High-Yielding Soybean: Genetic Gain x Fertilizer Nitrogen Interaction

Ignacio A. Ciampitti, Cropping Systems Specialist
K-State Research & Extension; ciampitti@ksu.edu
Fernando Salvagiotti, INTA Argentina
salvagiotti.fernando@inta.gob.ar

@KSUCROPS (TWITTER)

K-STATE Research and Extension

INTA

Ministerio de Agricultura, Ganadería y Pesca
Presidencia de la Nación

Crop Production Team

KSUCROPS

Introduction: Presentation Outline

OUTLINE:

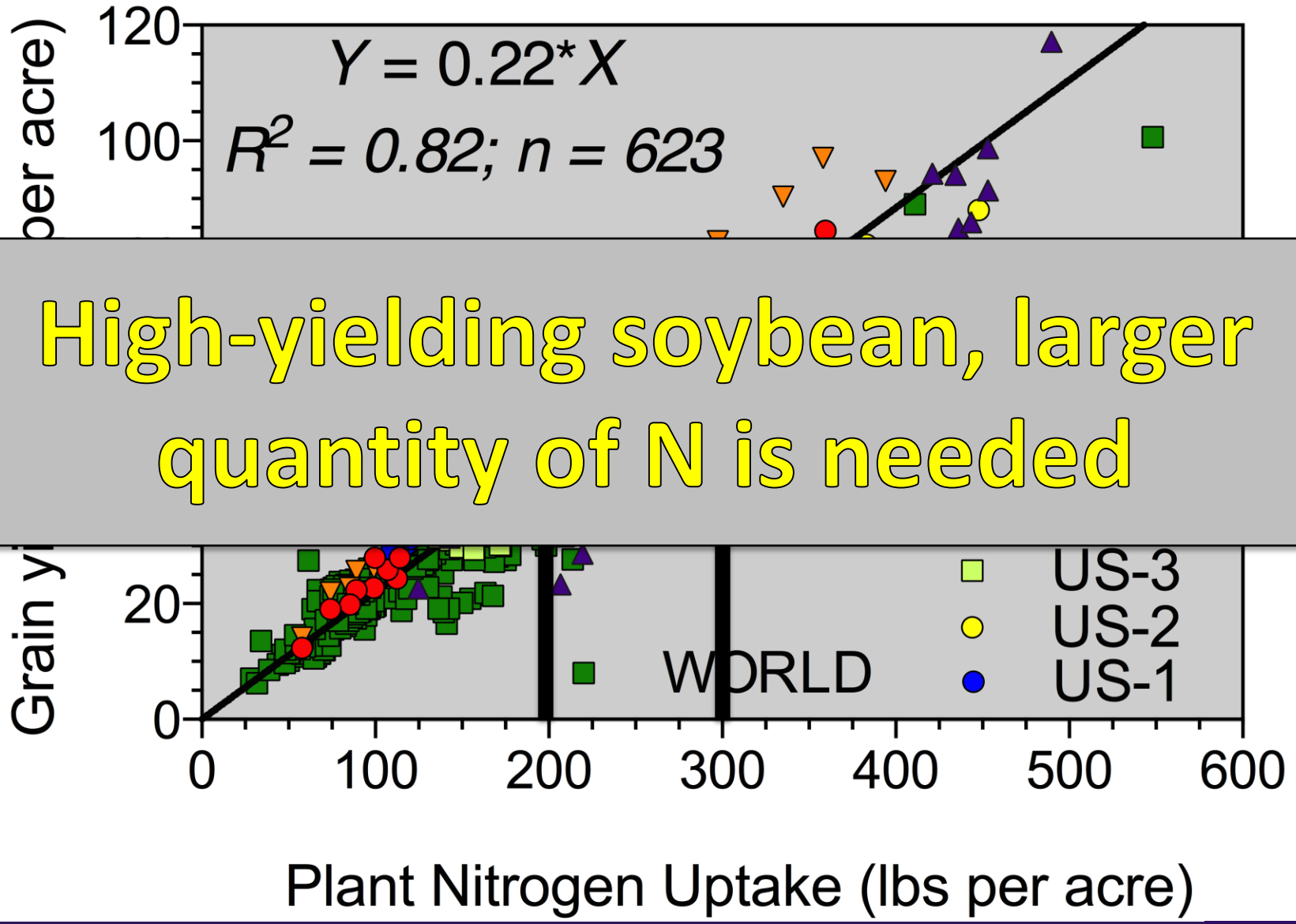
- Total N demand
- Soybean N Studies
- Results
- Conclusions

K-STATE Research and Extension

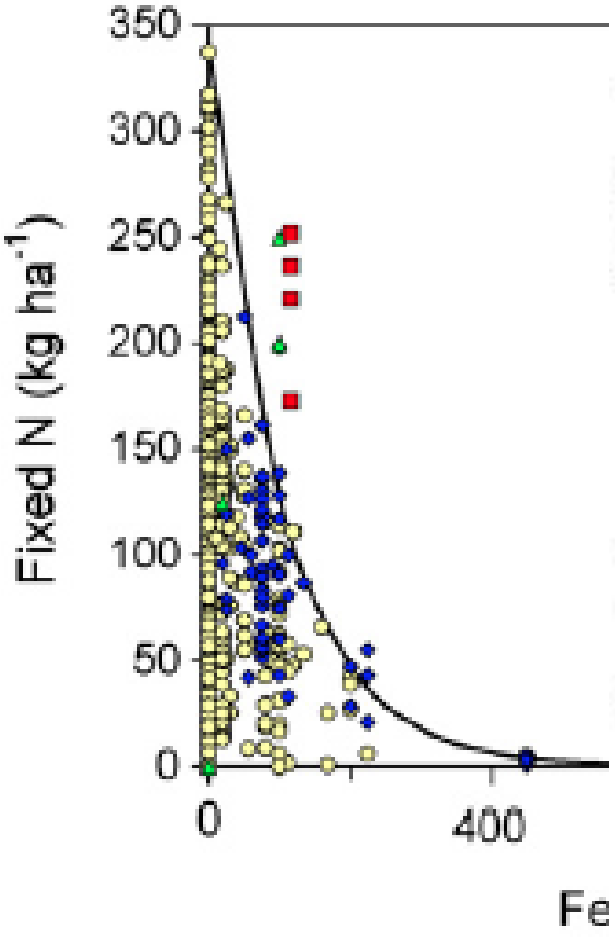
Crop Production Team
KSUCROPS
©K-State, IA Ciampitti

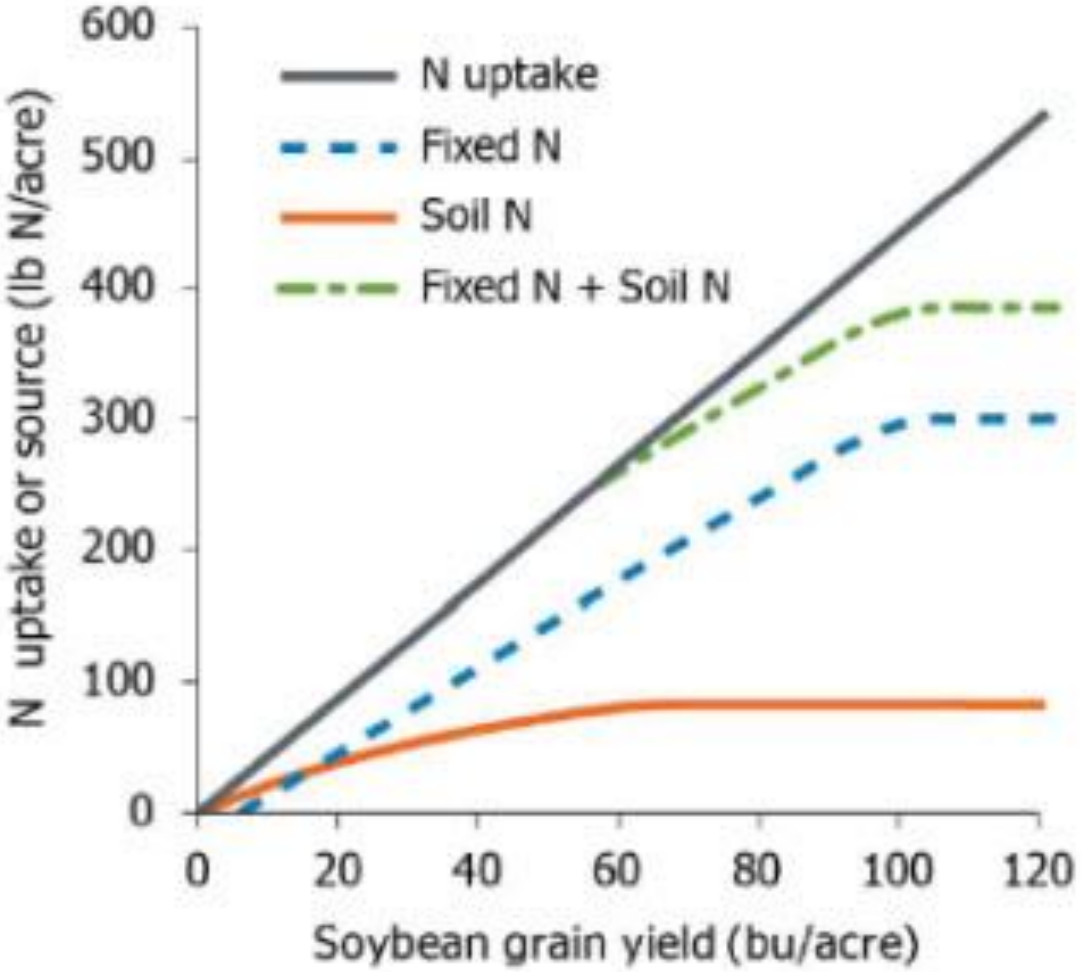
© IA Ciampitti, K-State Univ

Plant N Demand vs. Grain Yield: Review



High-yielding soybean, larger quantity of N is needed





Application of N fertilizer early in the season can rapidly inhibit biological N fixation (BFN) and ↓ fixation N.

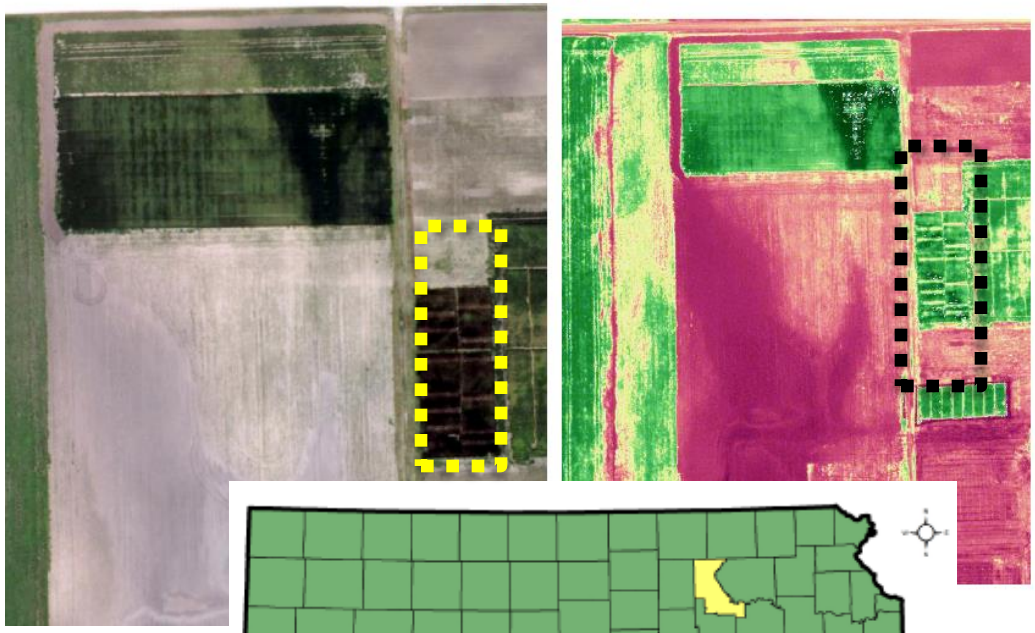
© IA Ciampitti, K-State Univ

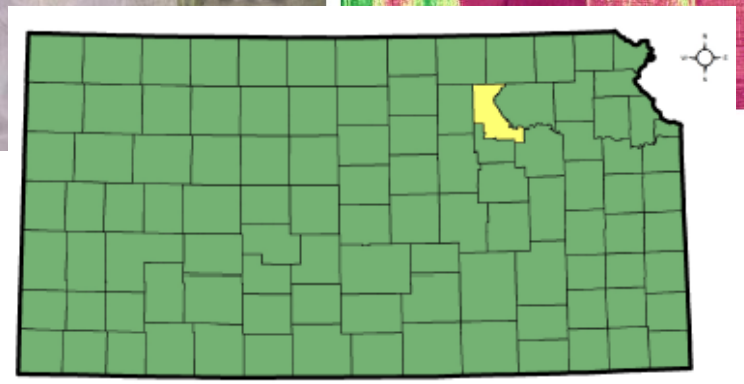
Soybean Genetic Gain x Fertilizer N interaction

Experimental sites

ASHLAND SITE, KS

Aerial Imagery Flown August 3, 2015

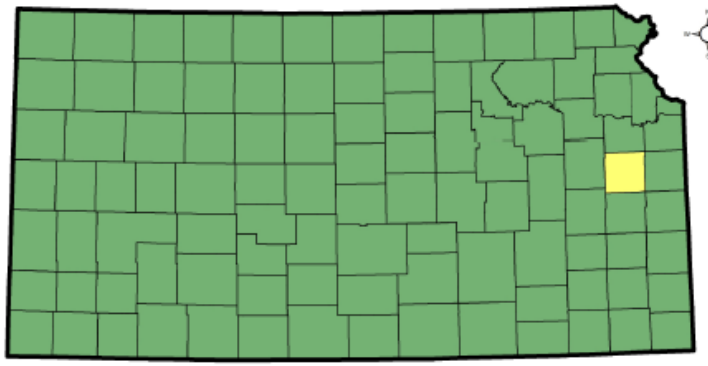




Riley County, KS

OTTAWA SITE, KS

2015 USDA NAIP Imagery



Franklin County, KS

© IA Ciampitti, K-State Univ

Soybean Genetic Gain x Fertilizer N interaction

Experimental sites

Soil Pre-planting conditions

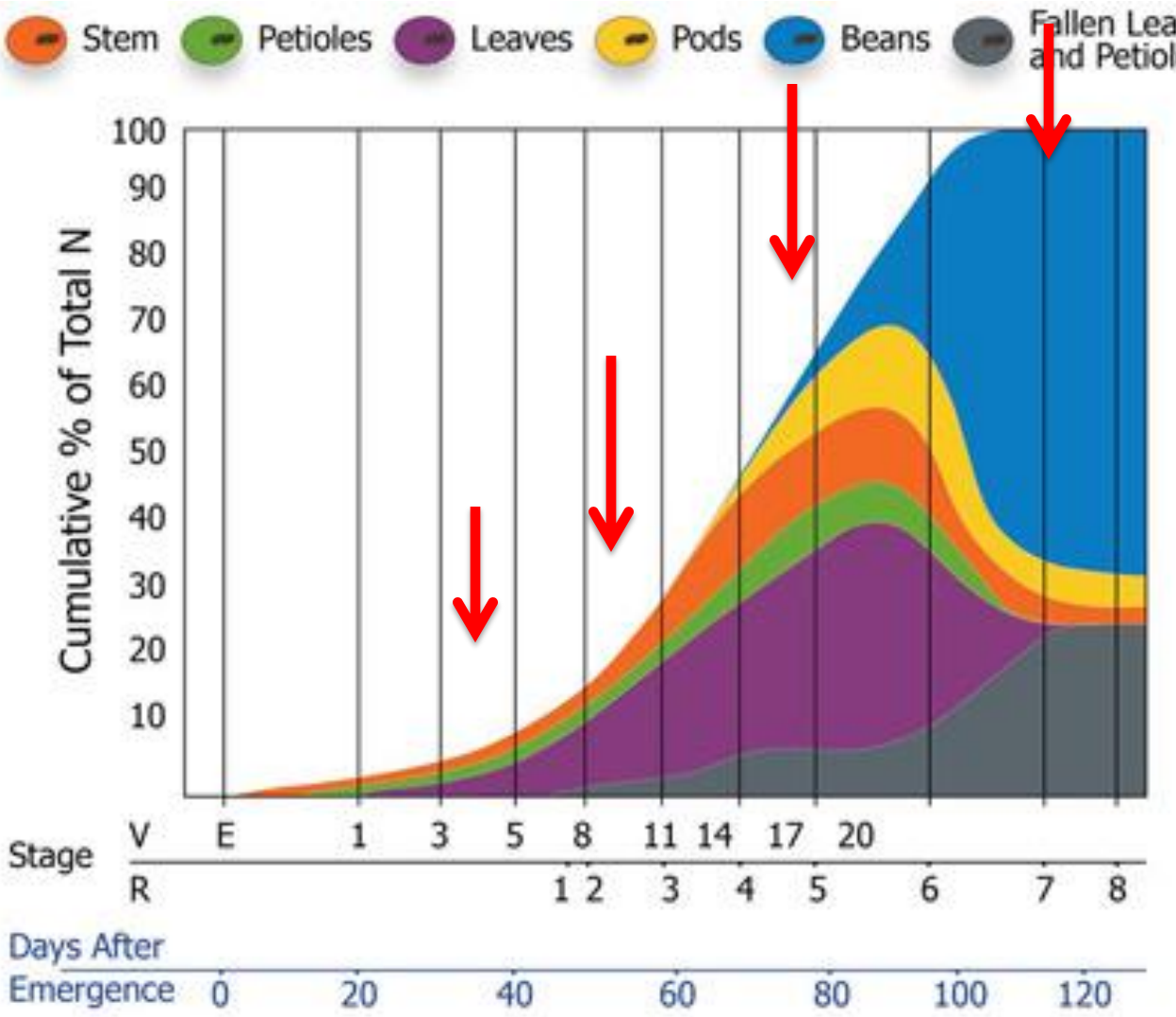
Soil Parameters	Location	
	Ashland	Ottawa
pH – units-	7.9	6.5
Mehlich P (ppm)	60	7.4
CEC (meq/100g)	13.2	25.9
OM (%)	1.58	3.32
K (ppm)	264	191
Ca (ppm)	2145	3273
Mg (ppm)	71.1	532

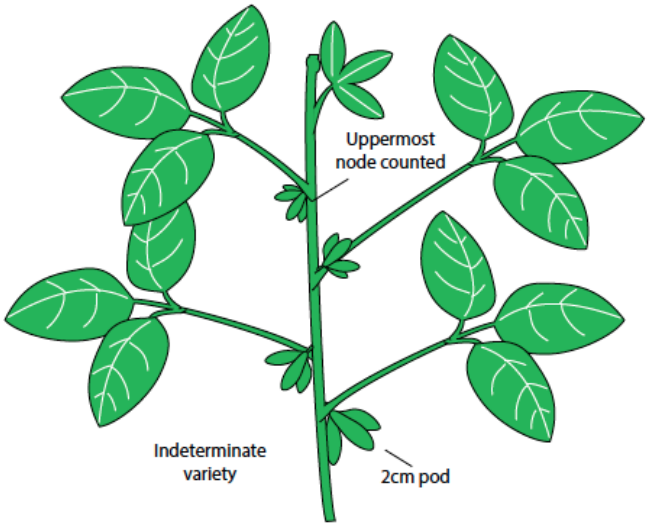
Treatment description

Treatment	Varieties	N application
1	non-RR	non-N
2	non-RR	550 lbs N
3	non-RR	late-N (50 lbs N)
4	RR-1	non-N
5	RR-1	550 lbs N
6	RR-1	late-N (50 lbs N)
7	RR-2	non-N
8	RR-2	550 lbs N
9	RR-2	late-N (50 lbs N)

© IA Ciampitti, K-State Univ

NITROGEN Uptake: Sampling Time





Full Pod

(~50% Total N Uptake)

40-45 days to Maturity

© IA Ciampitti, K-State Univ

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

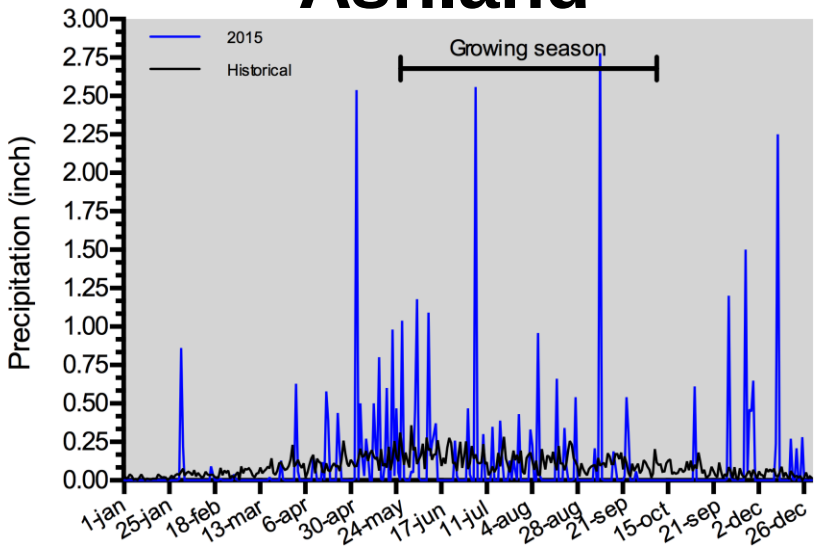
Grain Yield

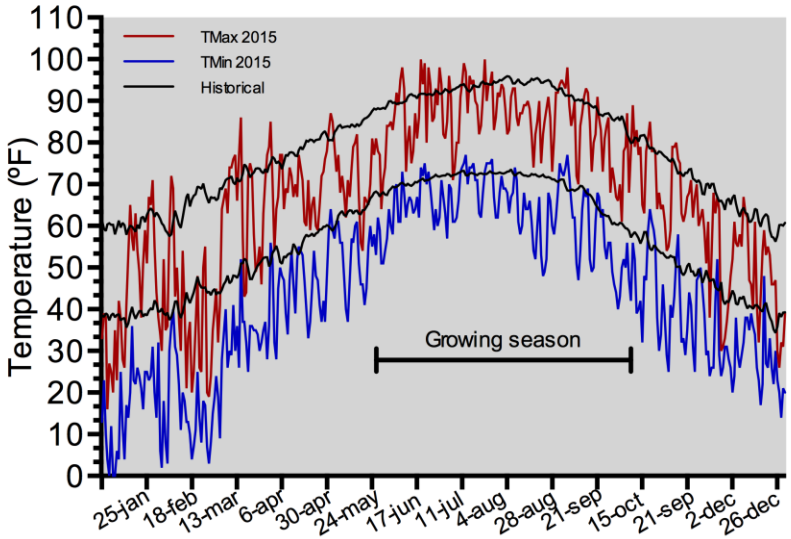
- Machine-harvested central two-rows (5x50 ft)
- Plants were also collected to estimate:
  - final grain number,
  - seed weight,
  - Grain harvest index (HI)

© IA Ciampitti, K-State Univ

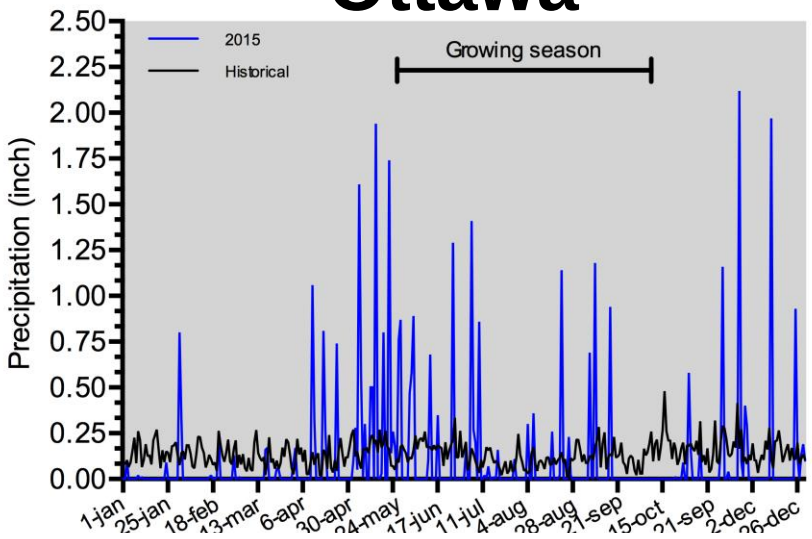
Weather Conditions: 2015 Season

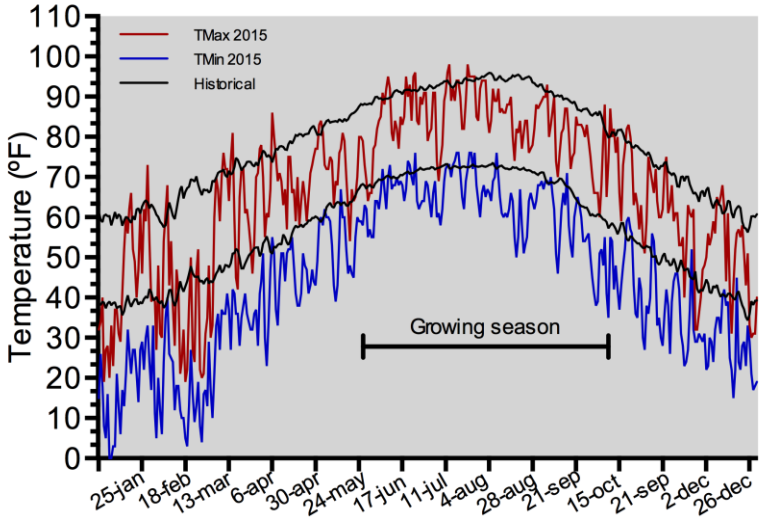
Ashland





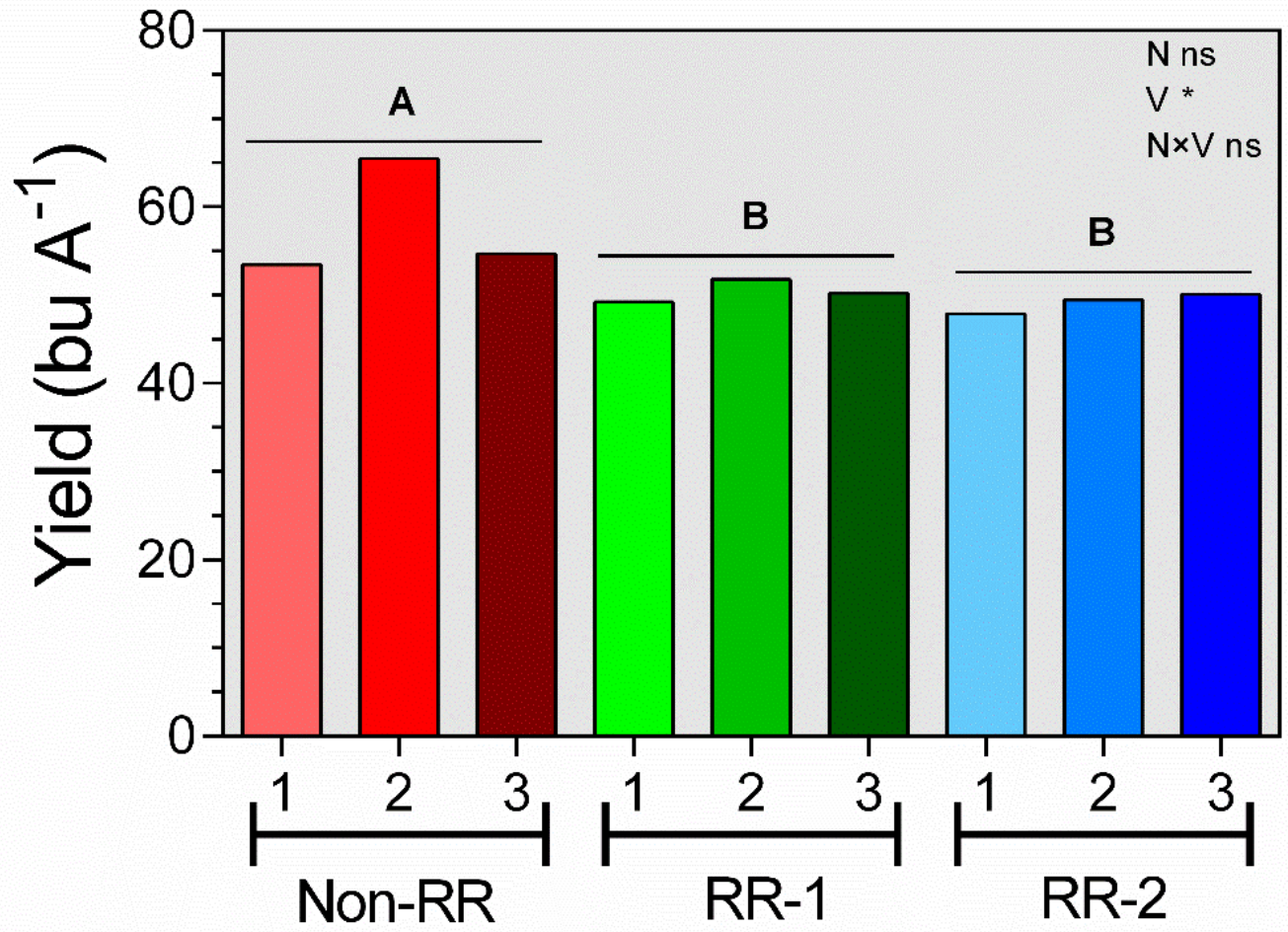
Ottawa





© IA Ciampitti, K-State Univ

Ashland Yields



N application:
1 - non N
2 - 500 - 600 lbs ac^{-1}
3 - Late N (50 lbs ac^{-1})

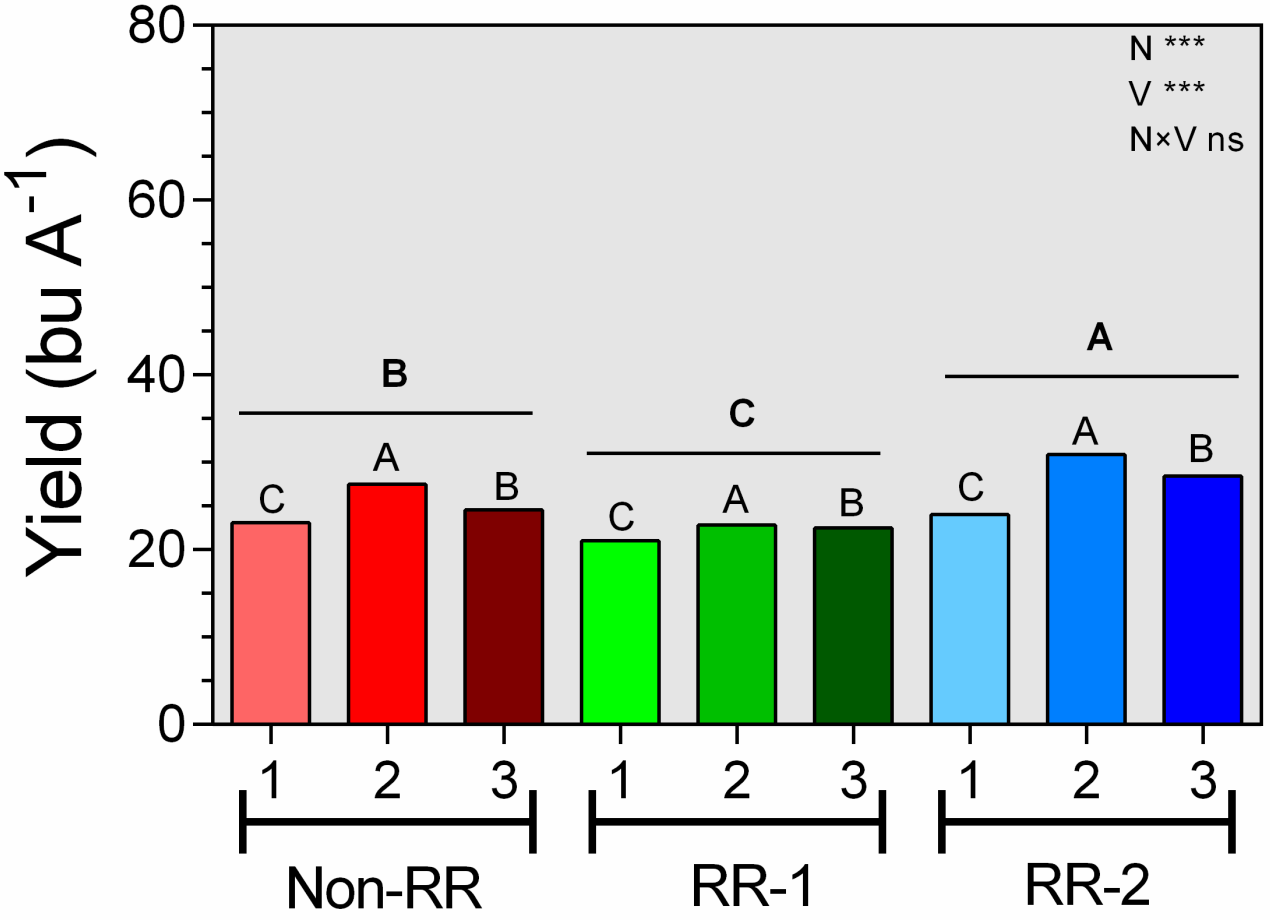
* significance <0.05
ns: no significance

N application (N)
Variety (V)
Interaction (N×V)

Variety = non-RR > RR-1 = RR-2

© IA Ciampitti, K-State Univ

Ottawa Yields



N application:
1 - non N
2 - 500 - 600 lbs ac^{-1}
3 - Late N (50 lbs ac^{-1})

*** significance <0.001
ns: no significance

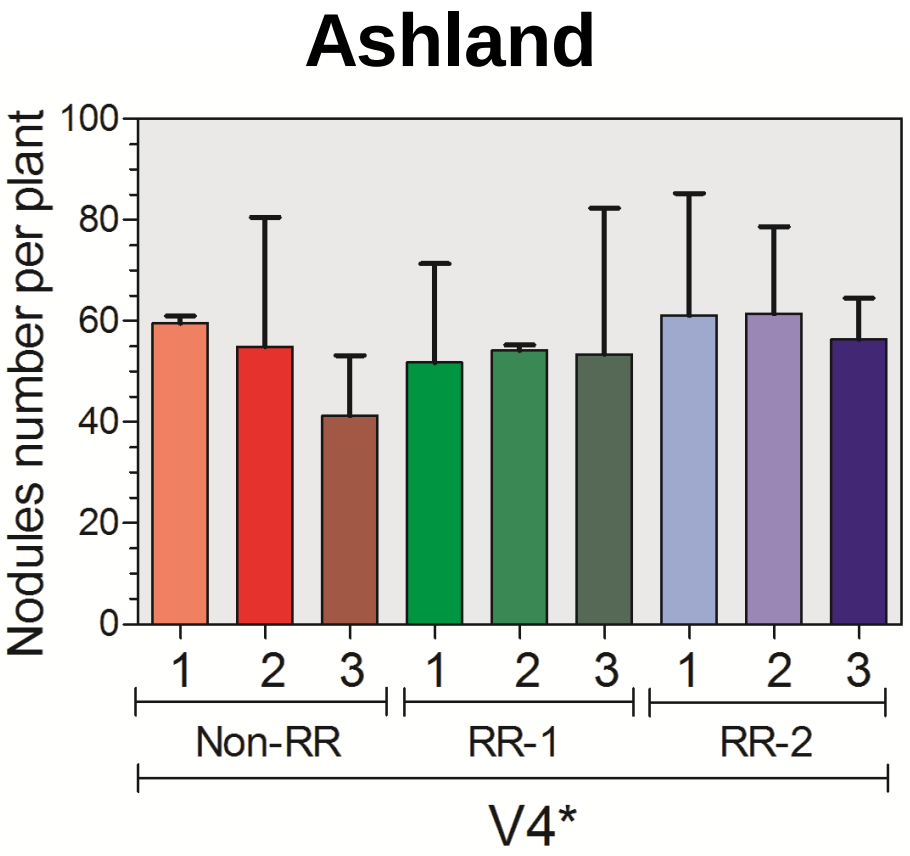
N application (N)
Variety (V)
Interaction (N×V)

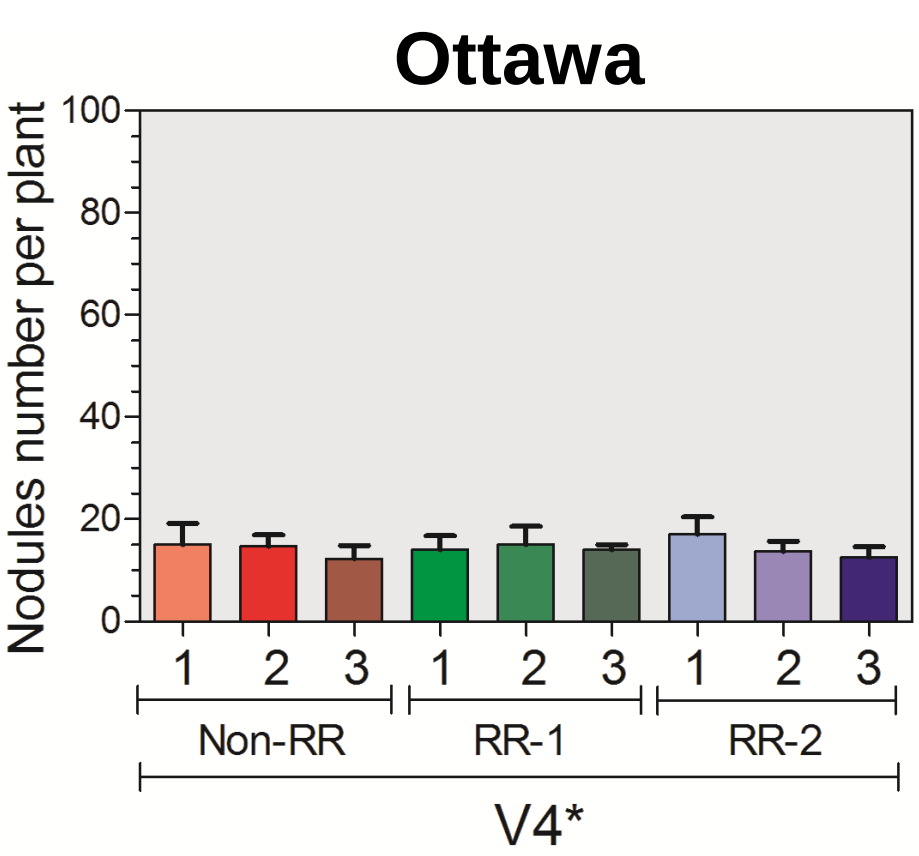
Variety = RR-2 > non-RR > RR-1

Nitrogen = Nfert > LateN > nonN

© IA Ciampitti, K-State Univ

Per-Plant Nodule Count

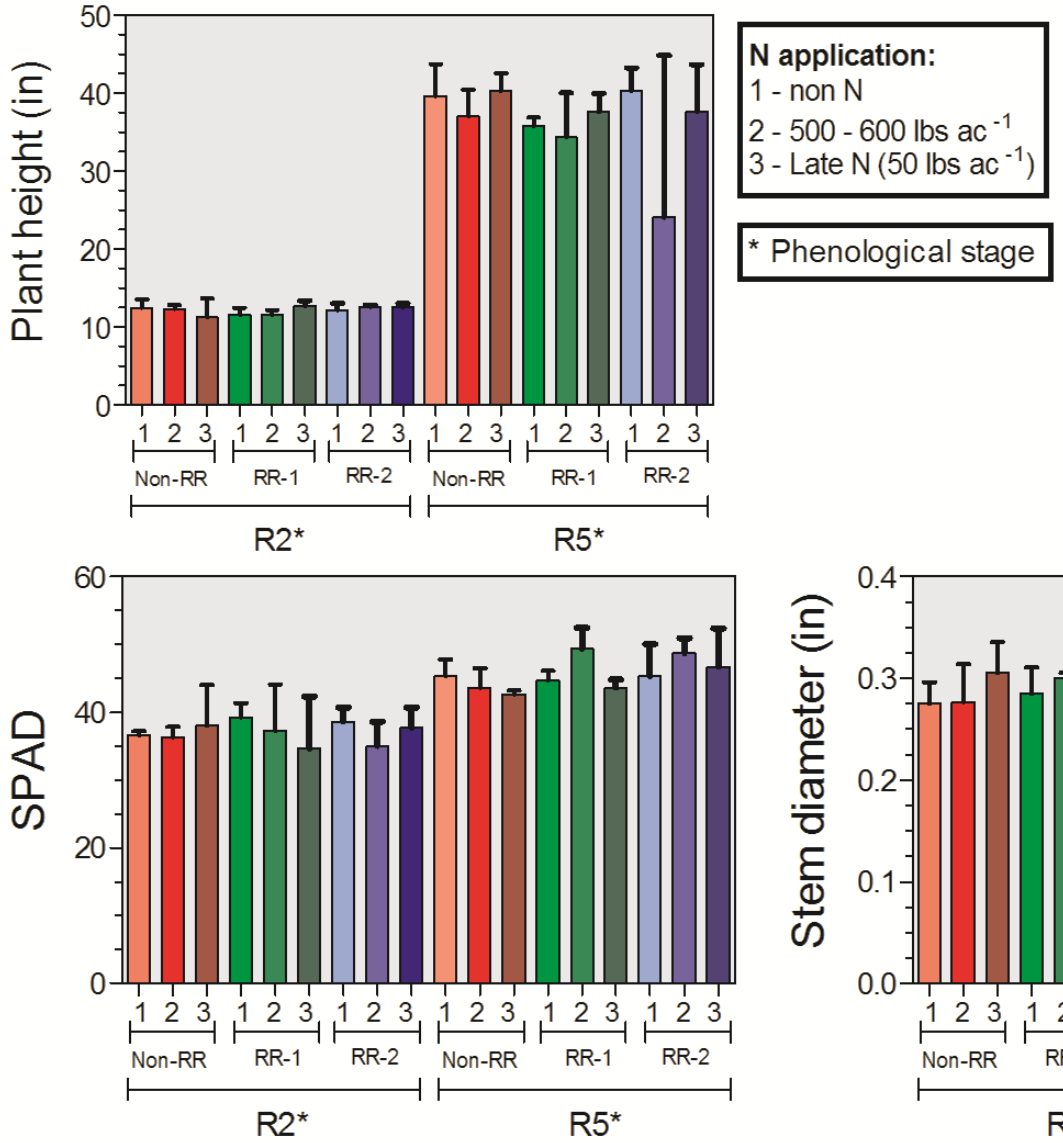




Nodule count per plant was superior at Ashland (previous soybean) relative to Ottawa.

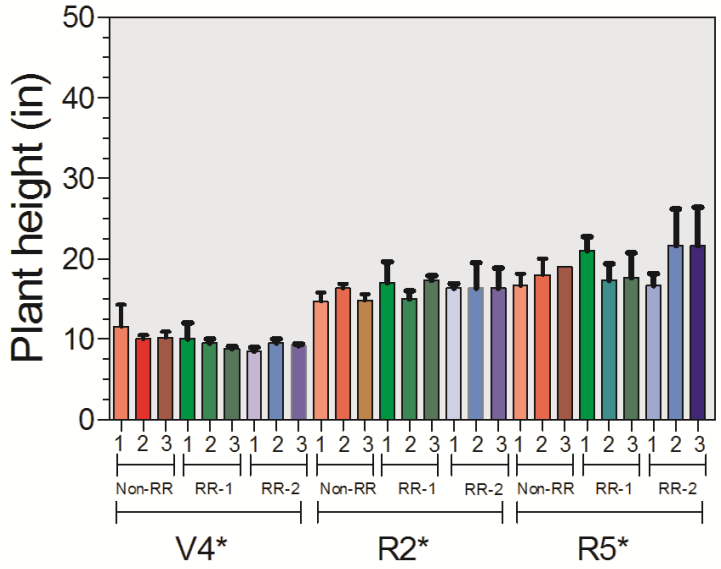
© IA Ciampitti, K-State Univ

Ashland



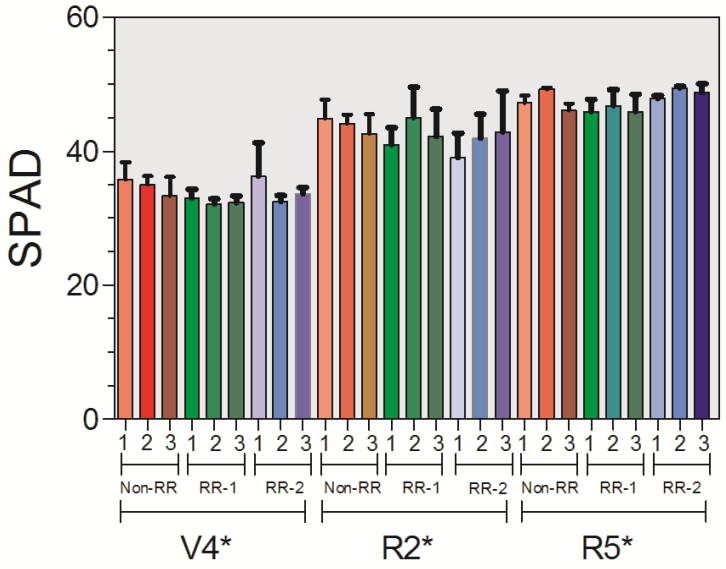
© IA Ciampitti, K-State Univ

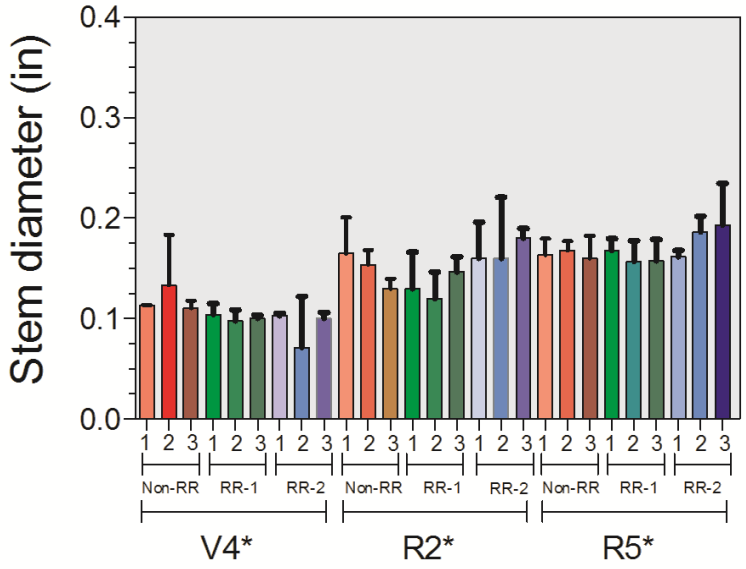
Ottawa



N application:
1 - non N
2 - 500 - 600 lbs ac^{-1}
3 - Late N (50 lbs ac^{-1})

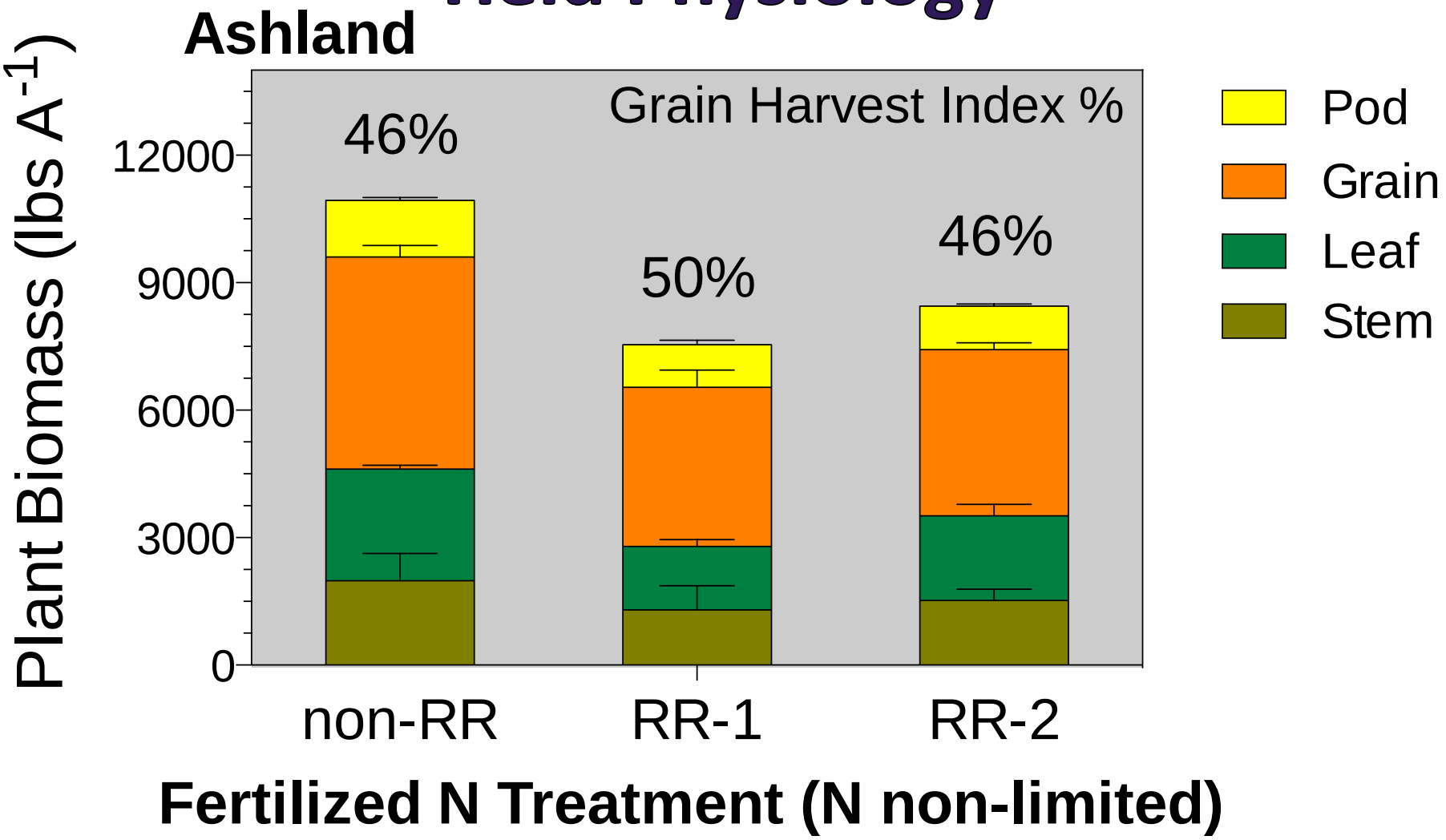
* Phenological stage





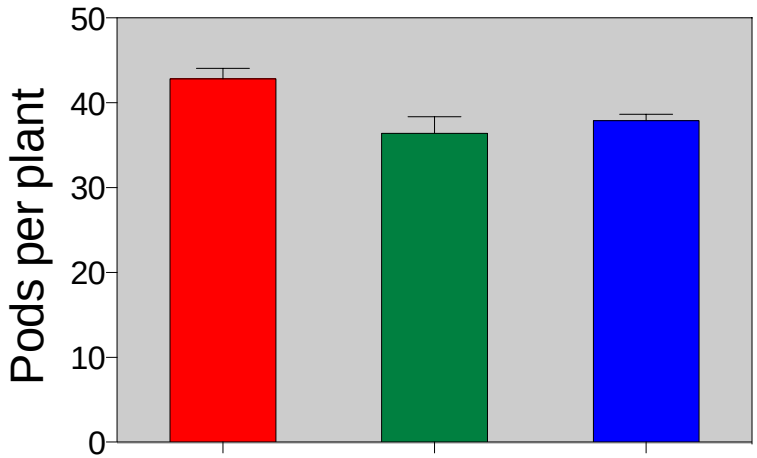
© IA Ciampitti, K-State Univ

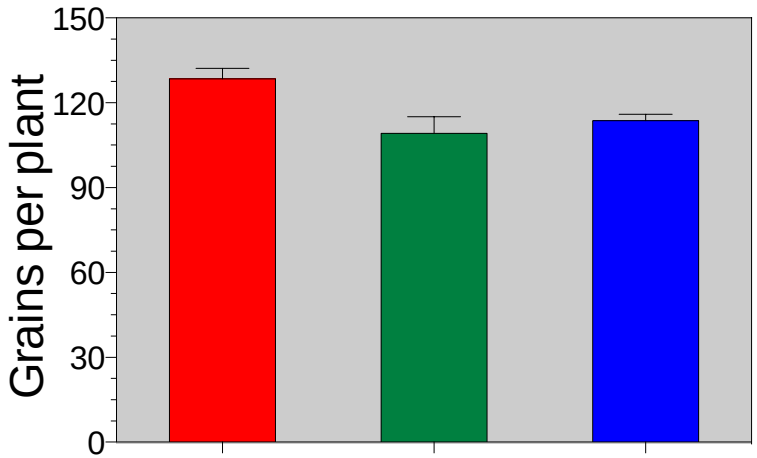
Yield Physiology

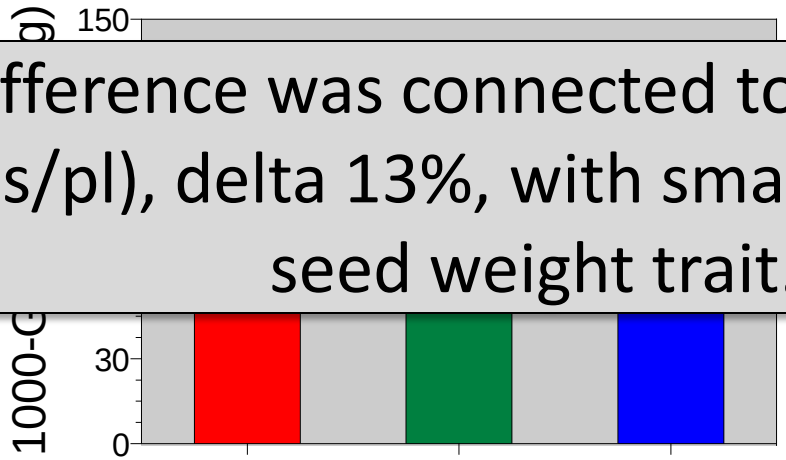


© IA Ciampitti, K-State Univ

Ashland Yield Physiology







Main yield difference was connected to the number pods per plant (grains/pl), delta 13%, with small variation (5-7%) on seed weight trait.

Fertilized N Treatment (N non-limited)

© IA Ciampitti, K-State Univ

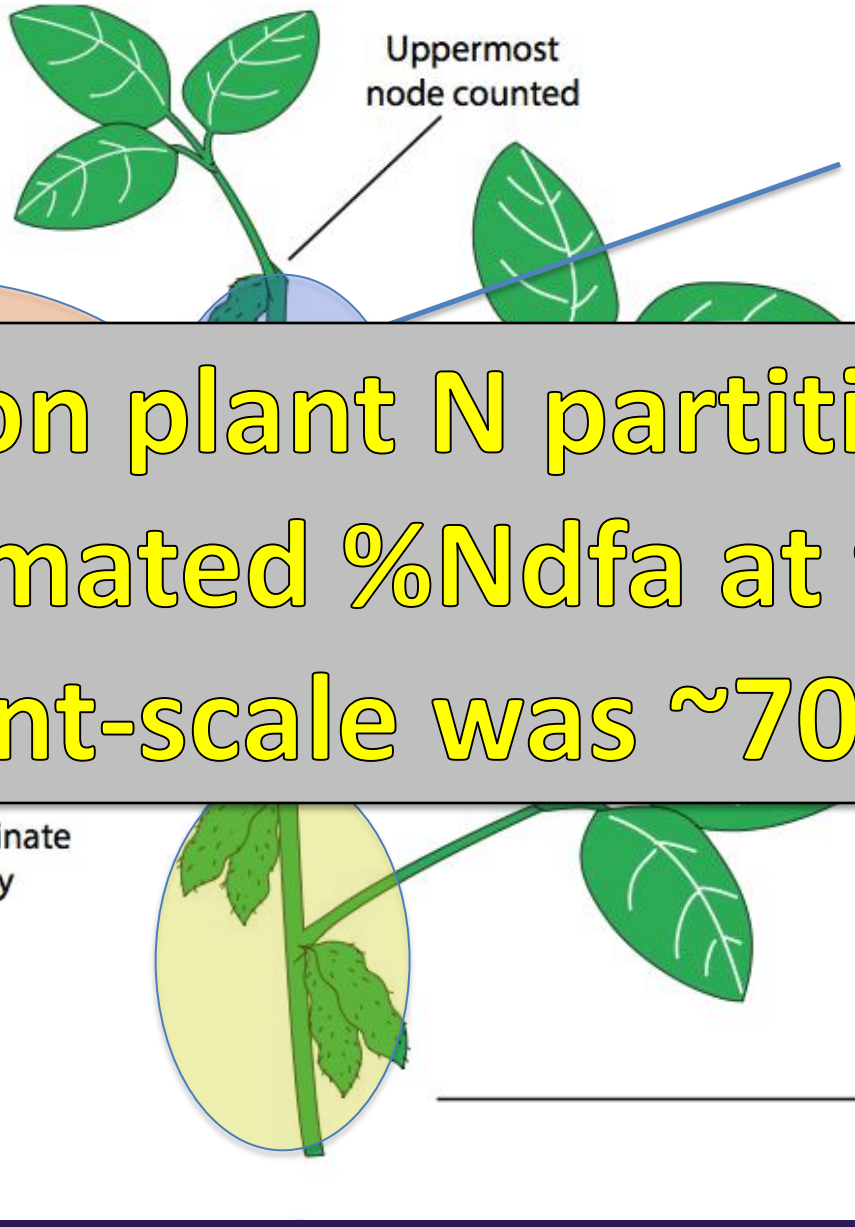
Ashland Site

© IA Ciampitti, K-State Univ

15N Isotopic Measurements

Leaf
65 %Ndfa

Stem
50 %Ndfa



Based on plant N partitioning, estimated %Ndfa at the plant-scale was ~70%.

© IA Ciampitti, K-State Univ

Conclusions

- Soybean yield at Ashland Bottoms site was greater (ranged from 49 to 58 bushels per acre) than at Ottawa (ranged from 21 to 31 bushels per acre), which primarily reflects G x E x M.

- At Ottawa, maximum agronomical yield was documented for the modern soybean variety (RR-2) when solely dependent on N fertilization (plus residual soil N). On the other side, lowest yield were recorded for RR-1 var. when was dependent on the BNF as the main source of N nutrition (plus residual soil N).

- At Ashland, fertilizer N x variety interaction was negligible. Statistically, the non-RR variety showed greater yield when compared to RR-1 and RR-2.

- At Ashland, the plant height, SPAD, stem diameter and the number of nodules per plant were greater than at Ottawa, reflecting on the greater soybean yield potential at Ashland.

- In summary, further evaluation and research is needed in order to properly dissect the “true” genetic contribution on soybean yield and its interaction with N nutrition.

KANSAS STATE UNIVERSITY

QUESTIONS
THANKS!

Fluid Fertilizer Foundation

K-STATE Research and Extension

Ignacio A. Ciampitti, K-State Univ
Crop Production Specialist
ciampitti@ksu.edu, 785-410-9354

@KSUCROPS

/KSUCROPS

© K-State Univ, IA Ciampitti