Nebraska Soybean Board
Year-End Research Findings Report

DS VB

10/31/2017

Please use this form to summarize the practical benefits of your research project and what has been accomplished. Your answers need to convey why the project is important and how the results impact soybean production.

Project Title: *Resource Use Efficiency of High-Yield Soybean (#70326)*

Contractor & Principal Investigator: *UNL–Department of Agronomy. PI: Patricio Grassini*

Please check/fill in appropriate box: ☐ ***Continuation research project***
☒ ***Year 3 of 3 research project (for example: Year 1 of 2)***

1. ***What was the focus of the research project or educational activity?***

The goal of this project is to quantify light capture, nitrogen uptake, and water use requirements of soybean in highly productive producer fields where crops yields approach their potential. The ultimate goal is to understand what is needed to achieve very high yields and use this information to fine tune current soybean management in order to bring current farm yields closer to the potential

2. ***What are the major findings of the research or educational activity?***

During the crop seasons of 2015, 2016 & 2017, experiments were successfully conducted at four producer irrigated fields, with previous history of high soybean yields (80+ bu/ac), located at Atkinson, Mead, Saronville, and Smithfield. Main difference from the experiment conducted in year 1 of the project (year 2015) was inclusion of a separate treatment (years 2016 & 2017) that received periodic applications of nitrogen fertilizer to guarantee that crop nitrogen requirements for growth were fully met. The objective of including this treatment was to evaluate if high-yield soybean is limited, to any extent, by nitrogen supply. Just to give an idea of the magnitude of the work accomplished, our crew drove more than 20,000 miles per year during the summer months and collected more than 500 soy plant samples each season! We carefully recorded all management practices, including time of planting and irrigation events and application of fertilizer and pesticides. The four selected fields nicely portrayed the diversity of tillage methods across soybean producing regions in NE. Plant samples were collected EVERY WEEK and soil cores were taken at the beginning and end-of-season and also periodically during the growing season. These samples were collected and brought to our lab to determine growth stage, leaf area, total biomass, and partitioning of biomass into different plant organs (stems, leaves, seeds). Plant samples were dried, grinded, and sent to lab to determine nitrogen concentration. Equipment to measure light and water use were installed at each field and instruments were periodically checked by our crew and data downloaded. We have also installed a John Deere Field Connect (JDFC) equipment in each field and within the sampling site. The equipment and installation were provided at NO COST by John Deere. The JDFC included a meteorological station that recorded incoming solar radiation, maximum and temperature, relative humidity, rainfall, and wind speed, and also a soil water sensor probe that measures water in the upper 4 ft of the soil. We have also measured contribution from biological N fixation by installing a small corn plot near our soybean experimental area. We have just finished collected the yield samples from the 2017 crops at the four sites. We still need to process the rest the data collected during the 2017 growing season but, a priori, it seems like the four producers have achieved very high yields (ranging from 80 to 95 bu/ac) and one of the key elements to reach such high yield level was to plant early to make sure that the crop canopy 'harvests' most of the sunshine by the time soybean approaches R3, which coincides to the time in which soybean starts to set pods and seeds. Good fertilizer and weed programs were key

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for developing a green healthy green canopy that converts the sunshine into crop biomass and yield. See appended TECHNICAL REPORT, summarizing the experiments conducted during the Year 2 of the project (note that we are still processing the samples from Year 3 so results are not available yet).

3. ***Briefly summarize, in lay terms, the impact your findings have had, or will have, on improving the productivity of soybeans.***

This is the very first explicit effort to understand what is needed to produce 80+ bu/ac soybean routinely in producer fields. Likewise, this is the first study to evaluate the degree of limitation by nitrogen supply in environments that allow expression of soybean yield potential (80+ bu/ac). We believe that results from this project will help fine tune current management of soybean fields in order to bring producer soybean yields closer to their potential, by narrowing the existing yield gap. This is the third year of the project, and we are not done in processing the samples and data, but, a priori, it look like, similarly to the first two years of the project (2015 & 2016), the yield obtained at the four producer fields in 2017 were very high (all above 80 bu/ac) and we are excited to understand what combination of resources (light, water, nitrogen) and management (planting, density, MG, fertilizer) allowed these fields to achieve such high yield level. We also want to highlight that the four producers have told us how important is to have on-farm projects like ours in order to help NE soybean producers to sustain future soybean yield gains through better agronomic management.

4. ***Describe how your findings have been distributed to (a) farmers and (b) public researchers. List specific publications, websites, press releases. etc.***

We met with the four producers during wintertime in 2016 & 2017 to share the results from Years 1 & 2 experiments. Dr Patricio Grassini (Project PI) gave presentations about results from this project at the 2016 & 2017 winter UNL Crop Production Clinics at 8 locations in NE (total # of attendants: 500 per year). Patricio also presented these results at five extension event organized at Mead NE (2015), Bertrand NE (2015, 2016 & 2017), and Atkinson (2016) with a total of ca. 350 attendants. Nicolas Cafaro (PhD student working on this project) also presented the results at the NSB meeting at Lincoln NE in March 2016. We have published a UNL Extension Circular that includes results derived from this study: Grassini P, Rees J, Specht, J, Cafaro La Menza N 2016. What does it take to produce 80 bu/ac soybean? Extension Circular 3000. University of Nebraska-Lincoln. URL: http://extensionpubs.unl.edu/publication/9000017620473/what-does-it-take-to-produce-80buac-soybean/ ***We have also published a peer-reviewed scientific article: Cafaro La Menza N, Monzon JP, Specht J, Grassini P (2017) Is soybean yield limited by nitrogen supply? Field Crops Res. 213, 204-212. We will keep disseminating results from the project through extension avenues and scientific articles during 2018.***

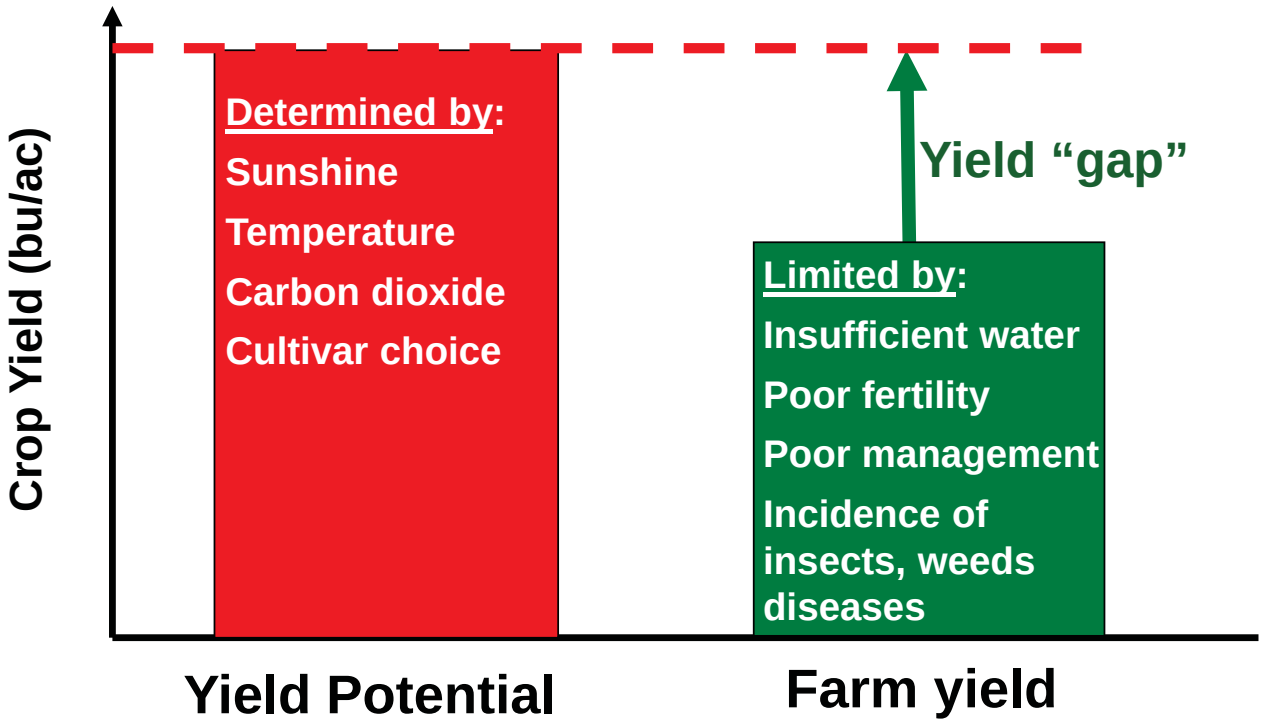
5. ***Did the checkoff funding for your project leverage any additional state or Federal funding? Please list sources and dollars approved.***

The funding provided us support and incentive to write another big 10-state 3-year proposal on soybean benchmarking, which was funded by the North Central Soybean Research Program (NCSRP) at a level of 1.5 million (total for the 3 years). Patricio Grassini is the PI of the funded NCSRP project.

SEE APPENDED TECHNICAL REPORT.

This form must accompany the fourth quarter (final report)

Yield potential, farm yield, and yield gaps



Modified from van Ittersum and Rabbinge (1997)

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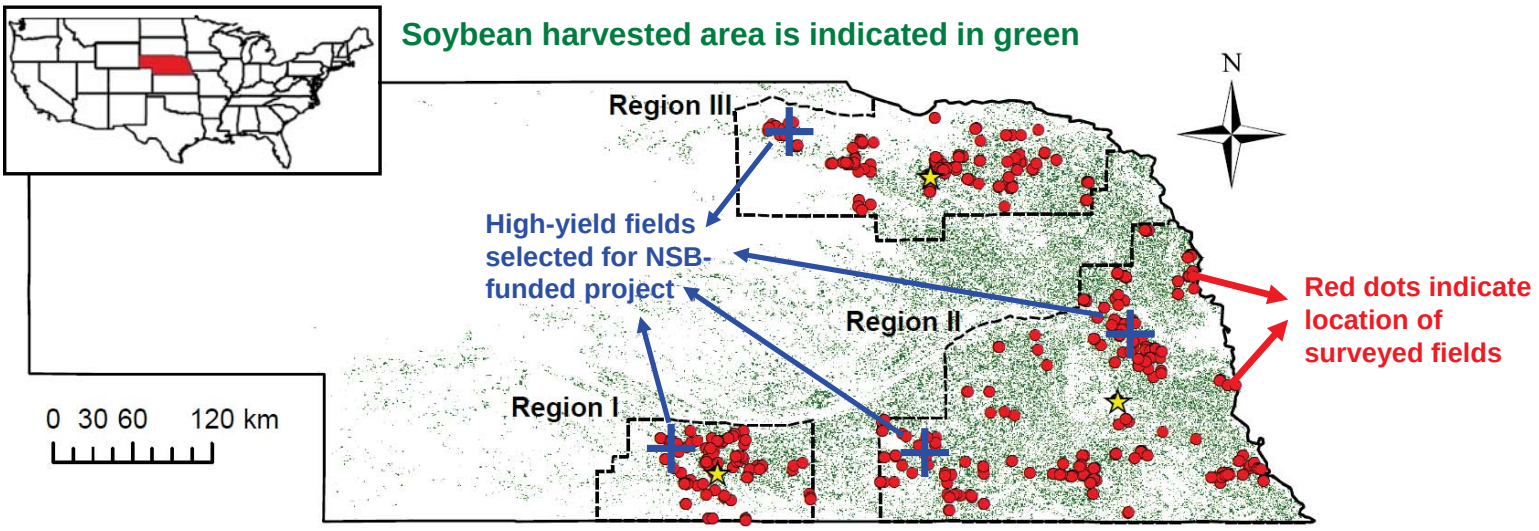
Selected fields for NSB project

Data from 500+ soybean fields in NE planted in 2010, 2011, and 2012 (collected through a previous NSB-funded project) were used as basis for selecting the high-yield fields (80+bu/ac) for the present NSB project



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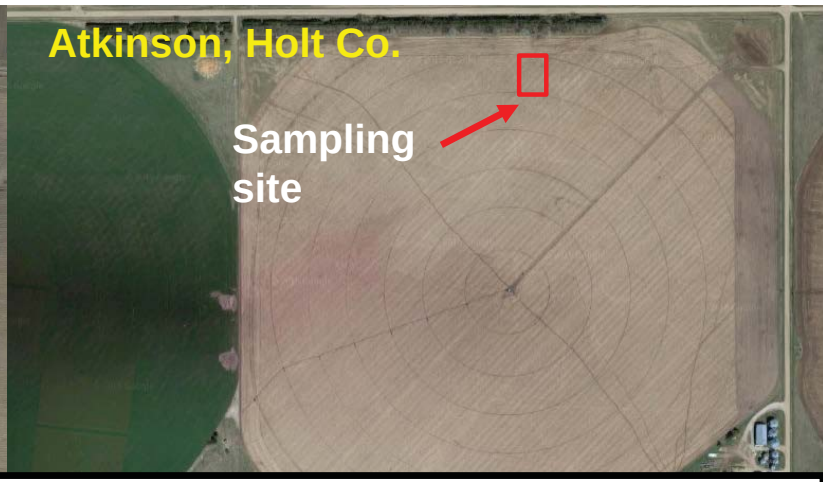
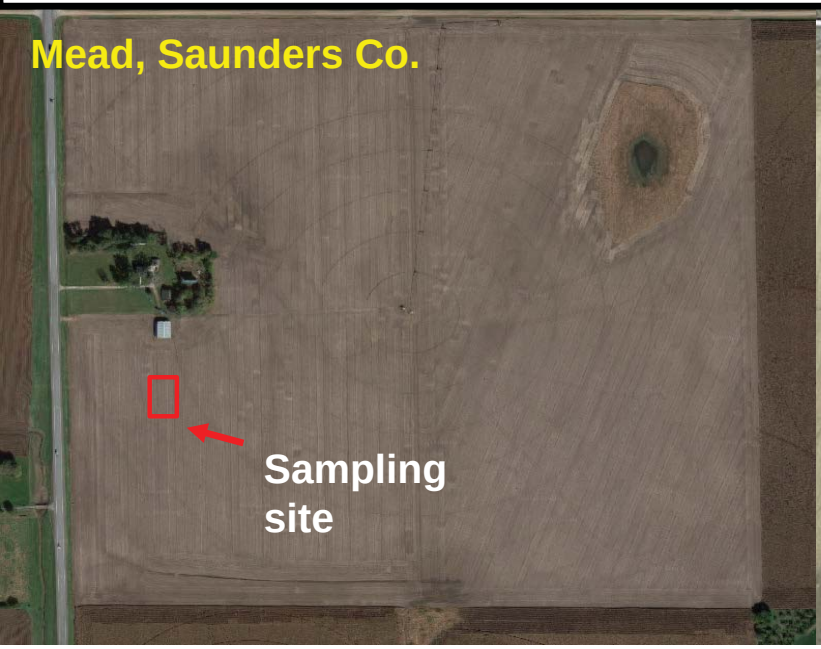
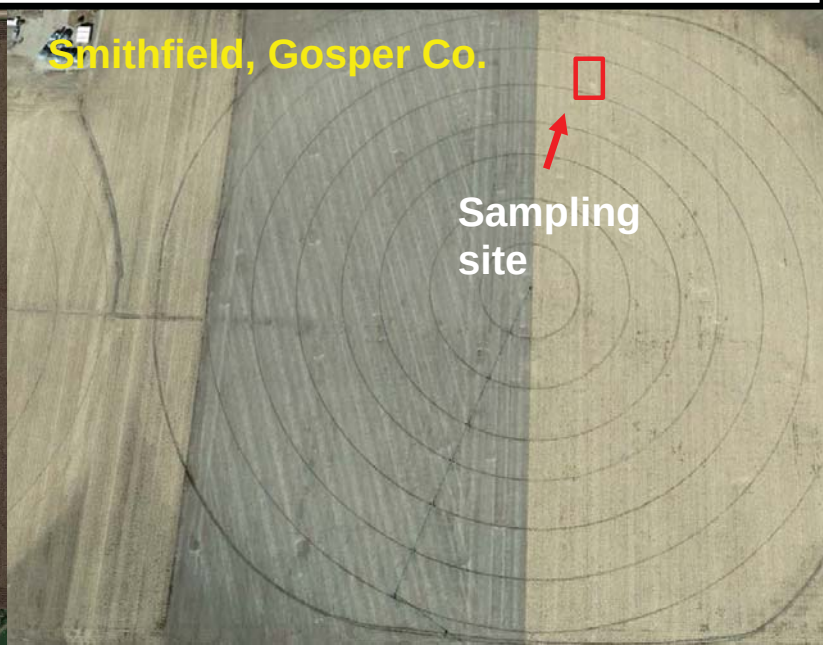


Selection of sampling sites in each field in 2016 was based on yield maps from previous years, proximity to road, and representativeness of local soil





2016 soybean field management

Location	Sowing date	Variety maturity group	Seeding rate (seeds ac^{-1})	Tillage	Fertilizer (lb ac^{-1})	Irrigation (in) & N credit from irrigation (lb N/ac)	Fungicide/ Insecticide at R3?
Saronville (Clay Co)	April 26	2.4	140K 30”	Disk	N(15) P(31) S(9) Zn(1)	7.6 inches 6 lb N/ac	YES
Atkinson (Holt Co)	April 25	2.7	160K 30”	Disk	N(18) P(20) K(45) Ca(55) Mg(7) S(15) Zn(1.5)	11.6 inches 51 lb N/ac	YES
Mead (Saunders Co)	May 8	2.7	140K 30”	Strip-till	N(12) P(18) S(10) Zn(1)	2 inches <1 lb N/ac	YES
Smithfield (Gosper Co)	May 13	2.4	180K 30”	No-till	P(34) S(1)	3.3 inches 2 lb N/ac	YES

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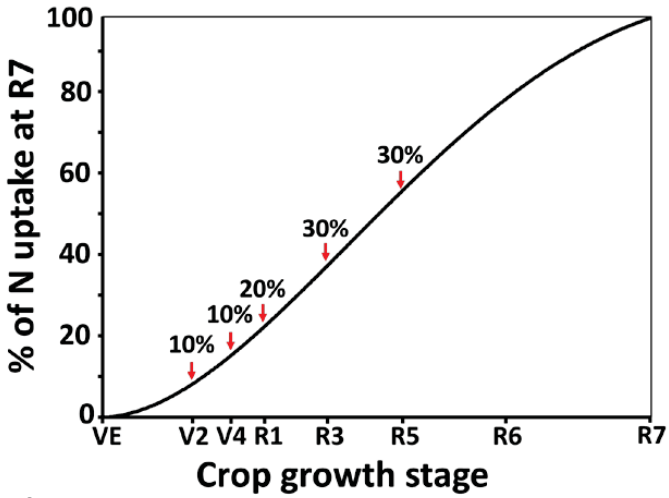
Experimental treatments

‘Zero-N’ fertilizer: relied on N from soil organic matter mineralization, starter, irrigation, and fixation.

‘Full-N’ fertilizer: N fertilizer was added based on:

- Site-specific yield potential
- 4.8 lb N per bushel requirement
- 70% fertilizer recovery



Yield potential ↓ 110 bu/ac x N requirement ↓ 4.8 lb N per bu / Fertilizer recovery efficiency ↓ 0.7 ≈ 800 lb N fertilizer/ac

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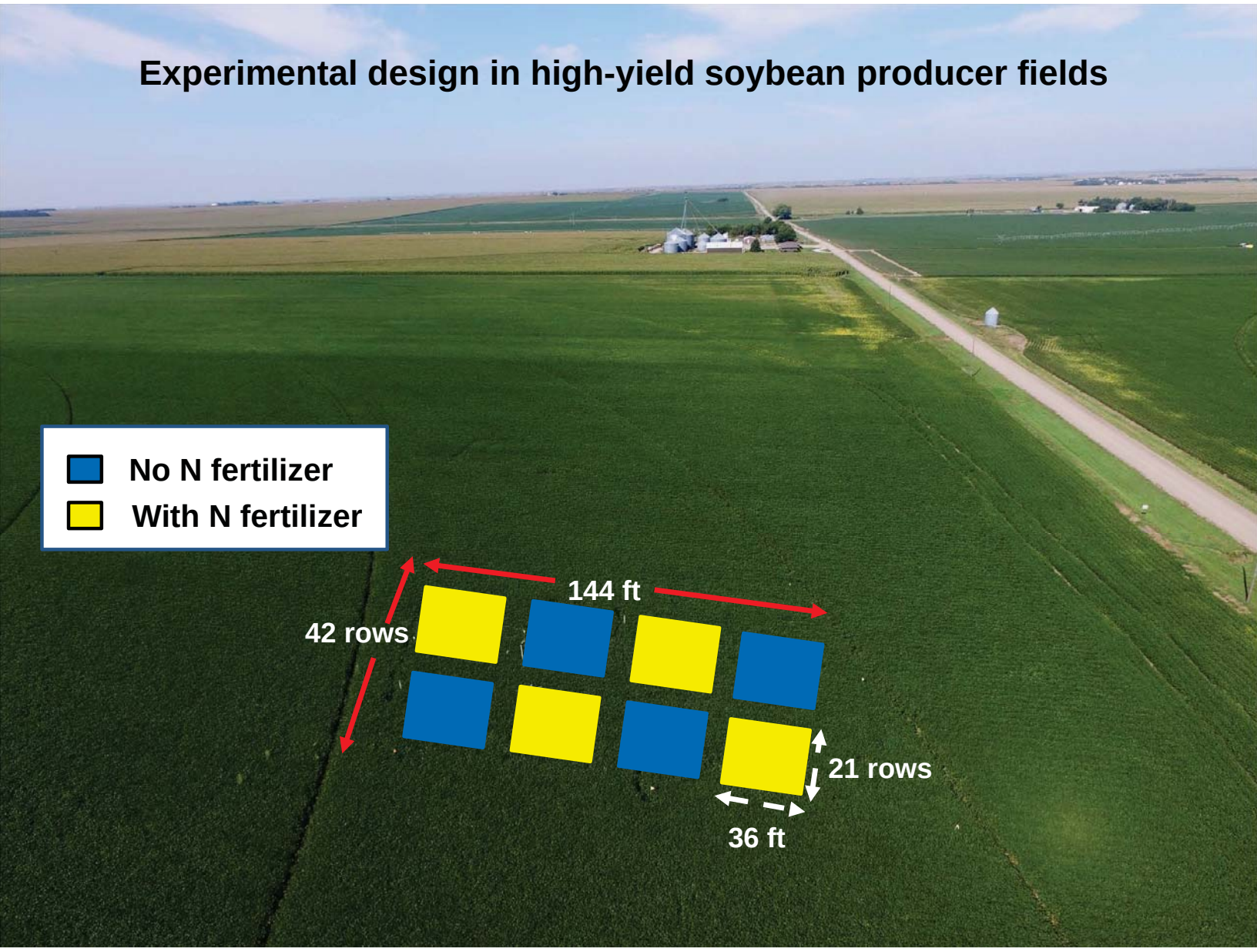

Weekly crop staging and collection of plant samples

Crop staging

Plant samples

Leaf area, dry matter, and nitrogen content

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2016 soybean yields

(all yields reported at 13% seed moisture content)

Producer yields (from 72 to 92 bu/ac) were much higher than average county yields. There was a yield response to N fertilizer in all fields.

Location	Average last 4-year county yield (bu/ac) *	Producer-reported average field yield (bu/ac) **	UNL-experiment yield (bu/ac) ***		UNL-experiment N uptake (lb/ac)	
			No N	With N	No N	With N
Saronville	61	79	87	95 (+9%)	357	390
Atkinson	56	92	83	90 (+8%)	482	511
Mead	61	72	79	92 (+16%)	384	414
Smithfield	65	84	79	85 (+8%)	324	340
				+8.5 bu/ac		+26 lb N/ac

* Average county irrigated soybean yield reported by USDA-NASS.
** Entire-field yield reported by producer.
*** Based on four subsamples (2 contiguous rows x 10 ft length) at each field.

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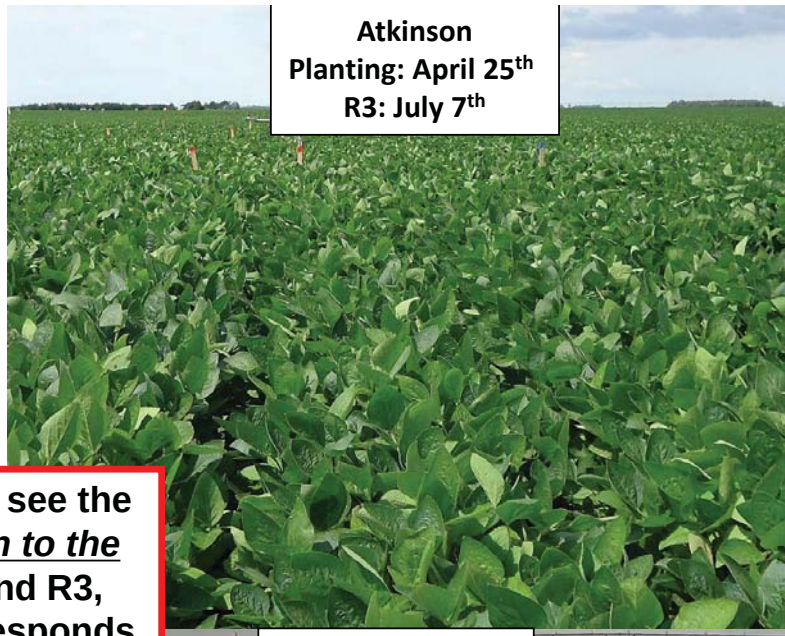

We want to see the field *'green to the eye'* around R3, which corresponds to beginning of pod setting in soybean