High-Yielding Soybean: Genetic Gain x Fertilizer Nitrogen Interaction

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Introduction: Presentation Outline

OUTLINE:

- Total N demand
- Soybean N Studies
- Results
- Conclusions

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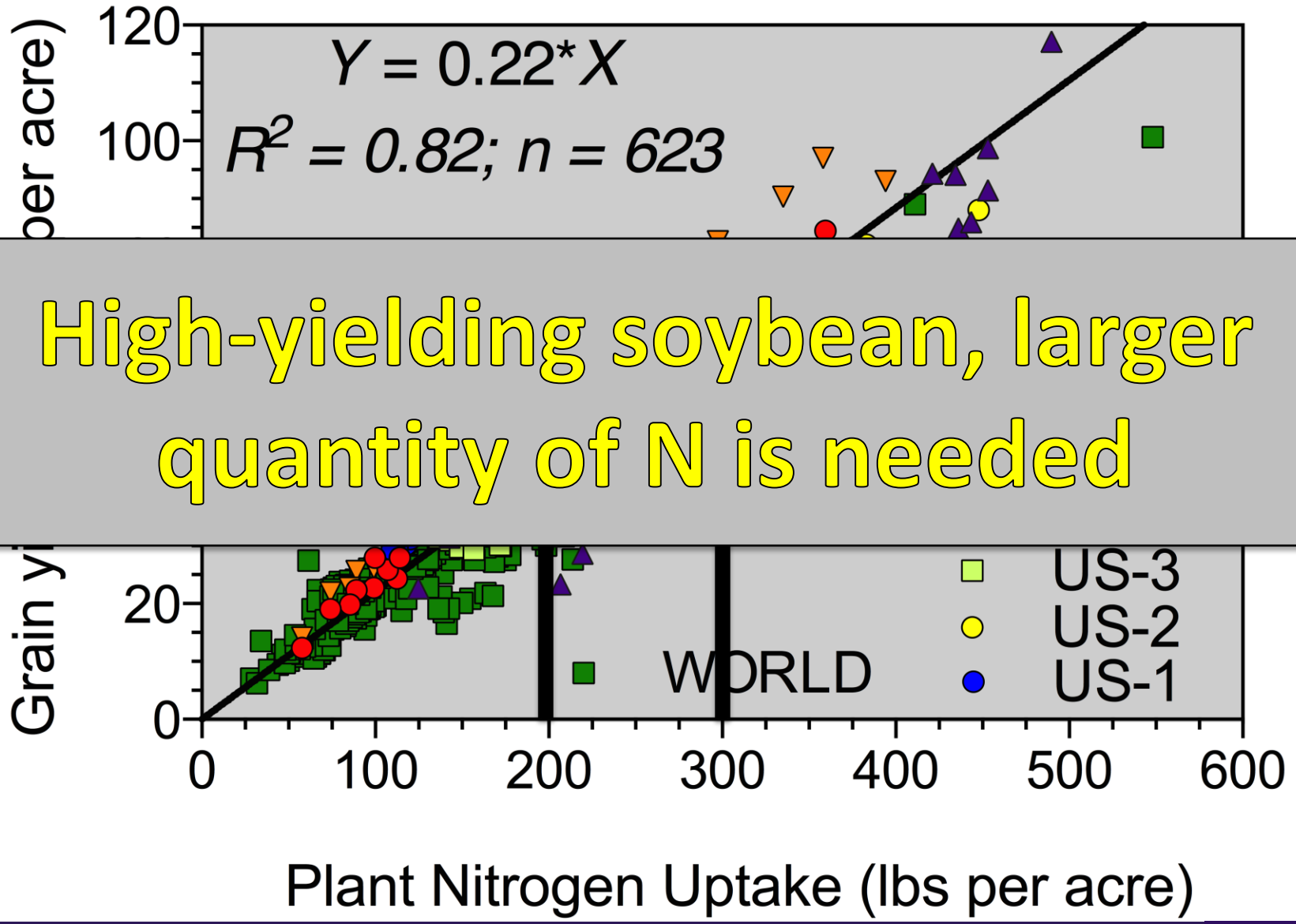
Plant N Demand vs. Grain Yield: Review



High-yielding soybean, larger quantity of N is needed

Soybean Genetic Gain x Fertilizer N interaction

Experimental sites

Ottawa, Ashland, and Rossville, KS

Oliveros, ARG

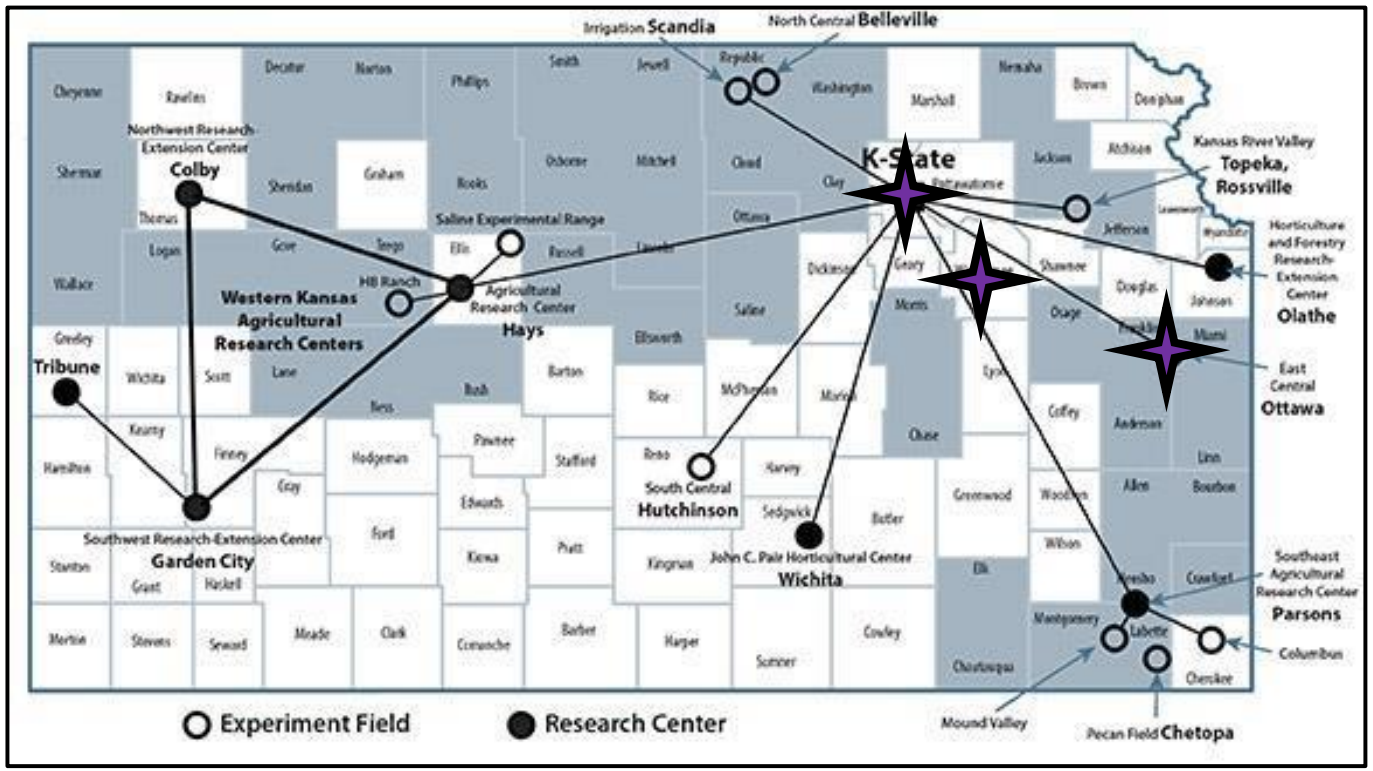


Figure 1. Map of the state of Kansas and Argentina identifying the four field studies conducted during the 2016 growing season: Ottawa (1), Ashland (2), Rossville (3) -US and Oliveros (4) –ARG.

Soybean Genetic Gain x Fertilizer N interaction

Treatments description

Treatment	Release Decades	Varieties	N application
1	1990's	non-RR	non-N applied
2			All N provided by fertilizer (600 lbs ac^{-1})
3			late-season N (50 lbs ac^{-1})
4	2000's	RR-1	non-N applied
5			All N provided by fertilizer (600 lbs ac^{-1})
6			late-season N (50 lbs ac^{-1})
7	2010's	RR-2	non-N applied
8			All N provided by fertilizer (600 lbs ac^{-1})
9			late-season N (50 lbs ac^{-1})

Pre-plant Soil characterization

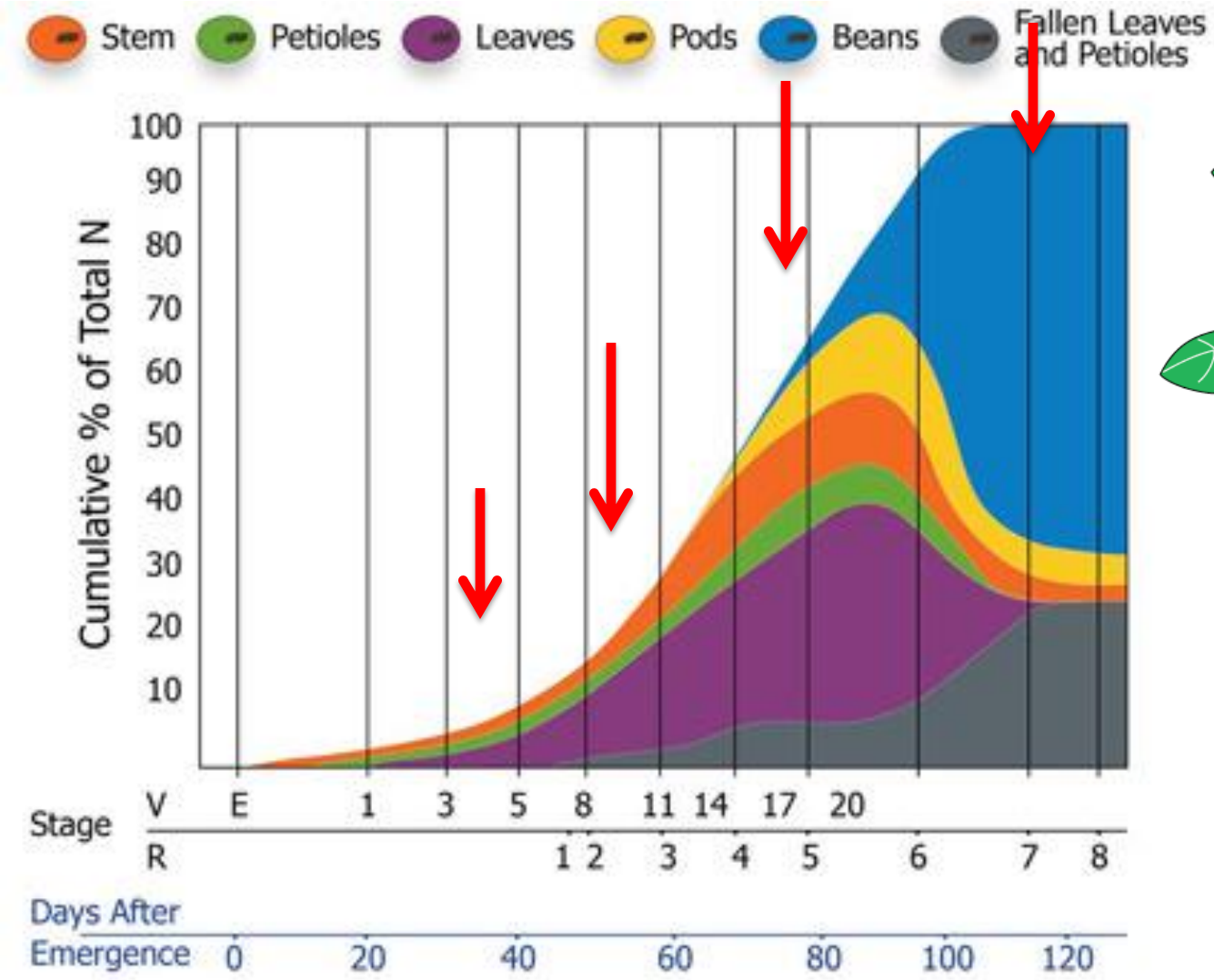
Soil parameters	Location			
	Ashland 6 inch depth	Ottawa 6 inch depth	Rossville 6 inch depth	Argentina 8 inch depth
pH	6.7	5.7	6.9	5.55
Mehlich P (ppm)	22	14	21	12
CEC (meq/100g)	9	18.5	11	-
OM (%)	1.5	4.3	2.17	2.14
K (ppm)	181	80	153	-
Ca (ppm)	1599	2665	2074	-
Mg (ppm)	179	393	202	-
$N\text{-}NO_3$ (ppm)*	2.5	5	3	6.3

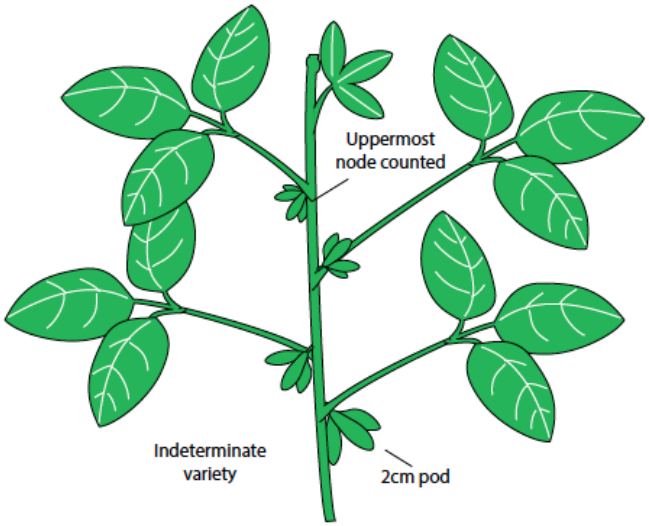
Soybean Genetic Gain x Fertilizer N interaction

Treatments description

Location	Description	Release Decades
Rossville (Kansas, US)	P3981, Williams 82, 9391	1980's
	9392, 93B82	1990's
	93Y92, 93B67, 93M90	2000's
	P34T43R2, P35T58R, P39T67R, 94Y23, P31T11R	2010's
Oliveros (Santa Fe, Argentina)	A4422, Williams	1980's
	A3910, DM49	1990's
	DM3700, DM4800	2000's
	NS4955, SRM3988	2010's
Ottawa and Rossville (Kansas, US)	P39B82	1990's
	93Y92	2000's
	P34T43R2	2010's

NITROGEN Uptake: Sampling Time





Full Pod

(~50% Total N Uptake)

40-45 days to Maturity

Plant Trait Determinations

In-Season

- Plant Height at V4, R2, R5
- Stem diameter at V4, R2, R5
- SPAD measurements at V4, R2, R5
- Light interception at V4, R2, R5
- Leaf Area Index at V4, R2, R5

Plant Biomass/Nutrient

- Plant Biomass sampling at V4, R2, R5, and R7

- Leaf and Stem (Vegetative)
- Pods, Grains (Reproductive)

Roots

- Root Sampling at V4 stage
- Root Scanning
- Nodule Count

Grain Yield

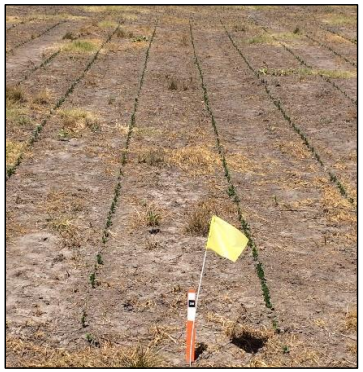
- Machine-harvested central two-rows (5x50 ft)
- Plants were also collected to estimate:
  - final grain number,
  - seed weight,
  - Grain harvest index (HI)

In-season Activities

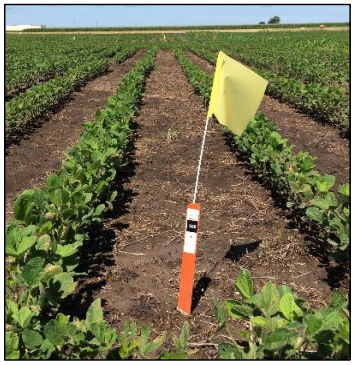
In-Season Activities
2015 and 2016 Growing Seasons

VC
Emergency

V1
Stand Count

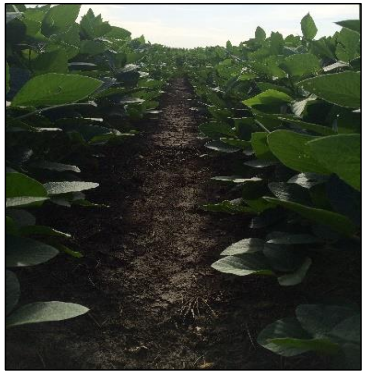


V4
Biomass Sampling



V6
Root Sampling

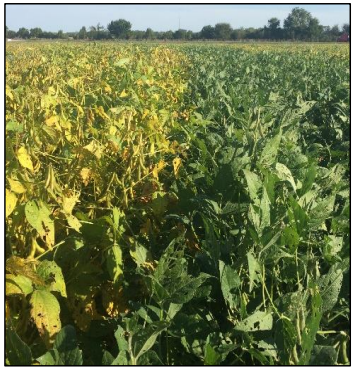
R2
Biomass Sampling



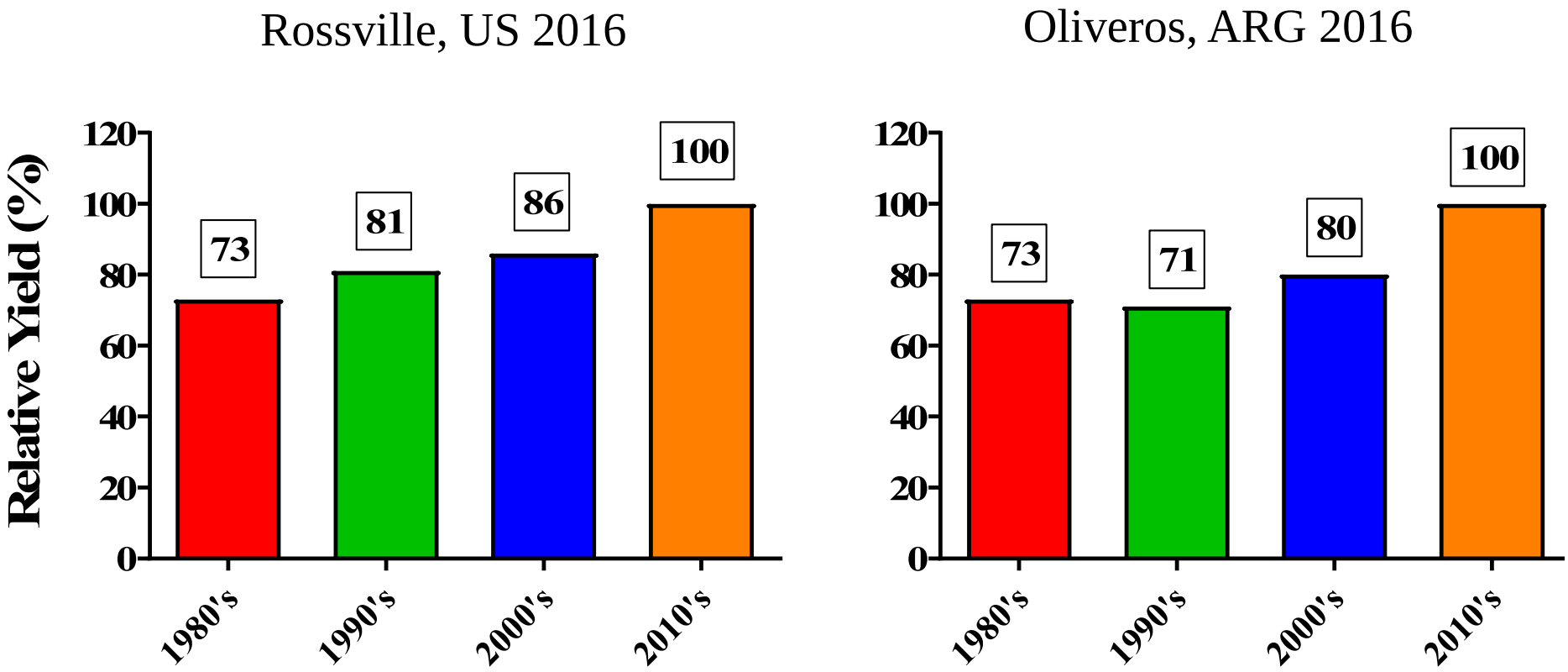
R3
N Application

R5
Biomass Sampling

R6-R7
Senescence/Maturity



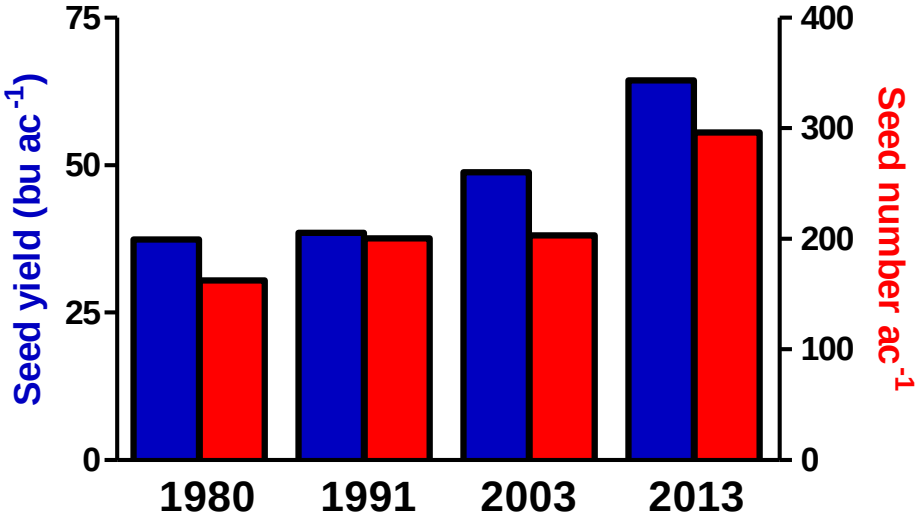
Historical Yield Gains

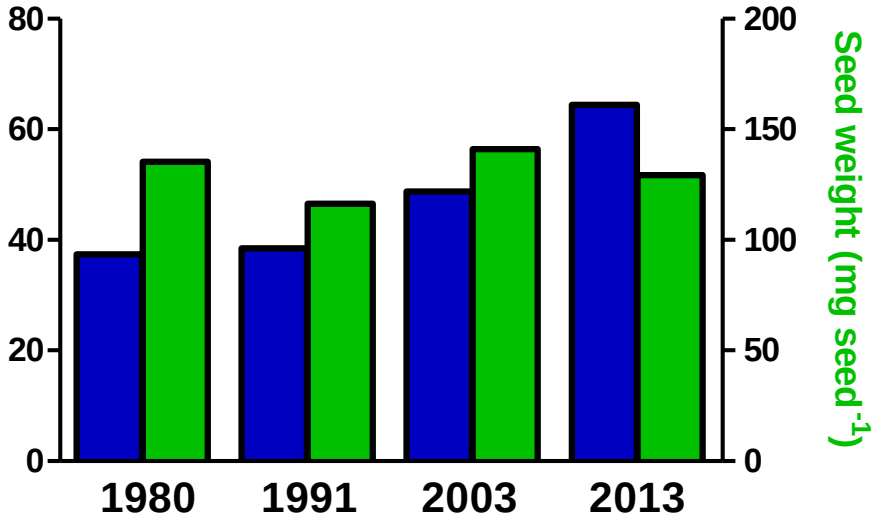


Historical yield improvement for US and ARG soybean commercial varieties

Historical Yield Gains

Seed yield: numerical components



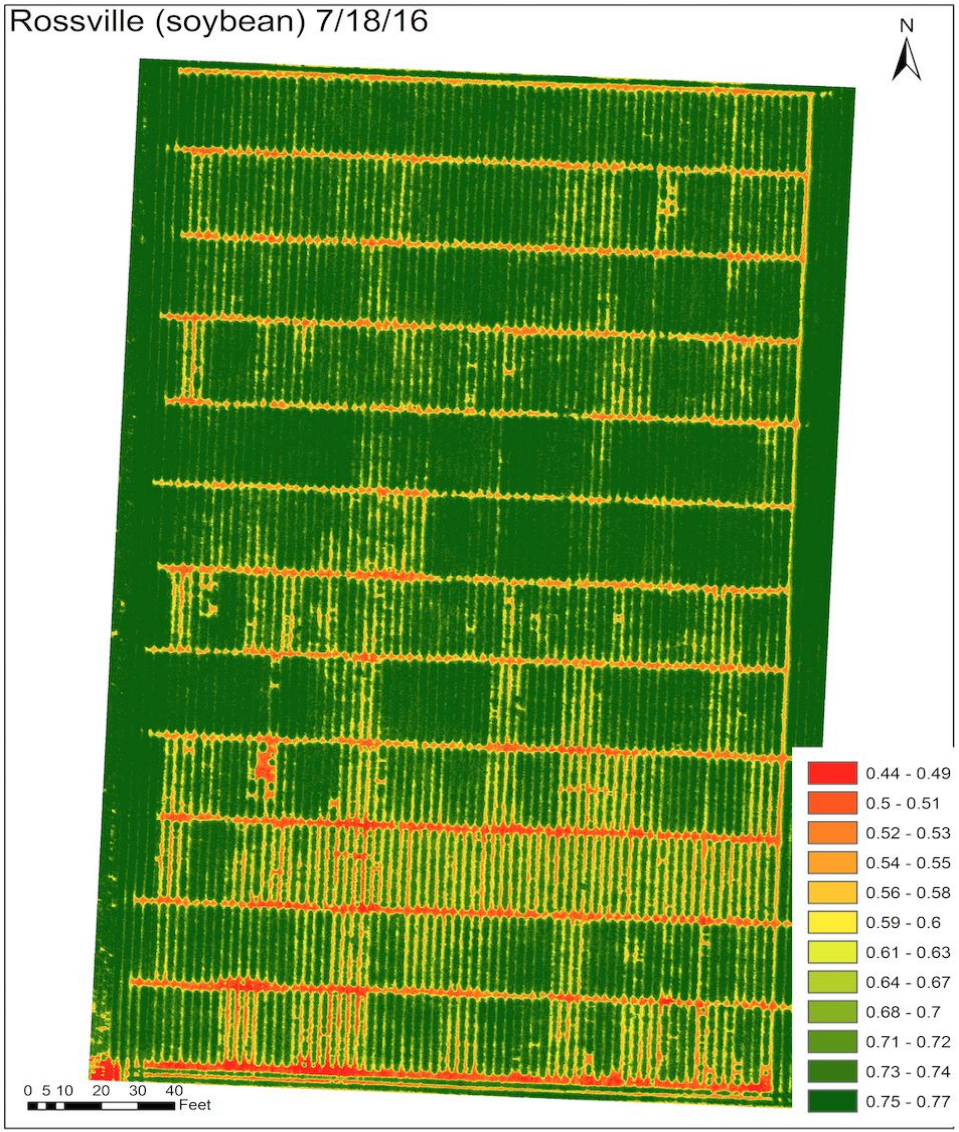


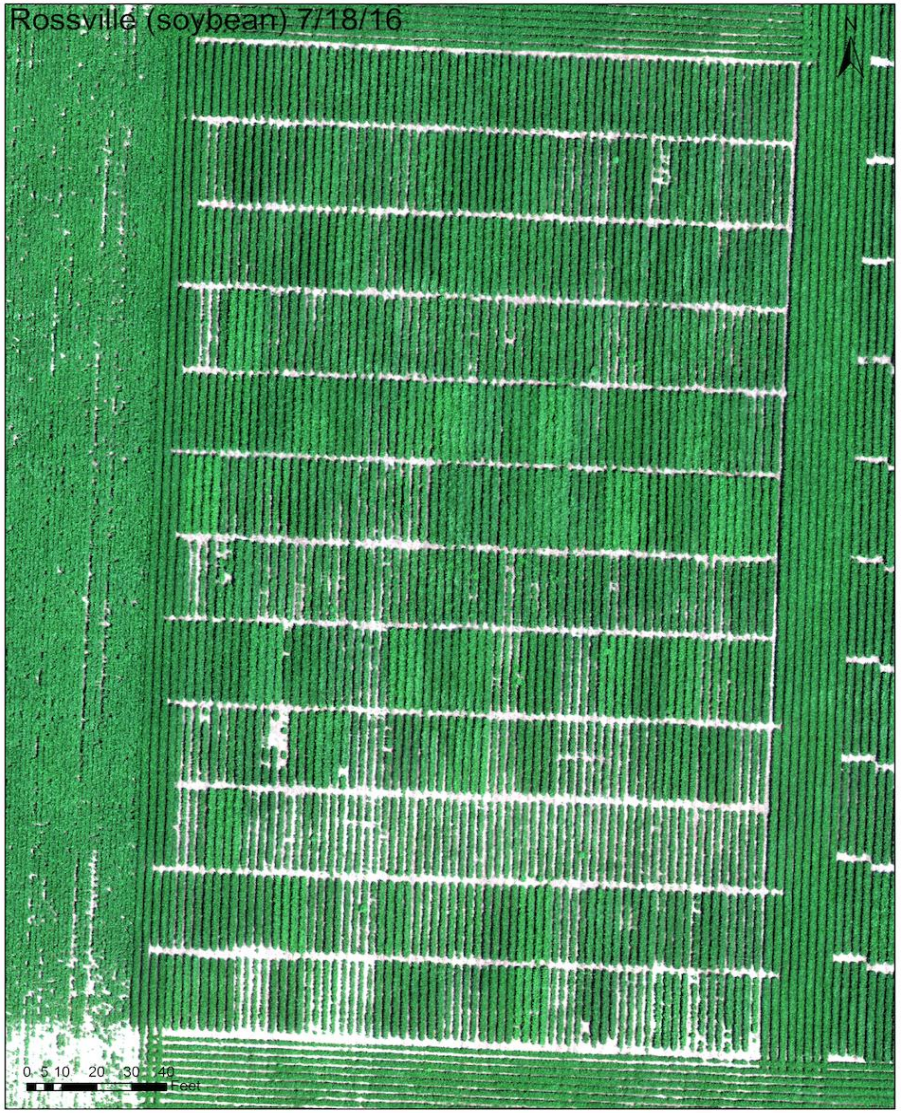
Seed number follow the same trend that seed yield. Improving with genetic gain.

Seed weight did not follow a similar trend with genetic yield gain.

Rossville Site (KS) – Soybean G x N

Imagery data collected via drone from mid-season (July). NDVI analysis in progress.





Historical Yield Gains

RESULTS

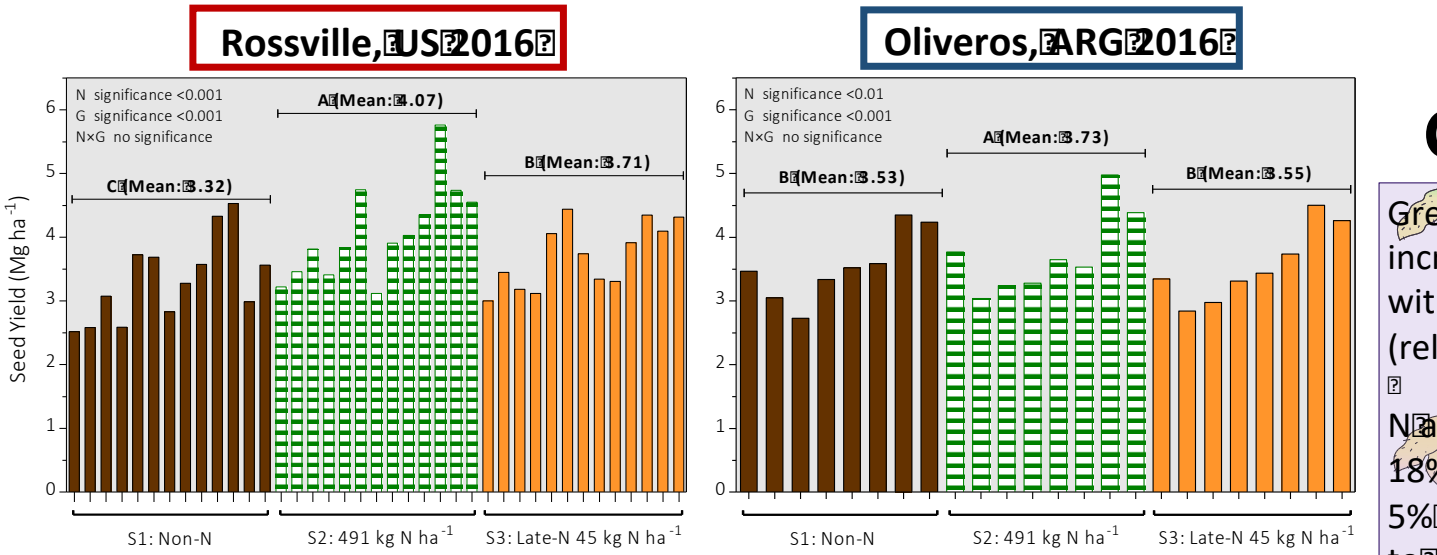
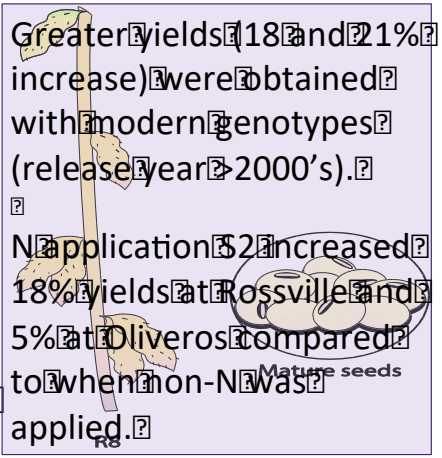


Figure. Seed yield for soybean genotypes with different N fertilization strategies at Rossville, US and Oliveros, ARG during the 2016 growing season.

Historical Genotypes

Greater yields (18 and 21% increase) were obtained with modern genotypes (release year > 2000's).

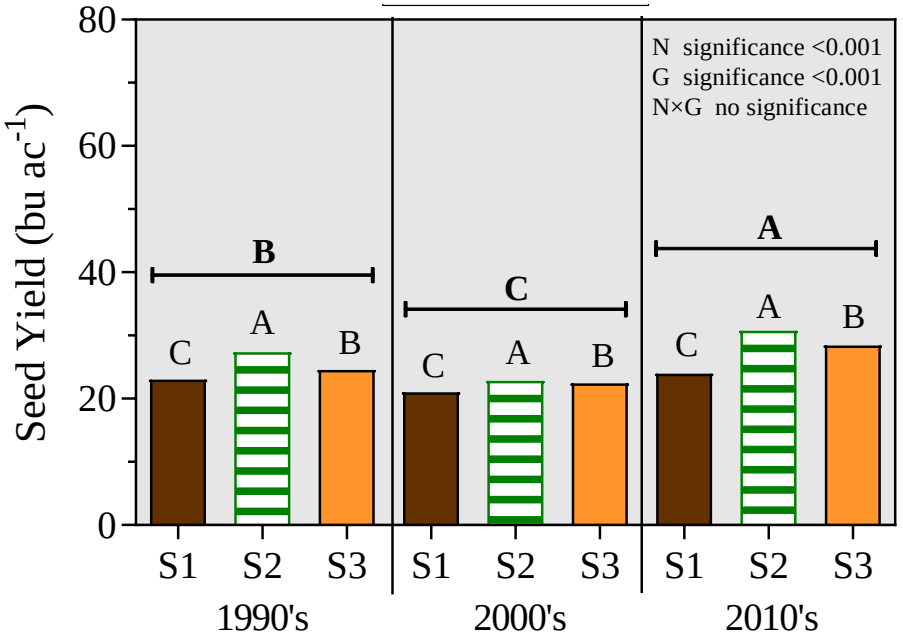
N application S2 increased 18% yields at Rossville and 5% at Oliveros compared to when non-N was applied.



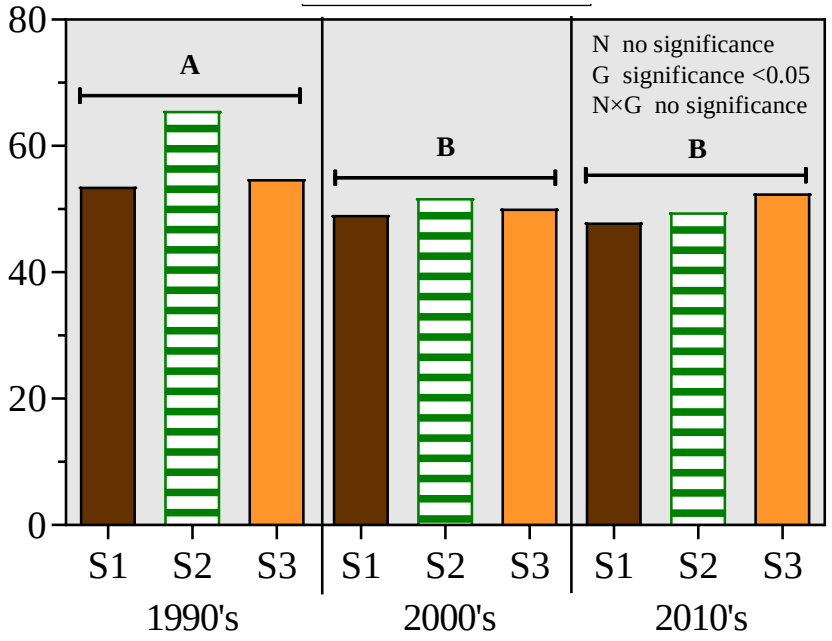
Historical yield improvement for US and ARG soybean commercial varieties

Seed Yields

Ottawa



Ashland

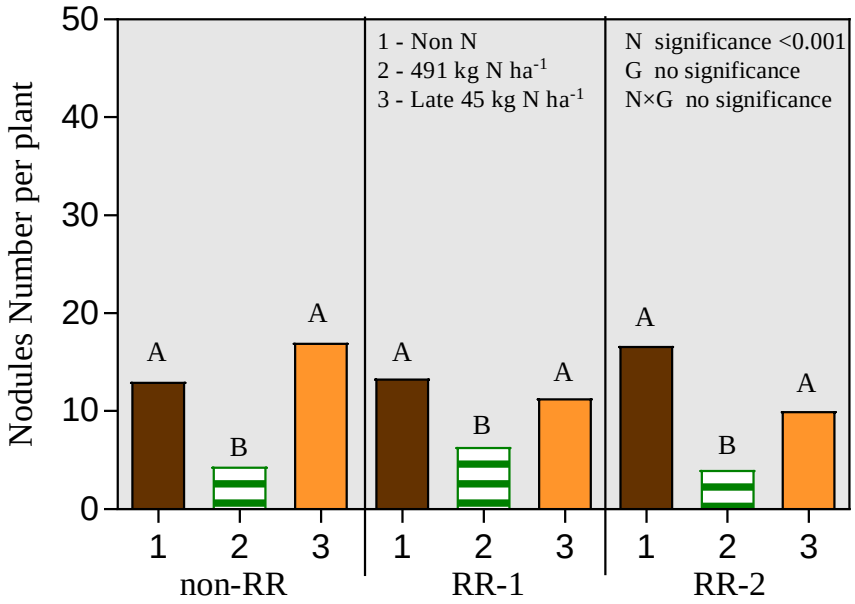


At Ottawa, G x N = high N rate +yields > Non-N

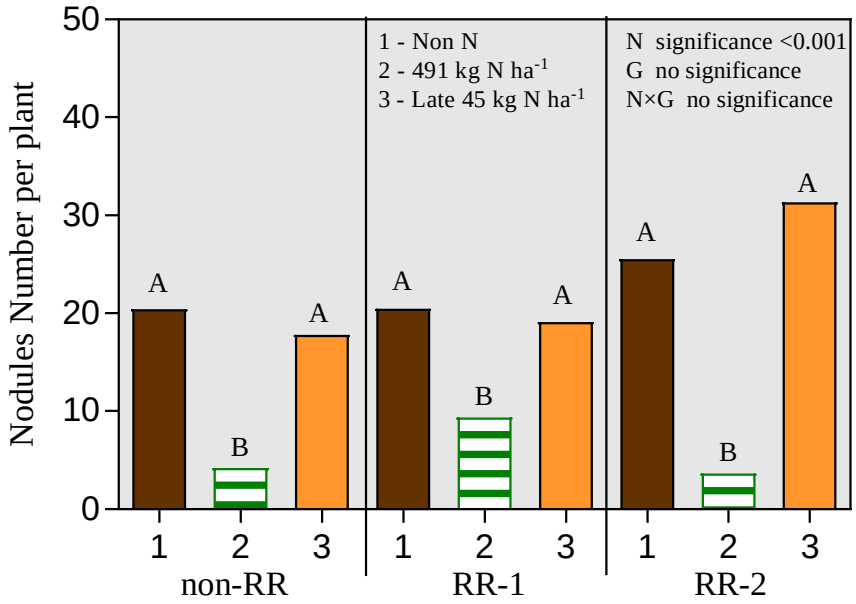
At Ashland, G effect = 1990's > 2000's & 2010's

Soybean Physiology: Nodule Count

Ottawa



Ashland



Nodule count per plant was superior when non-N and late-N was applied relative to the high-N rate at both Ottawa and Ashland.

Soybean Physiology: Biomass and HI

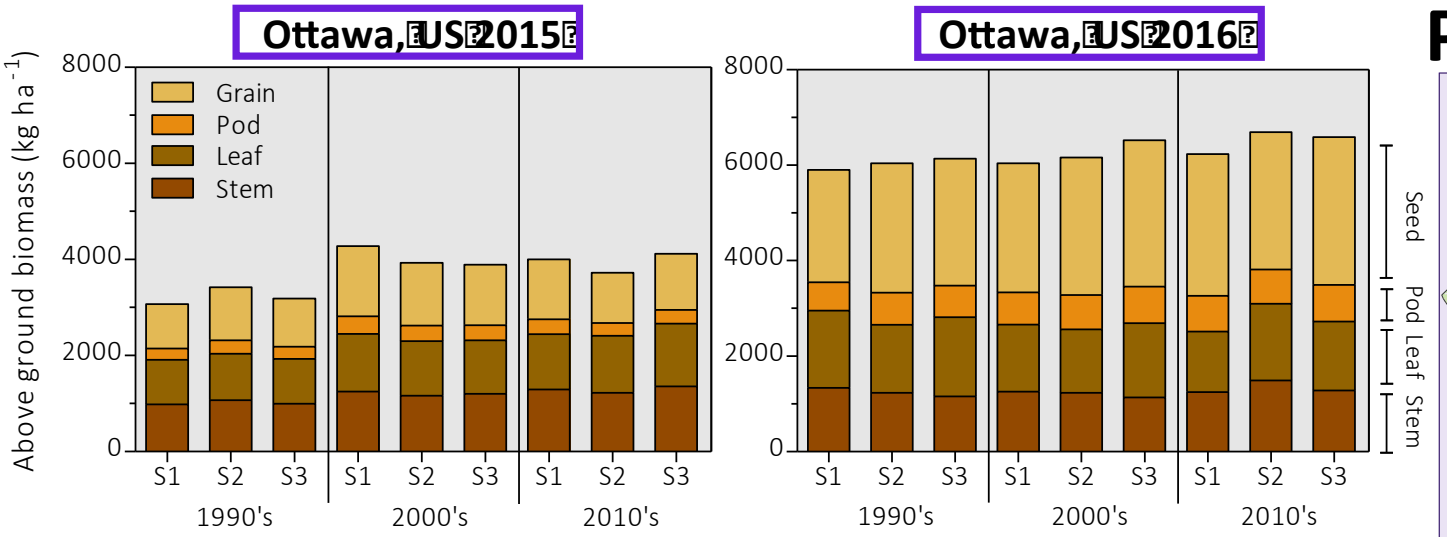
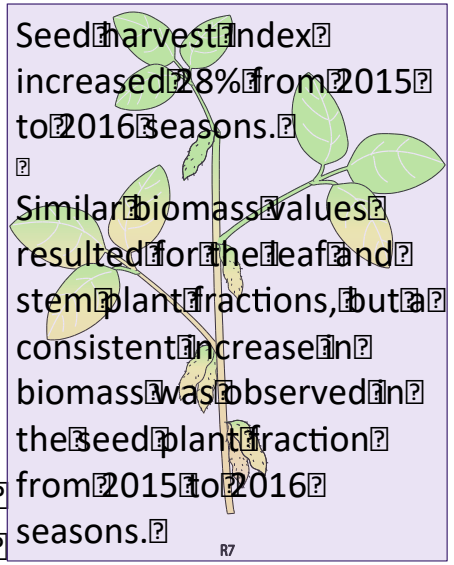


Figure 4. Aboveground plant biomass and plant fractions, expressed in dry weight (seed, pod, leaf and stem) at Ottawa, US during 2015 and 2016 seasons.

Plant Biomass

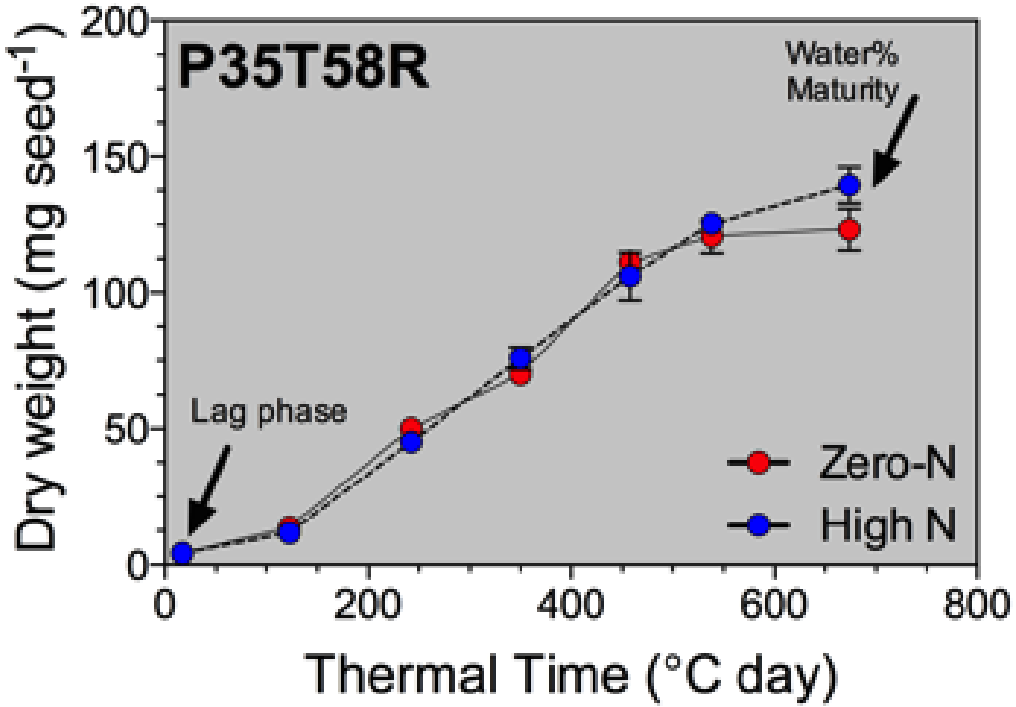
Seed harvest index increased 28% from 2015 to 2016 seasons.

Similar biomass values resulted for the leaf and stem plant fractions, but a consistent increase in biomass was observed in the seed plant fraction from 2015 to 2016 seasons.



For higher yields, both improvements in seed biomass and harvest index (seed to total plant biomass ratio) were recorded

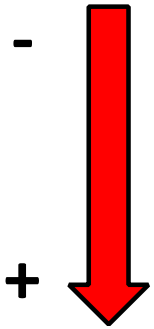
Soybean Physiology: Grain Filling



Seed dry weight evolution during the grain filling versus thermal time (40 days after R5 stage) for soybean var. P35T58R

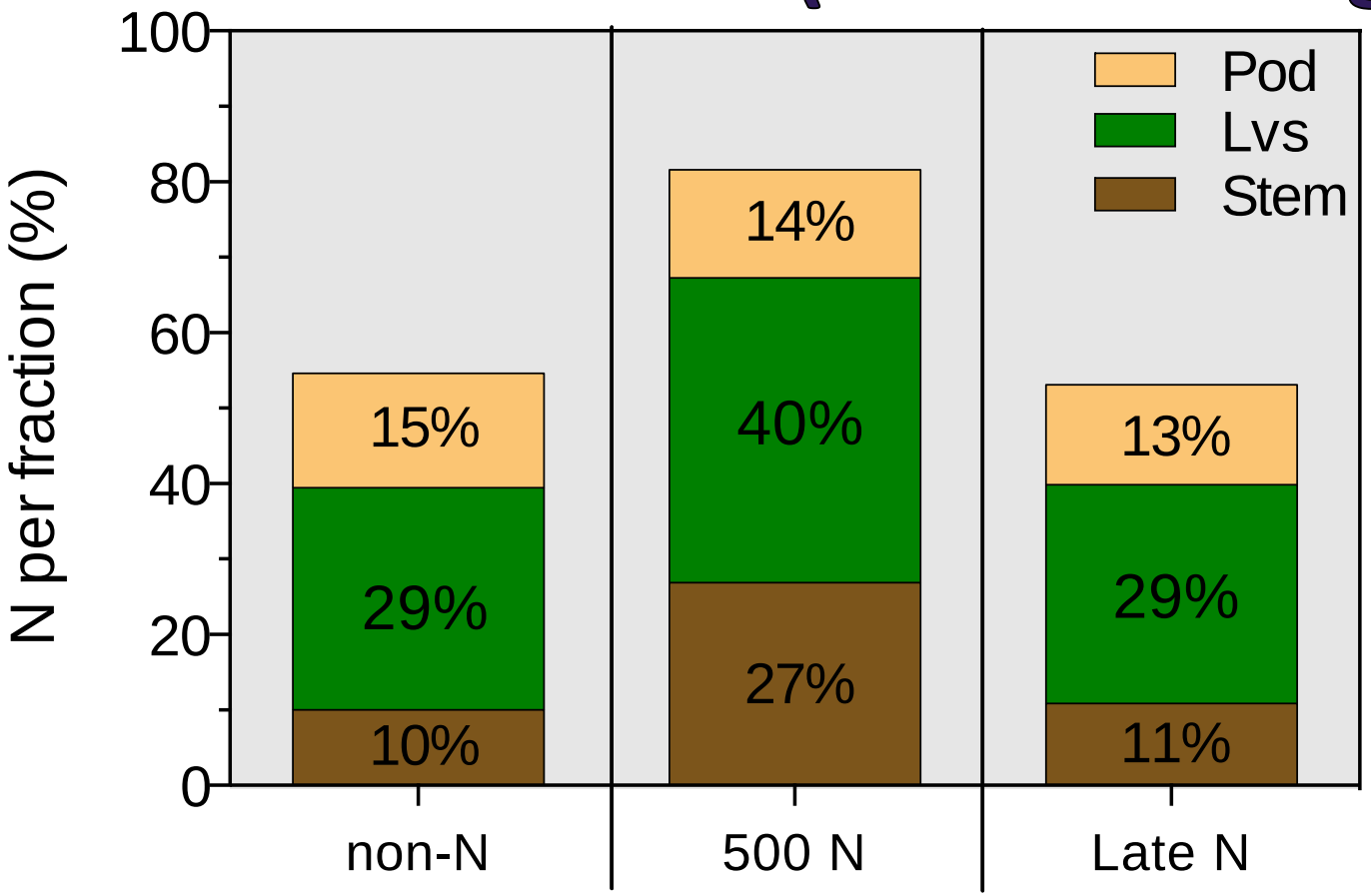
5 days difference = ~10 bu/a

Stressfull condition



Duration	Final seed weight	Seed weight loss	Seed yield
days	mg seed^{-1}	%	bu ac-1
35	131	-	64
33	123	6	61
30	112	15	55
28	104	20	51
25	93	29	46

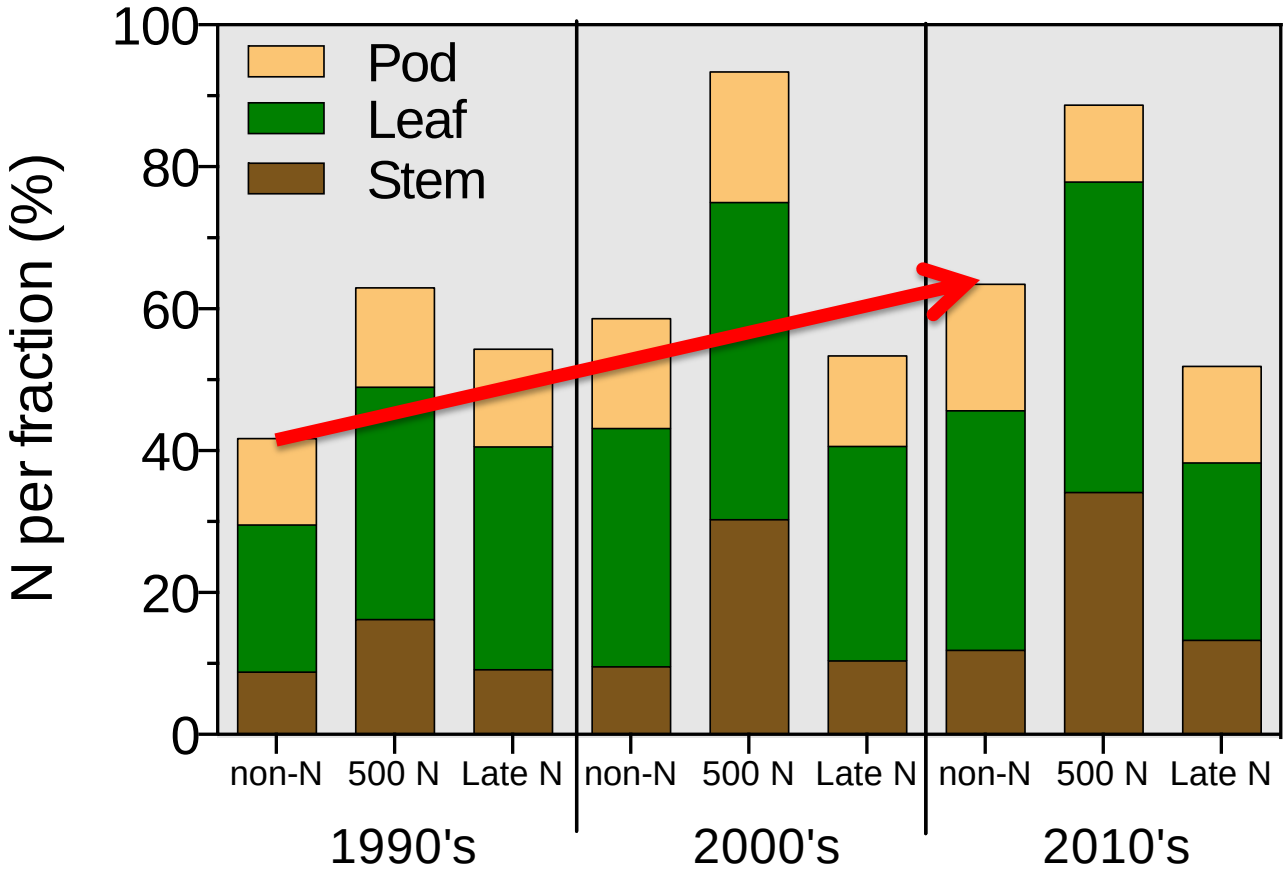
N Remobilization (R5 to R8 stages)



High N = > +N coming from Veg. Structures

Non-N & Late-N = > +N from BNF

N Remobilization



High N = > +N coming from Veg. Structures

Non-N & Late-N = > +N from BNF (40-50%)

Conclusions

- All site-year environments documented differences in yields across genotypes.
- Higher yields were observed for modern soybean genotypes, released in-and-after the 2000's decade.
- Fertilizer N response was observed in most of the environments. Fertilizer strategies 2 (late-N) and 3 (fertilizer N applied) showed greater yields across genotypes and environments.
- Further research is recommended to keep exploring the effects of genetic gain and fertilizer N application on soybean yields.

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QUESTIONS
THANKS!

Fluid Fertilizer Foundation

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