Corn Response to Increasing Plant Density

(OSCIA Middlesex SCIA Major Grant)

Purpose:

The purpose of this trial was to examine corn plant density under three distinct scenarios: a) field scale trials that compare yield and profitability under a range of corn seeding rates, b) the impact that higher seeding rates might have on corn performance when other stress levels are increased and c) the impact that the trend to higher seeding rates might have on corn replant decisions.

Methods:

a) Field scale population trials: cooperators were asked to plant field scale plots with 3 different target plant densities; 30 000, 35 000, and 40 000 plants per acre. A variety of hybrids were used. Actual populations were recorded (based on plant counts) and placed within a target population category. Most sites were replicated with 2 of each population. All other factors except seeding rate were held constant. In total 10 sites were completed by the Middlesex Soil and Crop Improvement Association.

b) High Density and other Stresses: an experiment was conducted in 2010 at the Elora Research Station to determine the interaction of stress, fertility, and corn density (see Figure 1). The experimental design was a split-split plot design with the no-stress, weed competition, and soil compaction as main plot treatments, with or without starter fertilizer as split-plot treatments, and four plant densities as split-split plot treatments. All plots were side-dressed with 168 kg/ha of N (UAN) when corn was at the 8-leaf tip stage.

Weed competition consisted of seeding winter wheat immediately prior to corn planting. Wheat was killed with glyphosate on June 21, when corn was at the 10-leaf tip stage. Weeds were controlled in the no-stress and compaction treatments with glyphosate applied when corn was at the 2 leaf-tip stage. Soil compaction was implemented by vehicle compaction on May 3, one day after receiving 17 mm of rainfall. Starter fertilizer treatments were: (i) no starter fertilizer; and (ii) starter fertilizer (224 kg/ha of 5-20-20 plus 95 L/ha of 28-0-0 applied 5 cm below and 5 cm to the side of the seed furrow, and 47 L/ha of 6-24-6 applied in the seed furrow). Pioneer 38N88 was planted at densities of 24, 30, 36, and 42,000 plants per acre on May 18, 2010. Grain yield was measured at maturity on November 10, 2010.

c) Density and Re-planting Decisions: an experiment was conducted at Elora to evaluate the impact of density and planting date. Corn was planted at a range of seeding rates (12, 18, 24, 30 and 36,000 seeds per acre) at the end of April. Subsequent plots were then planted at the end of May at 30,000 plants per acre. The experiment examined the seeding rate that corresponded with maximum yield when planted in late April, the yield obtained from a full (30,000 plants per acre) when planted in late May and the plant population from late April plantings that would have represented a break even status compared to re-planting in late May. Six hybrids were compared under all planting date and population scenarios.

Figure 1. Photo of population and stress experiment at Elora with plots of increasing weed stress and soil compaction.

Results:

a) <u>Field scale population trials</u>: all 10 trials are presented in Table 1 with statistical analysis to compare differences between treatments.

Table 1: Summary of each site

Site	Hybrid	Target Population (pl/ac)					
		30000		35000		40000	
		Actual Pop	Yield* (bu/ac)	Actual Pop	Yield* (bu/ac)	Actual Pop	Yield* (bu/ac)
1	DKC50-18	28,250	198 ab	33,500	205 a	38,750	196 b
2	DKC50-19	30,500	131 a	34,250	132 a	40,250	132 a
3	DKC53-41	28,000	192 a	35,000	198 a	38,500	191 a
4	P0125HR	30,567	206 a	35,300	203 ab	40,500	201 b
5	DKC50-44	30,250	219 a	35,083	217 ab	39,750	213 b
6	DKC50-45	28,250	190 a	34,250	198 a	38,750	188 a
7	DKC48-37	30,209	128 a	35,152	127 a	41,084	127 a
8	DKC50-44	30,628	187 a	35,733	182 a	40,209	172 a
9	P0118HR	30,628	194 c	35,733	203 b	40,209	210 a
10	DKC50-45	30,250	204 a	34,250	199 ab	39,500	196 b

* significance level of p=0.1 Yields within a site followed by the same letter are not significantly different.

There were no significant differences between populations densities at any of the 10 sites at the p=0.05 significance level. There was a trend (p=0.1) for the 30 000 and 35 000 plants/acre densities to yield significantly higher than the 40 000 plants/ac density (Table 1). As such, this data indicates no real advantage to corn seeding rates above 30,000 plants per acre.

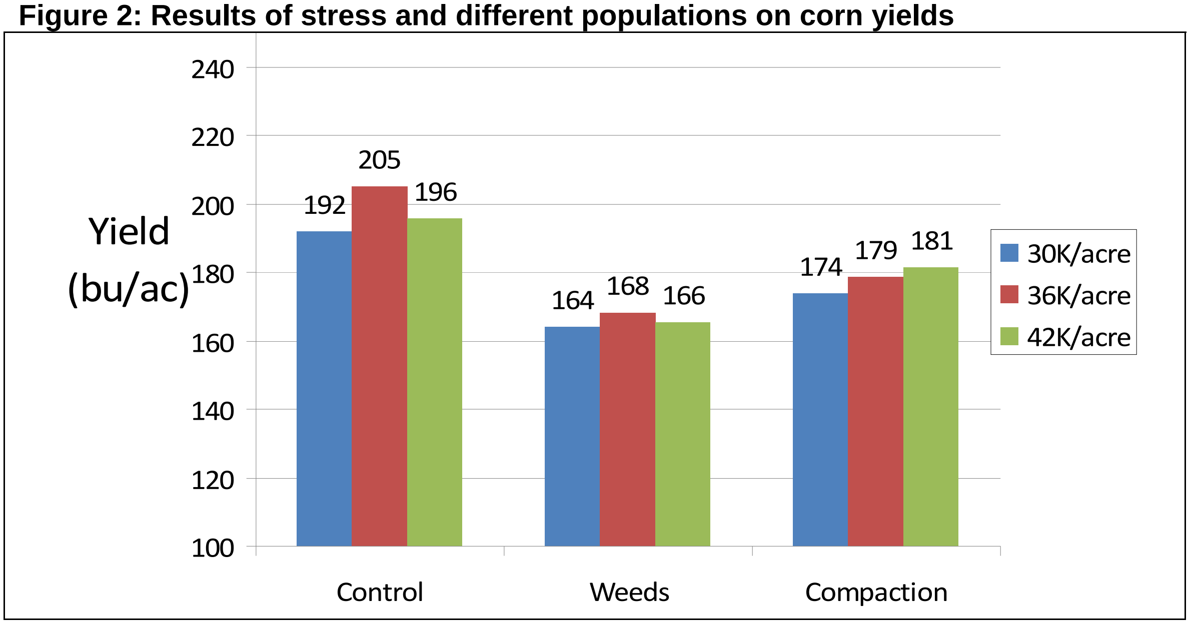
Table 2 provides an economic consideration of costs ($/ac) of increasing plant density from 30 000 to 35 000 plants/ac. The market price of corn and the costs of a bag of seed were factored together to give the net return to a producer.

Table 2: Net Returns ($/ac) to Seed Investment

Yield (bu/ac)	Seed Cost ($ /bag)		
	$200	$250	$300
All	-3.77	-6.89	-10.02
110-204	-7.6	-10.73	-13.85
>204	0.07	-3.05	-6.18

b) High Density and other Stresses: in the stress free plots moving from 30,0000 to 36,000 plants/ac did increase yields by 7 bu/ac. This impact was not as evident when stresses of increased soil compaction or increased competition from weeds existed (see Figure 2). Seeding rates of 42,000 plants/ac did not on average improve yields compared to lower populations, however it should be noted that under the weedy or soil compaction conditions the 42,000 plants/ac yields were not reduced compared to lower populations as one might have been expected.

Figure 2: Results of stress and different populations on corn yields



Excellent growing conditions, including adequate rainfall, may have mitigated stress factors. These conditions also resulted in record regional yields in 2010 and in adjacent research plots, uncontrolled weeds reduced corn yield by only 27% compared to a reduction of 60% in 2007 when mid-summer precipitation was below normal.

c) Density and Re-planting Decisions: this experiment also resulted in very high yields; average yield across the 6 hybrids was 219 bu/ac for those plots that were planted in late April. The plant population that maximized early planted yields varied considerably among the 6 hybrids; ranging form 28,458 to 35,786 plants/ac (see Table 3). Minimum populations before you would obtain higher net returns from a late May re-plant averaged 18,362 plants/ac but again there was significant range among the hybrids tested.

Table 3: Impact of planting date and population on corn yields, Elora 2010.

Hybrid	Early Plant Max. Yield	Early Plant Max. Pop.	Replant Yield (@ 30K)	Early Plant Min. Pop.*
38N88	218	29,535	193	19,590
A6012G3	233	32,464	196	19,576
CVR44	221	31,879	158	14,908
DKC3826	221	35,786	179	20,118
MZ3490	225	30,667	176	16,356
N17H-3000GT	195	28,458	176	19,625

* Early plant minimum population is the plant population from a late April planting date that you would need to have in order to be at an economic break-even point compared to re-planting in late May and achieving at 30,000 plants/ac stand.

Summary:

a) Field scale trials in 2010 did not result in a positive response to moving populations from 30 to 35 or 40,000 plants/ac. Average yields were quite high across the field sites. Although there is a large amount of interest in increasing seeding rates this data would suggest growers should move in that direction with caution.

b) Contrary to our original hypothesis, there was no significant interaction between corn density and stress. Stress reduced corn yield but higher densities did not result in an increased loss of yield relative to the lower plant populations. Yields increased as corn density increased from 24,000 to 30 and 36, 000 plants/ac, respectively. No further improvement in yield was obtained by increasing density to 42,000 plants/ac.

c) Optimum corn densities ranged from 28,500 to 36,000 plants/ac in early planted corn and appeared to hybrid dependent. Threshold density for when to replant a poor stand in late May averaged 18,362 plants/ac.

Next Steps:

All of the research listed here will be repeated in 2011. We will continue to examine the role of higher corn plant populations in increasing yields and to study the effect of hybrids and other stresses on this relationship.

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