

# Soybean Stand Establishment Under No-Till Management

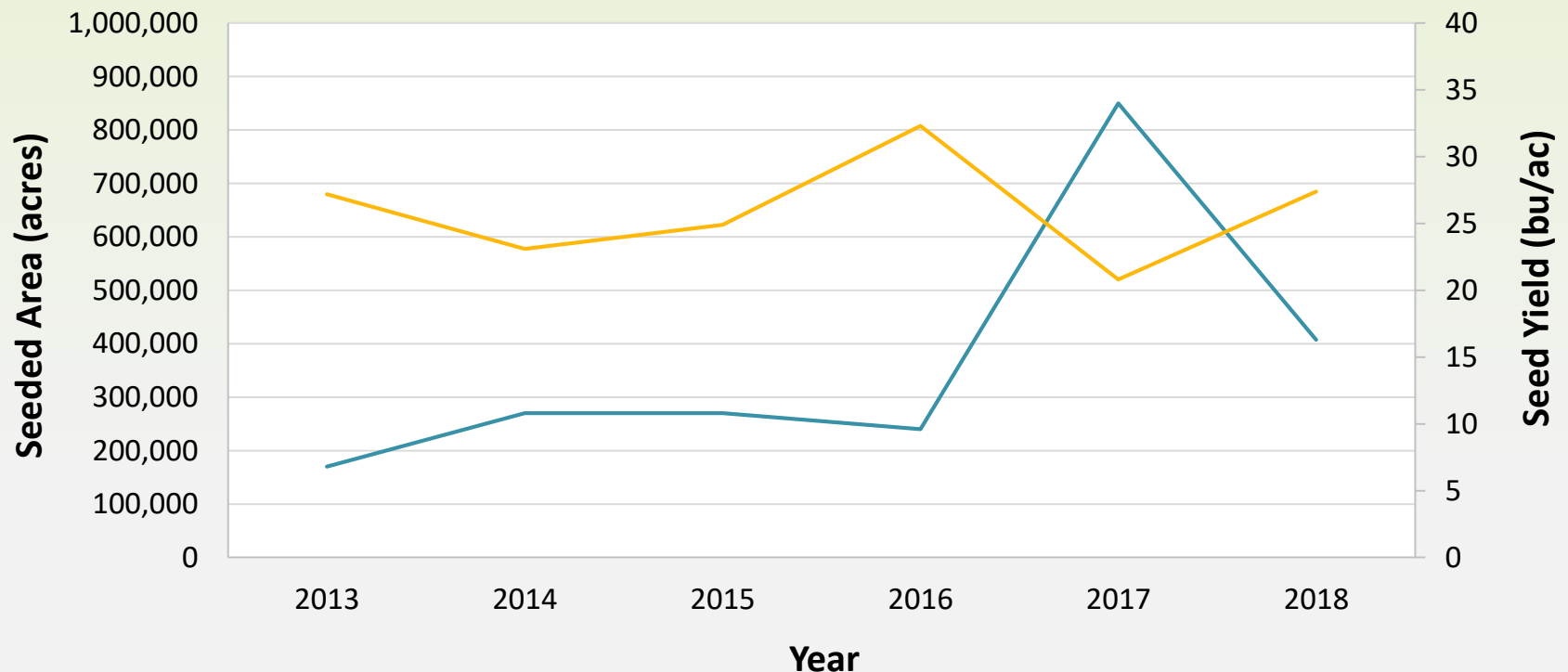
Chris Holzapfel, MSc, PAg  
Indian Head Agricultural Research Foundation



# Background

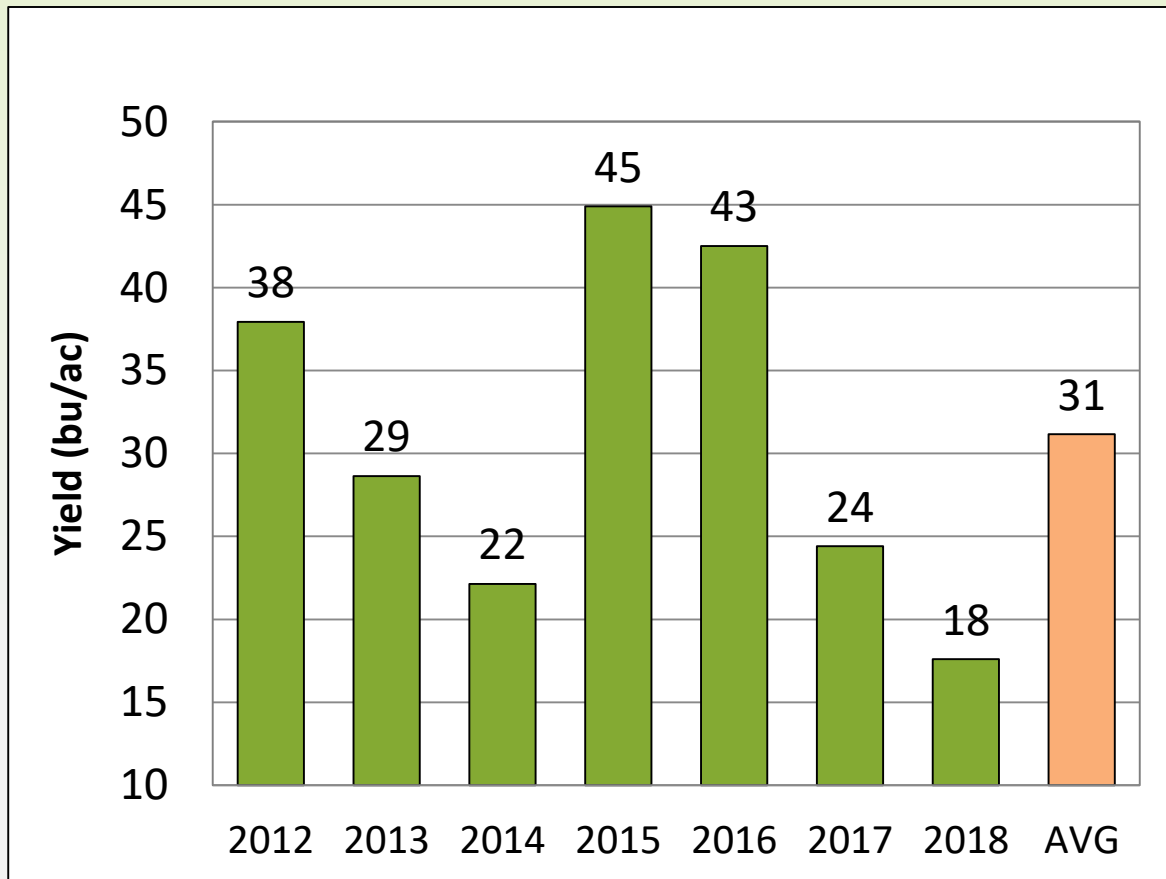
- Soybeans are a relatively new crop in Saskatchewan & the majority of agronomic recommendations that arrived with them were either imported from other regions where climate and/or management practices differed or based on limited local data generated primarily by the seed industry

## SK Soybean Acres & Average Yields



# Soybean Performance at Indian Head

- IHARF has grown soybeans near Indian Head every year since 2012 – with some variability depending on specific practices, yields over that period have ranged from 18-45 bu/ac with an overall mean of 31 bu/ac





# Presentation Overview

- Initiated several public/producer funded trials focussing on establishment under no-till management in 2014, additional fertility trials in 2015, and residue management work initiated in 2017-18
- Topics that have/are being addressed & will be covered include:
  1. Seeding Dates
  2. Seeding Rates
  3. Row Spacing
  4. Seeding Depth
  5. Seed-Placed Fertilizer
  6. Previous crop residue management



# Effects of Seeding Date

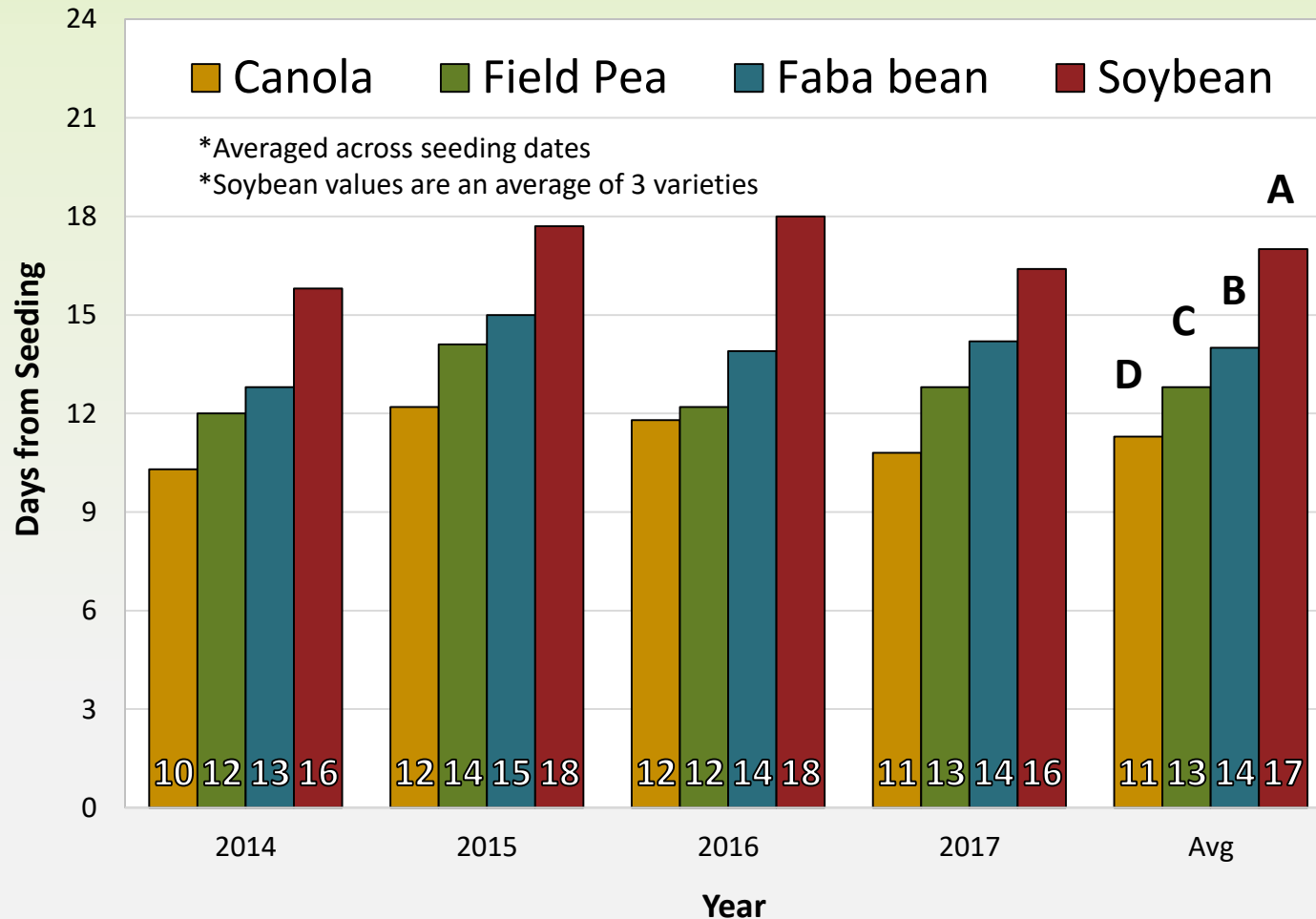
- The challenge is that soybeans should be seeded into warm soils but are also sensitive to fall frost, have long growing season requirements & require substantial soil moisture to germinate...thus there is a potentially short optimal seeding window & temptation to seed early
- Trials in 2014-2017 targeted early-, mid- and late May seeding dates & measured the effects on soybean establishment, development & yield relative to other crops (i.e. field pea, faba bean and canola)
- Trials conducted at both Indian Head (IHARF) & Swift Current (WCA) but only Indian Head will be presented





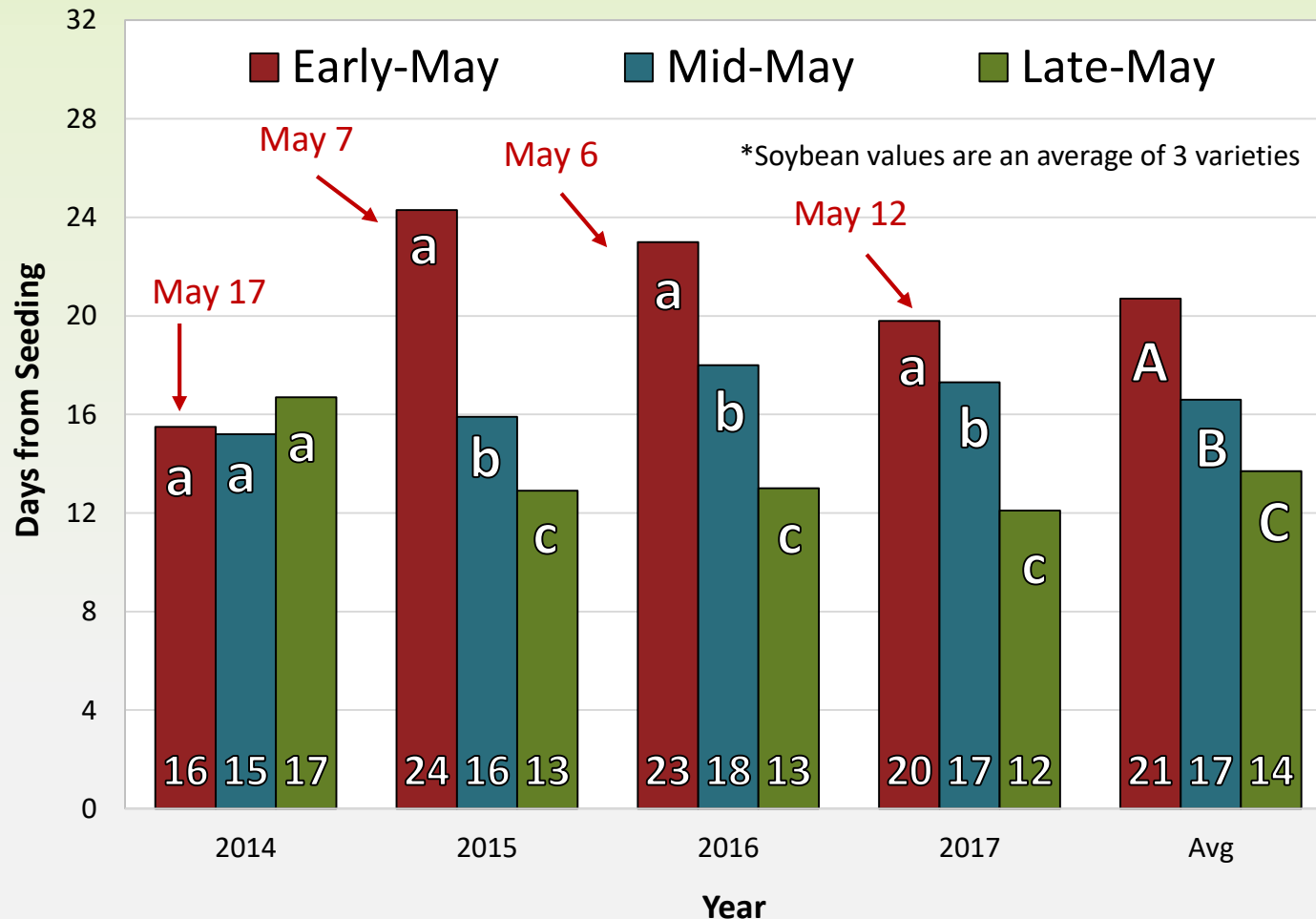
# Days to Emergence × Crop Type

## Indian Head (2014-2017)



# Seeding Date Effects on Days to Soybean Emergence

## Indian Head (2014-2017)

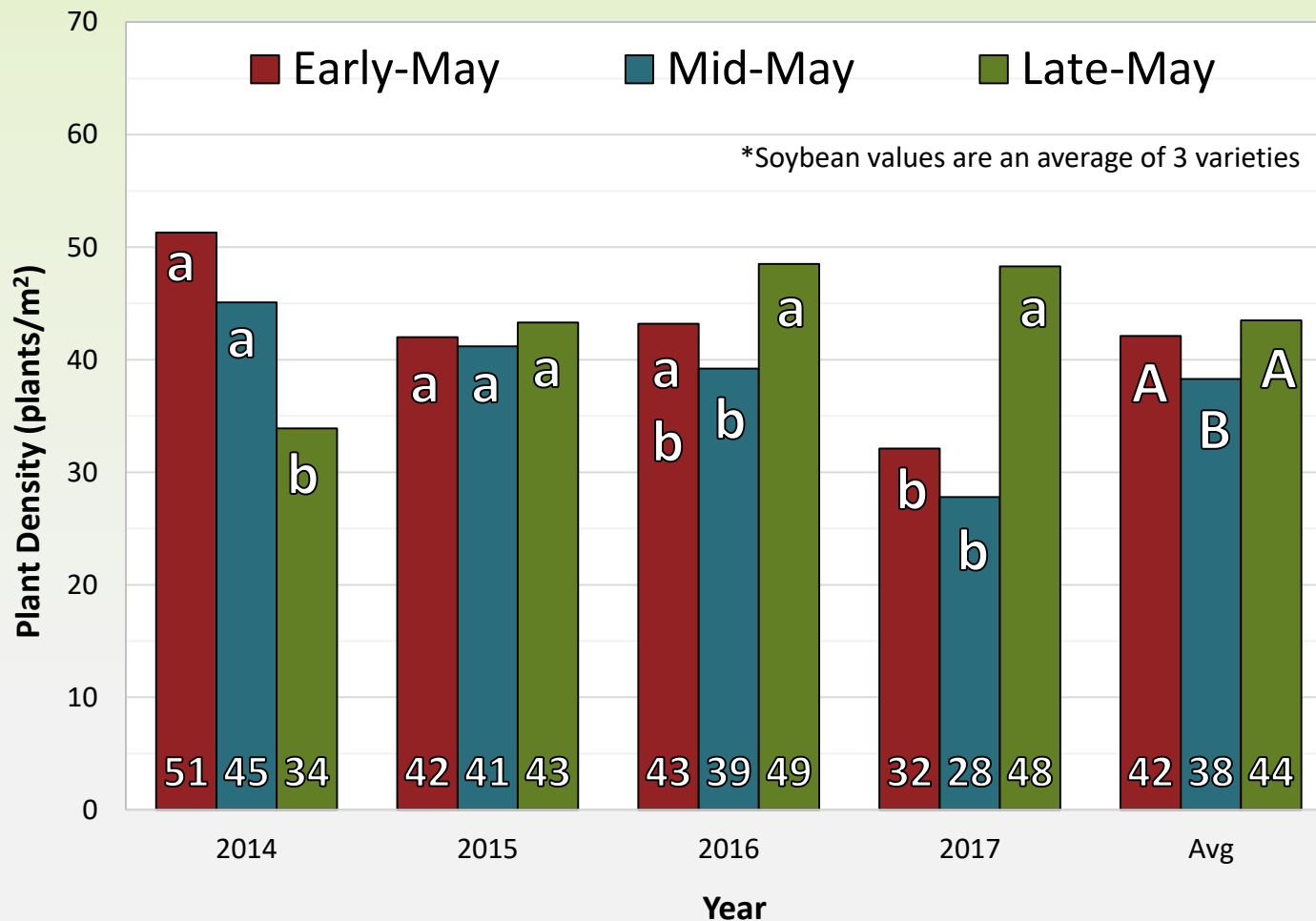


### Overall F-tests

Year: 0.008  
 Date: <0.001  
 Crop: <0.001  
 D x C: 0.088  
 Y x D: <0.001  
 Y x C: 0.686  
 Y x C x D: 0.951

# Seeding Date Effects on Soybean Plant Density

## Indian Head (2014-2017)



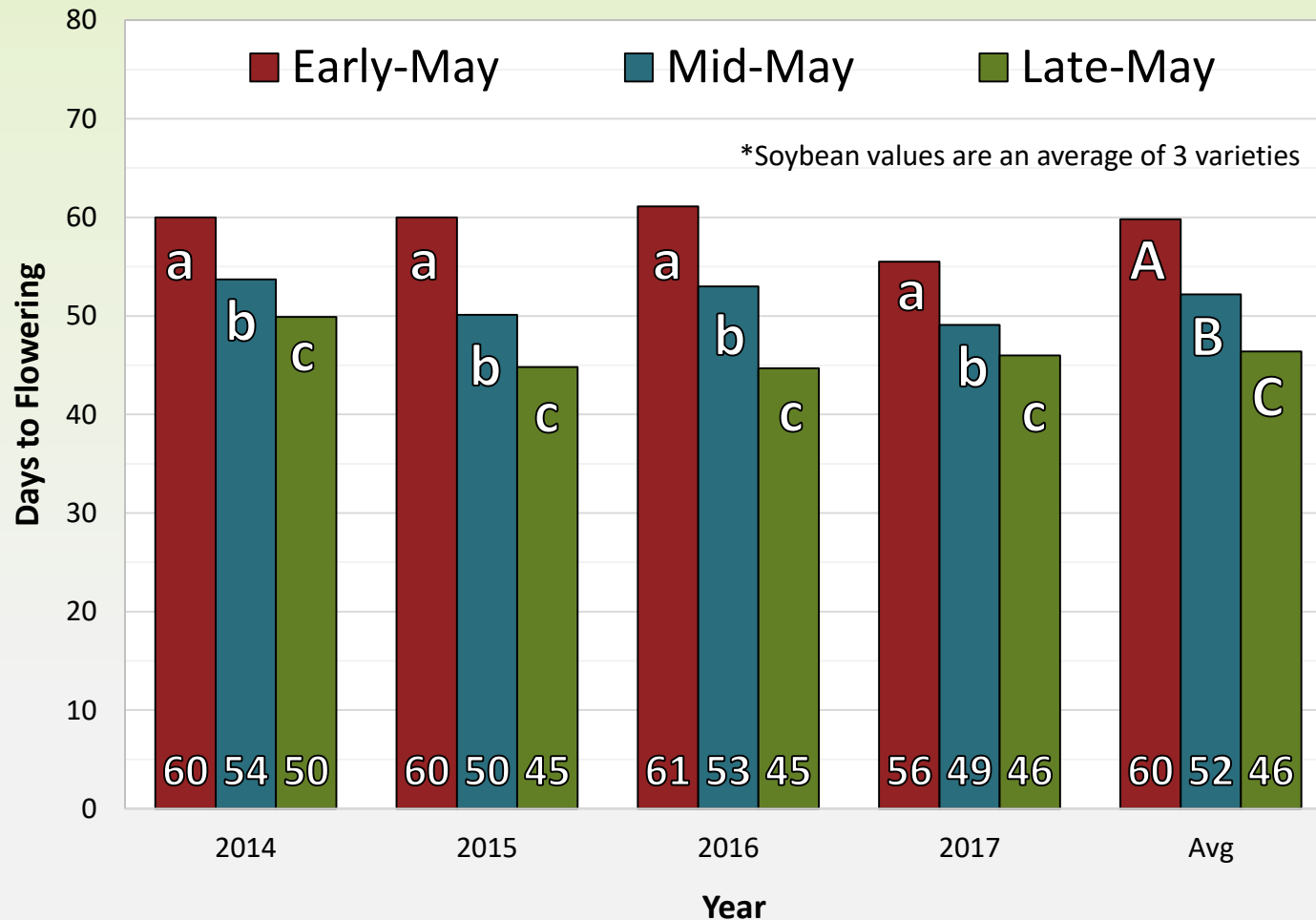
### Overall F-tests

Year: <0.001  
 Date: <0.001  
 Crop: <0.001  
 D x C: <0.001  
 Y x D: <0.001  
 Y x C: <0.001  
 Y x C x D: <0.001



# Seeding Date Effects on Soybean Flowering Date

## Indian Head (2014-2017)

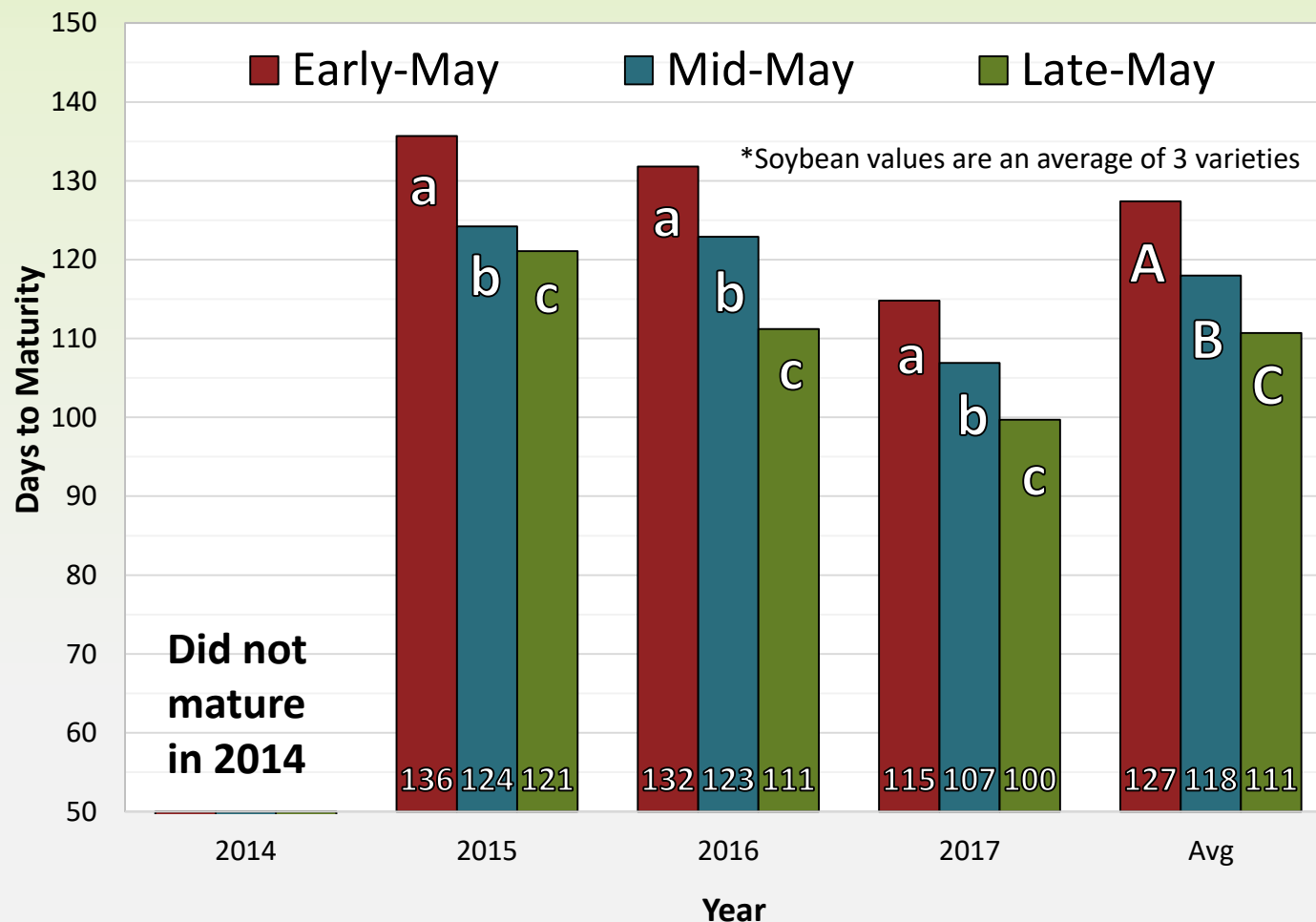


### Overall F-tests

Year: <0.001  
 Date: <0.001  
 Crop: <0.001  
 D x C: <0.001  
 Y x D: <0.001  
 Y x C: <0.001  
 Y x C x D: <0.001

# Seeding Date Effects on Soybean Maturity Date

## Indian Head (2014-2017)

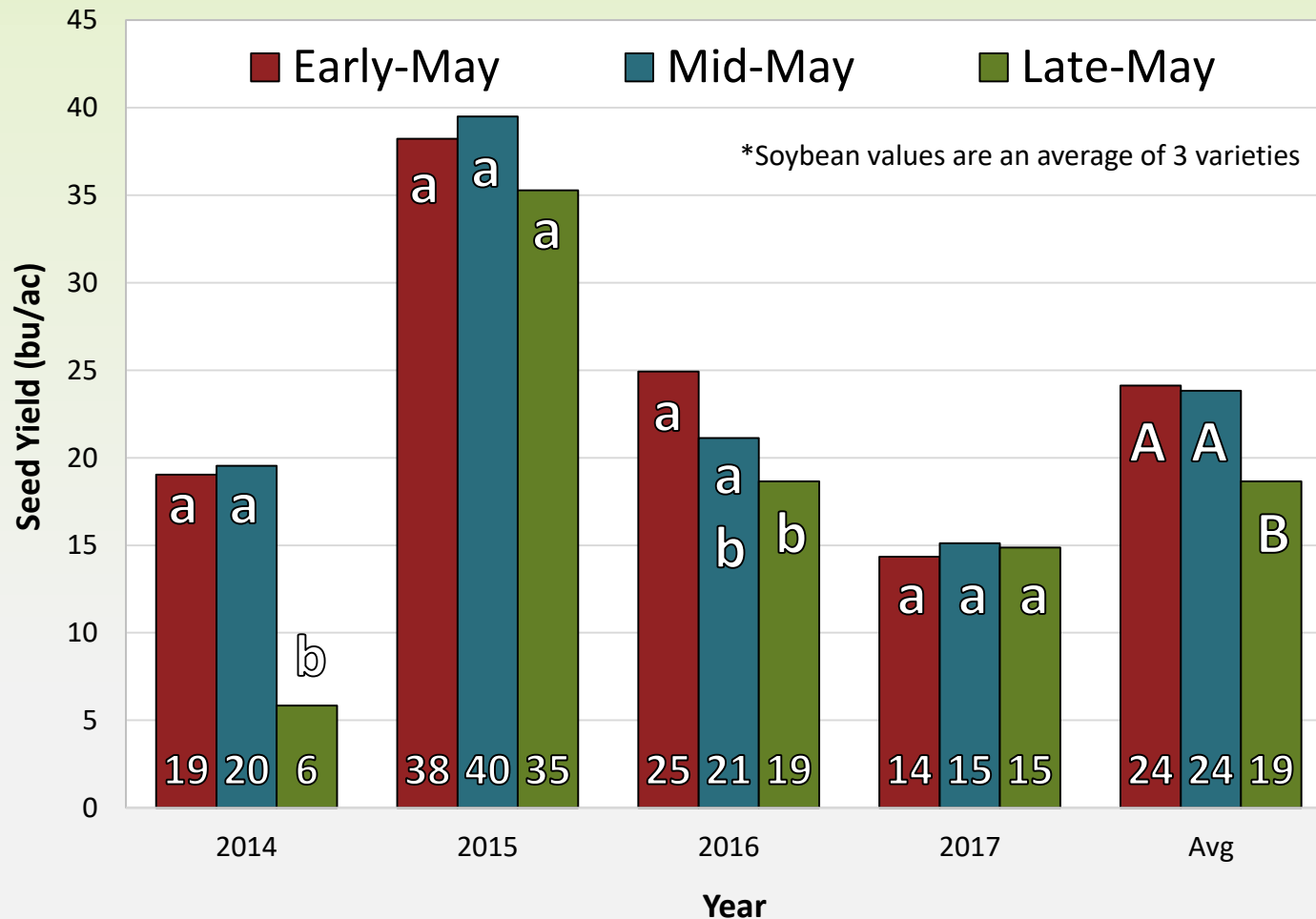


### Overall F-tests

Year: <0.001  
 Date: <0.001  
 Crop: <0.001  
 D x C: <0.001  
 Y x D: <0.001  
 Y x C: <0.001  
 Y x C x D: <0.001

# Seeding Date Effects on Soybean Seed Yield

## Indian Head (2014-2017)



### Overall F-tests

Year: <0.001  
 Date: <0.001  
 Crop: <0.001  
 D x C: <0.001  
 Y x D: <0.001  
 Y x C: <0.001  
 Y x C x D: <0.001



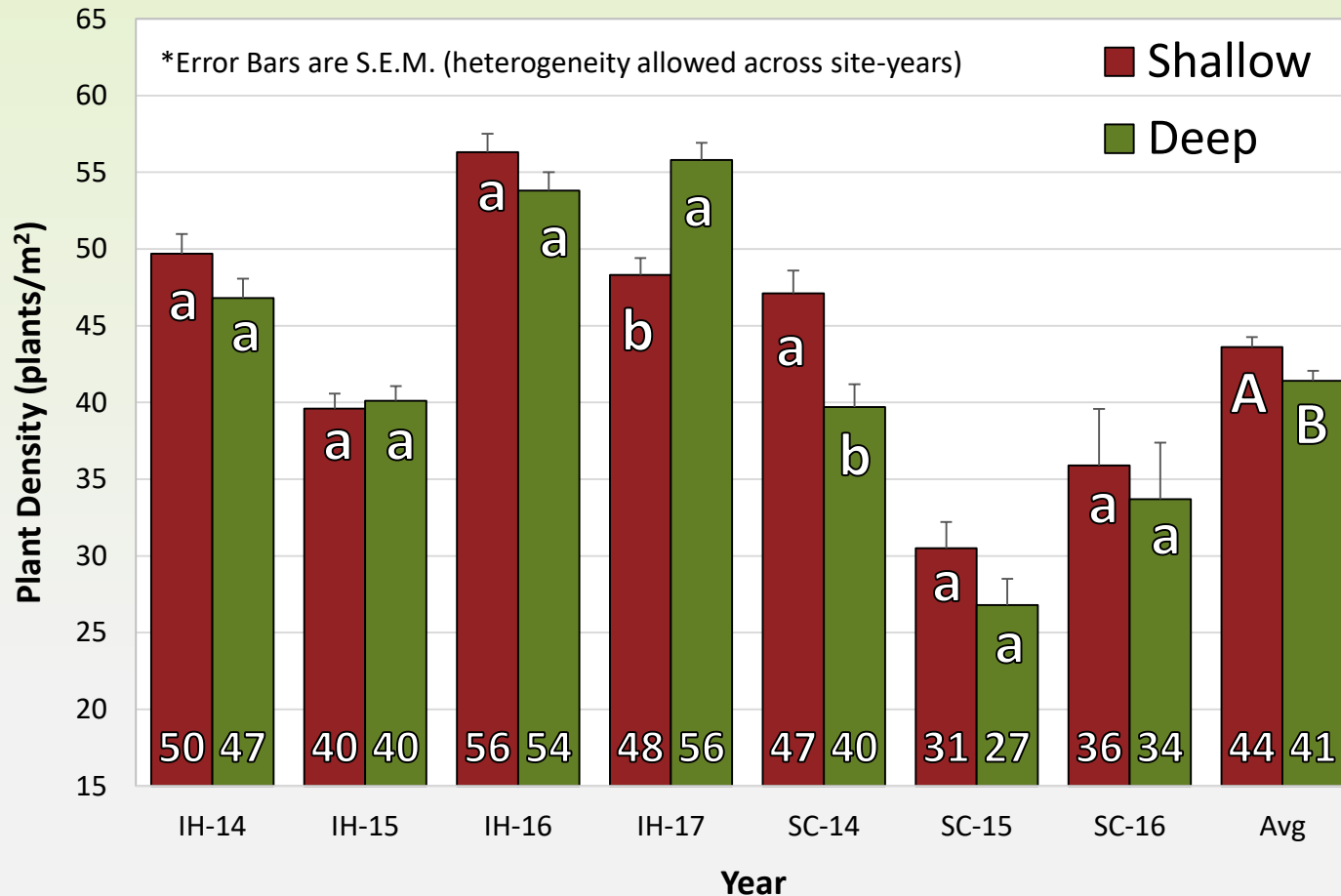
# Effects of Seeding Depth

- As a relatively large seeded pulse that requires substantial moisture to germinate, growers may be inclined to increase soybean seeding depth compared to cereal crops or other oilseeds
- In 2014-2017 at both Indian Head & Swift Current evaluated soybeans seeded at two distinct depths: Shallow (~0.75") or Deep (~1.3-1.5")
  - The deep seeding depths that could be achieved were limited by equipment capabilities
- Seeding depth treatments were evaluated in combination with a wide range of seed rates; however, very few interactions existed & seeding rate responses will be discussed separately
- Data from Swift Current in 2017 was excluded due to extreme drought



# Seeding Depth Effects on Soybean Plant Density

## Indian Head (2014-2017)

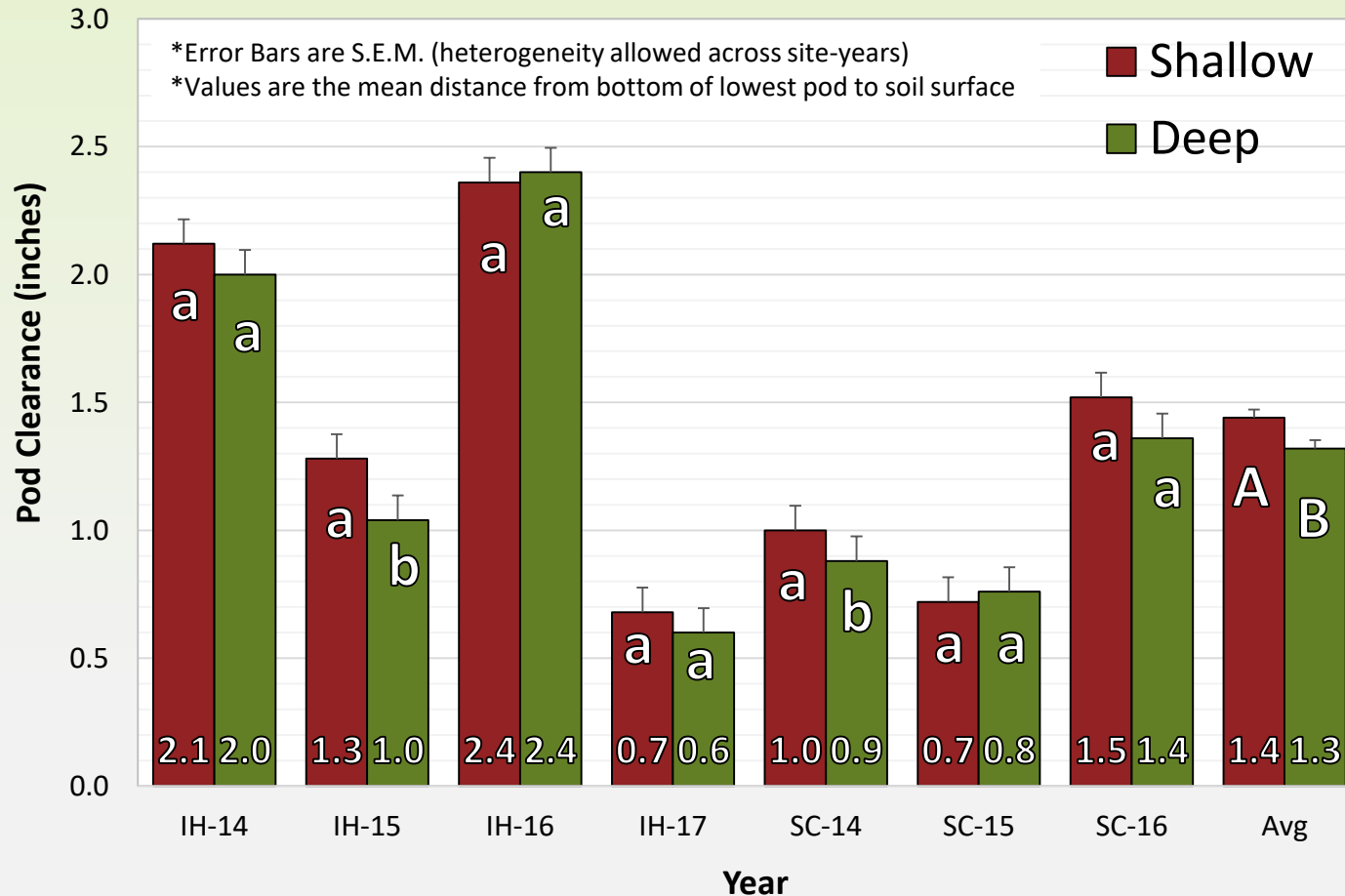


### Overall F-tests

Site-Yr: <0.001  
 Depth: 0.021  
 Rate: <0.001  
 D x R: 0.363  
 S x D: <0.001  
 S x R: <0.001  
 R x D x R: 0.400

# Seeding Depth Effects on Soybean Pod Ground Clearance

## Indian Head (2014-2017)



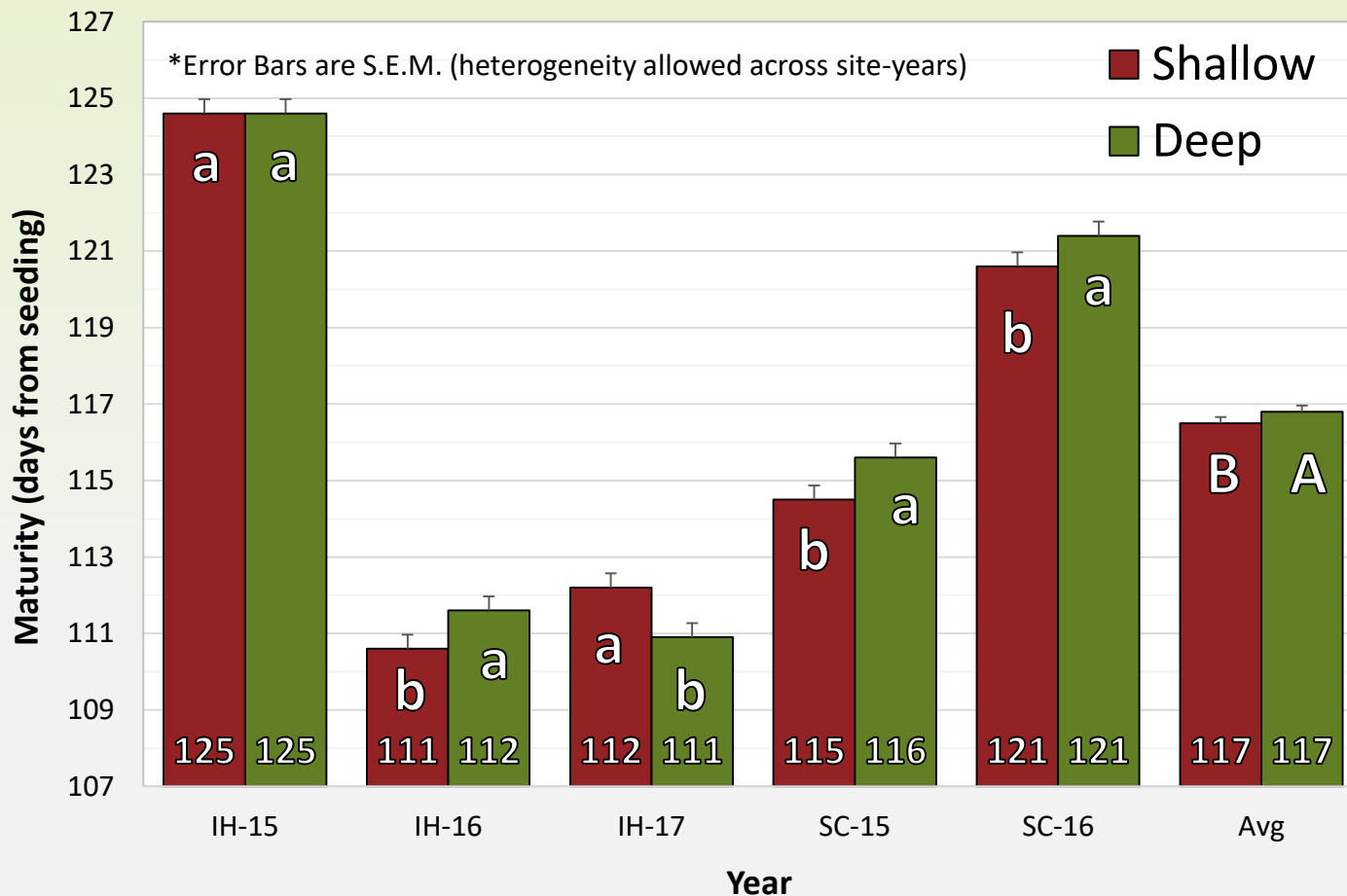
### Overall F-tests

Site-Yr: <0.001  
 Depth: <0.001  
 Rate: <0.001  
 D x R: 0.034  
 S x D: 0.276  
 S x R: <0.001  
 R x D x R: 0.874



# Seeding Depth Effects on Soybean Maturity Date

## Indian Head (2014-2017)

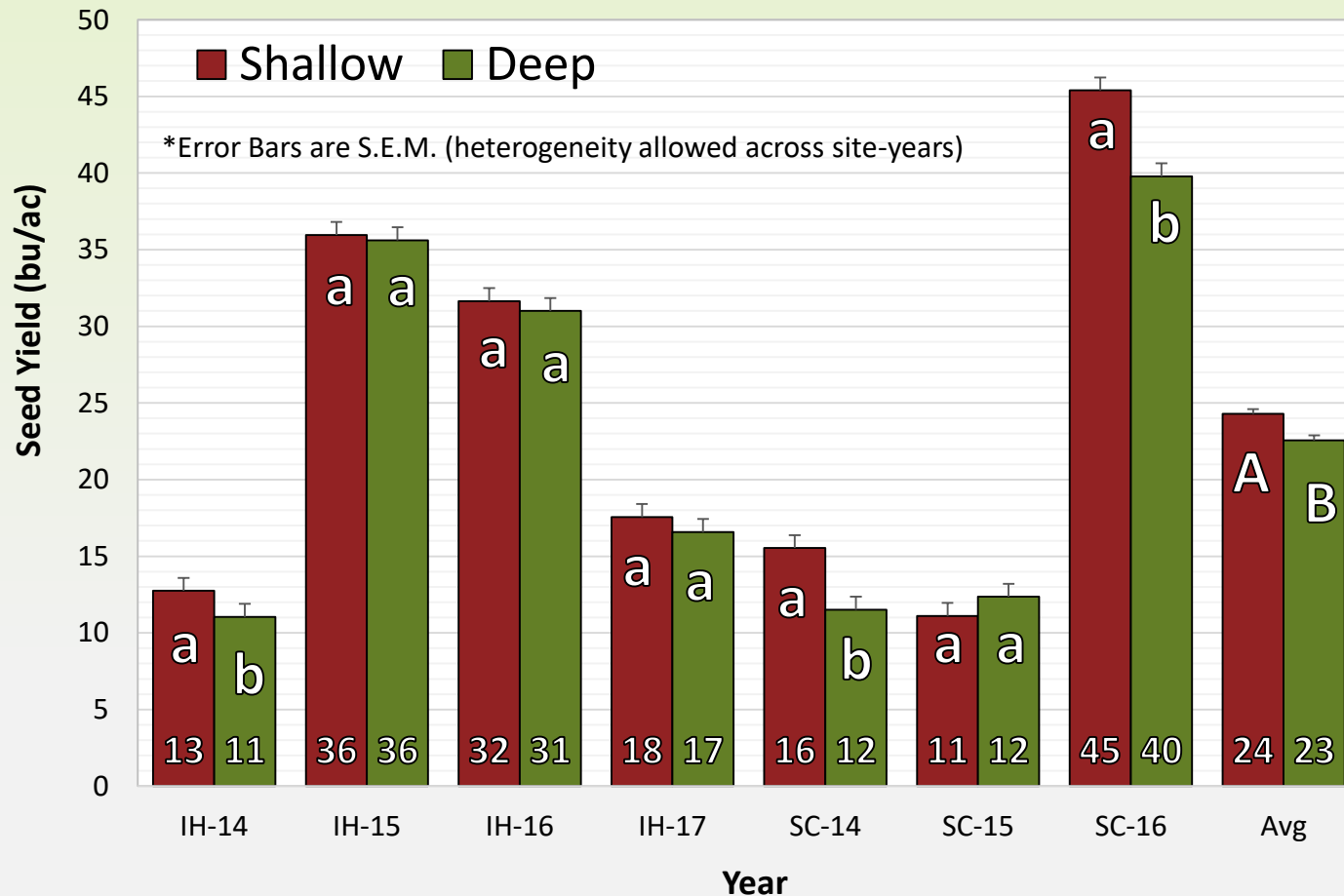


### Overall F-tests

Site-Yr: <0.001  
 Depth: 0.005  
 Rate: <0.001  
 D x R: 0.050  
 S x D: <0.001  
 S x R: <0.001  
 R x D x R: 0.033

# Seeding Depth Effects on Soybean Seed Yield

## Indian Head (2014-2017)



### Overall F-tests

Site-Yr: <0.001  
 Depth: <0.001  
 Rate: <0.001  
 D x R: 0.497  
 S x D: <0.001  
 S x R: <0.001  
 R x D x R: 0.001

# Effects of Seed Rate

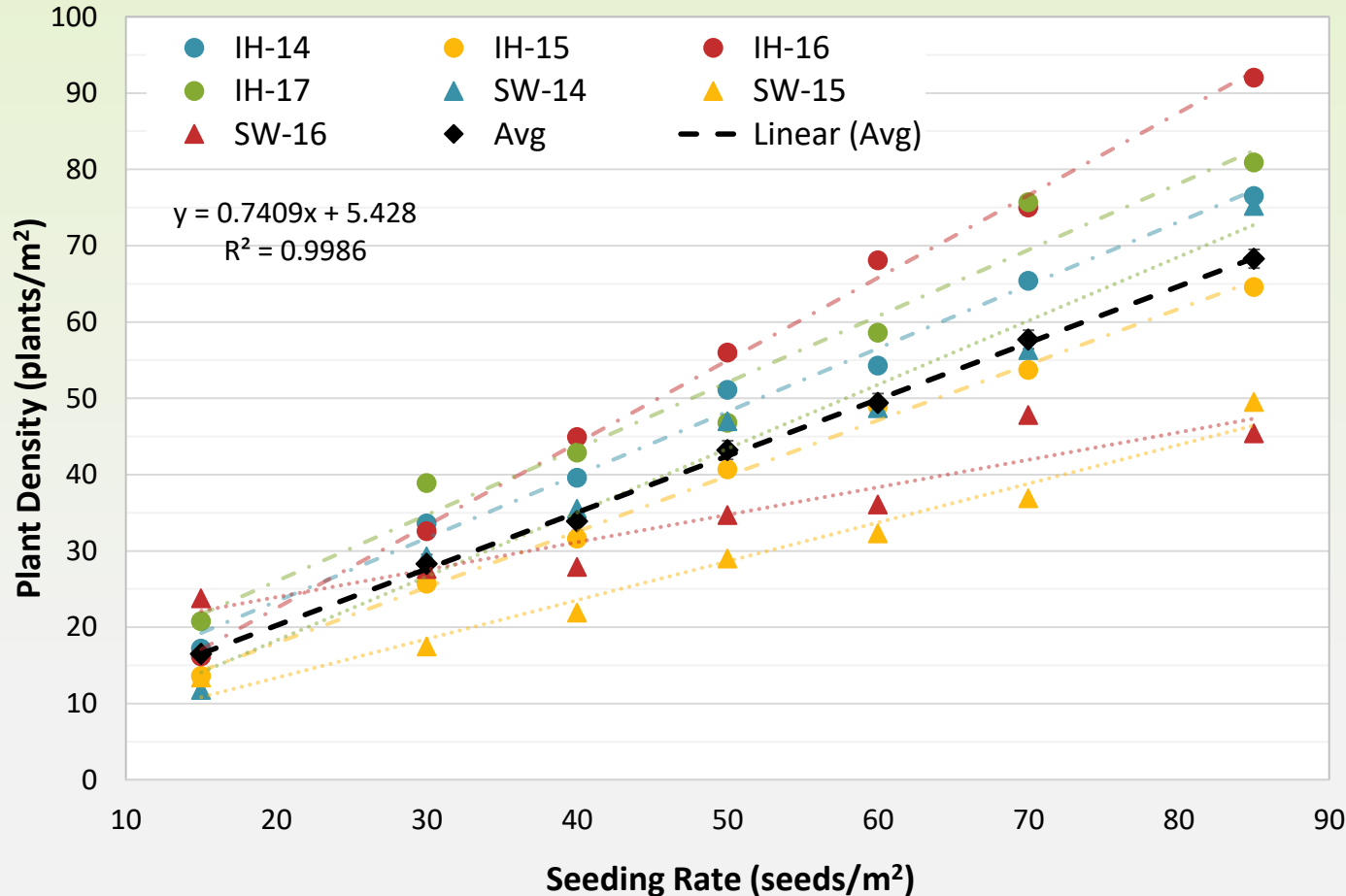
- Seed is one of the most expensive inputs in soybean production; therefore understanding minimum thresholds under representative conditions is important
- Trials in 2014-2017 at Indian Head & Swift Current evaluated soybeans seeded at seven seed rates ranging from ~60-350K seeds/ac (15-85 seeds/m<sup>2</sup>)
  - Rates were selected to include treatments that would be both substantially less than and greater than those required to optimize yield
- Seeding rate treatments were evaluated in combination with the two previously discussed seeding depths (no notable interactions between the two factors detected)
- Data from Swift Current 2017 was excluded due to extreme drought





# Seed Rate Effects on Soybean Plant Density

## Indian Head & Swift Current (2014-2017)



### Overall F-tests

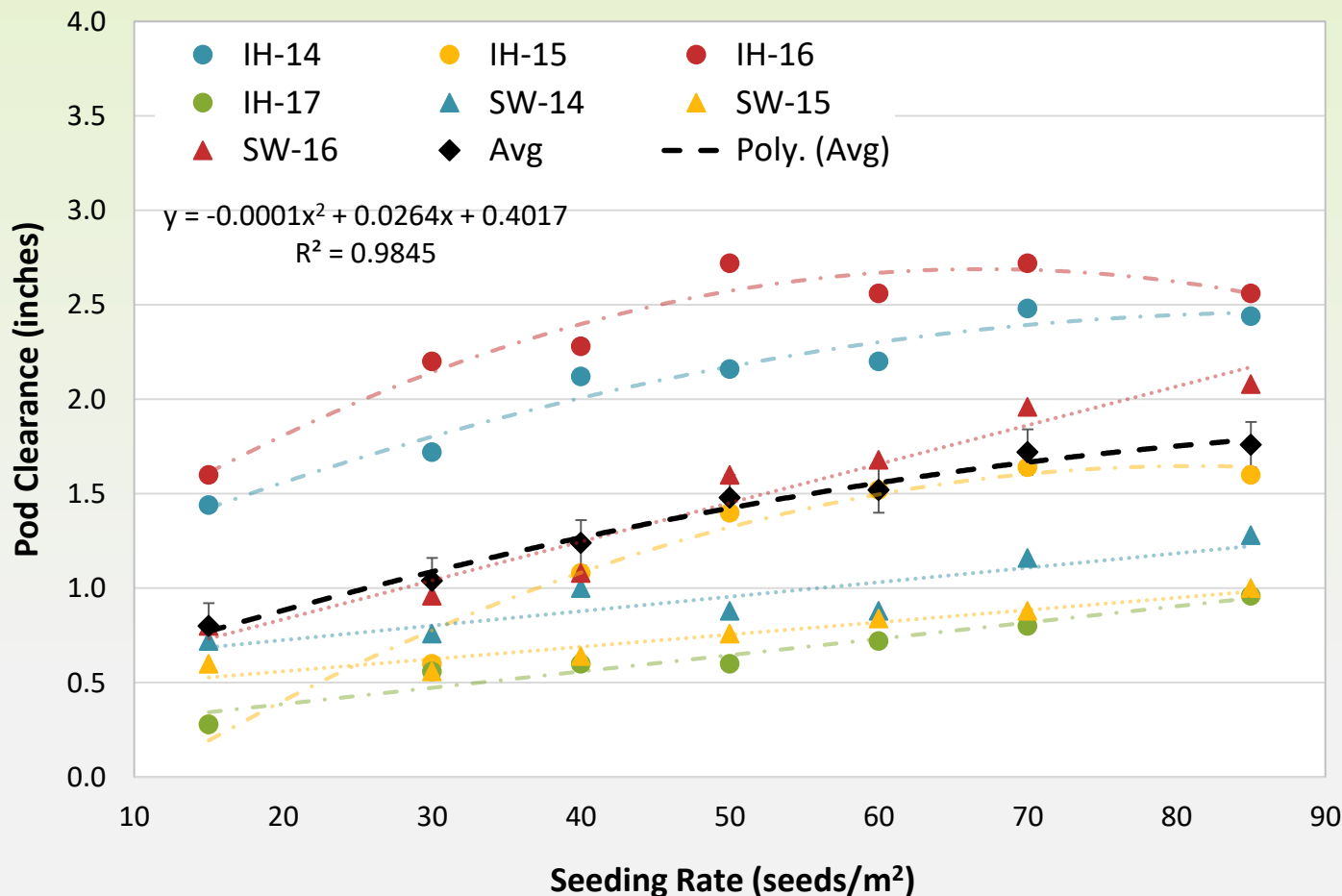
Site-Yr: <0.001  
 Depth: 0.021  
 Rate: <0.001  
 D x R: 0.363  
 S x D: <0.001  
 S x R: <0.001  
 R x D x R: 0.400

### Orth. Contrasts

IH-14: <0.001 (lin)  
 IH-15: <0.001 (lin)  
 IH-16: <0.001 (lin)  
 IH-17: <0.001 (lin)  
 SW-14: <0.001 (lin)  
 SW-15: <0.001 (lin)  
 SW-16: 0.002 (lin)  
 Avg: <0.001 (lin)

# Seed Rate Effects on Soybean Pod Ground Clearance

## Indian Head & Swift Current (2014-2017)



### Overall F-tests

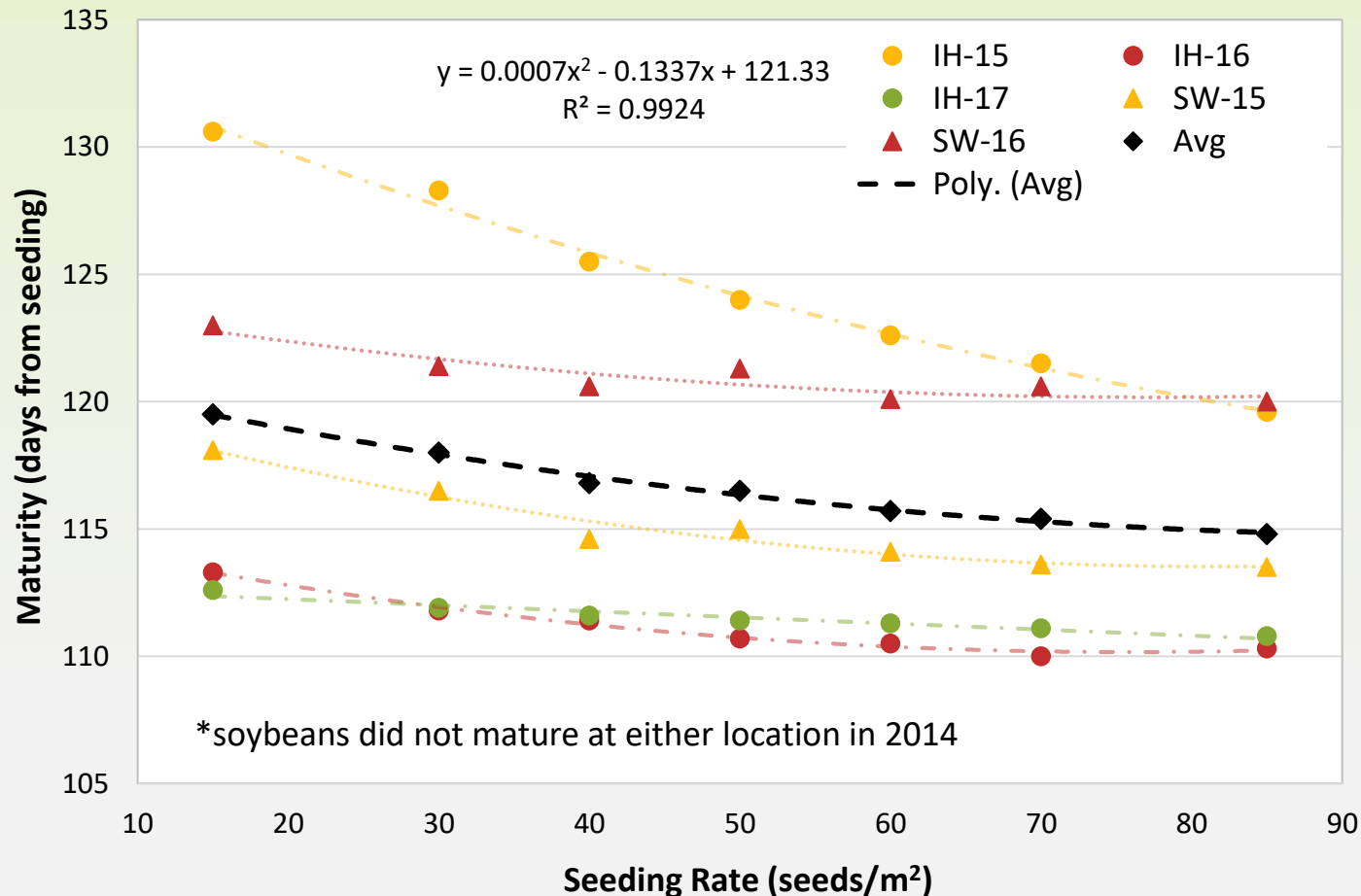
Site-Yr: <0.001  
 Depth: <0.001  
 Rate: <0.001  
 D x R: 0.034  
 S x D: 0.276  
 S x R: <0.001  
 R x D x R: 0.874

### Orth. Contrasts

IH-14: 0.036 (quad)  
 IH-15: <0.001 (quad)  
 IH-16: <0.001 (quad)  
 IH-17: <0.001 (lin)  
 SW-14: <0.001 (lin)  
 SW-15: <0.001 (lin)  
 SW-16: 0.002 (lin)  
 Avg: <0.001 (quad)

# Seed Rate Effects on Soybean Maturity

## Indian Head & Swift Current (2014-2017)



### Overall F-tests

Site-Yr: <0.001  
 Depth: 0.005  
 Rate: <0.001  
 D x R: 0.050  
 S x D: <0.001  
 S x R: <0.001  
 R x D x R: 0.033

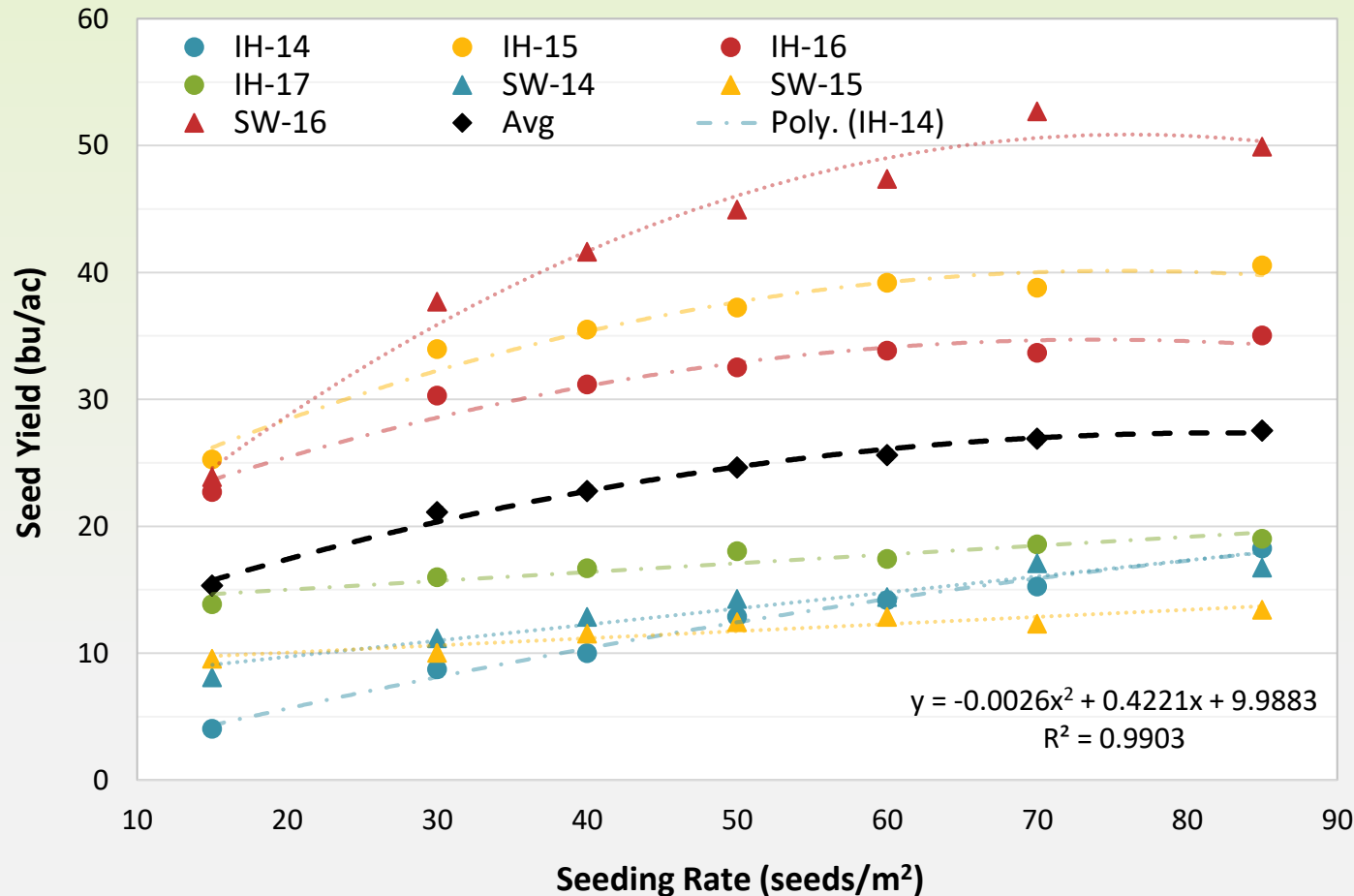
### Orth. Contrasts

IH-14: n/a  
 IH-15: 0.002 (quad)  
 IH-16: 0.004 (quad)  
 IH-17: <0.001 (lin)  
 SW-14: n/a  
 SW-15: <0.001 (quad)  
 SW-16: 0.014 (quad)  
 Avg: <0.001 (quad)



# Seed Rate Effects on Soybean Seed Yield

## Indian Head & Swift Current (2014-2017)



### Overall F-tests

Site-Yr: <0.001  
 Depth: <0.001  
 Rate: <0.001  
 D x R: 0.497  
 S x D: <0.001  
 S x R: <0.001  
 R x D x R: 0.001

### Orth. Contrasts

IH-14: <0.001 (lin)  
 IH-15: <0.001 (quad)  
 IH-16: <0.001 (quad)  
 IH-17: <0.001 (lin)  
 SW-14: 0.035 (quad)  
 SW-15: <0.001 (lin)  
 SW-16: <0.001 (quad)  
 Avg: <0.001 (quad)

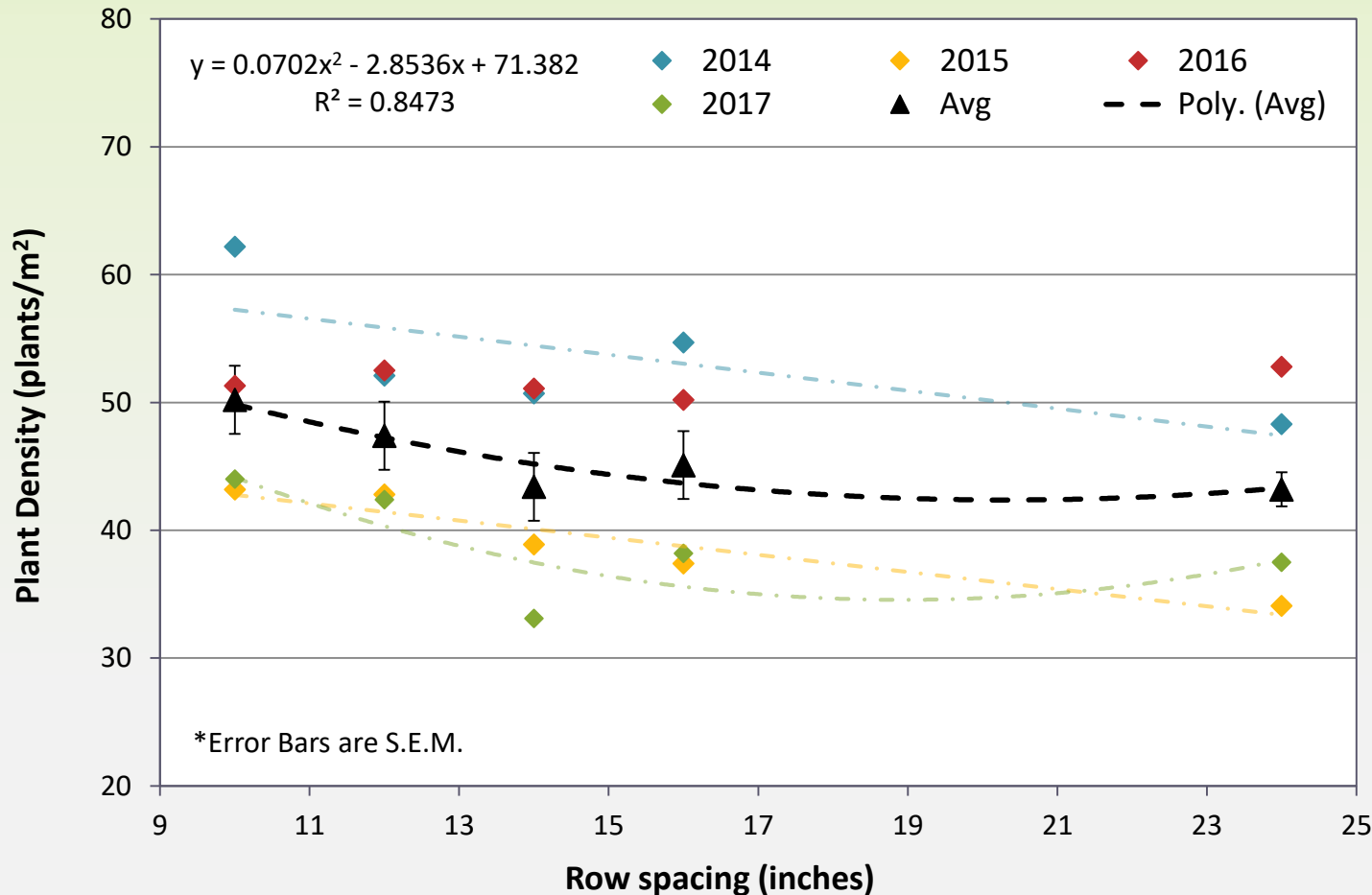
# Effects of Row Spacing

- With research from traditional soybean growing areas showing equal or greater yields with 'solid' seeding but a large proportion of the crop seeded using planters, soybeans were expected to be reasonably well adapted to a wide range of row spacing levels
- Trials in 2014-2017 evaluated soybeans seeded at five row spacing levels ranging from 10-24" under no-till management & with a very early maturing variety
- Row spacing treatments were evaluated in combination with the three seeding rates, centred around the expected optimum of ~200,000 seeds/ac
- Trials only conducted at Indian Head due to the specialized equipment requirements



# Row Spacing Effects on Soybean Plant Density

## Indian Head 2014-2017



### Overall F-tests

Year: <0.001  
 Row Spacing: <0.001  
 Seed Rate: <0.001  
 RS x SR: 0.306  
 Y x RS: 0.102  
 Y x SR: 0.057  
 Y x RS x SR: 0.975

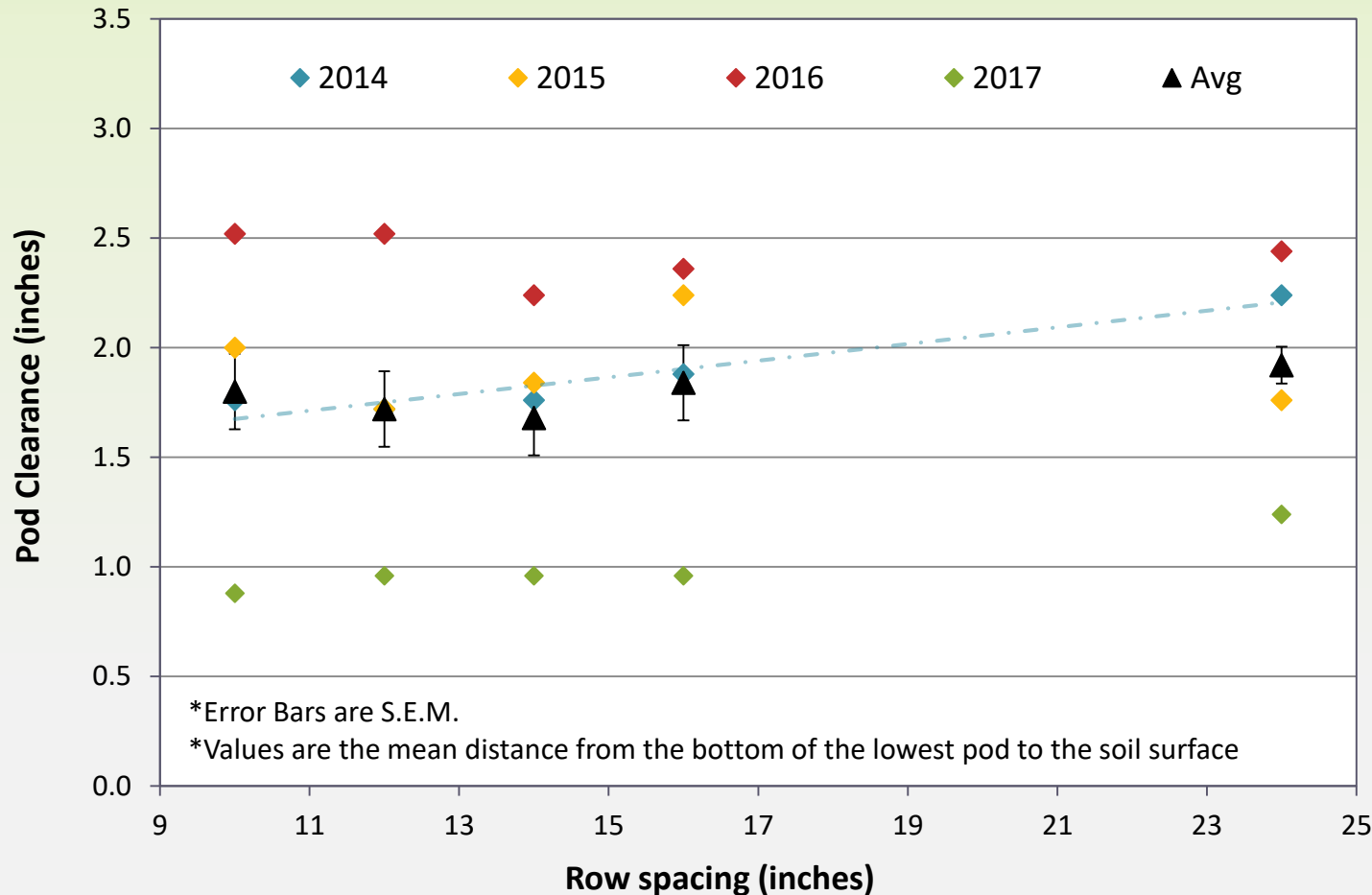
### Orth. Contrasts

IH-14: 0.002 (lin)  
 IH-15: 0.004 (lin)  
 IH-16: not significant  
 IH-17: 0.031 (quad)  
 Avg: 0.014 (quad)



# Row Spacing Effects on Soybean Pod Ground Clearance

## Indian Head 2014-2017



### Overall F-tests

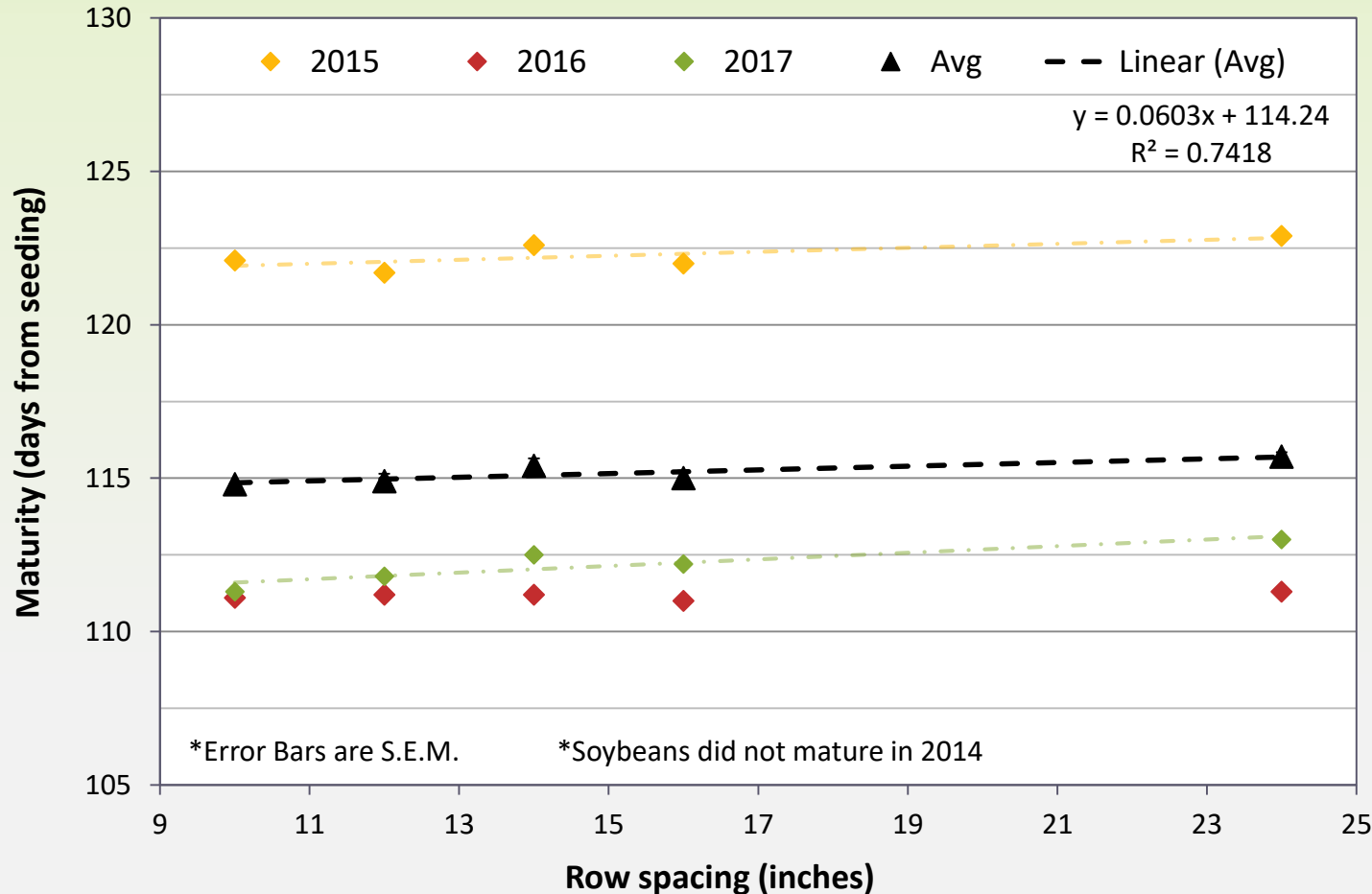
Year: <0.001  
 Row Spacing: 0.379  
 Seed Rate: n/a  
 RS x SR: n/a  
 Y x RS: 0.437  
 Y x SR: n/a  
 Y x RS x SR: n/a

### Orth. Contrasts

IH-14: 0.022 (lin)  
 IH-15: not significant  
 IH-16: not significant  
 IH-17: not significant  
 Avg: not significant

# Row Spacing Effects on Soybean Maturity

## Indian Head 2014-2017



### Overall F-tests

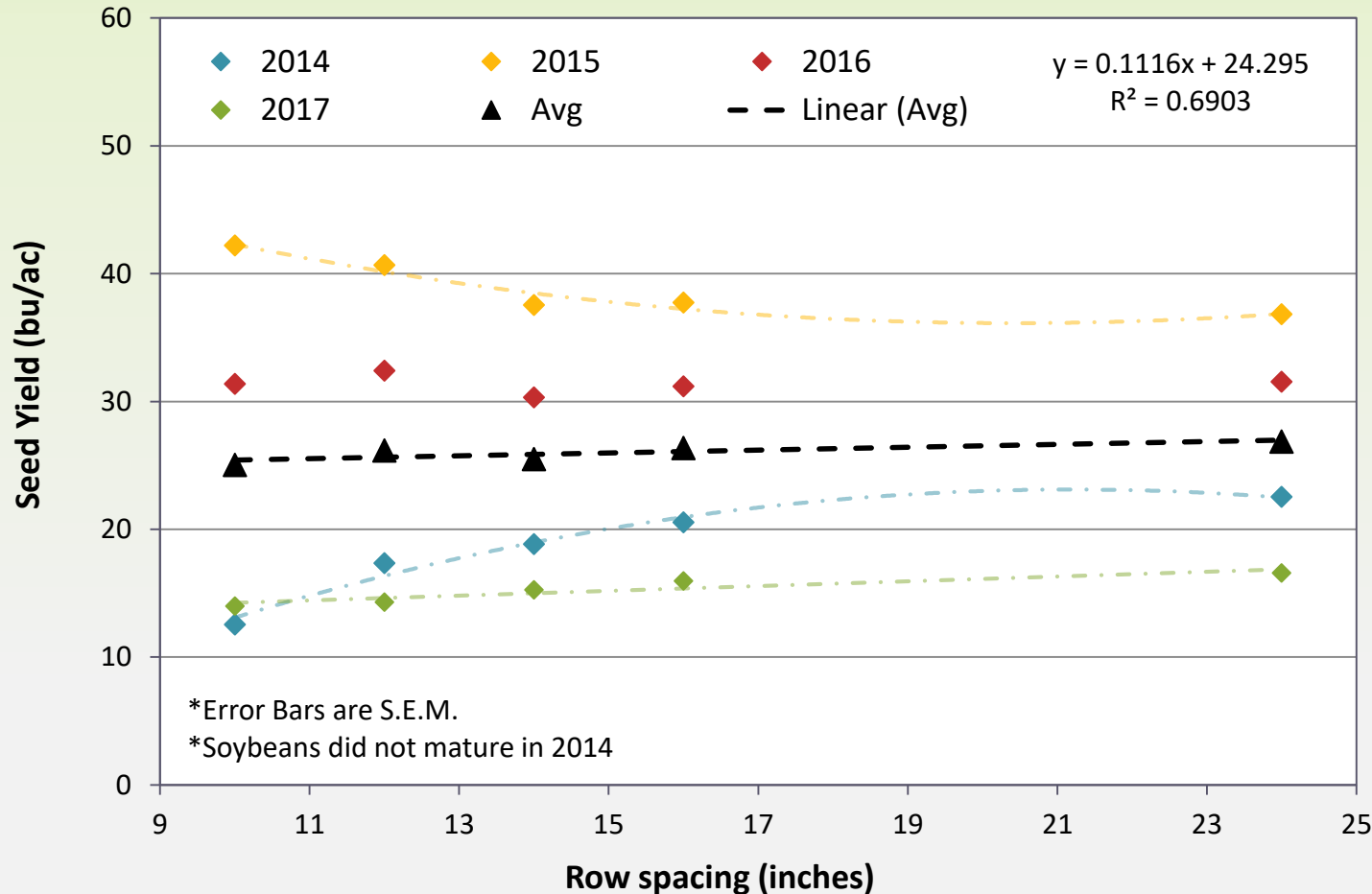
Year: <0.001  
 Row Spacing: <0.001  
 Seed Rate: <0.001  
 RS x SR: 0.350  
 Y x RS: 0.044  
 Y x SR: 0.022  
 Y x RS x SR: 0.478

### Orth. Contrasts

IH-14: n/a  
 IH-15: 0.004 (lin)  
 IH-16: not significant  
 IH-17: <0.001 (lin)  
 Avg: <0.001 (lin)

# Row Spacing Effects on Soybean Seed Yield

## Indian Head 2014-2017



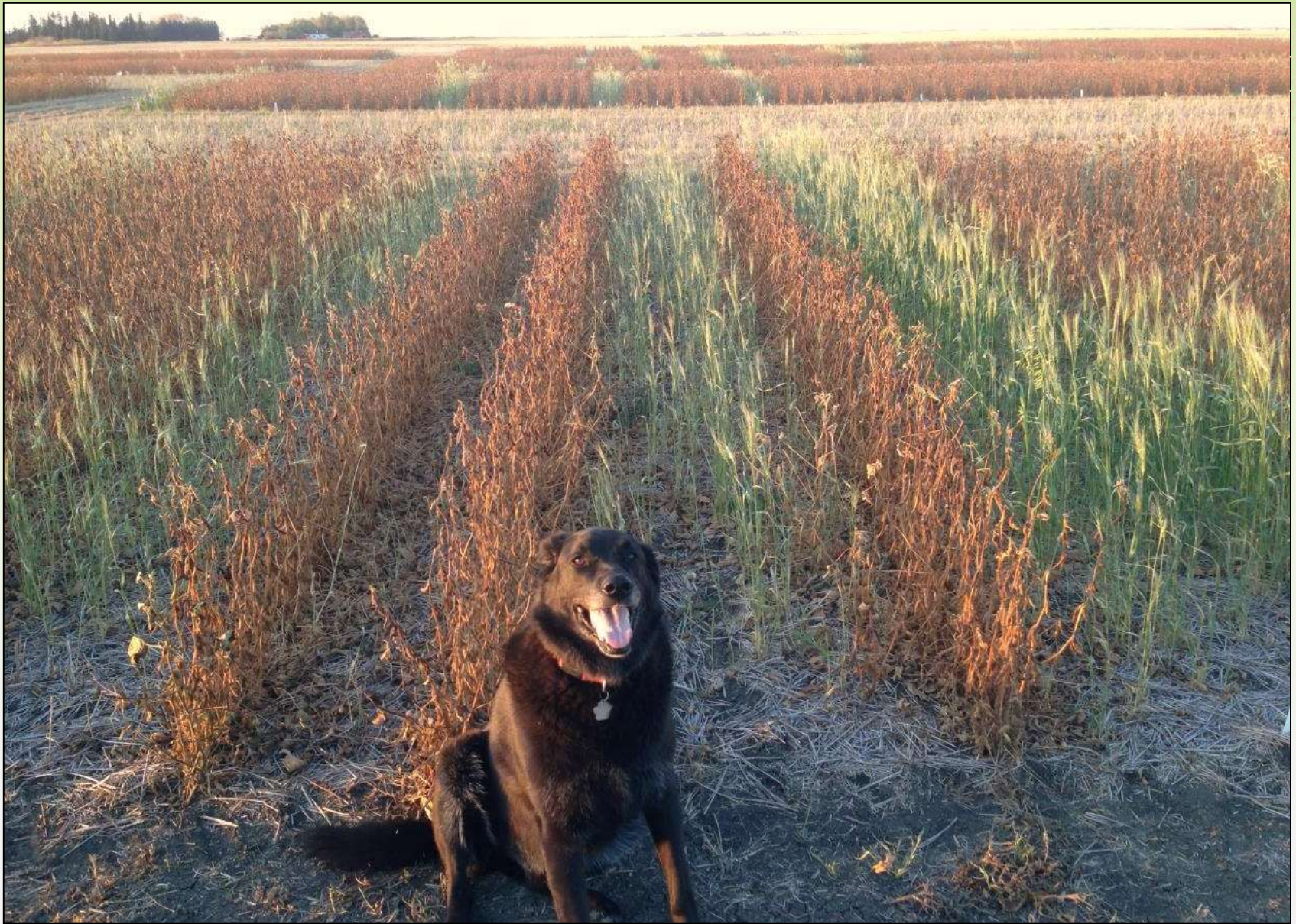
### Overall F-tests

Year: <0.001  
 Row Spacing: 0.031  
 Seed Rate: <0.001  
 RS x SR: 0.162  
 Y x RS: <0.001  
 Y x SR: <0.001  
 Y x RS x SR: 0.478

### Orth. Contrasts

IH-14: <0.001 (quad)  
 IH-15: 0.004 (quad)  
 IH-16: not significant  
 IH-17: 0.020 (lin)  
 Avg: 0.007 (lin)







# Phosphorus Fertilizer Placement

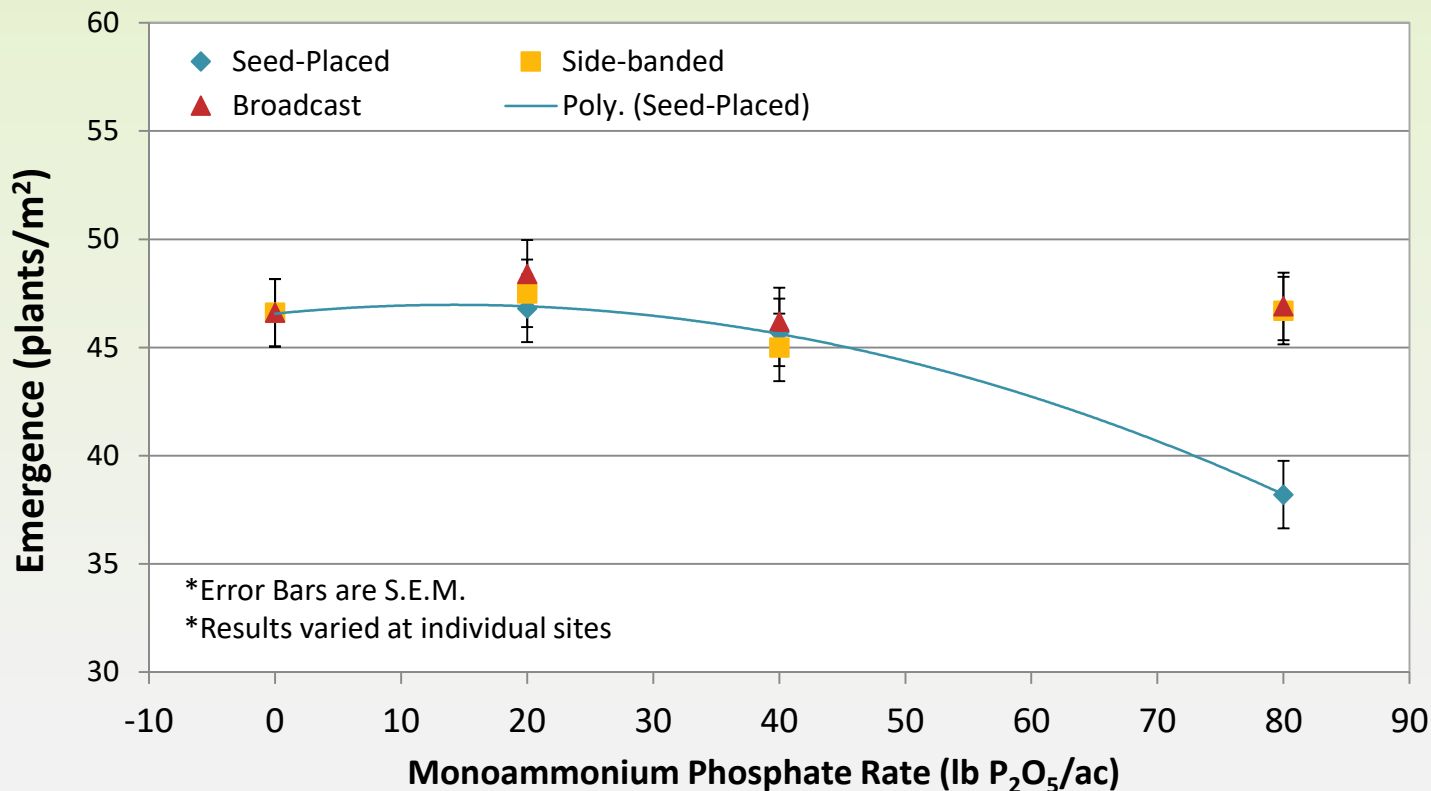
- Soybeans have generally been considered sensitive to seed-placed P and the recommendation from SPG is to not exceed 10-20 lb  $P_2O_5$ /ac depending on row spacing
- With removal rates of approximately 0.85 lb  $P_2O_5$ /bu (26 lb  $P_2O_5$ /ac in a 30 bu/ac crop) application rates will generally exceed that maximum recommended safe rates
- Field trials conducted from 2015-17 at Indian Head, Outlook, Melfort & Scott evaluated rates of 0-80 lb  $P_2O_5$ /ha applied either in the seed-row, a side-band or as a pre-seed broadcast
- The protocols were based on a U of M project (Bardella, Flaten) initiated in Manitoba the previous season with a total of 28 sites



Full report online: [www.iharf.ca/wp-content/uploads/2018/04/P-recommendations-for-Soybean-in-Saskatchewan-Final-Report.pdf](http://www.iharf.ca/wp-content/uploads/2018/04/P-recommendations-for-Soybean-in-Saskatchewan-Final-Report.pdf)

# P Fertilizer Rate & Placement Effects on Soybean Emergence

Twelve Site-Year Average (2015-2017)



## Overall F-tests

Site-Year: <0.001  
Treatment: <0.001  
Site × Trt: 0.001

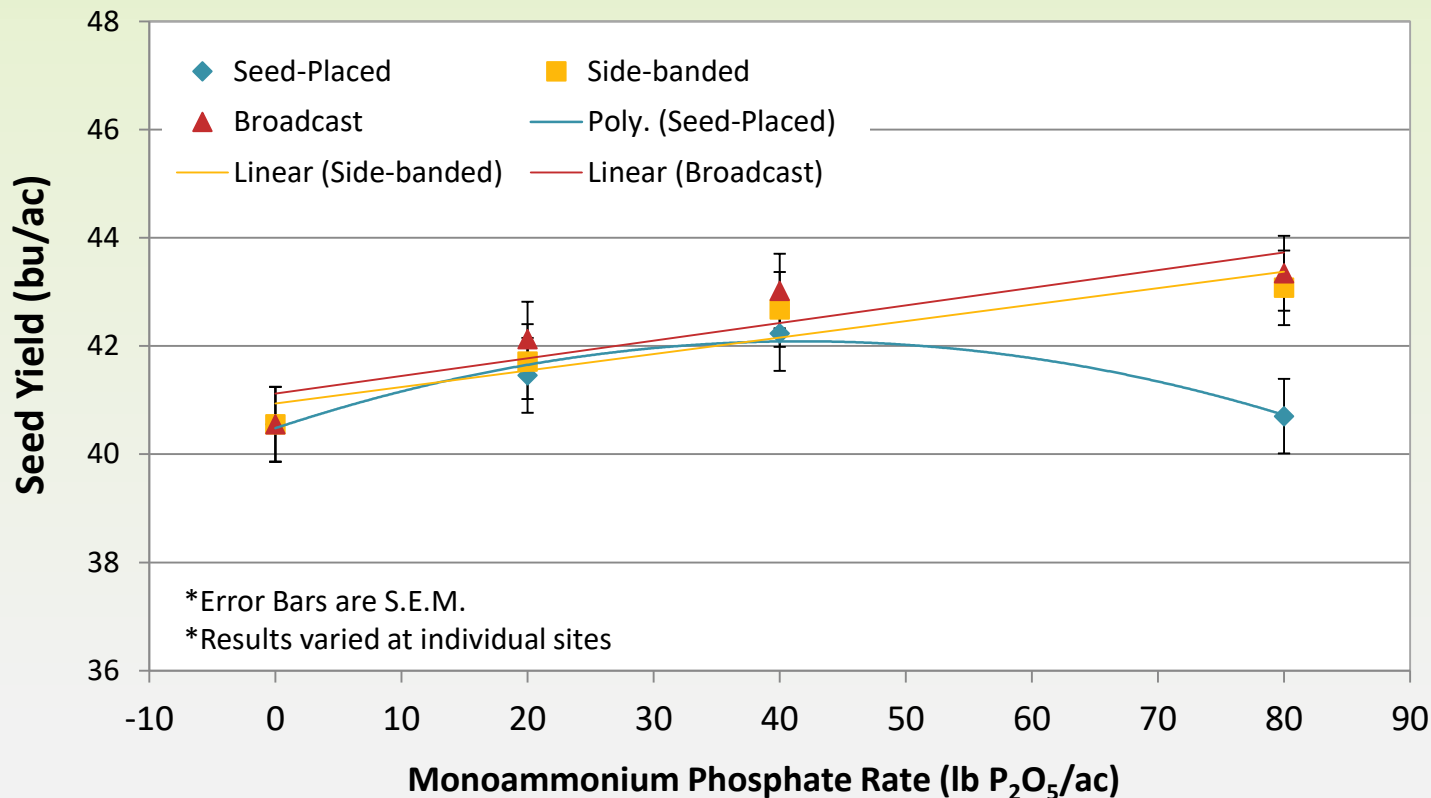
## Contrasts

OP vs Rest: 0.594  
Sp vs Sb: 0.022  
Sp vs Bc: 0.004  
Sb vs Bc: 0.531  
Sp-lin: <0.001  
Sp-quad: 0.057  
Sb-lin: 0.844  
Sb-quad: 0.632  
Bc-lin: 0.865  
Bc-quad: 0.874

Phosphorus placement and rate effects on soybean emergence averaged over a 3-year period at Indian Head, Outlook, Scott and Melfort, Saskatchewan. This average response should be interpreted cautiously as the specific effects varied from site-to-site.

# P Fertilizer Rate & Placement Effects on Soybean Seed Yield

Twelve Site-Year Average (2015-2017)



**Overall F-tests**  
 Site-Year: <0.001  
 Treatment: 0.005  
 Site × Trt: <0.001

**Contrasts**  
 OP vs Rest: 0.007  
 Sp vs Sb: 0.035  
 Sp vs Bc: 0.005  
 Sb vs Bc: 0.488  
 Sp-lin: 0.968  
 Sp-quad: 0.028  
 Sb-lin: 0.003  
 Sb-quad: 0.223  
 Bc-lin: 0.001  
 Bc-quad: 0.105

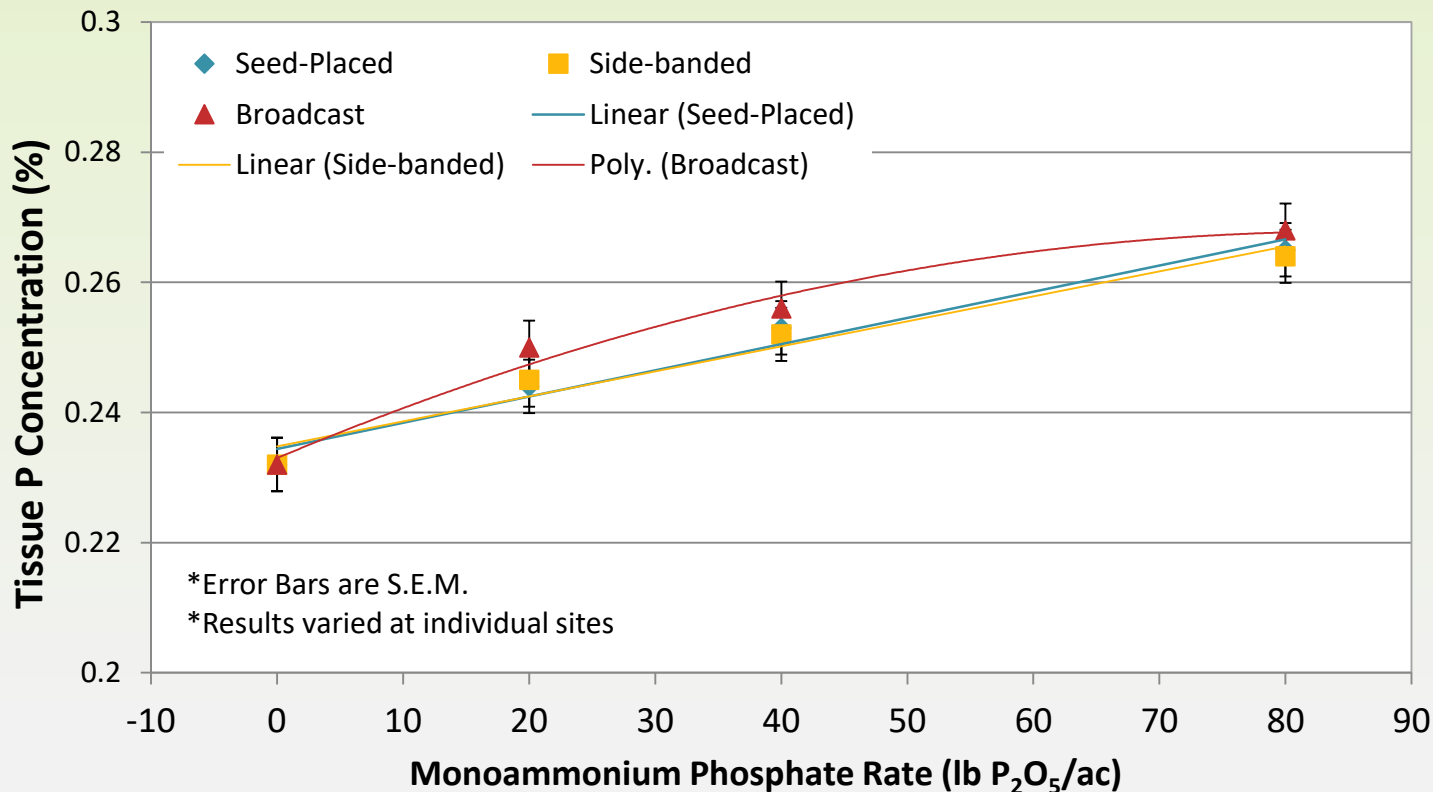
\*Error Bars are S.E.M.  
 \*Results varied at individual sites

Phosphorus placement and rate effects on soybean seed yield averaged over a 3-year period at Indian Head, Outlook, Scott and Melfort, Saskatchewan. This average response should be interpreted cautiously as the specific effects varied from site-to-site.



# P Fertilizer Rate & Placement Effects on Soybean Tissue P Concentration

Twelve Site-Year Average (2015-2017)



## Overall F-tests

Site-Year: <0.001  
Treatment: <0.001  
Site × Trt: <0.001

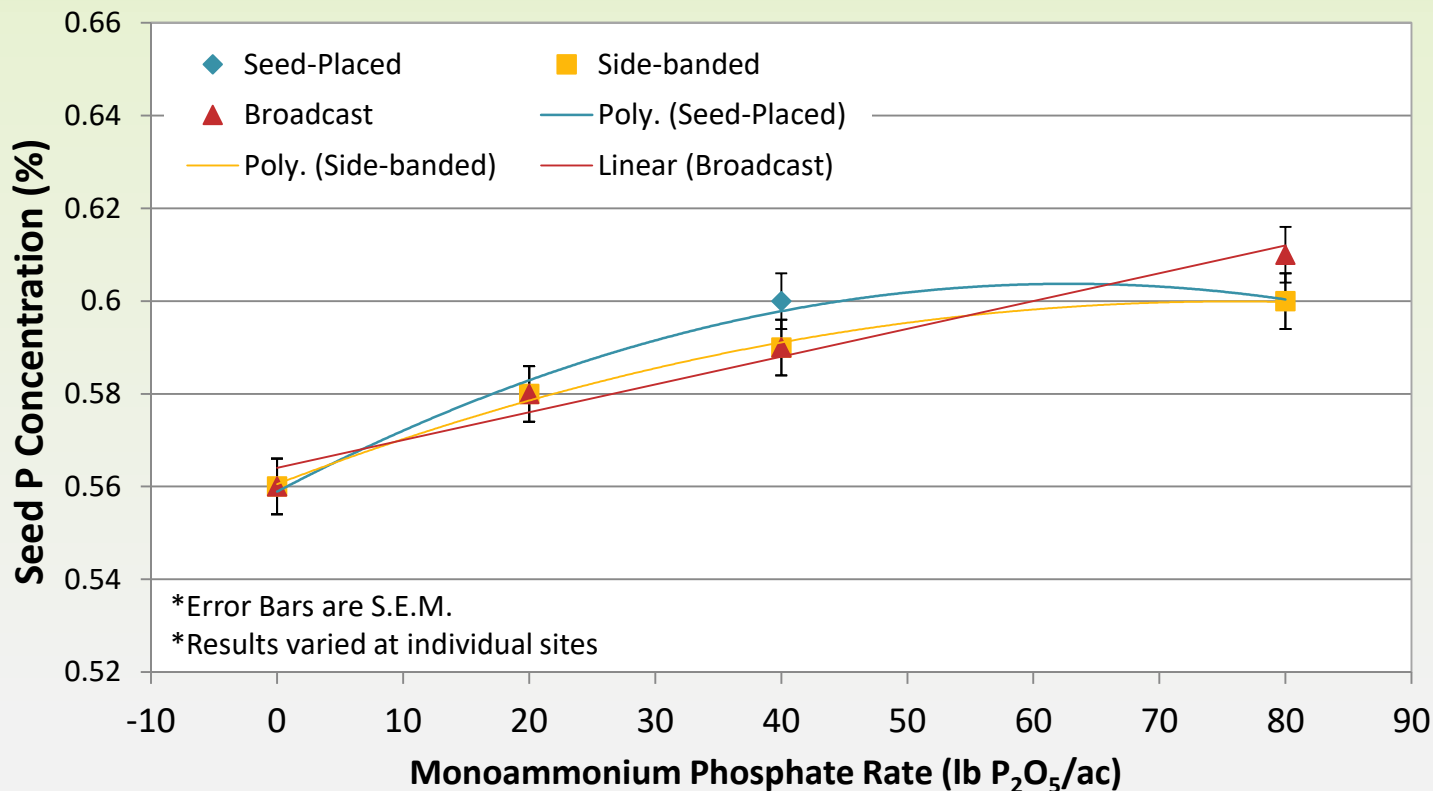
## Contrasts

OP vs Rest: <0.001  
Sp vs Sb: 0.860  
Sp vs Bc: 0.151  
Sb vs Bc: 0.107  
Sp-lin: <0.001  
Sp-quad: 0.158  
Sb-lin: <0.001  
Sb-quad: 0.189  
Bc-lin: 0.001  
Bc-quad: 0.025

Phosphorus placement and rate effects on percent soybean tissue P concentrations (growth stage R4-R6) averaged over a 3-year period at Indian Head, Outlook, Scott and Melfort, Saskatchewan. This average response should be interpreted cautiously as the specific effects varied from site-to-site.

# P Fertilizer Rate & Placement Effects on Soybean Seed P Concentration

Twelve Site-Year Average (2015-2017)



## Overall F-tests

Site-Year: <0.001  
Treatment: <0.001  
Site × Trt: <0.001

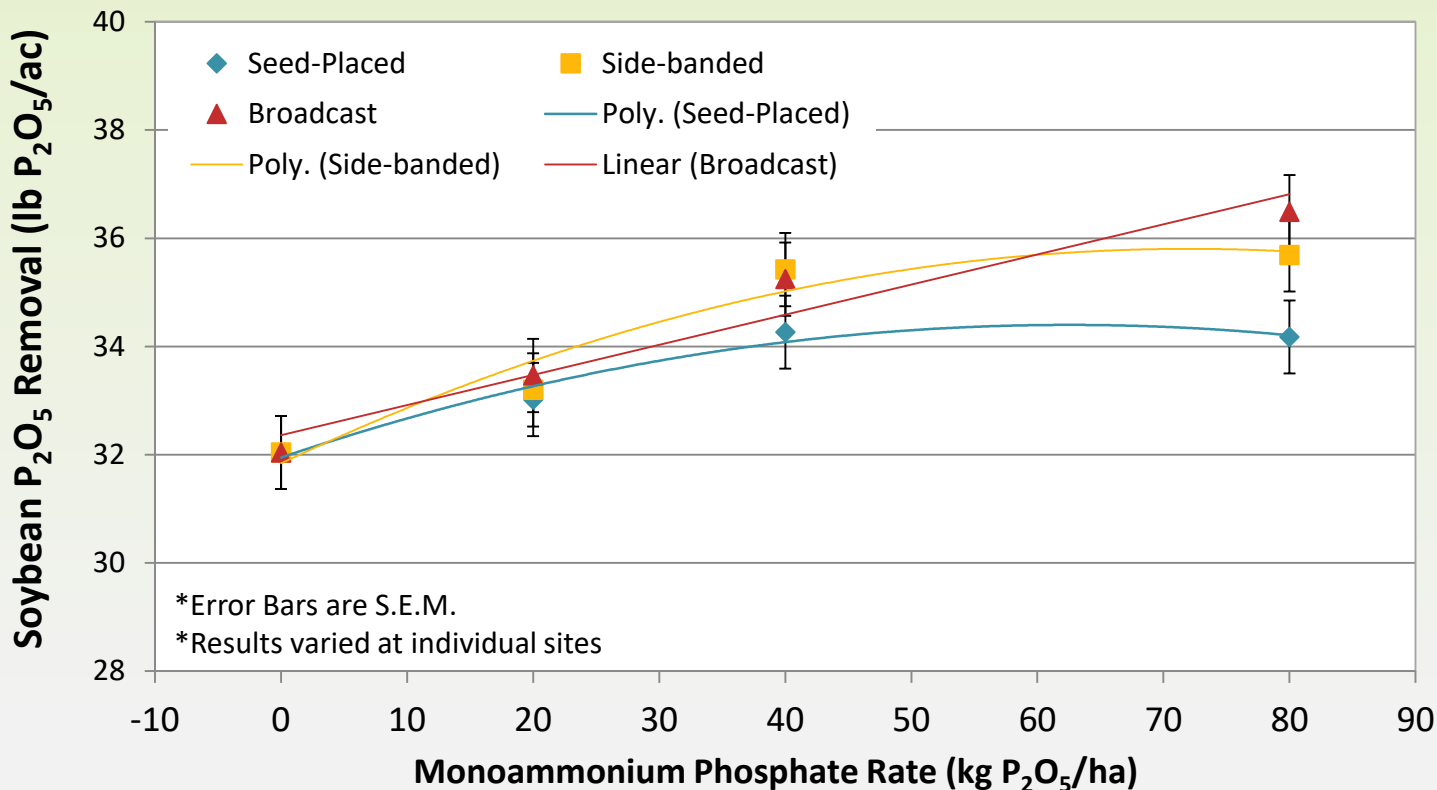
## Contrasts

OP vs Rest: <0.001  
Sp vs Sb: 0.635  
Sp vs Bc: 0.898  
Sb vs Bc: 0.547  
Sp-lin: <0.001  
Sp-quad: 0.011  
Sb-lin: <0.001  
Sb-quad: 0.040  
Bc-lin: 0.001  
Bc-quad: 0.823

Phosphorus placement and rate effects on percent soybean seed P concentrations averaged over a 3-year period at Indian Head, Outlook, Scott and Melfort, Saskatchewan. This average response should be interpreted cautiously as the specific effects varied from site-to-site.

# P Fertilizer Rate & Placement Effects on Soybean Removal of P<sub>2</sub>O<sub>5</sub>

Twelve Site-Year Average (2015-2017)



## Overall F-tests

Site-Year: <0.001  
Treatment: <0.001  
Site × Trt: <0.001

## Contrasts

OP vs Rest: <0.001  
Sp vs Sb: 0.034  
Sp vs Bc: 0.006  
Sb vs Bc: 0.515  
Sp-lin: <0.001  
Sp-quad: 0.011  
Sb-lin: <0.001  
Sb-quad: 0.040  
Bc-lin: 0.001  
Bc-quad: 0.823

Phosphorus placement and rate effects on soybean P<sub>2</sub>O<sub>5</sub> removal (in the harvested seed) averaged over a 3-year period at Indian Head, Outlook, Scott and Melfort, Saskatchewan. This average response should be interpreted cautiously as the specific effects varied from site-to-site.



# Prev. Crop Residue Management

- Soybeans require both a long growing season & warm soils to germination – fall tillage or burning have sometimes been promoted to ‘blacken’ the soil surface and promote earlier warming
- Growers in most regions of the Prairies practice no-till and would prefer to direct seed into stubble in order to conserve moisture, soil structure and labour
- With MPSGA funding & an IHARF site, Ramona Mohr (AAFC Brandon) is currently evaluating the effects of various stubble management options when combined with early versus late-May seeding dates
- 2018 was the first year of the project and results are not yet available



# Prev. Crop Residue Management

## Current Study Treatments

### Two Seeding Dates

- Early (early as possible in May)
- Late (last week of May, after soils have warmed up but not so late as to likely be limiting)



### Six Residue Treatments

- 6" stubble – straw removed
- 6" stubble – straw retained
- 12" stubble – straw removed
- 12" stubble – straw retained
- Fall Tillage
- Fall Burn





# Preceding Research (Mohr 2015-17)

## Soil Temp × Seeding Date Effects on Soybean Yield

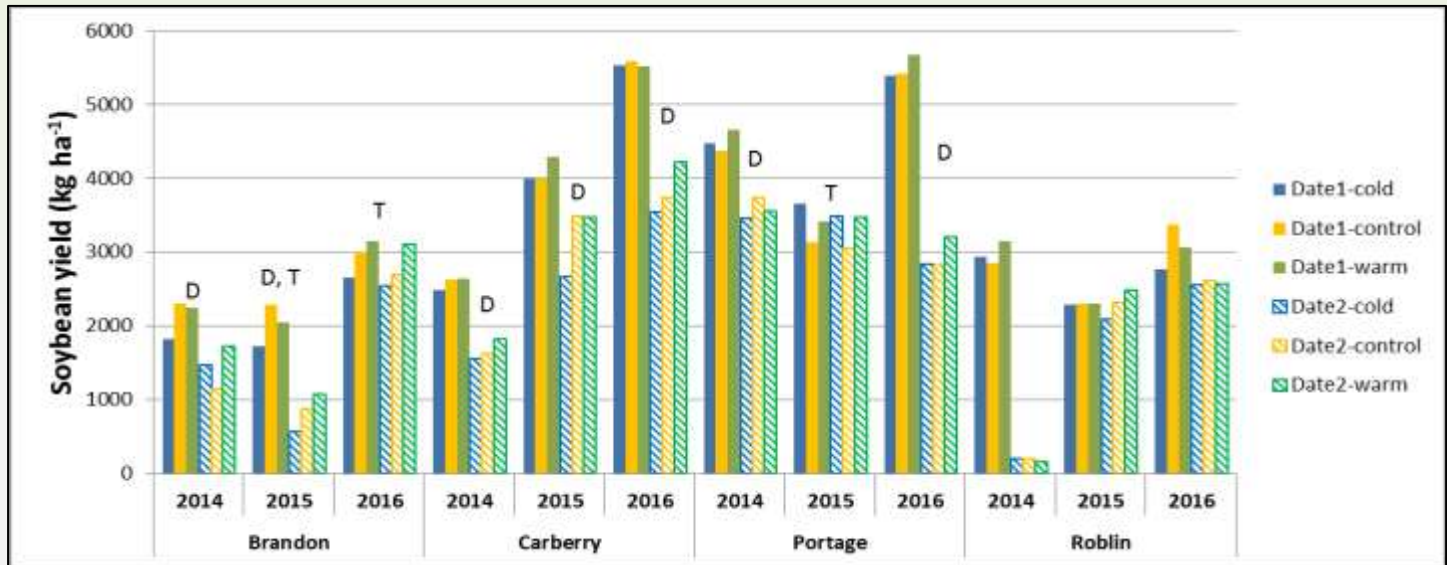
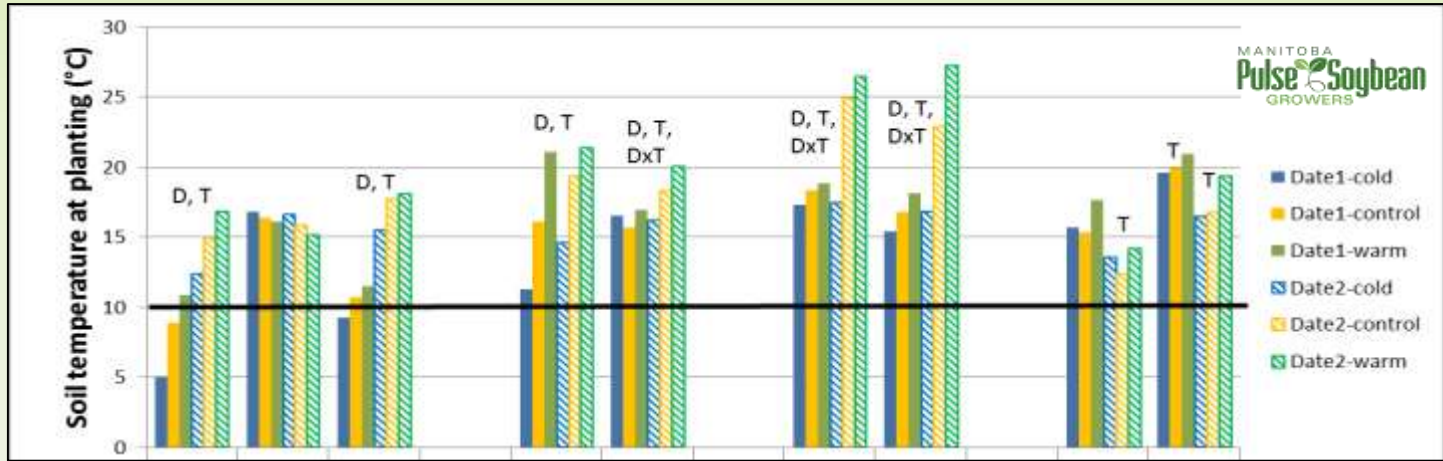


- Soil coverings used to produce varying soil temperatures at planting (Brandon 2014).



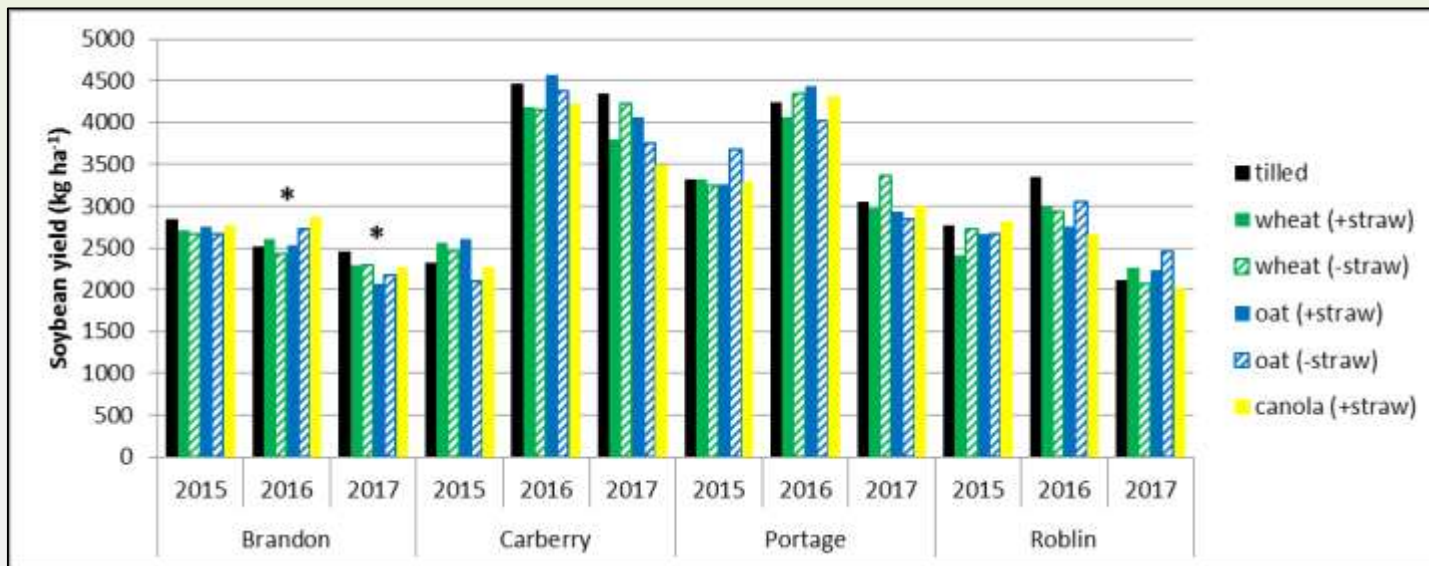
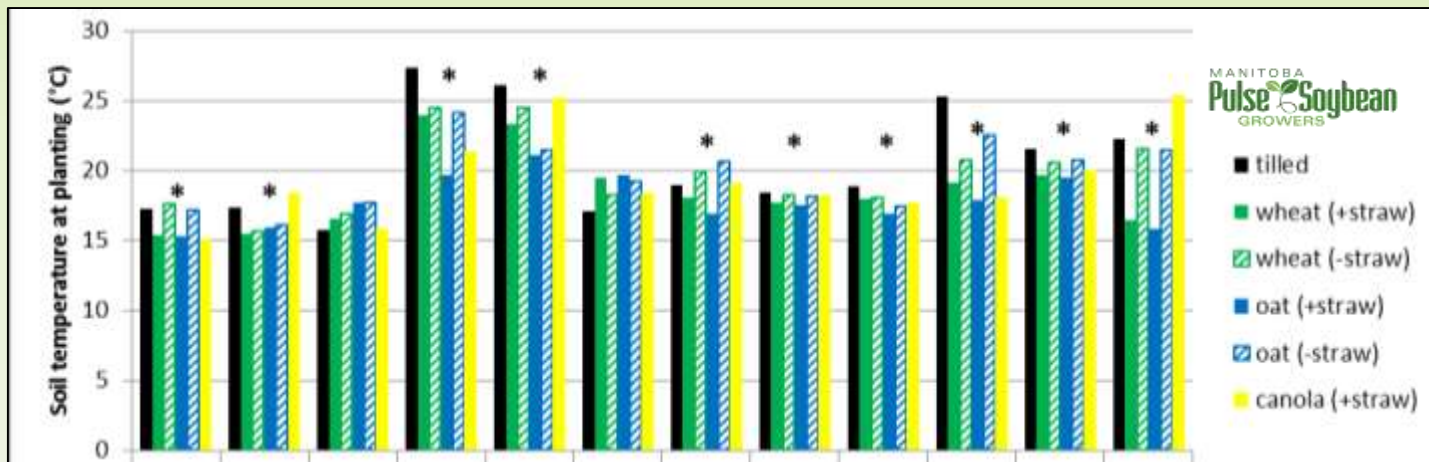
# Preceding Research (Mohr 2015-17)

## Soil Temp × Seeding Date Effects on Soybean Yield



# Preceding Research (Mohr 2015-17)

## Residue Effects on Soil Temperature & Soybean Yield



# Take-Home Messages

- No yield or maturity advantage to seeding soybeans in early- versus mid-May; however, seeding in late May / early June led to lower yields
- Seeding rate responses were generally consistent with industry recommendations where yields & maturity were optimized at 50-60 seeds/m<sup>2</sup> (200-240K seeds/ac)
  - Responses to higher seeding rates mostly only occurred under very low yielding conditions & were unlikely to be economical
- Seeding depth effects were minor (partly due to limited range in actual depths that could be achieved) but, when they occurred, usually favoured shallower seeding
- Specific results varied from year-to-year but showed that soybeans are generally adapted to a wide range of row spacing levels
  - Narrow (10-12") row spacing favoured under optimal conditions while wider row spacing tended to yield higher under more stressful, low yielding conditions
- Soybeans may not be as sensitive to seed-placed 11-52-0 as previously thought but reduced stands & yield frequently occurred at the highest rates & seed placement was never advantageous over other placement methods
  - Seedling injury / stand reductions were never detected at 40 lb P<sub>2</sub>O<sub>5</sub>/ac of seed-placed MAP
- Previous crop residue management research is in progress
  - Preceding work suggests that tillage can result in warmer early spring soils but effects on soybean growth or yield are unlikely especially if soils have warmed up to 10-15 °C



# THANK YOU

Chris Holzapfel, MSc PAg

Phone: 306-695-4200

Email: [cholzapfel@iharf.ca](mailto:cholzapfel@iharf.ca)

Website: [www.iharf.ca](http://www.iharf.ca)

Twitter: @CBHolz13, @IHARF\_SK

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