With-in Row Plant Spacing in Corn

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Background

- Recent interest in the grain yield response of corn to plant spacing variability.
  - ✓ Planter “tuning” services offered
- Pioneer agronomists estimate yield losses of between 5 and 10 bushels/A in corn stands with non-uniform spacing.
- Some advertisements in popular press claim up to 20% yield increases with properly tuned planters.

Objective

- To determine the relationship between corn yield response and plant spacing variability.

Previous Research on Corn Grain Yield Response to Plant Spacing Variation

- Iowa: Non significant up to 6 inches standard deviation
  - ✓ Erbach et al. (1972)
- Illinois: Non significant
  - ✓ Johnson and Mulvaney (1980)
  - ✓ Dungan et al., (1958): hills
- Indiana: Non significant and Significant (web)
  - ✓ Nielsen (1997)
  - ✓ Nielsen (web): Grain yield decreases 2.5 bu/A for each inch standard deviation > 2 inches
- Ontario: Non significant
  - ✓ Daynard et al. (1983, 1981, 1979)
- Kansas: Significant
  - ✓ Krall et al. (1977): 3.4 bu/A decrease for each inch increase standard deviation
  - ✓ Vanderlip et al (1988): grain yield decreased when standard deviation values were greater than 2.4 inches
- Nebraska: Non significant in hills
  - ✓ Kiesselbach and Weihing (1933)

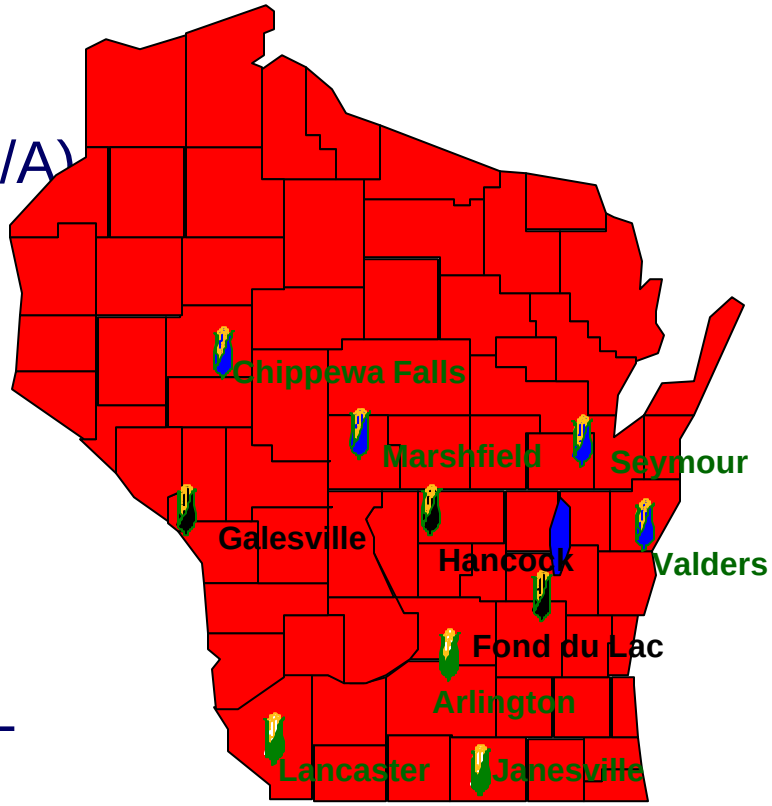
Stand Characteristics of WI Corn Fields Evaluated for Stand Uniformity (n= 127)

	Average	Minimum - Maximum
Standard deviation (inches)	3.3	1.9 – 6.8
Doubles per 50 ft. (≤2”)	5.4	0.1 – 25.9
Gaps per 50 ft. (≥12”)	7.0	1.0 – 16.9
Average spacing (inches)	7.2	4.7 – 14.8
Planting rate (plants/A)	30,553	21,000 – 42,000
Actual plant density (plants/A)	29,727	21,916 – 44,605
Stand as % planted	97	78 - 121

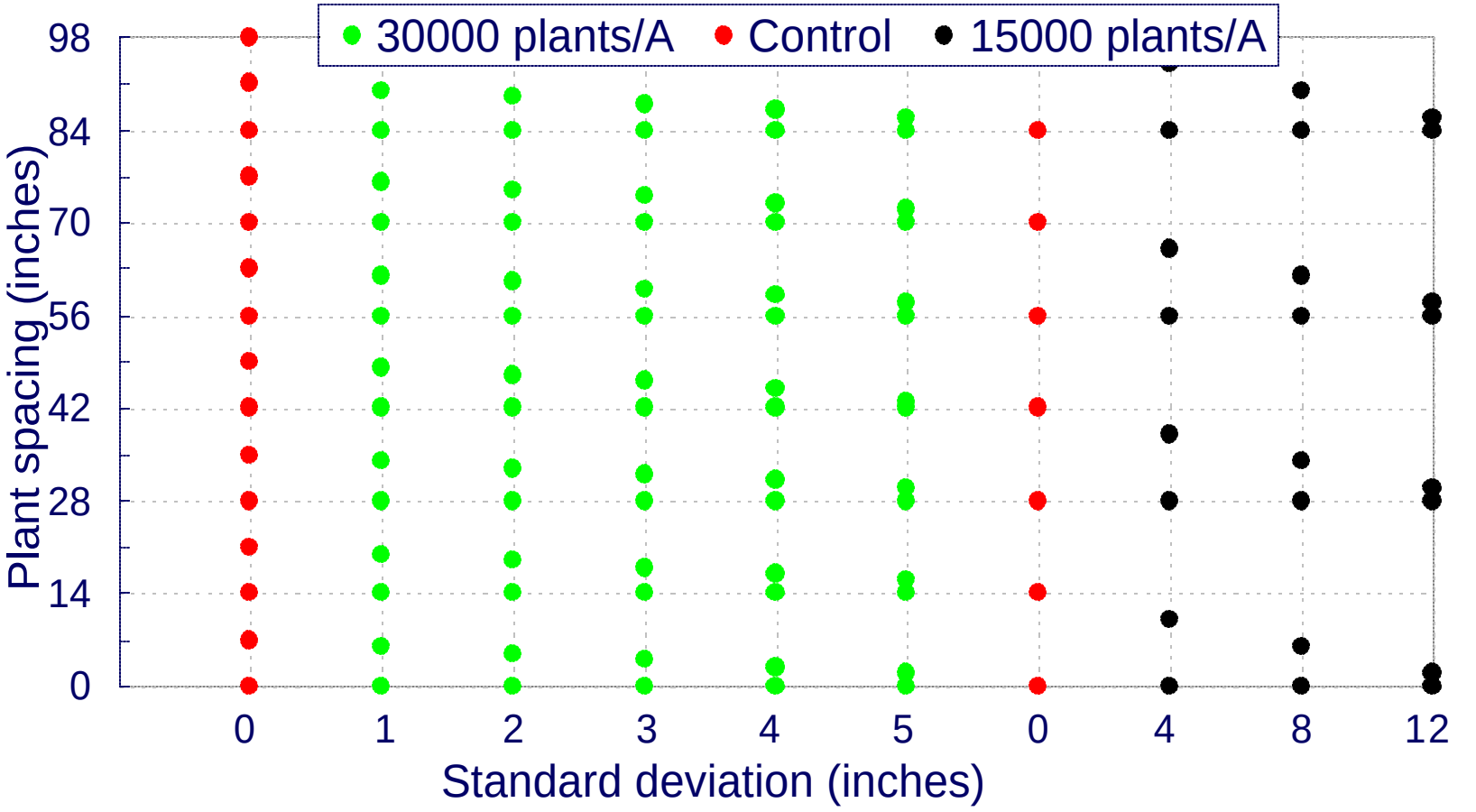
Rankin, 2000

Corn Plant Spacing Variability 1999-2001 Materials and Methods

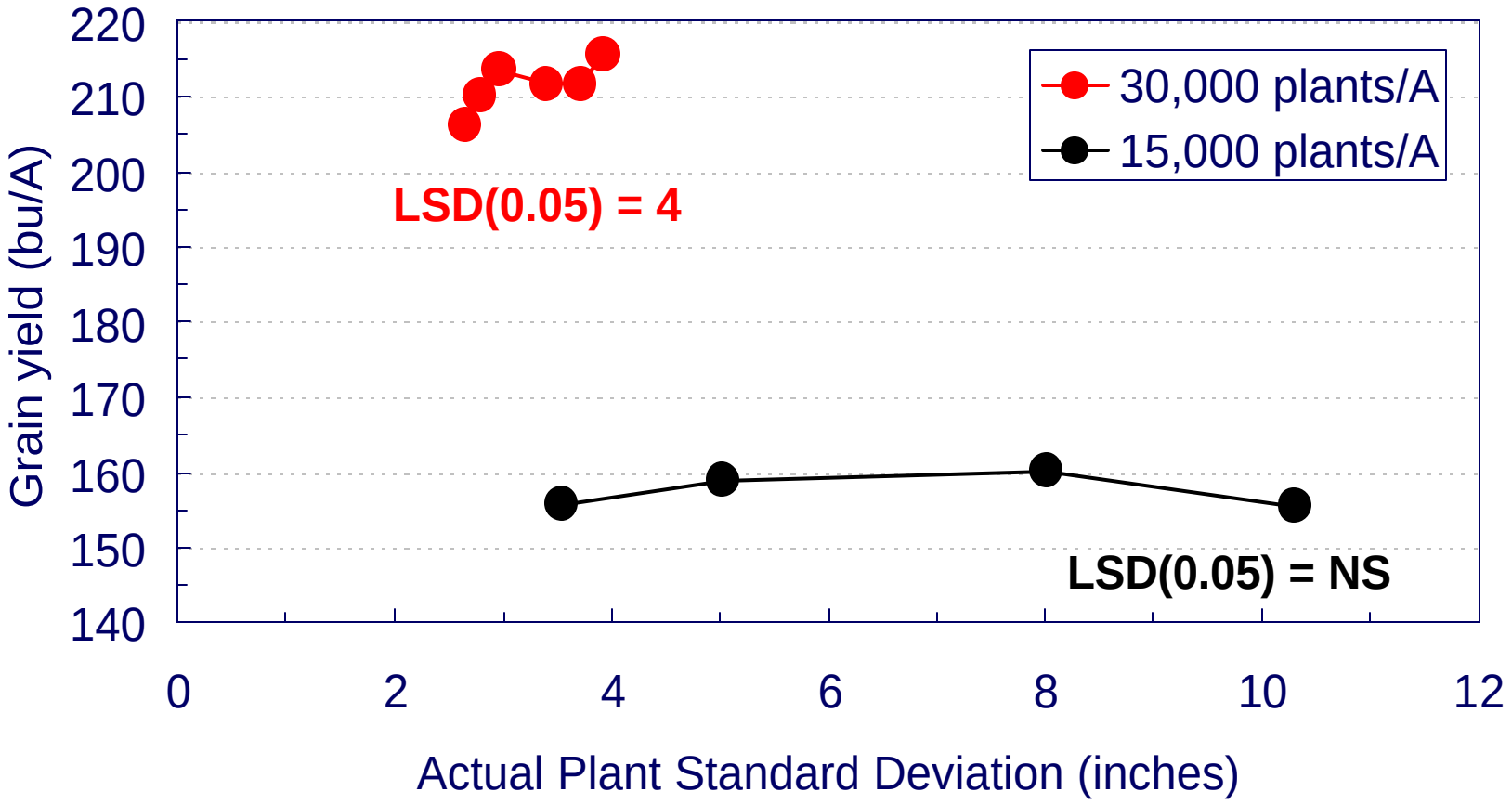
- Target plant population
  - ✓ 7 inches (30,000 plants/A)
  - ✓ 1999: 14 inches (15,000 plants/A)
- Target standard deviation
  - ✓ 0 to 12 inches
- Hybrid
  - ✓ P35R57: ARL, JAN, LAN
  - ✓ C4111: FON, GAL, HAN
  - ✓ N3030Bt: CHI, MAR, SEY, VAL



Plant Spacing Variability Treatments 1999 (2-Plant Pattern)



Corn yield response to plant spacing variability treatments during 1999. Values are averaged across all locations.



Significance of corn plant spacing variability treatments during 1999

30,000 plants/A Location	Plant density	Plant standard deviation	Grain yield	Grain moisture	Lodging	Grain test weight
Arlington	NS	**	NS	NS	NS	NS
Janesville	NS	**	NS	NS	NS	NS
Lancaster	†	†	NS	NS	NS	NS
Fond du Lac	NS	*	*	NS	NS	NS
Galesville	NS	*	NS	*	NS	NS
Hancock	NS	*	NS	NS	NS	NS
Chippewa Falls	NS	**	NS	NS	NS	NS
Marshfield	NS	*	NS	NS	NS	NS
Seymour	*	**	NS	NS	NS	NS
Valders	NS	**	NS	NS	NS	NS

**, *, and † indicates significance at $P \leq 0.01$, 0.05 and 0.10, respectively

Significance of corn plant spacing variability treatments during 1999

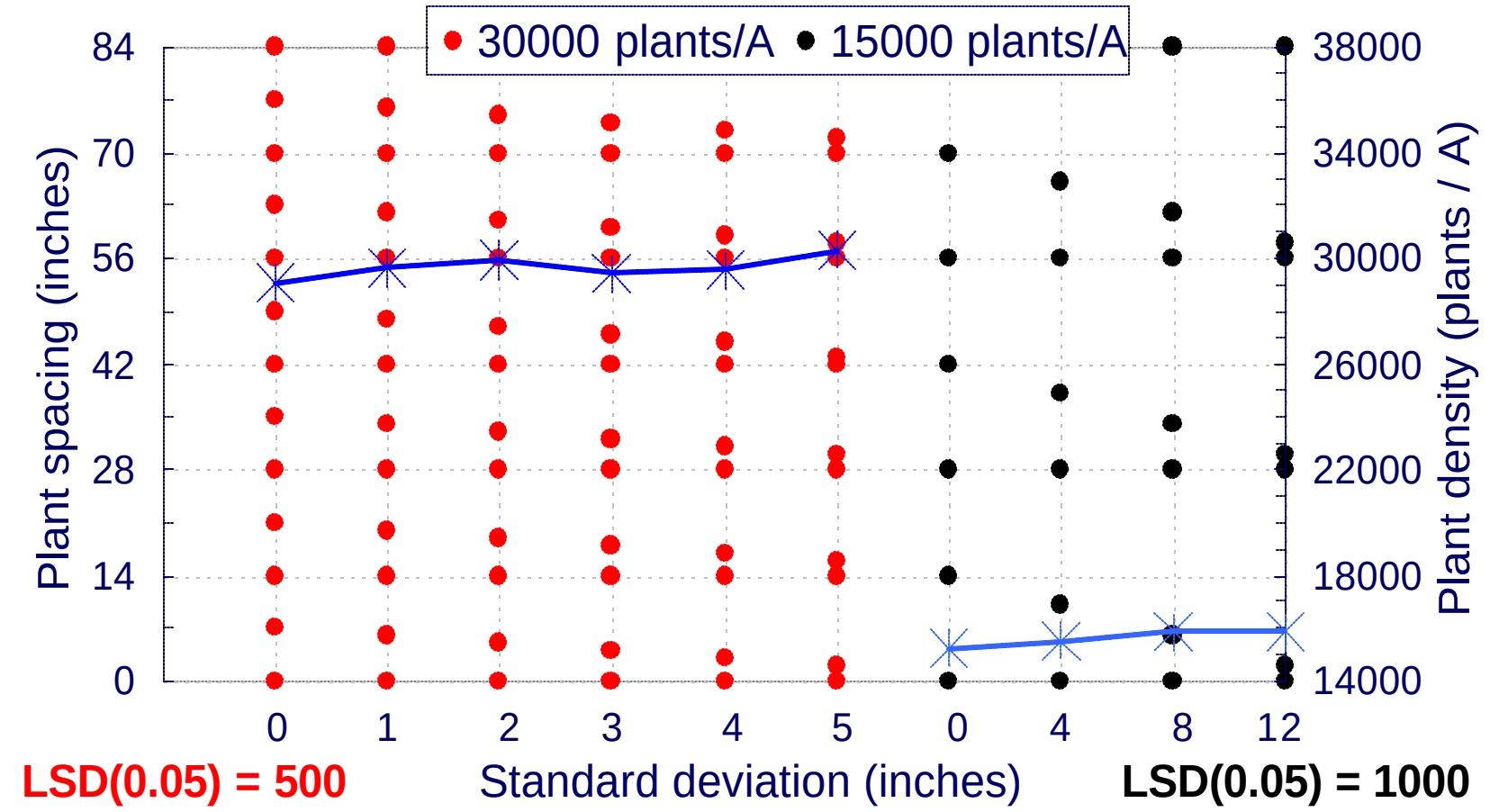
15,000 plants/A Location	Plant density	Plant standard deviation	Grain yield	Grain moisture	Lodging	Grain test weight
Arlington	*	**	NS	NS	NS	NS
Janesville	NS	**	NS	NS	NS	NS
Lancaster	**	**	NS	NS	NS	NS
Fond du Lac	NS	**	NS	NS	†	NS
Galesville	NS	**	†	NS	NS	NS
Hancock	NS	**	NS	NS	NS	NS
Chippewa Falls	NS	**	NS	NS	NS	NS
Marshfield	NS	**	NS	NS	NS	†
Seymour	†	**	*	NS	NS	NS
Valders	†	**	NS	NS	NS	NS

**, *, and † indicates significance at $P \leq 0.01$, 0.05 and 0.10, respectively

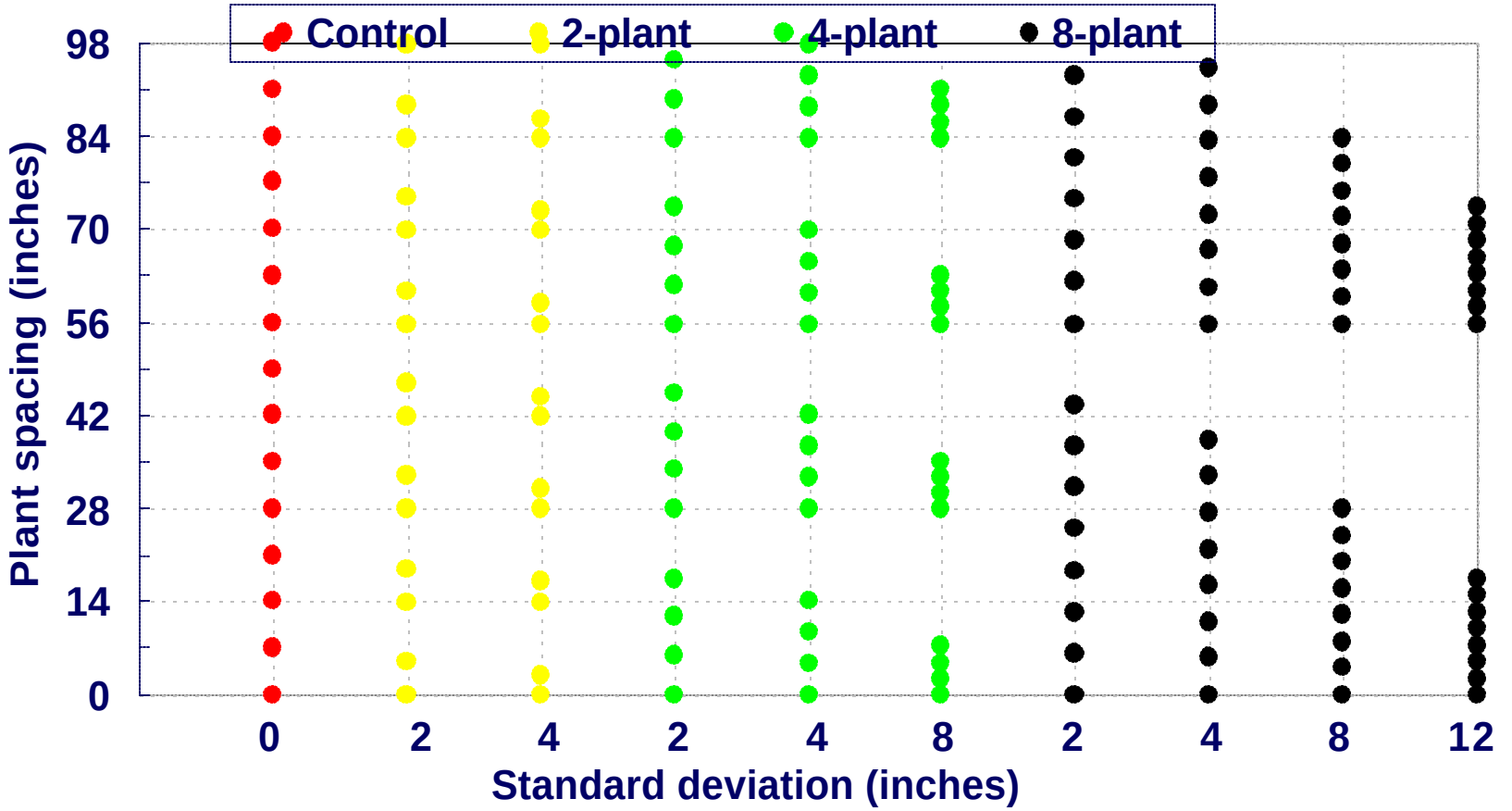
Expected corn yield changes (%) for various plant densities in Wisconsin

Plants / Acre	Northern	Southern
36,000	100	99
34,000	99	100
32,000	98	100
30,000	97	100
28,000	95	99
26,000	93	97
24,000	91	95
22,000	89	92
20,000	86	89

Corn harvest plant density of spacing variability treatments during 1999. Values are averaged across all locations.



Plant Spacing Variability Treatments 2000-2001
Plant Population = 30,000 Plants/A

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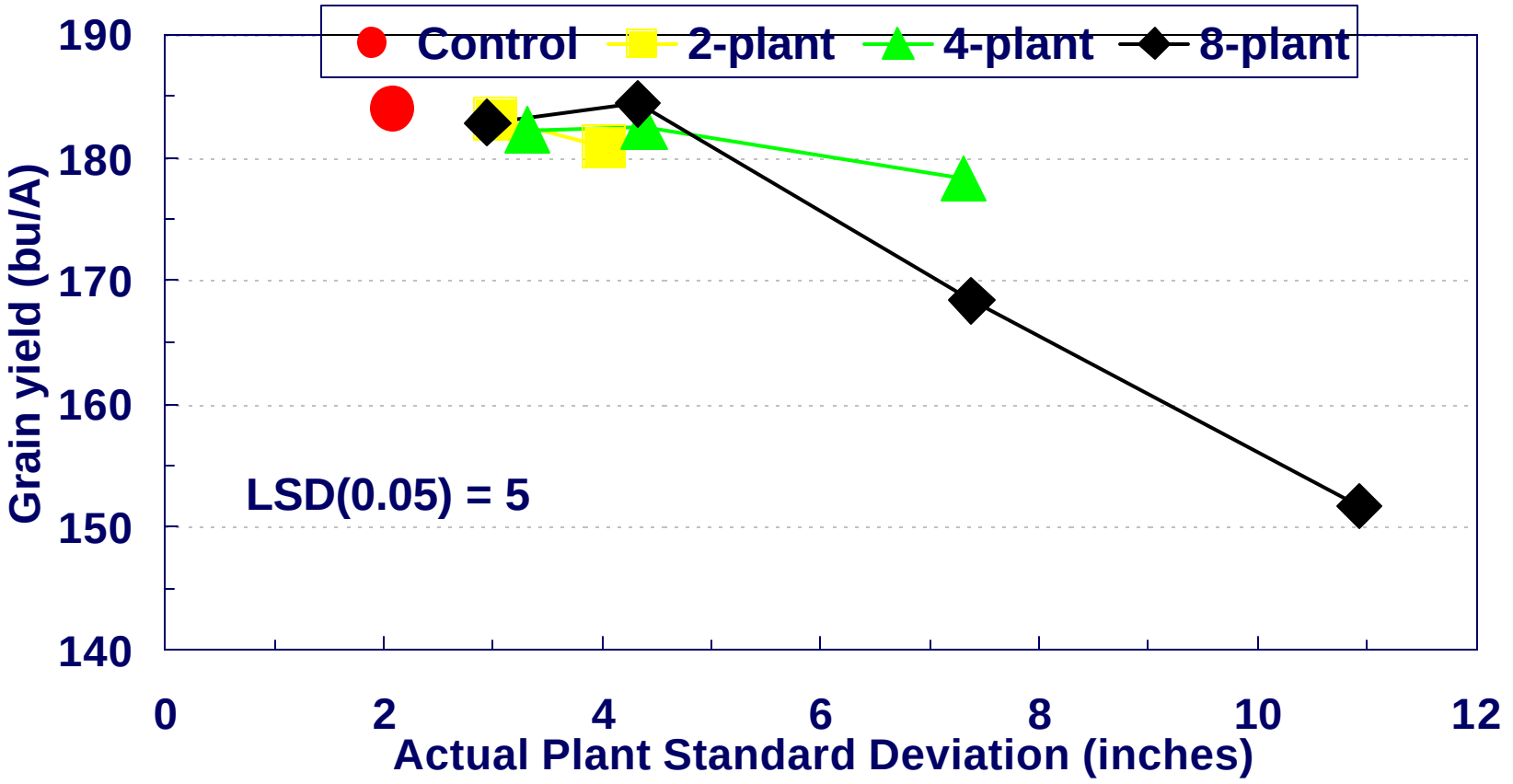
Corn yield response to plant spacing variation during 2000 and 2001. Values averaged across all locations.



Significance of corn plant spacing variability treatments during 2000

30,000 plants/A Location	Plant density	Plant standard deviation	Grain yield	Grain moisture	Lodging	Grain test weight
Arlington	**	**	**	NS	†	NS
Janesville	**	**	NS	NS	NS	NS
Lancaster	†	**	†	NS	NS	NS
Fond du Lac	†	**	*	NS	NS	NS
Galesville	NS	**	**	NS	NS	NS
Hancock	†	**	**	NS	NS	†
Chippewa Falls	†	**	NS	NS	†	NS
Marshfield	**	**	**	NS	NS	NS
Seymour	NS	**	**	NS	NS	NS
Valders	NS	*	**	NS	NS	NS

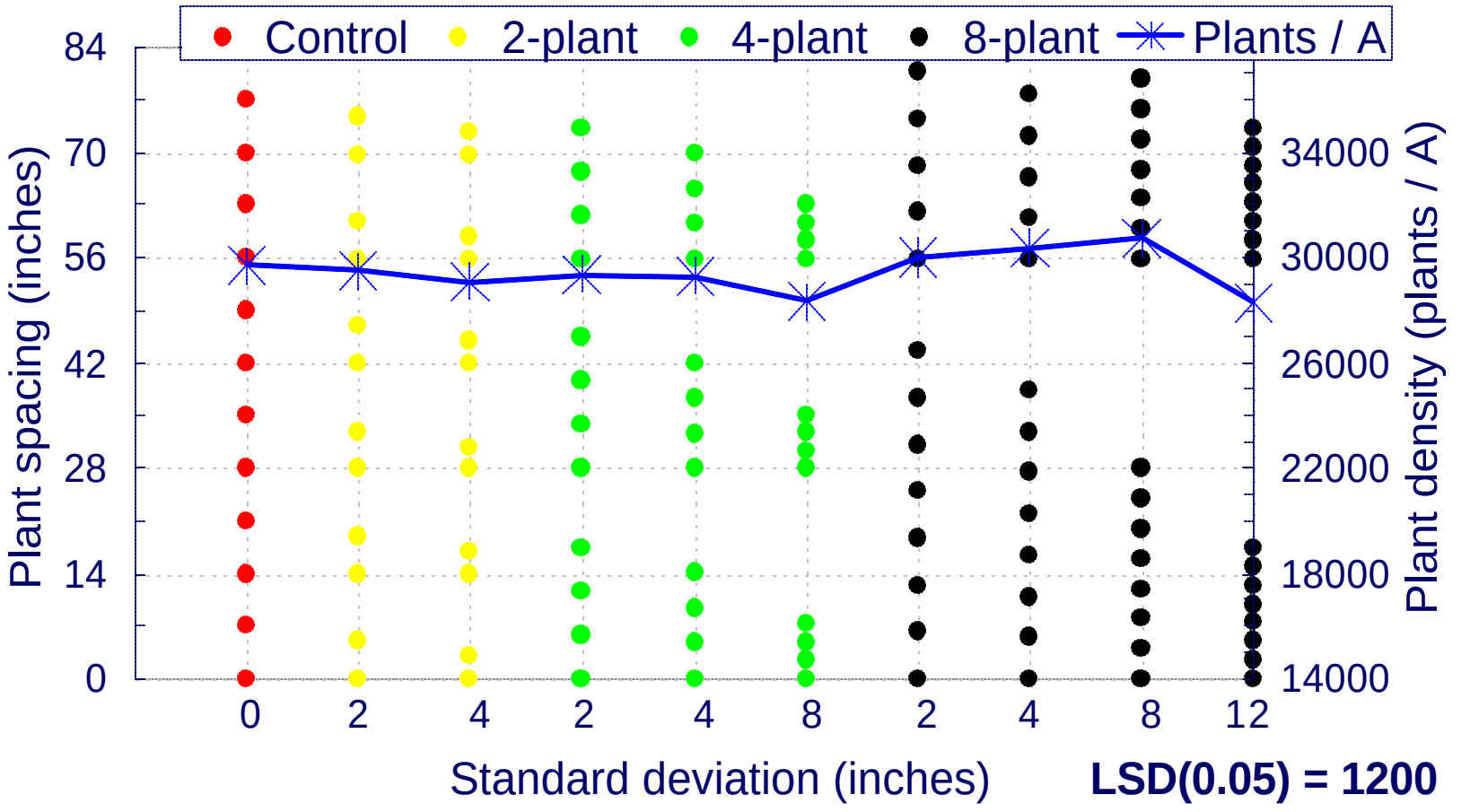
**, *, and † indicates significance at $P \leq 0.01$, 0.05 and 0.10, respectively

Significance of corn plant spacing variability treatments during 2001

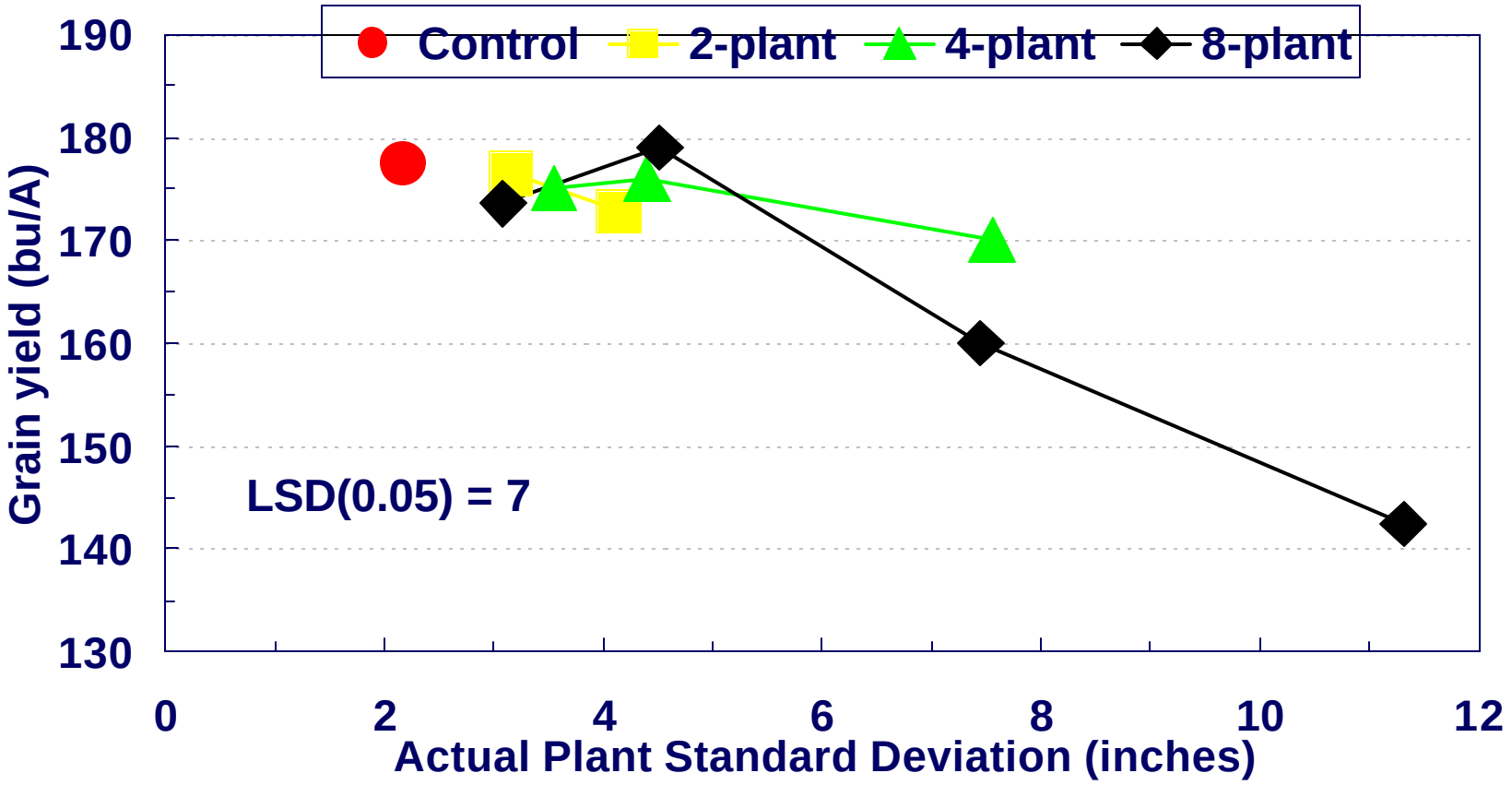
30,000 plants/A Location	Plant density	Plant standard deviation	Grain yield	Grain moisture	Lodging	Grain test weight
Arlington	**	**	NS	NS	NS	NS
Janesville	**	**	**	NS	NS	NS
Fond du Lac	*	**	†	NS	NS	NS
Galesville	**	**	**	NS	NS	†

**, *, and † indicates significance at $P \leq 0.01$, 0.05 and 0.10, respectively

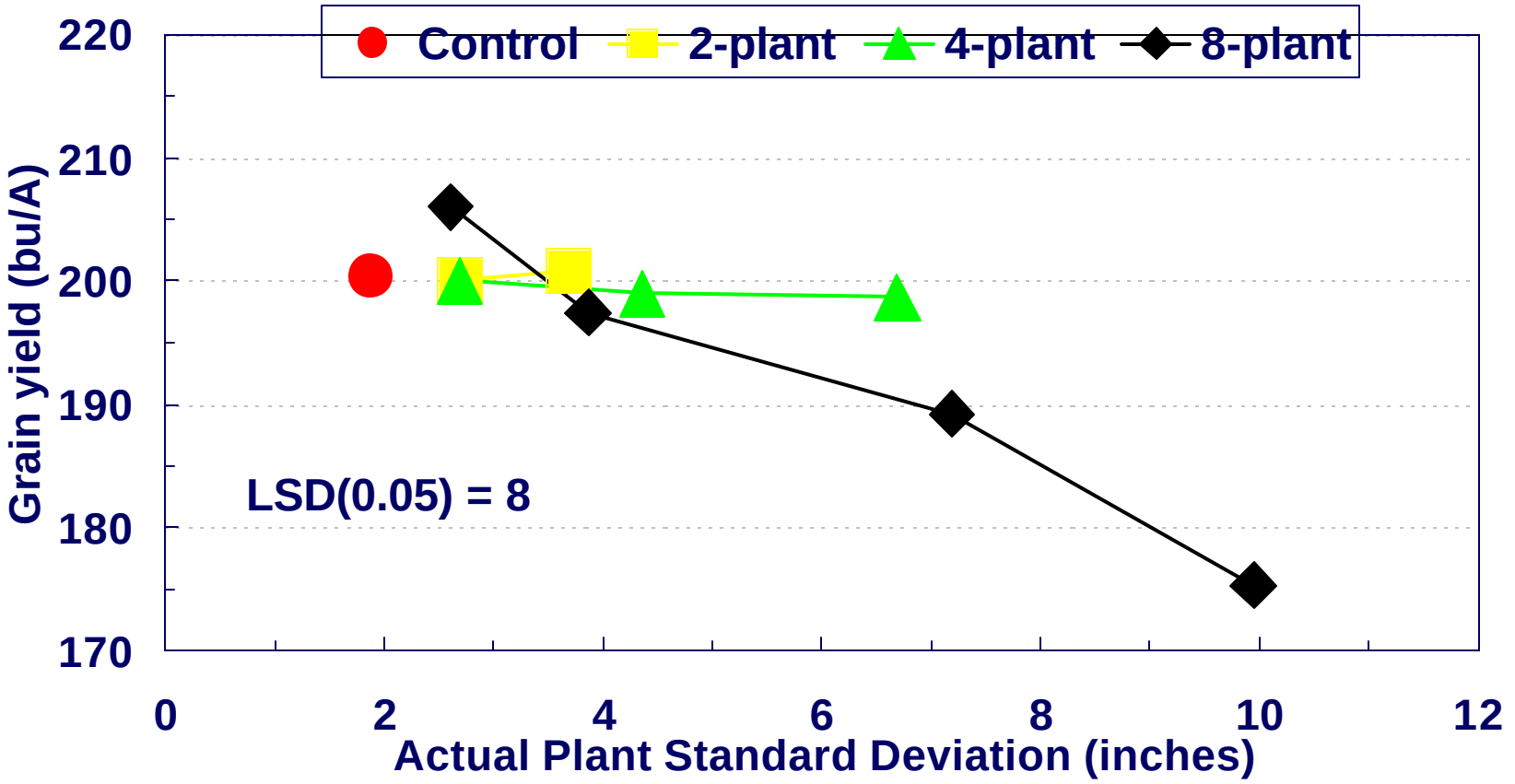
Corn harvest plant density of spacing variability treatments during 2000. Values are averaged across all locations.



Corn yield response to plant spacing variation during 2000. Values averaged across all locations.



Corn yield response to plant spacing variation during 2001. Values averaged across all locations.



Summary

- Grain yield decreased in 4- and 8-plant patterns where standard deviation of plant spacing treatments was greater than 5 to 7 inches.
  - ✓ Possibly due to competition and/or a population decrease (plant death)
- In most agronomic situations, plant spacing variation has no effect on grain yield or other agronomic measures as long as population is not affected.
  - ✓ Do planters need to be tuned?
  - ✓ Other types of plant variability?

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OLD SLIDES

Theoretical and Experimental Evaluation of With-in Row Plant Spacing in Corn

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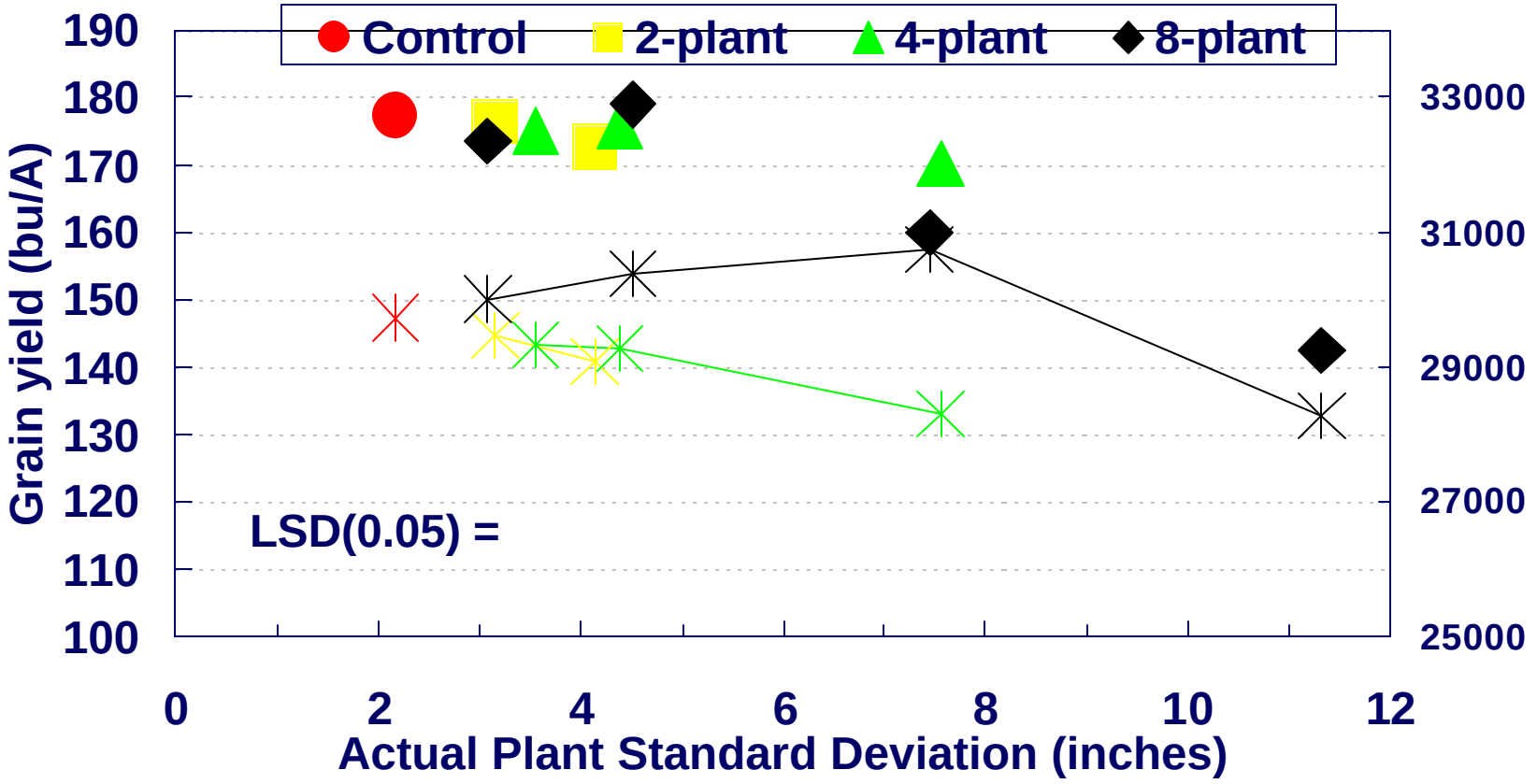
Corn Yield Response to Plant Spacing Variation during 2000. Values averaged across all locations.



Stand Characteristics of 87 WI Corn Fields Evaluated for Stand Uniformity

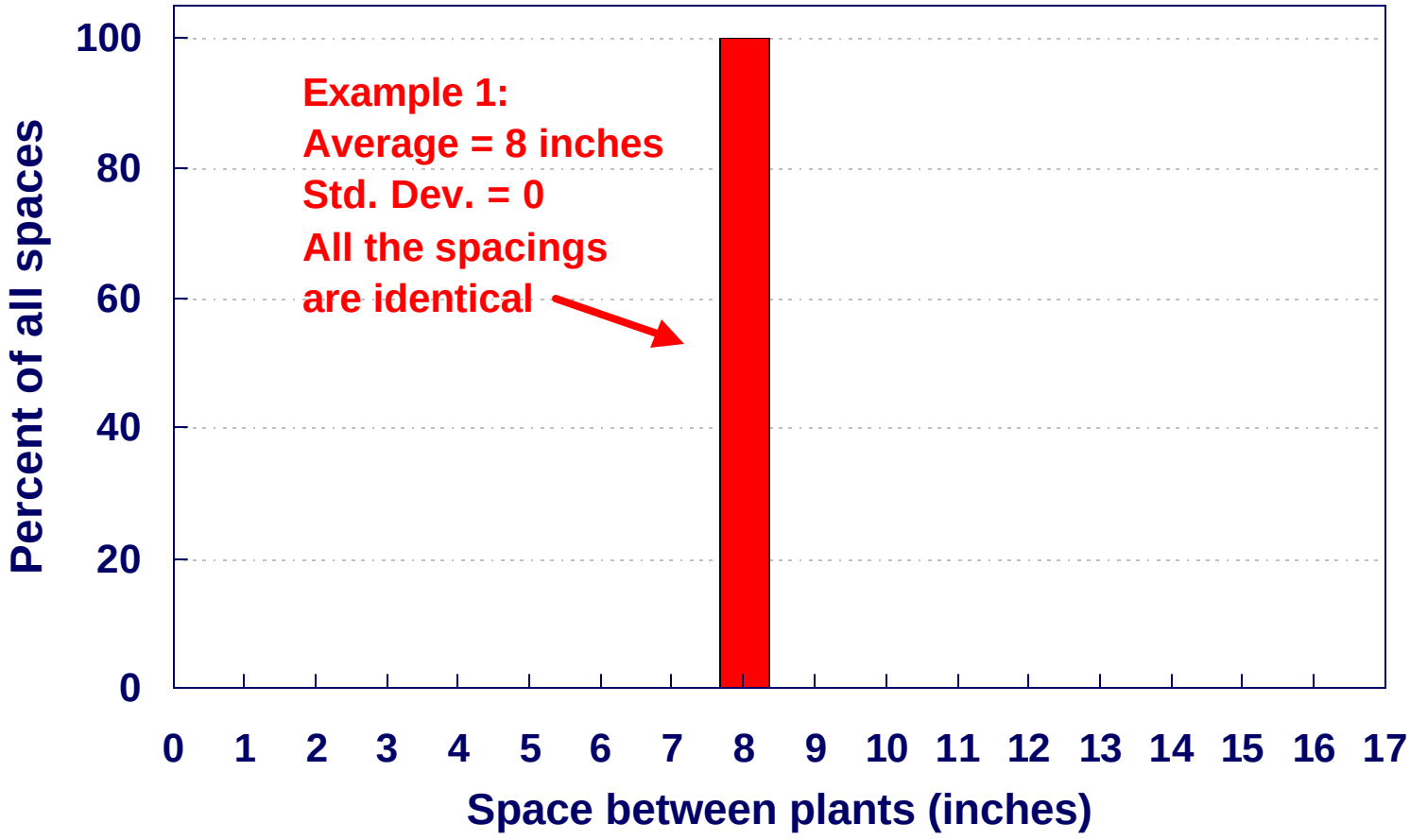
	All-farm Average	All-farm Range
Standard Deviation	3.3	1.9 – 5.9
Doubles per 50 ft.	5.1	0.1 – 25.9
Gaps per 50 ft.	7.3	1.0 – 16.9
Average Spacing	7.2	5.4 – 10.1
Planting Rate	30,311	21,000 – 35,600
Actual Plant Density	29,377	22,264 – 35,501
Stand as % Planted	97.1%	77.8% - 113.5%

Rankin and Lauer, 2000

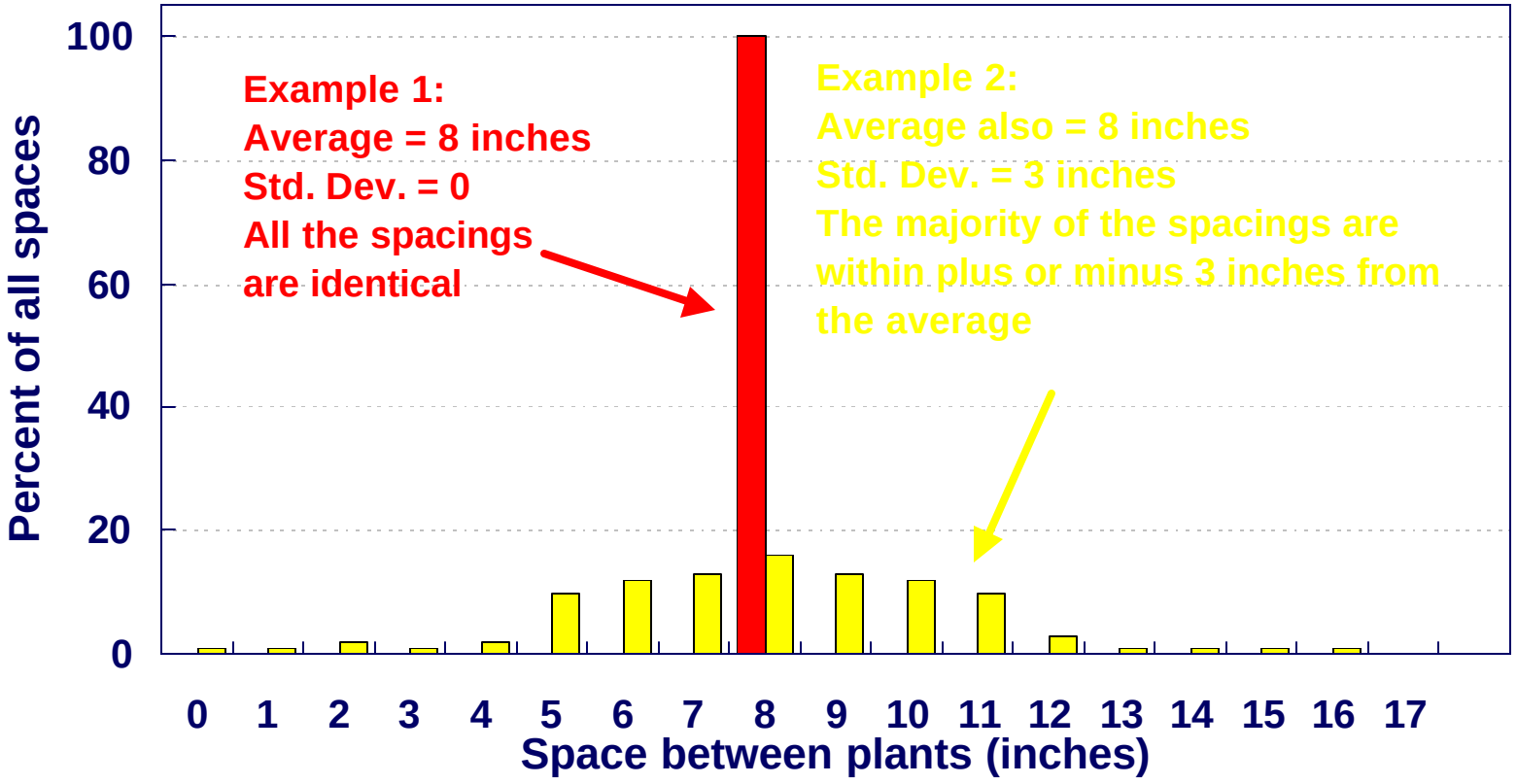
What is Spacing Variation in Corn?

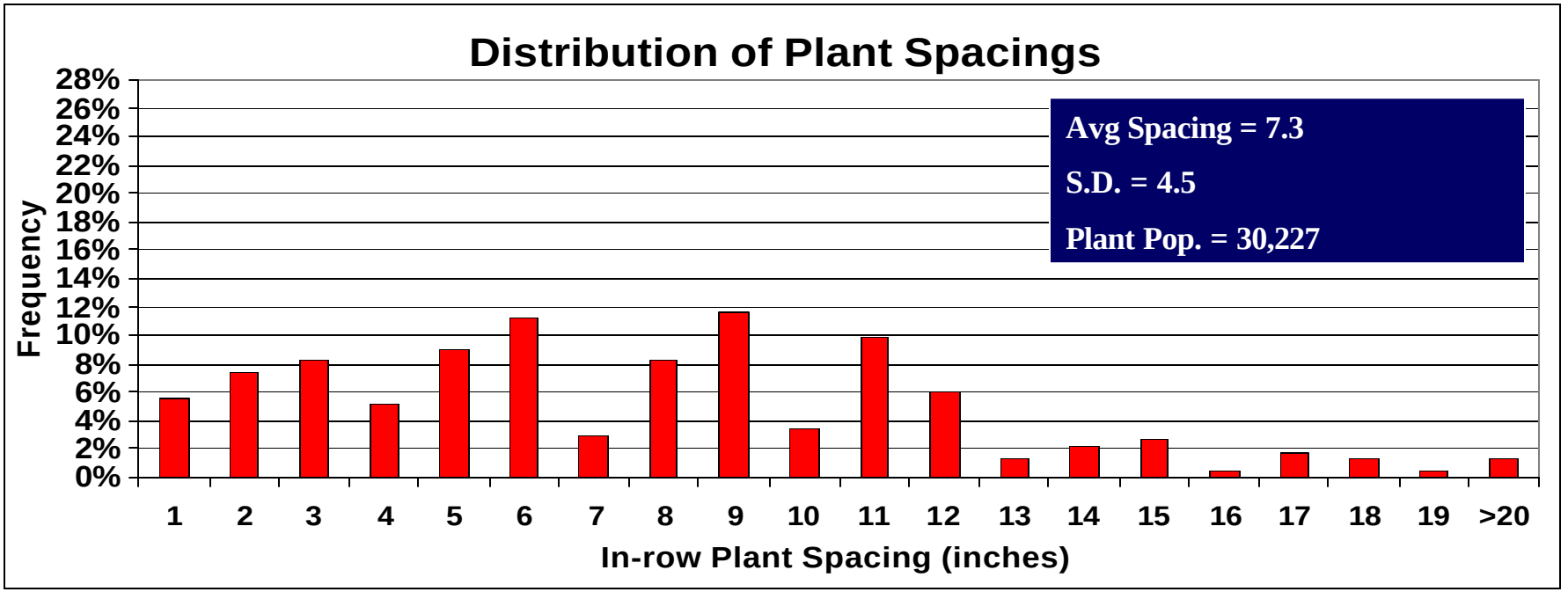
- Spacing variation at the same population
  - ✓ Difficult to establish and repeat
- Spacing variation from reduced population
  - ✓ Less seeded than originally thought.
  - ✓ Typically observed in commercial production fields
- Temporal variation
  - ✓ Due to speed, crusting, “thickening-up” stands, dry soils, etc.
  - ✓ May be most important

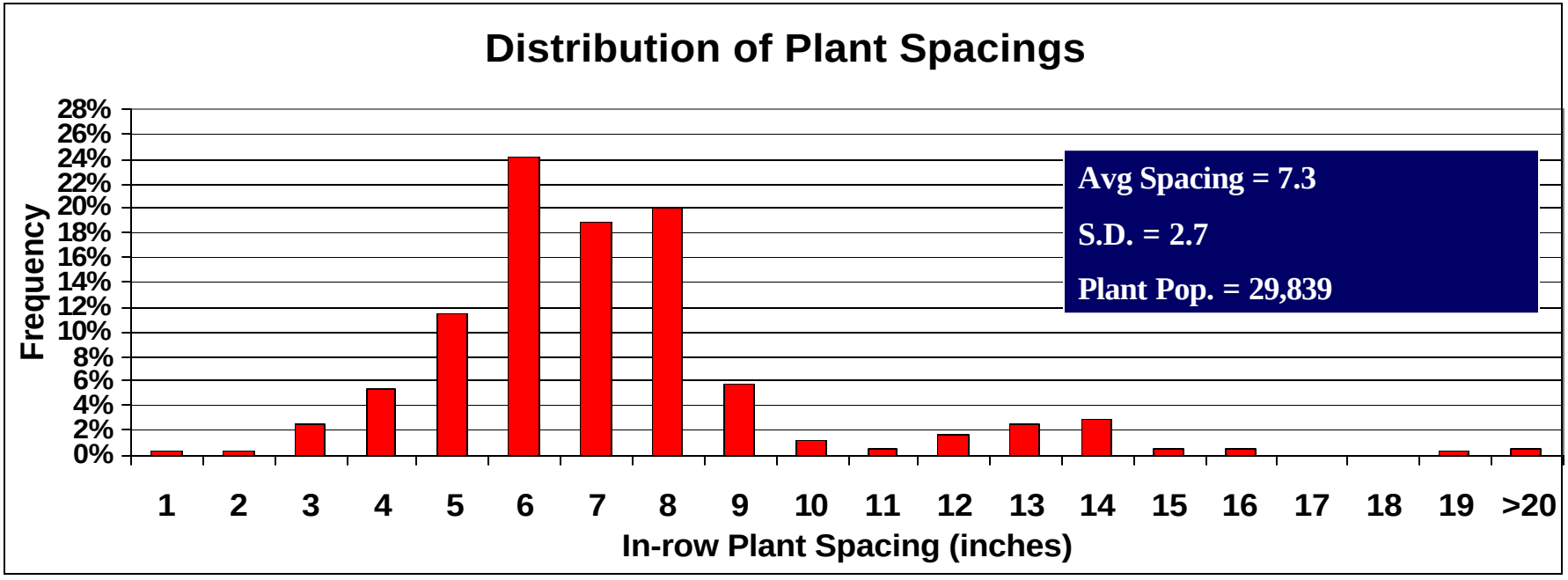
An Illustration of Variability



An Illustration of Variability




Distribution of Plant Spacings
Frequency
28%
26%
24%
22%
20%
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
Avg Spacing = 7.3
S.D. = 4.5
Plant Pop. = 30,227
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
>20
In-row Plant Spacing (inches)


Distribution of Plant Spacings
Frequency
28%
26%
24%
22%
20%
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
Avg Spacing = 7.3
S.D. = 2.7
Plant Pop. = 29,839
1
2
3
4
5
6
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16
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>20
In-row Plant Spacing (inches)

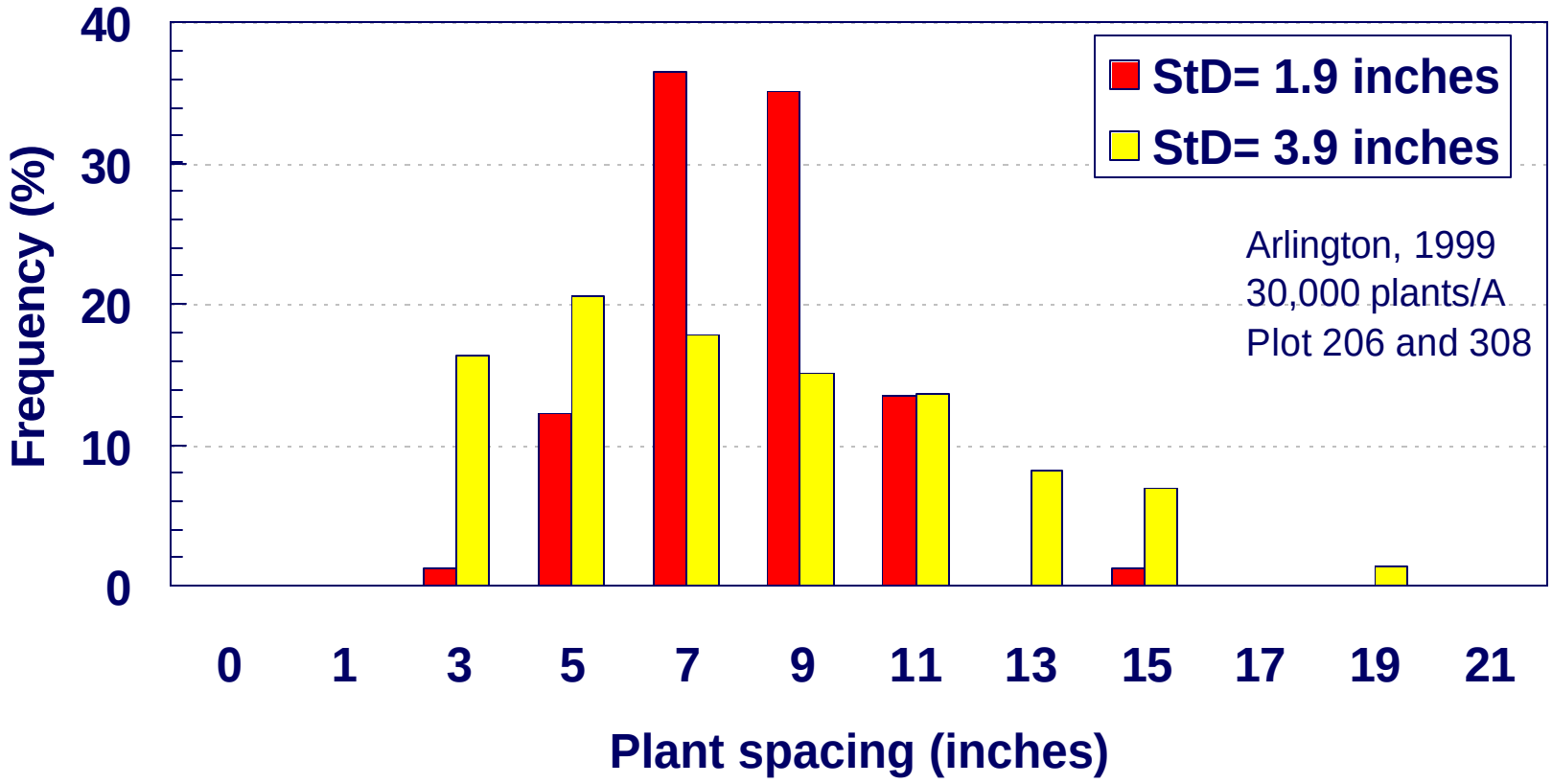
Objective

- To measure the response of corn to plant spacing variation at different populations.

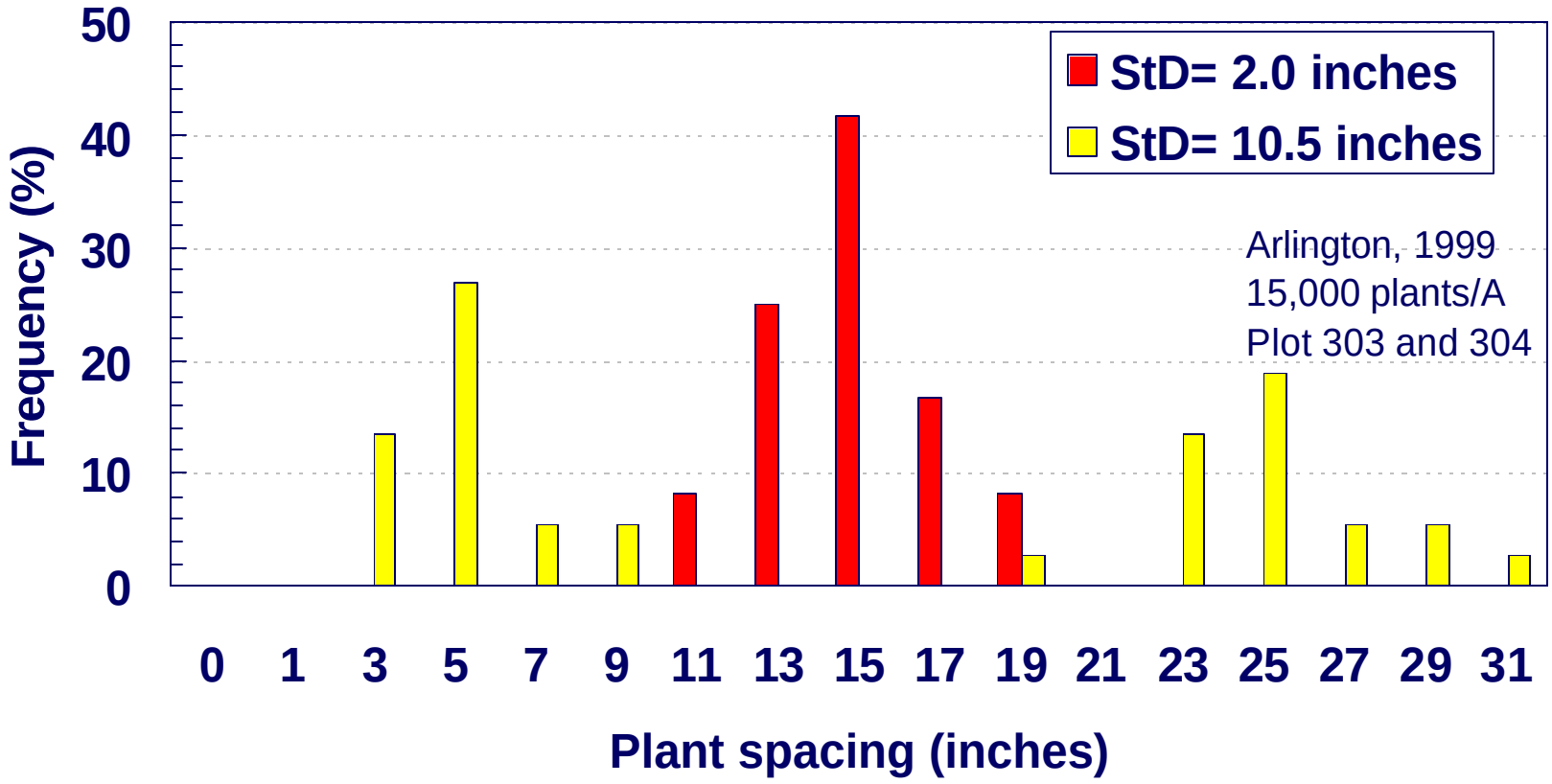
Corn Plant Spacing Variation
Materials and Methods - Experiment II

- RCB, 4 reps, Arlington, Cargill 4111
- Target plant populations
  - ✓10,000; 20,000; 30,000 and 40,000 plants/A
- Target plant spacing standard deviation
  - ✓0, 1, 2, and 3 inches

Corn Plant Spacing Histogram of Low and High Standard Deviation Plots



Corn Plant Spacing Histogram of Low and High Standard Deviation Plots



1999 Wisconsin Corn Performance Trials - Grain Summary

	1989-1998		1999		Percent
Location	*N*	Yield	*N*	Yield	Change
Arlington	1727	185	198	222	+ 20
Janesville	1727	177	198	222	+ 25
Lancaster	1727	170	198	192	+ 13
Fond du Lac	1525	159	159	207	+ 30
Galesville	1525	157	159	202	+ 29
Hancock	1524	178	159	202	+ 13
Chippewa Falls	1276	147	168	169	+ 15
Marshfield	990	137	168	179	+ 31
Seymour	922	144	69	171	+ 19
Valders	1400	145	168	199	+ 37
Ashland	129	129	16	157	+ 22
Spooner	1901	123	189	168	+ 37
White Lake	582	85	63	147	+ 73

Note: Seymour average includes New London 1989-1992.

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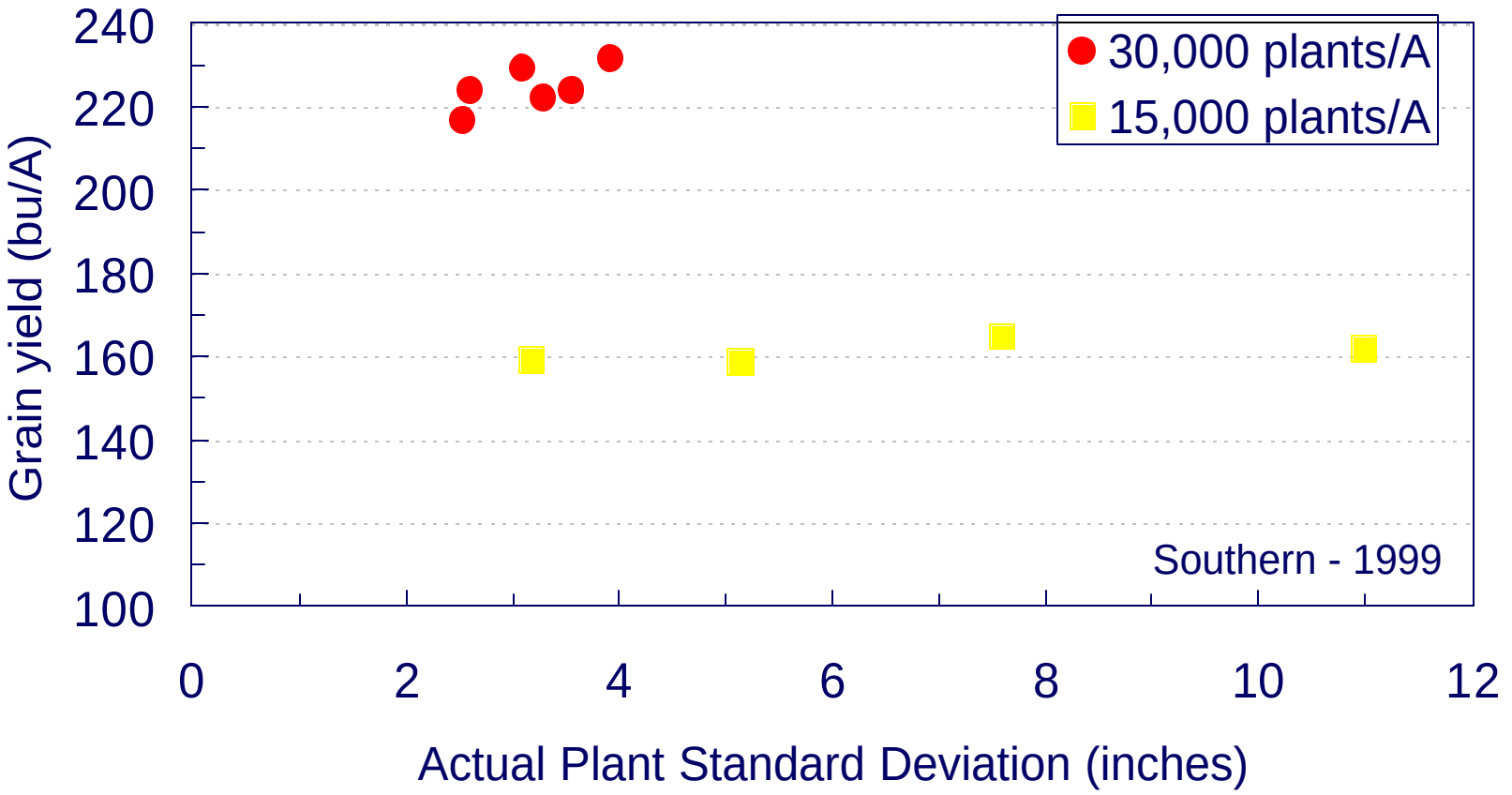
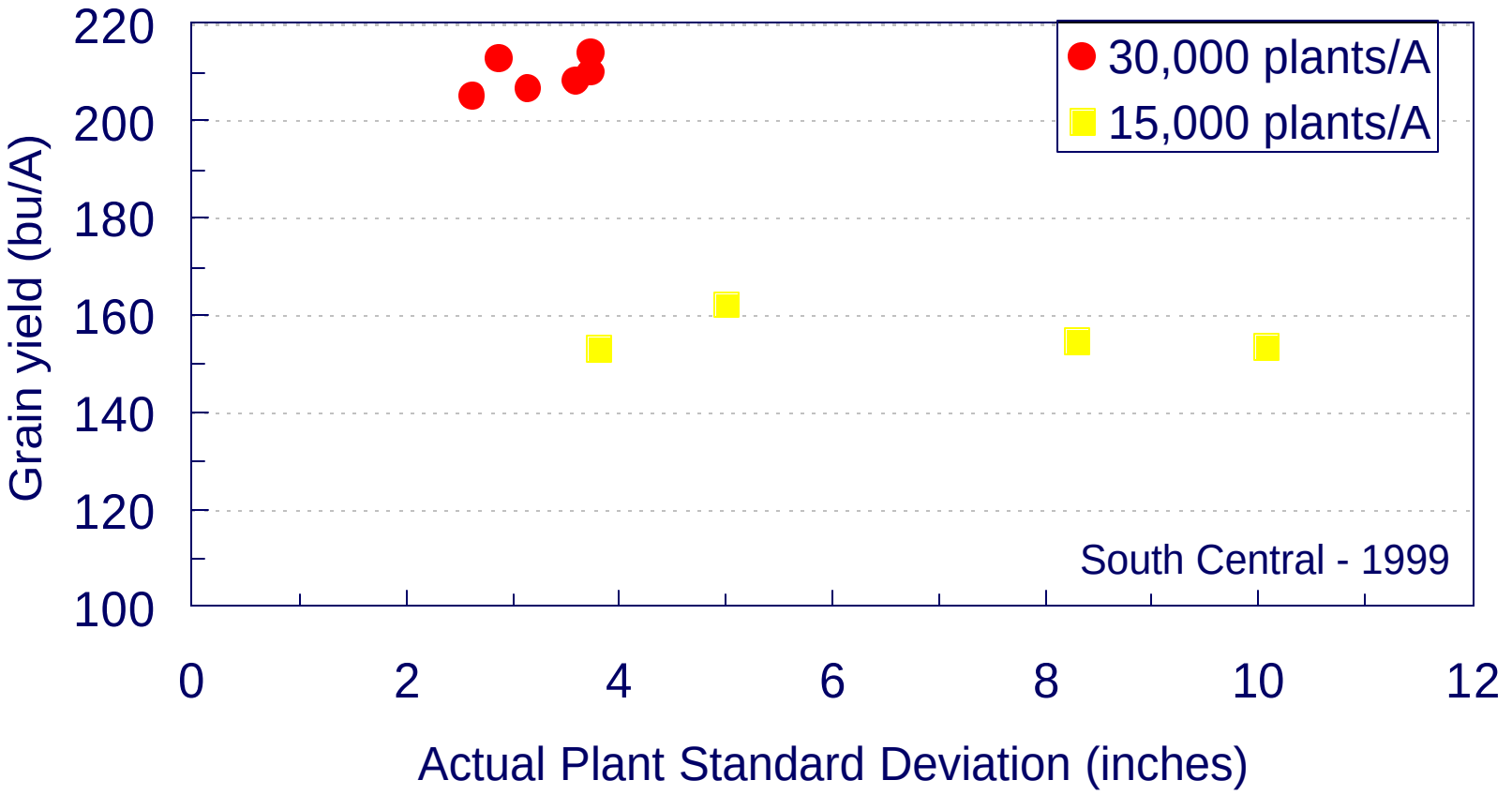
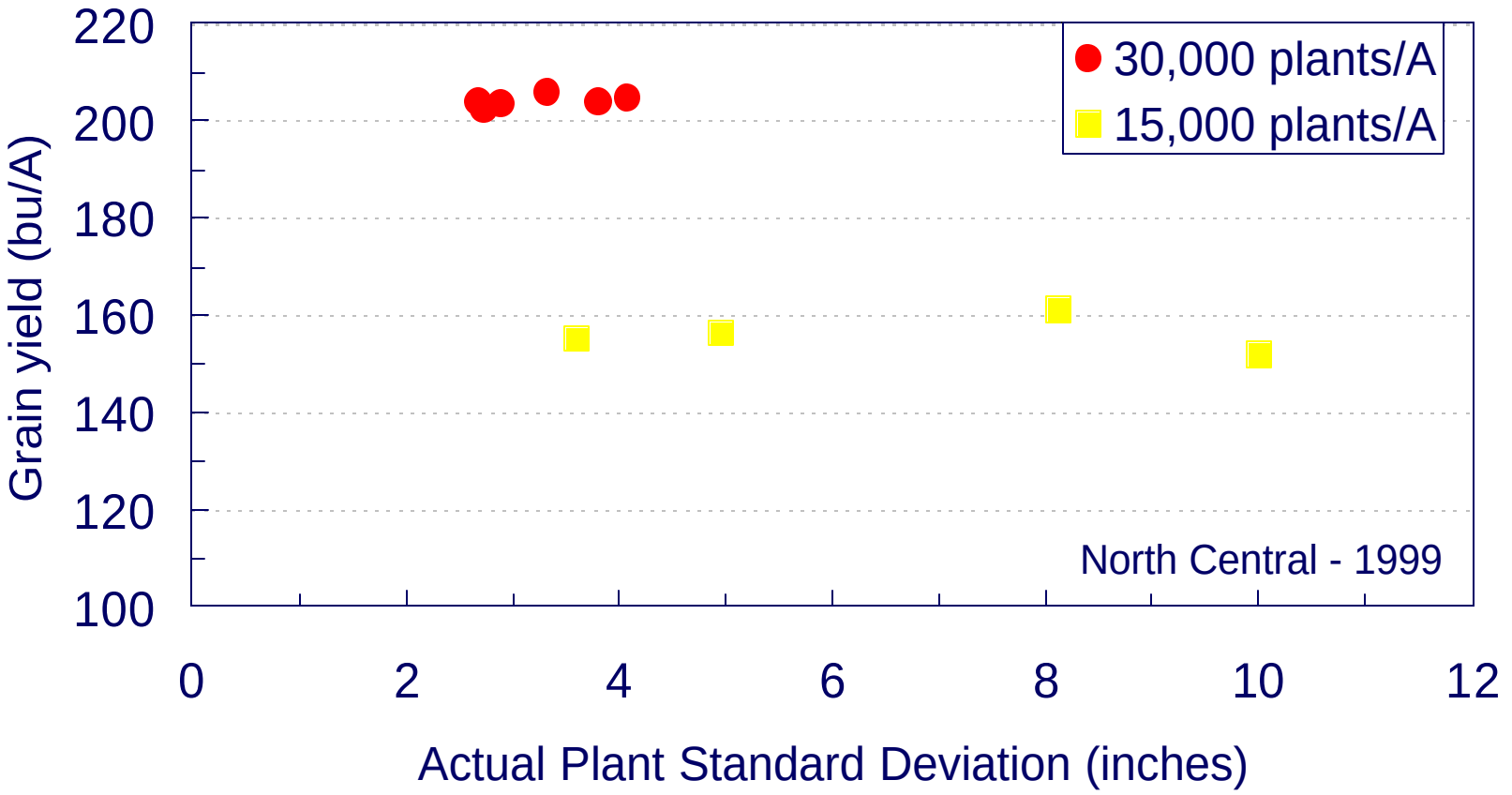
Corn Yield Response to Plant Spacing Variation



Corn Yield Response to Plant Spacing Variation



Corn Yield Response to Plant Spacing Variation

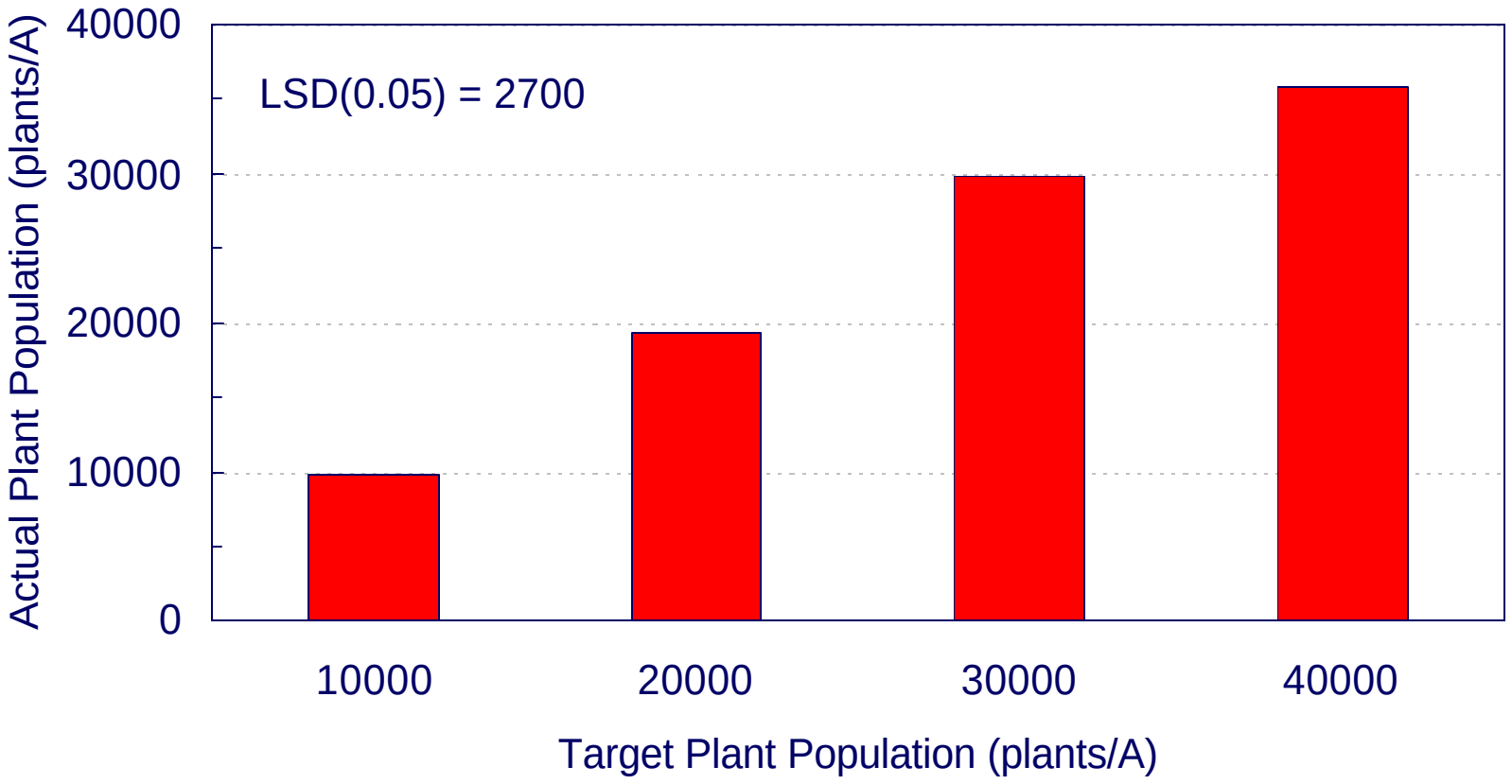


Significance of Plant Population and Spacing Variation on Corn

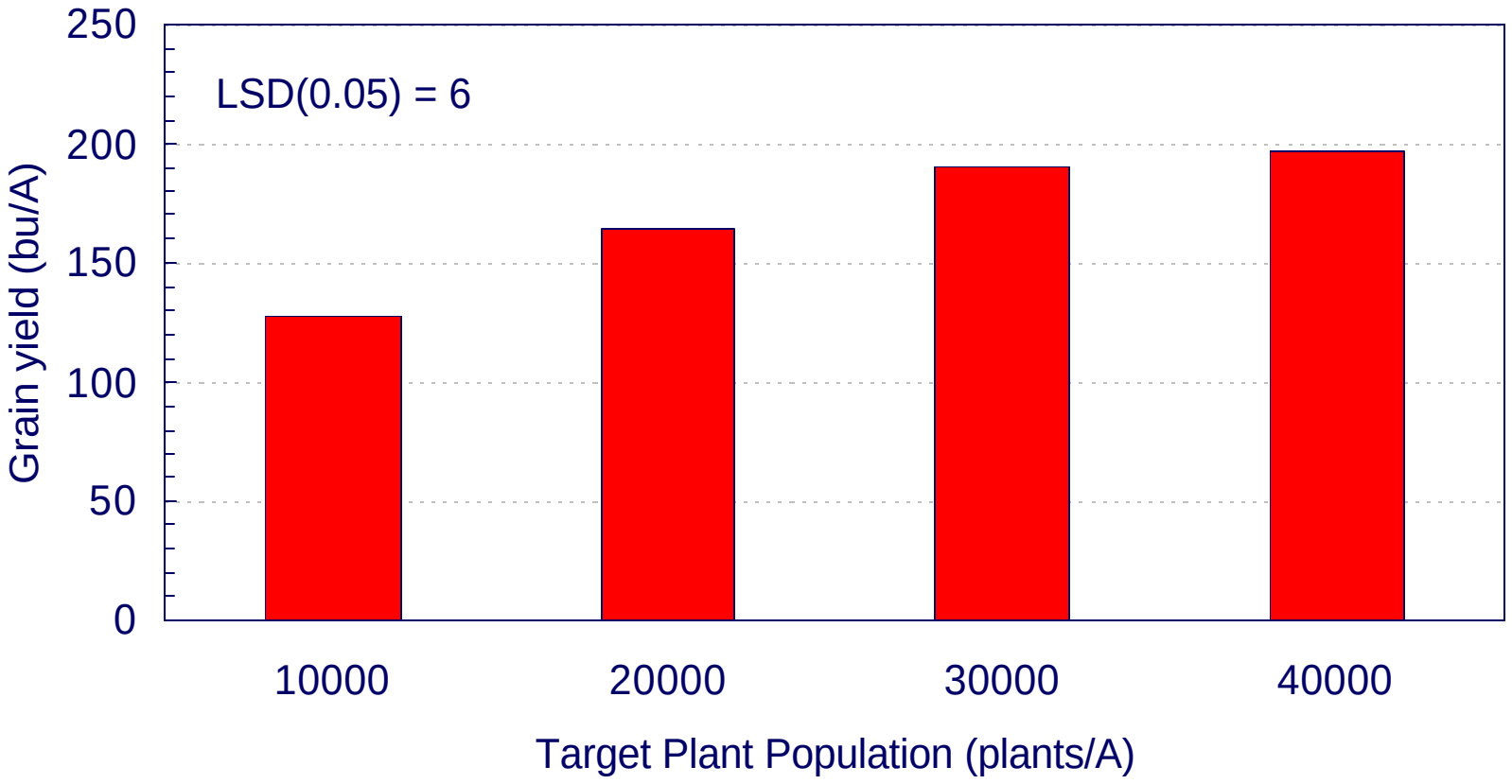
Factor	Plant spacing	Plant standard deviation	Grain yield	Grain moisture	Lodging	Grain test weight
Population (P)	**	**	**	**	**	**
Target Standard Deviation (S)	NS	†	NS	NS	NS	NS
P x S	NS	NS	†	*	NS	NS

**, *, and † indicates significance at $P < 0.01$, 0.05 and 0.10, respectively

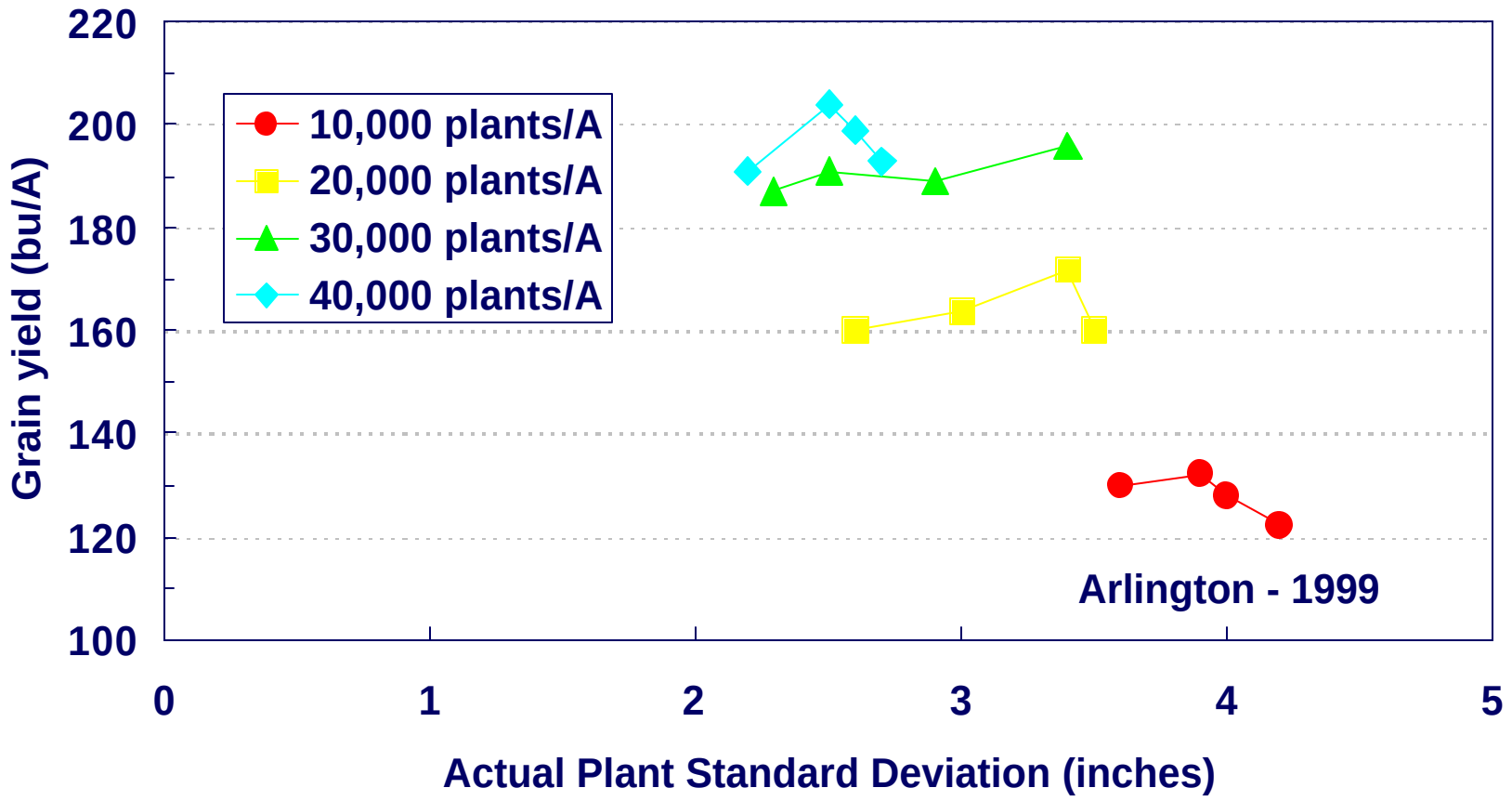
Actual Plant Population in Thinned Plots - Arlington, 1999



Corn Grain Yield Response to Plant Population - Arlington, 1999



Corn Yield Response to Plant Spacing
Spacing Variation



Plant Spacing and Standard Deviation