MANAGING CONTINUOUS CORN FOR HIGH YIELDS

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Abstract

Many "contest-winning" corn yields have historically been produced in fields where corn is grown continuously, often with extensive tillage, high soil test values of P and K, high N rates, and high plant populations. We are conducting a series of research trials at four sites in Illinois, in which we are varying tillage, fertilizer rates, and plant population in a factorial experiment at several Illinois locations. Over ten site-years to date, tillage deeper than normal increased yield at two site-years, both at the same location (Monmouth), where deep tillage was done with a "cut" moldboard plow. Added fertilizer (100 lb N per acre, plus extra P and K) increased yield at five site-years, while raising the population from 32 to 40 thousand plants per acre significantly decreased yield at five site-years, and increased yield only once. Interactions among tillage, fertilizer rate, and population have been uncommon and inconsistent, though across environments, raising the population has tended to decrease yield less with both deeper tillage and higher fertilizer rates. This work is ongoing, but to date we have failed to show consistent yield increases from increasing tillage, fertilizer, or plant population levels, or from interactions among these inputs. Even disregarding economics, we have found no consistent "formula" for raising continuous corn yields.

Introduction

Recent high yields recorded by Francis Childs in Iowa and by others have usually been from fields where corn is grown continuously. This has resulted in support for the idea that such yields may be high *because* corn follows corn. There is no known research data supporting this idea; our recent work in Illinois shows that in direct comparisons, corn following corn produces 7 to 10 percent less yield than corn following soybean. On the most productive fields, continuous corn can certainly produce high yields, but inputs needed to produce such yields must be investigated and rationalized.

While we have accumulated a considerable amount of data on the nitrogen response of corn following corn compared to that of corn following soybean, we do not know the effects of some of the "high yield practices" used by some producers, including those producers who are attempting to produce yields above 300 bushels per acre. Such practices typically include deep and thorough fall tillage, high N rates, and high plant populations. Most fields also have high to very high P and K levels, usually as a result of high inputs from fertilizer and/or manure over a period of years.

While this set of practices clearly results in high yields, it is possible, or even likely, that some of these practices may contribute little or nothing to yield. This study is designed as a way to isolate the effects of deep tillage, additional plant nutrient supply, and higher plant population, and interactions

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among these factors, on corn yield at a number of productive sites in Illinois.

Materials and Methods

Trials were established in 2003 at two locations, and were expanded in 2004 and 2005 to four locations, all University of Illinois Research and Education Centers operated by the Department of Crop Sciences: 1) DeKalb (North Central Illinois), with predominantly Drummer-Flanagan silt loam-silty clay loam soils; 2) Monmouth (West-Northwestern Illinois), with predominantly Tama-Muscatine silt loam soils; 3) Urbana (East Central Illinois), with predominantly Drummer silty clay loam soil; and 4) Orr Center, near Perry in West-Southwestern Illinois, with Clinton-Keomah-Rushville silt loam soils. In 2005, we established two locations at Urbana, in preparation for moving the trial from Site A to Site B.

Treatments were arranged as a 2 x 2 x 2, split-split-plot factorial, in a randomized complete-block design with 4 replications. The previous crop was corn, and in second and subsequent years at each location, treatments were kept in the same plots as in the previous year. Main plots consisted of 1) fall chisel plow following corn, and 2) deep tillage using a modified mini-moldboard or another tillage tool capable of soil disturbance to a depth of about 15 inches. Subplots consisted of two levels of fertilizer: 1) normal amounts of P and K according to soil test values and 220 lb of N in the spring, and 2) an additional increment of 80 lb P_2O_5 and 150 lb K_2O per acre annually, and an additional 100 lb N in the spring, for a total of 320 lb of N. Sub-subplots consist of two final plant populations – 32,000 and 40,000 per acre, established after emergence following planting of about 45,000 seeds per acre. Hybrids used at the different sites included Pioneer 33P67, Pioneer 34H31, Pioneer 34B24, and Pioneer 33N11. Sub-subplots were eight (30-inch) rows wide by 60 ft long. Yields within each sub-subplot were taken by machine harvest of the center 4 rows.

Results and Discussion

The trial at Urbana in 2004 did not include the plant population variable, and the DeKalb location was lost to water damage in 2004. The 2003 cropping season was average at Monmouth, where yields averaged 179, and outstanding at Urbana, where the average trial yield was 241 bu/acre (Table 1). The 2004 season was very favorable at most locations, with high yields in most areas, and relatively high yields for corn following corn compared to corn following soybean seen in other trials. Yields averaged 200, 238, and 224 bu/acre at Monmouth, Urbana, and Perry, respectively. In 2005, dry weather affected yields at most locations, and yields ranged from only 101 bu/acre at Monmouth to 209 bu/acre at the DeKalb.

Deep tillage increased yield significantly in both 2004 and 2005 at Monmouth, where a "modified (cut-down) mini-moldboard" plow was used (Table 1). A similar plow was used at DeKalb in 2005, but did not increase yield there. There was no significant tillage effect at any of the other sites. Across the ten site-years, deep tillage increased yield by an average of 5 bu/acre. Extra fertilizer increased yield significantly at five of the ten locations, and by an average of 10 bu/acre over all site-years (Table 1). The interaction between tillage and fertilizer was significant at only one location – Perry in 2005, where the yield increase from extra fertilizer was large when tillage was by chisel plow, but not when deeper tillage was used.

Raising the plant population from 32 to 40 thousand per acre decreased yield at five of nine sites, and increased yield at only one site (Table 1). Response to raising the population ranged from a decrease of 16 bu to an increase of 9 bu/acre, with an average response over nine locations being a loss of 6 bu/acre. There was an interaction between tillage and population at four of the locations; in 2003, there was less loss of yield from high populations with deep tillage than with chisel, while at two locations in 2005 (Urbana B and DeKalb), there was more loss of yield from high populations under deep tillage than with normal tillage. There was an interaction between fertilizer rate and population at three sites, and all showed less loss in yield from high population under the higher fertilizer rate.

Interactions among the management variables averaged across ten site-years are shown in Fig. 1. The largest loss in yield from high plant population came under normal tillage and fertilizer rates, while raising the fertilizer rate under normal (chisel) tillage "protected" yields from loss due to high plant population. The negative effect of higher population was more consistent, but smaller, with deep tillage. The inconsistency among site-years to date means that we cannot predict that these effects and interactions will occur consistently in the future; that is, considering site-years as random effects makes most main effects and interactions non-significant. It is clear from these results that simply raising inputs of tillage, fertilizer rates, and plant populations is not a "formula" for high yields in continuous corn, even though some of these inputs might return additional yield in some environments. This is true even if such inputs are not required to pay for themselves, as is usually the case for "contest" fields. In commercial production fields where such inputs have to pay for themselves, the inconsistency we have found is an even larger barrier to increased acceptance. This research is ongoing.

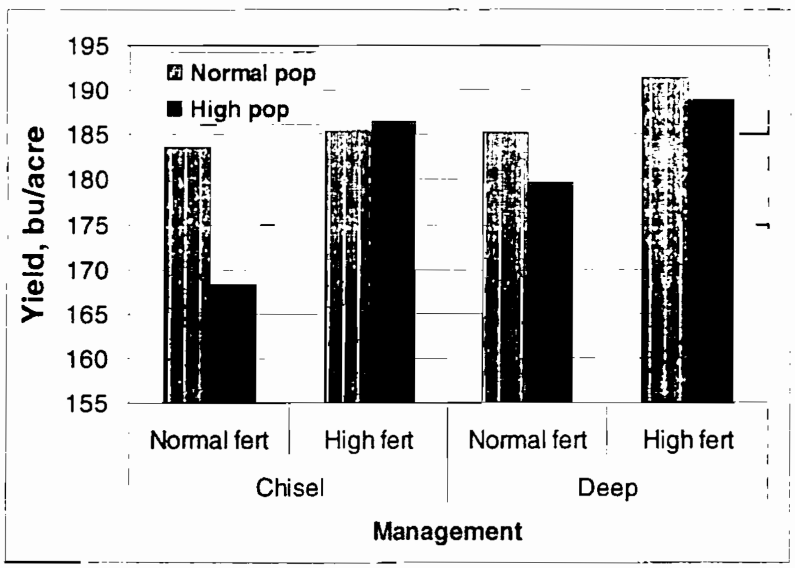

Figure 1. Yield as affected by interactions among management factors over 10 site-years of continuous corn in Illinois.

Table 1. Corn yields as affected by tillage, fertilizer rate, and plant population in continuous corn at ten Illinois sites. Differences between main effect are shown only f that effect was significant. For interactions, significance is shown at the 5 or 10% level by ** and *, respectively.

Tillage	Fertilizer	Population	UR-03	MN-03	OR-04	UR-04	MN-04	OR-05	UR-05A	UR-05B	MN-05	DK-05	Average
							bushels per acre						
Chisel			242	177	222	237	185	177	131	198	90	205	187
Deep			240	182	227	241	217	164	128	192	114	214	192
Difference, deep - chisel							**32**				**24**		**5**
	Normal		230	176	221	230	195	165	122	195	98	211	184
	High		252	183	228	248	208	175	137	196	105	208	194
Difference, high - normal			**21**		**8**	**18**	**13**	**10**					**10**
		Normal	245	187	223		207	166	132	199	109	210	186
		High	237	172	226		196	175	127	191	95	209	181
Difference, high - low			**-8**	**-16**			**-11**	**9**		**-8**	**-13**		**-6**
Chisel	Normal		233	172	219	232	178	165	125	198	87	206	182
Chisel	High		252	182	225	241	192	188	137	199	93	204	191
Deep	Normal		228	179	222	228	211	166	119	192	110	216	187
Deep	High		252	185	231	255	223	161	137	192	118	213	197
Tillage x fertilizer								**					
Chisel		Normal	250	189	223		194	174	134	199	96	202	185
Chisel		High	235	166	221		176	180	128	197	84	209	177
Deep		Normal	240	186	223		219	157	130	200	121	218	188
Deep		High	239	178	230		215	170	126	185	106	210	184
Tillage x population			*	**						*		**	
	Normal	Normal	236	185	220		202	166	128	203	110	210	184
	Normal	High	225	167	222		187	164	116	186	87	212	174
	High	Normal	254	190	227		212	165	136	195	108	210	188
	High	High	249	176	230		204	185	138	196	103	207	188
Fertilizer x population								**		**	*		
Site average yield			**241**	**179**	**224**	**238**	**200**	**170**	**129**	**195**	**101**	**209**	

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