertical line up from a date to the plotted curve.

The steepness of the plotted line indicates how rapidly N is released.

This graph may help you decide if you want to adjust your N fertilizer at planting or sidedress.



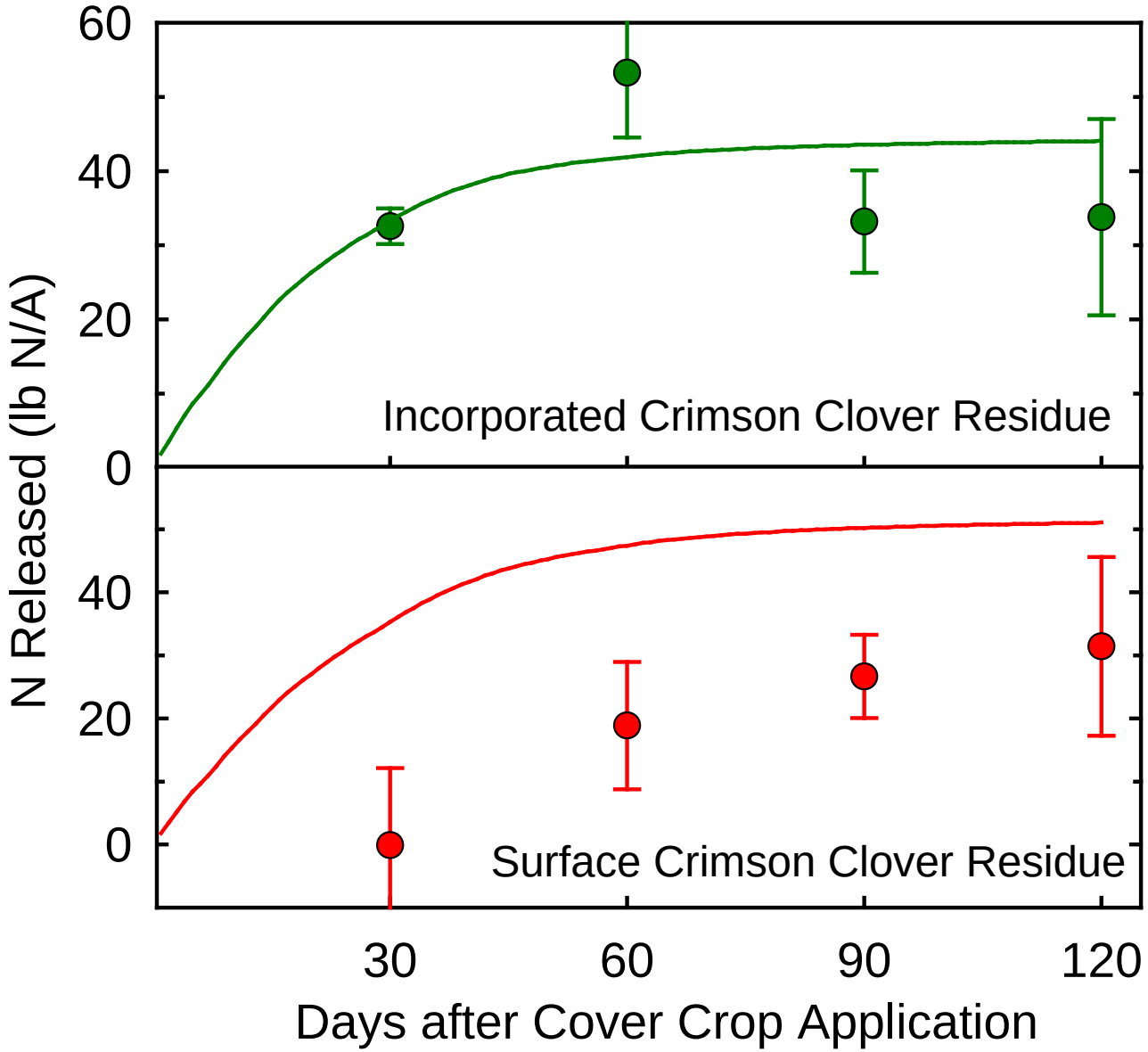
Cowpea as Partial N Source for Broccoli

Cover Crop	Total N	Fertilizer N	Cover Crop N	Broccoli Yield
	---------- kg N ha^{-1} ----------			--- kg ha^{-1} ---
2013				
No	0	0	0	1254 b
No	56	56	0	3057 a
Yes	56	10	46	3296 a
2014				
No	0	0	0	1355 b
No	84	84	0	3329 a
Yes	84	37	47	3481 a
2015				
No	0	0	0	2478 b
No	84	84	0	5555 a
Yes	84	20	64	4820 a

Cost-Effective Supply of Nitrogen for Organic Vegetable Production

- Example – Broccoli - 150 kg N/ha
- Feathermeal as a N source?
  - $1600/ha to supply 150 kg N/ha
- Cowpea/feathermeal as N sources?
  - Cowpea establishment cost - $110/ha
  - Cowpea supplied 60 kg N/ha
  - Feathermeal provided 90 kg N/ha - $1000
  - Total cost: $110 + $1000 =$1110/ha
- No difference in yield
- Cost savings: $1600 - 1110 =$490/ha

Nitrogen Overestimation for Surface Residues



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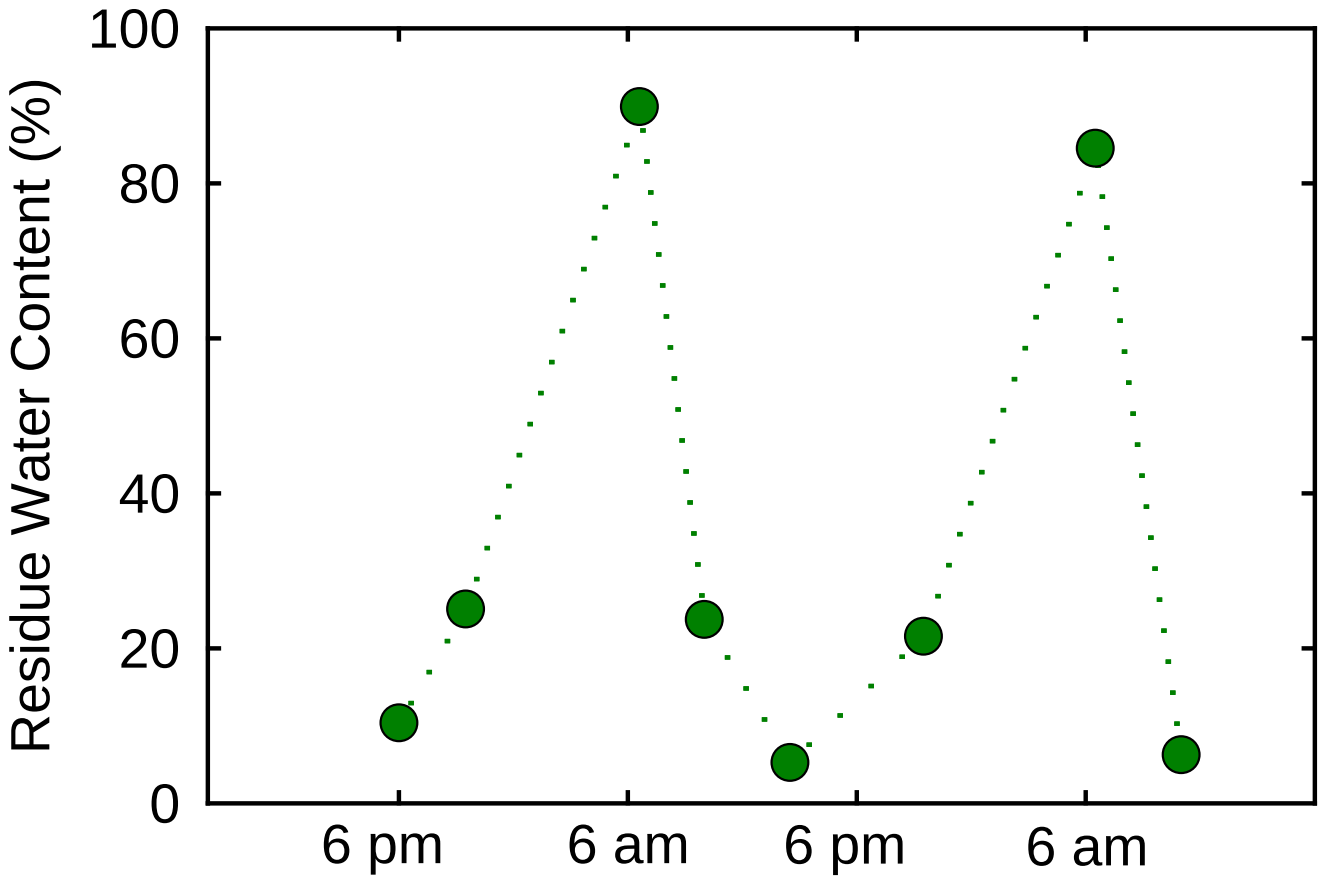
Daily Change in Water Content of Surface Crimson Clover Residue



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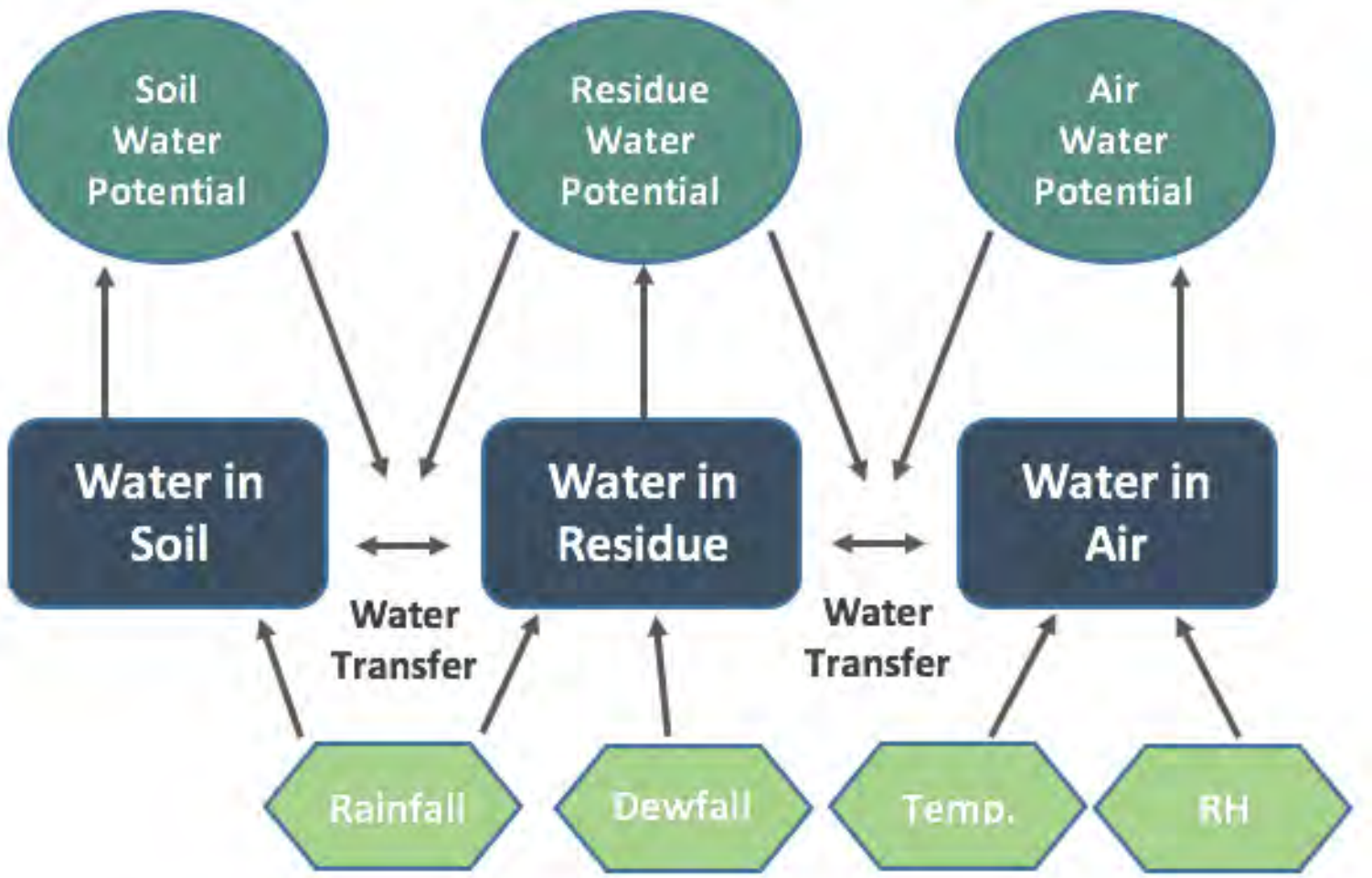
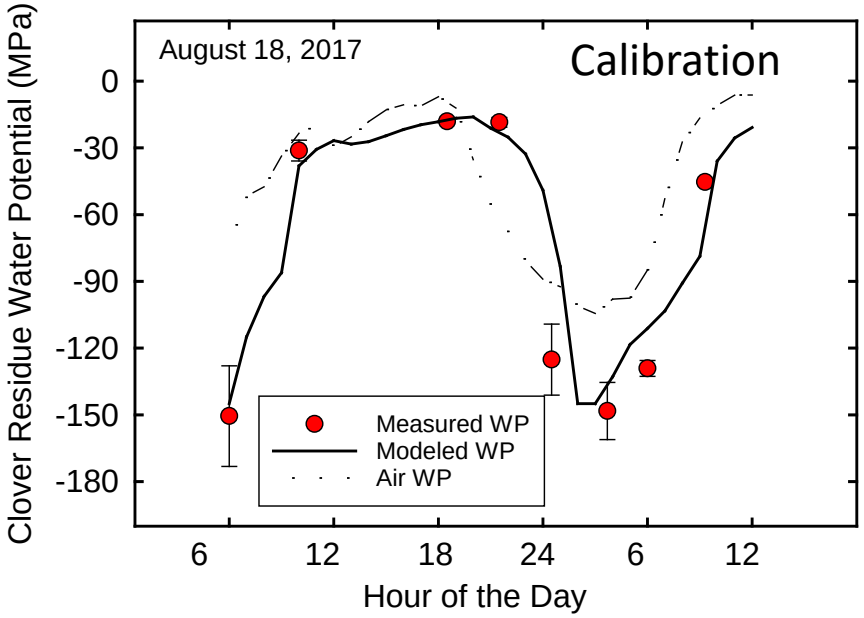
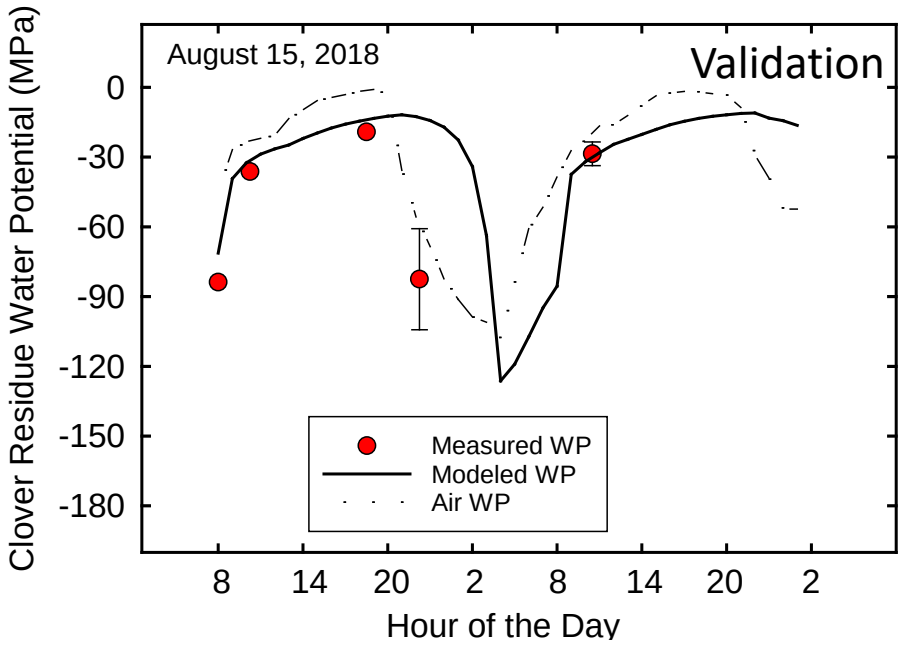
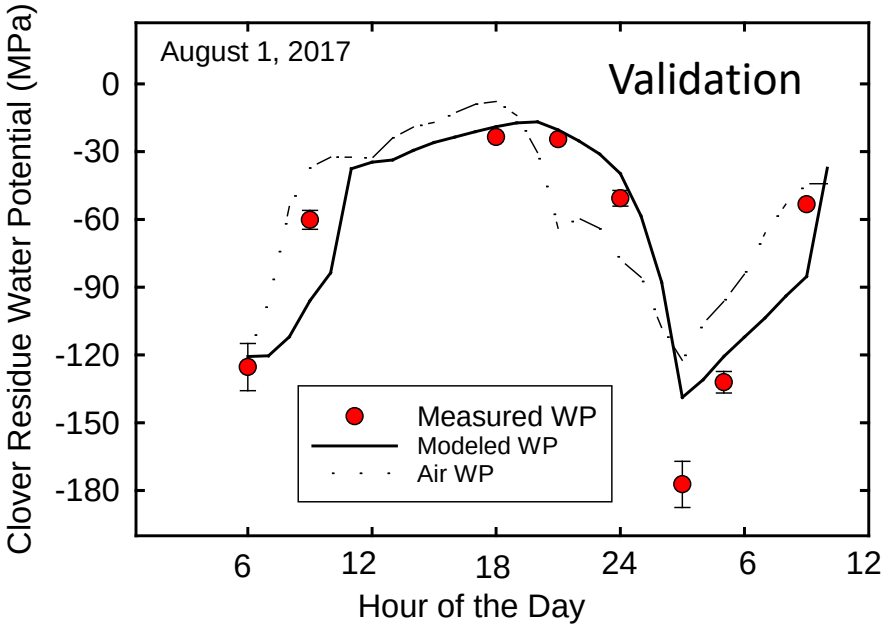
Model of Water Content of Surface Residue

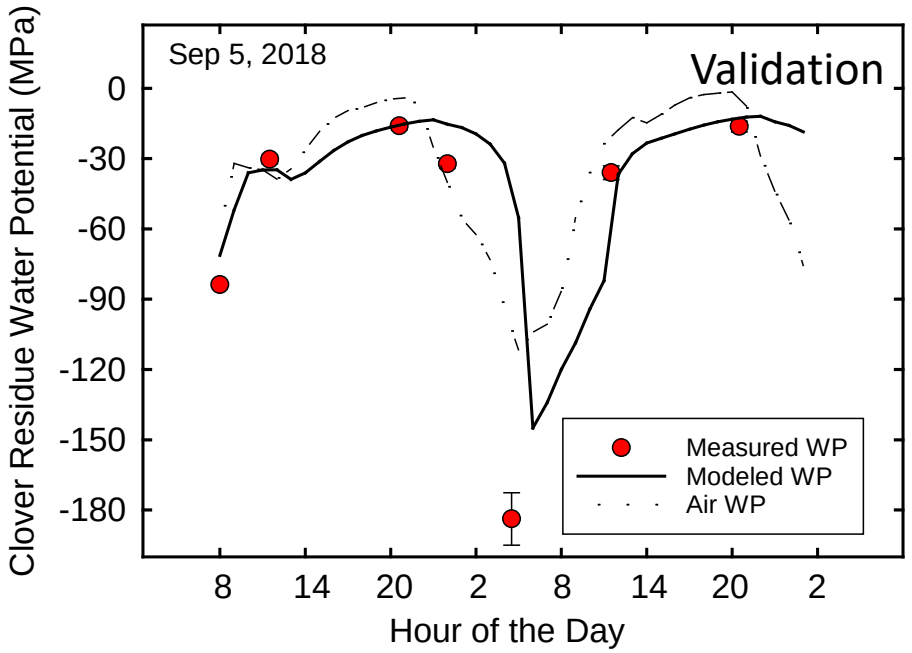


Crimson Clover Residue on the Soil Surface

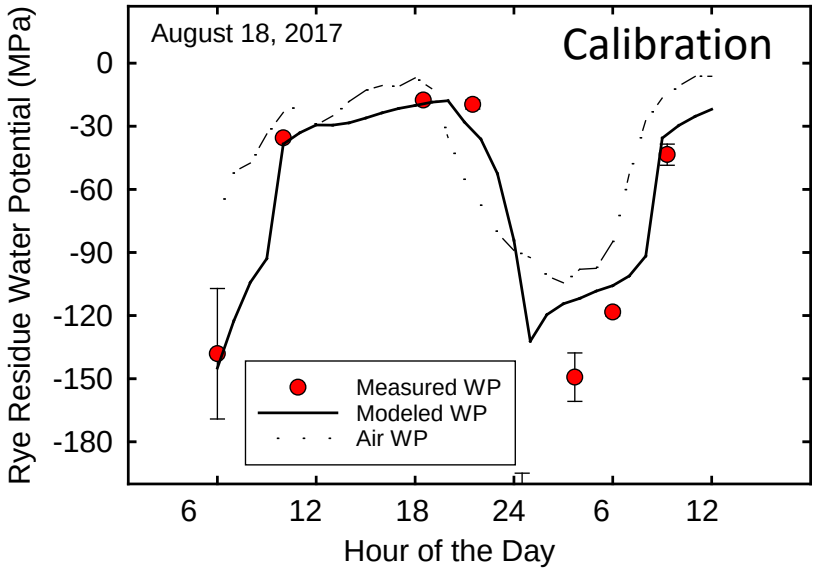


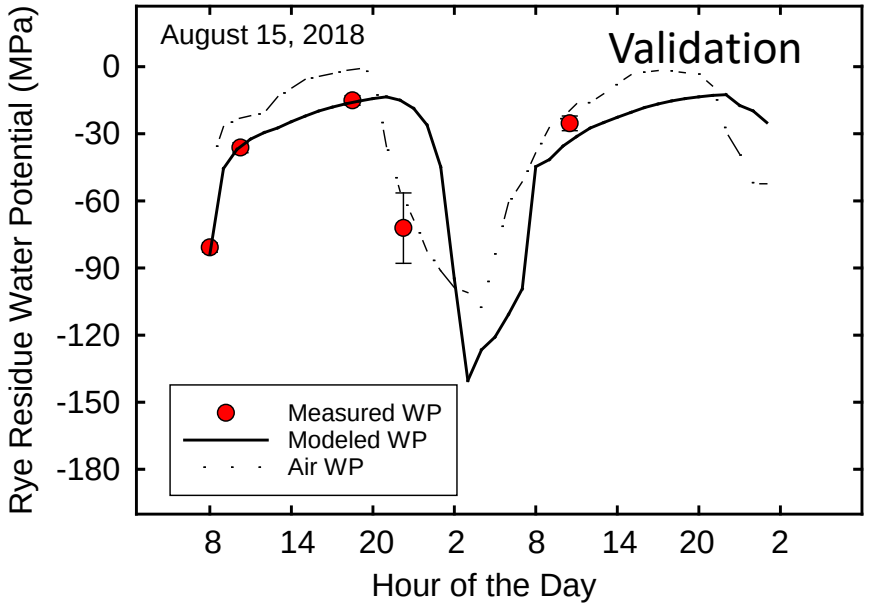


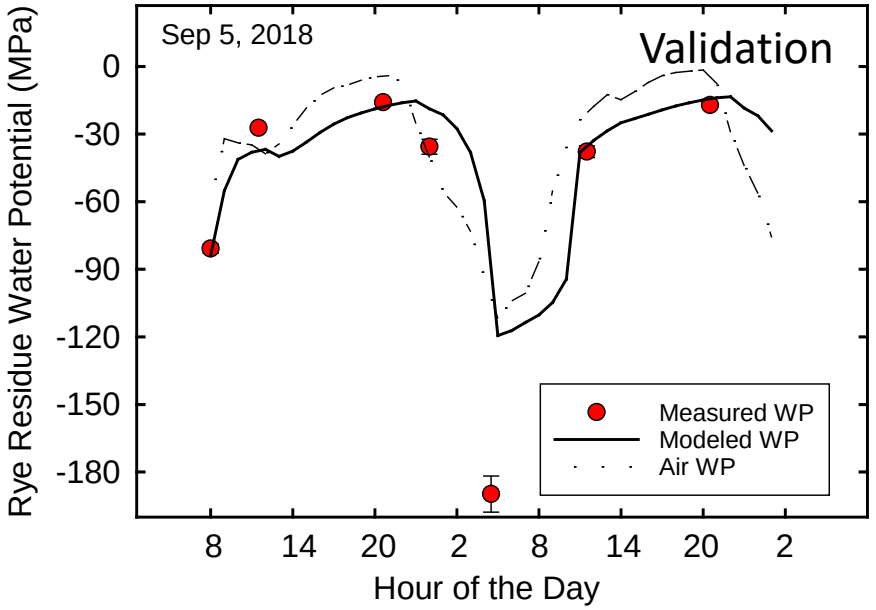




Rye Residue on the Soil Surface







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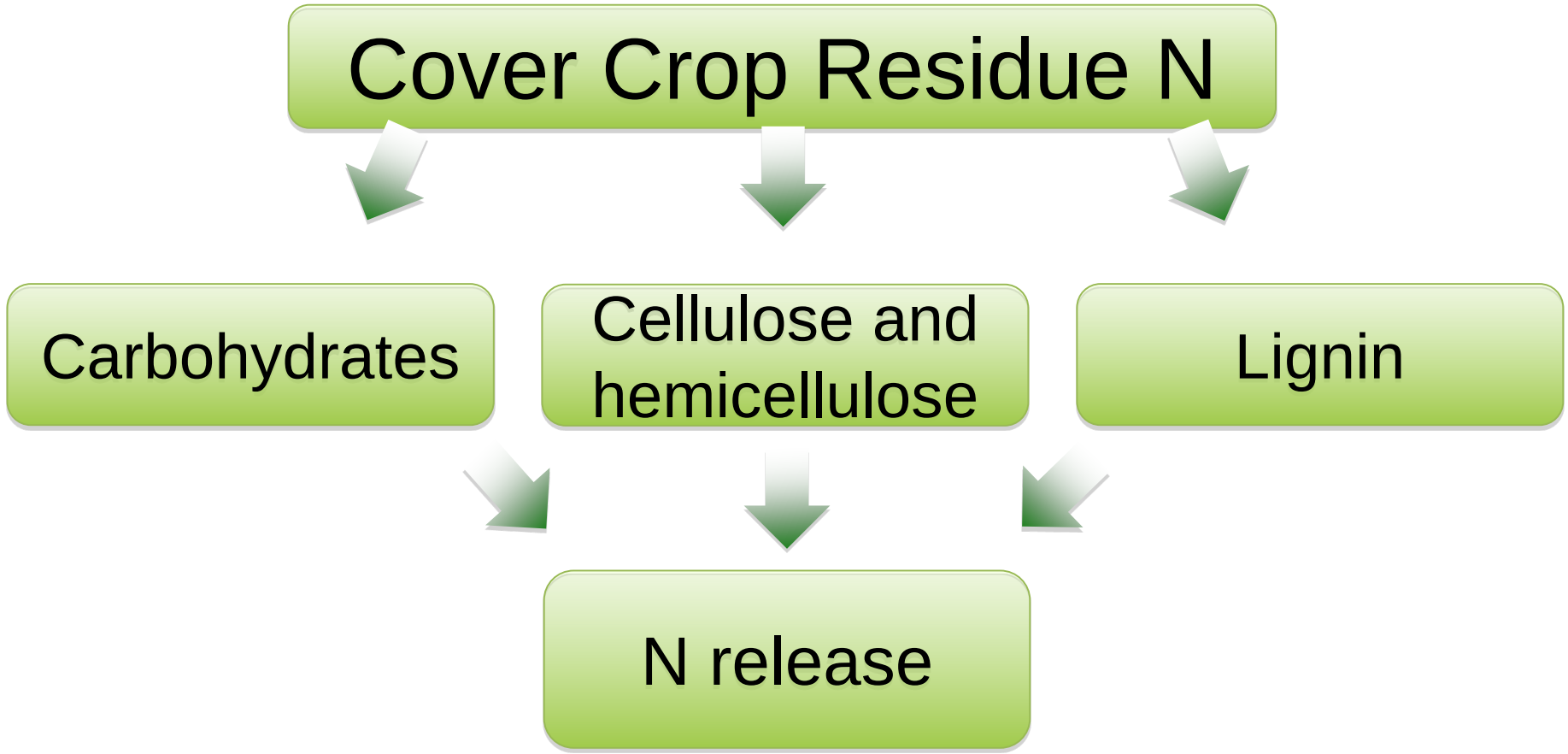
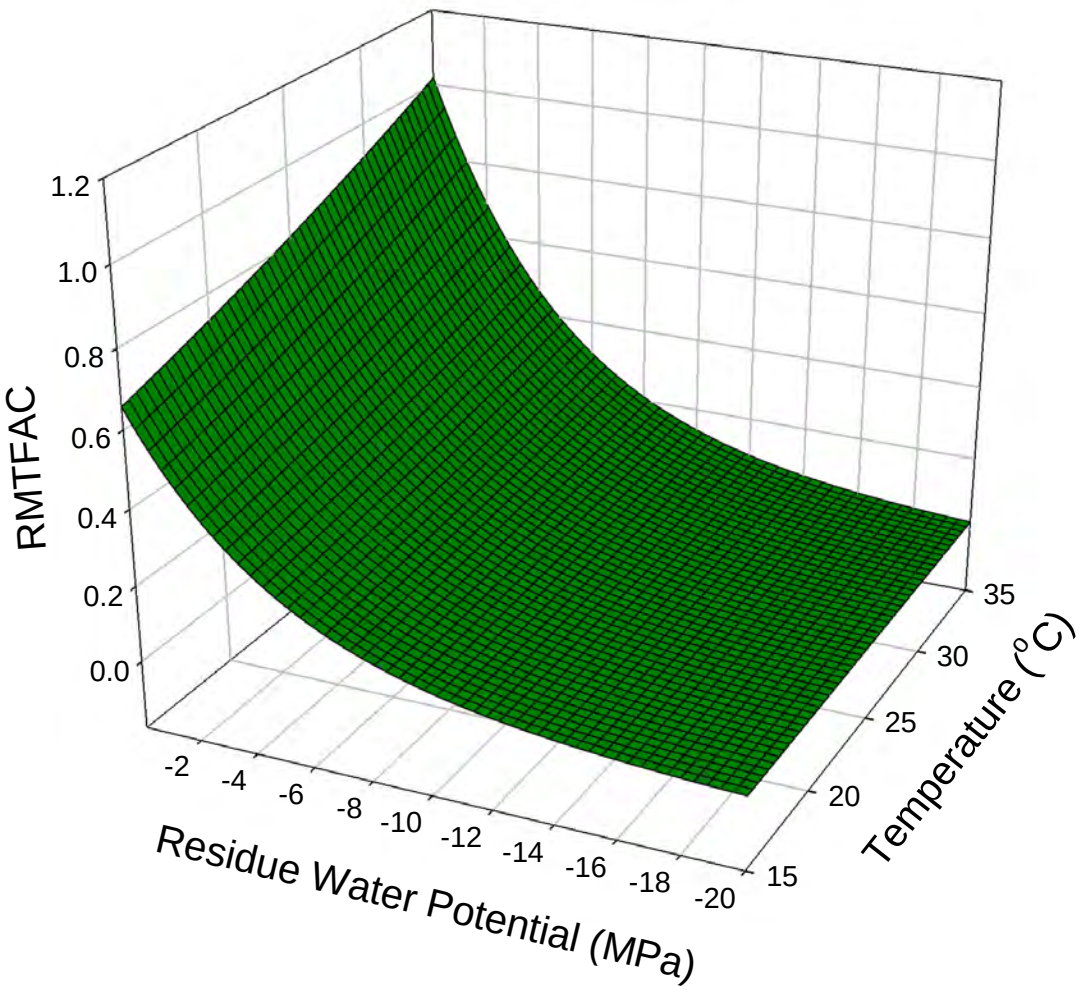
Estimating N Mineralization from Cover Crops



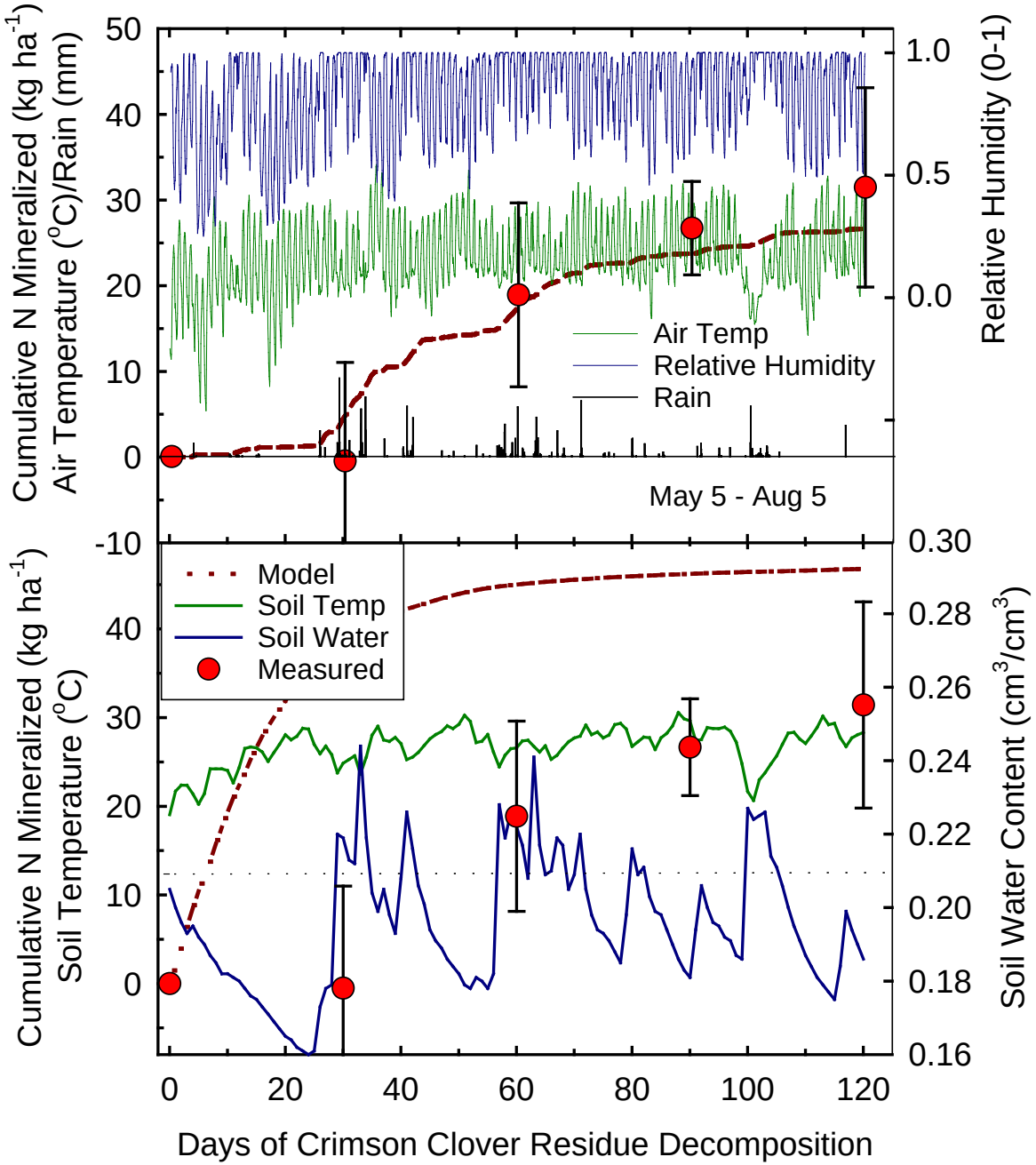
RMTFAC for Crimson Clover Residue

RMTFAC = exp(-0.741356+0.02187*Temp+0.19804*MPa)

R^2=0.99



Thapa et al., 2019


Cumulative N Mineralized (kg ha-1)
Air Temperature (oC)/Rain (mm)
Relative Humidity (0-1)
Air Temp
Relative Humidity
Rain
May 5 - Aug 5
Model
Soil Temp
Soil Water
Measured
Cumulative N Mineralized (kg ha-1)
Soil Temperature (oC)
Soil Water Content (cm3/cm3)
Days of Crimson Clover Residue Decomposition

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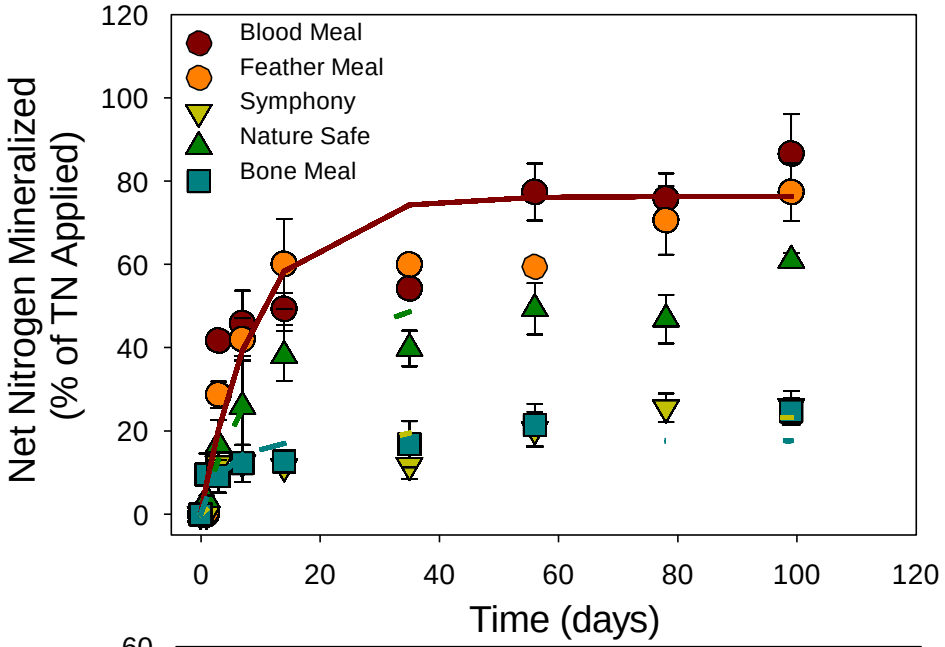
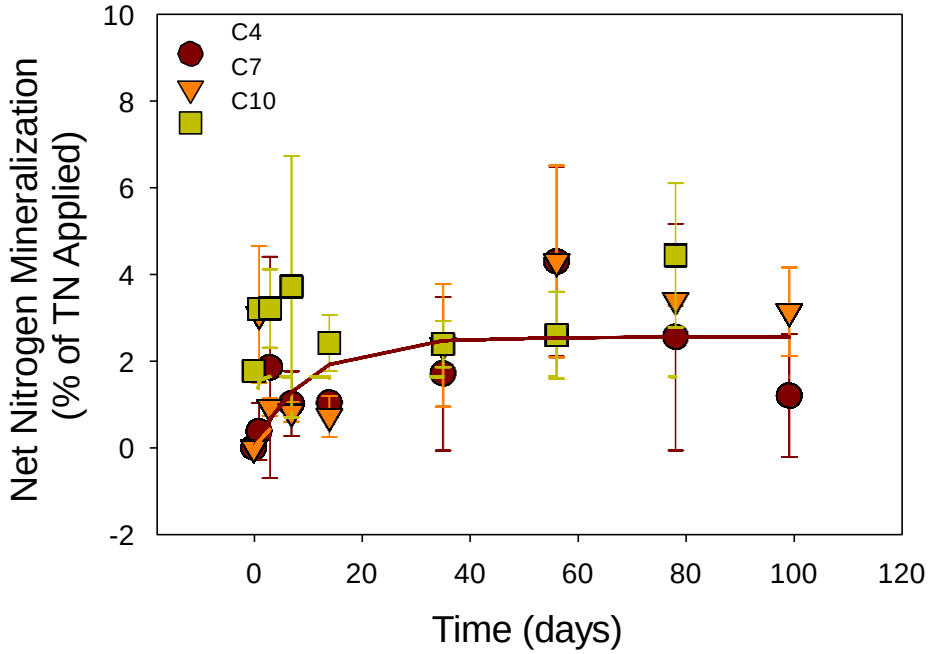
- Organic producers need estimates of N mineralized from organic fertilizers
- 50+ organic fertilizers were evaluated for kinetics of N mineralization

	Total C	Total N	C:N
	g kg^{-1}		
Poultry Litters			
PL1	254	31	8.1
PL2	366	37	10.0
PL3	346	44	7.9
PL4	376	36	10.3
PL5	396	47	8.4
PL6	318	39	8.1
PL7	347	37	9.4
PL8	420	52	8.0
PL9	338	42	8.0
PL10	282	43	6.6
PL11	344	40	8.7
PL12	387	46	8.5
PL13	405	41	9.9
PL14	428	55	7.8
PL15	374	39	9.6
Composts			
C1	337	31	10.8
C2	524	41	12.8
C3	235	8	27.8
C4	171	16	10.9
C5	298	3	103.5
C6	266	16	17.0
C7	281	25	11.0
C8	507	11	46.1
C9	229	10	23.0
C10	200	13	14.9
C11	348	19	18.0
Fertilizers			
Sodium Nitrate	3	153	0.0
Blood Meal	548	144	3.8
Feather Meal	552	154	3.6
Symphony	358	53	6.8
Fish Meal	449	113	4.0
Crab Shell	262	48	5.5
Alfalfa Meal	477	30	16.1
Harmony	332	54	6.2
Fish Mix	375	82	4.6
Mustard Seed	541	63	8.6
Veggie Mix	396	76	5.2
Soybean Meal	471	71	6.7





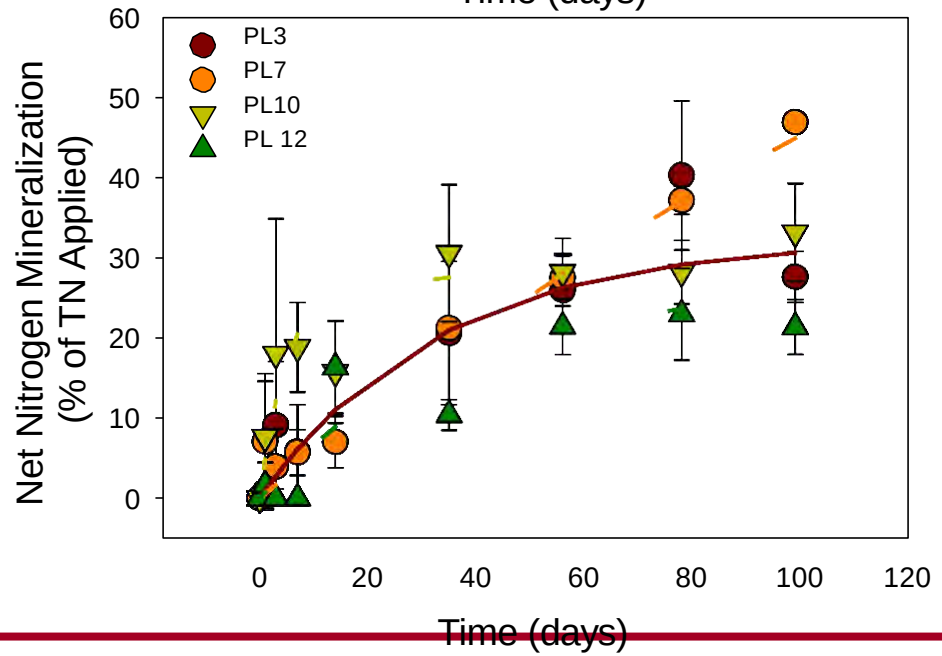
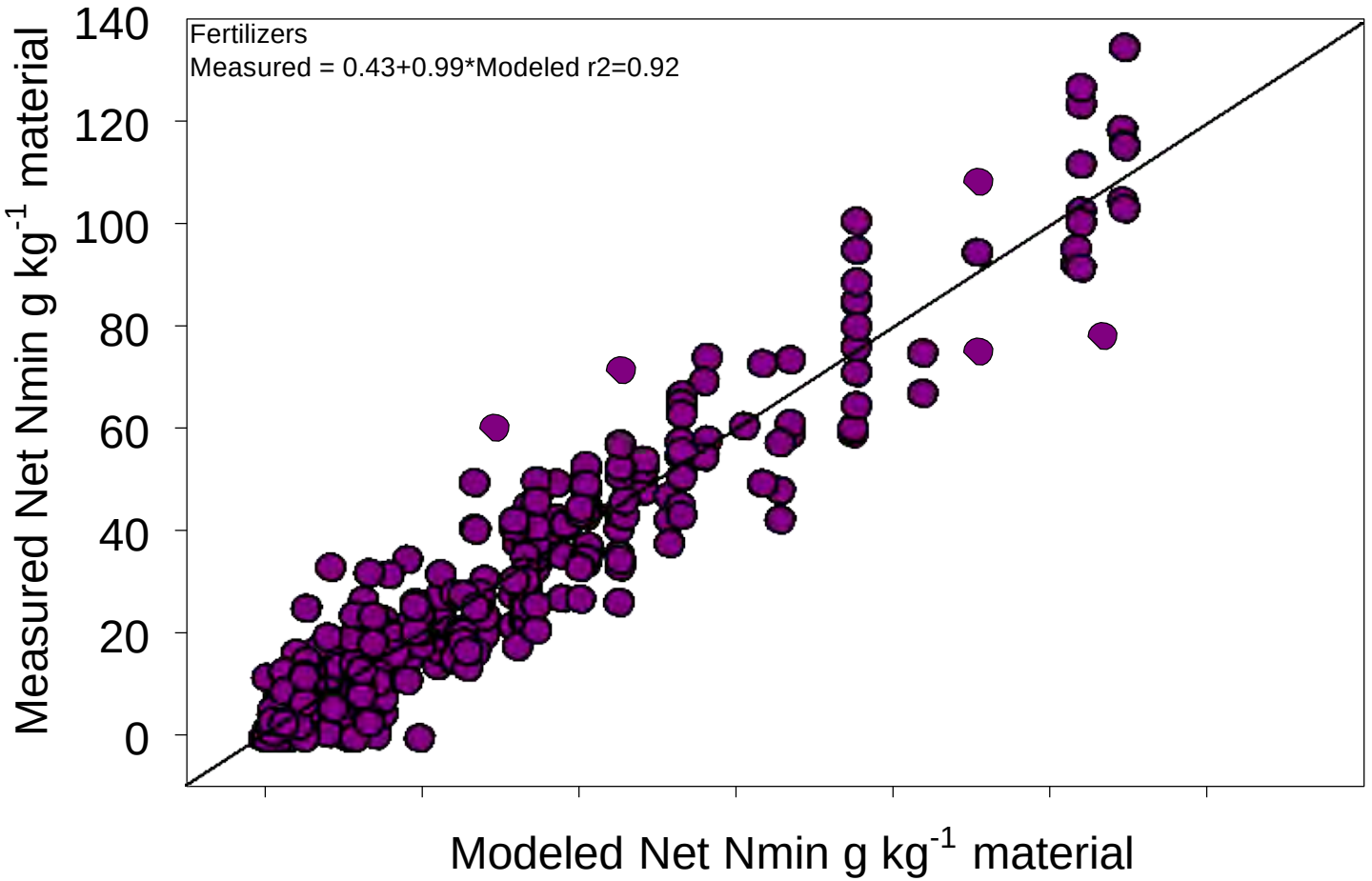


Fig. 1. Net N mineralization as a percent of the total N applied for selected fertilizers, poultry litters, and composts use in this study.

Modeled versus measured values for net N mineralized



ORGANIC FERTILIZER NITROGEN AVAILABILITY CALCULATOR

Welcome

Organic producers use a wide variety of nitrogen fertilizers from commercial products (made from animal byproducts and seed meals) to manures and composts. These organic N sources must undergo mineralization to become plant available inorganic N. How quickly these organic N sources mineralize depends on the amount of microbial activity, which also depends on the nitrogen concentration of the organic N source and local weather conditions. **This calculator aids in estimating the N available from different organic fertilizers, composts, and poultry litters based on a laboratory analysis of your N sources and your local weather station data, allowing you to make better decisions on when and how much of the organic N sources to apply.**

What to Expect from the Nitrogen Calculator

This calculator will aid in predicting how much nitrogen will be available to your crop and when it will be available from the application of poultry litter, composts, and/or organic N fertilizers. Using data collected from the SSARE grant, over 50 materials were used to develop the calculator. By selecting the weather station closest to your farm, the calculator will give estimates of the release of nitrogen over the growing season, which can be combined with nitrogen credits from our cover crop calculator to estimate the N available to your crop.

Instructions

Using the calculator tab located in the bar above, answer questions in order. Please feel free to use the contact tab for any help with the calculator.

ORGANIC FERTILIZER NITROGEN AVAILABILITY CALCULATOR

Calculator

Is this information Correct? If not, click a data point to edit it.

- Weather Station: **Horticulture Research Farm**
- Target Rate of Nitrogen: **100** lbs N/acre
- Crop: **Lettuce**
- Planting Date: **05/01/2019**
- Days to Harvest: **40**
- Nitrogen Credit From Cover Crop: **15** lbs N/acre

- Poultry Litter: **5** lbs/acre
- N-P-K: **2.9-2.6-2.8**
- Date Applied: **03/19/2019**
- Incorporated: **NO**

- Organic Fertilizer: **Feather Meal**
- N-P-K: **13-0-0**
- Application Rate: **10** lbs/acre
- Date Applied: **04/10/2019**

- Second Organic Fertilizer: **Blood Meal**
- N-P-K: **12-0-0**
- Application Rate: **5** lbs/acre
- Date Applied: **04/10/2019**

- Third Organic Fertilizer: **Cottonseed Meal**
- N-P-K: **6-3-2**
- Application Rate: **2** lbs/acre
- Date Applied: **04/10/2019**

- Inorganic Fertilizer
  N-P-K: **3-1-0**
- Application Rate: **4** lbs/acre
- Date Applied: **03/15/2019**

- Second Inorganic Fertilizer
  N-P-K: **1-5-0**
- Application Rate: **2** lbs/acre
- Date Applied: **03/15/2019**

- Third Inorganic Fertilizer
  N-P-K: **0-0-3**
- Application Rate: **1** lbs/acre
- Date Applied: **03/15/2019**

NO RETURN TO PREVIOUS

RUN MY MODEL

ORGANIC FERTILIZER NITROGEN AVAILABILITY CALCULATOR

Calculator

Total N Applied: 100 lbs/acre
Total P Applied: 50 lbs/acre
Total K Applied: 75 lbs/acre

In addition to the amount of available N released from your cover crop, when it is released is important to guide your N management.

This graph will give you an idea about when the N is being released. Days after cover crop termination is on the horizontal axis and amount of available N on the vertical axis. To determine how much available N will be available at a given time, follow a vertical line up from a date to the plotted curve.

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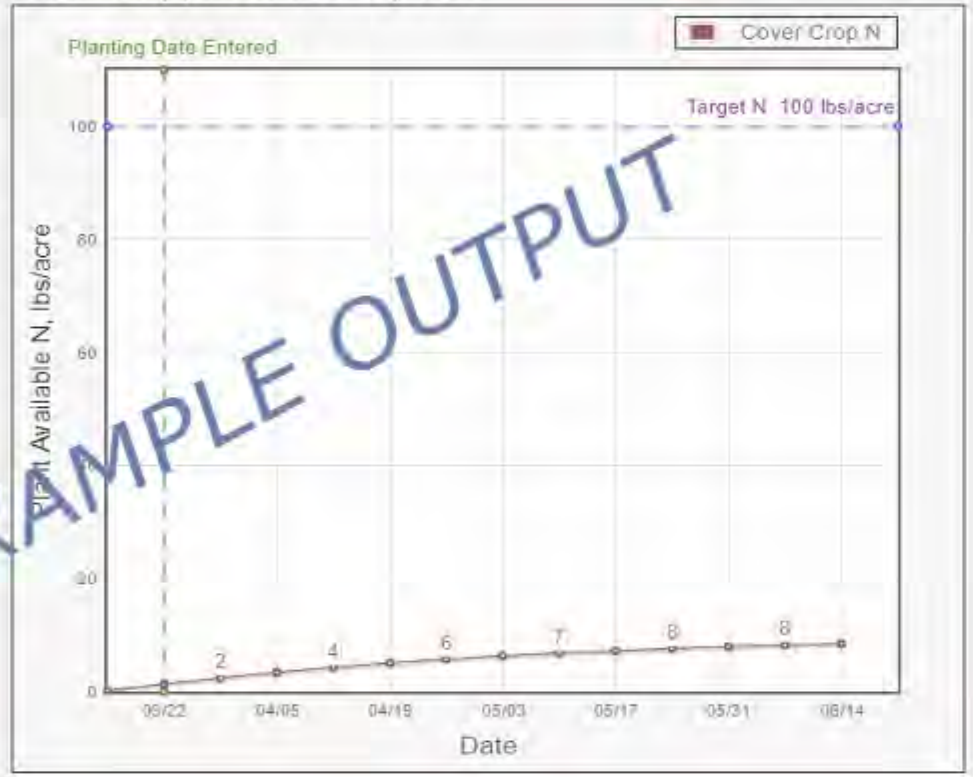

PREVIOUS

Summary

- Residues of legumes and early-stage cereals can supply significant amounts of N to the subsequent crop.
- A web model that uses residue quality, soil moisture, and temperature can estimate the amount of N released from ***incorporated*** cover crop residues.
- Model is available at: **aesl.ces.uga.edu/mineralization**.
- Work is in progress to add the capability to estimate N release from ***surface residues*** taking into account air temperature and relative humidity.
- A web model will be available to estimate the amount of N released from organic fertilizers (driven by temperature and water content).

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