Controlled Release Nitrogen Fertilizers for Agriculture

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Smarter Ways To Grow™

Presentation Overview

- Fundamentals of Controlled Release Fertilizers (CRFs)
- How can they be used in CA/AZ?

How do they work?

What are the benefits?

How can we increase nitrogen use efficiency?

- Apply 4R nutrient stewardship
  - Apply the correct fertilizer source in the right amount as close as possible to when and where the crop needs it
  - Understand the relationship between irrigation management and nutrient management to control N losses
  - Use enhanced efficiency fertilizers as sources when/where appropriate

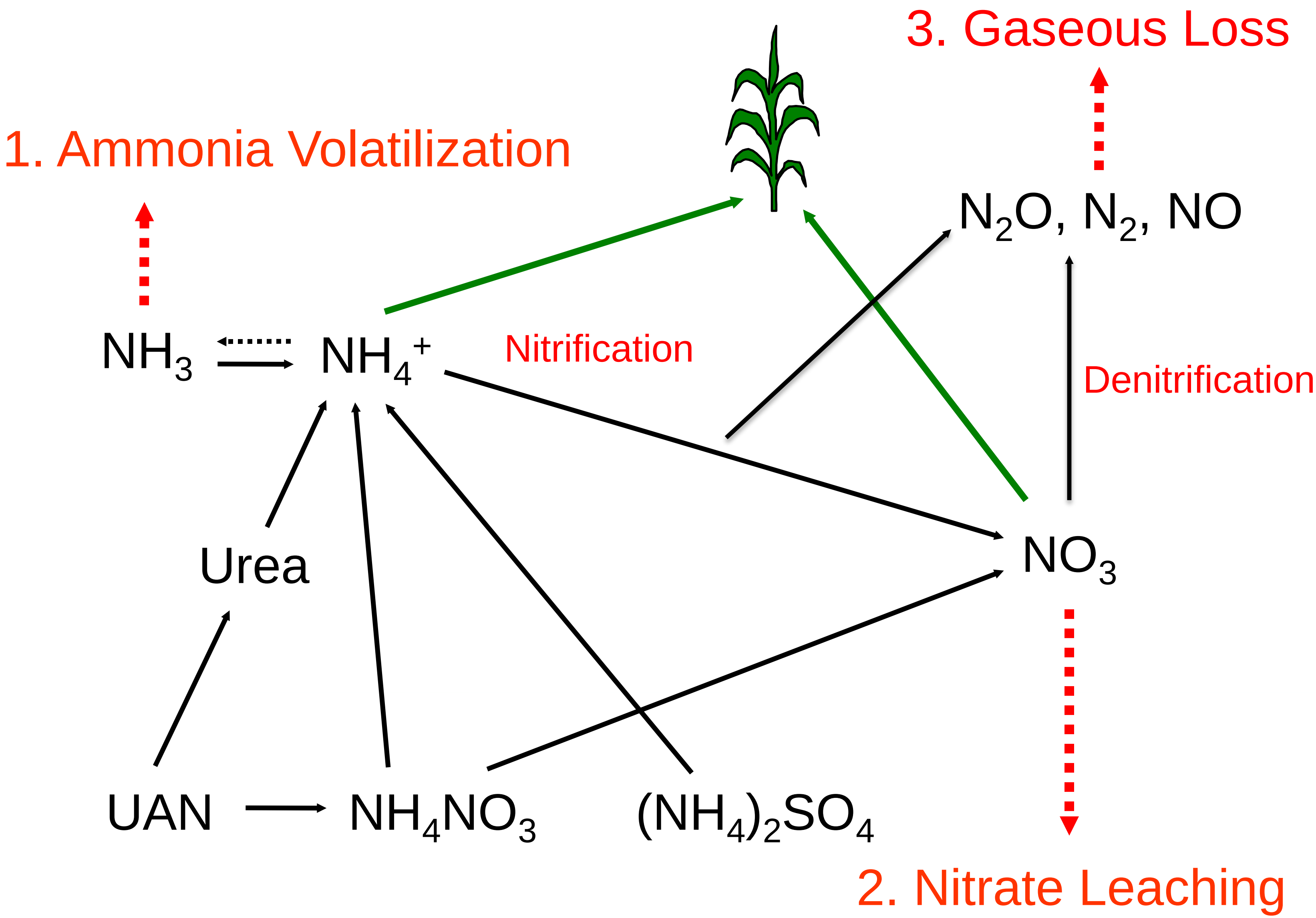
Objective is to satisfy crop demands for optimum growth while avoiding nitrogen losses to the environment

Why use enhanced efficiency fertilizers (EEFs)?

- Growers may have to reduce N rates
- Cannot use excess N as a form of insurance against N loss
- N inputs must be budgeted according to nutrient management plans (science)
- Under a tight N budget (working on the edge of sufficiency), N losses can have a significant impact on yield or quality
- EEFs help to extract the most from the N that is applied by helping to control N losses

EEFs are beneficial to growers and the environment

N Loss Mechanisms



Enhanced efficiency nitrogen products

- **Inhibitors (liquids and solids)**
  - Chemicals that are added to standard fertilizers
  - Examples: Agrotain, Agrotain Plus, N-serve, Instinct
- **Slow Release Fertilizers (SRFs)**
  - Urea reaction products (liquids and solids)
  - Sulfur coated urea
- **Controlled Release Fertilizers (CRFs)**
  - Polymer-coated granular fertilizers

Commercially available EEFs

Controlled Release (Polymer Coated) Fertilizers

Agrium Advanced Technologies	ESN, POLYON, DURATION
everris.	OSMOCOTE
Haifa NutriTech (HNT)	MULTICOTE
CHISSO-ASAHI	NUTRICOTE, MEISTER
SHAW'S / KNOX	SURFKOTE, XRT
FLORIKAN	FLORIKOTE

SLOW RELEASE (UREA FORMALDEHYDE, METHYLENE UREA)

Agrium Advanced Technologies	NITROFORM, NUTRALENE, BCMU
Lebanon Seaboard	METHEX, MESA
sadepan chimica	SAZOLENE
JOHN CLEVELAND	GENERIC METHYLENE UREA

SLOW RELEASE (PC SULFUR COATED UREA)

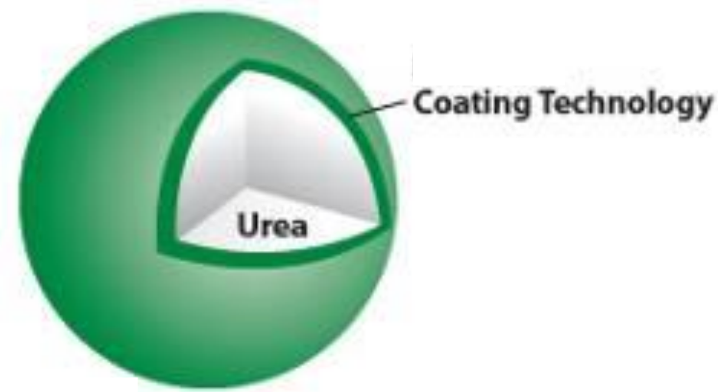
Agrium Advanced Technologies	XCU
TurfCare supply corp.	POLY-PLUS, LESCO
everris.	POLY-S

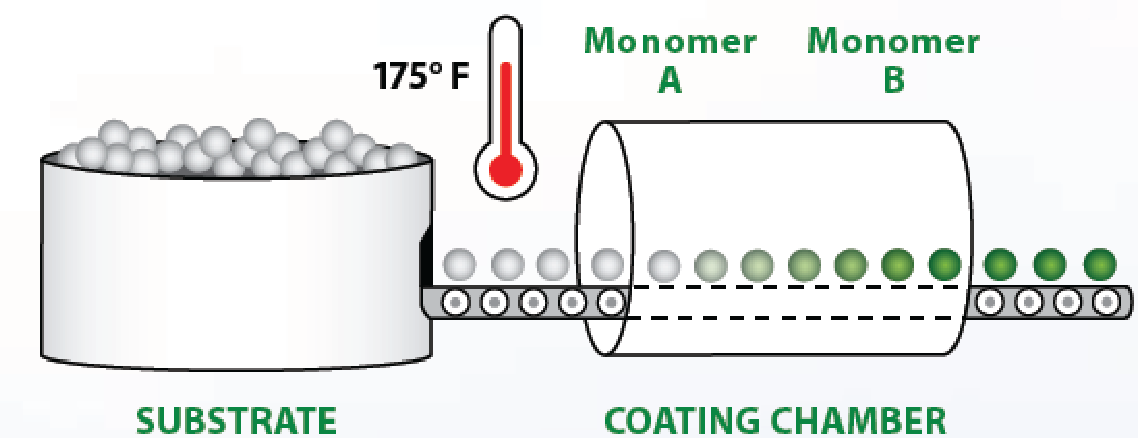
INHIBITORS (Not controlled or slow release)

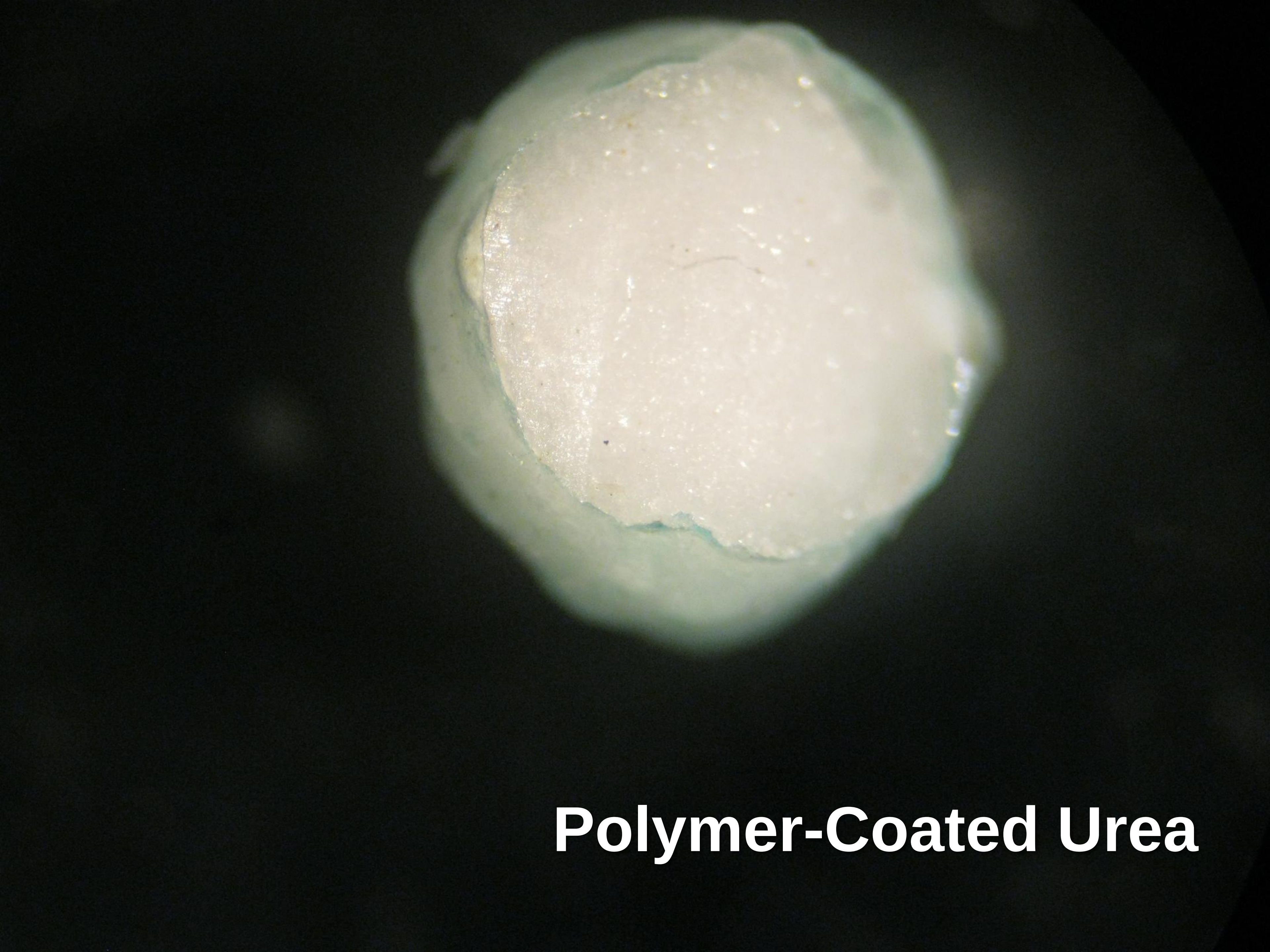
KOCH	AGROTAIN, SUPER-U, UMAXX, UFLEXX
DOW AGROSCIENCE	N-SERVE, INSTINCT
COMPO	ENTEC (DMPP)

Manufacturing of Polymer-Coated Plant Nutrients

- Reactive Layers Coating (RLC)
- Thin polymer coatings
- Continuous throughput
- Economy of scale







Polymer-Coated Urea

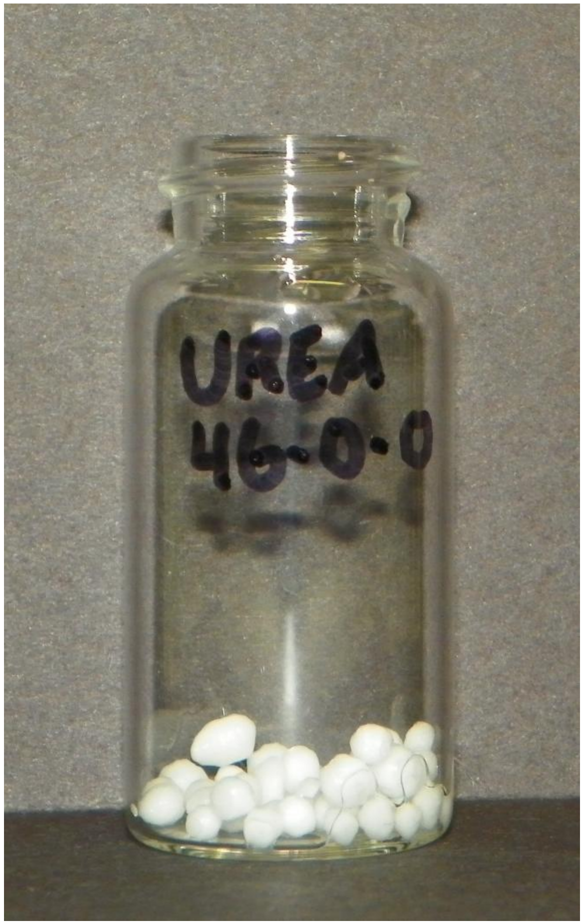
Difference between standard and controlled release nitrogen fertilizers

- Standard nitrogen fertilizers become 100% exposed to soil processes when applied
  - Examples include urea (46-0-0), ammonium sulfate (21-0-0), ammonium nitrate (34-0-0), and calcium nitrate (15.5-0-0)

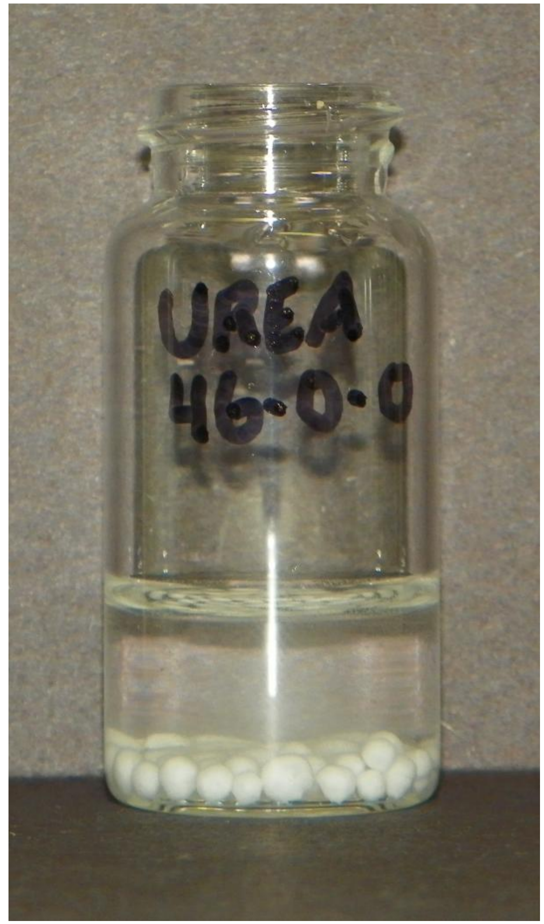
- Controlled release nitrogen fertilizers are standard granular fertilizers encased in a polymer coating

Nutrients held inside polymer coating are protected from soil processes until released

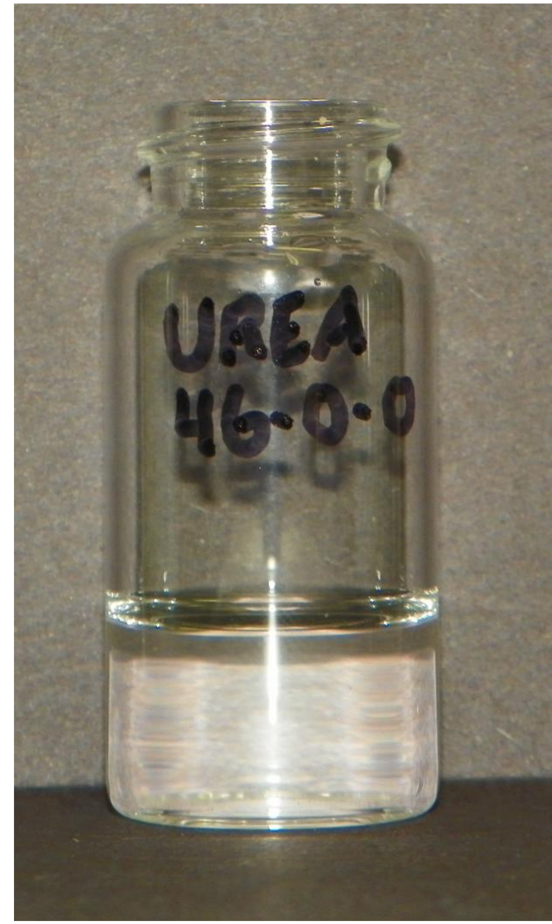
Standard fertilizer dissolving in water



Urea (46-0-0)

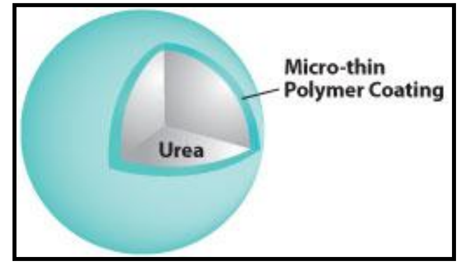


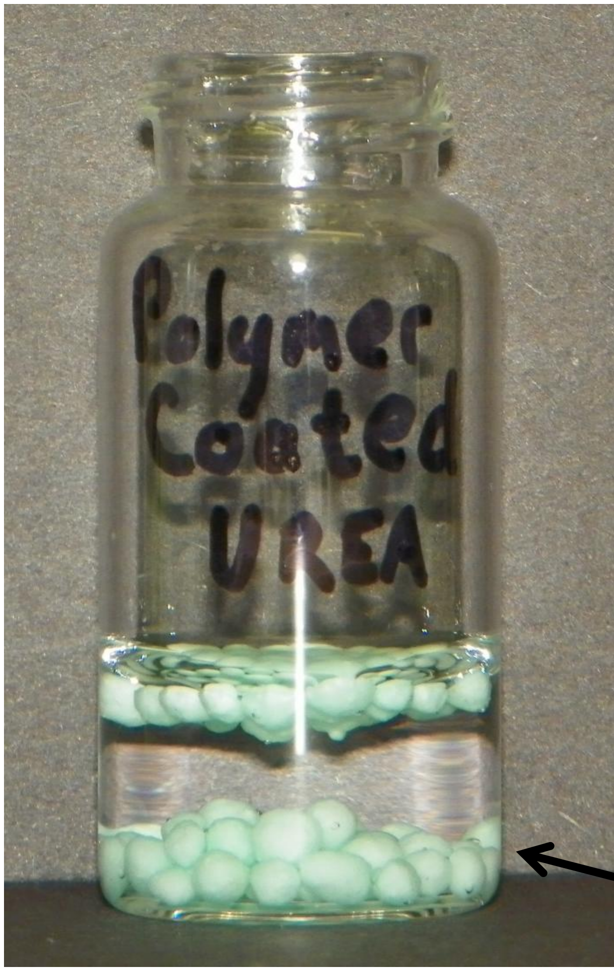
Water added

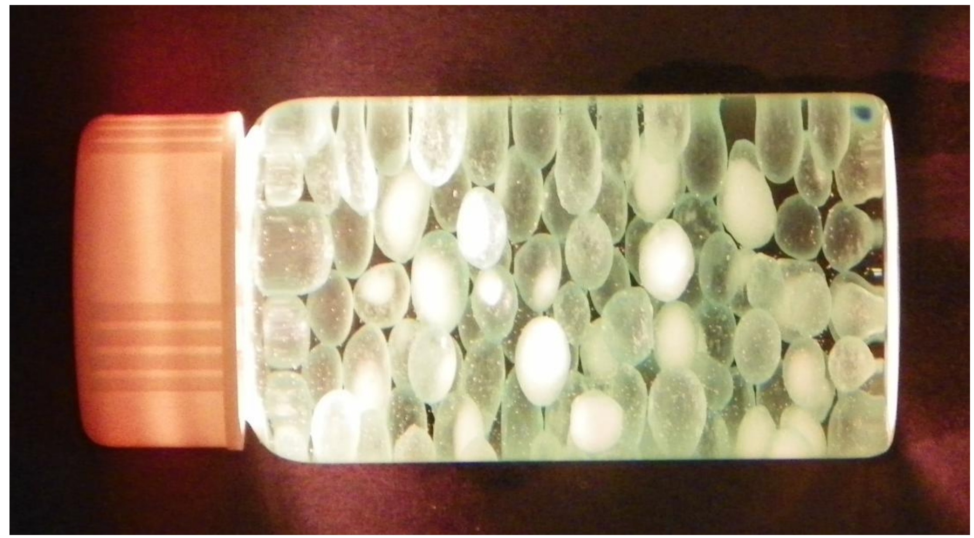


5 minutes later (dissolved)

Polymer-coated urea (PCU) is protected from soil processes





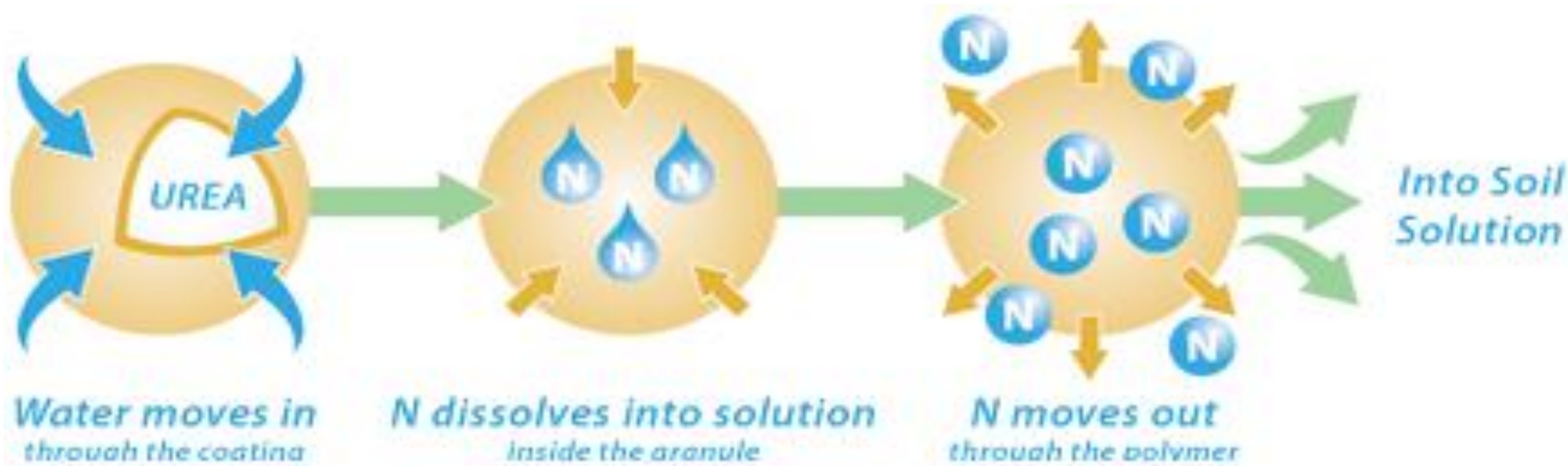


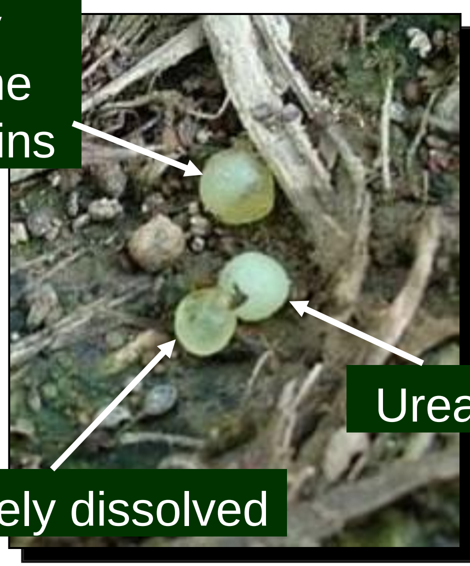
Several weeks after adding water:

- **Dissolved urea is inside coating**
- **Some of the urea inside is not completely dissolved**

Hours after adding water

How Do Polymer-Coated Fertilizers Work?





Factors that control nutrient release from CRF

- **Temperature**
  - Solutes such as urea move through the coating by <u>diffusion</u> which is dependent on temperature

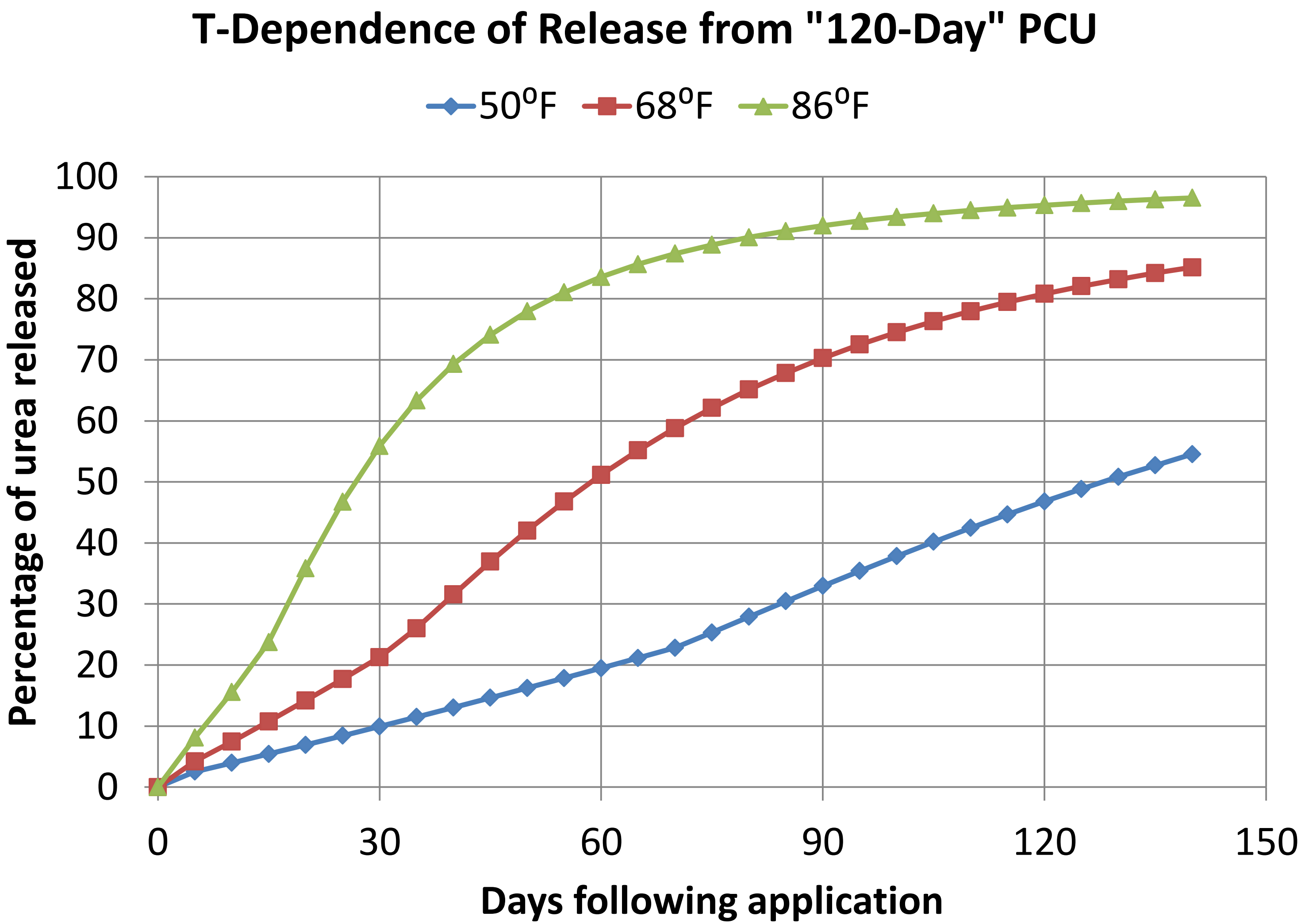
- **Coating weight or thickness (for a given coating chemistry)**
  - As coating thickness increases, the diffusion time through the coating increases

- Moisture is required but is a non-factor for irrigated crops

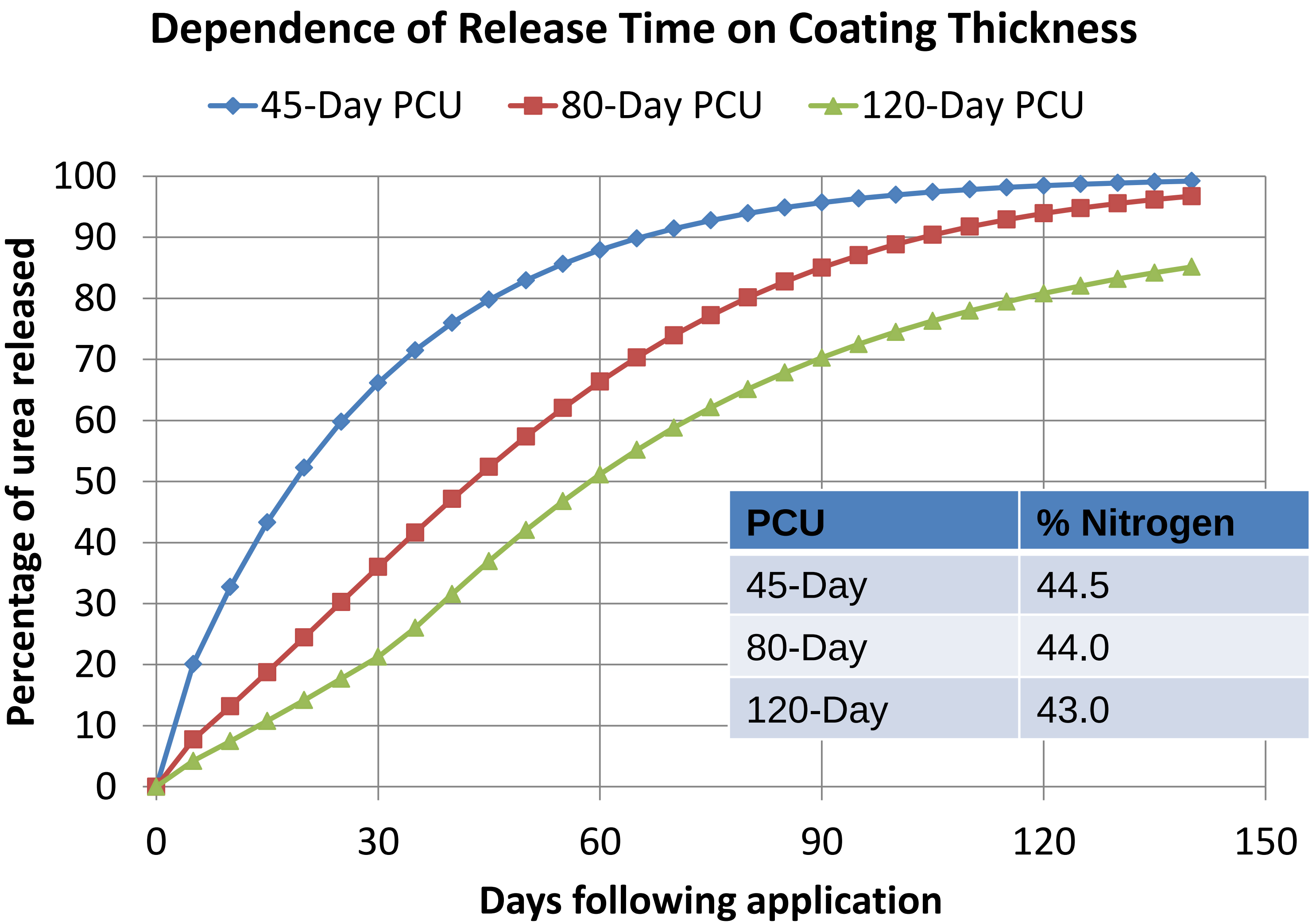
- Unaffected by pH, salinity, aeration, and microbial activity

- Coatings <u>do not</u> "break down" to release nutrients

Effect of temperature on release



Effect of coating weight on release



PCU	% Nitrogen
45-Day	44.5
80-Day	44.0
120-Day	43.0

Benefits from using CRFs

- **Increases N use efficiency**
  - Helps maintain/increase productivity at reduced N rates
  - Reduces N loss to environment

- **Improves nutrient delivery to the plant**
  - Releases nutrients in small increments over time

- **Reduces the number of fertilizer applications**
  - Allows for front-loading of fertilizer N at pre-plant timings
  - Provides flexibility and cost savings in applications

Durability of Coated Fertilizer

- Coatings can be damaged by excessive handling
- Damage occurs from abrasion and impact
- Damage shortens release time and can reduce value
- Application equipment should be in good repair and properly adjusted
- Handle similar to seed
- Follow manufacturer guidelines for handling

When handled properly, CRFs can be used effectively for production agriculture

Market Potential for CRF

- Controlled release fertilizers (CRFs) currently are a negligible percent of worldwide consumption
- Given population and environmental pressures, CRFs will gain significance

World demand for fertilizer nitrogen is increasing and so is demand for nitrogen use efficiency

How can CRFs be used in CA/AZ?

- **Crops**
  - Corn, wheat, rice, cotton
  - Vegetable and melon
  - Leafy Greens
  - Tree & Vine

- **Advantages over standard fertilizers include**
  - Improved performance
  - Increased productivity at reduced N rates
  - Reduced number of applications

California Wheat Producing Counties

California Wheat

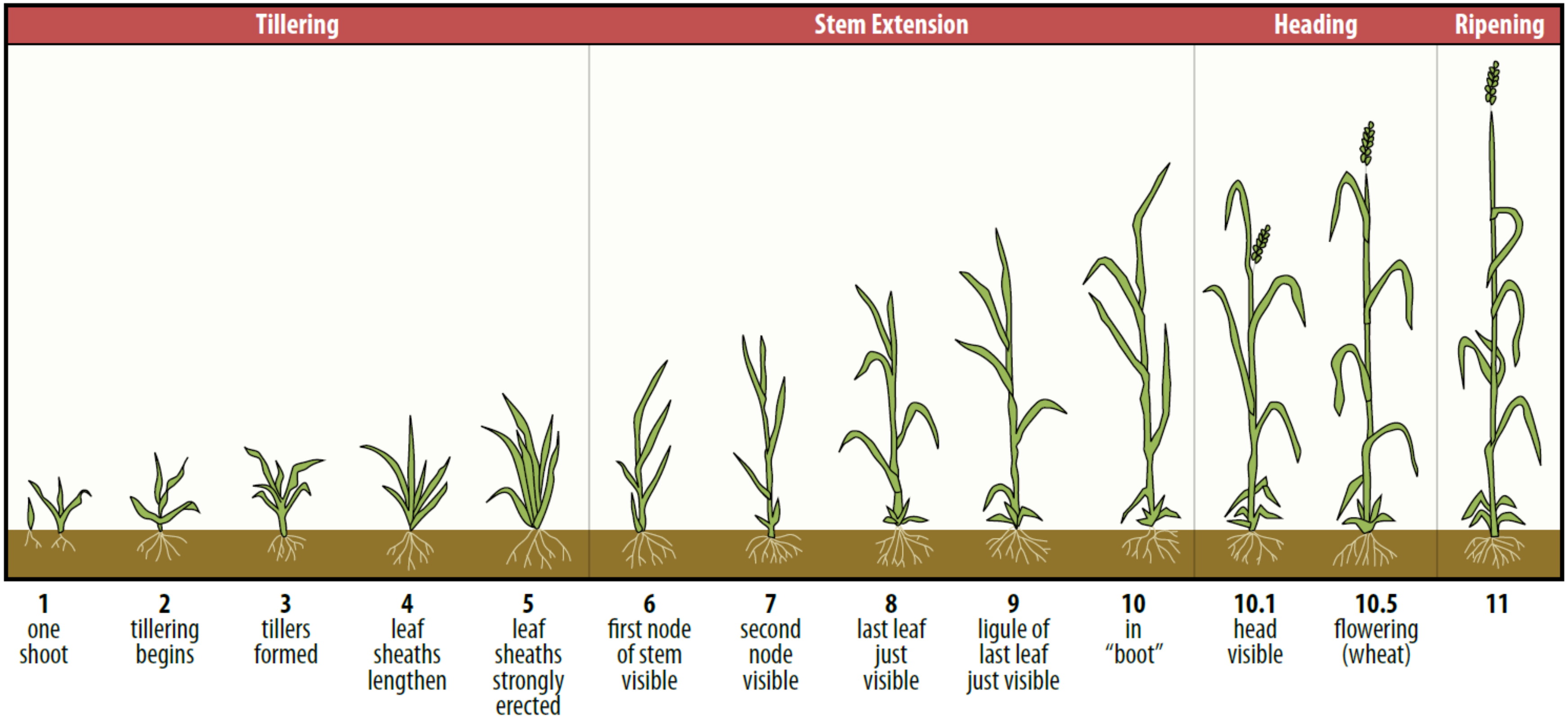
- Spring varieties
- Fall/winter plantings
- Split N applications
- Top-dress and fertigate N
- 3 lb N/100 lb grain
- 4 ton/A crop: 240 lb N/A

Durum Trial (Dr. Tom Thompson, U. Arizona)

	Nitrogen Application Rate (lb N/A)						
Trt No.	Pre-plant	5-leaf	Joint	2-node	Heading	Late flowering	Total N (lb N/A)
1	25 (urea) 30 (MAP)	55	54	50	40	25	279
2	249 (PCU) 30 (MAP)	0	0	0	0	0	279
3	187 (PCU) 30 (MAP)	0	0	0	0	0	217
4	125 (PCU) 30 (MAP)	0	0	59	40	25	279

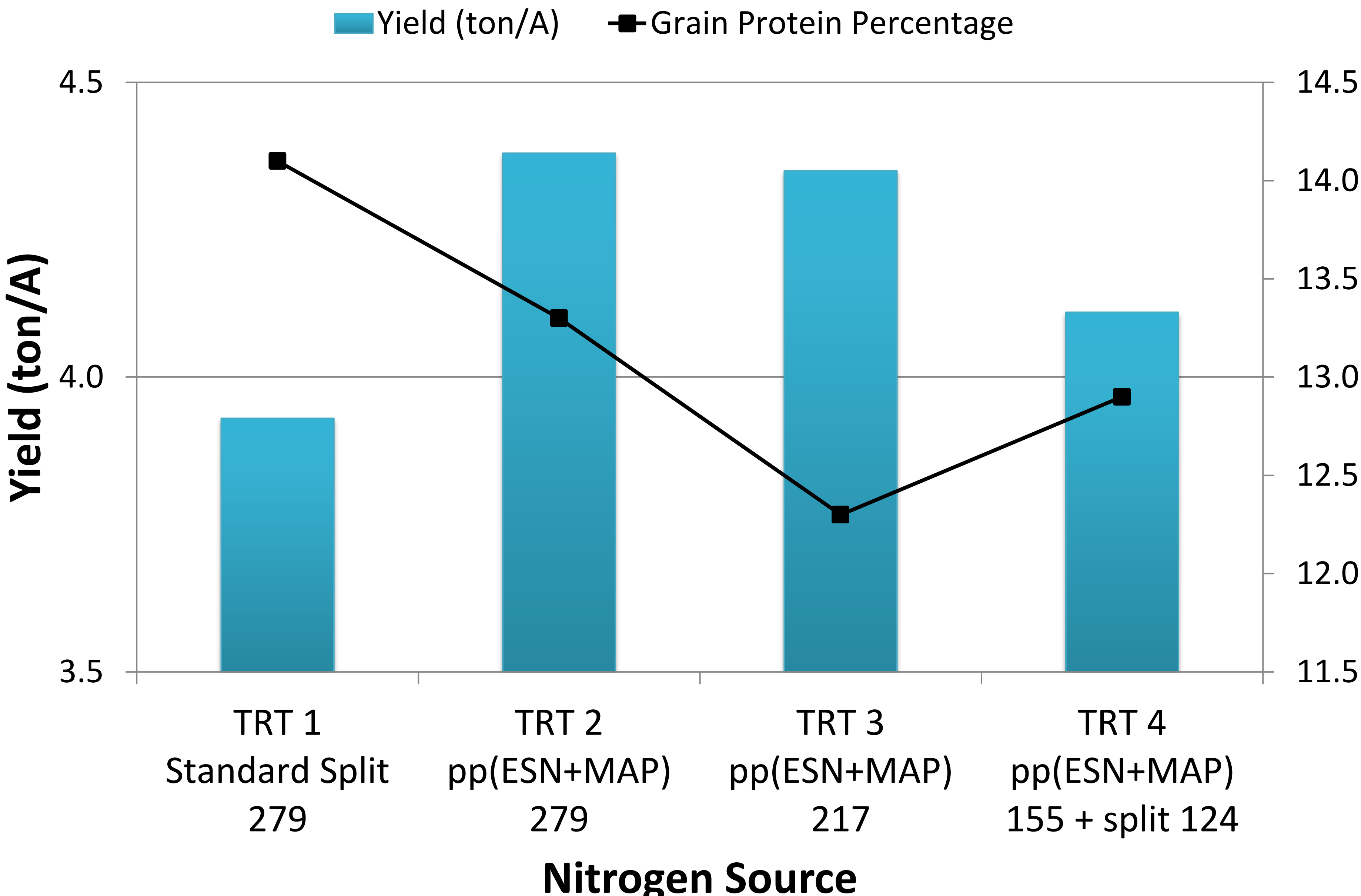
PCU (ESN) vs Standard

Figure 2-1. The Feekes scale of wheat development.



Trt.							
1	55	55	54	50	40	25	lb N/A
2	249/30	0	0	0	0	0	lb N/A
3	187/30	0	0	0	0	0	lb N/A
4	125/30	0	0	59	40	25	lb N/A

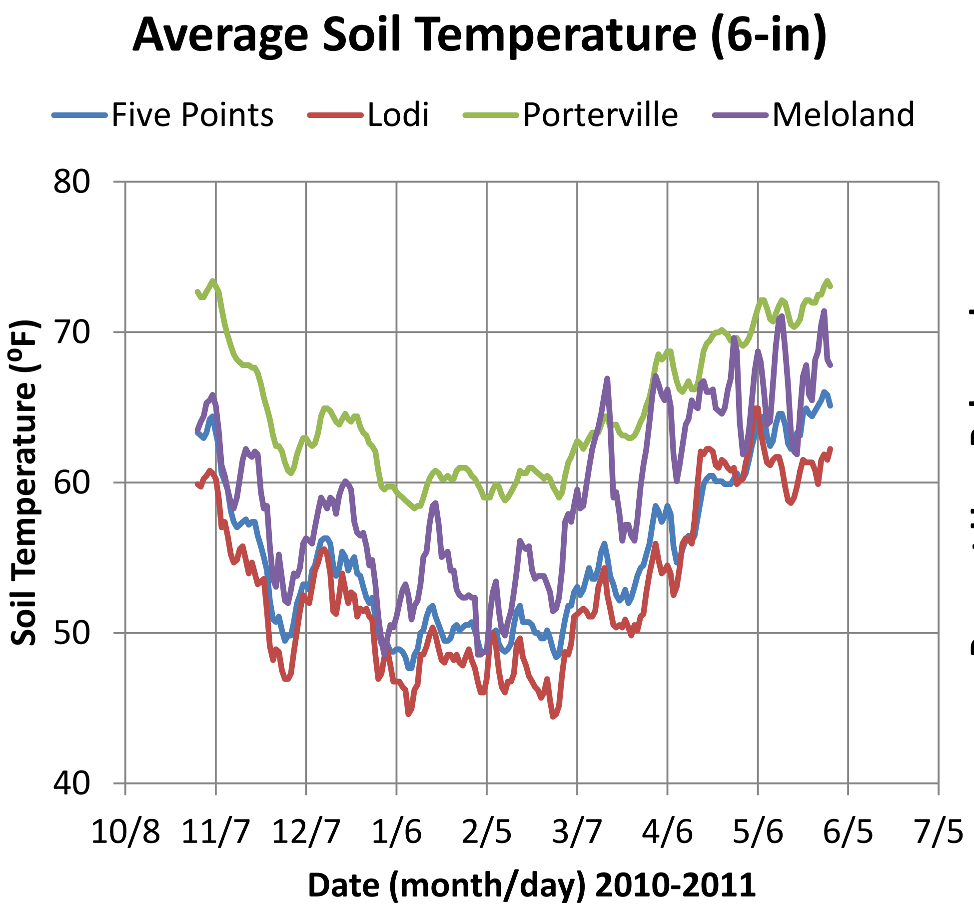
Durum (Maricopa, AZ)

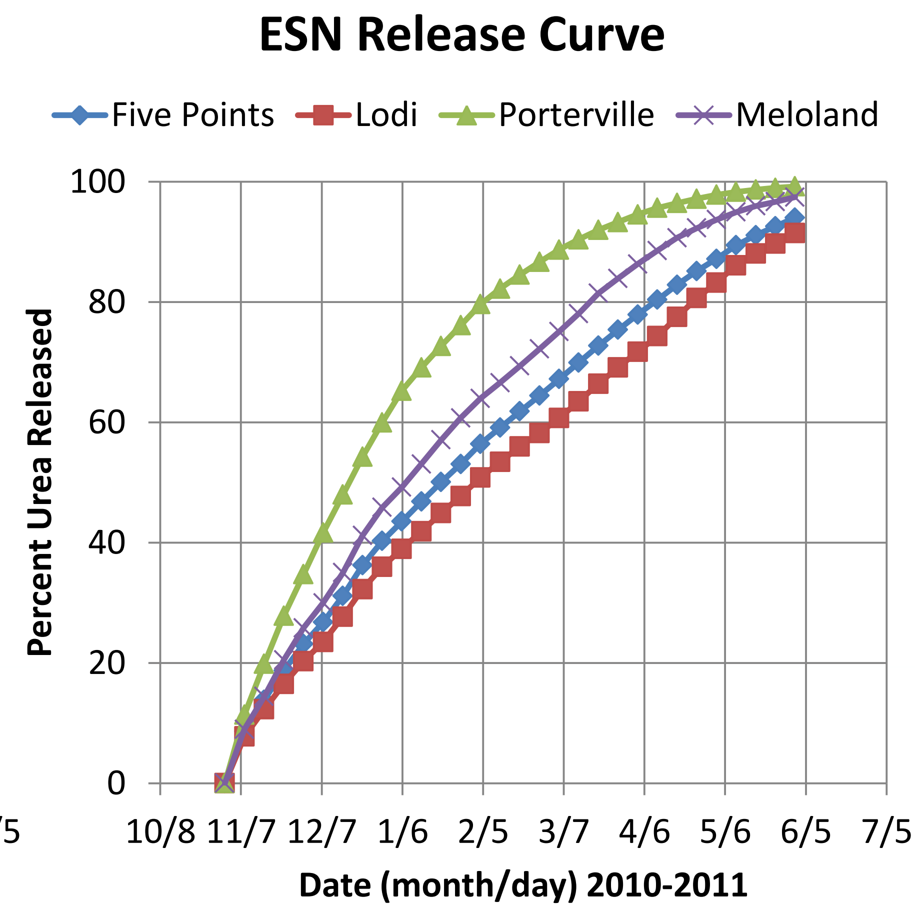


Durum Trial Summary

- Yield and protein differences were not significant
- Results suggest for 4.0-4.5 ton crop:
  - 220 lb N/A as 85/15 PCU-N/Urea-N pre-plant
    - May need extra N (50 lb/A) in pre-plant application for stubble decomposition
  - 50 lb N/A as standard fertilizer at flowering
- Ballpark economics (+$0.20-0.30/lb N over cost of urea)
  - $37-56/A increase over urea (187 lb PCU-N/A)
  - 4-6 bu/A (240 lb/A) increase to cover upcharge ($9 wheat)
  - Eliminates expense and inefficiency of fertigation

Predicted ESN Release Curves (Degree-Day Model)

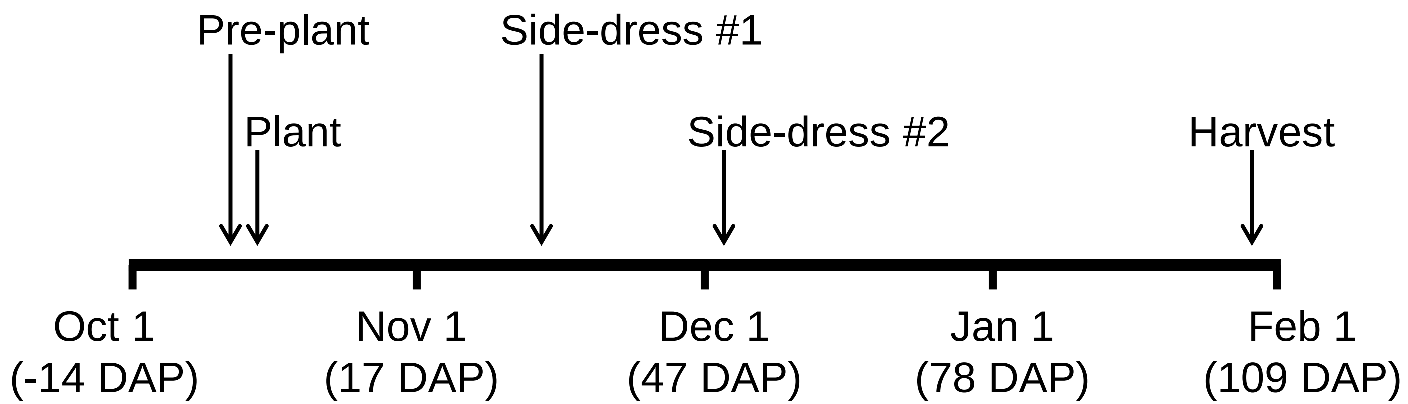


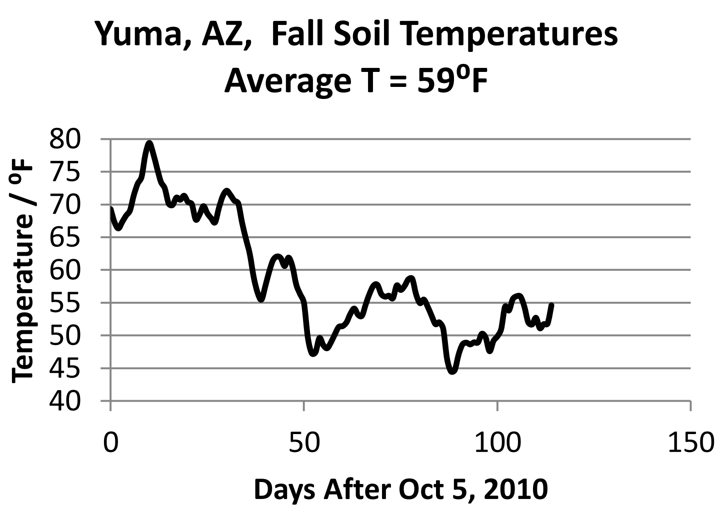


PCU for Vegetables and Leafy Greens (CA/AZ)

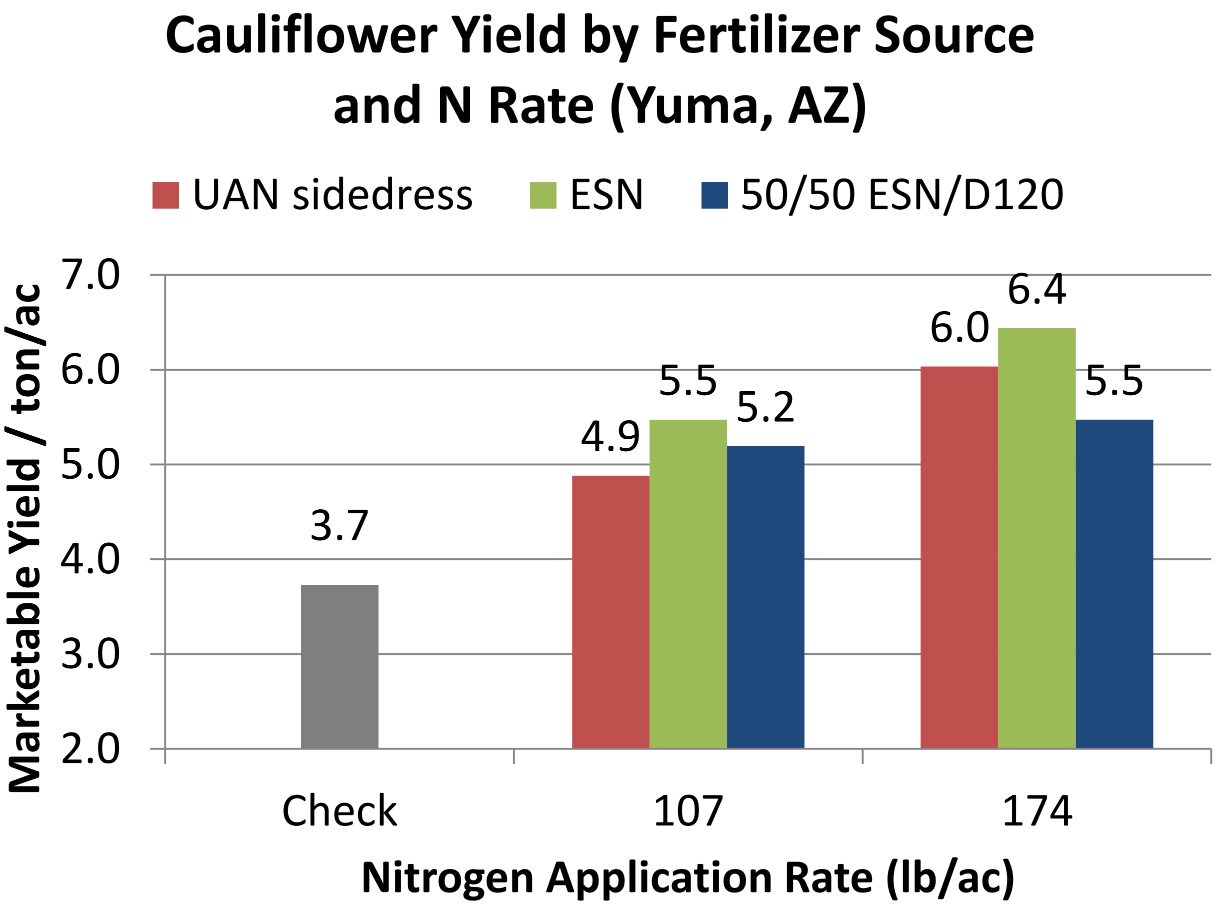
- Vegetable, melon, and head lettuce under furrow irrigation
  - Dr. Charles Sanchez (Yuma, AZ)
- Spinach under sprinkler irrigation
  - Richard Smith (Salinas, CA)
- Romaine lettuce under drip irrigation
  - Richard Smith (Salinas, CA)

Cauliflower (Yuma, AZ)
Application Timeline and Soil Temperatures

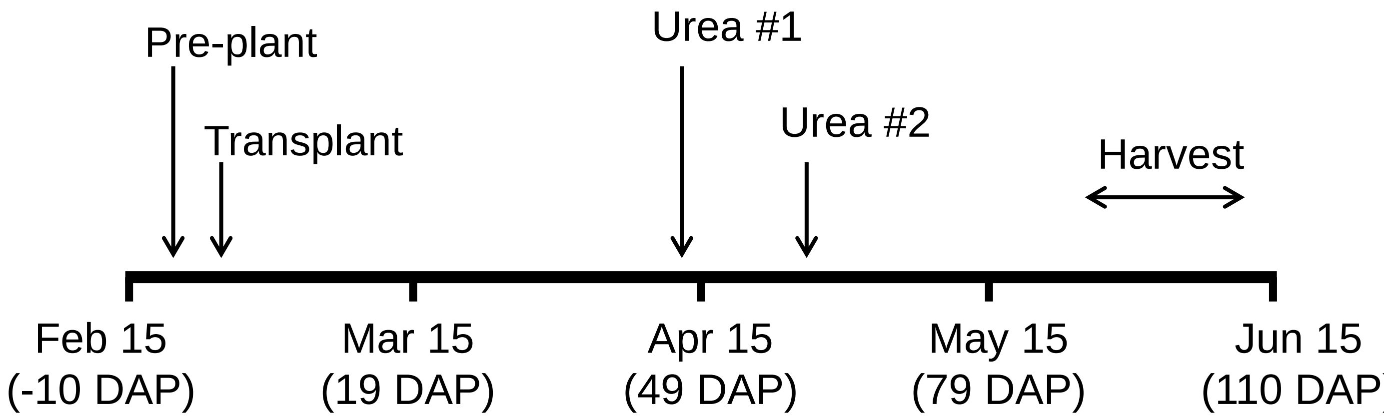


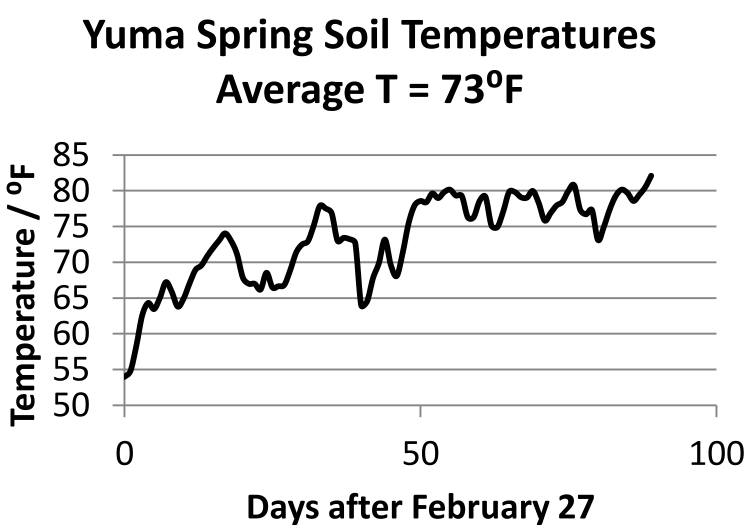


Cauliflower Yield vs N Rate



Seedless Watermelon (Yuma, AZ) Application Timeline and Soil Temperatures





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Total Watermelon Yield *vs* N Rate