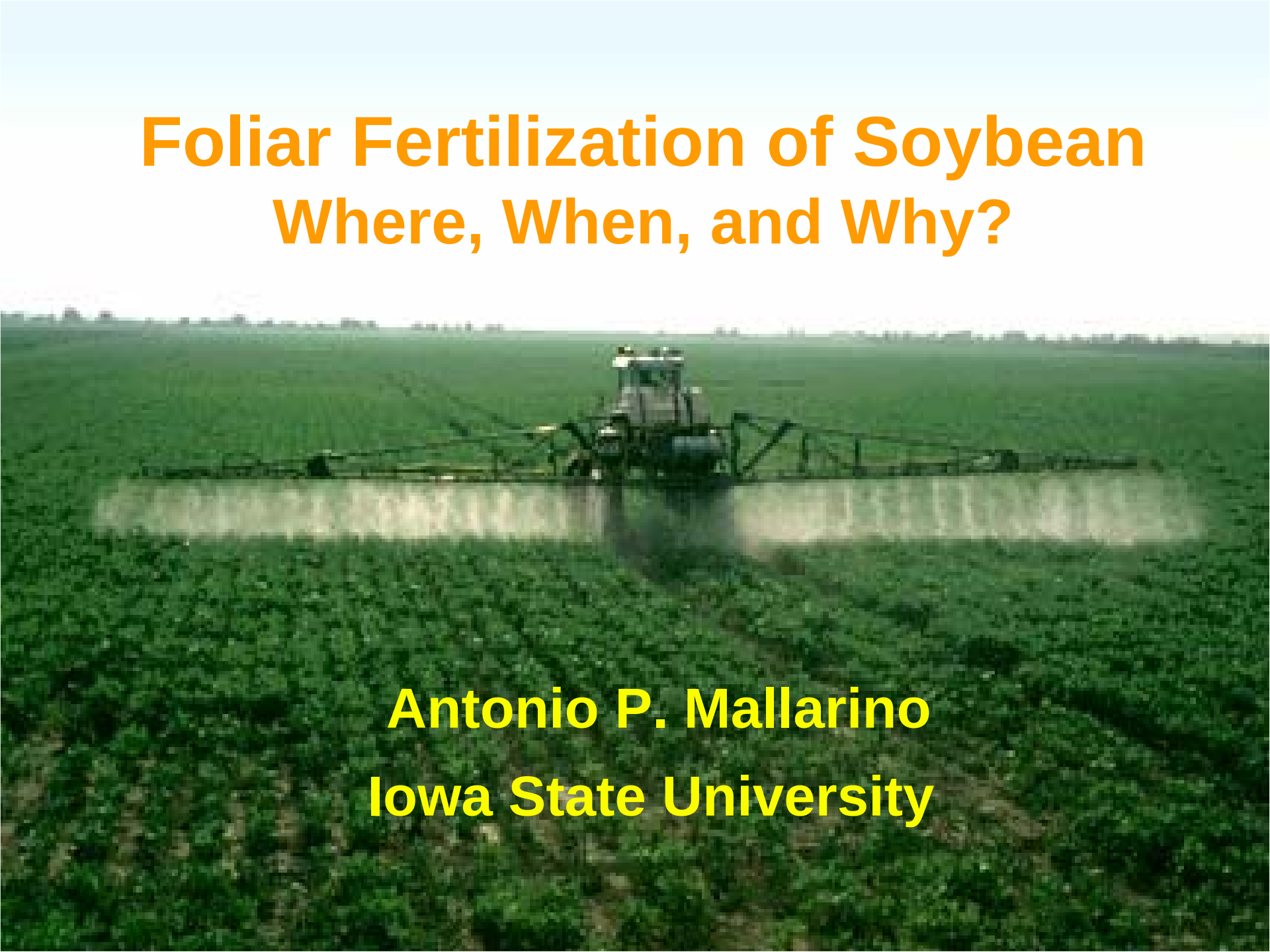
Foliar Fertilization of Soybean
Where, When, and Why?



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Foliar Fertilization

- Crops can use foliar-applied nutrients.
- High salt or ammonia concentrations damage leaf tissue.
- Known to be useful for application of micronutrients to high-value vegetable and orchards mainly because small amounts are needed.
- Could supplement primary P, K, S pre-plant application to soil.

Spraying Soybean at Late Growth Stages

N-P-K
N-P-K-S
Nitrogen

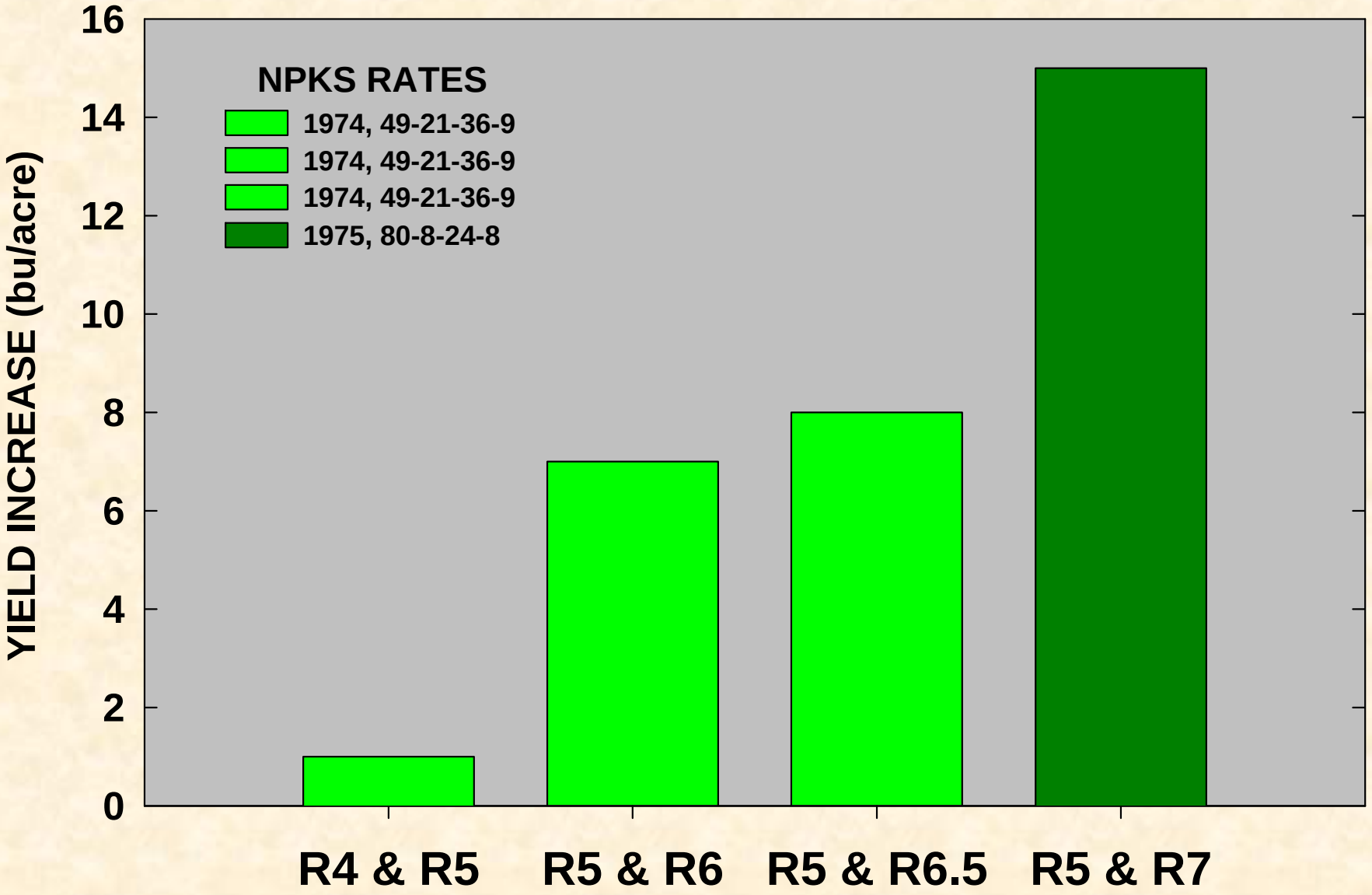
Nutrition at Reproductive Stages

- Remediate too low pre-plant fertilization
- Reduced root activity during late seed development stages.
- Increased translocation of nutrients and carbohydrates to the seed.
- Leaf senescence, low photosynthesis.
- Foliar fertilization could increase and green leaf area duration, protein and carbohydrate synthesis, and grain yield.

Iowa Research at Late Stages

- Dr. Hanway's work in the middle 70's.
- Sprayed soybean with various nutrient mixtures, frequencies of applications, and at several reproductive stages.
- Concluded that N-P-K-S increased soybean yield.
- A ratio 10 - 2.2 - 3.6 - 0.5 (N-$P_2 0_5$-K_2O-S), close to the ratio in grain, was the best.

Spraying NPKS at Late Stages



Spraying N, NPK, or NPKS

But many trials across the Midwest and South from the late 1970's to the middle 1980's did not reproduce the results

Example: TVA-Sponsored Research

Trials	Spray times	Soybean yield		
		Check	With	% loss
214	1-5	36.7	34.8	- 5.2
27	1	36.4	34.9	- 4.1
54	2	36.9	35.3	- 4.3
101	3	36.1	33.9	- 6.4

More Recent Research

- Mainly research with Nitrogen
  - Minnesota: many fields in the early 2000's, no yield increase or decrease
  - Kansas: in the mid 1990's, yield increase in high-yield conditions under irrigation, response in six of eight fields
  - Nebraska: late 1990's to 2000's, no clear results, mainly no response

Spraying Soybeans at Early Growth Stages

N-K
N-P-K
N-P-K-S
N-P-K-S-Micros

Nutrition at Early Vegetative Stages

- Low rates of foliar-applied fertilizer can supplement soil fertilization when N fixation or NPKS uptake are limited.
- Could stimulate plant growth and nutrient uptake during early growth.
- Could be cost-effective if applied mixed with some post-emergence herbicide.
- Yield responses were shown in cotton.

1994 - 2006 Iowa Research Projects

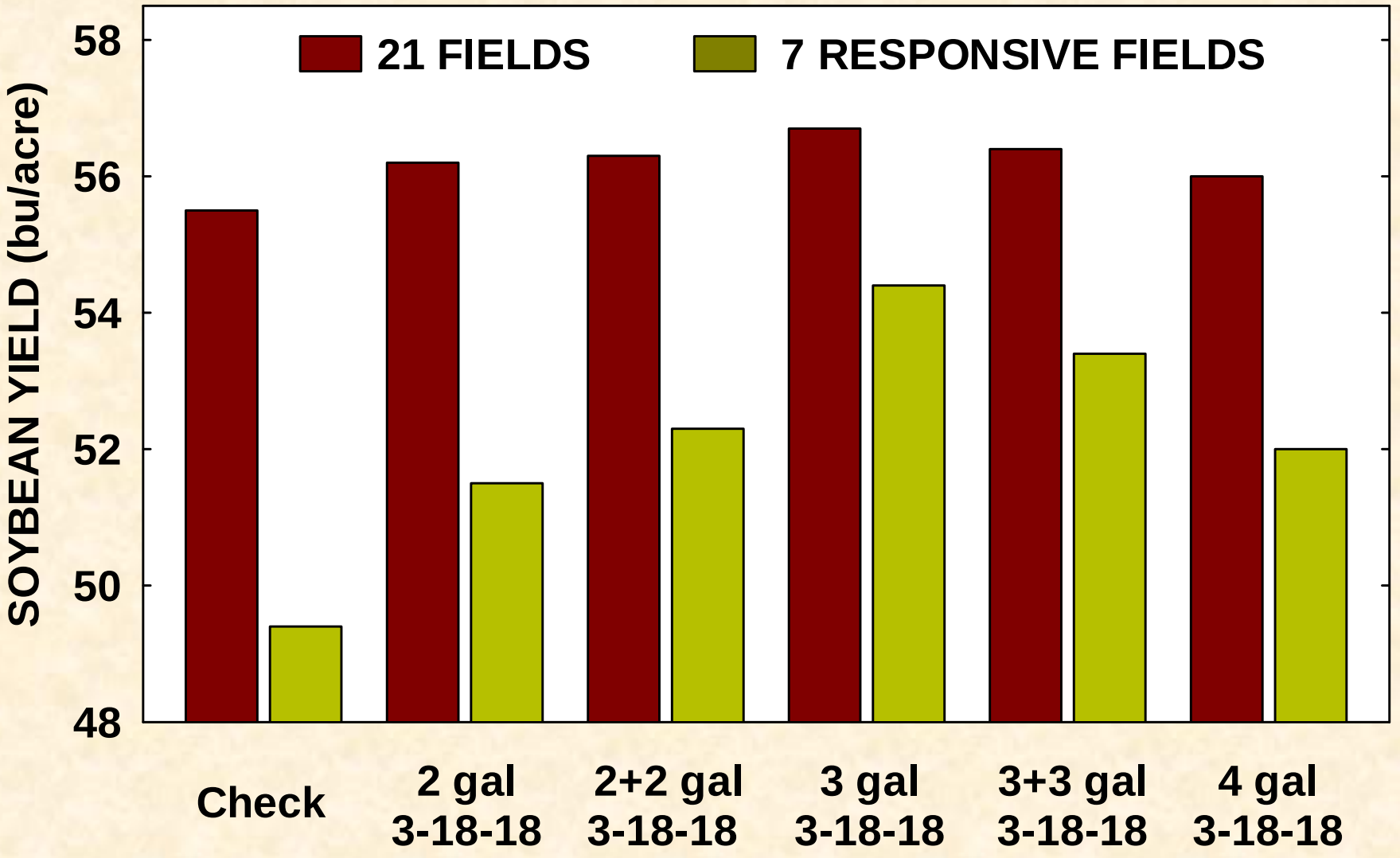
Foliar Fertilization Projects

- Chisel-disk, no-till, ridge-till systems.
- Spray at early growth stages (V5 -V7)
  - 38 trials with NPK mixtures. 1994 - 1996
  - 18 trials with NPK, NPKS, NPKS + micros In 1997 and 1998
  - 26 on-farm trials with 3-18-18, from 1998 to 2002, strips or conventional plot trials
- Interactions with fungicide application
  - 5 trials with 8 treatments. In 2005 and 2006.

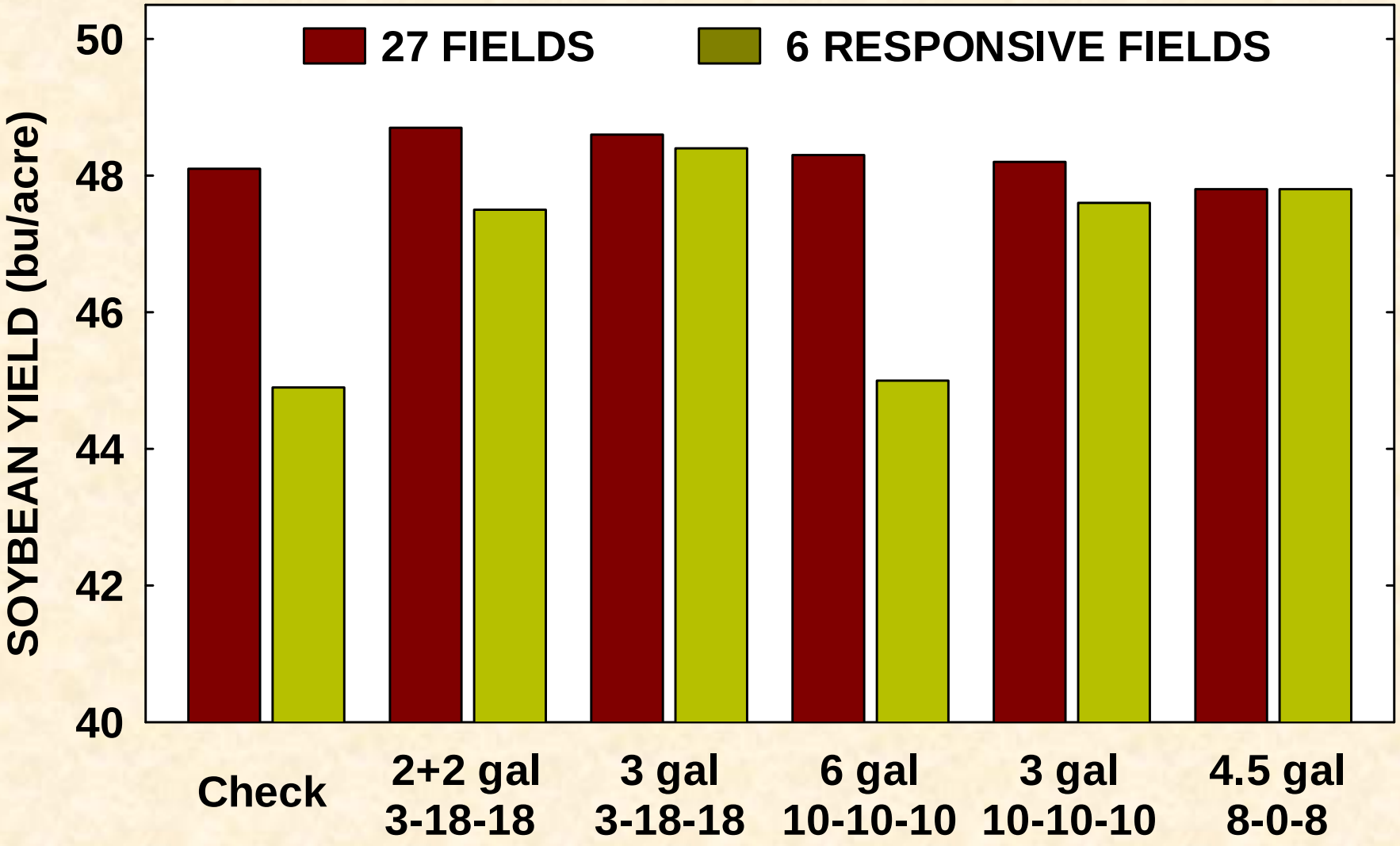
Method & Time of Application

- Rates from 2 to 6 gal/acre, one or two applications.
- 1st spray at V5, usually 4 to 6 open true leaves across the field.
- 2nd spray 8 to 10 days later.
- In strip trials, 3-18-18 fertilizer was mixed with Roundup.
- Measured soil tests, grain yield, growth, and nutrient uptake.

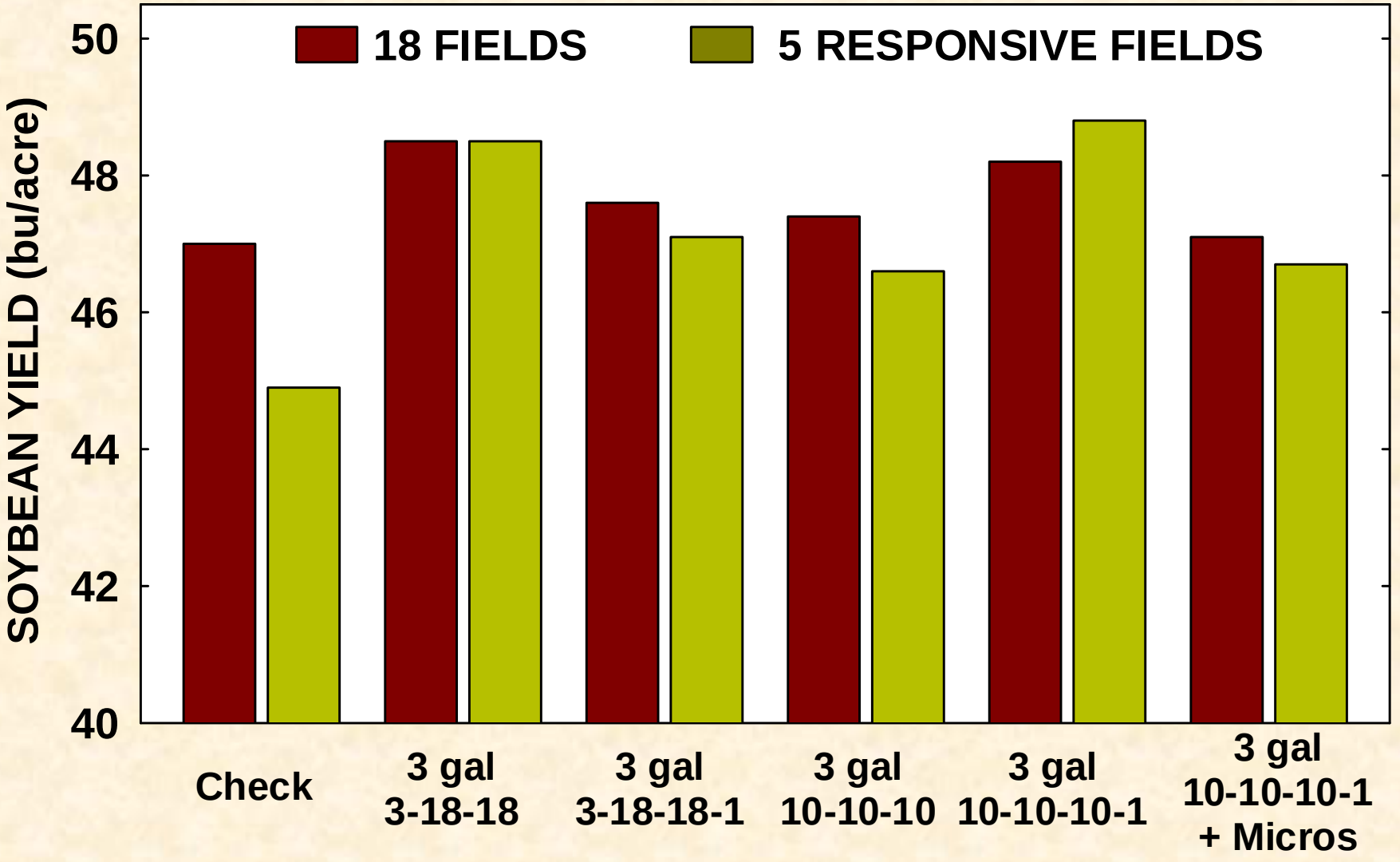
First Set of Trials



Second Set of Trials



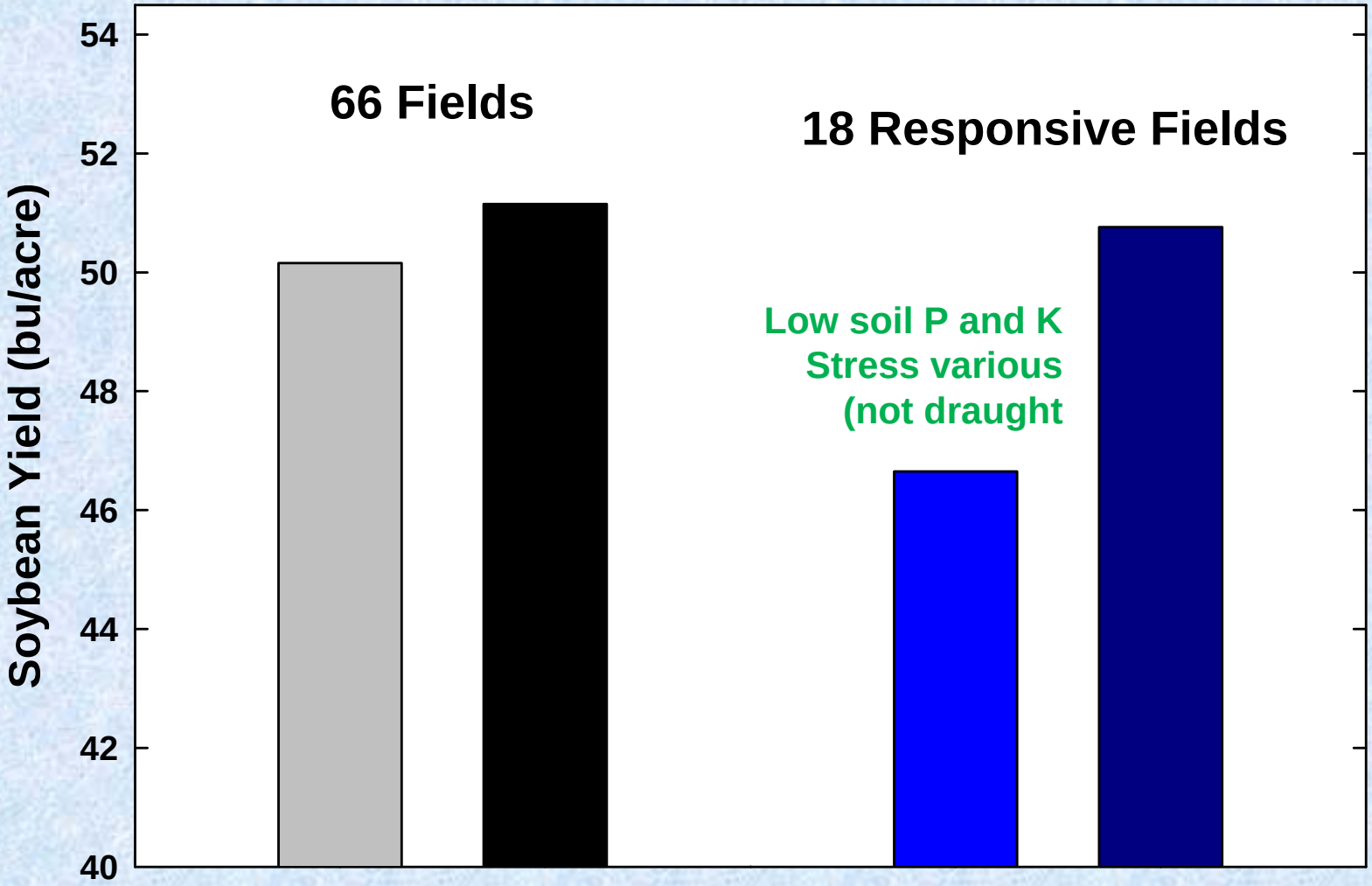
Third Set of Trials



Foliar Spray at Early Stages

- Foliar fertilization at early stages increased yield in 15 to 20% of the fields. Many tested Optimum or High.
- Average yield increase in responsive fields was about 4 bu/acre. Increase across all fields was 0.5 to 1 bu/acre.
- The most consistent responses were to 3 gal/acre of 3-18-18 fertilizer, and a single application usually was enough.

Problems Predicting a Response



Foliar Iron in Calcareous Soils

- Soybean iron chlorosis is common in high-pH, calcareous soils.
- Several of the 18 sites were calcareous, but we saw no consistent response.
- Other Iowa research in four fields, two iron chelate products at various rates: no consistent yield increase.
- Minnesota research: no large yield increase with severe deficiency.

Mixing Fluid Fertilizer with Fungicides

Treatments at Five Fields

- Five fields, optimum or higher in P & K
- Headline fungicide alone
- 3 gal 3-18-18
  - at V5 to V6 alone
  - at V5-V6 and R2-R3
  - At R2-R3 + Fungicide
- 3.3 gal UAN at R2-R3
  - at R2-R3 alone
  - at R2-R3 + Fungicide

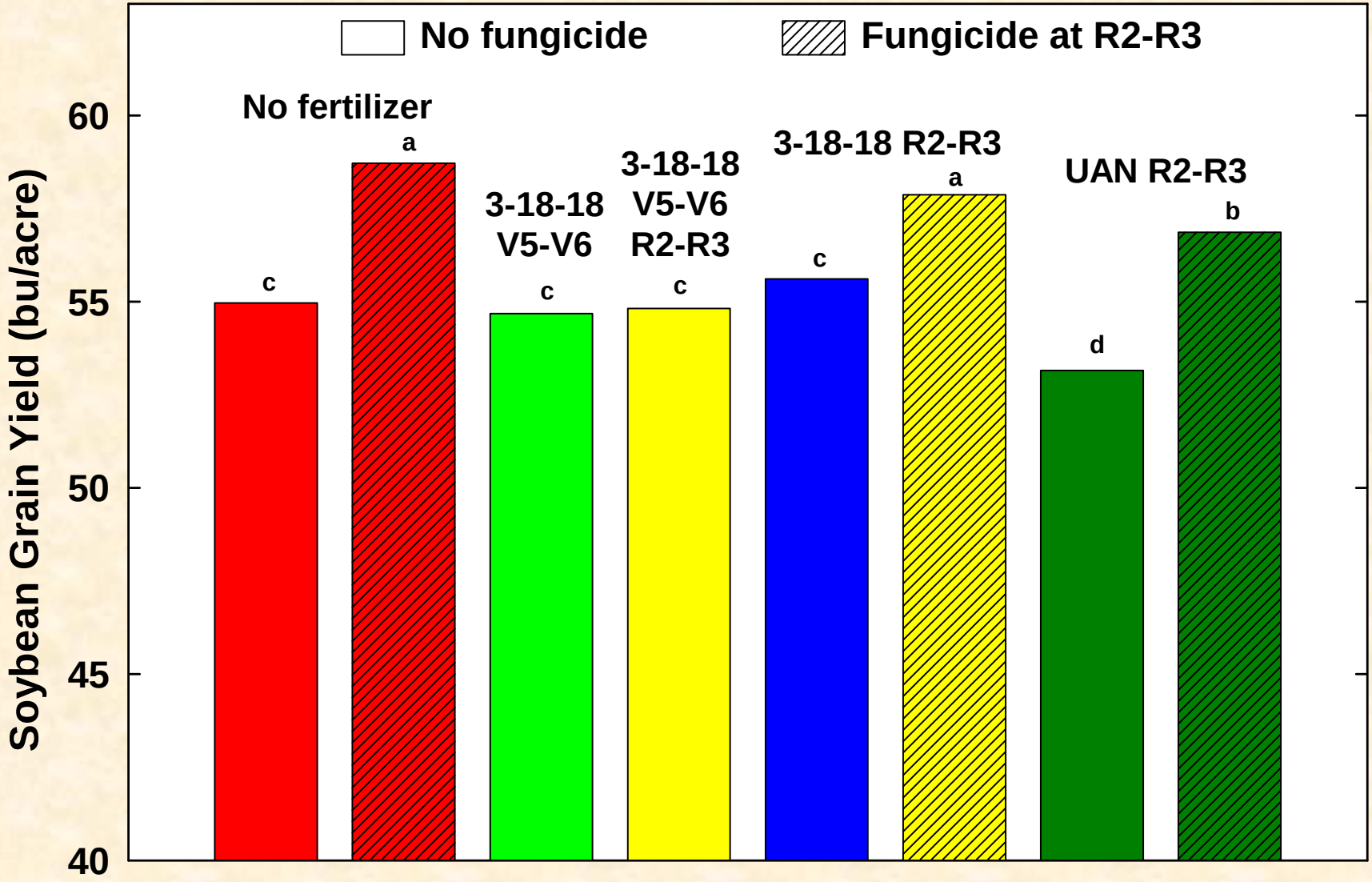
Leaf Burn and Green Leaf Area

Treatment	Burn	Green
	---------- % ----------	
Control	0	7
Fungicide Only	0	33
3-8-15 V5-V6	0	7
3-8-15 R2-R3	2	6
3-8-15 V5-V6 & R2-R3	3	7
3-8-15 R2-R3 + Fung.	2	25
UAN R2-R3	13	6
UAN R2-R3 + Fung.	20	29

Disease Control

Treatment	Brown Spot		Bacterial Blight	
	Incid.	Sev.	Incid.	Sev.
Control	99	2.5	62	1.3
Fungicide @ R2-R3	73	1.2	41	1.0
3-18-18 @t V5-V6	98	2.5	72	1.2
3-18-18 @t R2-R3	98	2.3	62	1.3
3-18-18 @ V5-V6 & R2-R3	98	2.3	73	1.3
3-18-18 @ R2-R3 + Fung.	72	1.4	53	1.0
UAN @ R2-R3	100	2.4	66	1.3
UAN @ R2-R3 + Fung.	71	1.1	43	1.0

Average Yield Results



Foliar Fertilization for Soybean

- Not recommendable across all fields.
- Tactical use: Target fields to increase the chance of economic return, but criteria to choose fields aren't clear.
- Cutting fertilization to soil is risky.
- Can be mixed with some herbicides and fungicides, but conditions that make a response to each product likely seldom are the same.