Optimum Plant Population for Corn in Minnesota

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SUMMARY

This publication summarizes research on corn plant population conducted at the University of Minnesota Research and Outreach Centers in Lamberton and Waseca from 2005 to 2008. Overall, the results from this research indicate that:

- Optimum plant population does not change with planting date or row width, but early-maturing hybrids may require a higher plant population than full-season hybrids. Yield increases resulting from higher plant populations are primarily the result of increased light interception during grain-fill by the crop canopy.
- While the economically optimum plant population varies according to the cost of seed and the price of corn, the plant population needed to maximize profitability ranges from about 32,000 to 34,000 plants/A under current economic conditions.

IMPACT OF PLANTING DATE ON OPTIMUM PLANT POPULATION

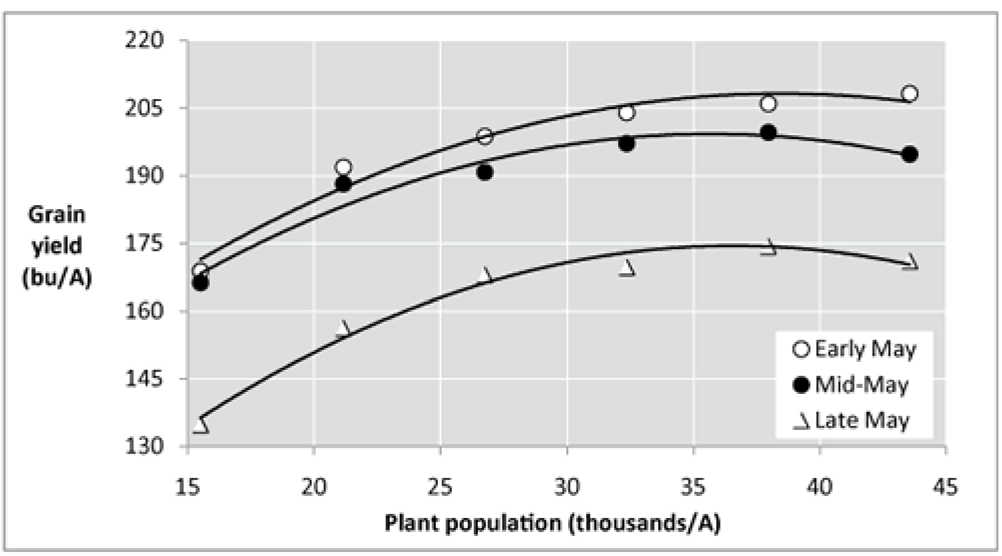

Figure 1.

Figure 1. Corn response to plant population for three planting dates. Data are averages over two locations (Lamberton and Waseca) in 2008.

Planting date has a considerable impact on corn yield. When compared to an early May planting date for a population of 32,400 plants/A, our results from 2008 at Lamberton and Waseca show that yield was reduced by 3% and 17% when planting was delayed until mid-May and late May, respectively (Figure 1). This study also found that the optimum plant population was statistically similar across all three planting dates. However, the data in Figure 1 show that the optimum plant population may be slightly higher with early planting possibly due to the greater yield potential of early-planted corn. Producers may also consider planting a few more seeds when planting early to compensate for reduced emergence in cooler and wetter soils. Seeding rates needed to achieve to various plant populations based on expected emergence are listed in Table 1.

Table 1. ***Seeding rates needed to obtain various stands based on expected emergence.***

Desired stand (plants/A)	Seeding rate based on expected emergence (seeds/A)		
	85%	90%	95%
30,000	35,300	33,300	31,600
31,000	36,500	34,400	32,600
32,000	37,600	35,600	33,700
33,000	38,800	36,700	34,700
34,000	40,000	37,800	35,800
35,000	41,200	38,900	36,800
36,000	42,400	40,000	37,900

IMPACT OF ROW SPACING ON OPTIMUM PLANT POPULATION

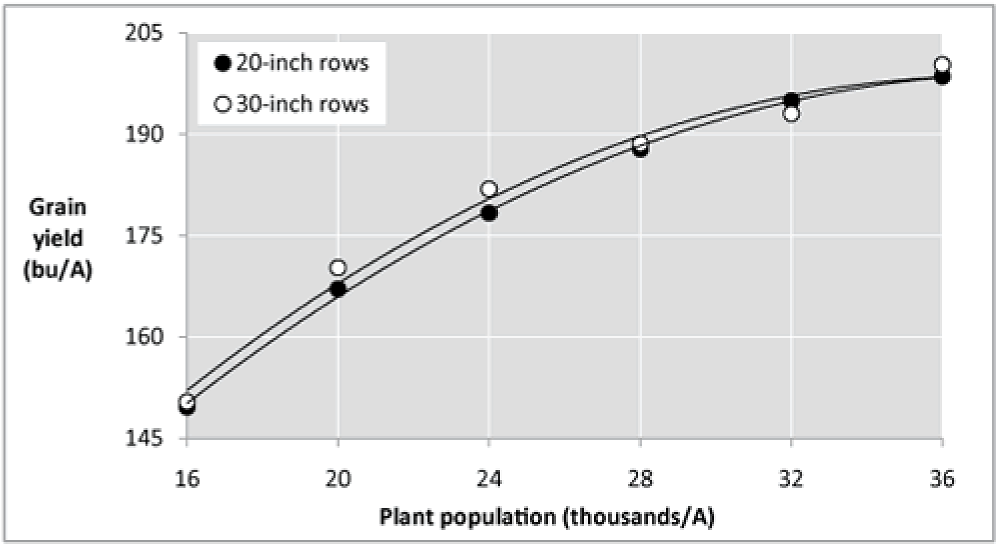

Figure 2.

Figure 2. Corn response to plant population for two row spacings. Data are averages over two locations (Lamberton and Waseca) and three years (2005 to 2007).

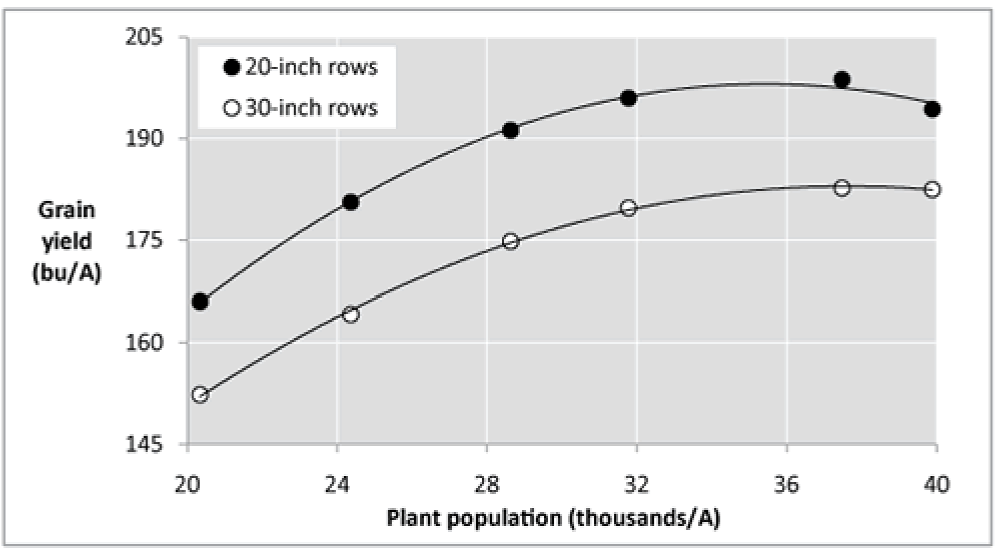

Figure 3.

Figure 3. Corn response to plant population for two row spacings in 2008. Data are averages over 4 hybrids and two locations (Lamberton and Waseca).

From 2005 to 2007 at Lamberton and Waseca, yield response to plant population was evaluated in 20- and 30-inch rows for a single full-season hybrid (Figure 2). The results fron this set of trials show no yield advantage for planting corn in narrow rows for any plant population, and indicate that the optimum plant population is similar for both 20- and 30-inch rows.

In 2008, experiments at Lamberton and Waseca evaluated the response of four hybrids to plant population in both 20- and 30-inch rows. Averaged across hybrids and locations, yield response to plant population was similar for both 20- and 30-inch rows (Figure 3). This supports the results from the row spacing trials conducted from 2005 to 2007 (Figure 2), and further indicates that optimum plant population is not affected by row spacing. However, unlike the results from 2005 to 2007, yield with 20-inch rows in 2008 was consistently higher than that with 30-inch rows for all hybrids. Averaged across hybrids, locations, and plant populations in 2008, yield was 9% greater with 20-inch rows than with 30-inch rows (Figure 3). It is unclear why there was an advantage to narrow rows in 2008, but not in 2005 to 2007.

IMPACT OF HYBRID SELECTION ON OPTIMUM PLANT POPULATION

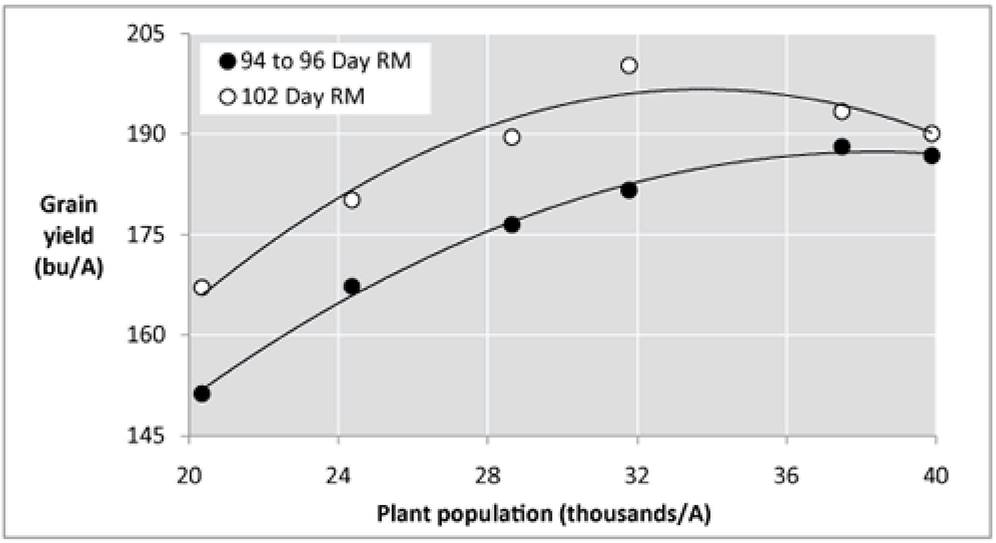

Figure 4.

Figure 4. Corn response to plant population in 2008. Data for each maturity group are averages over two hybrids, two row spacings (20- and 30-inch rows), and two locations (Lamberton and Waseca).

Of the four hybrids evaluated in the row spacing study in 2008 (Figure 3), two hybrids had a relative maturity (RM) of 94 and 96 days, and the other two hybrids had a RM of 102 days. While optimum plant population differed between the two maturity groups (Figure 4), it dic not differ between the two hybrids within each maturity group. Averaged across locations and row spacings, the economically optimum plant population based on a seed cost of $250/80,000 seeds and a corn price of $4.00/bu was 34,800 plants/A for the 94 to 96 day RM hybrids, and 31,400 plants/A for the 102 day RM hybrids. Since earlier-maturing hybrids tend to be shorter and have less leaf area than full-season hybrids, it is possible that they may require higher plant populations for optimum light interception. However, we did not find that one of the maturity groups or hybrids was better suited to narrow rows than the others.

ADDITIONAL CONSIDERATIONS FOR OPTIMUM PLANT POPULATION

Increases in grain yield resulting from higher plant populations are primarily due to increased light interception by the crop canopy during grain-fill. In the planting date trial shown in Figure 1, light interception by the crop canopy was measured just after silking (Figure 5). Each data point in Figure 5 represents canopy light interception and the corresponding grain yield for each level of plant population, averaged across three planting dates and two locations. The results show that as plant population was increased from 15,600 to 32,400 plants/A, canopy light interception increased from 82 to 92% and grain yield increased from 157 to 190 bu/A. However, as plant population was increased from 32,400 to 43,600 plants/A, light interception only increased from 92 to 95% and grain yield increased by just 1 bu/A.

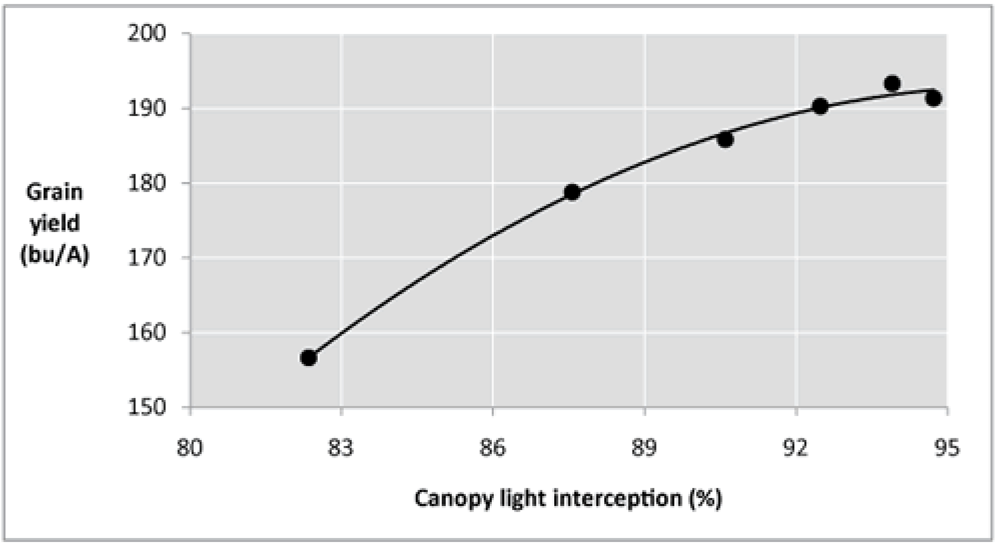

Figure 5.

Figure 5. Relationship between canopy light interception during grain-fill and corn grain yield, averaged across three planting dates and two locations (Lamberton and Waseca) in 2008. Individual data points are for six plant populations ranging from 15,500 to 45,600 plants/A.

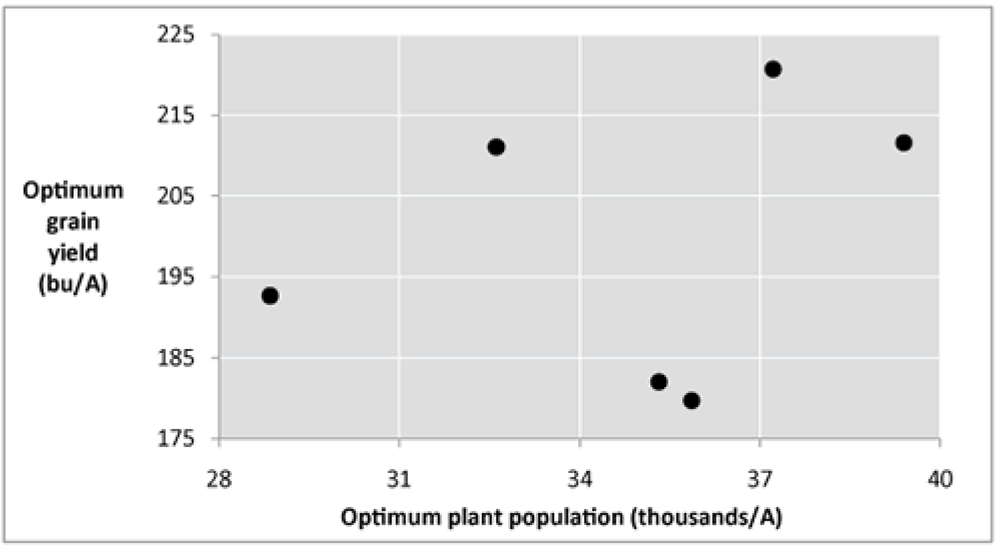

Figure 6.

Figure 6. Relationship between economically optimum corn plant population and grain yield at the optimum plant population from 2005 to 2007 at Lamberton and Waseca. Data are averages over two row spacings. Economically optimum plant population was calculated based on a seed cost of $250/80,000 seeds and a corn price of $4.00/bu.

The results in Figure 5 indicate that the optimum plant population is clearly related to the amount of light interception during grain-fill, and that the economically optimum plant population is likely near the minimum plant population needed to intercept the majority of the light during grain-fill. Thus, plant population should be managed with the goal of optimizing light interception. Light interception during grain-fill can be evaluated by looking under the crop canopy near solar noon on a calm, sunny day. Fields with optimum plant population will have very little sunlight hitting the soil surface, and also very few plants without ears.

Another consideration with regard to optimum plant population is yield potential. Many researchers have shown that the optimum plant population is greater under higher-yielding environments. For example, using data from 1991 to 1994 from four locations in Illinois, Nafziger (2002) reported that as optimum grain yield increased from 135 to 225 bu/A, the optimum plant population increased from about 25,000 to 32,000 plants/A. In other words, the optimum plant population increased by approximately 780 plants/A for each 10 bu/A increase in optimum grain yield. Results from a much smaller set of data in Minnesota do not support higher plant populations in environments with greater yield potential (Figure 6), possibly due to the narrower range of optimum yields in this set of data.

GENERAL GUIDELINES FOR OPTIMUM PLANT POPULATION

Figure 7.

Figure 7. Response of corn yield potential to plant population, averaged over 34 plant population comparisons from 2005 to 2008 at Lamberton and Waseca.

The data presented in this publication represent a total of 34 plant population comparisons from 10 experiments conducted between 2005 and 2008 in southern Minnesota. The economically optimum plant population was calculated for various seed costs and corn prices for each of these experiments, and the weighted averaged was then calculated across experiments to develop a general set of guidelines (Table 2). These results indicate that a plant population of approximately 32,000 to 34,000 plants/A is needed to maximize profitability. Corn response to plant population averaged over all experiments in this publication is reported in Figure 7 and Table 3, which are useful for estimating yield loss due to reductions in plant population caused by unexpected weather or soil conditions.

Table 2. *Economically optimum plant population for various seed costs and corn prices. Optimum plant populations were calculated based on data from 34 plant population comparisons conducted between 2005 and 2008 at Lamberton and Waseca.*

Seed cost ($/unit)*	Corn price ($/bu)				
	3.00	3.50	4.00	4.50	5.00
175	33,600	34,100	34,500	34,800	35,000
200	33,100	33,700	34,100	34,400	34,700
225	32,600	33,200	33,700	34,100	34,400
250	32,100	32,800	33,400	33,800	34,100
275	31,600	32,400	33,000	33,400	33,800
300	31,100	31,900	32,600	33,100	33,500

*One unit is 80,000 seeds. Optimum plant populations do not include the extra seed needed for stand.

Table 3. *Relationship between corn plant population and yield potential using the data from Figure 7. Data are averages of 34 plant population comparisons from 2005-2008 at Lamberton and Waseca.*

Population (plants/A)	Grain yield potential (%)
36,000	100
34,000	99
32,000	99
30,000	97
28,000	95
26,000	93
24,000	91
22,000	88
20,000	84
18,000	80
16,000	76

REFERENCES

Nafziger, E.D. 2002. Corn. p. 22-34. In R.G. Hoeft and E.D. Nafziger (ed.) Illinois agronomy handbook. 23rd ed. Univ. of Illinois, Urbana.

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