Corn Agronomy Update

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Plant population affects yield by influencing all of the primary corn yield determinants: number of ears per acre, number of kernels per ear, and the weight per kernel. The optimum plant population for a field is determined by many factors, including the environment and crop management practices. According to the Corn Production in Manitoba manual (1999), current plant population recommendations for grain corn are:

- under normal yield conditions: 22,000 to 24,000 plants per acre
- under reduced yield conditions: 18,000 to 22,000 plants per acre
- under optimum yield conditions: up to 28,000 plants per acre

In comparison, Ontario recommendations state final plant population should range from 26,000 to 32,000 plants per acre.

Advances in plant breeding have made modern hybrids better able to withstand the stresses of high plant populations. As well, increased levels of fertility and improved herbicide weed control measures have helped to realize yield benefits from increasing plant population.

Can Manitoba corn producers increase their optimum yield potential by increasing plant population? Are the current population recommendations accurate? Should these recommendations be altered if using narrow row spacing? The Manitoba Corn Growers' Association undertook two studies to answer these questions. As well, a plant population survey of producers participating in the Manitoba Corn Growers Association yield competition was done to see if producers are utilizing the current recommendations.

I. Plant Population Study

Three hybrids of varying CHU ratings were grown at four different plant densities in Carman and Reinland in 2001 and in Graysville and Reinland in 2002. The hybrids were 39W54 (2100 CHU), 39T68 (2250 CHU), and 39A26 (2350 CHU). Each hybrid was seeded at a plant density approximately two thirds greater than the target density and was thinned after emergence to achieve the desired plant densities of 18,000, 24,000, 28,000, and 36,000 plants per acre. The sites were managed to produce a minimum yield of 110 bu/ac. Yield, moisture content at harvest, density, and stem breakage were measured.

What We Found

- Population had a significant effect on yield at three out of the four site years, where an increase in population led to an increase in yield (see Table 1, Table 2, Table 3, and Table 4).
- Population had no significant effect on moisture content at three out of the four site years. The only exception occurred at the Reinland 2001 site (Table 2), where increased population led to an increase in moisture content.
- Population had no significant effect on density at all four site years, indicating an increase in population did not negatively affect grain quality.
- Population had a significant effect on stem breakage at two of the four site years, where increases in plant population increased stem breakage.
- Increased stalk breakage at the Reinland 2001 site (Table 2) and the Graysville 2002 site (Table 3) did not translate into decreased yield, indicating the increase in yield due to increasing plant density overcame any yield or harvest losses resulting from stem breakage.

- Hybrid had a bigger influence on moisture and density than population at all four site years (data not presented). Rather, moisture and density was more influenced by maturity of the hybrid.
- Generally, no interaction between hybrid and population for yield, moisture, density, or stem breakage occurred at all four site years, indicating all three hybrids responded similarly to increases in population.

Table 1: Corn grain yield, moisture content, density, and stem breakage response to plant population treatment effects at Carman, MB (2001).

	Yield bu ac^{-1}	Moisture %	Density lb bu^{-1}	Stem Breakage %
Population (plants $acre^{-1}$)				
18,000	129	22.7	57.9	4.6
24,000	137	23.3	57.6	6.5
28,000	139	22.8	57.7	5.3
36,000	142	23.4	57.3	6.2
LSD (0.05)	11.4	1.1	0.5	2.9
Source of Variation	ANOVA (P>F)			
Population	0.1431	0.4398	0.2277	0.5424

Table 2: Corn grain yield, moisture content, density, and stem breakage response to plant population treatment effects at Reinland, MB (2001).

	Yield bu ac^{-1}	Moisture %	Density lb bu^{-1}	Stem Breakage %
Population (plants $acre^{-1}$)				
18,000	141	20.1	58.4	3.1
24,000	154	20.1	58.4	3.8
28,000	155	19.8	58.1	6.3
36,000	171	21.1	58.0	12.0
LSD (0.05)	8.9	0.9	0.6	3.1
Source of Variation	ANOVA (P>F)			
Population	**0.0001**	**0.0390**	0.5380	**0.0001**

Table 3: Corn grain yield, moisture content, density, and stem breakage response to plant population treatment effects at Graysville, MB (2002).

	Yield bu ac^{-1}	Moisture %	Density lb bu^{-1}	Stem Breakage %
Population (plants acre^{-1})				
18,000	108	22.7	57.9	0.8
24,000	132	22.6	57.3	1.2
28,000	125	23.3	57.4	2.5
36,000	133	23.6	57.2	2.7
LSD (0.05)	10.2	1.1	0.8	1.1
Source of Variation	ANOVA (P>F)			
Population	**0.0001**	0.1926	0.3655	**0.0023**

Table 4: Corn grain yield, moisture content, density, and stem breakage response to plant population treatment effects at Reinland, MB (2002).

	Yield bu ac^{-1}	Moisture %	Density lb bu^{-1}	Stem Breakage %
Population (plants acre^{-1})				
18,000	117	20.4	56.7	1.7
24,000	135	20.2	57.0	1.5
28,000	139	20.9	56.5	2.2
36,000	144	20.8	56.2	2.6
LSD (0.05)	6.2	0.8	0.7	1.5
Source of Variation	ANOVA (P>F)			
Population	**0.0001**	0.2180	0.1618	0.4610

Results indicated Manitoba corn producers might be able to realize an increase in yield by increasing their plant population. The two year study showed that increases in yield were possible up to 36,000 plants per acre without a decrease in quality or an increase in moisture content or stem breakage. The study also showed that the three hybrids studied could handle the increases in population. However, hybrid choice played a large role in determining moisture content at harvest and density.

II. Survey of Manitoba Corn Producers

In fall of 2003 while sampling for the Corn Yield Competition, final plant populations were measured to get a small picture of what populations Manitoba corn producers are using.

What We Found

Results from the survey indicated that producers are not using the current recommendations outlined in the Corn Production in Manitoba manual. Instead, the majority of producers are using higher plant populations than what the recommendations state (see Table 5).

Table 5: Number of producers utilizing the current plant population recommendations.

Current Recommendation	% of Producers (# of producers)
Normal Conditions 22,000 - 24,000 plants/ac	2% (1)
Low Yield Conditions 18,000 - 22,000 plants/ac	9% (4)
High Yield Conditions Up to 28,000 plants/ac	39% (17)
Not Mentioned >28,000 plants/ac	48% (21)

III. Effect of Row Spacing on Population

With the expansion of corn acres in Manitoba into non-traditional growing areas, questions often arise on the use of conventional seeding equipment for corn production. Producers often wonder what corn populations they should be targeting if they are using narrower row spacing. In 2003, a two-year study was initiated by the Manitoba Corn Growers Association and Manitoba Agriculture, Food and Rural Initiatives to determine optimum plant populations for narrow row spacings.

The hybrid 39M27 was grown at three different plant densities (24,000, 30,000 and 36,000 plants per acre) in three different row spacings (30, 20 and 7.5 inch) at Carman and Reinland. The sites were managed to produce a minimum yield of 110 bu/ac. Yield (grain and silage), moisture content at harvest, density, stem breakage, and silage quality parameters were measured.

Preliminary results indicated that the 20-inch row spacing had the highest yields, followed by the 7.5-inch and the 30-inch (see Table 6). However, when statistical analysis was done, there was no significant difference in yields between the row spacings. When population was examined, there was no consistent trend indicating which plant population was optimum for each row spacing. The results suggest that choosing a plant population based on management and environmental factors is more important than choosing a plant population based on row spacing.

Table 6: Corn grain yield response to row spacing treatment effects at Carman and Reinland, MB (2003).

	Grain Yield (bu/ac)	
Row Spacing (inches)	Carman	Reinland
30	149.6	142.8
20	155.5	154.4
7.5	151.0	150.0

Revision of Plant Population Recommendations
The results from the plant population study indicated that Manitoba corn producers should be aiming for higher plant populations to realize higher yields. The survey conducted in the fall of 2003 provided evidence that in fact corn producers are using higher plant populations than recommended in the Corn Production in Manitoba manual. Therefore, based on research and producer trends, perhaps the recommendations should be as follows:

- For grain corn: 24,000 to 26,000 plants per acre.
- Under optimum yield conditions: 26,000 to 30,000 plants per acre.
- In areas of lower CHU accumulation or lower yield conditions: 22,000 to 24,000 plants per acre.

Preliminary results from the narrow row spacing trials indicated producers do not need to modify their plant populations based on row spacing.

Choosing a Plant Population - Before Seeding
Before corn producers go out and increase their target plant population on their farms, several factors need to be considered.

1. Stalk lodging resistance of hybrid - Under high plant populations, there is often increased incidence of lodging due to a reduction in average stalk diameter. Hybrids with a good reputation for stalk strength can generally handle the shift to higher populations.

2. Seeding date - Benefits from higher plant densities will be obtained when corn is planted early. Later plantings result in larger, leafier plants which leads to more inter-plant competition and is at a greater risk of drought or heat-stress.

3. Field selection - Choose fertile, well-drained fields with good moisture holding capacity.

4. Growing conditions - Ensure conditions in the area can handle an increase in plant population. Factors to evaluate include soil moisture, temperature, and potential pest issues (i.e. increased chance of corn borer infestations).

5. Management practices - Make sure the crop is managed to handle the increase in plant population. Examine the fertility program and pest (weeds, diseases, insects) control measures.

6. Economics - Producers need to consider the economic return of planting more seed. Table 7 outlines the costs involved and the additional bushels required to make it a break-even proposition.

Table 7: Number of bushels per acre required to pay for a 4000 seed per acre increase in planting rate for seed corn at various prices.

Cost per Bag of Seed	Cost per 4000 Seeds	Breakeven (bu/ac)
$120	$6.00	2.0
$140	$7.00	2.3
$160	$8.00	2.7
$180	$9.00	3.0

Assuming price of $3.00 per bushel

But once the producer has decided on what the optimum population is for their farm and the hybrid their growing, the producer now needs to hit the target population. To achieve the target plant population:

- seed 5-10% more seeds than the target population to account for germination or seedling growth losses
- fine tune and calibrate planter
- don’t drive too fast as skips can reduce plant populations.

What Agronomists and Producers Should Look at After Seeding

Although the seeding operation may be done, a little field scouting once the crop is up and growing will help to determine if the producer hit their target or missed the mark. To figure out the actual population, count the number of plants in a row length equal to 1/1000 acre. So, for 30-inch row spacing, count the plants in a 17’4” row. For a 36-inch row spacing, count the plants in a 14’6” row. Multiply that number by 1000 to get the number of plants per acre. Do this several times in a field to get a representative sample. If the producer hit their target population, this part of their seeding operation is going well. If not, the producer should check over the planter (or examine the driver!) to see if anything can be improved upon.

In addition to evaluating plant population, also look at the uniformity of emergence and the uniformity of plant spacing within the row. All three factors play a large role in helping get the corn crop off to a good start in optimizing yield potential.