Genetic Gain × Fertilizer Nitrogen Interaction on Soybeans

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INTRODUCTION

Soybean yields are determined by Genotype × Environment × Management (G × E × M) practices interaction. On overall, 50-60% of soybean nitrogen (N) demand is usually met by Biological Nitrogen Fixation, BNF (Salvagiotti et al., 2008).

An unanswered scientific knowledge is still related to the ability of the BNF process to satisfy soybean N demand at different yield levels.

OBJECTIVES

- Evaluate the performance of historical and modern soybean genotypes on yields.
- Study the contribution of N, at different rates and timings, on soybean yields.

MATERIAL AND METHODS

Three field experiments were conducted during the 2015-16 growing seasons (Fig. 1)
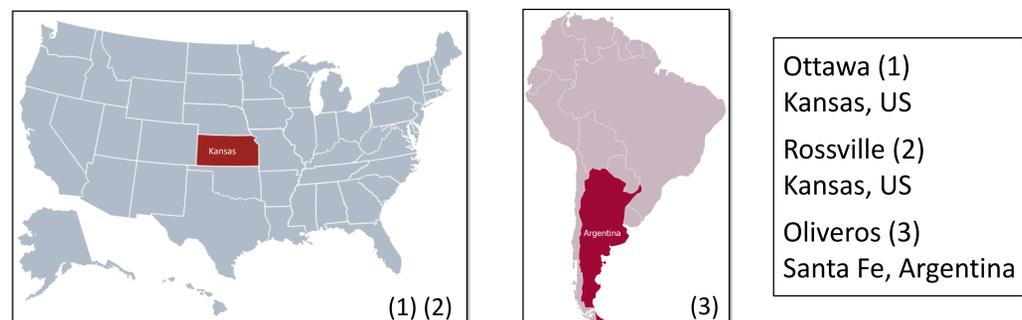

Ottawa (1) Kansas, US

Rossville (2) Kansas, US

Oliveros (3) Santa Fe, Argentina

Figure 1. Map with experiment locations evaluated during 2015-2016 growing seasons in Kansas (US) and Santa Fe (Argentina).

Table 1. Soybean genotypes and release decades utilized in 2015-2016 seasons.
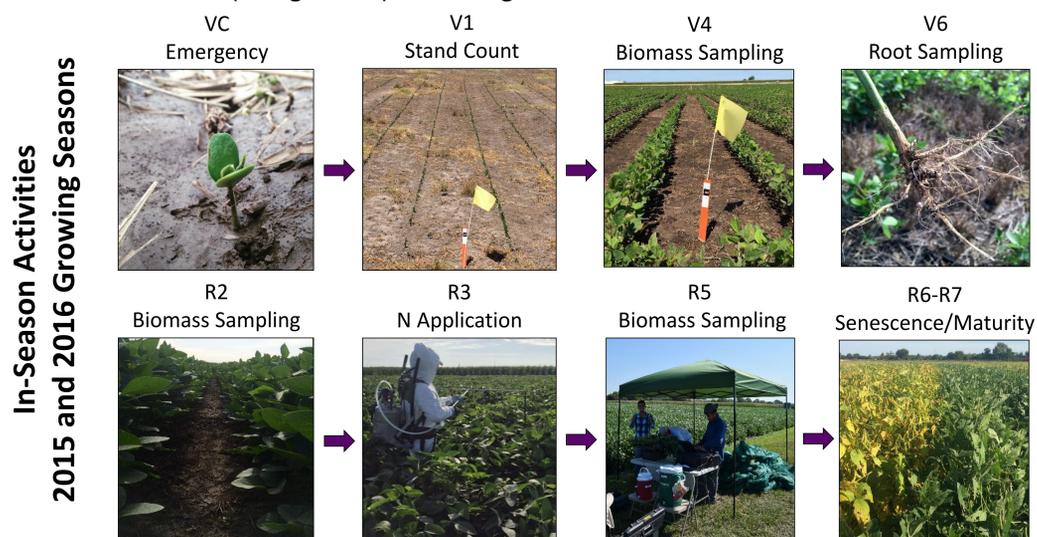
Location	Description	Release Decades
Rossville (Kansas, US)	P3981, Williams 82, 9391	1980's
	9392, 93B82	1990's
	93Y92, 93B67, 93M90	2000's
	P34T43R2, P35T58R, P39T67R, 94Y23, P31T11R	2010's
Oliveros (Santa Fe, Argentina)	A4422, Williams	1980's
	A3910, DM49	1990's
	DM3700, DM4800	2000's
	NS4955, SRM3988	2010's
Ottawa and Rossville (Kansas, US)	P39B82	1990's
	93Y92	2000's
	P34T43R2	2010's

Three N management strategies were applied at different rates and timings:

S1: Non-N applied, only inoculated.
S2: All N provided by fertilizer (491 kg N ha^{-1}); split at planting, R1, and R3 stages.
S3: Late-season N (45 kg N ha^{-1}) at R3 stage.

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

RESULTS

Rossville, US 2016 — N significance <0.001, G significance <0.001, N×G no significance; A (Mean: 4.07), B (Mean: 3.71), C (Mean: 3.32)

Oliveros, ARG 2016 — N significance <0.01, G significance <0.001, N×G no significance; A (Mean: 3.73), B (Mean: 3.53), B (Mean: 3.55)

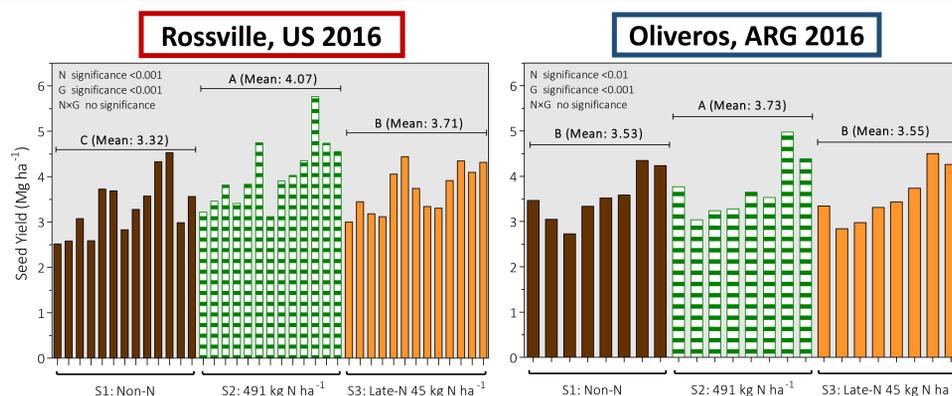S1: Non-N; S2: 491 kg N ha^{-1}; S3: Late-N 45 kg N ha^{-1}

Figure 2. 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.

Genotype by N Interaction

At Rossville (2016), yields ranged from 3.3 to 4.7 Mg ha^{-1}.

At Oliveros (2016), genotype and N application showed positive interaction, highest yield (5 Mg ha^{-1}) was observed with the modern soybean genotype and the N management approach S2.

At Ottawa, yields ranged from 1.4 to 2.1 Mg ha^{-1} in 2015, and 2.8 to 3.4 Mg ha^{-1} in 2016. Higher yields were observed for modern soybean genotypes and the S2 and S3 N management approaches.

Rossville, US 2016 — N no significance, G significance <0.05, N×G no significance

Oliveros, ARG 2016 — N no significance, G significance <0.001, N×G significance <0.05

Ottawa, US 2015 — N significance <0.001, G significance <0.001, N×G no significance

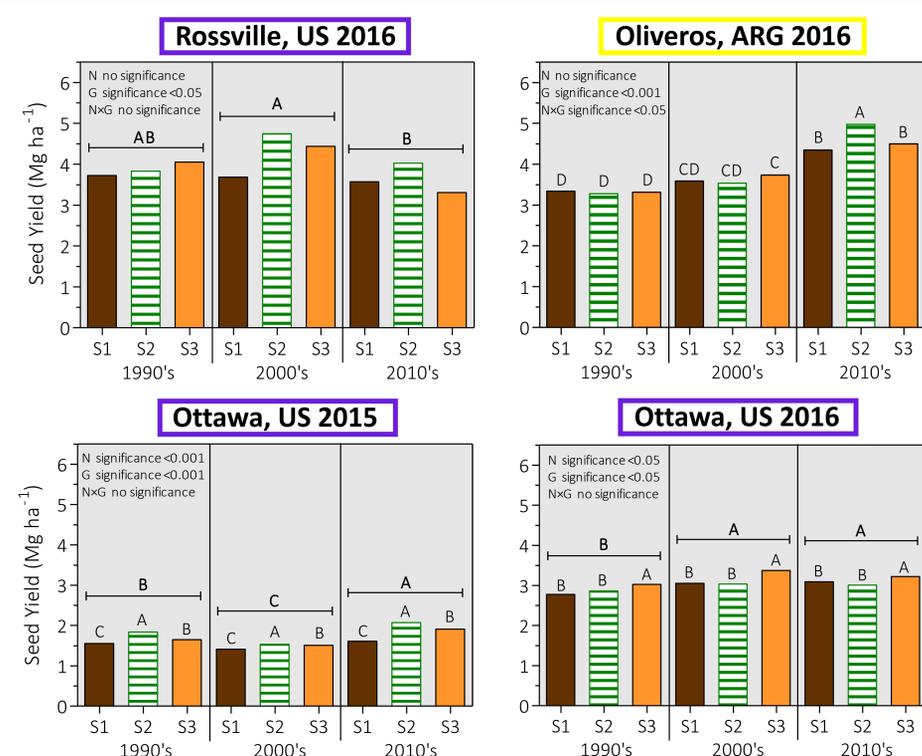Ottawa, US 2016 — N significance <0.05, G significance <0.05, N×G no significance

Figure 3. Seed yield for soybean genotypes by N fertilization strategies at US (Ottawa and Rossville) and ARG (Oliveros) during 2015-2016 growing seasons.

Plant Biomass

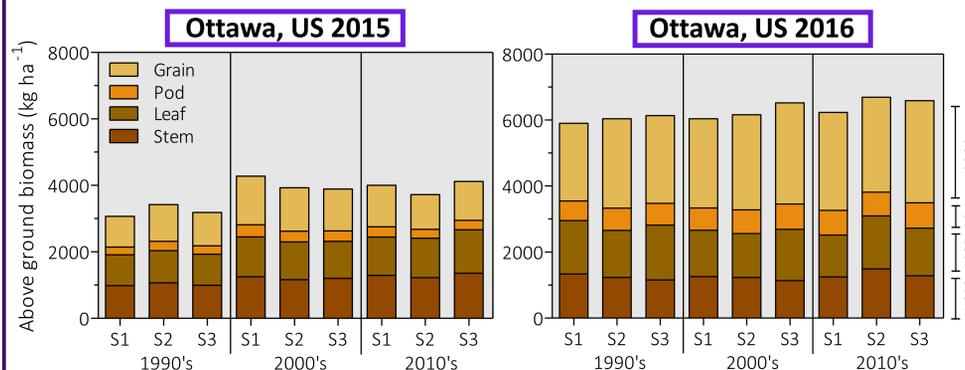Ottawa, US 2015; Ottawa, US 2016; Grain, Pod, Leaf, Stem

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.

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.

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 (S2) and 3 (S3) 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.