Field Evaluation and Demonstration Controlled Release N Fertilizers

Charles A. Sanchez and Richard Smith

University of Arizona and UC Davis Cooperative Extension

Primary production area for cool season leafy vegetables is California and Arizona

Hollister, CA
Located approximately 30 miles northeast of Salinas, Hollister's very mild climate and longer days make it a superb growing location. The optimal weather also allows us to grow much longer into the season.
Approximate growing season: January – April and July – December

Salinas, CA
The Salinas Valley is a coastal region with rich soil and moderate summer temperatures, which creates an ideal growing climate for a variety of vegetables.
Approximate growing season: April 15 - October 15

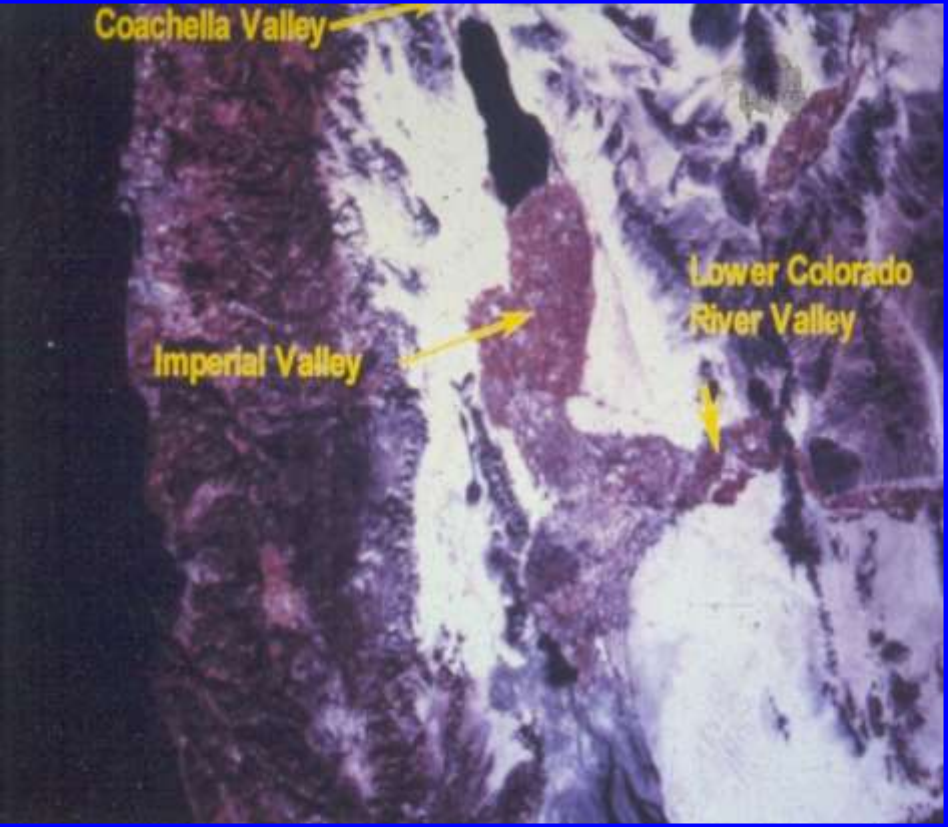
Tres Picos, CA
With warm weather conditions that are good for lettuce, romaine and mix leaf, Huron provides a bridge of consistency between the transitional growing phases of Salinas and Yuma.
Approximate growing season: October 15 - November 30 and March 15 - April 15
(Summer crops are grown between June 20 and August 15)

Arvin, CA
About 100 miles north of Los Angeles in the Central Valley, Arvin's warm weather and deep, well-drained soil assists with the transitional growing phases between Salinas and Yuma.
Approximate growing season: July

Oxnard, CA
Oxnard is a coastal region that offers a rich, moist growing climate with temperate winter weather for growing celery and other varieties of Tanimura & Antle vegetables.
Approximate growing season: November 15 - June 15

Imperial Valley and Yuma, AZ
The desert-growing region offers sunny, warm winters with ample irrigation from the Colorado River. A vast array of microclimates creates suitable growing conditions in multiple regions, including Brawley and El Centro.
Approximate growing season: October 25 - March 15

Background



- The Colorado River Valleys of southern Arizona and California and the Imperial and Coachella Valleys of California represent more than 600,000 acres of irrigated cropland.
- This region produces more than 95% of the nations vegetables during the fall-winter-spring season each year.

Crops are typically established with sprinkler irrigation

After stand establishment, subsequent irrigation is typically by furrow.

The amount of water consumed by the crop is often smaller than the amounts applied.

Potential for N leaching is often high.

Controlled release N (CRN) fertilizers potentially reduce leaching and other N losses by delaying N release to match crop uptake

CRN Technologies

- Old Duration (Sulfonated EPDM elastomers)
- Meister (Thermoplastic resins (polyolefins))
- PolyS (Sulfur and Polymer coating)
- Polyon ((Polyurethane)
- New Duration and ESN (Polyurethane)
- GalXe (Polyurethane)

Classification

- The number of days for 80% release in water at 20^o C.
- The percentage N is inversely related to polymer coating thickness.

CRN 150 = CRN 42

CRN 120 = CRN 43

CRN 90 = CRN 44

CRN 45 = CRN 44.5

Experiments on University Research Farms

2000 to 2014

EXPERIMENT- DEMONSTRATIONS IN GROWER FIELDS 2012-2014

Possible outcomes to CRN programs

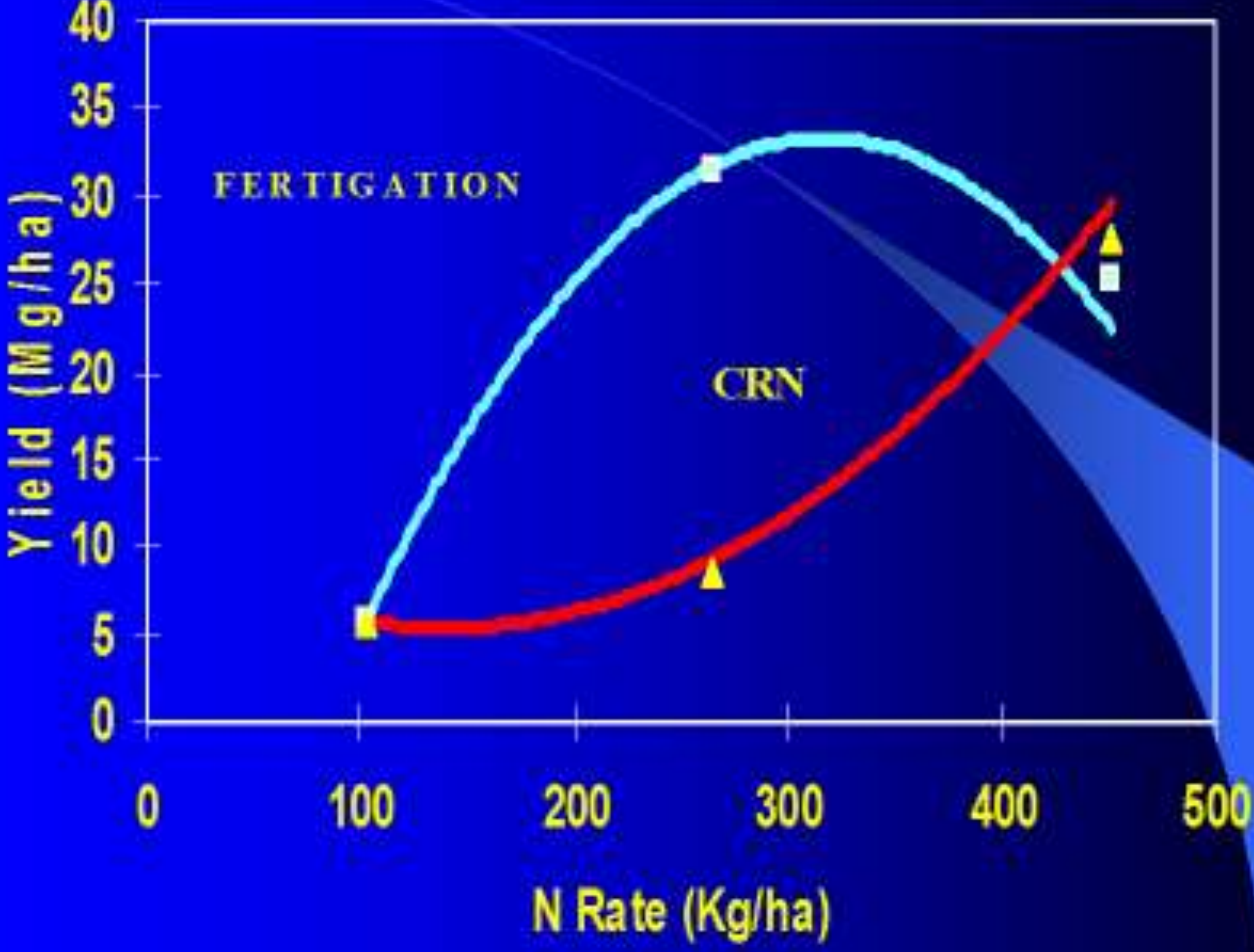
- Reduction in yield compared to conventional N fertilizer practices.
- No response compared to traditional N management practices.
- A reduction in N fertilizer required for optimum production compared to conventional N fertilizer management.
- Improved yield and quality compared to conventional N fertilizer management.
- A combination of reduced N fertilizer required for maximum production in addition to improved yield and quality.

Possible outcomes to CRN programs

- Reduction in yield compared to conventional N fertilizer practices.

1. When product release rates are mismatched with crop demand.

2. When a rapid release rate associated with high soil temperatures, in combination with less-than-optimum placement, results in osmotic stress or ammonia toxicity to the crop


FERTIGATION
CRN
Yield (Mg/ha)
N Rate (Kg/ha)
0
5
10
15
20
25
30
35
40
0
100
200
300
400
500

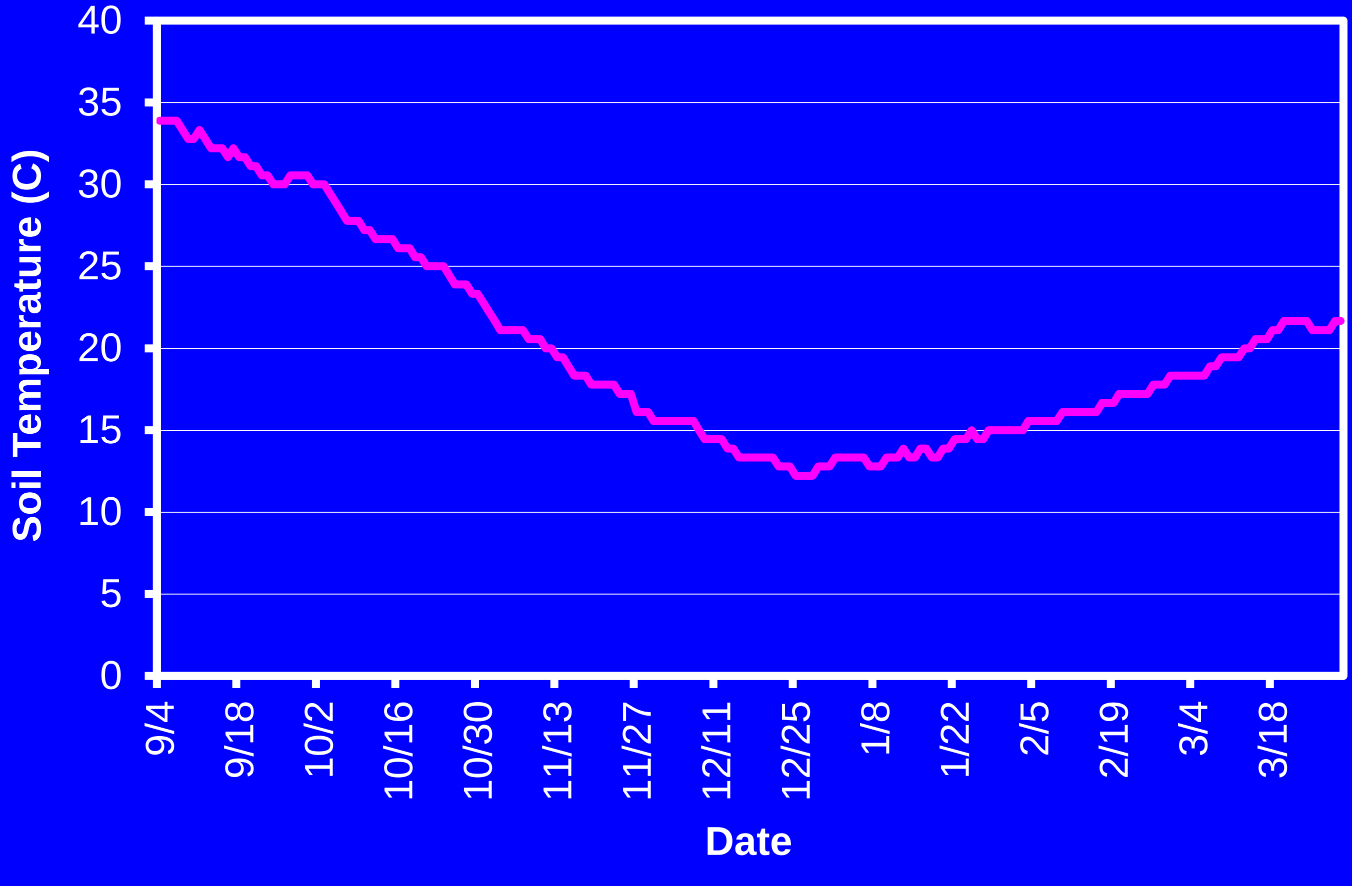
Head Lettuce (Yuma, AZ)

- Grower Demonstration Trial (3 treatments)
- Silty Clay Loam   sprinkler/furrow irrigation   42" beds
- Wet date Oct 18, Harvested Jan 24
- Pre-plant applications Oct 16 incorporated by power mulching

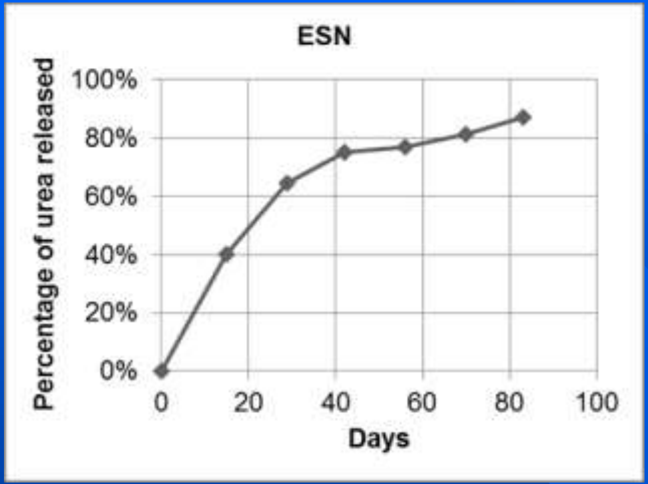
Marketable yield of iceberg lettuce to N management practice in a grower field in Yuma.

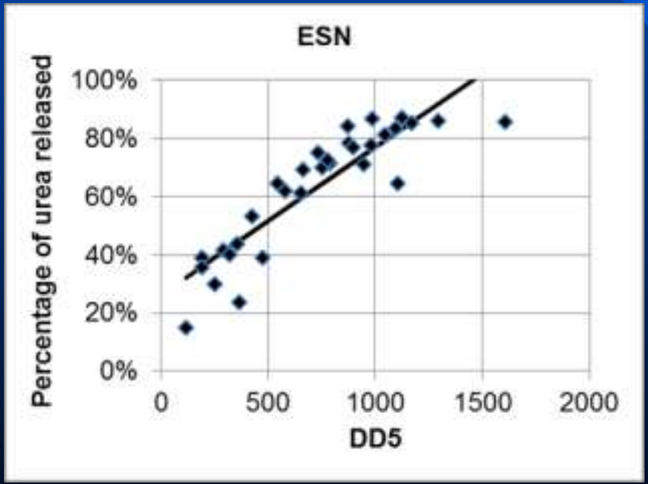
Treatment	Practice	Marketable Yield (MT/ha)
1	GSP 300 lbs A/ MAP 25 gal UN32 SD Water Run (5+20+10 gal UN32/A) Total N 246 lbs N/A	55.8
2	CRN#1 300 lbs/A MAP 112 lbs N as CRN 25 gal UN32 SD Water Run 5 gal UN32/A Total N 262 lbs N/A	47.9
3	CRN#2 300 lbs/A MAP 188 lbs N as CRN Water Run 5 gal UN32/A Total N 239 lbs N/A	45.2
LSD		4.9

Mean Soil Temperature During Winter Cropping Period in Desert



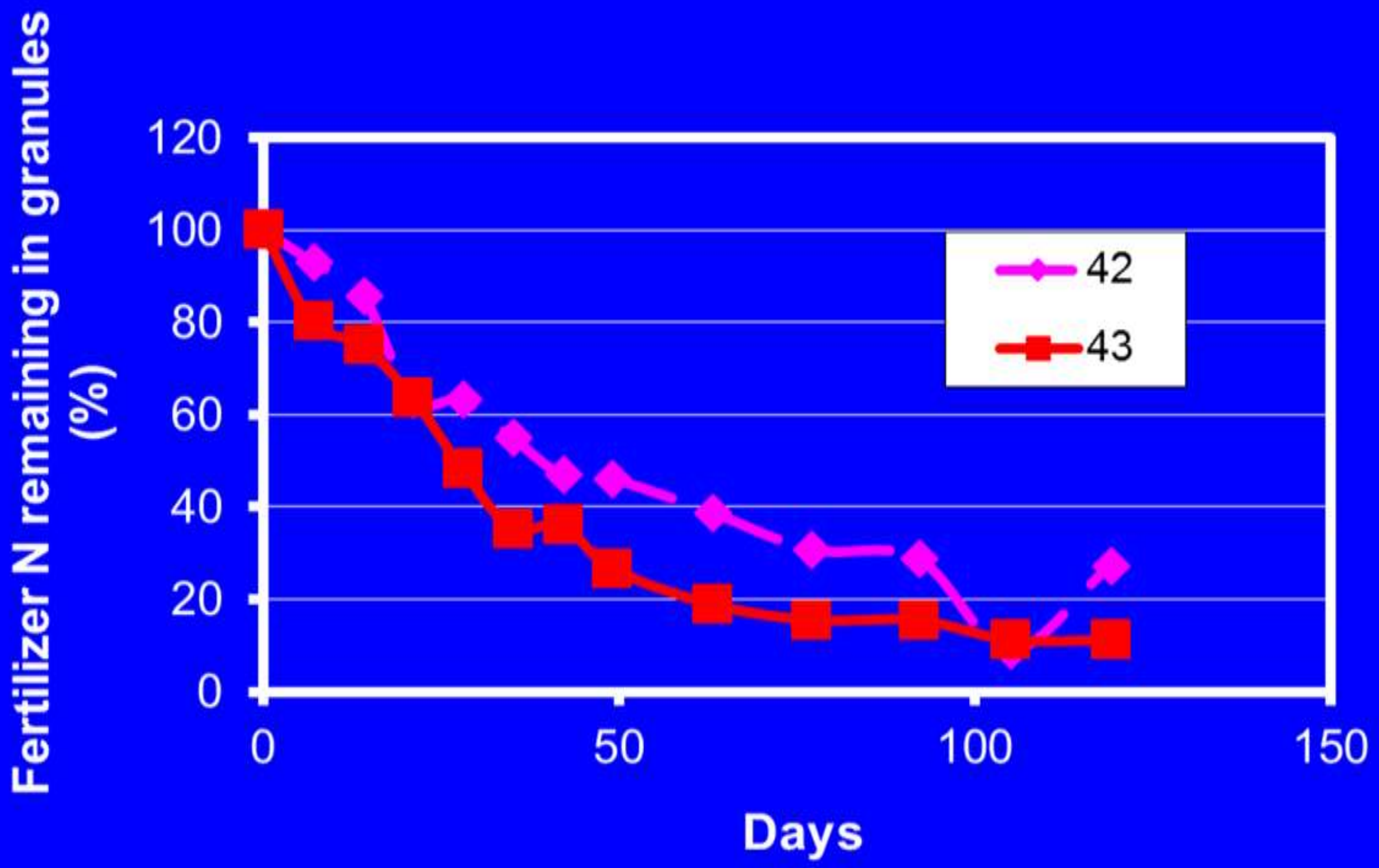
N Release Mismatch should no longer be an issue



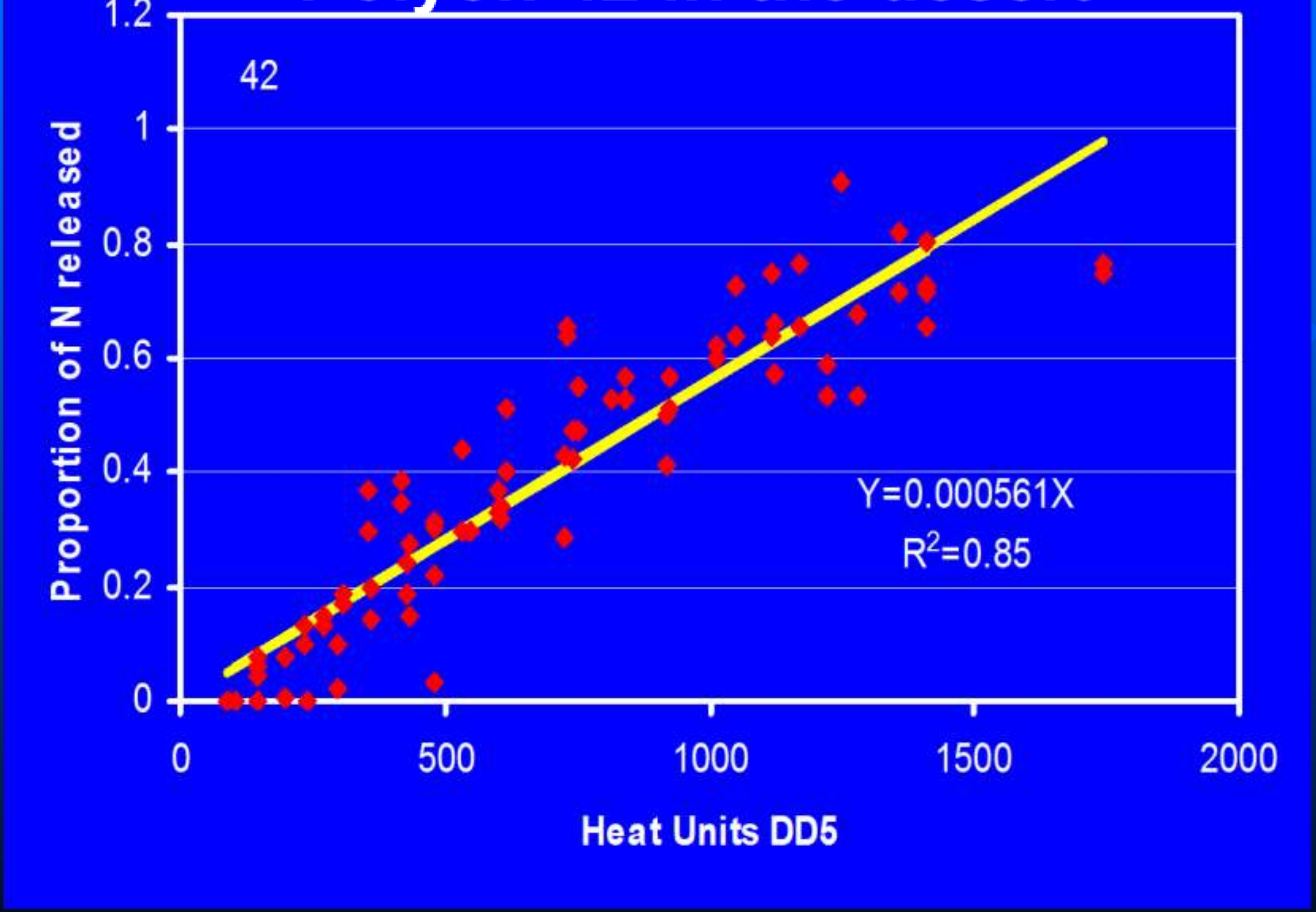


- Temperature summation models have provided us the means of matching the appropriate CRN product with crop and planting windows in desert production systems.
- We now have to model to reconcile product N release with crop demand.

Measured N Released in one fall experiment for Polyon 42 and 43



Observed and predicted release of Polyon 42 in the desert



Typical lettuce planting curve and soil temperature summation

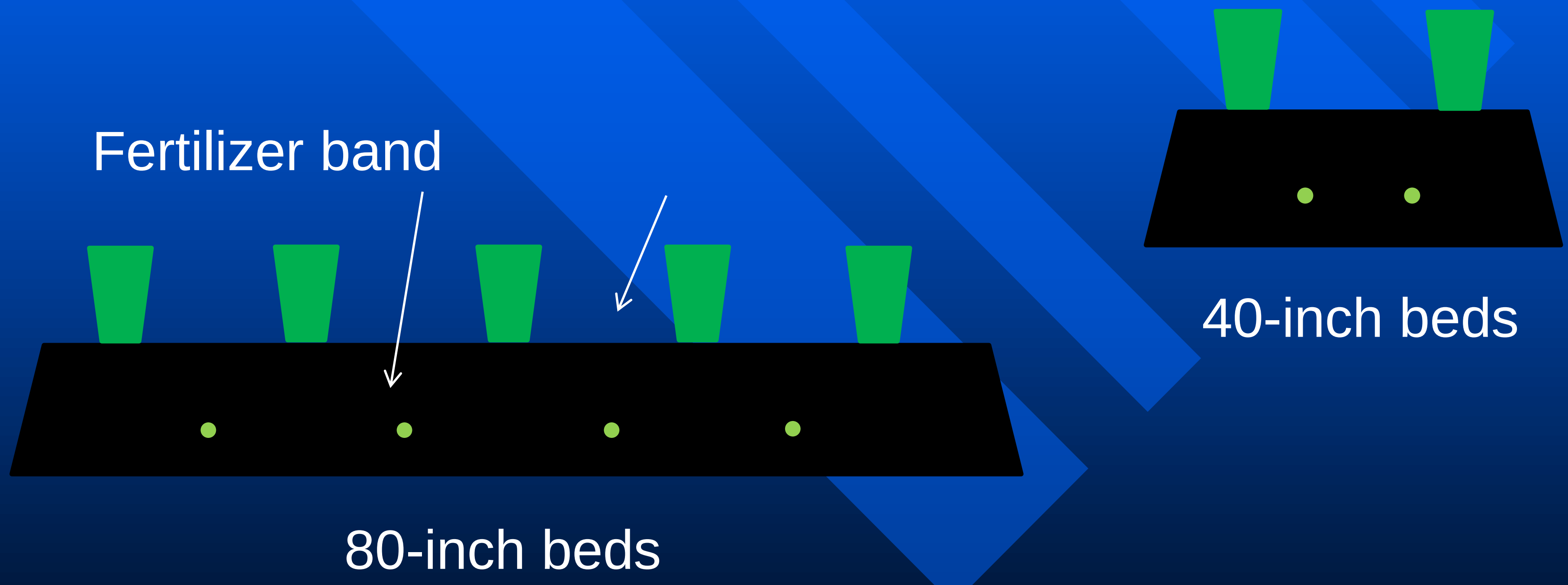
Planting Date	Harvest Date	Days to harvest	Mean Soil Temp.	Soil DD5
Sept. 6	Nov. 19	74	26.5	1615
Sept. 12	Nov. 27	76	25.1	1543
Sept. 23	Dec. 22	90	21.3	1488
Oct. 1	Jan. 7	98	19.2	1411
Oct. 8	Jan. 26	110	17.7	1407
Oct. 20	Feb. 14	117	16.4	1340
Oct. 27	Feb. 22	118	15.9	1295
Nov. 6	Mar. 4	118	15.5	1249
Nov. 12	Mar. 8	116	15.3	1209
Nov. 23	Mar. 13	110	15.2	1132
Dec. 6	Mar. 21	105	15.5	1111

Temperature summation to 90% release for Polyon products

Product	Temperature sum (Base 5)
Polyon 42	1604
Polyon 42/43	1565
Polyon 43	1415
Polyon 43/44	1283
Polyon 44	929

Band Placement as a Strategy to Avoid Crop Damage

Place band at 3-5” depth and offset to avoid potential for fertilizer burn and to ensure fertilizer placement in wetting zone



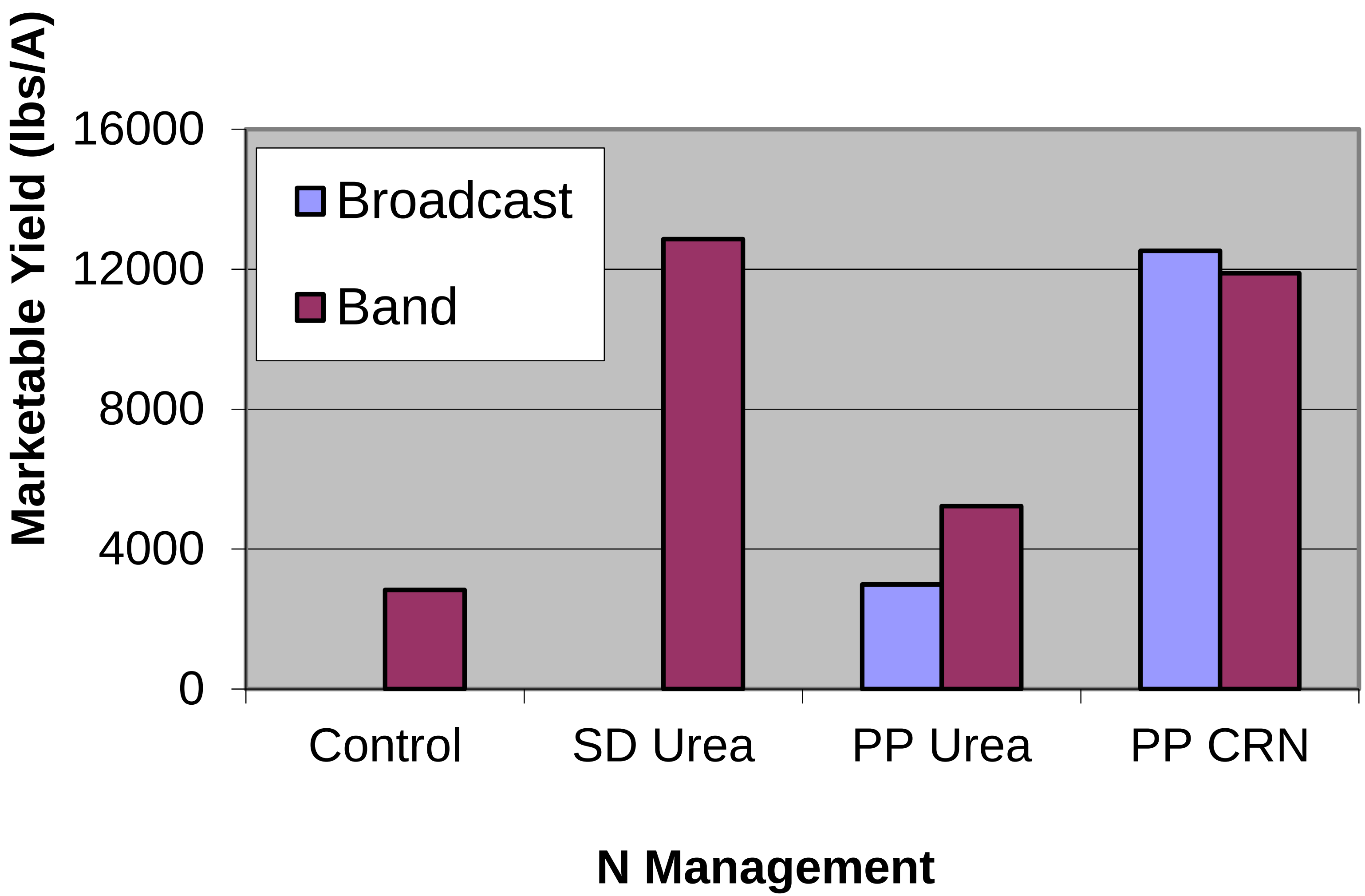
Blending can affect N release rate

Possible outcomes to CRN programs

- ⇔ No response compared to traditional N management practices.

-This occurs where N timing by conventional management is adequate and N leaching and denitrification losses are minimal. This is the situation we sometimes observe on heavier textured soils and where irrigation management is generally good. The only advantage of a controlled release program under this situation is reduced tractor cost for side dressing or top dressing N, and this cost savings infrequently covers the higher costs of CRN. However, application logistics may be simplified using CRN which is an intangible benefit to growers.

Response of broccoli to sidedress urea and pre-plant urea and CRN at Yuma Agricultural Center.



Dry matter accumulation of celery to N Management in fall-winter Yuma Valley

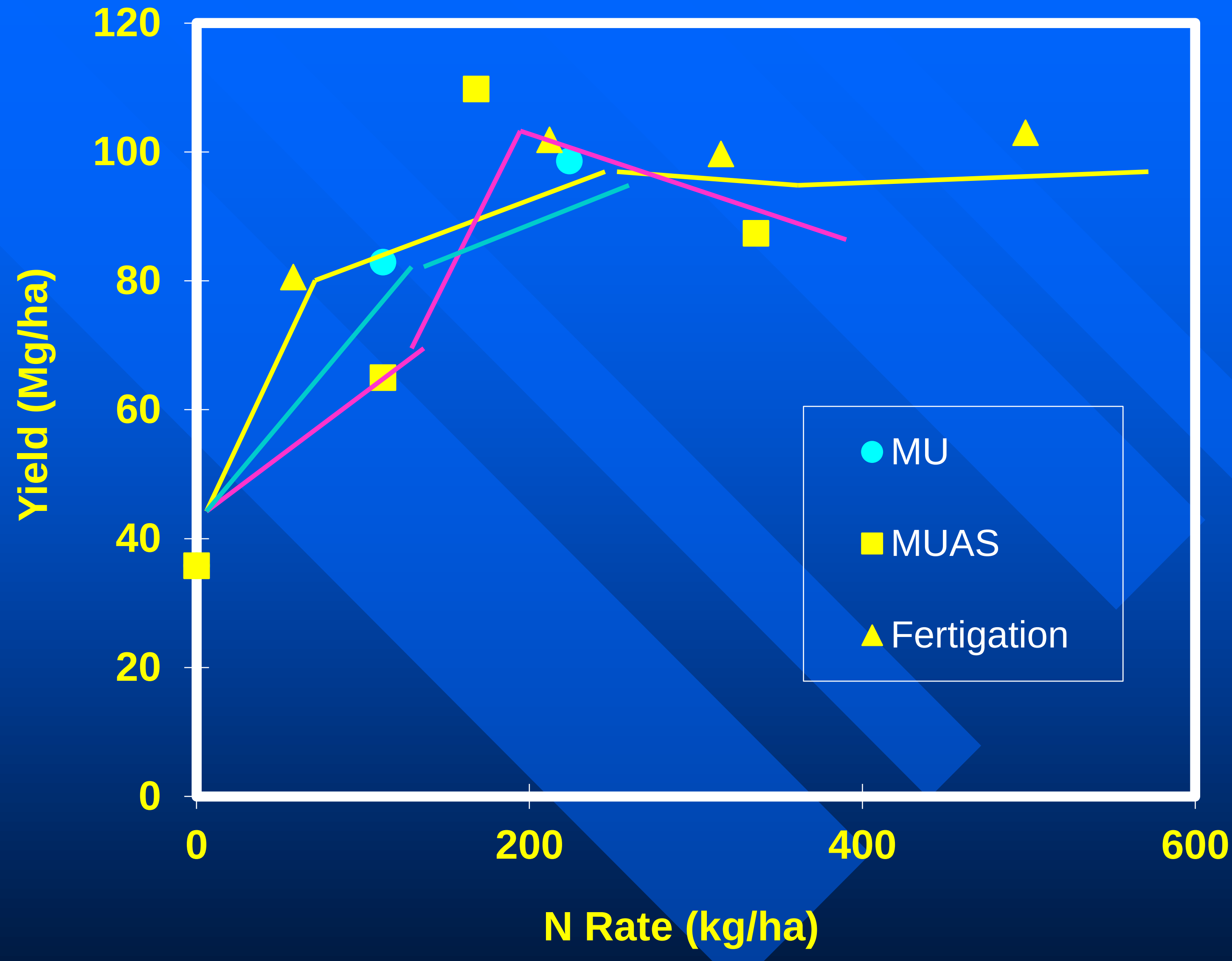
Treatment	Date			
	11/6	12/3	12/23	2/13
	Plant Dry weight (g/plant)			
GSP	0.8	5.4	21.0	56.6
CRN 90 (132 lbs N/A)	2.0	9.5	22.6	55.6
CRN 120 (132 lbs N/A)	1.8	10.2	20.5	64.6
CRN 90 (176 lbs N/A)	1.6	9.4	18.7	59.8
CRN 120 (176 lbs N/A)	1.1	7.5	18.9	68.9
LSD	0.6	2.1	4.1	9.8

.
LSD=Least significant difference at P=0.05. NS=not significant.

Yield response of celery to N management in fall-winter in Yuma Valley

Treatment	Yield (MT/ha)
GSP	118.4
CRN 90 (132 lbs N/A)	107.0
CRN 120 (132 lbs N/A)	116.6
CRN 90 (176 lbs N/A)	115.8
CRN 120 (176 lbs N/A)	107.6
LSD	NS

LSD=Least significant difference at P=0.05. NS=not significant.



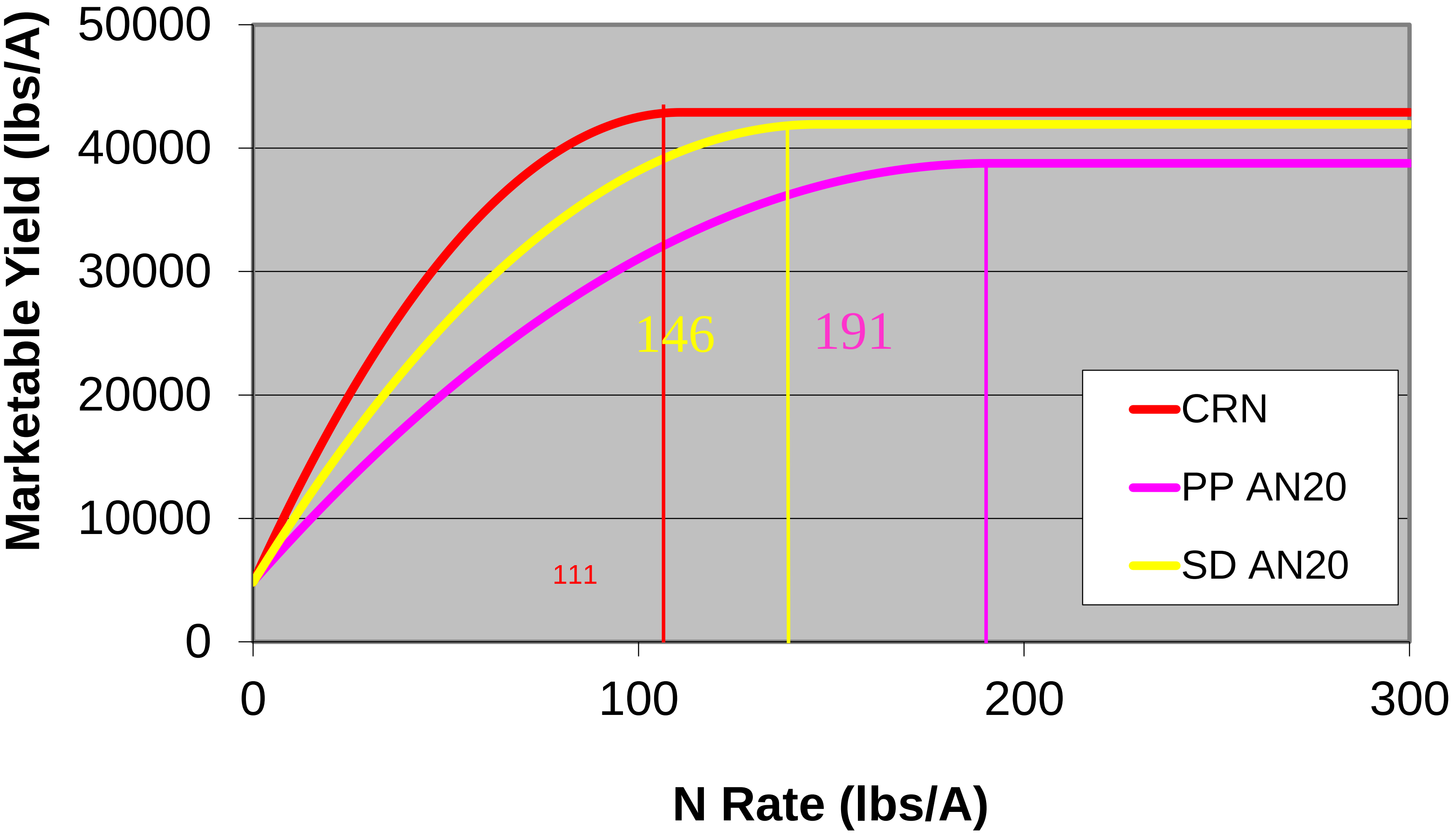
Yield (Mg/ha)
0
20
40
60
80
100
120
N Rate (kg/ha)
0
200
400
600
MU
MUAS
Fertigation

Possible outcomes to CRN programs

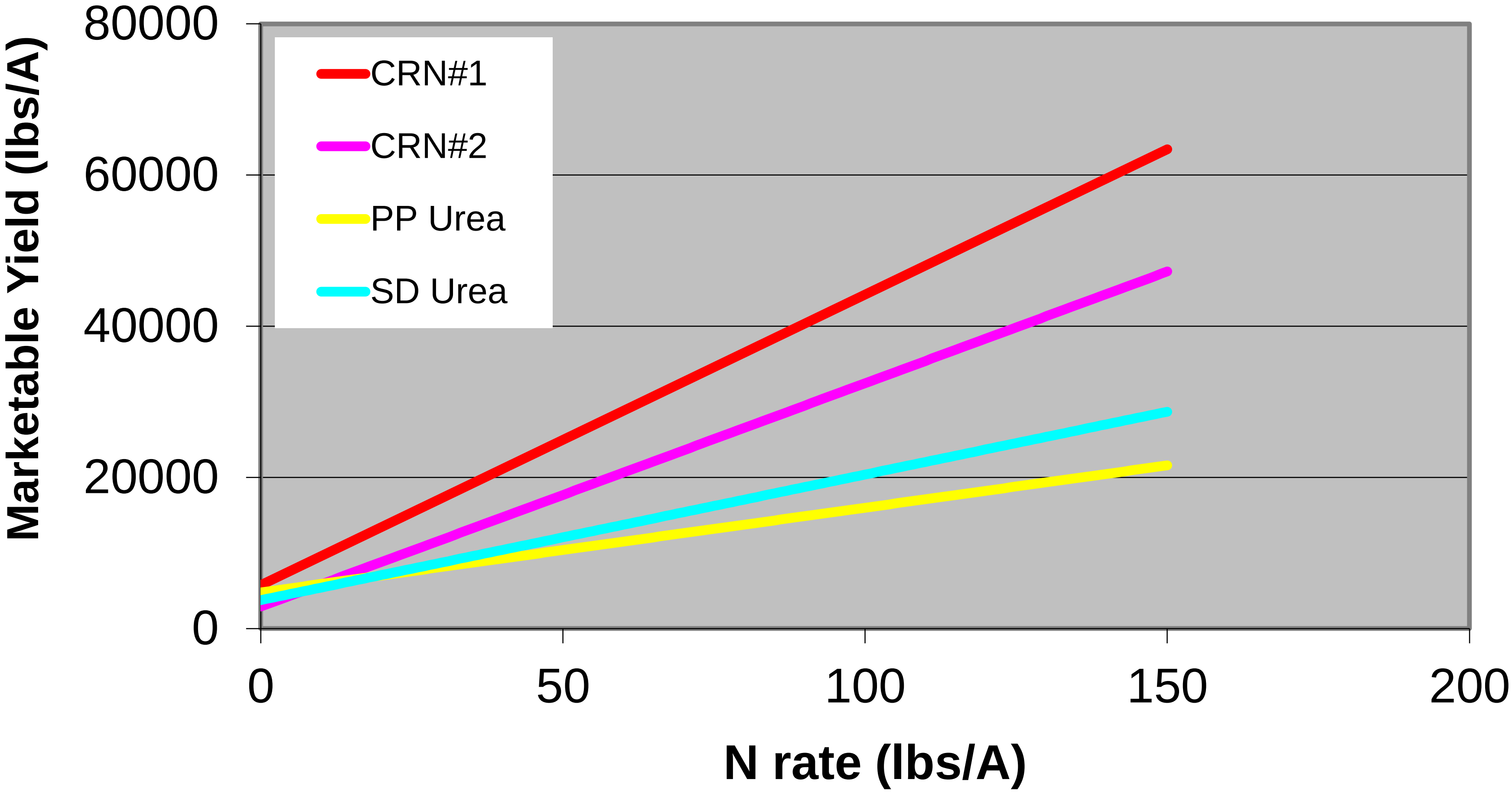
- A reduction in N fertilizer required for optimum production compared to conventional N fertilizer management.
- Improved yield and quality compared to conventional N fertilizer management.
- A combination of reduced N fertilizer required for maximum production in addition to improved yield and quality.

-The frequency for positive responses increase as soil textures become increasingly coarse, and irrigation management more problematic.

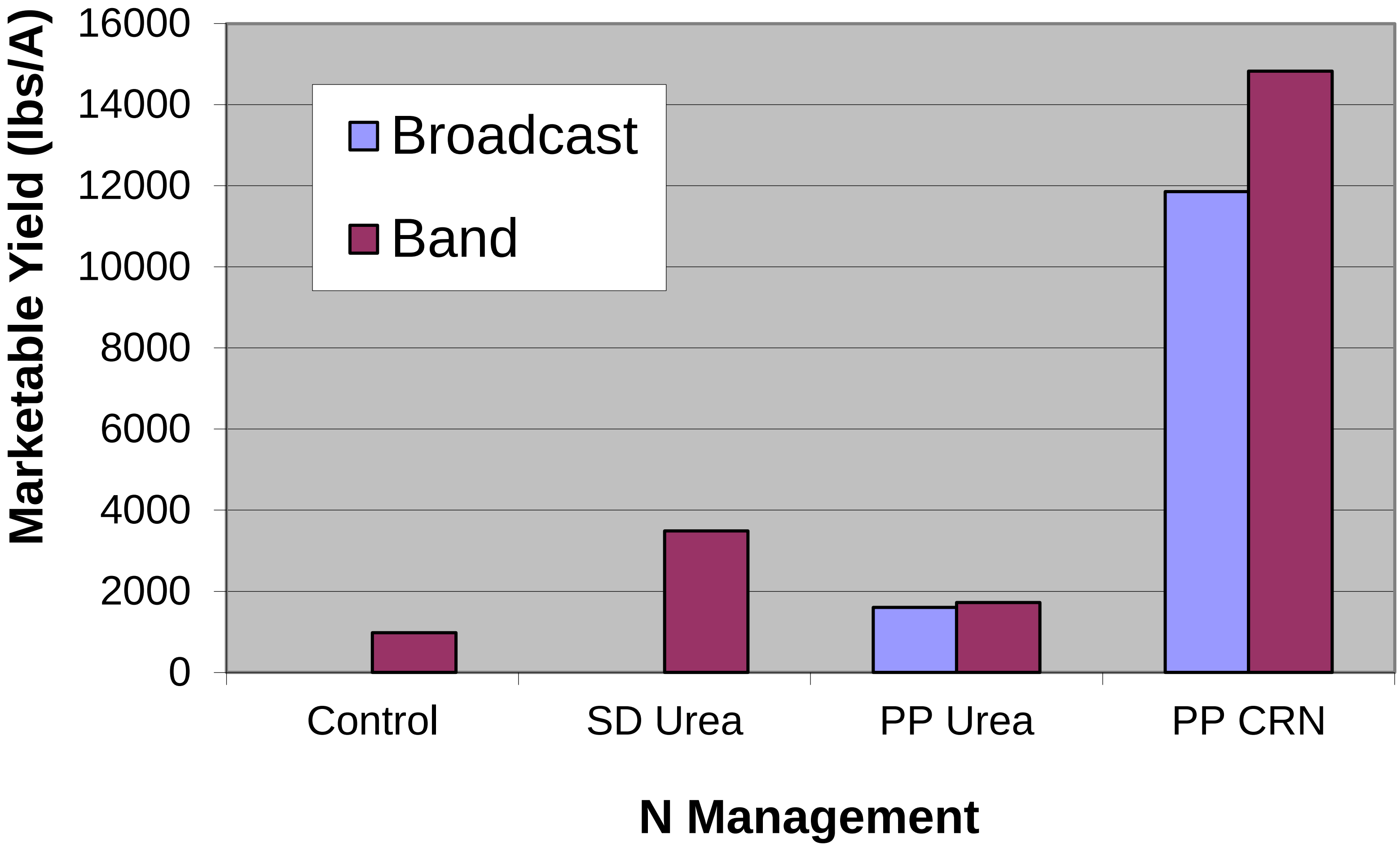
Response of iceberg lettuce to sidedress AN20 and preplant AN20 and CRN at Yuma Agricultural Center.



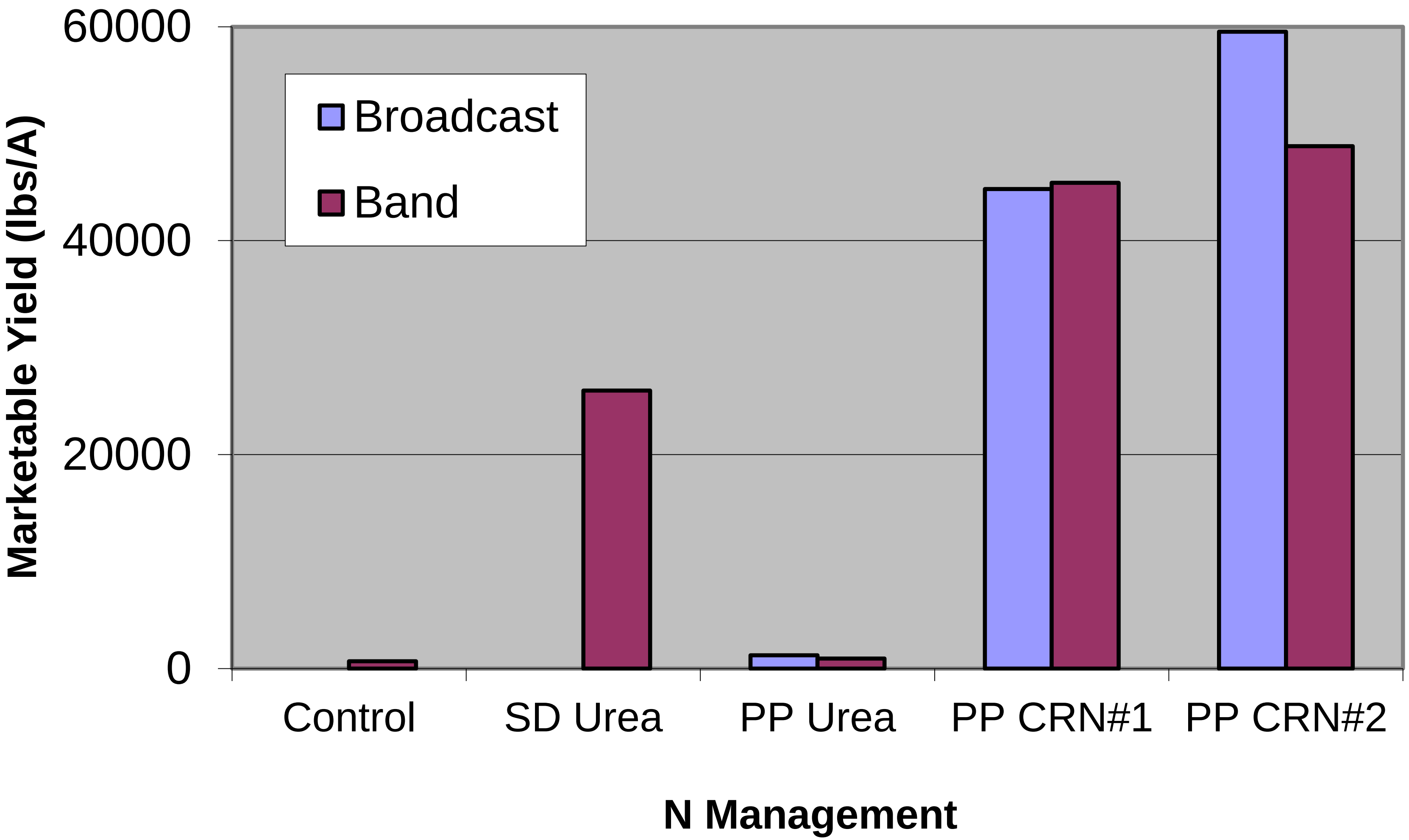
Response of iceberg lettuce to sidedress urea and preplant urea and CRN at Yuma Agricultural Center.



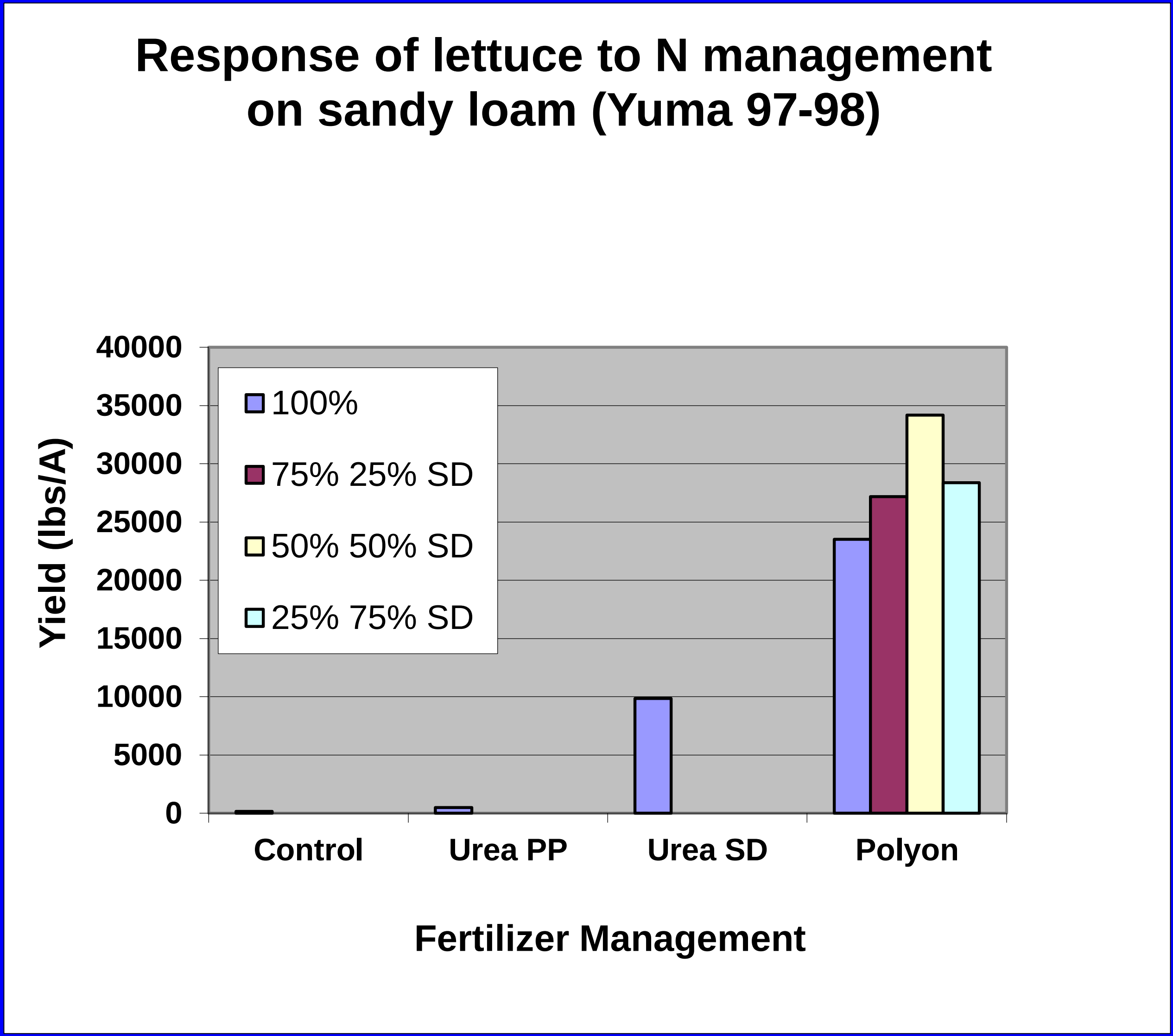
Response of Cauliflower to N Management on loamy sand. Urea applied at 285 lbs N/A and CRN applied at 241 lbs N/A



Response of iceberg lettuce to sidedress urea and preplant urea and CRN at the Yuma Agricultural Center.



- **Sometimes program with mixed CRN and soluble sources are most economical**



Spinach (Coachella, CA)

Treatment	Practice	N rate	Marketable Yield (MT/ha)
1	GSP	3-35-0 (25 lb N) td-AMS (63 lb N) td-AMS (63 lb N) **Total = 151 lb N/ac**	14.4
2	CRN#1	3-35-0 (25 lb N) pp-CRN (100 lb N) td-AMS (32 lb N) **Total = 157 lb N/ac**	17.7
3	CRN#2	3-35-0 (25 lb N) pp-CRN (150 lb N) **Total = 175 lb N/ac**	16.9
LSD			2.5

Romaine Hearts (Coachella, CA)

Treatment	Practice	N rate	Marketable Yield (MT/ha)
1	GSP	3-35-0 (25 lb N) sd-AN20 (105 lb N) sd-AN20 (105 lb N) **Total = 235 lb N/ac**	47.0
2	CRN#1	3-35-0 (25 lb N) pp-CRN (115 lb N) sd-AN20 (53 lb N) **Total = 193 lb N/ac**	52.5
3	CRN#2	3-35-0 (25 lb N) pp-CRN (165 lb N) **Total = 190 lb N/ac**	58.6
LSD			5.0

Summary

- Over a decade of field research has shown there are production situations in the desert where CRN programs give positive crop yield and quality responses
- The use of CRN program is economically viable in many desert cropping systems.
- CRN product release rates must be correctly matched with N uptake needs of crops.

Summary (continued)

- Temperature summations models have provided us the means of matching the appropriate CRN product with crop and planting window.
- On farm demonstrations for technology transfer are on-going.