Proceedings of the
2007 CPM Short Course and
MCPR Trade Show

December 4 – 6, 2007
Minneapolis Convention Center

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Soybean Seeding Rates: What's the number?

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Outline

- Seeding rates
  - Introduction
  - 2007 results
  - Seeding rate x row spacing interactions
  - Losses through emergence and attrition
  - Seed distribution
  - Populations and Iron Chlorosis
  - New recommendations
Interest is growing in reduced seeding rates. What’s driving this?

- **Transitions**
  - Bin-run → conventional bagged seed
  - Conventional → Roundup Ready
  - Roundup Ready → Second generation RR

- **Inflation**
  - Seed companies will charge what the market will bare. Currently, its quite a lot.
Soybean Seed and Herbicide Costs per Acre (1990-2007)

(Iowa Farm Business Association, 2007)
Overview – Soybean Populations

- Incremental yield improvement from increased seeding rates – *per se* – are very small
- Seeding rates serve primarily to establish a minimum stand
  - Higher populations yield better only when stand establishment is very poor.
  - Replanting can be averted by higher initial seeding rates, but often damage is too large
- Risk avoidance –or– “insurance”
  - Increasing rates – insurance against poor emergence and hail
    - A 30% increase in seeding rate requires a 1 Bu/A additional return.
    - or- One needs 10 bu in 1 of 10 years to pay for a 30% increase.
Overview – Soybean Populations

- The seeding rate to obtain a required stand is dependant on

  Abiotic –
  - Soil conditions, weather, and their interaction
    - temp, water, residue, compaction, crusting, and precipitation (including hail)
    - planting equipment (planter vs. air seeder)
  - Biotic - Seed quality, herbicide injury, insects, disease, or operator error.
average = 20.0"

% Percent
< 10"
10" (10-19)
20" (19-29)
30" (29-35)
>35"
Row Spacing
2002

MN SOYBEAN PRODUCTION WEBSITE > WWW.SOYBEANS.UMN.EDU
2007 NASS-MN
## Current State Recommendations

<table>
<thead>
<tr>
<th>State</th>
<th>Germination</th>
<th>30”</th>
<th>15”</th>
<th>7.5”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iowa-seeds</td>
<td>90%</td>
<td>125 to 140</td>
<td>125 to 140</td>
<td>125 to 140</td>
</tr>
<tr>
<td>Kentucky-plants</td>
<td>80%</td>
<td>111 to 139</td>
<td>139 to 167</td>
<td>119 to 179</td>
</tr>
<tr>
<td>Michigan-seeds</td>
<td>90%</td>
<td>122 to 157</td>
<td>139 to 174</td>
<td>175 to 280</td>
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<tr>
<td>Missouri-seeds</td>
<td>90%</td>
<td>140,000</td>
<td>175,000</td>
<td>200,000</td>
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<tr>
<td>Ohio-seeds</td>
<td>90%</td>
<td>129,000</td>
<td>160,000</td>
<td>196,000</td>
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<tr>
<td>Indiana-seeds</td>
<td>90%</td>
<td>129,000</td>
<td>160,000</td>
<td>196,000</td>
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<tr>
<td>Wisconsin</td>
<td>-</td>
<td>-</td>
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<td>-</td>
</tr>
</tbody>
</table>

*Old versus new*
Seth’s recommendations for Minnesota producers (through 2005)

- Seeding rates should be determined by soybean maturity group being planted (independent of latitude or row space)
  - Group II’s – 170K live seeds per acre
  - Group I’s – 180K live seeds per acre
  - Group 0’s – 190K live seeds per acre
  - Group 00’s – 200K live seeds per acre

- Seeding rate may be reduced by 10% when seeded with precision planters

- Seeding rate should be increased by 10% when using some sort of broadcast planter (drill or air seeder)
2007 Seeding rate trials

- Fritz Breitenbach, Lisa Behnken, Dave Nicolai, and Liz Stahl
- 5 seeding rates (50K-150K)
- 3 of the above rates also +/- CruiserMaxx
- 5 sites (south of Rosemount)
Yield vs Seeding Rate at 5 locations -- 2007

Seeding Rate

50K 75K 100K 125K 150K 50K 100K 125K

Yield (bu / acre)

0 10 20 30 40 50

Untreated
Treated

50K 75K 100K 125K 150K 50K 100K 125K

b a ab a ab b ab ab
Yield vs Seeding Rate - Rochester 2007

<table>
<thead>
<tr>
<th>Seeding Rate</th>
<th>Yield (bu / acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50000</td>
<td>50 (Untreated)</td>
</tr>
<tr>
<td>75000</td>
<td>50 (Untreated)</td>
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<tr>
<td>100000</td>
<td>50 (Untreated)</td>
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<tr>
<td>125000</td>
<td>50 (Untreated)</td>
</tr>
<tr>
<td>150000</td>
<td>50 (Untreated)</td>
</tr>
<tr>
<td>50000</td>
<td>50 (Treated)</td>
</tr>
<tr>
<td>100000</td>
<td>50 (Treated)</td>
</tr>
<tr>
<td>125000</td>
<td>50 (Treated)</td>
</tr>
</tbody>
</table>

The yield is consistent across all seeding rates for both untreated and treated conditions.
Yield vs Seeding Rate - Rock Dell 2007

Seeding Rate

Yield (bu / acre)

- Untreated
- Treated

Yield

Seeding Rate

50000 75000 100000 125000 50000 100000 125000

Yield (bu / acre)

50 40 30 20 10 0

Seeding Rate
Yield vs Seeding Rate - Rosemount 2007

Seeding Rate

Yield (bu / acre)

Untreated
Treated

a a a a a a a a

Seeding Rate

50000 75000 100000 125000 150000 50000 100000 125000
Yield vs Seeding Rate - Spring Valley 2007

Seeding Rate
50000  75000  100000  125000

Yield (bu / acre)
0  10  20  30  40  50  60  70  80

Untreated  Treated
bc  bc  ab  ab  a  c  ab  ab
Fall stand counts vs Yield at 5 locations in 2007

Yield (bu / acre)

Fall stand counts

- Untreated
- Treated
### Soybean Population Strip Trials at the Dolan site in Sibley County -- Gold Country 2717 NRR

<table>
<thead>
<tr>
<th>Planted population per acre</th>
<th>Yield adjusted for moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>164,000</td>
<td>57.5</td>
</tr>
<tr>
<td>130,000</td>
<td>55.8</td>
</tr>
<tr>
<td>103,000</td>
<td>51.9</td>
</tr>
<tr>
<td>74,500</td>
<td>53.6</td>
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</tbody>
</table>
# Soybean Population Strip Trials at the Doug Toreen site in Renville County – Gold Country 2717 NRR

<table>
<thead>
<tr>
<th>Planted population per acre</th>
<th>Yield adjusted for moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>164,000</td>
<td>42.8</td>
</tr>
<tr>
<td>130,000</td>
<td>44.9</td>
</tr>
<tr>
<td>103,000</td>
<td>49.5</td>
</tr>
<tr>
<td>74,500</td>
<td>50.0</td>
</tr>
</tbody>
</table>
2007 Study conclusion

- This year’s study re-emphasizes the ability of soybean to produce maximum yields at “low” populations
- Seeding rates above 100K were not needed to maximize yields
- Occasionally, reduced yields from higher seeding rates do show up.
- CruiserMaxx had no impact on yield or yield response to populations
Seeding Rate Effect on Yield Across 13 Iowa Environments (2005-2007)

LSD (0.05) = 1.1 bu/acre

Row spacing X seed treatment = NS
Row spacing X seeding rate = NS
Seed treatment X seeding rate = NS
Row spacing X seed treatment X seeding rate = NS

www.soybeanmanagement.info
Seeding Rate Effect on Final Plant Population Across 13 Environments (2005-2007)

LSD (0.05) = 3300 plants/acre

Row spacing X seed treatment = NS
Row spacing X seeding rate = NS
Row spacing X seed treatment X seeding rate = NS
Iowa Conclusions

- 100,000 plants at harvest is sufficient for maximizing yields.
- Plant at 125-140K under good conditions
Row spacing effects

- Many states still recommend higher seeding rates for narrow rows
Classic Soybean Yield Response to Row spacing and Plant Population

Yield (Bu / A)

- 10" Rows
- 20" Rows
- 30" Rows

Plant Population (seeding rate)

125,000 175,000 225,000

Yield (Bu / A):
- 42
- 43
- 44
- 45
- 46
- 47
- 48

10" Rows:
- 125,000: 42 Bu / A
- 175,000: 45 Bu / A
- 225,000: 48 Bu / A

20" Rows:
- 125,000: 43 Bu / A
- 175,000: 46 Bu / A
- 225,000: 49 Bu / A

30" Rows:
- 125,000: 44 Bu / A
- 175,000: 47 Bu / A
- 225,000: 50 Bu / A
Soybean Yield Response to Row Spacing and Plant Population
12 Environments in 1999-2000

Plant Population (seeding rate)

Yield (Bu / A)

10" Rows
20" Rows
30" Rows

100,000 175,000 250,000
Seth’s recommendations for Minnesota producers (through 2005)

- Seeding rates should be determined by soybean maturity group being planted (independent of latitude or row space)
  - Group II’s – 170K live seeds per acre
  - Group I’s – 180K live seeds per acre
  - Group 0’s – 190K live seeds per acre
  - Group 00’s – 200K live seeds per acre

- Seeding rate may be reduced by 10% when seeded with precision planters

- Seeding rate should be increased by 10% when using some sort of broadcast planter (drill or air seeder)
Soybean emergence and attrition

What effects do population, row spacing, and seed distribution have on emergence and attrition?

Seeds, seedlings, and plants compete with each other when they are very close to one another within a row.

Does planting machinery affect emergence?
Air Seeder, Drill, or Planter?
Air Seeder, Drill, or Planter?
1999 Lamberton Seed Treatment Study
-stand counts-

Plants (seeds) / Acre

Low
Medium
High

Planted: 77% Low, 72% Medium, 70% High
V1: 77% Low, 72% Medium, 70% High
V4: 60% Low, 78% Medium, 49% High
Seeding Rate Effect on Final Plant Population Across 13 Environments (2005-2007)

LSD (0.05) = 3300 plants/acre

Row spacing X seed treatment = NS
Row spacing X seeding rate = NS
Row spacing X seed treatment X seeding rate = NS

www.soybeanmanagement.info

- Final plant population (plants/acre)
  - 15" spacing: 104100
  - 30" spacing: 95200

LSD (0.05) = 2700 plants/acre
Adjusted soybean emergence 2000 - 2002 (10 locations)

![Graph showing adjusted emergence losses (%) versus seeding rate for different row spacings.](chart.png)

- **Seeding Rate:** low, medium, high
- **Row Spacings:** 10" Rows, 20" Rows, 30" Rows

Adjusted emergence losses (%)

10" Rows
20" Rows
30" Rows

Potter, Naeve, and Kurle
Soybean attrition 2000 - 2002
(10 locations)

Fall stand (% loss of spring stand)

Seeding Rate

- low
- medium
- high

10" Rows
20" Rows
30" Rows

Potter, Naeve, and Kurle
Adjusted total soybean stand losses
emergence + attrition
2000 - 2002 (10 locations)

Seeding Rate

Adjusted total stand losses (%)

-40 -35 -30 -25 -20 -15 -10 -5 0

10" Rows
20" Rows
30" Rows

Potter, Naeve, and Kurle
Soybean plant mortality by growth stage

Location Year

Lamberton '00 Lamberton '01 Morris '00 Morris '01

Plant mortality (% of dead plants)

0 20 40 60 80 100

Very early vegetative growth (VE-V2)
Late vegetative growth (V2-R2)
Pre-canopy though maturity (R2-R7)

Potter, Naeve, and Kurle
Non-competitive plants in uniform or clumped stands

Dead or Stunted Pants (% of initial stand)

<table>
<thead>
<tr>
<th>Location Year</th>
<th>Uniform seed distribution</th>
<th>0% Clumped (random distribution)</th>
<th>25% Clumped</th>
<th>50% Clumped</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamberton '00</td>
<td>0</td>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Lamberton '01</td>
<td>5</td>
<td>15</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Morris '00</td>
<td>10</td>
<td>20</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Morris '01</td>
<td>20</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

LSD P<0.10

Potter, Naeve, and Kurle
Seed distribution – conjecture

- Poor distribution will only effect yields when –
  - Seeding rather low rates (125-140K)
  - In poor growth environments (weather-disease-fertility)
- Double- and triple-drops do not cost yield, but those seeds may be wasted
- Wide rows amplify the effects of poor distribution
- Producers using older soybean planter units or drills cannot afford to be too conservative about seeding rates.
- One can still buy a lot of beans for the price of a new planter
Seeding rate and date of planting

- Should early or late planted soybeans be planted at higher than normal rates?
- What about row spacing?
Population effects on soybean yield across planting dates and years

Indexed Grain Yield (yield : maximum yield⁻¹)

Days after 1 April

y = 0.87x² + 0.0029x - 0.000042

r² = 0.13

y = 0.82x² + 0.0059x - 0.000082

r² = 0.31
Row spacing effects on soybean yield across planting dates and years

Indexed Grain Yield (yield × maximum yield)

Days after 1 April

1 May

1 June

2000 - 25 cm

2001 - 25 cm

Regression equations:

For 2000 - 25 cm:
y = 0.91x^2 + 0.0028x - 0.000047
r^2 = 0.22

For 2001 - 25 cm:
y = 0.77x^2 + 0.0060x - 0.000078
r^2 = 0.27
Planting Date by Seeding Rate Interaction

Graph showing yield (bu/acre) on the y-axis and seeding rate (seeds/acre) on the x-axis, with four planting dates: Late April, Early May, Late May, and Early June. The graph includes lines for each planting date with the following LSD values:
- LSD 0.05 PD = 2.2 bu
- LSD 0.05 PPA = 1.1 bu
- LSD 0.05 PD X PPA = NS

LSD (0.05) = 4800 plants/acre
Populations and Iron Chlorosis

- Increased populations have been shown to "green soybeans up" during the season.
- There is some evidence that this might translate to yield.
Wendell 2002

Seeding rate

Yield

Iron Chlorosis Score

175K  225K  275K  325K  375K
Foxhome 2003

Seeding rate

Yield

Iron Chlorosis Score

175K 225K 275K 325K 375K
Herman 2003

Seeding rate

Yield

Iron Chlorosis Score

175K 225K 275K 325K 375K

0 10 20 30 40

1 2 3 4
Average of 5 site years

Seeding rate

Yield

Iron Chlorosis Score

175K 225K 275K 325K 375K
Summary – Iron Chlorosis and population

- Smaller interplant distance does seem to reduce stresses from Iron Chlorosis (e.g., higher seeding rates in wide rows)
  - This may be NO$_3^-$ related

- There are some unknown factors that can reduce yields with these narrow interplant distances that is probably independent of Iron Chlorosis
  - This is most likely water mediated

- Eventually – variable seeding rates may be useful
Soybean yields are determined final plant stands, not seeding rate.

Final stands are dependant on:
- Seeding rate
- Row spacing
- Date of planting
- Environmental conditions – season long (but primarily directly after planting)
- Biotic effects – pathogens and insects
Overall Summary (overall yield trends)

- Examination of MANY multi-site population studies from across the Midwest...
  - Under most conditions there appears to be a very small and linear yield advantage to increased seeding rates.
    - Usually 1 bu for 75-100K
    - Too small to pay for extra seed
  - Occasionally, multi-site studies include rare instances of large yield decreases from increased seeding rates – due to late season drought. Results in flat yield response curves over site.
Overall Summary (attrition)

- Attrition sucks, but it does work in parallel with agronomic principles
  - Attrition is greatest in
    - Wide rows
    - Higher populations
    - Early planting

- Because wide rows, high seeding rates, and early planting benefit less from increased harvest populations, few interactions are noted in most studies
Overall Summary (recommendations)

- Harvest stands of 100,000 are required to maximize yields (in Southern Minnesota)
- Greater final stands will be required in Central and Northern Minnesota, but the latitude effect hasn’t been well modeled.
  - 125,000 in Central
  - 150,000 in Northern
- How you (or your customer) get(s) there is your business
Under ideal conditions seeding rates of 140,000 are sufficient

- Independent of row spacing
- Poor distribution caused by old planters/drills or excessive plating speed (<6 mph) requires higher seeding rates – 10%
- Increased risk due to early planting or cold/rainy 10 day forecasts requires higher seeding rates – 10%
Overall Summary (recommendations & caveats)

- Under ideal conditions seeding rates of 140,000 are sufficient.

- Production in Central and Northern MN requires higher seeding rates:
  - Group II’s – 140K live seeds / acre
  - Group I’s – 150K live seeds / acre
  - Group 0’s – 160K live seeds / acre
  - Group 00’s – 170K live seeds / acre
Overall Summary (recommendations & caveats)

- Under ideal conditions seeding rates of 140,000 are sufficient.
- Production on IDC prone soils requires higher seeding rates.
- All recommendations based on viable seeds, so reduced germ will require increased rates.
Overall Summary (recommendations)

- Since yield is determined by fall stand
  - Be liberal with seeding rates until you know what you have.
  - Take spring and fall stand counts in every field.
  - Note differences in risk factors (planting date, soil type, weather after planting).
  - Adjust seeding rates downward slowly over years.
### Economic Analysis Assuming 140,000 seeds per bag

<table>
<thead>
<tr>
<th></th>
<th>$8 per bushel</th>
<th></th>
<th>$9 per bushel</th>
<th></th>
<th>$10 per bushel</th>
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<td></td>
<td>28</td>
<td>32</td>
<td>36</td>
<td>28</td>
<td>32</td>
<td>36</td>
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<tr>
<td>75000</td>
<td>474c</td>
<td>472c</td>
<td>469b</td>
<td>535c</td>
<td>533c</td>
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<td>100000</td>
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<td>554b</td>
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<tr>
<td>125000</td>
<td>498ab</td>
<td>494ab</td>
<td>491a</td>
<td>563ab</td>
<td>560ab</td>
<td>556ab</td>
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<tr>
<td>150000</td>
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<td>564ab</td>
<td>560ab</td>
<td>556ab</td>
</tr>
<tr>
<td>175000</td>
<td>495b</td>
<td>490b</td>
<td>485a</td>
<td>562ab</td>
<td>557ab</td>
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<tr>
<td>200000</td>
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<td>498a</td>
<td>492a</td>
<td>572a</td>
<td>566a</td>
<td>560a</td>
</tr>
</tbody>
</table>

† Values within a column followed by the same letter are not significant at \( P \leq 0.05 \)
# Economic Analysis ($32 per bag)

<table>
<thead>
<tr>
<th>Seeds per lbs</th>
<th>75000</th>
<th>100000</th>
<th>125000</th>
<th>150000</th>
<th>175000</th>
<th>200000</th>
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<tbody>
<tr>
<td>$8 per bushel</td>
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<td></td>
</tr>
<tr>
<td>2600</td>
<td>473c</td>
<td>489b</td>
<td>497ab</td>
<td>497ab</td>
<td>493b</td>
<td>502a</td>
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<tr>
<td>2800</td>
<td>474c</td>
<td>491b</td>
<td>498ab</td>
<td>499ab</td>
<td>496b</td>
<td>505a</td>
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<tr>
<td>3000</td>
<td>475c</td>
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<td>500ab</td>
<td>501ab</td>
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<td>507a</td>
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<tr>
<td>$9 per bushel</td>
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<td>2600</td>
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<td>617b</td>
<td>627ab</td>
<td>629a</td>
<td>626ab</td>
<td>637a</td>
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<tr>
<td>2800</td>
<td>596d</td>
<td>618c</td>
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<td>620c</td>
<td>631bc</td>
<td>633ab</td>
<td>631bc</td>
<td>643a</td>
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</tbody>
</table>

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Thank you

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Seed Treatment and Seeding Rate Effect on Final Plant Population Across 13 Environments (2005-2007)

LSD (0.05) = 5600 plants/acre

Seeding rate (seeds/acre)

Plant population (plants/acre)

LSD (0.05) = 2300 plants/acre

Control: 94900

+3000 (+3.2%)

Apron Maxx: 97900

Cruiser Maxx: 106200

+11300 (+11.9%)
Summary –
Soybean Seed Treatment

- Apron Maxx (mefenoxam + fludioxonil) did have an effect on stand but not on yield
- Soybean yield and final plant population was increased with Cruiser Maxx (mefenoxam + fludioxonil + thiamethoxam)
  - Improved stand was quite consistent across all locations
  - Yield response was driven by bean leaf beetles
Planting date by seeding rate interaction at De Witt, Nevada, and Whiting (2004-2006)

LSD (0.05) = 4400 plants/acre

Seeding rate per acre

<table>
<thead>
<tr>
<th>Seeding Rate (plants/acre)</th>
<th>Final Plant Population (plants/acre)</th>
<th>LSD (0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>75,000</td>
<td>-1%</td>
<td>4400</td>
</tr>
<tr>
<td>125,000</td>
<td>-16%</td>
<td></td>
</tr>
<tr>
<td>175,000</td>
<td>-22%</td>
<td></td>
</tr>
<tr>
<td>225,000</td>
<td>-26%</td>
<td></td>
</tr>
</tbody>
</table>

\[ y = 0.50x - 954.03 \]

\[ R^2 = 0.41 \]

\[ y = 0.45x - 858.92 \]

\[ R^2 = 0.48 \]

\[ y = 0.36x - 681.98 \]

\[ R^2 = 0.31 \]
Locations

2005 2006 2007

Vincent

2005 2006 2007

Nevada

2005 2006 2007

Pella

2005 2006

Whiting

2006

De Witt
Decision Tree

How to get to a final stand of 100,000 plants per acre using a planter?

+ Good seedbed ("tillage")
+ 1-1.5 inch planting depth
+ Relatively new planter (< 5 yr old)
+ Moderate planting speed (< 6 mph)
+ Excellent seed quality

 IF you have 5 “+” ~ 125,000 seeds/acre
 IF you have 4 “+” ~ 140,000 seeds/acre
 etc.
Conclusion

IF you have PERFECT seedbed condition, perfect planter settings, good seed quality, and use a modern planter a seeding rate of 125,000 – 140,000 seeds per acre should be enough for 15, 20, 22, 30, and 36 inch row spacing.

We just need 100,000 plants per acre at harvest