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Purdue University, Agronomy Dept., W. Lafayette, IN 47907-1150

Planting Speed Effects on Stand Establishment and Grain Yield of Corn

Summary of 1993 On-Farm Trials

R.L. (Bob) Nielsen

Brief Summary

An on-farm strip trial was conducted in 1993 to evaluate the effect of planting speed on plant population, plant spacing variability, and grain yield of corn. Twenty-two farmers across Indiana, Illinois, and Iowa participated in the study. Treatments consisting of planting speeds of 4, 5, 6, and 7 mph were replicated three times on each farm.

Grain yields at 6 and 7 mph planting speeds were significantly less (3 bushels per acre) than those at 4 and 5 mph when analyzed across all of the planters in the study. With seven of the twenty-one planters, however, grain yield decreased from 1.6 to 4.7 bushels per acre with each 1 mph increase in planting speed. Such yield losses translate to potential dollar losses of $12 to $35 per acre ($2.50 corn).

A planting speed of 7 mph increased the **seeding rates** of the planters in this study by an average of about 710 plants per acre compared to speeds of 4 and 5 mph. For five of the planters, plant populations increased by 900 to 1300 plants per acre with every 1 mph increase in planting speed. Seeding rates of the other fourteen planters were affected to much lesser degrees by increased speeds.

Plant spacing variability (PSV) worsened with faster planting speeds across all of the planters. However, the level of increase in PSV was equivalent to a grain yield loss of only 3/4 bushel per acre.

While plant population was not affected dramatically by speed for all of the planters in the study, the possibility for large effects obviously exists and must be considered when contemplating changes in standard planting speed practices. One could conclude that the increase in PSV observed in this trial, in and of itself, does not warrant slowing down planting speed.

However, I would caution that many of the planters used in this study were reported to be well-maintained. PSV may increase more dramatically as speed increases for planters in poorer condition. One can conclude, as with the plant population responses, that while grain yield was not affected dramatically by speed for all of the planters in the study, the possibility for large effects obviously exists and must be considered when contemplating changes in standard planting speed practices.

The **Bottom Line** from this on-farm strip trial is that the effects of planting speed in corn can be important, but are not dramatic or consistent for every planter out in the countryside.

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Introduction

Planting speed can affect a planter's ability to uniformly singulate and deliver seed to the seed furrow. Planter manufacturers usually recommend a range of 'optimum' planting speeds within which their planters are designed to function optimally.

Excessively fast speeds typically result in **altered seeding rates**. Planting too fast with plate-type planters and some air-planters often results in lower seeding rates (seed cells 'missed'), while fingerpickup-type planters often seed more thickly at faster speeds because double- and triple-seed pickups are not eliminated prior to seed release.

As a consequence of altering seeding rates, **variability among plant-to-plant spacings** within rows worsens because of the presence of gaps or crowded plants instead of uniformly spaced plants. Plant spacing variability (**PSV**) can also occur even if seeding rates have not been altered, if random mixtures of gaps and crowded seeds are being delivered by the planter. Results from field research that I have conducted since 1987 have documented that variable plant-to-plant spacing within rows can dramatically decrease corn grain yield above and beyond any effect due to altered plant population[1].

PSV can be caused by a number of factors, many of which revolve around the maintenance and/or operation of the corn planter. In addition to seeding rate effects caused by seed singulation problems, excessively fast planting speeds cause the planter units to bounce more than at slower speeds. Planter bounce affects the delivery of the seed from the seed singulation mechanism to the furrow and can increase PSV regardless of whether seeding rate is affected or not. The effect of excessive planting speed is likely more severe with older, poorly maintained, and/or mis-adjusted planters than on newer, well maintained and well adjusted planters.

Intuition and logic suggest that if excessively fast planting speed alters the desired seeding rate and increases the plant spacing variability, then grain yield should decrease also. **The Goal Of This On-Farm Study** was to determine whether planter speed significantly affects plant population, uniformity of plant-to-plant spacing, and grain yield of corn across a variety of farms throughout the Midwestern CornBelt.

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[1] Nielsen, R.L. (Bob). (rev 11/93). *Stand Establishment Variability in Corn.* AGRY-91-01. Purdue University, Agronomy Department, W. Lafayette, IN 47907-1150

Research Procedures

Who Were The Players?

I extended an offer to each of Indiana's Extension Educators to identify one or more farmers to participate in the 1993 on-farm trials and to coordinate the activities involved with that farmer's participation. I also connected with Rich Fee, an editor with Successful Farming Magazine[2], who expressed interest in helping coordinate similar on-farm trials in Illinois and Iowa.

The only desired prerequisite for selecting a participating farmer (other than the obvious qualities desired in a good cooperator) was that the planter used in the study be well-maintained, adjusted, and in otherwise good operating condition. From these efforts, twenty-two farmers participated in the 1993 trials. Of this number, 5 were from Iowa, 9 were from Illinois, and 8 were from Indiana. Rich Fee coordinated the Iowa and Illinois sites, while seven different Extension Educators coordinated the Indiana sites (one Educator coordinated two sites). The Indiana counties represented in the trial were Bartholomew, Clark, Fayette, Franklin, Noble (2), Orange, and Warren.

What Were The Treatments?

I chose four planting speeds that likely encompass the range of speeds used by the majority of Midwestern corn farmers: **4, 5, 6, and 7 mph**. Each farmer was provided with a planting sequence that resulted in 12 individual plots[3], representing three replicates of the four planting speed treatments[4]. I strongly suggested that the tractor speeds be calibrated to verify the accuracy of the planting speed treatments.

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[2] Successful Farming Magazine, 1716 Locust St., Des Moines, IA 50309-3023

[3] For an example of a plot map for an individual farm, see Appendix B (page 21).

[4] Technically, the experimental design was a Randomized Complete Block with the four planting speed treatments randomized separately within each of the three replicates.

The width of each of the 12 plots was the farmer's choice, but I recommended that it be equal to 1 or 2 passes of the planter. The plot length was also the farmer's choice, but I recommended that it be no less than 500 feet.

What Data Were Measured?

Stand Establishment

Prior to pollination, plant-to-plant spacing was measured in order to calculate plant population and plant spacing variability within each plot. To ensure accurate calculations of plant population and PSV, the players were asked to measure 100 consecutive plant-to-plant spacings in each of the four center rows of each of the twelve plots.

To simplify the data collection procedure, the players laid a long measuring tape or surveyor's rod alongside the row to be measured. The linear position (feet and inches) of each of 100 consecutive plants was recorded[5]. This procedure enabled the players to collect the data faster than if the actual plant-to-plant spacings were measured for each pair of plants in the row.

After I received these data, they were entered onto **Microsoft® Excel™** (a computer spreadsheet program). Successive spreadsheets were developed with formulas designed to calculate the actual plant populations, plant-to-plant spacings, and plant spacing variability.

Plant spacing variability was calculated as the statistical *standard deviation* among the plant-to-plant spacings measured in each of the twelve plots per farm. In a general sense, the standard deviation value describes the distance on either side of the average plant spacing value where the majority of the plant spacings occurred.

> Think of this example, if the average plant spacing was 8 inches and the standard deviation was calculated to be 5 inches, it would mean that the majority of the measured plant spacings were within plus or minus 5 inches from that 8-inch average spacing. A more uniform group of plant spacings would result in a standard deviation less than 5 inches.

For each of the twelve plots, therefore, 400 plant positions were measured and recorded. For the complete study on each farm, 4800 plant positions were measured and recorded. For the twenty-two farms that participated in the on-farm trials, a sum total of 105,600 individual plant positions were measured and recorded.

[5] For example, the first plant in a row might have been at the 1 ft. mark, the second at the 1 ft. 8 in. mark, the third at the 2 ft. 5 in. mark, etc.

Grain Harvest

On each farm, plots were machine-harvested with the farmer's combine after the corn was mature. Harvested grain weight and grain moisture were measured from each of the 12 plots per farm with the use of commercial weigh wagons and portable grain moisture testers. Grain weights were recorded "as is" on a wet basis. Grain yield (bushels per acre) was calculated on the basis of 15% grain moisture (water shrinkage[6] only).

How Were The Data Summarized and Analyzed?

Data from each of the farms, except one that was not harvested, were analyzed individually for plant population, plant spacing variability, and grain yield[7]. Data from nineteen of the twenty-two farms were used in the overall analysis of variance for plant population, plant spacing variability, and grain yield[8]. Of the three farms not used in the overall analysis, one study was not harvested, one used a different range of speed treatments (5-8 mph rather than 4-7 mph), and one had an incomplete set of harvested replicates. The latter two farms were analyzed individually, however.

> Statistical analyses of experimental data attempt to identify those treatments that truly differ in their effects, as opposed to observed differences that may only be due to chance variation among the plots in the study. Researchers traditionally develop their conclusions based on a slim 5% probability that declared treatment differences are, in fact, due to chance alone.
>
> Such a small probability level is comforting in that it limits the probability of making mistakes when declaring two treatment effects to be different. On the other hand, a small probability level may cause a mistake of a different kind. That is, declaring two treatment effects to be similar when, in fact, they are different. Some researchers feel that greater probability levels should be used in the analysis of certain experiments to avoid the latter mistake. I am one such researcher and have consequently used a 20% probability level during the analyses of this study.

In those analyses where the probability that the treatment effects were significant at 20% probability level or lower, treatment comparisons were made using **L**east **S**ignificant **D**ifference (**LSD**) values also calculated at the 20% probability level. If any two treatment means differ by *at least* the LSD value, the observed treatment difference is probably real. If the two treatment means differ by *less* than the LSD value, the observed treatment difference is probably due only to chance variation within the study.

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[6] For more information on shrinkage, see NCH-61, *Calculating Grain Weight Shrinkage In Corn Due to Mechanical Drying*, available from your local Purdue Cooperative Extension Service office.

[7] The analysis of variance was performed with the ANOVA procedure in PC-SAS v6.03, as a RCB design.

[8] The overall analysis of variance was performed with the ANOVA procedure in PC-SAS v6.03, as a RCB design with the farms considered to fixed effect factors.

Results & Discussion

Plot Information Summary

The information provided in Table 1 summarizes miscellaneous details about the on-farm plots among the farms that participated in the study. The average planting date was May 14th. The average seeding rate was 26,355 seeds per acre. The average seeding depth was just under 2 inches.

Individual plot size averaged 10 rows wide by 903 feet long. Sixteen of the 22 farms used radar to determine/monitor planting speeds. The previous crop on 15 of the 22 farms was soybeans, the others mostly corn. Nine of the farms practiced no-till, while another nine practiced some form of reduced tillage.

Planter Information Summary

The information provided in Table 2 summarizes information requested from each participant about the planter used in the study. Four major planter manufacturers were represented in the study, although John Deere accounted for 13 of the 22 planters used.

The planters ranged in size from 4 rows to 12 rows, the latter accounting for nearly 50% of the planters in the study. The majority of the planters were set for 30-inch row spacings. The average planting speed used for general planting operations as reported by the farmers was 5.5 mph and only ranged from 4.5 to 6.0 mph.

The average age of the planters in the study was about 6 years old and ranged from brand-new to 18 years old. Acreage planted per year with these planters averaged 766 acres and ranged from 200 to 2,000 acres.

Table 1. Plot information summary for farmers participating in 1993 On-Farm Planting Speed Study.

		Seeding...			Plot...	
Farmer	**State**	**Date**	**Rate**	**Depth**	**Width**	**Length**
Last Name			*spa*	*in.*	*rows*	*ft*
Allen	IA	5/21/93	29,000	2	12	500
Balser	IN	5/10/93	26,000	2	8	1600
CalmerD	IL	5/13/93	24,900	1.5	4	500
CalmerM	IL	5/17/93	27,000	2	8	1144
Claypool	IA	5/21/93	28,000	2	12	500
Colburn	IL	5/11/93	27,500	2	8	500
Corkill	IL	5/14/93	27,200	1.75	12	500
Drake	IN	5/21/93	24,000	2	8	2540
Egan	IL	5/14/93	27,700	1.75	6	500
Glick	IN	5/9/93	27,000	1.25	12	2300
Holmes	IL	5/11/93	27,500	1.5	6	500
Holt	IL	5/13/93	26,200	2	12	500
Konger	IN	5/11/93	26,500	1.5	6	730
Lorenz	IN	5/11/93	26,200	1.5	12	1825
Maher	IL	5/12/93	26,300	2	12	500
Malle	IN	5/20/93	24,500	1.5	6	1505
Newman	IL	5/13/93	25,700	1.75	8	561
Porter	IA	5/24/93	24,200	2	12	500
Showalter	IA	5/21/93	29,000	2	12	500
Starr	IN	5/8/93	27,700	1.5	12	750
Symens	IA	5/20/93	24,500	2	12	520
Zink	IN	5/10/93	23,200	2	8	900
Average		**5/14/93**	**26,355**	**1.80**	**10**	**903**
Maximum		**5/24/93**	**29,000**	**2.00**	**12**	**2540**
Minimum		**5/8/93**	**23,200**	**1.25**	**4**	**500**

Table 2. Planter information summary for planters used in the 1993 On-Farm Planting Speed Study.

Farmer	State	Make	Model	Row#	Spacing	Age	PltSpd	Acres	Maint.	Tillage
Last Name				*Row Units*	*inches*	*years*	*mph*	*per year*	*last date*	
Allen	IA	IH	500	12	30	6	5	525	na	fall chisel
Balser	IN	JD	7000	8	36	15	6	900	1993	no-till
CalmerD	IL	NI/Kinze	na	4	36	8	5.5	400	1992	no-till
CalmerM	IL	JD	7000	8	30	4	5.5	300	1993	reduced till
Claypool	IA	JD	7000	12	30	18	5	2000	na	no-till
Colburn	IL	Kinze	na	8	36	3	5	550	na	reduced till
Corkill	IL	NI/White	na	12	30	2	5	700	na	no-till
Drake	IN	White	6100	8	36	0	5	800	na	ridge till
Egan	IL	JD	7000	6	30	14	4.5	200	1992	no-till
Glick	IN	JD	7200	12	30	1	6	1450	1993	reduced till
Holmes	IL	JD	7000	6	30	5	6	280	1992	no-till
Holt	IL	NI/White	na	12	30	1	6	1200	na	reduced till
Konger	IN	JD	7200	6	30	0	5.2	500	na	no-till
Lorenz	IN	NI/Kinze	na	6	30	3	6	400	1993	no-till
Maher	IL	JD	7200	12	30	4	6	1000	na	fall chisel
Malle	IN	JD	7200	6	30	1	5.5	700	na	no-till
Newman	IL	JD	7000	8	36	12	5.5	650	1993	reduced till
Porter	IA	JD	7100	12	30	5	5.5	600	na	reduced till
Showalter	IA	IH	800	12	30	na	6	1300	na	fall chisel
Starr	IN	JD	7000	12	30	14	6	800	1993	reduced till
Symens	IA	White	na	12	30	3	5.5	1000	na	reduced till
Zink	IN	JD	na	8	36	10	5.5	600	1993	fall chisel & no-till
Average				**9.2**	**31.6**	**6.1**	**5.5**	**766**		
Maximum				**12.0**	**36.0**	**18.0**	**6.0**	**2000**		
Minimum				**4.0**	**30.0**	**0.0**	**4.5**	**200**		

Note: The age listed in the table is based on the reported purchase date for when planter was purchased new. Age is based on model year for used planters, if provided, otherwise based on reported purchase date.

Stand Establishment

Plant Population

Overall, faster planting speed caused minor increases in plant population (i.e., seeding rate) in these trials (Fig. 1). Plant populations averaged 24,896 plants per acre for planting speeds of 4 and 5 mph. Significantly[9] more plants per acre were associated with the 7 mph planting speed (25,606 plants per acre).

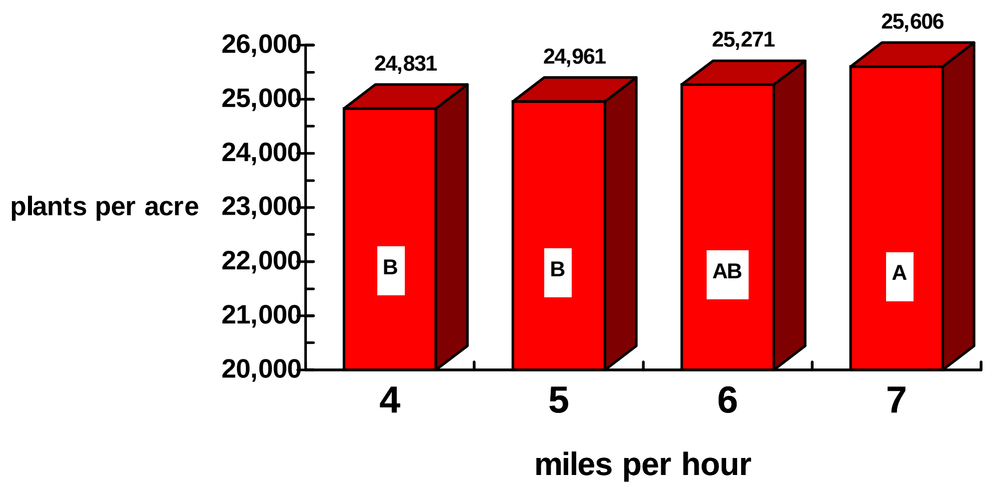

Figure 1. Effects of planting speed on plant population. Average of 19 farms, three replicates per farm. 1993 On-Farm Planting Speed Trial. R.L. Nielsen, Purdue University, Agronomy Dept. Columns that share a common letter are not significantly different (p<.20).

While plant population increased with planting speed, the total increase was not dramatic enough (less than 800 plants per acre) to have much influence on corn grain yield. This is especially true since the average plant population in these trials was just over 25,000 plants per acre, hardly a stressful population level to begin with. More importantly, some planters responded differently to planting speed than others (i.e., a statistically significant interaction).

Most of the planters responded to planting speed with minor responses in population. For 5 of the 21 planters in the study[10], however, plant population increased linearly with increased planting speed by 900 to 1300 plants per acre for every 1 mph increase in speed. Plant population decreased with increasing planting speed for one of the farms

[9] When the word "significant" is used in discussing the results of this study, it refers to differences among treatment effects that are statistically different at the 20% probability level (see Data Analysis, page 6).

[10] These planters were Claypool, Newman, Porter, Starr, and Zink.

that used a White 6100 air planter. Fig. 2 illustrates an example of opposite plant population responses to planting speed for two different planters.

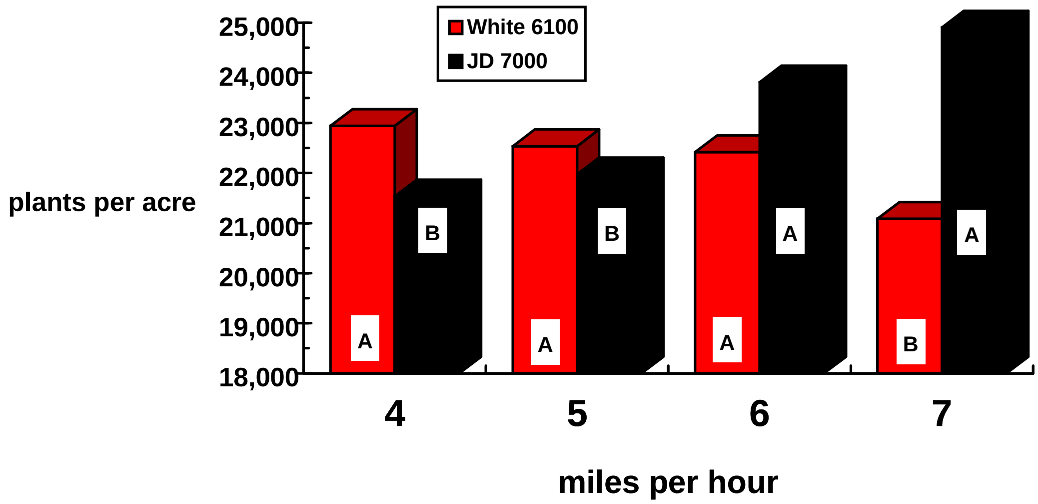

Figure 2. Opposite effects of planting speed on plant population, comparison of a White 6100 planter (Drake farm) and a John Deere 7000 planter (Starr farm). 1993 On-Farm Planting Speed Trial. R.L. Nielsen, Purdue University, Agronomy Dept. Columns for a given planter that share a common letter are not significantly different (p<.20).

Plant Spacing Variability

If you aren't yet comfortable with the concept of *standard deviation*, re-read the Research Procedure section that discusses its meaning (page 5). Just remember, that small standard deviation values mean more uniform plant-to-plant spacing.

Among the 19 farms included in the overall analysis, the average plant spacing variability (PSV) level was about 4 inches. Compared to other commercial fields I have surveyed in the past, this represents about an average level of uniformity (Fig. 3).

I consider a standard deviation of 2 inches to be an achievable goal for most modern planters. With that in mind, my earlier research[11] suggests that the average participant in this study could improve yields about 5 bushels per acre by decreasing PSV from 4 inches back to 2 inches.

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[11] Nielsen, R.L. (Bob). (rev 11/93). *Stand Establishment Variability in Corn.* AGRY-91-01. Purdue University, Agronomy Department, W. Lafayette, IN 47907-1150

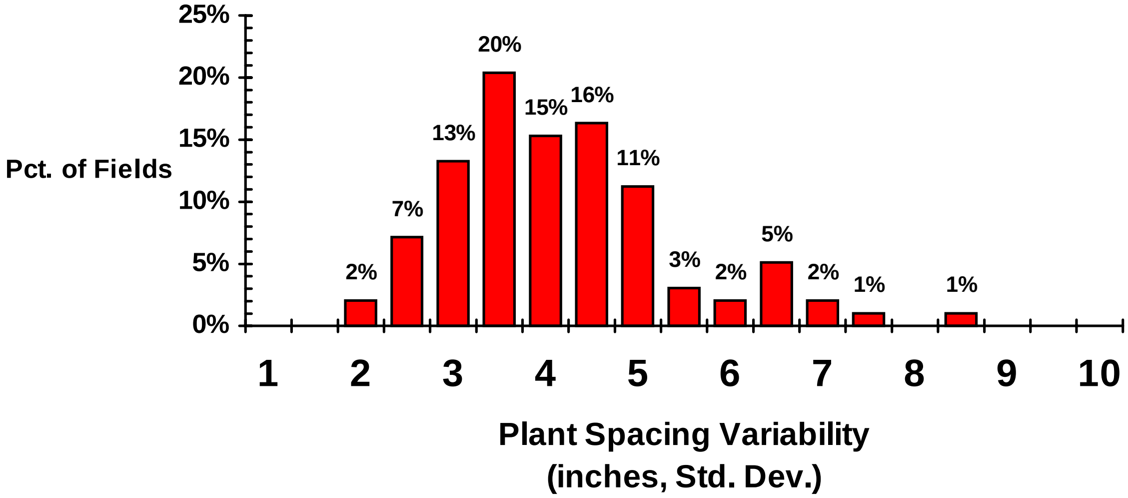

Figure 3. Range of plant spacing variabilities observed in commercial corn fields in Indiana, Illinois, and Iowa. Data from 98 fields sampled from 1987-93. R.L. Nielsen, J. Cardinal, and M. Fain, Purdue University, Agronomy Dept.

The overall analysis indicated that within-row plant spacing at 6-7 mph was significantly more variable than that at 4-5 mph across all the farms in the study (Fig. 4). While significant in a statistical sense, the increase in PSV was only 0.3 inches. From my earlier research with PSV, such a difference would translate to a yield loss of only about 3/4 bushel per acre. The effects of planting speed on PSV levels were similar enough across the 21 planters in the study that no statistically significant interaction could be identified in the analysis.

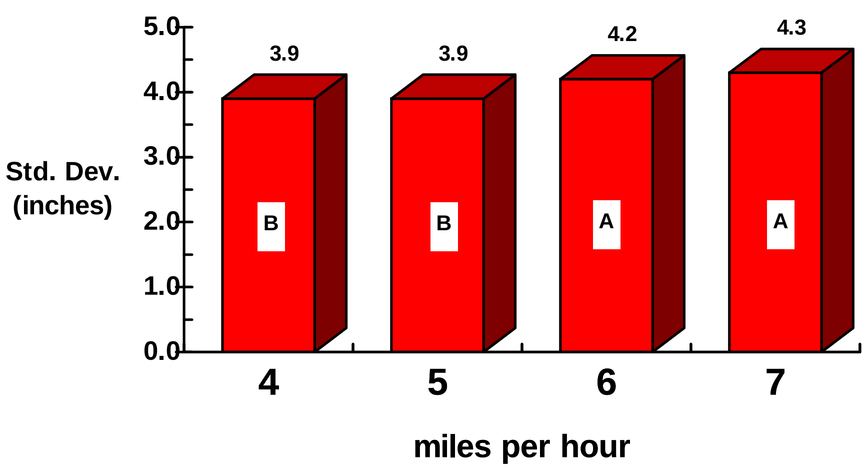

Figure 4. Effects of planting speed on plant spacing variability. Average of 19 farms, three replicates per farm. 1993 On-Farm Planting Speed Trial. R.L. Nielsen, Purdue University, Agronomy Dept. Columns that share a common letter are not significantly different ($p<.20$).

Grain Yield

Grain yields at 6 and 7 mph planting speeds were significantly less than those at 4 and 5 mph when analyzed across all of the planters in the study (Fig. 5). However, the grain yield difference was only about 3 bushels per acre.

The yield response to planting speed differed among the planters, however. Individual data analyses indicated that grain yield was significantly influenced by speed for only 7 of the 21 planters. Among these seven planters[12], grain yield decreased in a generally linear fashion in response to increased planting speed.

Yield losses among these seven planters ranged from 1.6 to 4.7 bushels per acre for each 1 mph increase in planting speed. Total yield loss with these seven planters by planting at 7 mph instead of 4 mph ranged from 4.8 to 14.1 bushels per acre (worth from $12 to $35 per acre at $2.50 corn).

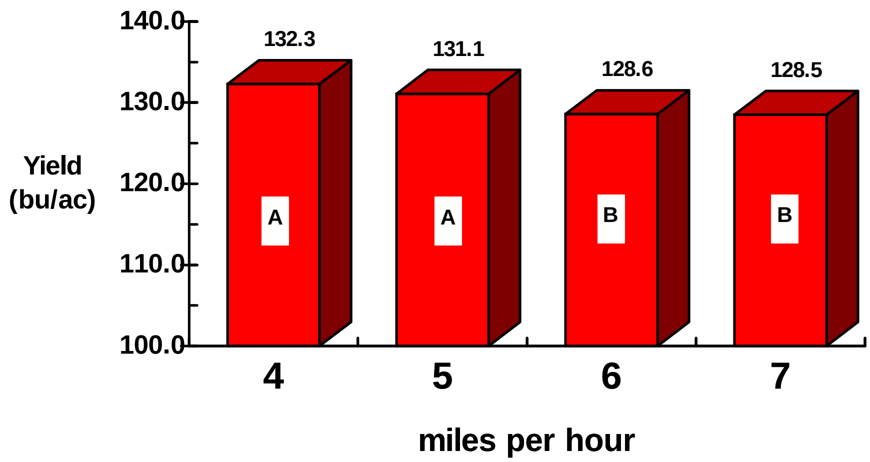

Figure 5. Effects of planting speed on corn grain yield. Average of 19 farms, three replicates per farm. 1993 On-Farm Planting Speed Trial. R.L. Nielsen, Purdue University, Agronomy Dept. Columns that share a common letter are not significantly different (p<.20).

The cause(s) of the yield loss at faster planting speeds was not clear from these data. As mentioned earlier, plant population significantly increased as planting speed increased for 5 of the 21 planters (see page 10). However, only two of these were among the seven that responded with yield losses to increased speed.

As was also discussed earlier, plant spacing variability generally increased for all of the 21 planters as planting speed increased (see page 12). The measured increase in PSV

[12] These planters were Balser, Claypool, Colburn, Drake, Konger, Porter, and Symens.

would only account for a total yield loss of about 1 bushel per acre, not enough to account for all of the observed yield loss due to increased planting speed.

An additional factor that might have been influenced by planting speed, but was not measured in these trials, is emergence uniformity. Faster planting speeds can easily decrease seeding depth uniformity and seed-to-soil contact, causing uneven emergence of the corn seedlings. Earlier research from Illinois and Wisconsin[13] indicates that uneven emergence can reduce grain yields as much as 10 to 20% because delayed emergers cannot compete with older, more established plants. Future research on the effect of planting speed on grain yield should attempt to measure the degree of emergence uniformity.

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[13] Carter, Paul and Emerson Nafziger. 1989. *Uneven Emergence in Corn.* NCR-344.

Conclusions

A planting speed of 7 mph increased the **seeding rates** of the planters in this study by an average of about 710 plants per acre compared to speeds of 4 and 5 mph. Five of the 21 planters were affected more than the others, but no common characteristics could be identified among these planters. For these 5 planters, plant populations increased by 900 to 1300 plants per acre with every 1 mph increase in planting speed.

Seeding rates of the other 14 planters were affected to much lesser degrees by increased speeds. While plant population was not affected dramatically by speed for all of the planters in the study, the possibility for large effects obviously exists and must be considered when contemplating changes in standard planting speed practices.

Plant spacing variability was affected by planter speed uniformly across all of the planters, but not in a linear fashion. Standard deviation of plant-to-plant spacing increased about 0.3 inch at the 6 and 7 mph speeds compared to the 4 and 5 mph speeds. This level of increase in PSV is equivalent to a grain yield loss of about 3/4 bushel per acre.

One could conclude that the increase in PSV observed in this trial, in and of itself, does not warrant slowing down planting speed. However, I would caution that many of the planters used in this study were reported to be well-maintained. PSV may increase more dramatically as speed increases for planters in poorer condition.

Grain yields at 6 and 7 mph planting speeds were significantly less than those at 4 and 5 mph when analyzed across all of the planters in the study. However, the grain yield difference was only about 3 bushels per acre. As with plant population, though, planters differed in their response to speed.

With seven of the twenty-one planters, grain yield decreased from 1.6 to 4.7 bushels per acre with each 1 mph increase in planting speed. One can conclude, as with the plant population responses, that while grain yield was not affected dramatically by speed for all of the planters in the study, the possibility for large effects obviously exists and must be considered when contemplating changes in standard planting speed practices.

The **Bottom Line** from this on-farm strip trial is that the effects of planting speed in corn do not appear to be dramatic or consistent for every planter out in the countryside. Newer, well-maintained planters likely tolerate a greater range of planting speed without significantly influencing seeding rate, plant spacing variability, or grain yield. However, as planters age or "get out of shape", the effects of speeds outside the recommended range of the manufacturer likely become more important.

If a farmer questions the capability of his/her planter to accomodate faster speeds, it would be worth the effort to check their planter's response to planting speed. The simplest way would be to conduct similarly constructed on-farm strip trials to measure the effect of speed on plant populations and grain yield. Use the example plot layout shown in Appendix B (page 21) as a guide for conducting an on-farm planting speed trial.

Reference List

If you have additional questions about the research reported herein, please contact me at:

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My INTERNET electronic mail address is **rnielsen@purdue.edu**

The references listed below contain information related to some of what you have read in this research summary report.

Carter, Paul and Emerson Nafziger. 1989. *Uneven Emergence in Corn.* NCR-344. Purdue University Cooperative Extension Service, W. Lafayette, IN.

Hicks, D.R. and H.A. Cloud. 1991. *Calculating Grain Weight Shrinkage in Corn Due to Mechanical Drying.* NCH-61. Purdue University Cooperative Extension Service, W. Lafayette, IN.

Nafziger, E.D., P.R. Carter, and E.E. Graham. 1991. *Response of Corn to Uneven Emergence.* Crop Sci. 31:811-815.

Nielsen, R.L. 1991 (rev 11/93). *Stand Establishment Variability in Corn.* AGRY-91-01. Purdue University, Agronomy Department, W. Lafayette, IN 47907-1150.

Nielsen, R.L. 1993. *Stand Establishment Variability in Corn.* Proceedings of the 1993 Integrated Crop Management Conference. pp. 109-116. University Extension, Iowa State University, Ames, IA.

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John Konger, Indiana	Kevin Lorenz, Indiana
Richard Maher, Illinois	Tom Malle, Indiana
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Murrel Symens, Iowa	Loren Zink, Indiana

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Appendix A: Rules of Game

What Were The Rules of the Game?

In order to facilitate the operation of this on-farm research project, I developed some "rules" or responsibilities that I expected the farmer, coordinator, and myself to follow during the conduct of the trial.

Farmer's Responsibilities

1. Perform all the usual spring field operations in preparation for planting.
2. Provide the hybrid seed corn for the study.
3. Identify the field or area of field suitably uniform for on-farm research.
4. Participate in laying out and flagging the study area in the field.
5. Provide and operate the tractor and planter for the study.
   - ✔ Complete the planter information and plot information sheets.
6. Perform all usual post-emergence field activities, such as cultivation.
7. Participate in measuring and recording the plant-to-plant spacing data in each plot of the study prior to pollination.
8. Provide and operate the combine to harvest the study.
9. Learn something valuable from the study.

Coordinator's Responsibilities

1. Identify the farmer(s) to participate in the study.
2. Help the farmer identify a field suitable for on-farm research.
3. Help the farmer calibrate planting speeds of the tractor/planter system.
4. Participate in laying out and flagging the study area of the field.
5. Coordinate the activities on the day of planting, including...
   - ✔ Verify the length of each plot in the study.
   - ✔ Help complete the planter information and plot information sheets, return to Nielsen.

6. Participate in measuring and recording plant-to-plant spacing data in each plot of the study prior to pollination.
   - ✔ Provide Nielsen with data.
7. Provide and operate the weigh wagon for grain harvest, including...
   - ✔ Record grain weights and grain moistures on the day of harvest.
   - ✔ Provide Nielsen with data.
8. Learn something valuable from study.

Nielsen's Responsibilities

1. Provide the protocol and plot layout indicating planting sequence of treatments.
   - ✔ Prior to planting, provide flags for plot identification, if needed.
2. Provide planter information and plot information record sheets.
3. Provide the protocol and record sheets for measuring and recording plant-to-plant spacings.
   - ✔ Participate in measuring and recording plant-to-plant spacing data, when schedule permits.
4. Provide the protocol and record sheets for measuring and recording grain weights and moistures at harvest.
   - ✔ Participate in activities on day of grain harvest, when schedule permits.
5. Summarize and analyze the plant spacing and grain harvest data.
6. Develop summary report based on individual and group data analyses.
   - ✔ Distribute to all participants and coordinators.
7. Learn something valuable from study.

Appendix B: Plot Map

Example Plot Map

Each treatment strip (plot) was 1 or more planter passes wide. Plot length was recommended to be no less than 500 feet. Each plot was harvested and weighed separately.

1 or more planter passes for border
Rep 1 ➨ 4 mph
Rep 1 ➨ 7 mph
Rep 1 ➨ 6 mph
Rep 1 ➨ 5 mph
Rep 2 ➨ 7 mph
Rep 2 ➨ 6 mph
Rep 2 ➨ 5 mph
Rep 2 ➨ 4 mph
Rep 3 ➨ 7 mph
Rep 3 ➨ 5 mph
Rep 3 ➨ 4 mph
Rep 3 ➨ 6 mph
1 or more planter passes for border