Increased Soybean Seeding Rates vs. Preemergence Herbicide Use

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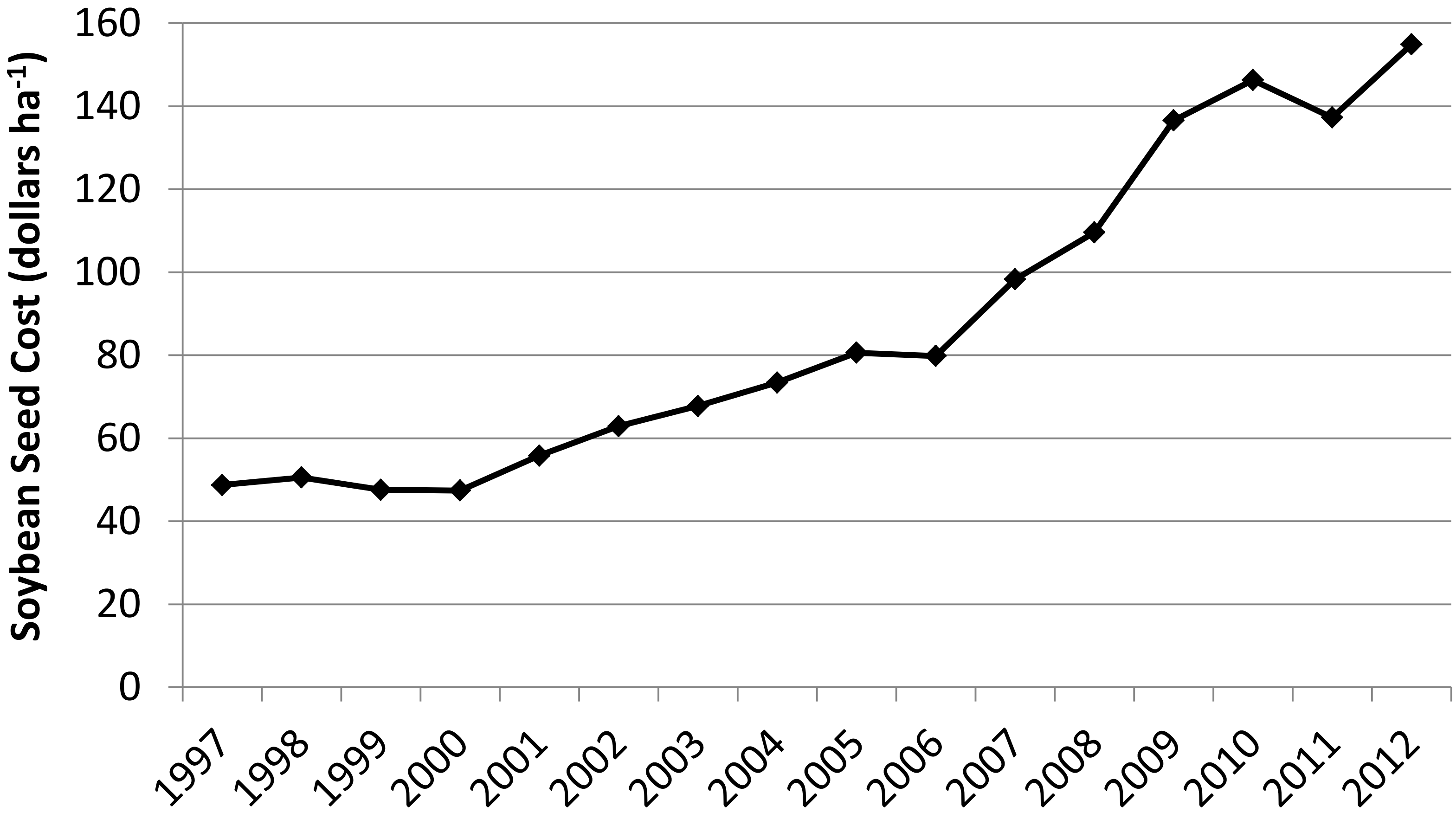
Background

- Soybean seed cost has dramatically increased since the mid 1990's



Source: (USDA ERS 2013)

Background

- Economic realities and improved genetics are driving a reduction in soybean seeding rates
- Current recommendations are to establish a stand of 247,000 plants ha^{-1}
- Lower seeding rates can slow canopy development
- Crop canopy closure aids in weed suppression
- Preemergence (PRE) residual herbicides may be more necessary for weed control in low seeding rate soybean systems

Background

- PRE residual herbicides:
  - Reduce amount of weeds exposed to postemergence (POST) applications
  - Allow for greater flexibility in POST application timing
  - Provide additional effective mode of action for resistance management
  - Protect crop from early-season weed competition
  - Enable quicker canopy closure??

Objective

- Establish the effectiveness of weed suppression by increased seeding rates in relation to PRE residual herbicide control in the context of herbicide resistance management
- Do higher seeding rates reduce number of weeds exposed to POST herbicide?

Methods

- **Site Description**
  - Two year study near Arlington, WI (2012 & 2013)
  - Field Preparation
    - Fall – chisel plowed
    - Spring – field cultivated
  - Planted mid-May in 38 cm wide rows
  - Predominant weeds
    - *Setaria faberi*
    - *Chenopodium album*
    - *Ambrosia artemisiifolia*
    - *Amaranthus retroflexus*

Methods

- 2 x 2 x 5 factorial in RCB
  - [2] with or without PRE herbicide
  - [2] POST herbicide programs
  - [5] seeding rates

Herbicide Treatments

PRE residual	*S*-metolachlor+ fomesafen
Conventional program	imazamox fb fluazifop
Glyphosate program	glyphosate+ imazamox

Seeding Rate Structure

	1000 seeds hectare^{-1}
High	470 GR[a]
Moderate	296 GR
High blend	296 GR 173 C
Low blend	148 GR 86 C
Low	148 GR

[a]GR = glyphosate-resistant seed

[b]C = conventional seed

Methods

- **Data Collection**
  - Weed counts
    - before POST applications
    - before soybean harvest
  - Soybean stand counts
  - Weekly soybean growth staging
  - Weekly canopy closure estimates
    - digital image capture method adapted from (Purcel, 2000. Crop Sci.)
  - Soybean yield adjusted to 13% moisture

- **Data Analysis**
  - Data were subjected to ANOVA using the Proc Mixed procedure in SAS
  - Means were separated using Fisher's Protected LSD test at $P \leq 0.05$
  - Weed density data were log transformed
    - Data presented were back transformed
  - Linear regression using the Proc Reg procedure in SAS

Methods

- Canopy closure estimation
  - Images were analyzed with SigmaScan Pro® to determine percent light interception
  - Cumulative intercepted photosynthetically active radiation (CIPAR) values were calculated

CIPAR = (average solar radiation (MJ m^{-2})*0.0864*0.5* % LI) summed over a given period of time

- V1 – R1 (critical period of weed control)
- Glyphosate treatments only

Edwards et al., 2005. Crop Sci.

Weed Density: Seeding Rate

- An increase in soybean population did not influence early or late-season weed growth in most scenarios

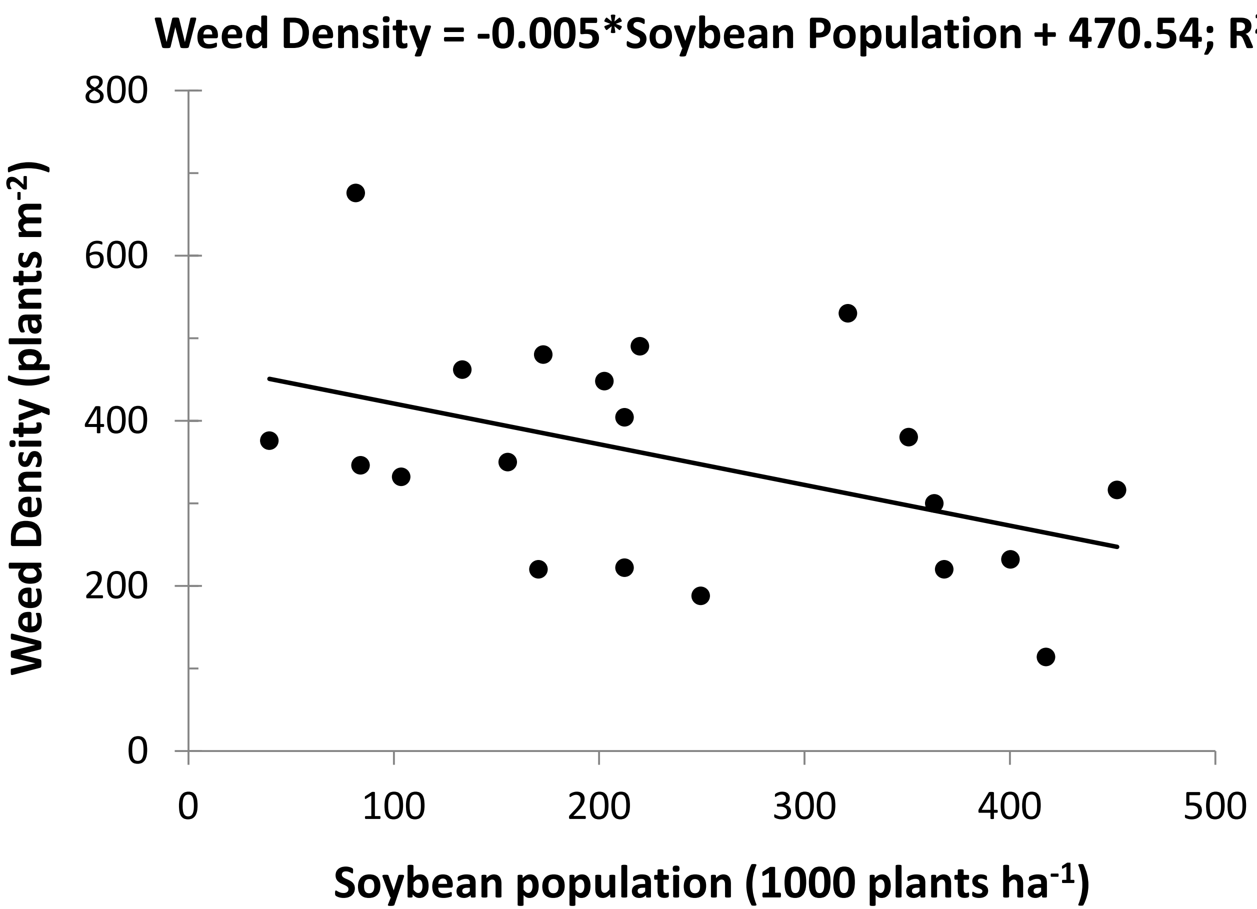
Model: $y = \beta_1 * \text{soybean population} + \beta_0$

Year	Herbicide program	Model significance (Pr>F): Total Density at POST timing	Model significance (Pr>F): Total Density at harvest[a]
2012	PRE	0.9036	0.5132
	NO PRE	**0.0468**	0.6187
2013	PRE	0.1071	0.0422[b]
	NO PRE	0.9714	0.2086

[a]Data were log transformed [b]Did not meet assumptions

- **Exception:** 2012 in plots without a residual herbicide at POST timing

- **Exception: 2012**



- Weed density decreased by 50.0 plants m^{-2} for each additional increase of 10,000 soybean plants

Weed Density: Residual Herbicide

Weed density at POST timing averaged across years

herbicide program	Density		
	broadleaves[a]	grasses[b]	total
	plants m^{-2}		
PRE	6	7	13
No PRE	98	77	188
Pr > F	<0.0001	<0.0001	<0.0001

[a]Broadleaf species included *Chenopodium album, Ambrosia artemisiifolia,* and *Amaranthus retroflexus*

[b]Grass species included *Setaria faberi, Eriochloa villosa*, and *Digitaria sanguinallis*

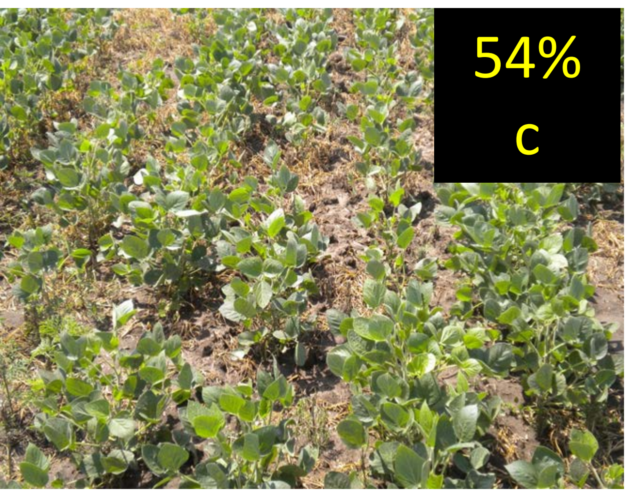
- Reduced total number of weeds exposed to POST application by 93%

Canopy at 3 weeks after POST (Soybean R2)

2012: seed rate * residual herbicide (P=0.0014)

With PRE herbicide (top)

Low (148K seeds/ha) **Mod (296K seeds/ha)** **High (470K seeds/ha)**



Without PRE herbicide (bottom)

Canopy at 3 weeks after POST (Soybean R2)

2013: seed rate * residual herbicide (P=0.6713)

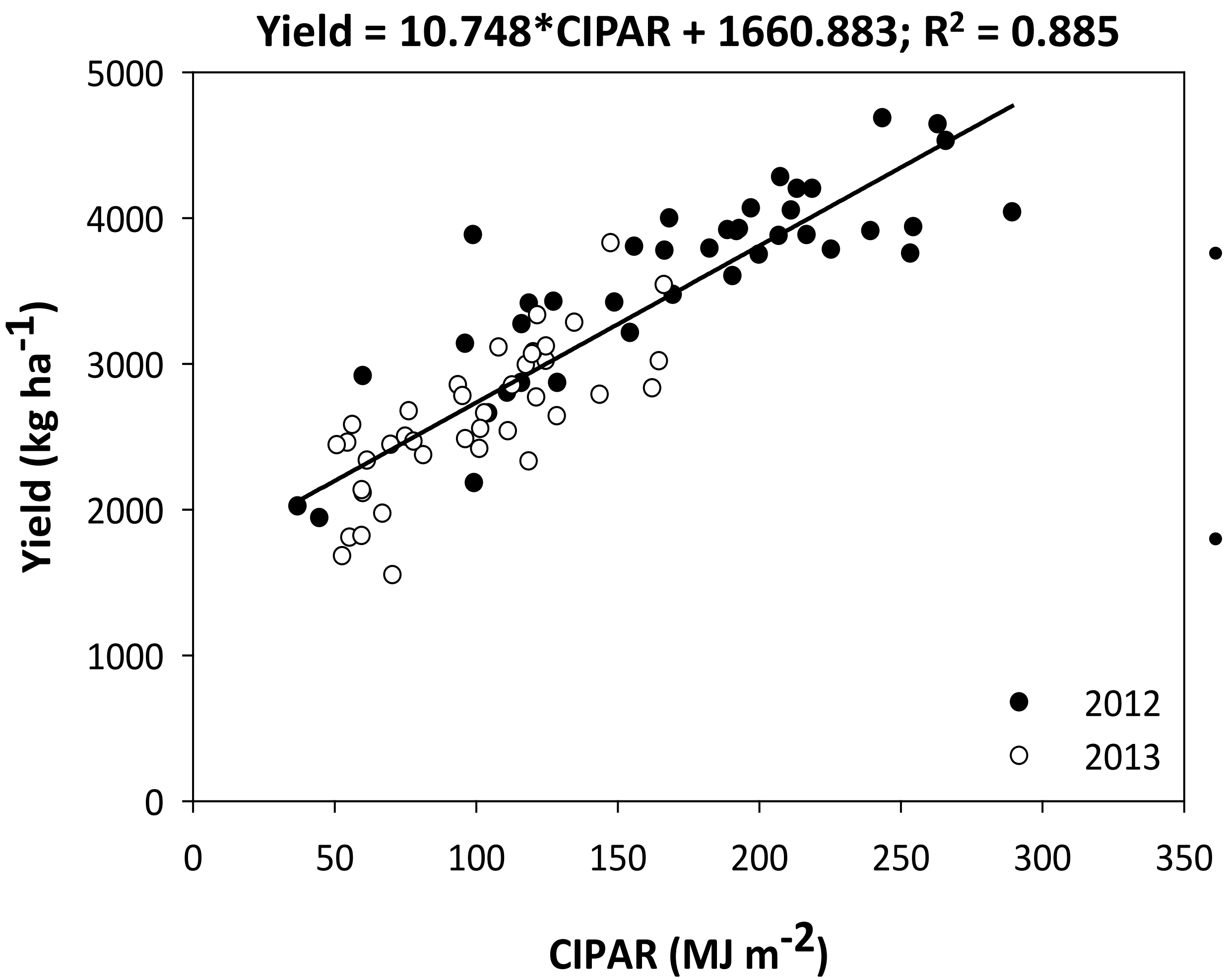
With PRE herbicide (top)

Low (148K)	56% B	**Mod (296K)**	71% A	**High (470K)**	79% A

seed rate (P=0.0001)

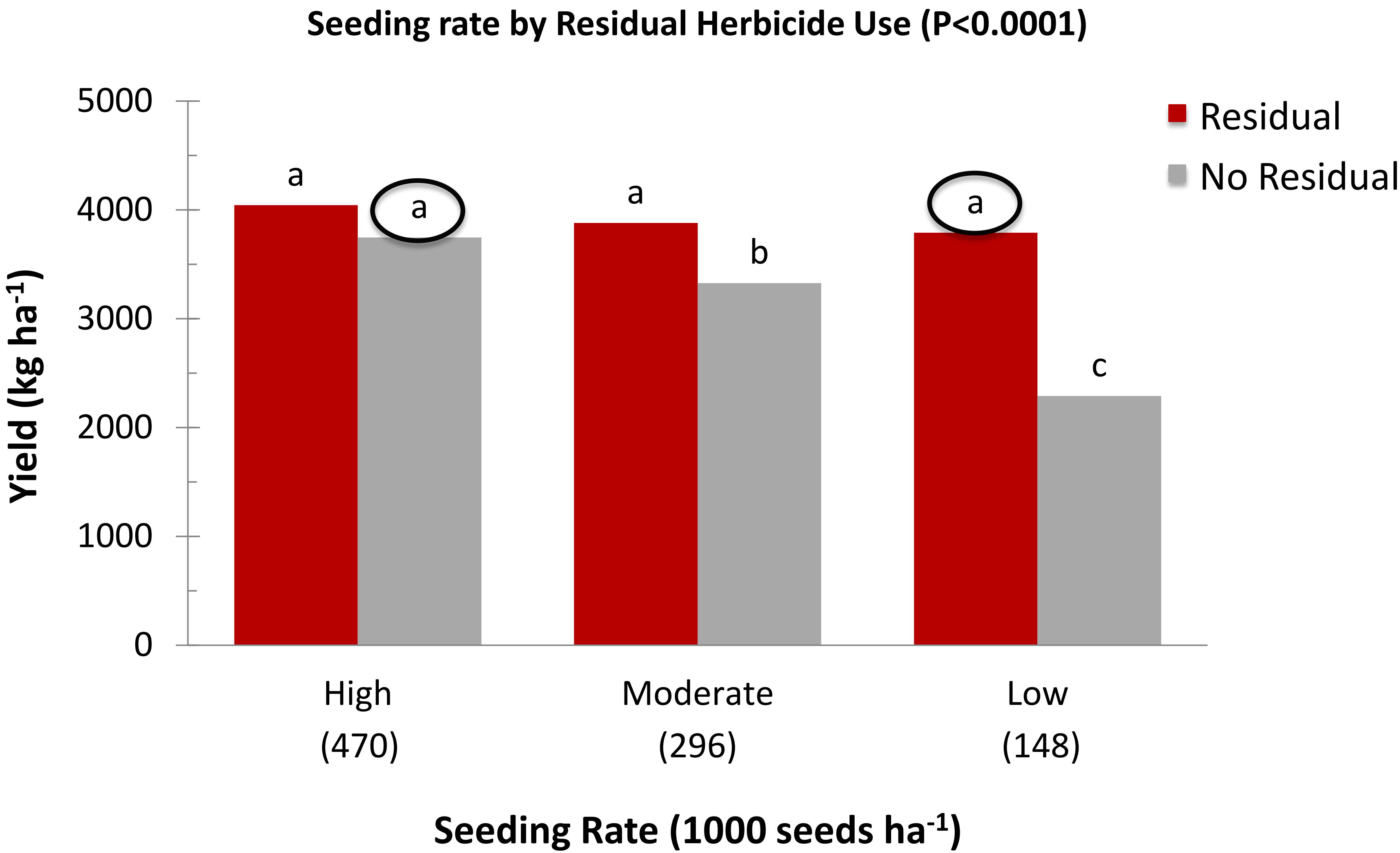
Without PRE herbicide (bottom)

Soybean Yield

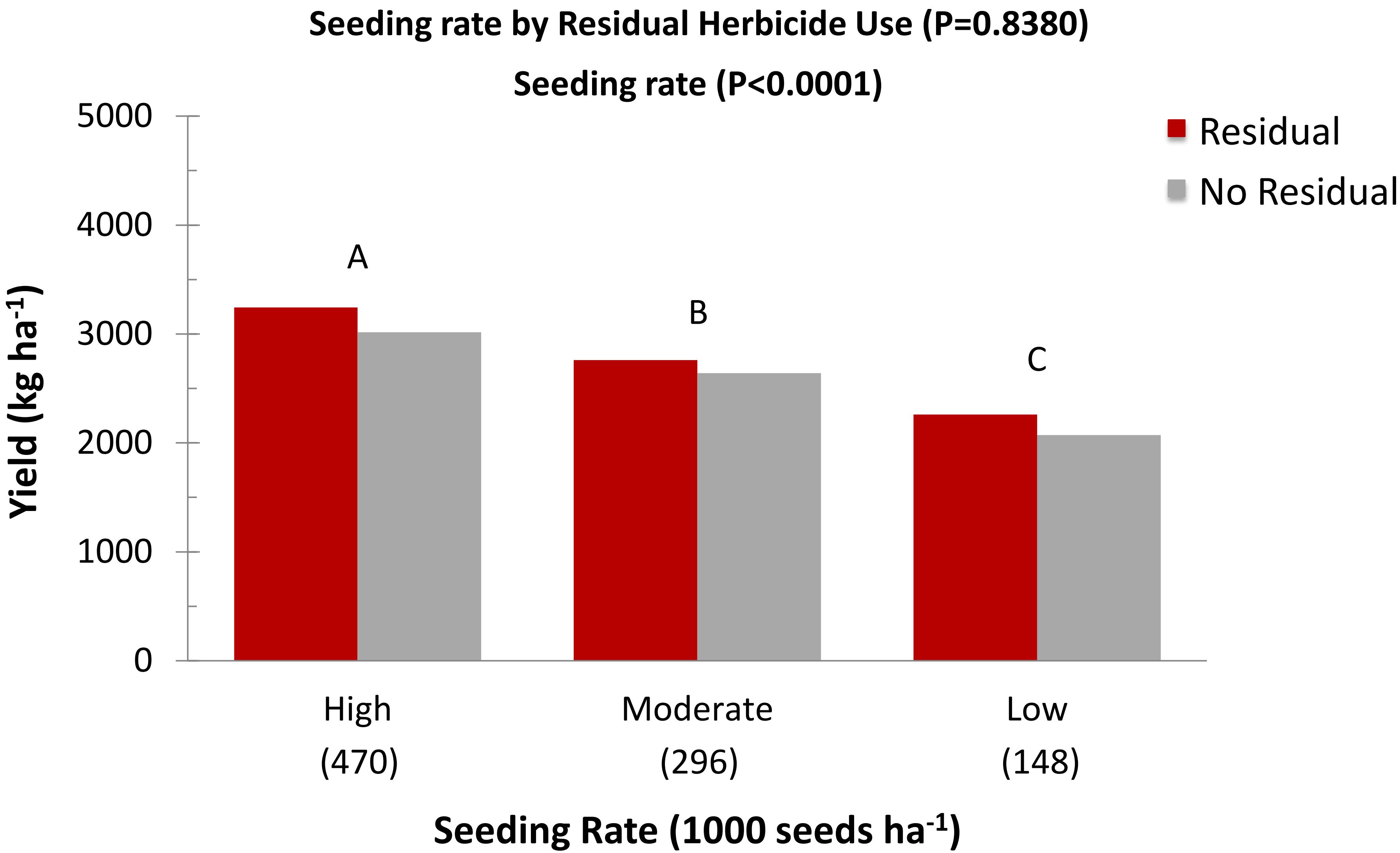


- CIPAR from V1 to R1 growth stages
  - Critical period of weed control (CPWC)
- 10.7 kg ha^{-1} increase in yield for each additional unit of CIPAR

2012 Soybean Yield



2013 Soybean Yield



Implications: Yield

- Soybean canopy closure is important to maximize yield
  - Higher seeding rates = quicker canopy closure (2013)
  - Early-season weed competition can delay canopy closure later in the season (2012)
- Residual herbicides can maximize canopy development by limiting early-season weed competition
  - Especially important at low seeding rates
- Lower seeding rates can increase risk of yield loss from weed competition if resources are limited (2012 drought)
  - A high seeding rate was necessary to maximize yield when soybean was subjected to high early season-weed competition (i.e. no residual herbicide)
  - Residual herbicides can reduce risk

Implications: Resistance Management

- Increased seeding rates may **NOT** be an effective method for herbicide resistance management
  - Did not reduce number of weeds exposed to POST applications
  - Did not reduce end of season weed densities
  - **Exception:** higher soybean populations decreased weed density prior to POST application in 2012
- Residual herbicides
  - Limited the number of weeds exposed to the POST herbicides by 93%
  - Reduced end of season weed densities

Acknowledgements

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Thank You!
Questions?