# Row Width in Corn Grain Production

Narrow row corn is generally defined as any row spacing less than 30 inches. These spacings increase the distance between plants in a row, potentially increasing yields due to more efficient use of available space and resources. However, yield benefits of narrow rows have not been large or consistent enough so far to motivate growers to switch from 30-inch rows in most areas of North America. This review article discusses narrow row corn trends and research results.

## Current Practices

The vast majority of corn acres in the U.S. and Canada are currently planted in 30-inch rows (Figure 1). This percentage has increased over recent years, from 80% in 2007 to 85% in 2012, while the percent of corn acres in wider row spacings (36- and 38-inch) has declined (data not shown). Adoption of narrow row corn has been very limited, with row spacings less than 30 inches currently used on less than 5% of corn acres in the U.S. and Canada. The most common narrow-row spacing is 20-inch, followed by 22-inch and 15-inch.

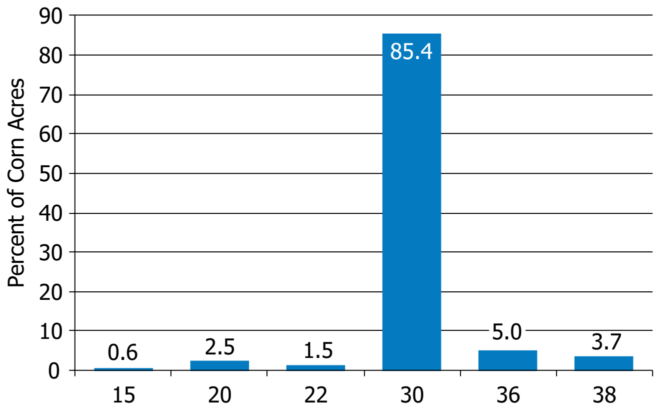


**Figure 1.** Corn row spacings (in inches) in North America as a % of all acres, 2012. DuPont Pioneer Brand Concentration Survey.

Corn acreage planted in narrow rows has been relatively stable over the past several years, comprising a combined 4.2% of corn acres in 2007 and 4.6% in 2012 (Table 1).

**Table 1.** Corn acreage planted to the most common narrow-row spacings from 2007 to 2012 in North America. Source: DuPont Pioneer Brand Concentration Survey.

| Row Width | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| inches | -------------- acres (%) -------------- | | | | | |
| 15 | 0.4 | 0.3 | 0.4 | 0.4 | 0.4 | 0.6 |
| 20 | 2.4 | 2.5 | 1.9 | 2.7 | 2.5 | 2.5 |
| 22 | 1.4 | 1.5 | 1.5 | 1.2 | 1.4 | 1.5 |
| All Narrow | 4.2 | 4.2 | 3.9 | 4.2 | 4.2 | 4.6 |

Regional adoption of narrow rows varies widely, with the highest adoption rate in the Northern Corn Belt states of Minnesota, Wisconsin, North Dakota and South Dakota (Figure 2). The most common narrow-row spacing in this region is 22-inch (5%), followed by 20-inch (4%).

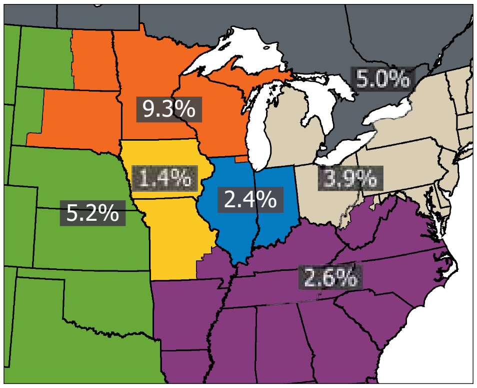


**Figure 2.** Narrow row corn adoption (15-, 20- and 22-inch) by region in North America as a % of total acres in 2012.

Source: DuPont Pioneer Brand Concentration Survey.

## Recent Row-Spacing Research

**University Research** - Over the years, research on narrow row corn has produced variable results, which suggests that multiple factors likely influence corn yield response to row spacing. Yield benefits with narrow row corn have been observed more frequently in the northern portion of the Corn Belt in the area north of approximately 43°N latitude (line running roughly through Mason City, IA; Madison, WI; and Grand Rapids, MI) (Lee, 2006). In a survey of several recent university corn row studies comparing 15-, 20- or 22-inch rows to 30-inch rows, the greatest yield benefits with narrow rows were observed in experiments conducted in Minnesota and Michigan (Table 2). An average yield advantage of 2.8% with narrow or twin rows was observed in northern studies, compared to no advantage on average (-0.2%) for narrow rows in Iowa, Indiana and Nebraska (Figure 3).

Even among northern locations, however, yield benefits to narrow rows were inconsistent. For example, Van Roekel and Coulter (2012) found no yield advantage to narrow rows in research conducted during 2009 and 2010 at two southern Minnesota locations. Research at these same two locations in the early 1990s found an average 7.3% yield advantage for 20-inch over 30-inch rows (Porter et al., 1997).

**DuPont Pioneer Research** - Similar results were observed in DuPont Pioneer research. Results from 76 research studies conducted between 1991 and 2010 showed an average yield advantage of 2.7% with narrow or twin rows in the Northern Corn Belt states of Minnesota, North Dakota, South Dakota, Wisconsin and Michigan, compared to a 1.0% advantage across studies in Illinois, Iowa, Indiana, Missouri, Nebraska, Ohio and the southern tip of Ontario (Figure 3).

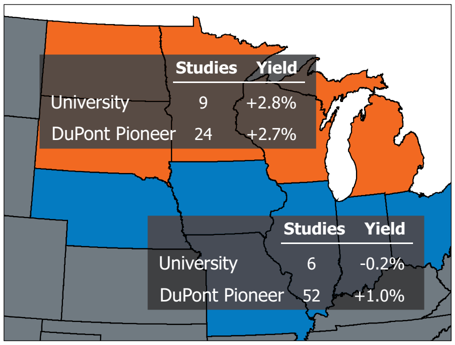


**Figure 3.** Average corn yield response to narrow rows in northern and central Corn Belt states observed in university and DuPont Pioneer studies conducted from 1991 to 2011.

DuPont Pioneer also conducted numerous on-farm research studies from 2010 to 2012 comparing yield in twin and 30-inch rows. Most of the studies were conducted in IL, IA and

**Table 2.** Yield advantage (%) of 15-inch, 20- or 22-inch, and twin rows compared to 30-inch rows observed in recent corn row-spacing research studies in the Midwestern U.S.

| | | | | | | | Yield Increase vs. 30-inch | | |
|---|---|---|---|---|---|---|---|---|---|
| Study | Location | Years | Locs | Hybrids | Yield Level | Populations | 15 | 20 or 22 | Twin |
| | | | | | bu/acre | 1000 plants/acre | ---------- % ---------- | | |
| 1 | Minnesota | 92-94 | 3 | 6 | 100-150 | 25, 30, 35, 40 | | 7.7 | |
| 2 | Minnesota | 97-99 | 1 | 1 | 100-150 | 33 | | 6.2 | |
| 3 | Minnesota | 98-99 | 1 | 2 | 150-175 | 30 | 5.9 | 2.8 | |
| 4 | Minnesota | 09-11 | 6 | 3 | 175-200 | 16.5, 22, 27.5, 33, 38.5, 44 | | 4.5* | |
| 5 | Michigan | 98-99 | 6 | 6 | 175-200 | 23, 26, 30, 33, 36 | 3.8 | 2.0 | |
| 6 | Nebraska | 09-11 | 1 | 3 | 200-225 | 28, 33, 38, 42 | | | 1.4 |
| 7 | Iowa | 00-02 | 1 | 3 | 150-175 | 20, 28, 36, 44 | 1.2 | | |
| 8 | N. Dakota | 06-08 | 1 | 2 | >225 | 25, 30, 35 | 0.0 | | 2.0 |
| 9 | Michigan | 98-99 | 1 | 1 | 150-175 | 24, 30, 34 | 0.5 | 0.8 | |
| 10 | Wisconsin | 98-01 | 1 | 1 | 175-200 | 34.5** | 0.0 | | |
| 11 | Iowa | 97-99 | 1 | 3 | 150-175 | 20, 28, 36 | 0.0 | | |
| 12 | Iowa | 95-96 | 1 | 3 | 150-175 | 20, 28, 36 | -0.6 | | |
| 13 | Minnesota | 09-10 | 2 | 3 | 150-175 | 16.5, 22, 27.5, 33, 38.5, 44 | | -1.0 | |
| 14 | Indiana | 09-11 | 1 | 3 | >225 | 28, 33, 38, 42 | | | -1.0 |
| 15 | Iowa | 97-99 | 6 | 6 | 150-175 | 24, 28, 32, 36 | -1.9 | | |

1: Porter et al., 1997; 2: Johnson and Hoverstad, 2002; 3: Sharratt and McWilliams, 2005; 4: Coulter and Shanahan, 2012; 5: Widdecombe and Thelen, 2002; 6: Novacek et al., 2013; 7: Pecinovsky et al., 2002; 8: Albus et al., 2008; 9: Tharp and Kells, 2001; 10: Pedersen and Lauer, 2003; 11,12: Pecinovsky et al., 2002; 13: Van Roekel and Coulter, 2012; 14: Robles et al., 2012; 15: Farnham, 2001.

*Average yield increase at 38,500 and 44,000 plants/acre. A significant row spacing by population interaction was observed.
**Approximate final stand, which differed from target populations.

MN; although, side-by-side comparisons were also done in CO, IN, KS, MO and OH. A total of 192 paired comparisons across 44 locations showed no overall yield advantage to twin rows over 30-inch rows (Figure 4).

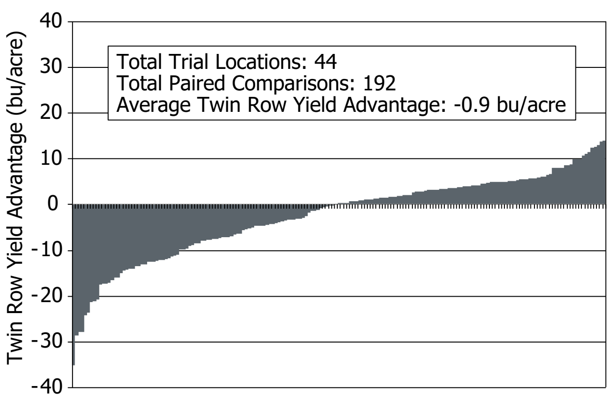


**Figure 4.** Yield advantage of twin rows compared to 30-inch rows in 2010-2012 DuPont Pioneer on-farm research studies.

## Rationale of Narrow Row Corn

Narrow rows reduce the crowding of plants within a row, reducing competition among individual plants and potentially enhancing their utilization of available light, water and nutrients. However, this does not explain why corn yield increases are observed in some cases but not in others and why narrow rows seem to provide a more consistent benefit in the northern Corn Belt. Identifying environmental and agronomic factors that tend to favor narrower rows can help determine the best fit for this practice in current and future corn production systems.

***Light Interception*** - Research has shown a strong relationship between improved yields in narrow rows and increased light interception (Andrade et al., 2002). Corn at a constant density can intercept more solar radiation when planted in narrow rows. This advantage is substantial during vegetative growth stages but diminishes as the crop approaches flowering. (Nafziger, 2006; Novacek et al., 2013; Robles et al., 2012; Sharratt and McWilliams, 2005; Tharp and Kells, 2001). By the time the plants reach silking, there is little or no difference in light interception between 30-inch and narrow rows. In addition, 30-inch rows in the Midwest have been shown to routinely capture over 95% of photosynthetically active radiation (PAR), which may be sufficient to maximize yield. Thus, narrow rows do not always have an inherent advantage.

**Central (Midwest) vs. Northern Locations** - Increased light interception is generally thought to be the reason that yield increases with narrow rows tend to be more frequent in the Northern Corn Belt (Thelen, 2006). In the absence of major water or nutrient limitations, corn yield is largely driven by the amount of solar radiation intercepted during the critical period for yield determination immediately before and after silking.

In the Central Corn Belt, this period normally begins in mid-July, about three weeks past the summer solstice (June 21, the date of maximum daylength). In mid- to late-July, these central locations are still receiving above 95% of maximum sunlight. Thus, sunlight may not often be yield-limiting, and the ability of narrow rows to capture more available sunlight may not be important. In northern locations, the critical period of yield determination occurs as much as a week later, and in addition, days shorten more rapidly. This means that many northern locations are receiving a lower % of their maximum solar radiation during the critical period. Thus, the ability of narrow rows to capture more available sunlight may be important to yield determination in the North.

***Water and Nutrient Recovery*** - The more equidistant plant spacing in narrow rows creates a more uniform distribution of roots within the soil profile, which reduces competition among individual plants for water and nutrients (Sharratt and McWilliams, 2005). Research has shown that narrow rows can improve nitrogen (N) use efficiency of corn by increasing the ability of the crop to recover N from the soil (Barbieri et al., 2008). This can improve yield in N-deficient conditions. Narrow rows have the added benefit of improving light interception when canopy development is limited by N deficiency. However, both of these advantages are reduced as N availability increases and may not result in increased yield when N is adequate (Barbieri et al., 2000; Barbieri et al., 2008).

The potential of narrow rows to increase yields by improving water uptake is less clear. Barbieri et al. (2012) found that narrow rows increased water uptake during the early stages of crop growth, but this advantage diminished as the season progressed. Total seasonal crop evapotranspiration ultimately did not differ between row spacings. Conversely, Sharratt and McWilliams (2005) found that narrow row corn did have greater total soil water extraction in one year of a two-year study. In any case, research does not indicate any broad advantage to narrow-row corn under drought stress conditions.

## Potential Interacting Factors

**Plant Population** - Some have speculated that crowding within the row could limit yields at future (higher) plant densities. Average corn seeding rates in the U.S. and Canada have increased linearly by over 5,000 seeds/acre in the last 20 years. If that trend continues, seeding rates of over 40,000 plants/acre will be common in the next 20 years. Row-spacing studies in corn have routinely tested for interactions with plant population and specifically, whether or not narrow rows have a higher optimum density than 30-inch rows. Several university studies (Table 2) have included plant populations in excess of 40,000 plants/acre and have found little evidence that narrow rows have a higher optimum population (with the exception of a study in far northwestern Minnesota) (Coulter and Shanahan, 2012). DuPont Pioneer research also found no increased advantage for narrower (twin) rows at high populations.

**Hybrids** - A common question is whether certain hybrids are more suited to narrow rows than others and if future genetic improvements may eventually produce hybrids specifically optimized for narrow rows. Many university row-spacing studies have included multiple hybrids but generally have found no difference in response to narrow rows. Of the 12 studies summarized in Table 2 that included more than 1 hybrid, only 1 (Study 15) reported a significant hybrid by row-spacing

interaction (Farnham, 2001). Out of six hybrids tested in this study, one yielded better in 15-inch rows, one yielded better in 30-inch rows, and four did not differ.

DuPont Pioneer on-farm twin-row studies conducted in 2010 included several locations with multiple hybrids, some with as many as 10 hybrids. Among 14 hybrids that were tested at 3 or more locations, no significant differences in yield between twin rows and 30-inch rows were observed nor were any hybrid by row-spacing interactions observed among hybrids compared at multiple locations (data not shown).

It has been suggested that improvements to stress tolerance in high population environments may yield new hybrids particularly suited to a high-density, narrow- or twin-row system. The idea of optimizing hybrids for narrow-row production has typically focused on leaf architecture, assuming that plants with more narrow and upright leaves may be more suited to narrow rows. Research thus far, however, has not shown a relationship between leaf architecture and yield response to row spacing among contemporary hybrids.

A study conducted in Michigan compared performance of six hybrids with differing leaf architecture in narrow rows (Widdicombe and Thelen, 2002). Of these hybrids, two had erect leaf orientation, three had semi-upright leaves and one had wide leaves. Average corn yield was significantly higher in narrow rows, but performance did not differ among hybrids. Research in Minnesota comparing two hybrids of differing leaf architecture also found no difference in yield response to narrow rows (Sharratt and McWilliams, 2005).

## Conclusions

The extensive history of research on corn row spacing has repeatedly shown that it is a very complex issue with many interacting factors. However, the accumulated body of DuPont Pioneer and university research conducted over the past 20 years does not indicate that the current standard 30-inch row spacing is limiting to corn productivity for most of the Corn Belt. Yield results in the Northern Corn Belt have tended to be more positive for narrow rows but still have shown a high degree of variability. Studies that have included multiple hybrids have generally found no difference in hybrid performance among row spacings, indicating that growers currently in narrow row systems are not limited in their choice of corn products for maximum performance.

**Sources** - *Enter this link in your browser to view sources:*

https://www.pioneer.com/home/site/us/agronomy/library/row-width-corn-grain-production/#sources