

Breeders vs. Agronomists: What we learned from the soybean decades study



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Outline

- ▶ **Review Past Sources of Yield Gain & Look at Previous Yield Trends**
- ▶ **What is the Decades Study?**
- ▶ **Hypothesis and Objectives**
- ▶ **Results**
- ▶ **Conclusions**
- ▶ **Questions**

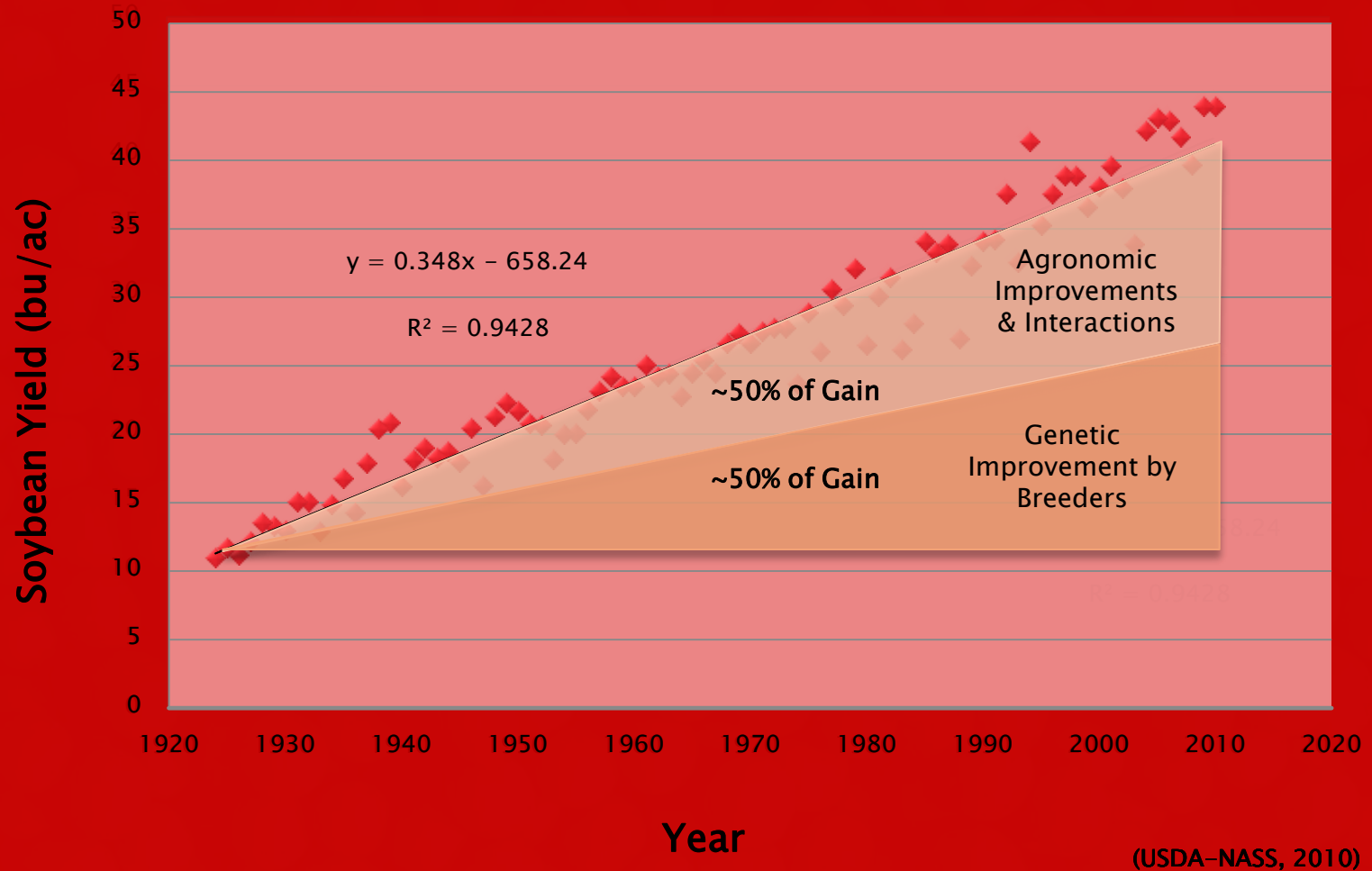


U.S. On-Farm Yields (1924-2010)



(USDA-NASS, 2010)

Where is Yield Gain Coming From?



Possible Sources of Agronomic Yield Gain

- ▶ **Earlier Planting**
- ▶ **Higher Seeding Rates**
- ▶ **Narrower Rows**
- ▶ **Use of Fungicides**
- ▶ **Improved Weed Control & Herbicide Use**
- ▶ **Reduced Harvest Losses**
- ▶ **Improved Nitrogen Use Efficiency**
- ▶ **Others?**

Specht et al. (1999)



The Soybean Decades Study

- ▶ **Collaboration between the University of Minnesota, University of Wisconsin, University of Illinois, and Purdue University**
- ▶ **Goal of quantifying agronomic sources of yield gain over time and interactions with genetic improvement**
- ▶ **4 Agronomic Variables of Interest:**
 - **Planting Date**
 - **Seeding Rate**
 - **Fungicide Use**
 - **Nitrogen Use Efficiency**



U.S. trend toward earlier planting

Percent of U.S. Soybean Area Planted by Week for the Period 1980-2010 (5-Year Avg.)‡

Week #	17	18	19	20	21	22	23	24	25	26
†	24-Apr	1-May	8-May	15-May	22-May	29-May	5-Jun	12-Jun	19-Jun	26-Jun
Year										
1980	---	---	11	28	49	62	77	85	92	95
1985	---	3	11	23	40	55	71	81	88	94
1990	---	8	23	43	60	73	82	88	93	96
1995	---	---	19	37	53	67	78	86	93	---
2000	3	8	19	37	55	67	78	---	---	---
2005	9	23	39	56	71	82	90	94	---	---
2010	8	19	35	57	75	84	90	94	97	---

† - Date nearest corresponding week number

‡ - Average percent planted of previous 5 years

*Source: USDA-NASS, 2011



lptv.com

1940-1950's

Early to Mid-
June Planting



soygrowers.com

1960-1980's

Mid-May to Early-
June Planting



hoosieragtoday.com

1990-2010's

Late-April to Mid-
May Planting

Why is this trend occurring?

What are the impacts of earlier planting over time?

Hypotheses

- ▶ We hypothesize that earlier soybean planting has been responsible for some part of the on-farm yield gain over time
- ▶ In addition to yield, we suspect earlier planting, along with breeding efforts have impacted soybean seed quality over time
- ▶ Finally, we predict that earlier planting has affected growth stage duration of the soybean plant, particularly the length of reproductive growth

Objectives of Wisconsin Research

- ▶ To determine the effects of earlier soybean planting on:
 1. Soybean yield over time
 2. Soybean seed quality (protein & oil) over time
 3. Soybean phenology



Experimental Design

- ▶ 59 MGII varieties released between 1928-2008 were planted at target dates of May 1st and June 1st
- ▶ 13 varieties replicated twice for a total of 72 plots per planting date
 - Plot size: 10' x 15'
 - Row spacing: 30" rows
 - Seeding rate: 150,000 seeds/acre
- ▶ Replicated across years (2010 & 2011) and locations (WI, IN, and IL)
- ▶ Yield, seed quality, and growth stage duration data were regressed over variety year of release using a linear-mixed model in SAS v.9.2

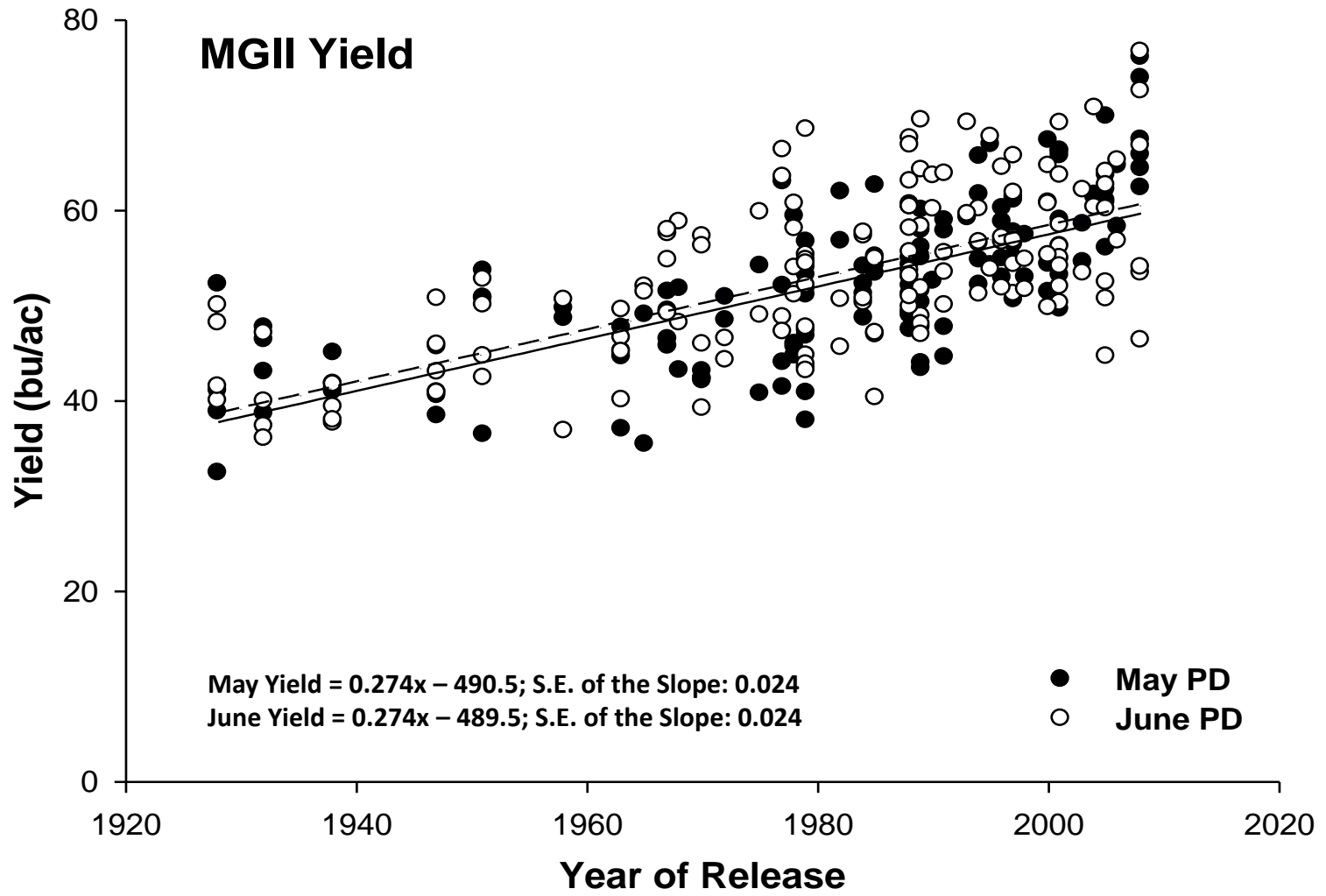


Variety	Release Year
Korean	1928
Mukden	1932
Richland	1938
Hawkeye	1947
Harosoy	1951
Lindarin	1958
Harosoy 63	1963
Hawkeye 63	1963
Amsoy	1965
Corsoy	1967
Beeson	1968
Amsoy 71	1970
Wells	1972
Harcor	1975
Private 7	1977
Private 8	1977
Wells II	1978
Vickery	1978
Corsoy 79	1979
Beeson 80	1979

Variety	Release Year
Century	1979
Amtcor	1979
Private 11	1982
Century 84	1984
Elgin	1984
Preston	1985
Private 15	1985
Burlison	1988
Private 9	1988
Elgin 87	1988
Conrad	1988
Jack	1989
Kenwood	1989
Private 1	1989
Private 2	1990
RCAT Angora	1991
Private 6	1991
Private 5	1993
Private 10	1994
Private 16	1994

Variety	Release Year
IA 2021	1995
Savoy	1996
Private 12	1996
Dwight	1997
Private 18	1997
IA 2038	1998
IA 2050	2000
IA 2052	2000
Loda	2001
Private 4	2001
Private 17	2001
IA 2068	2003
Private 3	2004
IA 2065	2005
Private 19	2005
Private 20	2005
IA 2094	2006
Private 13	2008
Private 14	2008
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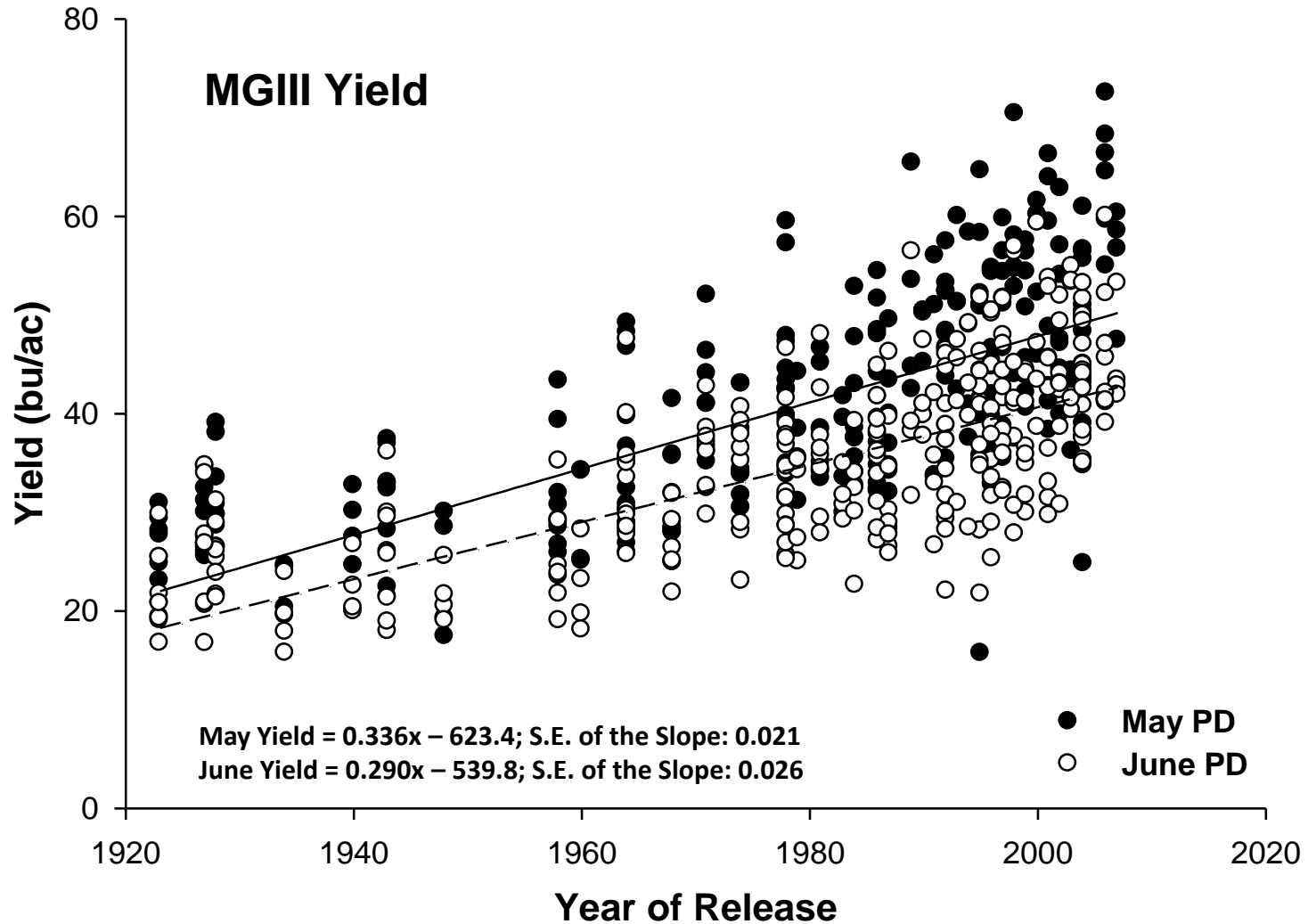
MGI soybean yield at early and late planting (2010-2011)



MGII Yield Results

- ▶ **There was no difference ($p=0.78$) in yield between the early May and early June plantings.**
 - **These results contradict past research across the upper Midwest advocating late April-early May planting for yield maximization (De Bruin and Pedersen, 2008; Pedersen and Lauer, 2003; Robinson et al., 2009.)**
 - **Oplinger and Philbrook (1992) noted no difference in soybean yield at 1 May and 31 May planting dates at the Arlington Research Station.**
 - **The magnitude of yield response to early planting is very location and year specific (De Bruin and Pedersen, 2008).**
- ▶ **There was no difference ($p=0.21$) in the rate of yield gain over time between the early and late planting in MGII soybeans.**
 - **There is no interaction between planting date and cultivar year of release.**

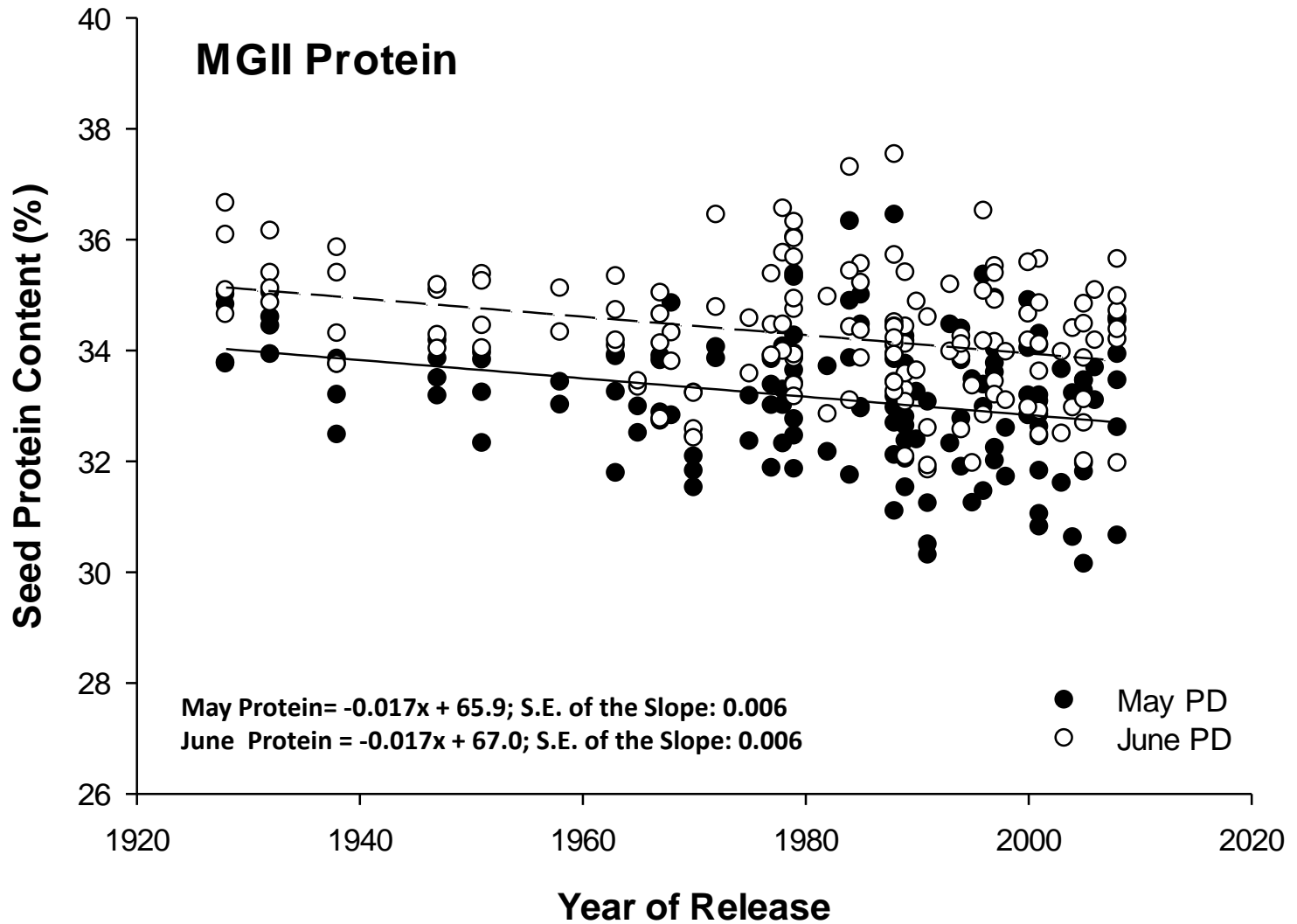
MGIII soybean yield at early and late planting (2010-2011)



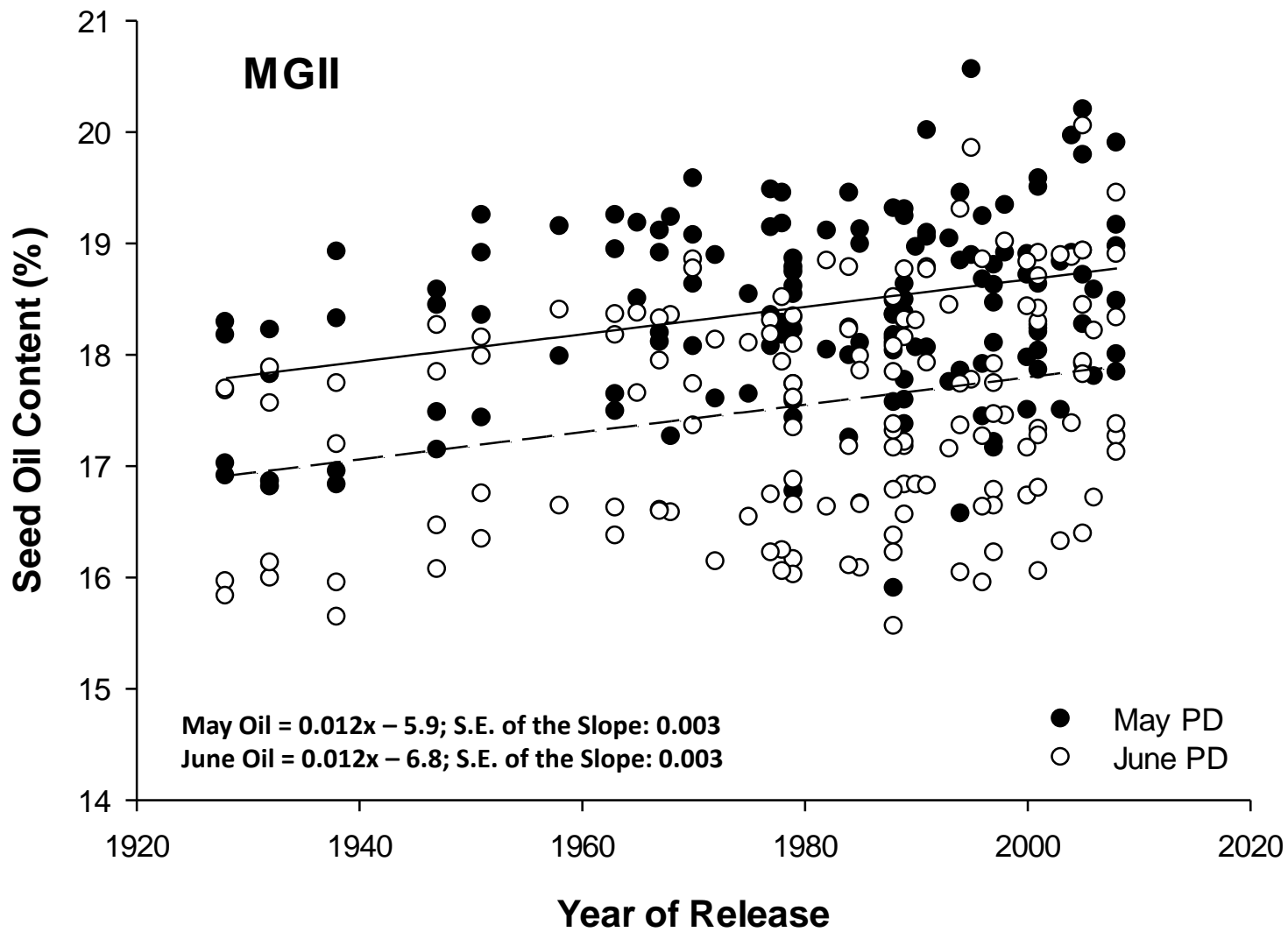
MGIII Yield Results

- ▶ **Early May planted soybeans provided higher ($p=0.046$) yields than soybeans planted in early June.**
 - **These results suggest a yield advantage to earlier planting of MGIII soybeans and are consistent with previous research done advocating late-April and early-May planting for maximum yields (De Bruin and Pedersen, 2008; Robinson et al., 2009)**
- ▶ **There was an observed difference ($p=0.03$) in the rate of yield gain over time between early and late planting in MG III soybeans.**
 - **16% greater rate of yield gain in May planted soybeans shows that there is an interaction between planting date and release year.**

MGII soybean seed protein content at early and late planting (2010-2011)



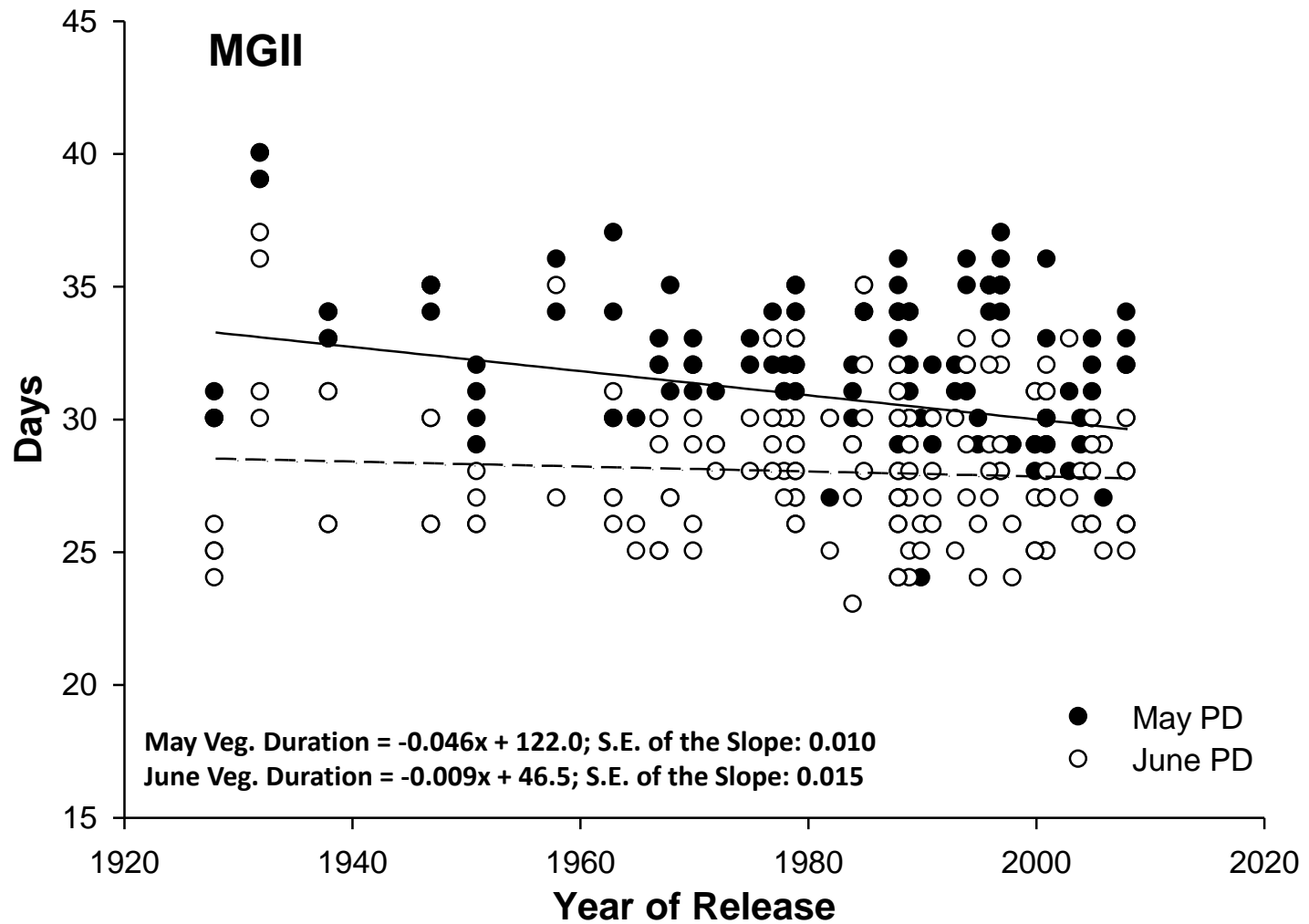
MGII soybean seed oil content at early and late planting (2010-2011)



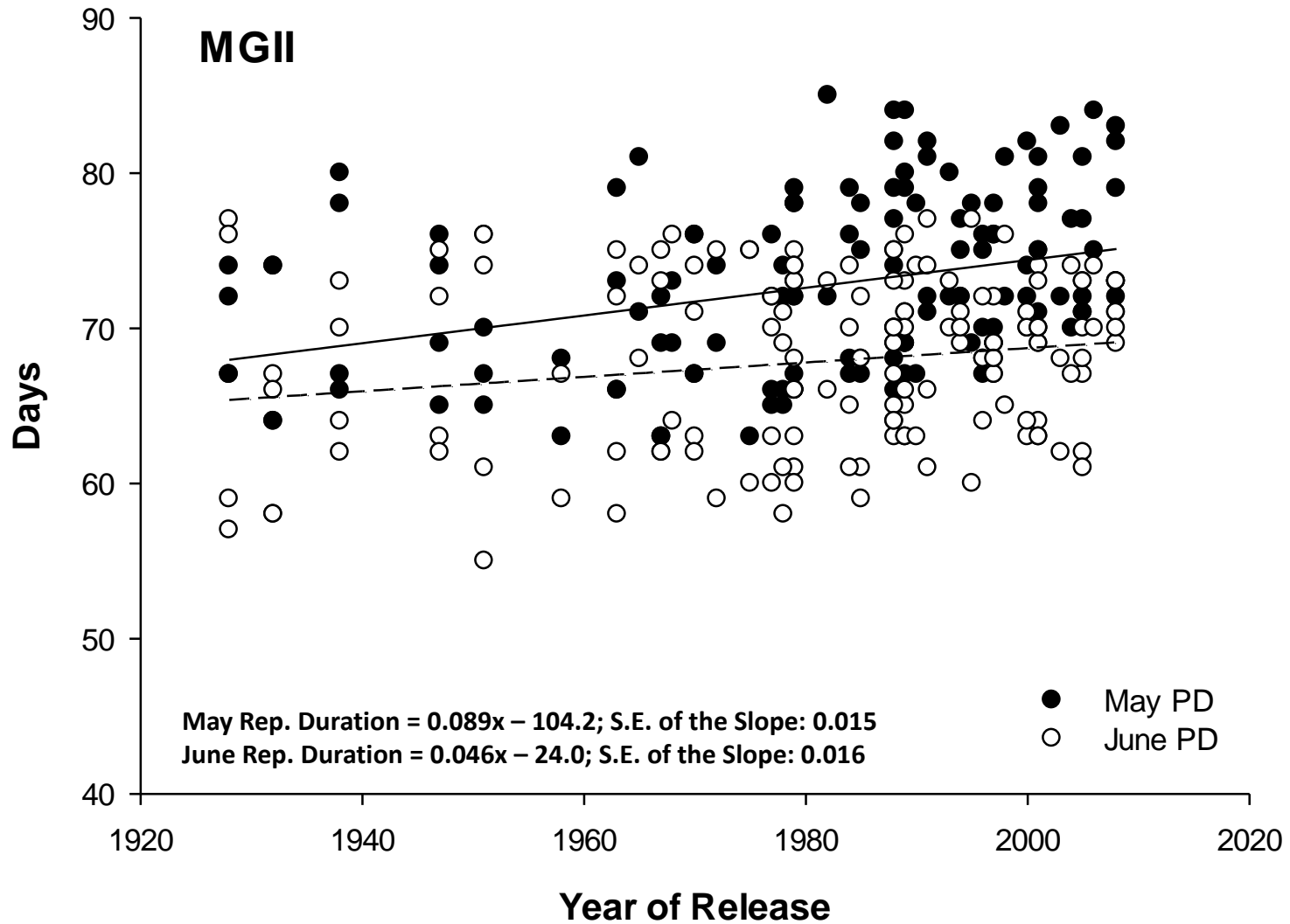
Seed Quality Results

- ▶ Seed protein levels have decreased ($p < 0.01$) over year of release while seed oil levels have increased ($p < 0.001$) over year of release in MGII soybeans.
- ▶ Planting date has influenced ($p < 0.001$) seed protein levels, with early June planted soybeans providing higher protein levels than May planted soybeans. Soybean seed oil levels were not affected ($p = 0.16$) by planting date.
- ▶ There was no difference ($p = 0.49$) in the rate of decrease in seed protein levels over time between the early and late planting. Likewise, there was no difference ($p = 0.29$) in the rate of increase in seed oil levels over time between the two planting dates.
 - There was no interaction between planting date or release year for oil or protein levels

Duration of vegetative growth (V1-R1) at early and late planting (2010-2011)



Duration of reproductive growth (R1-R7) at early and late planting (2010-2011)



Growth Stage Results

- ▶ The time spent in vegetative growth decreased ($p=0.06$) across year of release, while reproductive growth increased ($p<0.001$) across year of release.
- ▶ The rate of decrease in the amount of time spent in vegetative growth was greater ($p<0.001$) in early May planted soybeans, when compared to early June planted soybeans. Similarly, the rate of increase in the amount of time spent in reproductive growth was greater ($p<0.01$) in early May vs. early June planted soybeans.
 - The interaction in growth stage duration between the two planting dates suggests that trends towards earlier planting & breeding efforts have impacted the amount of time the soybean plant has spent in both vegetative and reproductive stages of growth.

Conclusions

- ▶ Soybean yields, seed oil content, and the duration of reproductive growth have all increased over year of release.
- ▶ Protein content and the length of vegetative growth have decreased over year of release.
- ▶ Earlier planting of soybean has resulted in decreased seed protein levels and an increased duration of reproductive growth.
- ▶ Earlier planting has not impacted yield or seed oil content in MGII soybean in the context of this experiment.
- ▶ Interactions between earlier soybean planting and breeding efforts have not influenced yield gain or seed quality in MGII soybean. These interactions have influenced MGIII soybean yield and the duration of time spent in vegetative and reproductive growth.
- ▶ Yield response to earlier planting in soybean is environment specific.

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References

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- ▶ **Pedersen, P. and J. G. Lauer. 2003. Soybean Agronomic Response to Management Systems in the Upper Midwest. *Agron. J.* 95: 1146–1151.**
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