Statistics: Used and Abused Tools of the Trade

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Statistics

- Tools for making decisions
  - “Is the untreated different than the treated?”
  - “What is the optimum fertilizer rate or seeding rate?”
  - “How much does delayed planting affect corn yields?”

We want to do this with some confidence about our final decision.

Confidence or Risk in Statistics

The basis for statistical decisions

Mean is often best forecast

	farm A	farm B
Five year average return per acre		
Average	$20	$20

How much confidence do you have in the $20 estimate?

When analyzing data

- The mean is a powerful measure/concept
- However, the mean does not convey all important and relevant information.
- We often also want to consider the variability in the data.

Measures of variability

- Range -- the difference between the largest reading and the smallest reading.

- Standard deviation -- a measurement of the total variability of the data. It is an average of deviations from the mean.

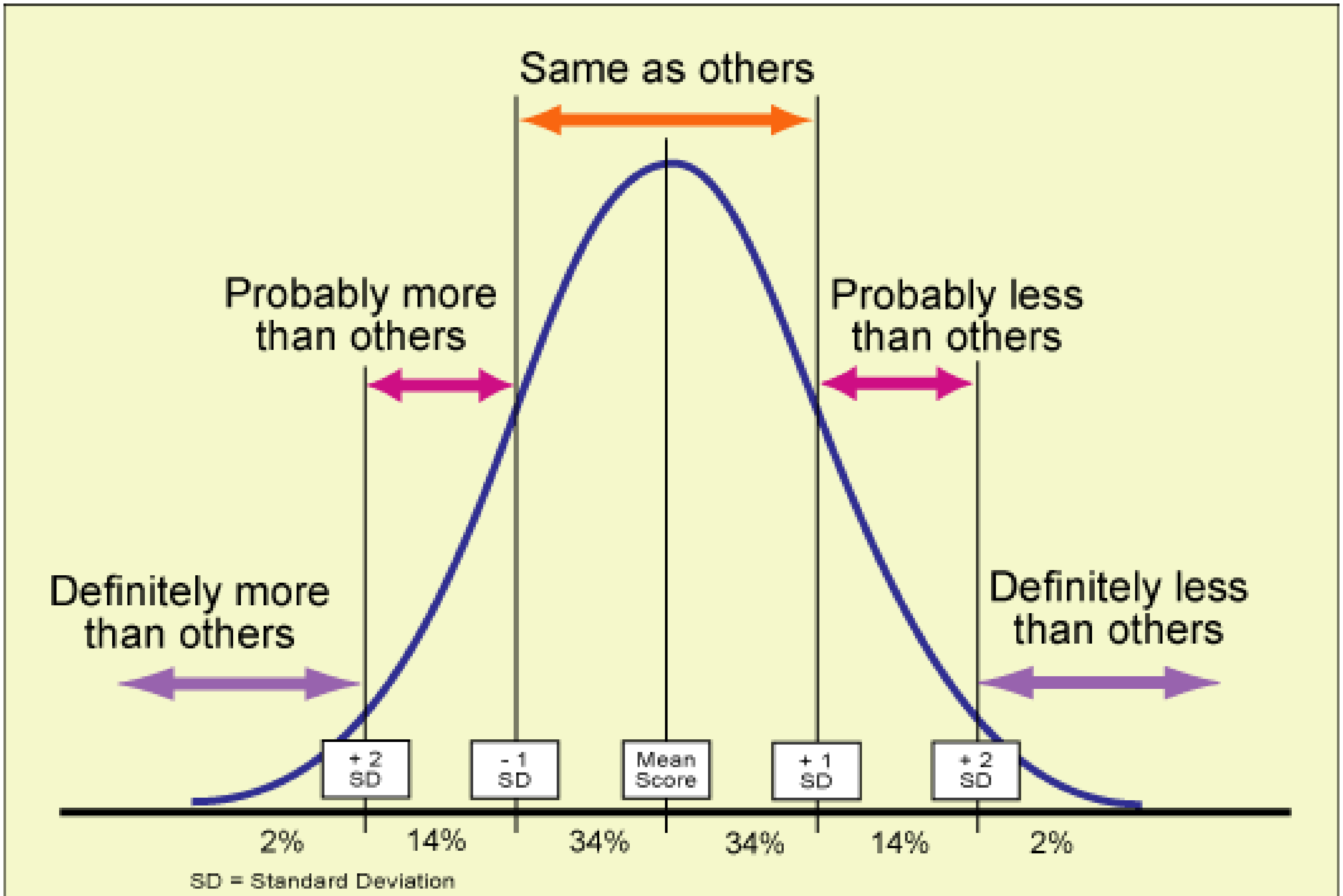
$$\boxed{s = \sqrt{\frac{\sum (x_i - x)^2}{n - 1}}}$$

- Coefficient of variation (CV) -- normalized measure of variability equal to standard deviation divided by the mean.

Standard deviation

- Same unit of measure as the original data
- Affected by extreme values, which tend to enlarge the standard deviation.
- Larger values for standard deviation indicate the data are more widely dispersed around the mean (i.e., more variable).
- Generally has the most meaning when data are normally distributed.

Probabilities and Statistics



Statistical Tests Often Used

- Mean Comparison
  - We have two or more products and we want to know if the response of one is **different** than the other
- Trend Analysis
  - We have a range of treatments of the same product and we want to know the **optimum**
- Spatial Analysis
  - Not going to talk about today

Mean Comparisons

Analysis of Variance

TABLE 4 continued. NORTHEAST KANSAS SPRINKLER IRR

BRAND	NAME	Topeka, Shawnee County YIELD (bu/a)	PAVG (%)	TW (lb/bu)	MOIST (%)	DAYS (silk)	LDG (%)	100 pp
RENZE	1357YGPL/RR	188	99	57	17	64	0	24.
RENZE	5347HX1/LL	192	101	56	18	66	2	25.
RENZE	8386YGCB	186	98	55	19	67	3	24.
RENZE	8428YGCB	177	93	56	18	65	1	25.
RENZE	9328YGCB/RR	**195**	102	57	19	65	2	24.
RENZE	9386YGCB/RR	178	93	57	18	65	0	25.
TAYLOR	77640 RR	185	97	58	16	64	1	24.
TAYLOR	930 RR/Bt	181	95	56	16	63	2	24.
TRIUMPH	1608VT3	--	--	--	--	--	--	--
TRIUMPH	1866Bt	--	--	--	--	--	--	--
TRIUMPH	1977CbRR	--	--	--	--	--	--	--
	AVERAGE	190	190	56	18	65	2	25.
	CV (%)	9	9	2	9	2	--	0.
	LSD (.05)	24	14	2	2	2	4	2.

* Seed treatments and hybrid traits located in Table 16.

** Yields in bold are in the top LSD group.

*** Unless two hybrids differ by more than the LSD, little confidence can be placed in one being superi

LSDs and Alphas

- We see $LSD_{(0.05)}$ and “significant at the alpha = 0.10” or “not statistically significant” in research reports.

- What does it mean?
- “Significant “ in statistics means “at the level of risk we are willing to accept, the evidence (sampled data) is sufficient to accept or discredit our H_0”

Null Hypothesis (H_0) and our "fears"

- Null hypothesis is typically
  - Hybrid A = Hybrid B
- Type I error is what our probabilities are focused on.
  - Type I is wrongly rejecting H_0
  - It happens when we conclude that Hyb A ≠ *B and* in reality they are the same.

Analysis of Variance

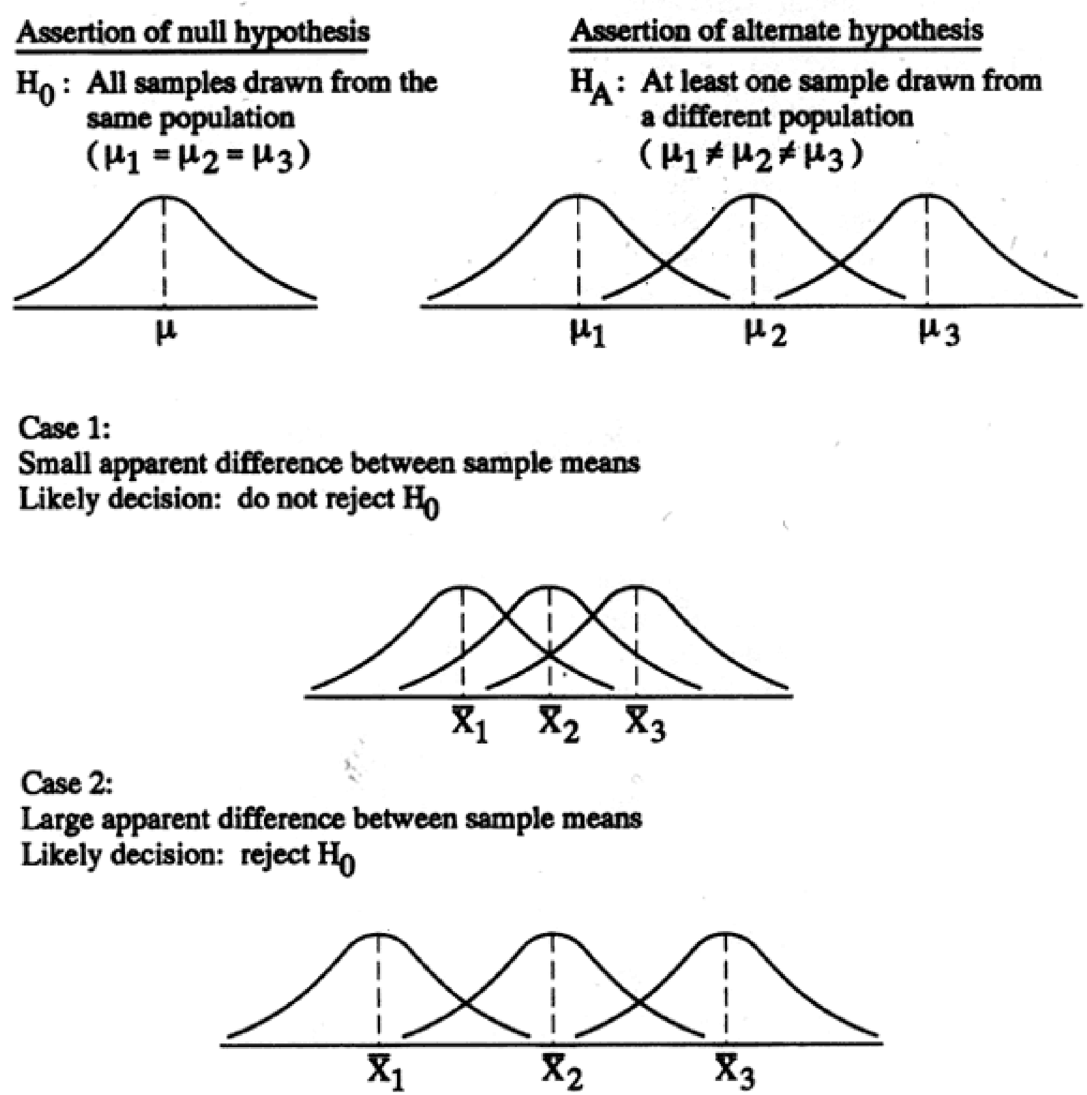


FIGURE 10.1
Null and Alternate Hypotheses in Analysis of Variance (ANOVA)

source: McGrew and Monroe (2000)

P value example

Treatment	Grain yield
	Mg ha^{-1}
2007	
Water status	
Adequate	4.52
Deficient	3.82
P value	0.005
2008	
Recommended N rate multiple	
Water status	
Adequate	5.32
Deficient	5.02
P value	0.1

- Human translation:
- In 2007, there is a 0.5% chance that these two are not different.
- In 2008, there is a 10% chance that these two are not different.

Risk and Research

- Academics and researchers have been conditioned to be low risk takers because our results turn into recommendations in real life.

- We want to be VERY certain that narrow rows are better than wide rows before a farmer spends big $$$ to switch.
- However, in real life, 95% confidence (5% Pr > F) is not always likely necessary.

Probabilities and Decisions?

Treatment	Cost ($/acre)	Benefit	Confidence Level ?
Soybean Inoculant	$ 1.00	2 bushel	

Analysis of Variance Examples

Plant Population (32,000 and 40,000 plants/acre)											
	LY1	LY2	LY3	LY4	LY5	LY6	LY7	LY8	LY9	LY10	Avg
Normal	245	187	223		207	166	132	199	109	210	186
High	237	172	226		196	175	127	191	95	209	181
	-8	**-16**	3		**-11**	**9**	-5	**-8**	**-13**	-1	**-6**

Bold numbers indicate years when means were different at the 10% level

Fertilizer											
	LY1	LY2	LY3	LY4	LY5	LY6	LY7	LY8	LY9	LY10	Avg
Normal	230	176	221	230	195	165	122	195	98	211	184
High	252	183	228	248	208	175	137	196	105	208	194
	21	7	**8**	**18**	**13**	**10**	15	1	7	-3	**10**

Bold numbers indicate years when means were different at the 10% level

E. Nafziger: "Managing continuous corn for high yields" white paper

Comparing Treatments

- Often we get data from a large number of different studies and want to use them to give us a better picture of the situation.
- How do we compare all of these results?
- Simple comparisons are often vary useful.

Soybean Row Spacing Example

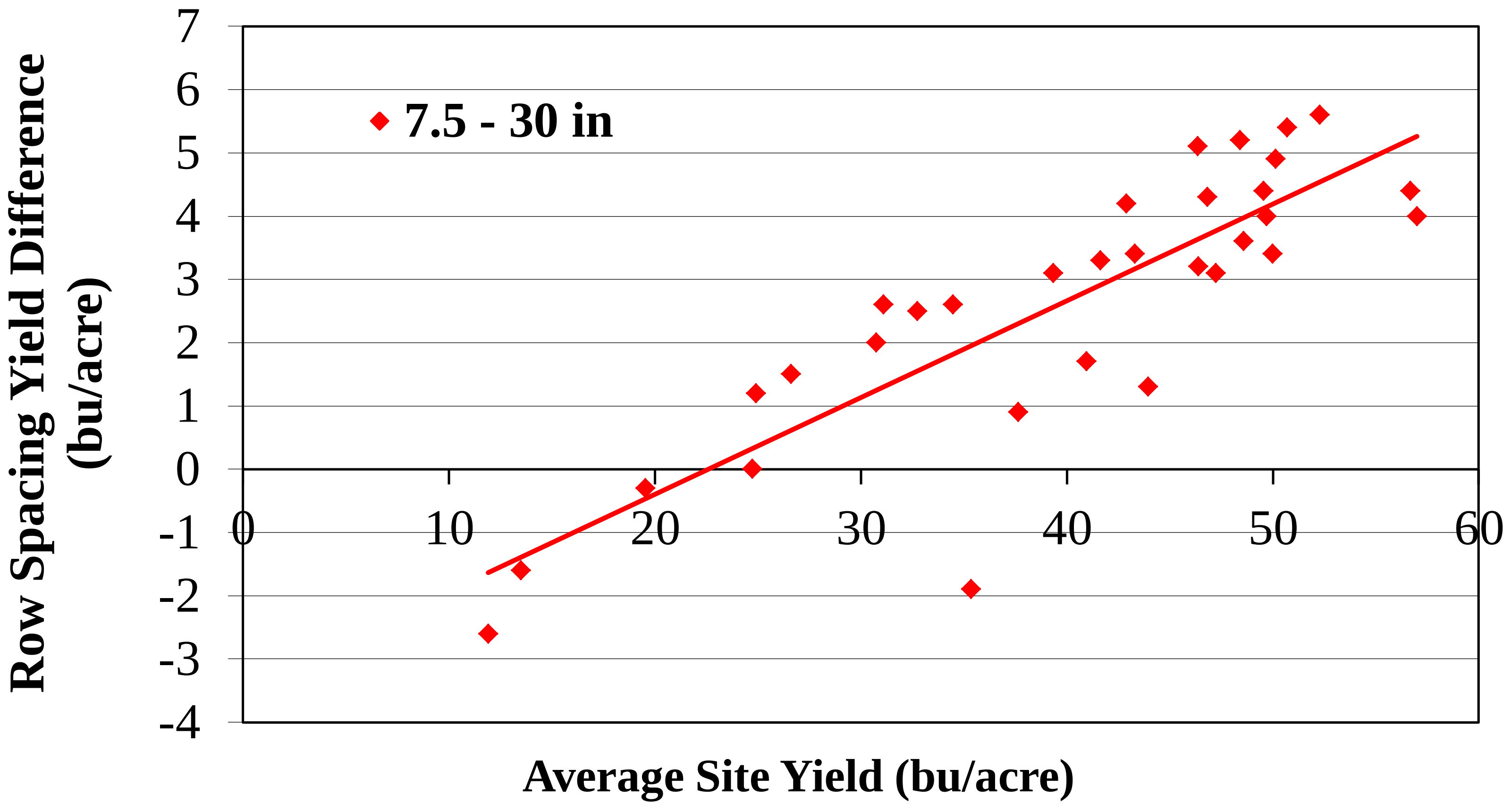
- When narrow row soybeans were being studied, a lot of results were being generated by universities.
- It seemed that some environments worked well, others did not?
- A **difference plot** can often be useful in determining environmental impacts.

Soybean Row Spacing Example

- Accumulate data
- Calculate the differences between the treatments
- Plot the data
  - Difference as the Y
  - Location average as the X.

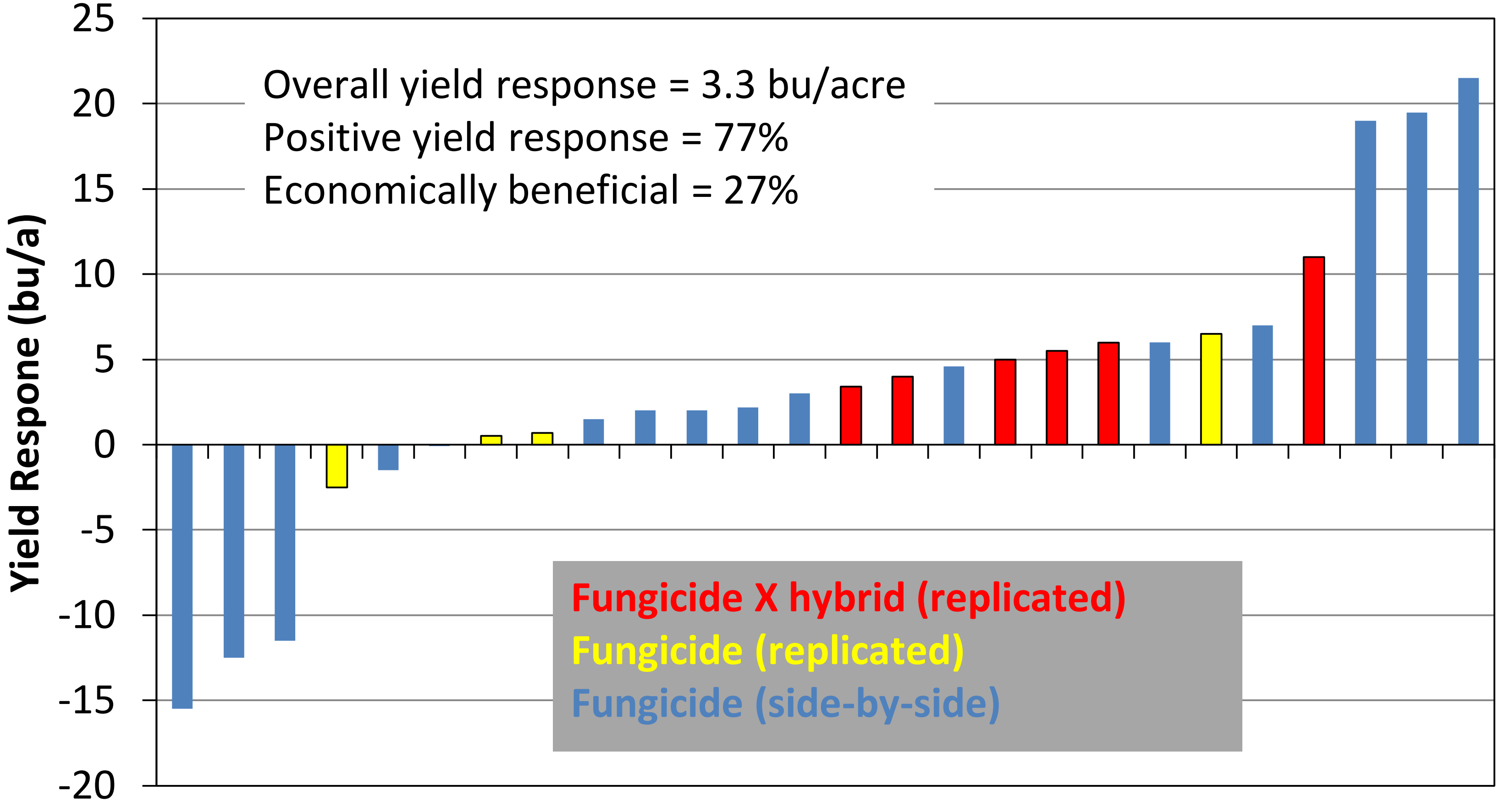
Location	Year	7.5 In	30 in	Difference	Loc Avg
Manhattan	1997	10.6	13.2	-2.6	11.9
Ottawa	1998	19.4	19.7	-0.3	19.6
Lincoln	1998	25.5	24.3	1.2	24.9
SW IA	1999	31.8	29.8	2.0	30.8
Lincoln	1999	32.4	29.8	2.6	31.1
Mead	2000	34.0	31.5	2.5	32.8
Manhattan	2000	34.4	36.3	-1.9	35.4
Columbia	2000	38.1	37.2	0.9	37.7
MO	2000	40.9	37.8	3.1	39.4
VA	2001	45.0	40.8	4.2	42.9
Ark	2001	44.6	43.3	1.3	44.0
Manhattan	2001	48.0	44.8	3.2	46.4
Ottawa	2001	51.0	45.8	5.2	48.4

Soybean Row Spacing Example

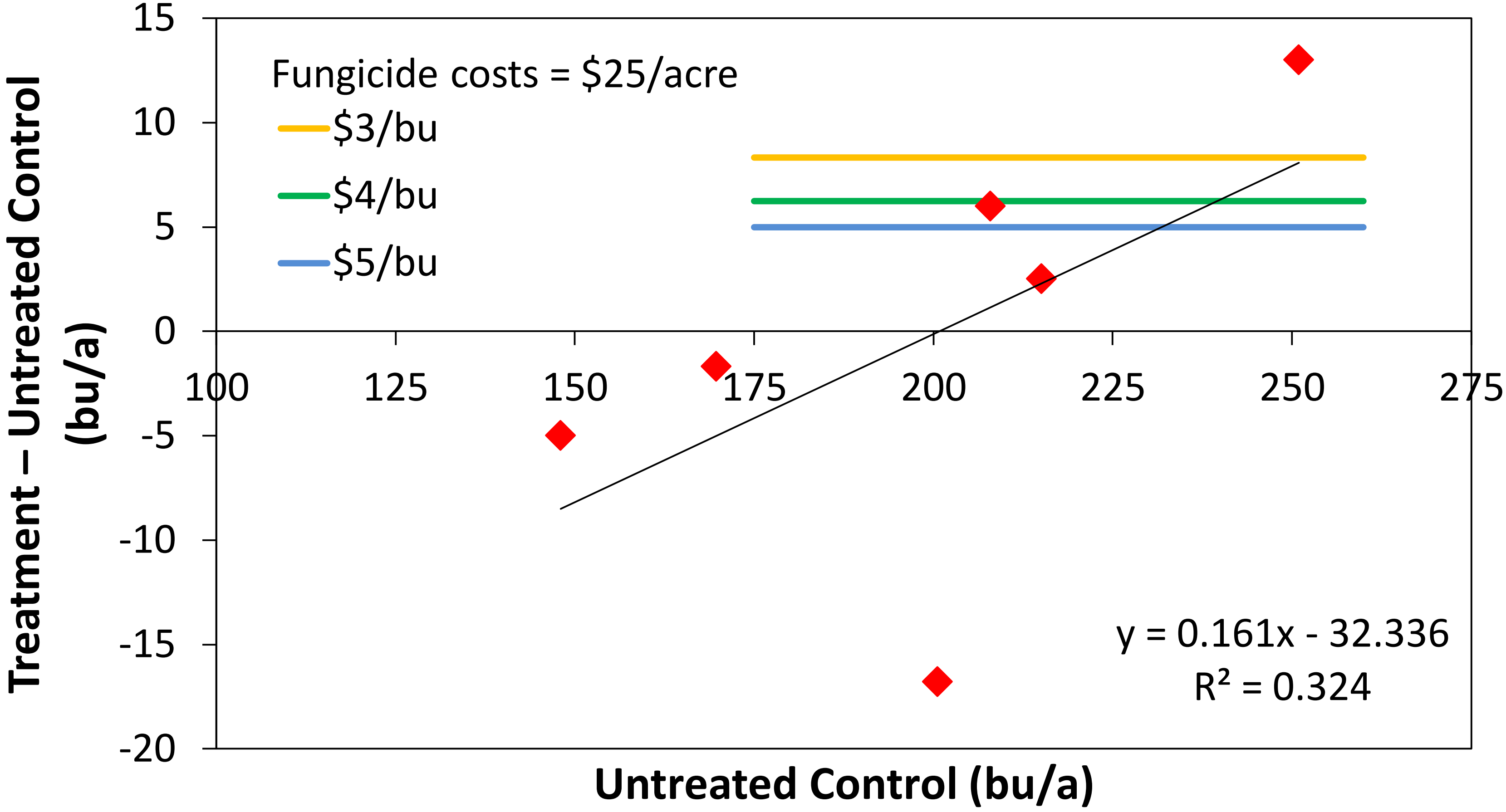


Foliar Fungicides – Corn

A. Robinson – Iowa St. Univ.



Corn Fungicides in Kansas



t-Tests and Single Comparisons

- The Student t-Test is useful for comparing two treatments (Hyb A vs Hyb B).
- It is very simple
- It can be done in Excel.

Replication	Hyb A	Hyb B
1	159	158
2	161	155
3	159	156
4	165	153
Average	161	156
St. Dev	2.8	2.1

Prob > Z = 0.01

Regression Analysis

- “Line fitting” Analysis
- Is the most appropriate analysis method for rate related data such as planting date, planting rate, fertilizer rates.
- Easy to conduct
- Requires less knowledge of “statistics” as we are often looking for optimums.

OverWorked and Mis-Used LSDs

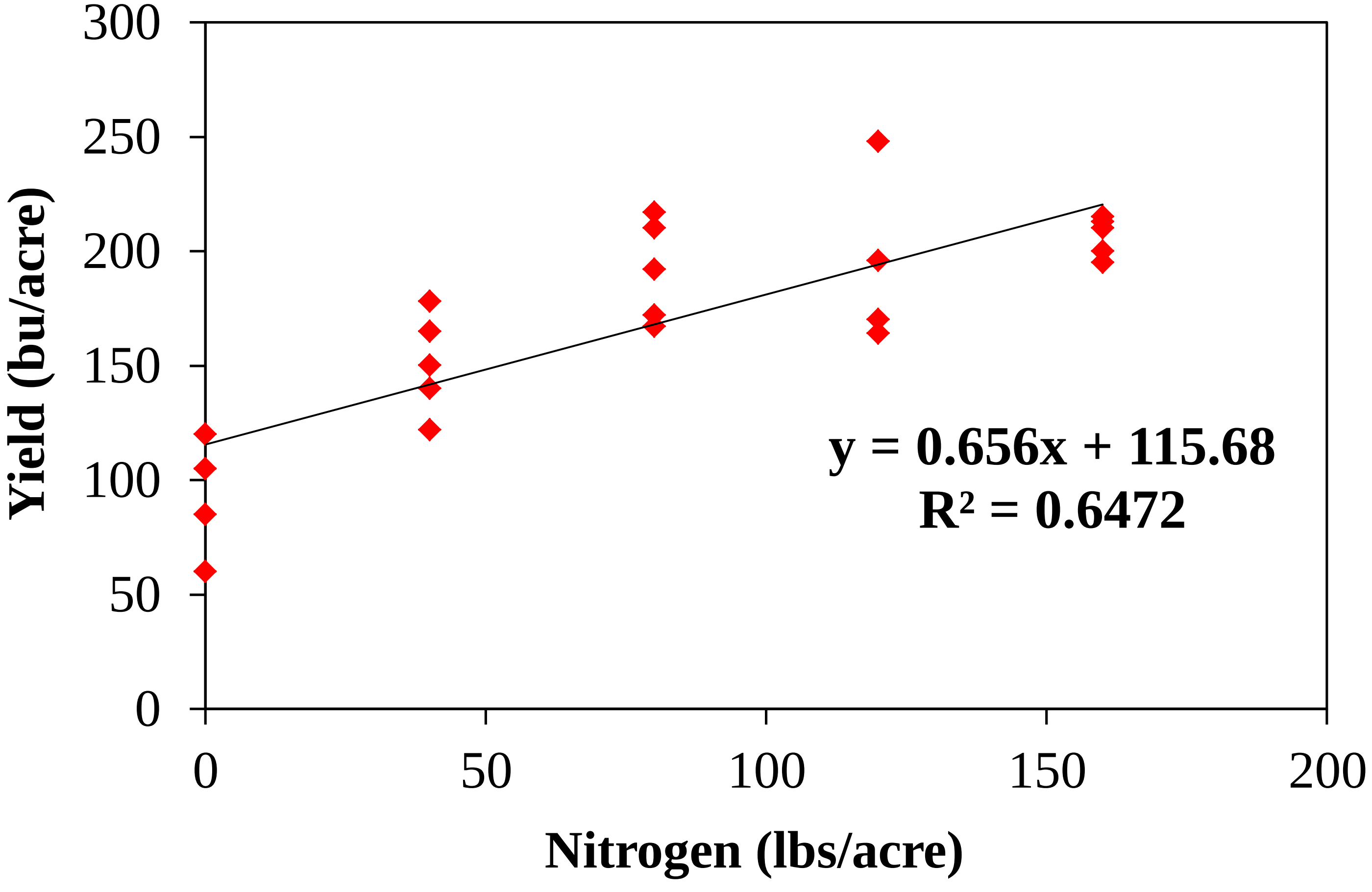
N Rate (lbs/acre)	Corn Yield (bu/acre)	
0	99	c
40	151	b
80	192	a
120	204	a
160	207	a

Means followed by the same letter are not different at the 0.05 significance level

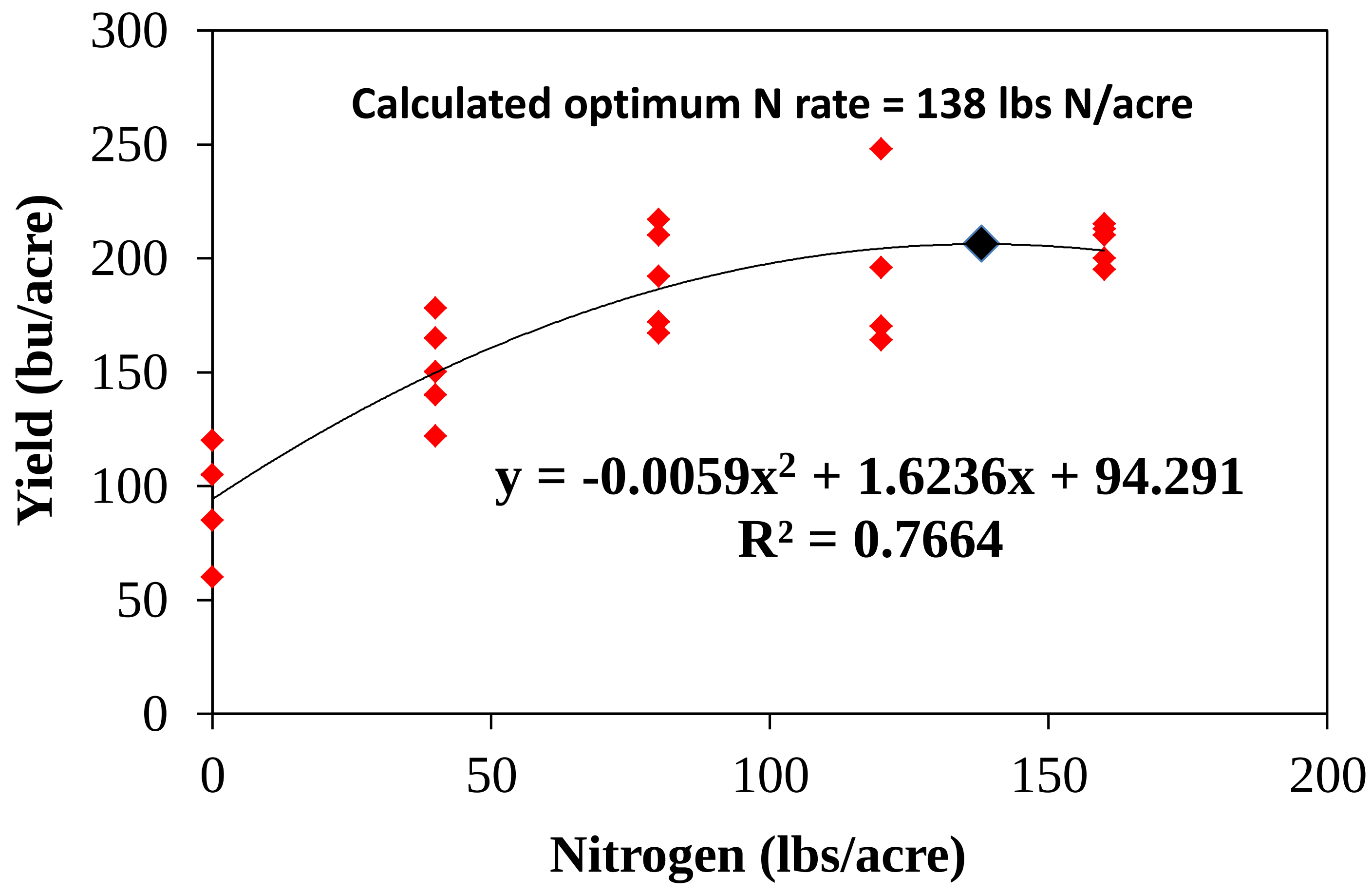
So what is the optimum or recommended N amount based on these data?

(Audience participation here…if awake)

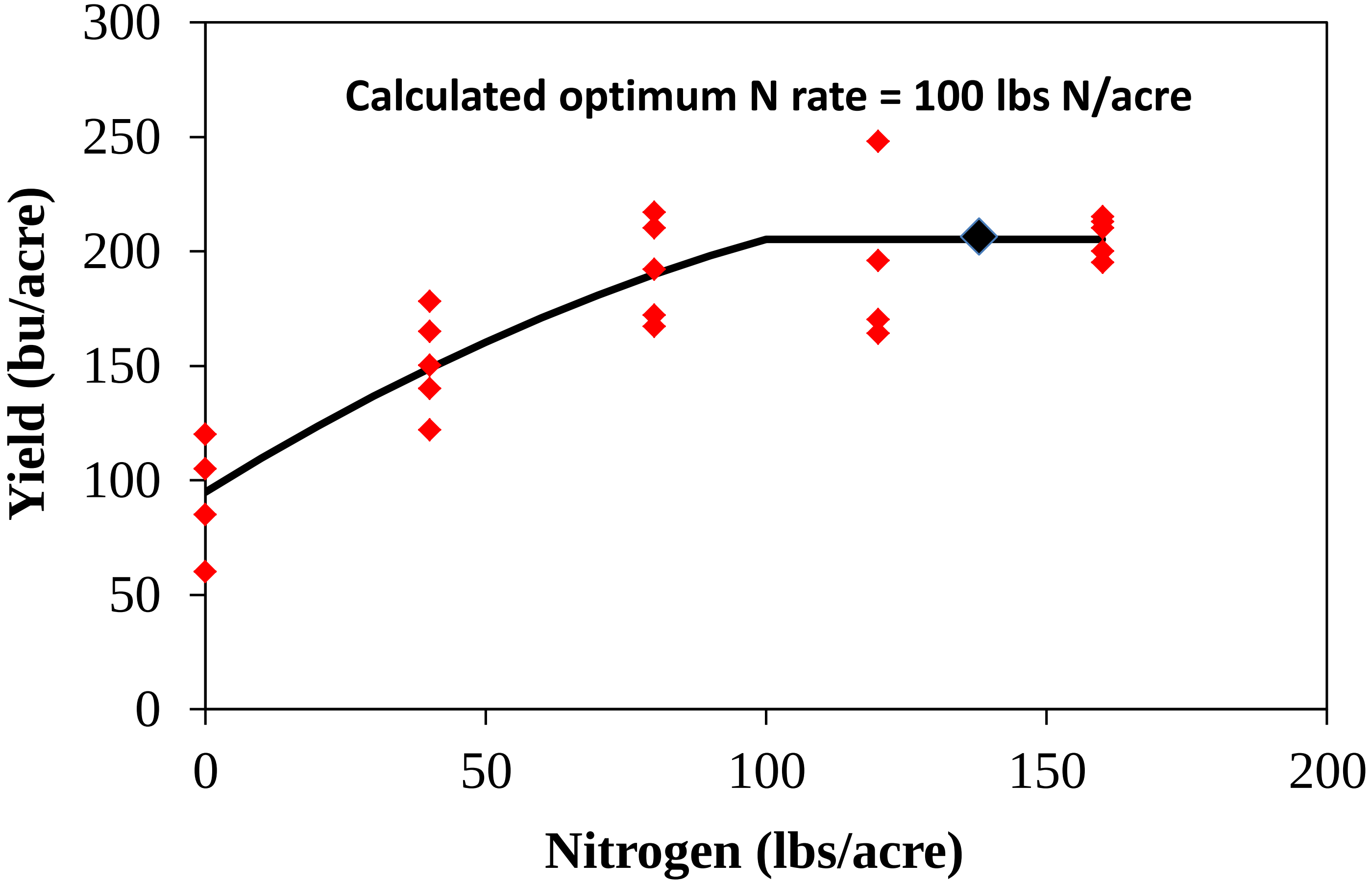
Corn Yield and N



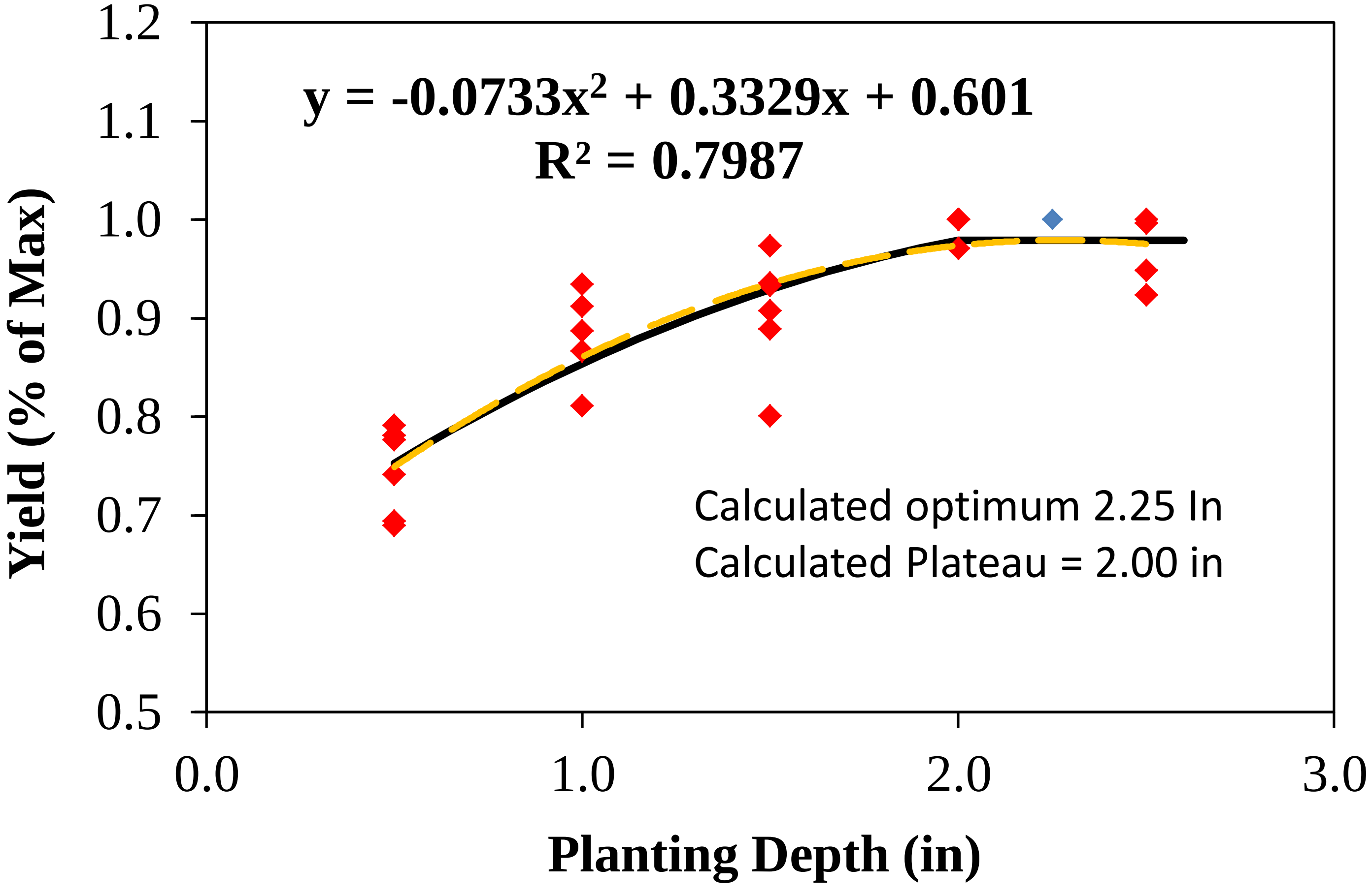
Corn Yield and N



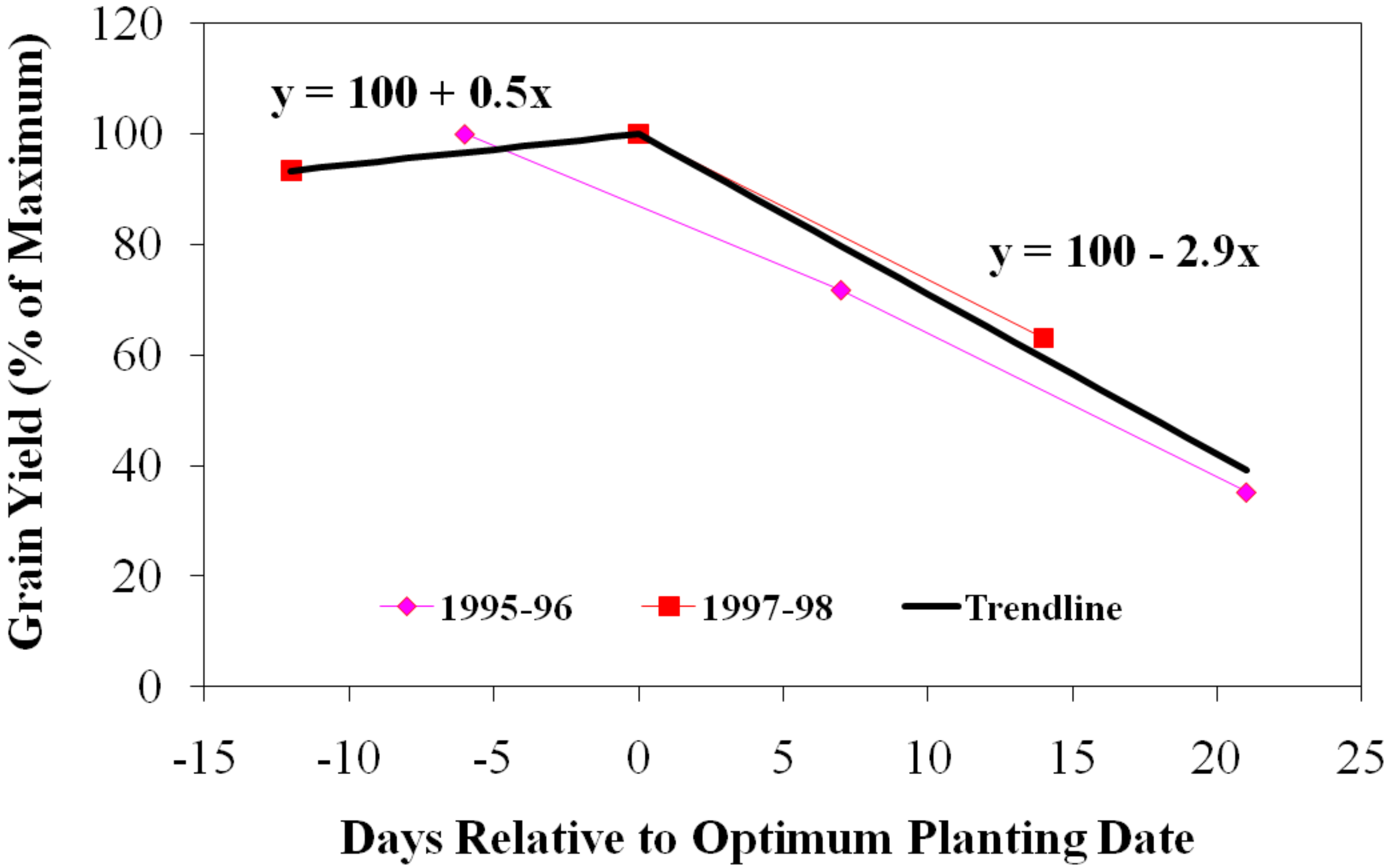
Corn Yield and N



Corn Planting Depth and Yield



Wheat - Date of Planting

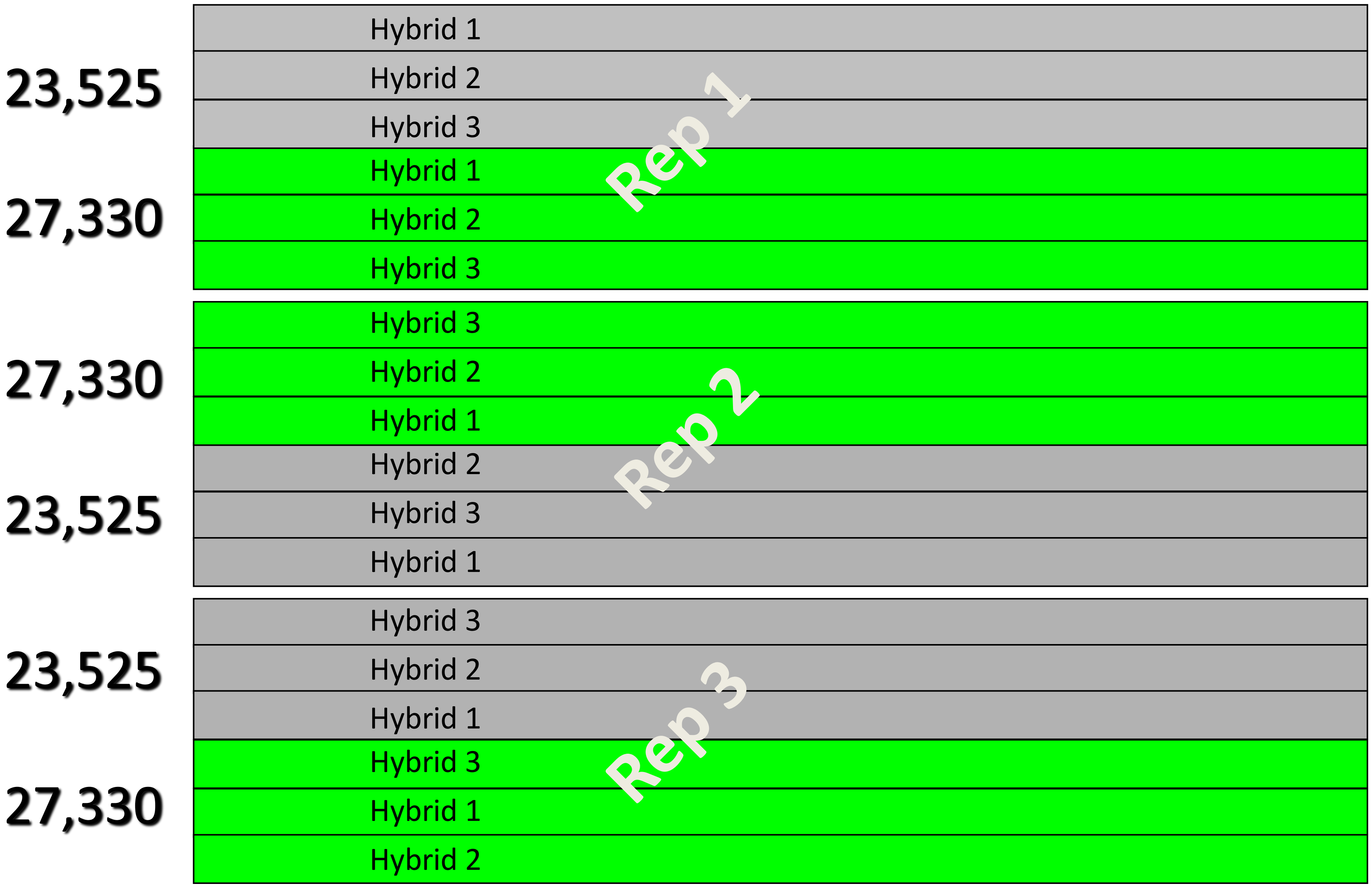


Data Sources

- Universities
  - Our job is to collect data, report it, AND give our opinion on what it means. Usually pretty conservative.
- Seed and Chemical Companies
  - Pioneer, Monsanto, and Syngenta (to name a few) have or are adding Crop Management personnel to collect production data. Ask for it.
- Collect your own…it is not difficult

Variable Rate Technology

Guidance Bars = Replication



Important Points

- Replication
  - Necessary for analysis and required to have confidence in results.
  - Often does not require a great deal of extra time if planned correctly.

- Yield Monitors and Yields
  - Use yield monitor to replace weigh wagon (measure grain mass).
  - Measure plot width and length manually.
  - Calculate yields and adjust for moisture as you normally would.
  - Do not use yield monitor calculated yields!! Errors could exist in plot length calculations by yield monitor because of incomplete header width and GPS error.

Summary

- Statistics are a tool that help you make informed decisions.
  - You must decide on the “risk” you are willing to take
- The key is to make sure that you are using real data to make decisions. “Plant health” does not increase price or decrease costs.
  - If you cannot measure it, you cannot manage it”
- Analysis of Variance or Mean Separations work for treatments that have yes/no decisions
  - treated vs untreated; Hyb A vs Hyb B

Summary

- Regression or trend analysis is what you want to evaluate rate or response data
  - yield response to fertilizer or to plant population.
- Get as much data on a subject as you can prior to making a decision.
  - Informed vs uninformed decisions
- Do not be afraid to use statistics and if needed, ask for help. There are a lot of people who can help you

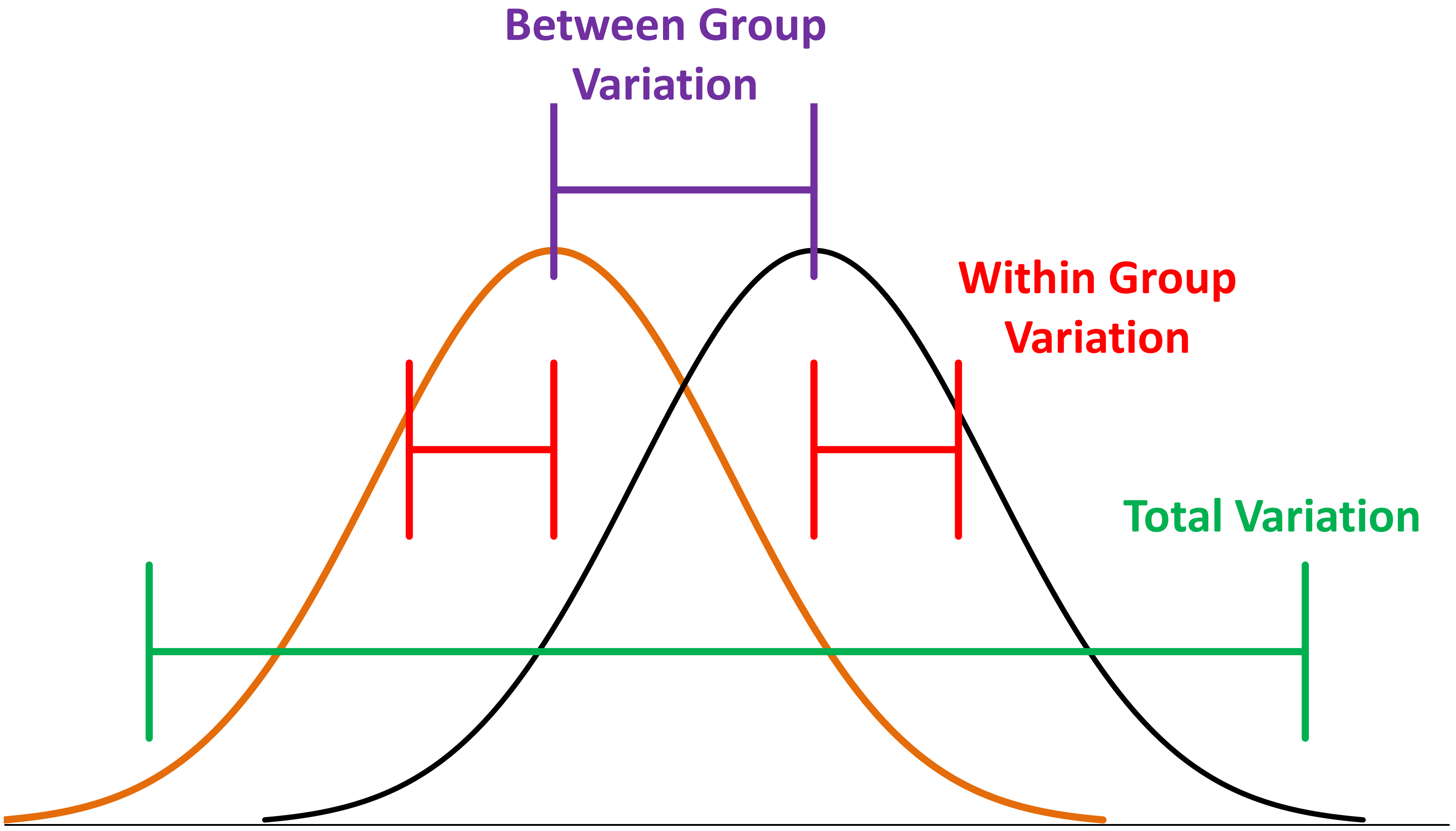
Mean Comparisons

Analysis of Variance

Replication	Hyb A	Hyb B	Hyb A	Hyb B
1	159	158	155	145
2	161	155	160	150
3	159	156	162	160
4	165	153	168	169
Average	161	156	161	156
St. Dev	2.8	2.1	5.4	10.7

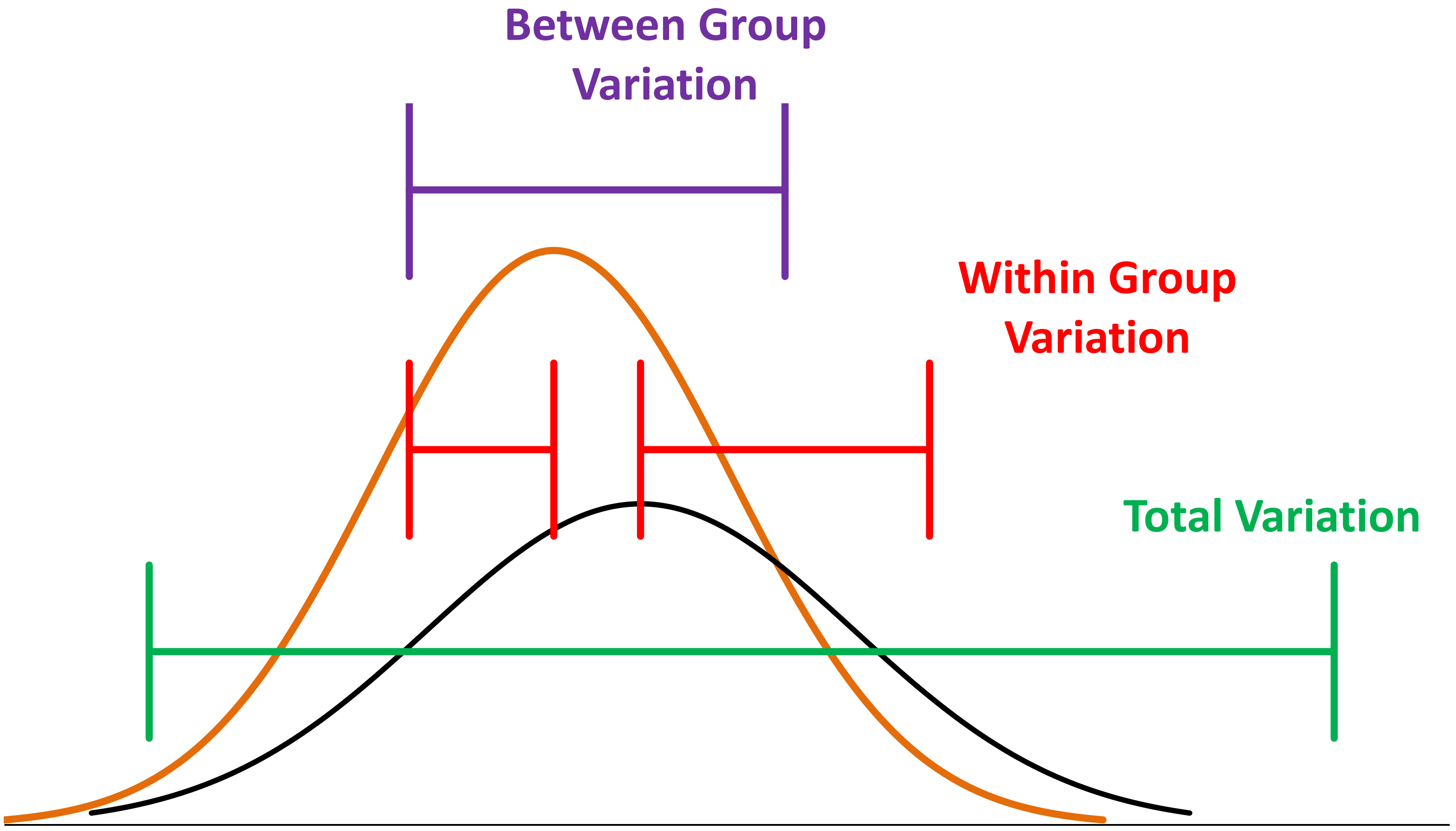
Source of Variation	Prob > F	Prob > F
Rep	0.97	0.11
Hybrid	0.04	0.21

Analysis of Variance



Analysis of Variance

"But it is 6 bu/a different"



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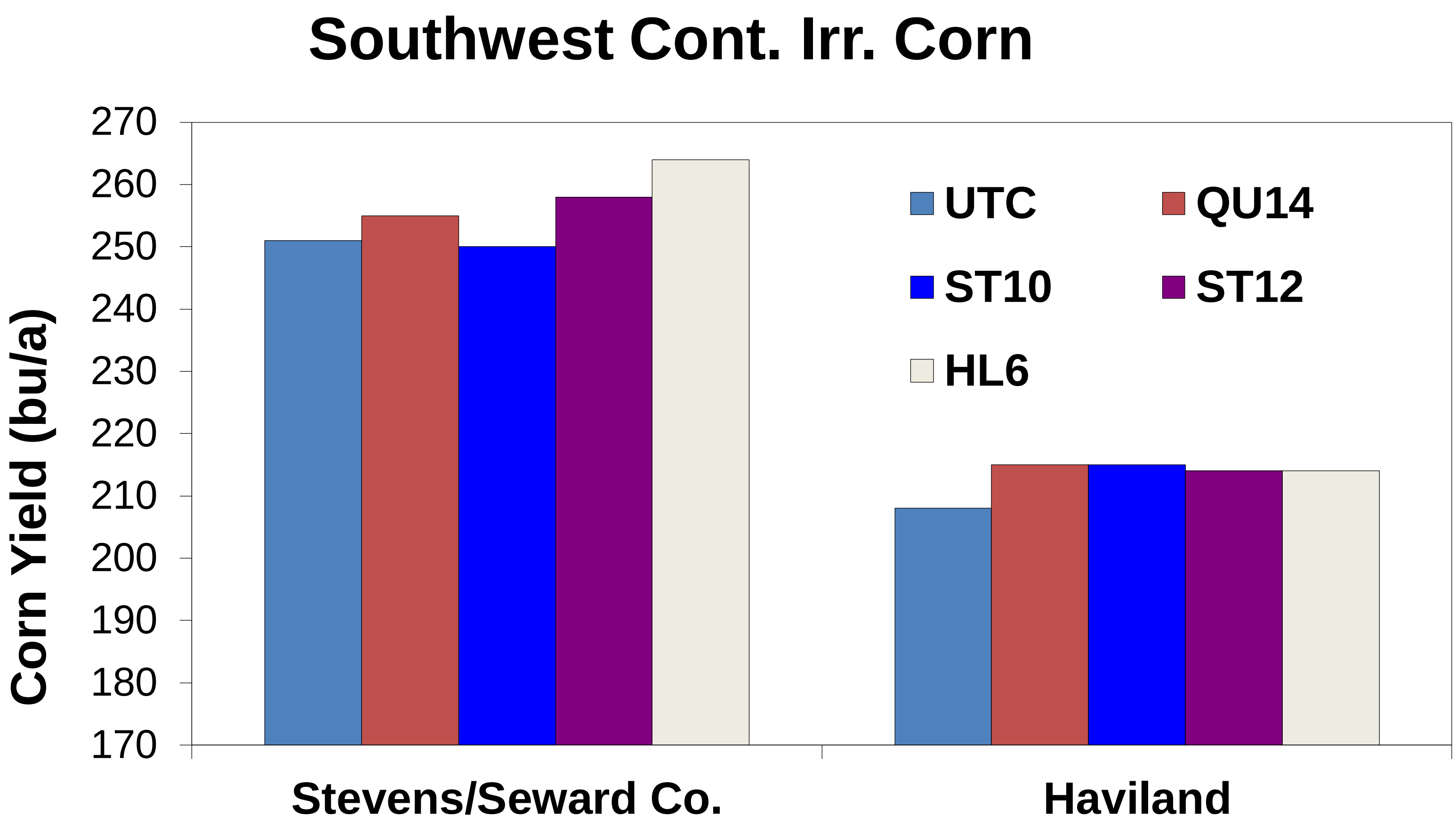

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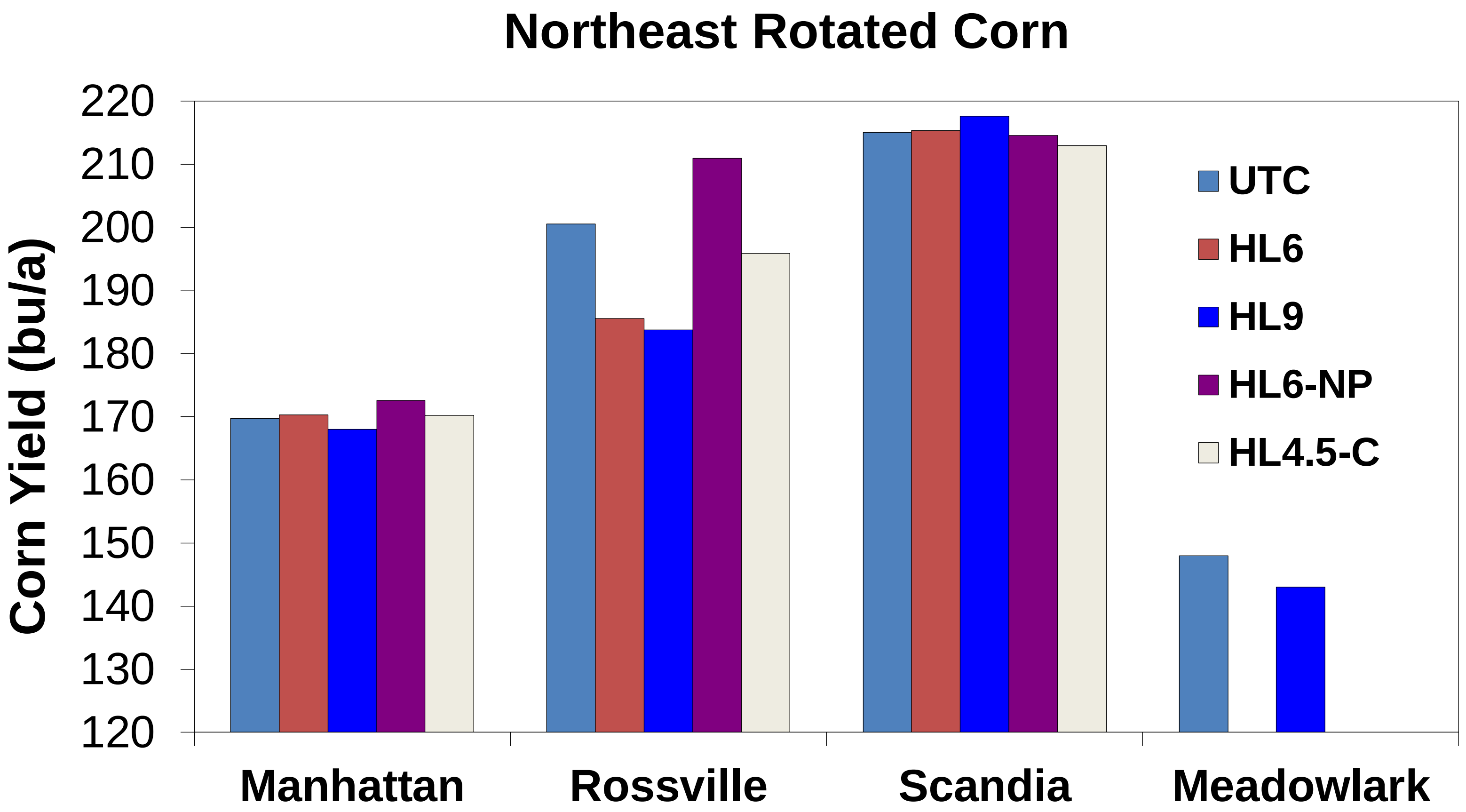

Soybean Fungicides

Manhattan 2006-2008 (multiple varieties)