MinnesotaCorn RESEARCH & PROMOTION COUNCIL

INNOVATION GRANT PROGRESS REPORT

PROJECT TITLE: Investigating Wide Row Corn on Yield, Soil and Water
REPORTING PERIOD: December 15, 2020
FARMER INNOVATOR: Mark Enninga
COLLABORATING ORGANIZATIONS/PERSONS:

- Spencer Enninga – Shareholder, Enninga Farms Inc
- Dr. Elizabeth Ann Enninga, Assistant Professor at Mayo Clinic, Rochester, MN
- Bob Recker – Founder, Cedar Valley Innovation LLC (CVI)
- Cheryl Heard – USDA NRCS Team Lead District Conservationist (Murray, Nobles, Rock, and Pipestone Counties)

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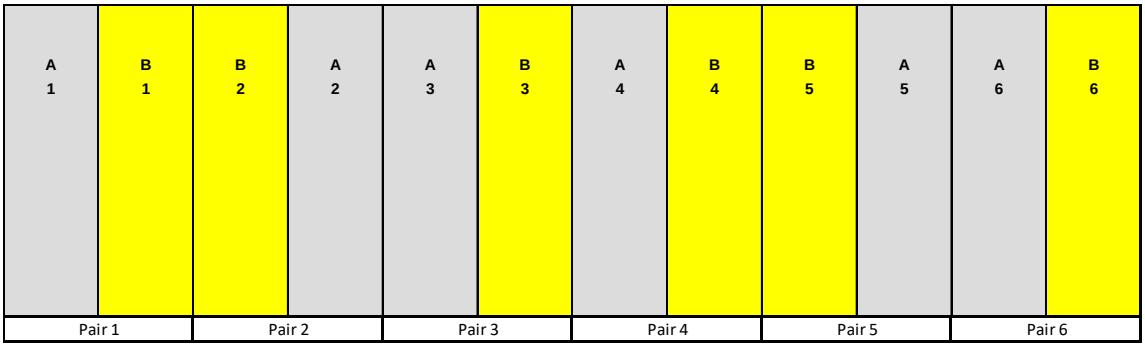
1.) PROJECT ACTIVITIES COMPLETED DURING THE REPORTING PERIOD. (*Describe project progress specific to goals, objectives, and deliverables identified in your project proposal.*)

We proposed to investigate the Wide Row Corn (WRC) concept and its effects on yield, soil and water quality. We hypothesized that WRC (44" row width) will not cause a yield penalty compared to narrow row corn (22" row width). To test this hypothesis, we completed the following activities:

- Arial drone flight to map trial field located in Nobles County, MN (3/2020)
- Planted 22" vs 44" Corn Trial, 6 replications, ½ long rows (**Figure 1**; 4/22/2020)

Figure 1 – Trial Design & Conditions



Condition A	22" Corn	Condition B	44" Corn
Planting Date:	4/22/2020	Planting Date:	4/22/2020
Hybrid:	LG5505VT2PRO RIB	Hybrid:	LG5505VT2PRO RIB
Brand:	LG	Brand:	LG
Fertilizer Source:	Hog Manure-Finishing	Fertilizer Source:	Hog Manure-Finishing
Fertilization Date:	11/6/2019	Fertilization Date:	11/6/2019
Harvest Date:	10/14/2020	Harvest Date:	10/14/2020
Harvest Moisture:	13%	Harvest Moisture:	13%

- 2 color time lapse cameras placed in trial, one looking at a 44" row facing north and one facing west looking down a 44" row to track corn and cover crop growth (4/22/2020)
- Corn preemergent herbicide applied (1pt Dual/acre; **Figure 2**; 4/24/2020)

Figure 2 – Emerged Corn in Trial, 22" (left) 44" (right)

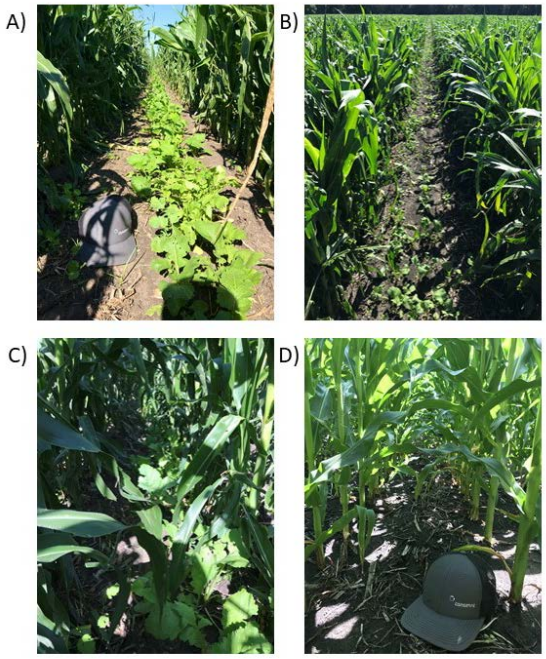
- Received cover crop seed (4/2020): 8# annual rye, 1# tillage radish, 1# purple top turnips, 1# rape, 1# buckwheat, ½# balansa clover
- Weed control assessment (6/2/2020) – moderate lambsquarters found in both 22" & 44" in a majority of the plot
- Corn post emerge herbicide applied (Durango 1qt/acre & AMS 17#/100 of water; 6/2/2020)
- Soil health baseline tests (infiltration, slake, & compaction; **Figure 3**; 6/5/2020) led by Cheryl Heard, NRCS

Figure 3 – NRCS Soil Water Infiltration Baseline Tests

Simulated Rainfall	Water Infiltration Time
1"	35 seconds
2"	2 minutes 25 seconds
3"	3 minutes 40 seconds
4"	4 minutes 23 seconds

- Multi-species cover Crop Seeded at V3 (6/9/2020) by New Vision Coop with JD 4930 with New Leader spreader. 100lbs of product applied per acre (cover crop seed and Urea)
- Weed control assessment (6/9/2020) – Very clean weed control in both 22" & 44" in majority of plot, occasional injured lambsquarters found
- Hail damage assessment (6/27/2020) – both 22" & 44" corn plants photographed; new growth leaves shredded
- Cover Crop stand assessment (6/27/2020) – photographed, some rows have good establishment/stand and some have limited stand, 22" corn noticeably lower cover crop stand, heavy rain on the evening of seeding may have contributed to washing of seed.
- Cover crop and corn stand assessment (**Figure 4**; 7/4/2020) – photographed, good growth on brassicas, limited on annual rye, 44" corn shorter in stature to 22" corn, observed limited cover crop growth in some rows

Figure 4 – Differences in Cover Crop Stand
A) 44” Good; B) 44” Poor; C) 22” Good; D) 22” Poor



- Cover crop and corn stand assessment (7/20/2020) – photographed, solid growth on brassicas, limited on annual rye, 44” corn still shorter in stature to 22” corn, observed limited cover crop growth in some rows, insects appear to be attracted to cover crop (observed damage to cover crop, but not corn), still signs of hail damage on corn on old leaves, large crack in soil in 44” rows attributed to planter rows that were turned off but not lifted
- Arial video and imaging completed by Bob Recker (7/20/2020)
- Plant, ear measurements, and yield estimates completed by Bob Recker and Mark Enninga (09/14/2020 – See Attached Report)
- Haney Soil Test collected by Extended Ag (7/24/2020)
- Plot harvest and individual conditions weighed by weigh wagon by Mark Enninga and Spencer Enninga (**Table 1, Figure 5**; 10/14/2020)

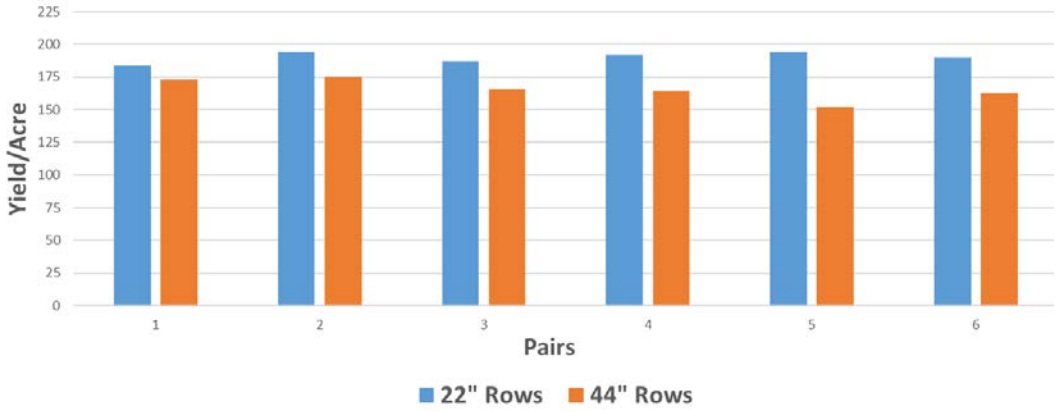
Table 1 – Trial Yield Results

Condition		*Grower/Field # Mark Enninga/Enning N*			
22" Rows	44" Rows				
Yield (bu/acre)		**Difference**	**Deviation**	**Deviation Squared**	
184	173	11.0	-14	186.8	
194	175	19.0	-6	32.1	
187	166	21.0	-4	13.4	
192	164	28.0	3	11.1	
194	152	42.0	17	300.4	
190	163	27.0	2	5.4	
	Sum	**148.00**		**549.3**	***Sum of Squares***
	Mean Difference	**24.67**			
	n:	5			
	Confidence Level:	0.05			
	Sample Variance:	109.87			
	Variance of the Mean:	18.31			
	Standard Error of the Mean:	4.28			
	$LSD_{.05}$:	11.00 bushels per acre			

t-Test: Paired Two Sample for Means

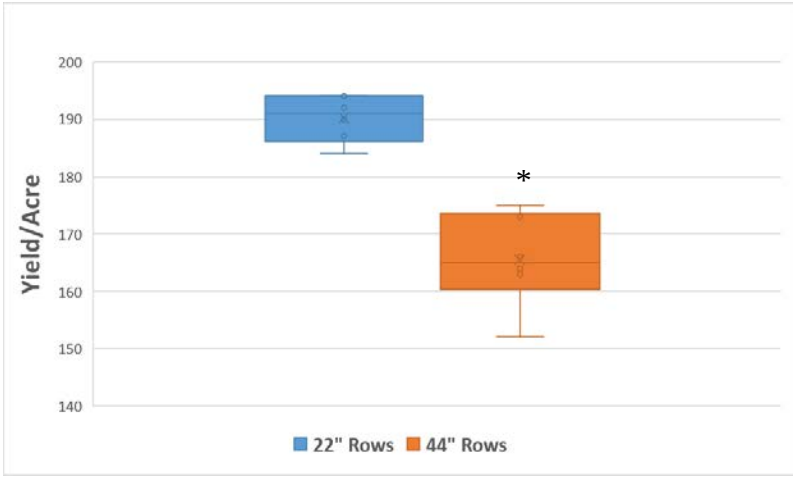
	22" Rows	*44" Rows*
Mean	190.17	165.50
Variance	16.17	67.50
Observations	6	6
Pearson Correlation	-0.40	
Hypothesized Mean Difference	0	
df	5	
t Stat	5.76	
P(T<=t) one-tail	0.00110	
t Critical one-tail	2.02	
P(T<=t) two tail	0.00221	
t Critical two-tail	2.57	

Figure 5 – Differences in Yield Between Each 22” vs. 44” Row



- In total, a statistically significant yield loss was observed in 44” rows compared to 22” rows, indicating that 44” rows have inferior yields to 22” rows (**Figure 6**).

Figure 6 – Total Median Yields in 22” Vs 44” Row Corn



- 30 cow/calf pairs started grazing harvested corn stover and cover crop on 11/1/2020.
- 30 cows continue to graze field as of 12/15/2020
- 30 cows removed from field on 12/22/2020

2.) IDENTIFY ANY SIGNIFICANT FINDINGS AND RESULTS OF THE PROJECT TO DATE.
(*There may be none to report at some stages of the project)*

- It is suspected that the cover crop seed washed down rows on the day it was seeded due to a >2" rain event (**Figure 7**). A low disturbance drill unit to seed the crop would be helpful to minimize soil disturbance, but also achieve better seed to soil contact.

Figure 7 – Time Lapse Camera Shots During Rain Event – Notice Water in Rows

- Limited soil disturbance assisted in weed control, despite limited residual herbicide used.
- There was crack in the soil consistently found in the 44" rows which appeared when the weather turned dry (**Figure 8**).

Figure 8 – Soil Crack in 44" Rows, Running with the Rows

- Lower height difference in the 44" corn was observed, unclear how this impacted corn yield.
- Hand check yield estimate on 9/14/2020 indicated a difference of 5 bushels. 44" being lower.
    - A randomly selected location was chosen for the hand yield check estimate comparison. "Good" plant spacing did not always result in a big ear. It would be helpful to measure emergence with a flag test as a way to better understand why certain ears are bigger than others. Good spacing didn't always correlate to big ears.
- **Harvest yields indicated 44" corn is inferior to 22" based on grain yield. 44" corn yielding on average 165.5 bushels compared to 22" corn, averaging 190.2 bushels. An average loss of 26 bushels.**
- Cow/Calf herd appeared to readily find the cover crop forage. A more consistent cover crop establishment would obviously allow for better cattle grazing opportunities. Forage quantity and quality could be measured and valued to offset yield difference with WRC.
- Additional questions to be considered:
    - Could the seed population per acre on WRC be lowered compared to standard and perform closer to standard row widths?
    - Is even emergence more predictive of good corn yields than row width and seed spacing?
    - Would different WRC configuration allow for a closer comparison in evaluating WRC, such as 22", 22", 88", 22". 22"?
    - What other cover crop mixes would provide better forage for grazing?
    - Are there future benefits to using the WRC? Water infiltration, more plant available nutrient availability, higher yields with future crops?
    - Would indexing nutrient needs to the row overcome the yield differences?

3.) CHALLENGES ENCOUNTERED. (*Describe any challenges that you encountered related to project progress specific to goals, objectives, and deliverables identified in the project proposal.*)

- A heavy down pouring rain (>2") occurred on 6/9/2020 which contributed to some washing of cover crop seeds which led to an uneven establishment of the cover crop.
- Hail storm occurred on 6/26/2020 causing damage to the plot. The corn did recover, but it set it back (**Figure 9**).

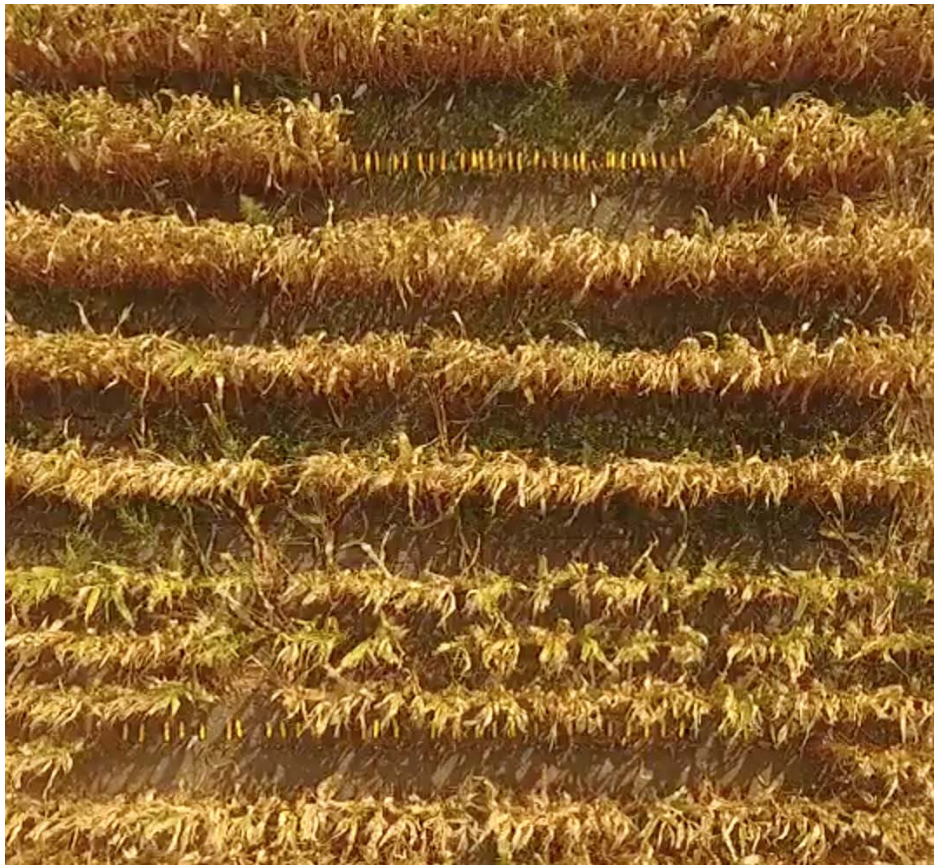
Figure 9 – Hail Damage to Trial Field

4.) EDUCATION AND OUTREACH ACTIVITES. *(Describe any opportunities to engage with farmers, influencers or the media about your project.)*
- MN Corn Growers Association Blog post, "Innovation Grant Spotlight: Can wide rows give cover crops a better start?" 5/5/2020
-*Agtake* e-mail newsletter (repost of original MN Corn Growers Blog post) – 5/13/2020
-*Corntalk*, MN Corn Growers Association Magazine (repost of original MN Corn Growers Blog post) – May 2020 Issue
-Radio interview with Mark Dorenkamp, Farm Broadcaster at Brownfield Ag NewsRadio – May 2020
-Personal Twitter Account – multiple posts

5.) HOW CAN WE HELP? *(Please let us know how we can improve the experience or assist in your project if possible.)*
-Hosting a virtual meeting with the MN Corn Innovation Grant recipients to discuss each other's research projects.

Wider Corn Row/Cover Crop Project

Field Visit Report



14 September 2020
Mark Enninga Farm
Fulda, MN

CVI

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Cedar Valley Innovation LLC
What's in Your Field?
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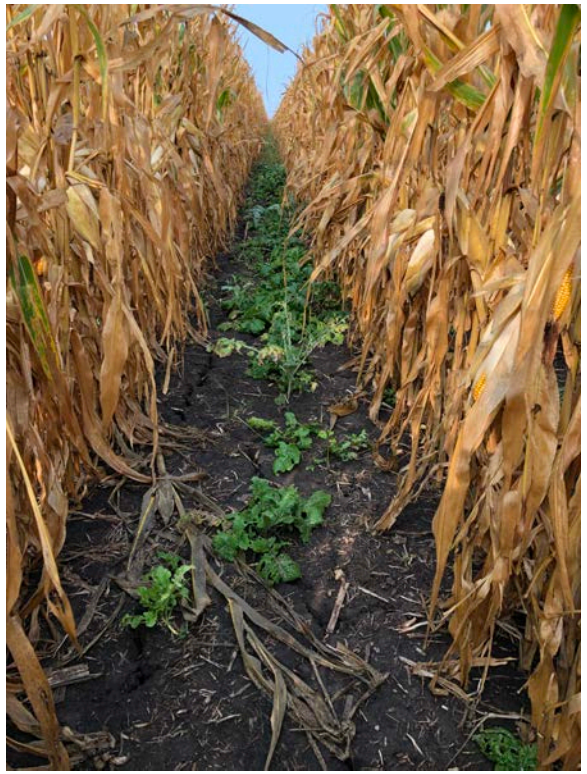
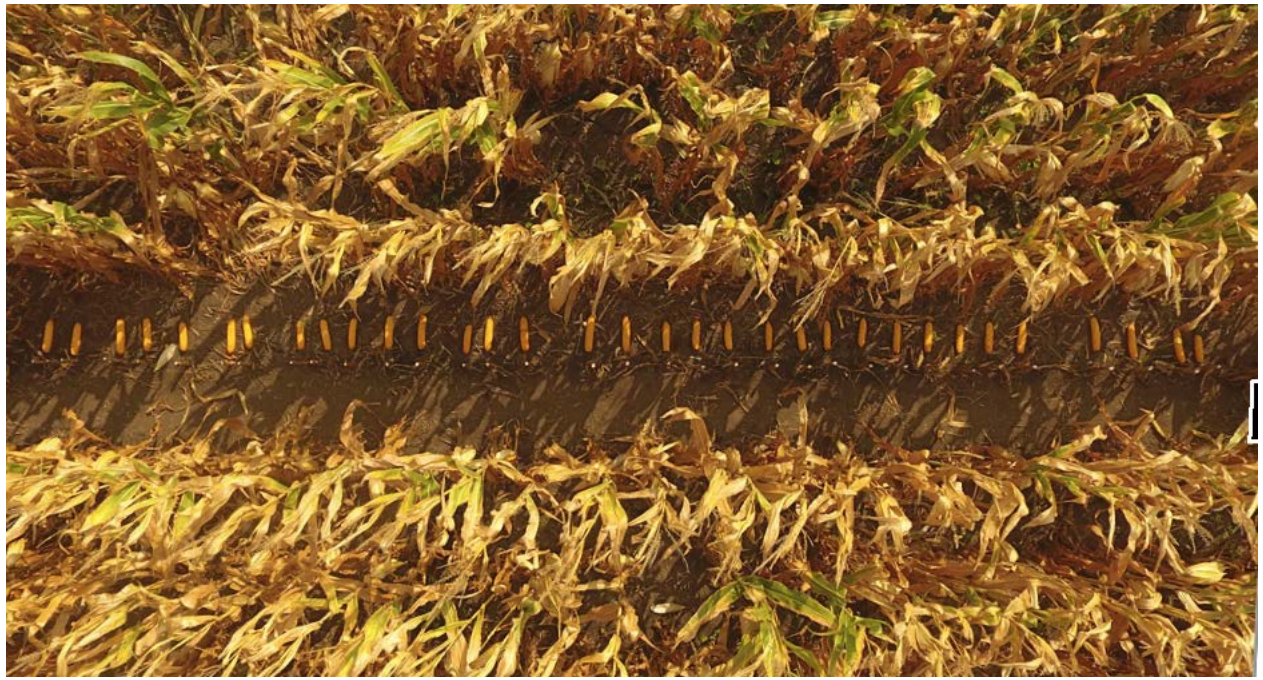
cedarvalleyinnovation.com

Version: 20 Sep 2020

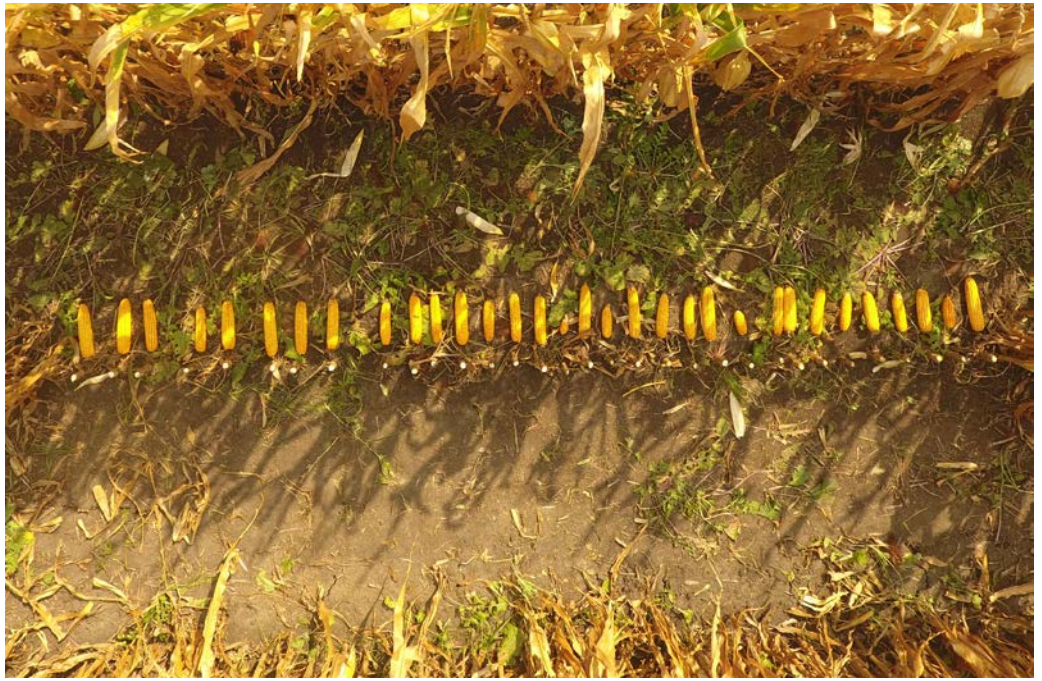


Yield and Variability Study

In a 22” row, 285” equals 1/1000th acre
33 Ears Measured (32,000 Population)
175 Bu/a



In a 44” row, 142.5” equals 1/1000th acre
32 Ears Measured (33,000 Population)
170 Bu/a



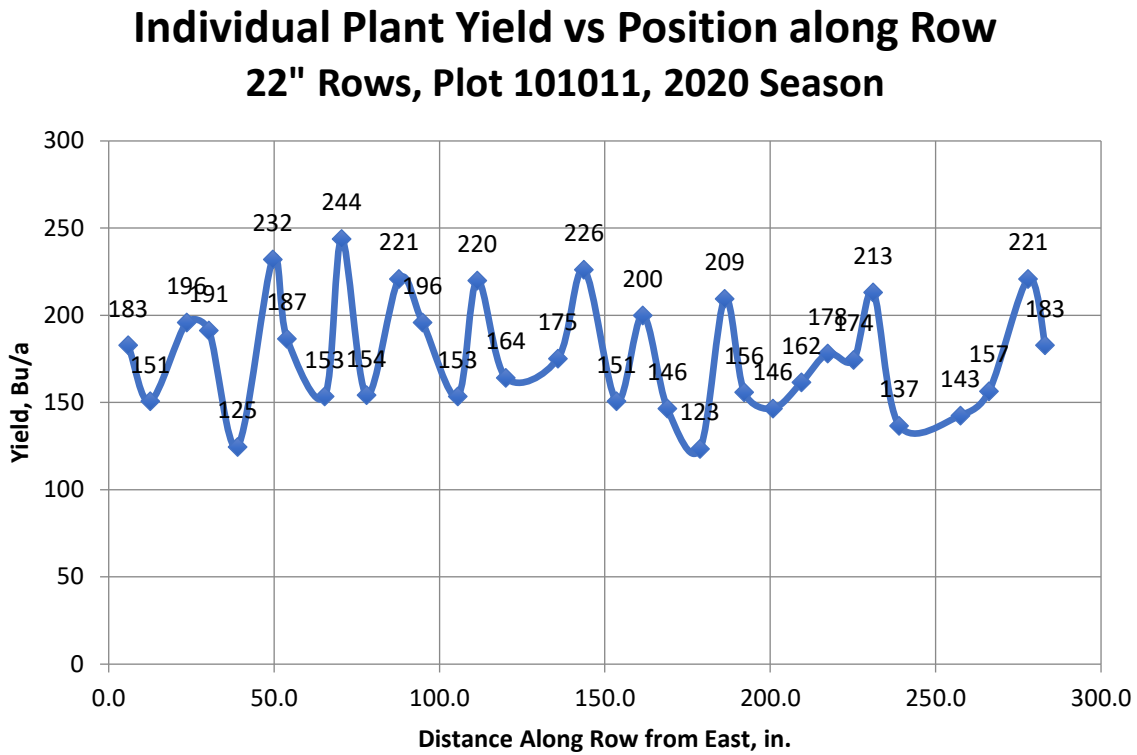
The Basis of this Analysis: Two 1/1000 acre rows

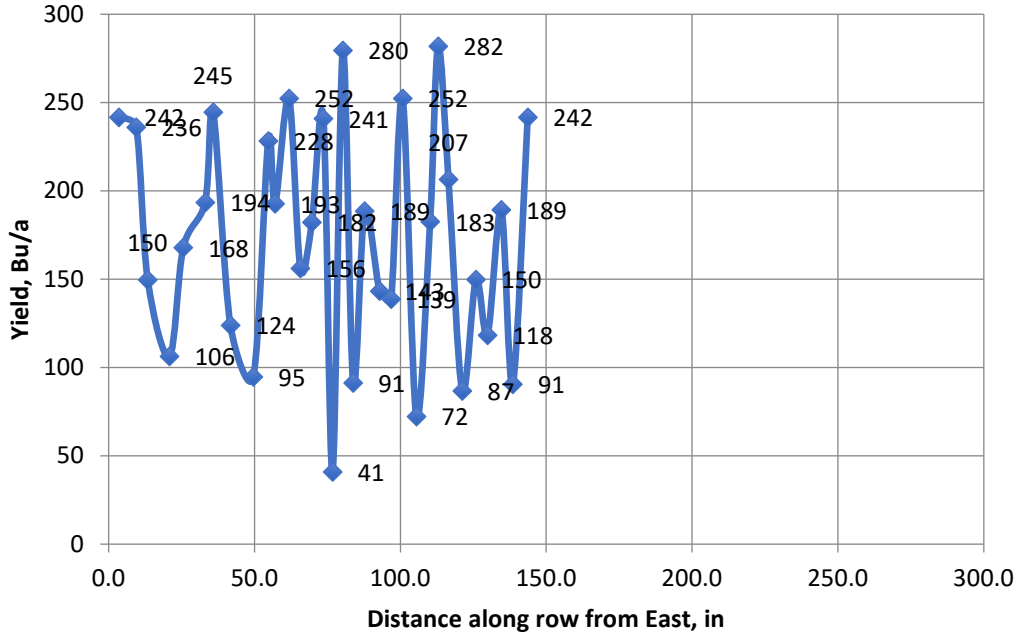
“Single Plant Yield” Definition & Calculation
Yield = Bushels Per Acre

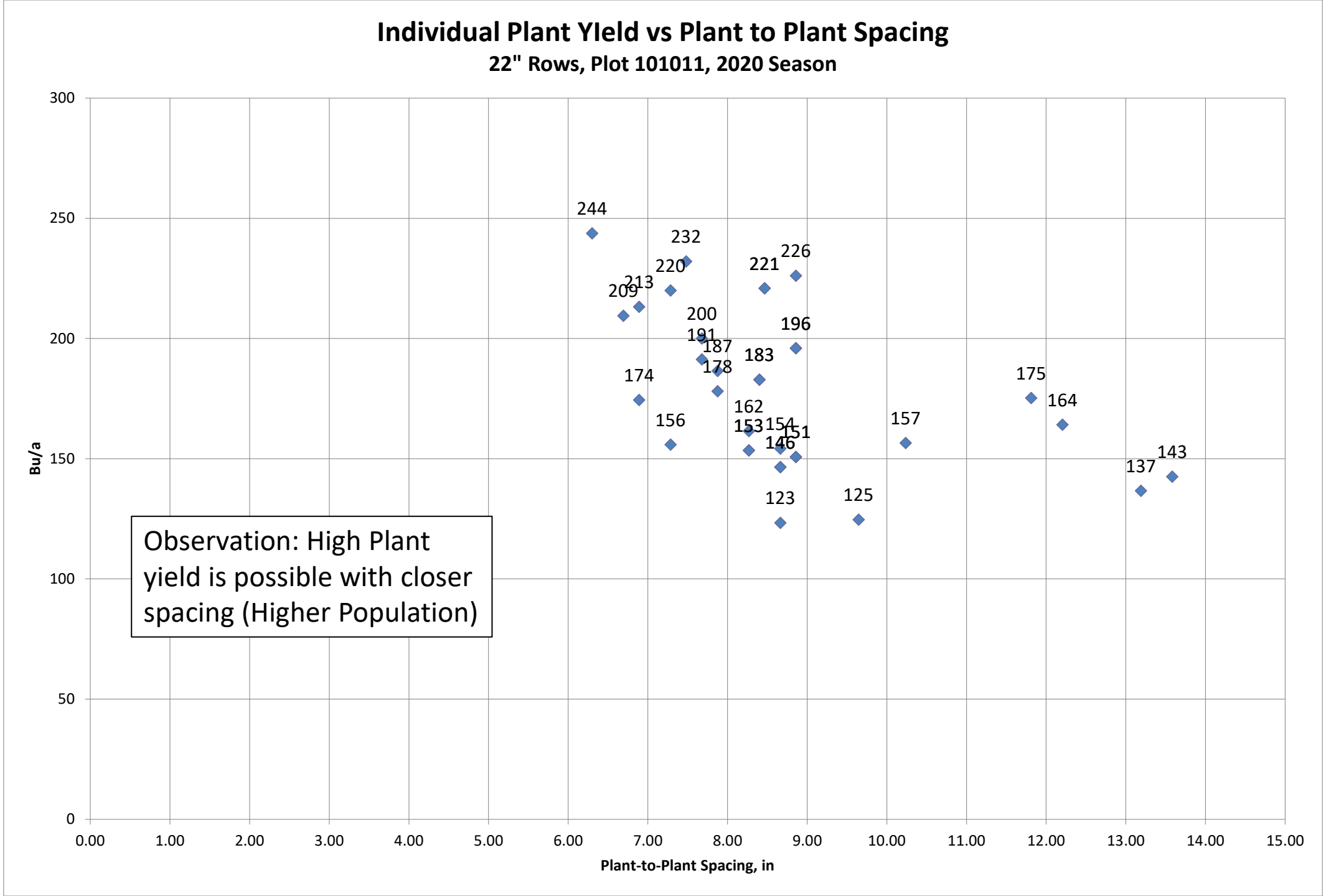
- The “Field Size,” in acres (@43,560 sq ft) is half the distance to the next plant on each side x half the distance to the next row on each side.

- The “Bushels” is the weight of the grain, corrected to 15% moisture on each ear. Estimated for each ear, based on the ratio of grain to ear and moisture for several ears in each plot.

Single Plant Yield, moving down the row

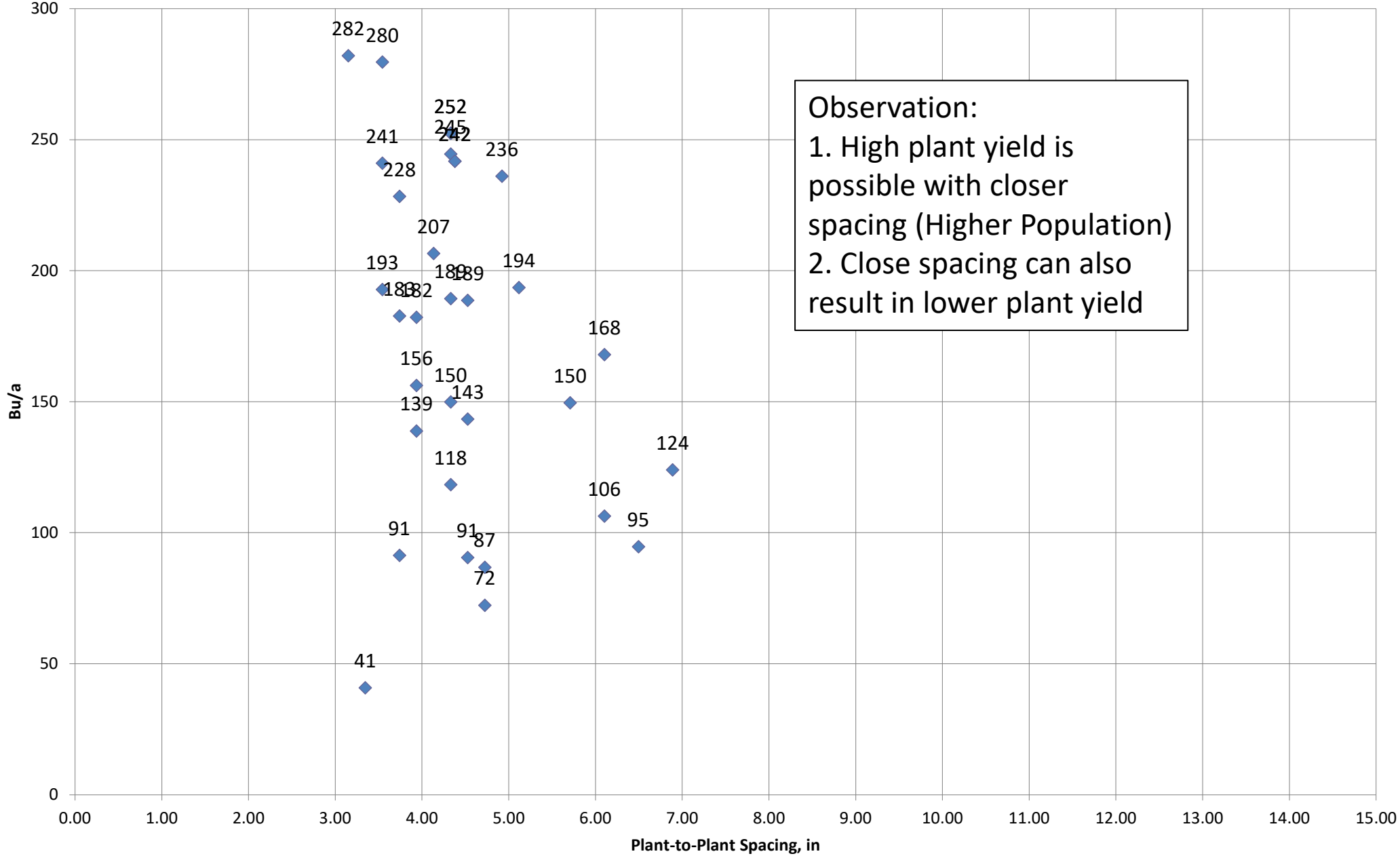





Individual Plant YIeld vs Plant to Plant Spacing
22" Rows, Plot 101011, 2020 Season
Bu/a
Plant-to-Plant Spacing, in
300
250
200
150
100
50
0
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
244
232
220
226
221
213
209
200
196
191
187
183
178
174
175
164
162
157
156
153
154
151
146
143
137
125
123
Observation: High Plant yield is possible with closer spacing (Higher Population)

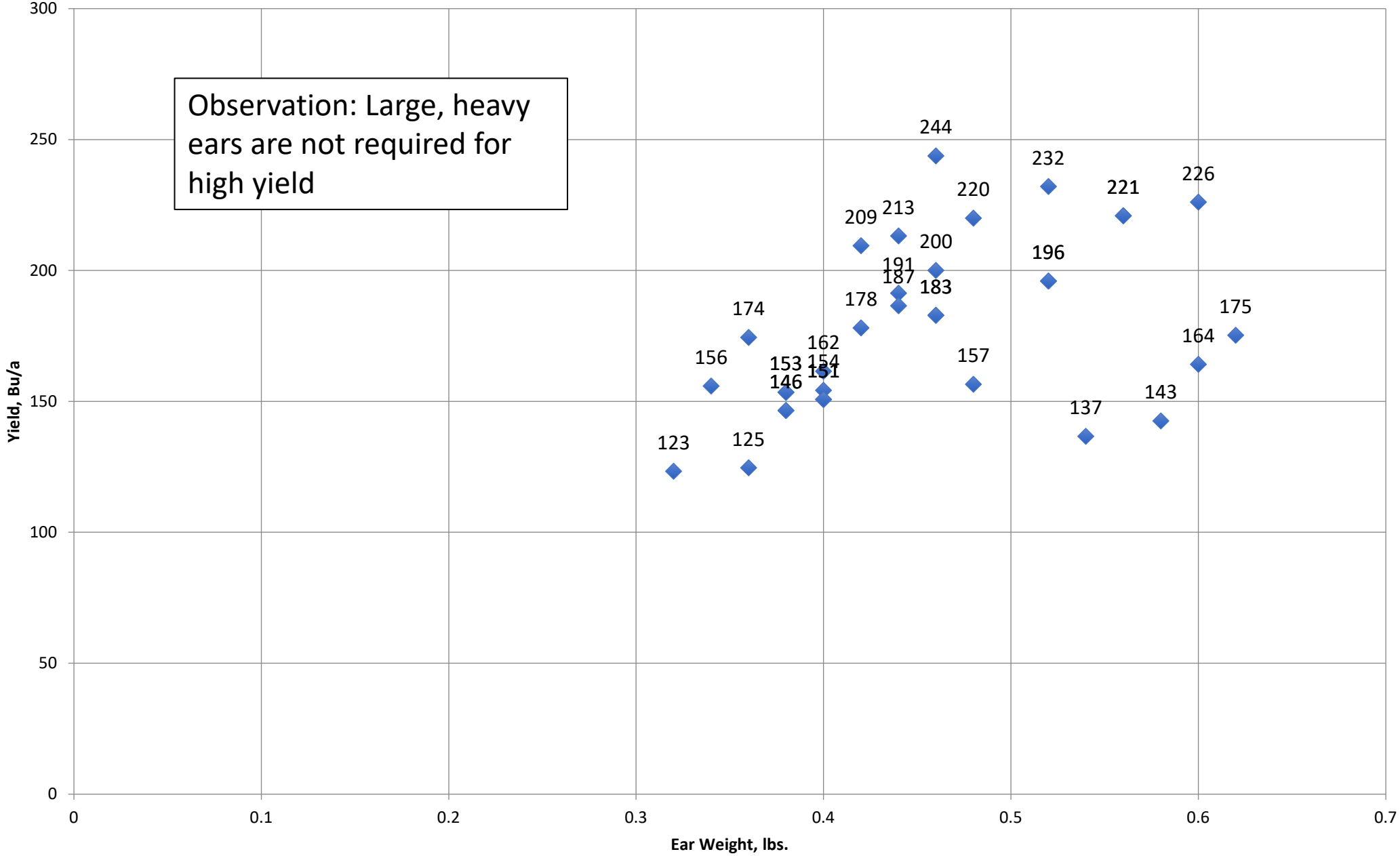
Individual Plant YIeld vs Plant to Plant Spacing

44" Rows, Plot 101011, 2020 Season



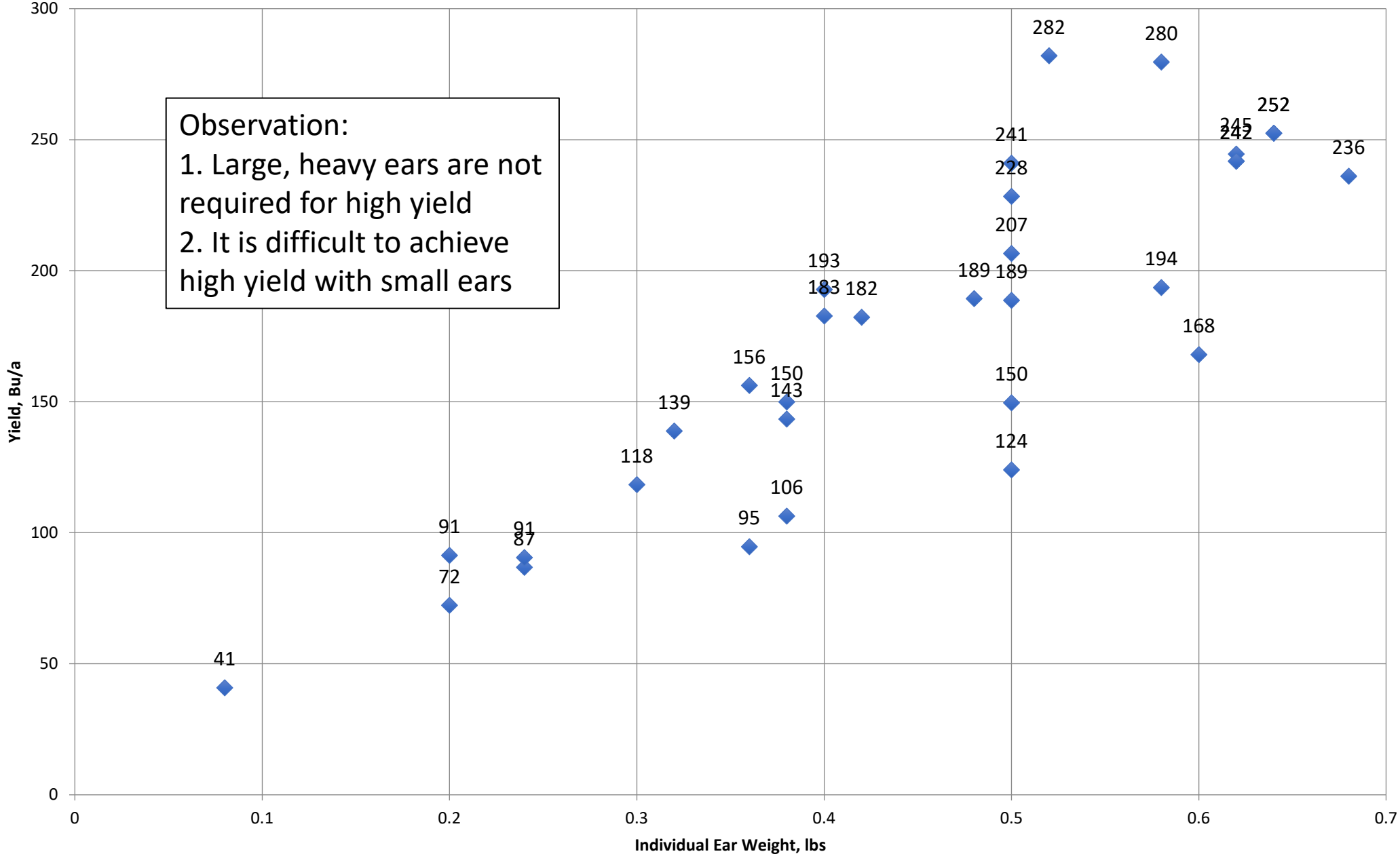
Individual Plant Yield vs Ear Weight

22" Rows, Plot 101011, 2020 Season



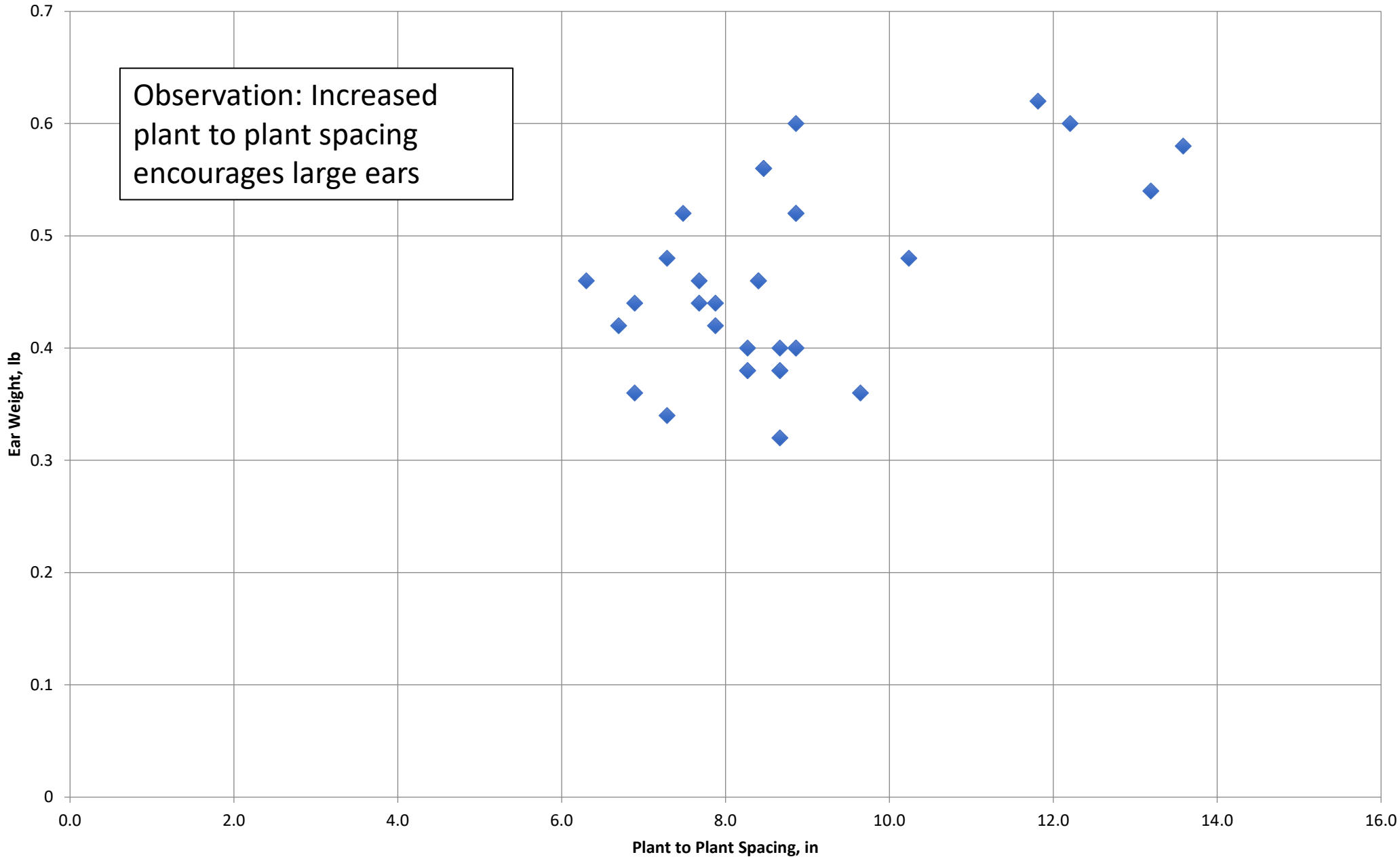
Individual Plant Yield vs Ear Weight

44" Rows, Plot 101011, 2020 Season



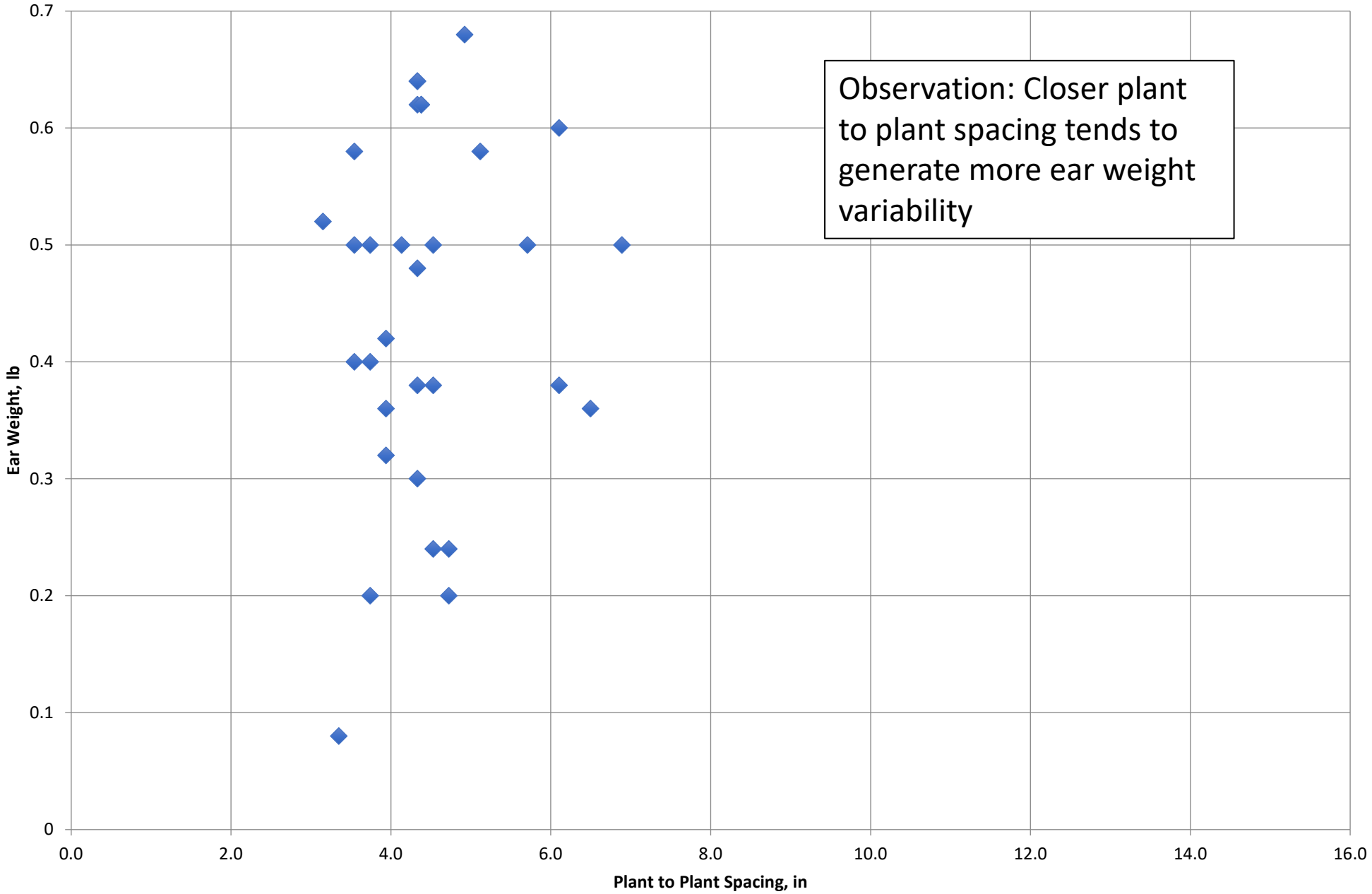
Individual Ear Weight vs. Plant to Plant Spacing

22" Rows, Plot 101011, 2020 Season



Individual Ear Weight vs Plant to Plant Spacing

44" Rows, Plot 101011, 2020 Season



Summary Statistics:

Variable	22” Rows	44” Rows
Plant Count	33	32
Yield, Bu/a	175	170
C.O.V of Yield	18%	38%
Average Ear Weight, lbs.	.456	.445
C.O.V of Ear Weight	18%	34%
Average Plant Spacing	8.72	4.48
C.O.V of Plant Spacing	20%	20%

Note: C.O.V is Coefficient Of Variability, the standard deviation of a population divided by the average value

Summary of Observations to Date

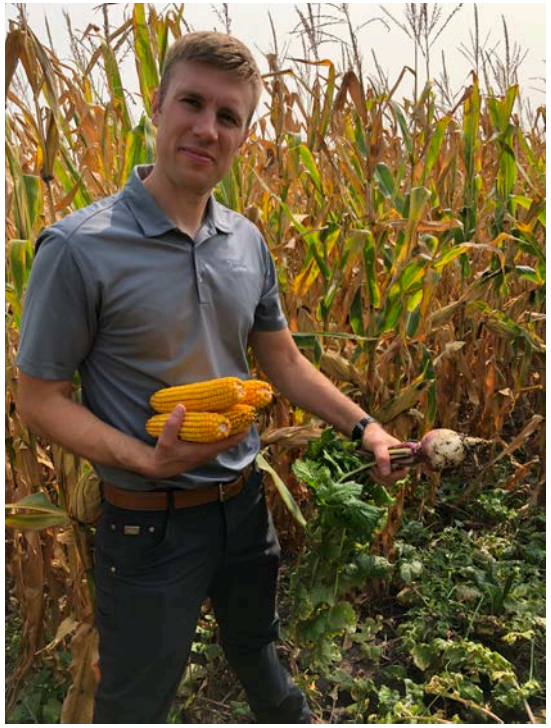
- Closer plant spacing seems to generate more variability in ear size
- Closer plant spacing is likely more demanding of uniformity of plant emergence, and a number of local micro-conditions such as seed-to-soil contact, moisture, fertility, etc.

- Overall yield appears to be statistically the same; the benefit (and necessity) of cover crops appears to be enhanced by the wider rows.

- Only one additional plant in the 44” rows would have given the same yield as 22” rows. This is normal experimental measurement variability.

Next Steps

- Machine harvest and field length weigh wagon yield data will be a great compliment to these findings and increase confidence in the results.



Thank You

Mark Enninga

Bob Recker