

Soybean: Understanding Why a Yield Plateau Might Occur

McLean County Study: 2003-2005

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Farmers across Kentucky have been questioning whether or not soybeans have reached a “yield plateau”. While county average yield data imply modest gains over 30 years, farmers were concerned that their better-producing fields were hitting this plateau.

A group of farmers from McLean County met with University of Kentucky research and extension faculty to discuss the issue of the yield plateau and to visit fields. From that discussion, the Kentucky Soybean Board was willing to fund an investigative look into the question of a possible yield plateau.

We started with the premise that plant growth is determined by the most limiting factor - weather (temperature, rain); crop management (variety, planting, weeds, diseases, insects); and soil management (nutrients, tillage, soybean cyst nematode (SCN)). Then we tried to determine what limiting factor, if any, was present in the McLean County fields we sampled.

There were two parts to the investigation. The first part was to characterize some soil biological, chemical, and physical properties of fields exhibiting different soybean yield levels. The second objective was to pull soil samples from soybean fields across the county to determine soil fertility and SCN levels.

For the first part, nine fields with the Melvin silt loam soil series were sampled. Of the nine fields, seven were row-cropped and two were wooded. Within each field, ten evenly-spaced sampling points were located along a 900-ft transect. By sampling from only one soil type, we could better determine if production practices were affecting yield. Also, by sampling two wooded areas, we could compare their soil properties with those due to row-cropping this silt loam soil.

A wide range of characteristics were assessed in each field, including soil fertility, soil structure, soil compaction, and SCN. Penetration resistance varied with depth and among fields (Figure 1). There were fields with shallow compaction and fields with deep compaction. Compaction occurred when penetration resistance levels were above 300 psi. Two fields were low in soil test P and K, while two fields were high for SCN. The overall summary of that part of the research project is given in Table 1.

For the second part of the project, 27 fields were sampled for soil fertility and SCN levels during the growing season. The county agent helped us select soybean fields in the county that were believed to be high-yielding. Soil samples were pulled according to

University of Kentucky recommendations. The soil test results from those samples are included in Table 2. Sixteen of the 27 fields had at least one yield-limiting factor. Nine of the fields were low in potassium (K), seven were low in phosphorus (P) and ten fields were low in soil pH.

Several yield-limiting factors, including soil fertility, soil structure and soil-borne pests were observed in McLean County. The limiting factors for each field were often different. Reducing secondary tillage and fertilizing and adjusting soil pH according to soil test recommendations would alleviate most of the limiting factors we observed in these McLean County soybean fields. Rotation away from soybean for a year to two, as well as use of SCN-resistant varieties would help manage fields with high SCN counts.

These findings were shared with producers at a meeting in McLean County. We have not followed up on individual fields to determine if yield-limiting factors have been alleviated.

Figure 1. Soil penetration resistance with depth.

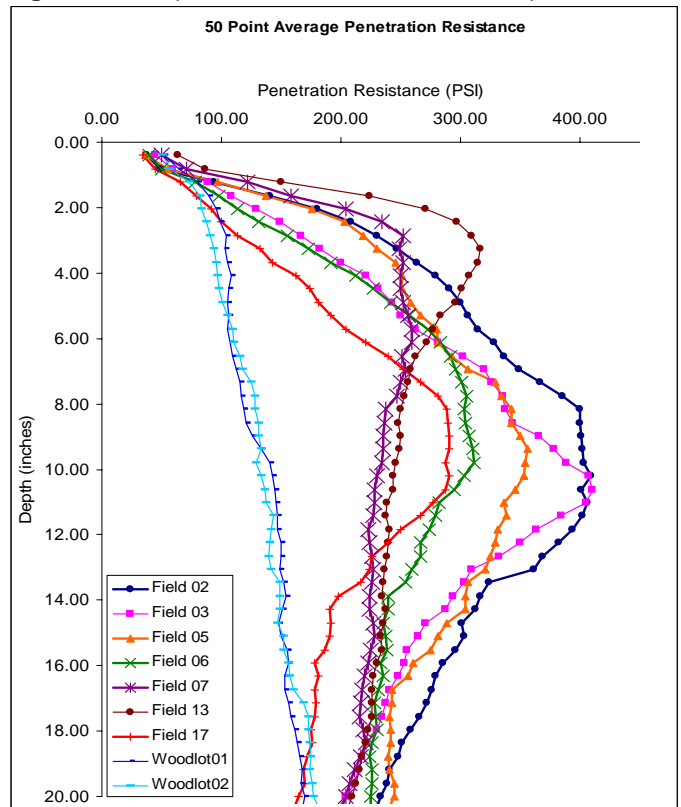


Table 1. Yield limiting factors for seven intensively sampled soybean fields.

Field #	Field Type	Limiting Factors
2	row-crop	penetration resistance, structure
3	row-crop	penetration resistance, structure
5	row-crop	SCN, penetration resistance, structure
6	row-crop	
7	row-crop	SCN
13	row-crop	P, K
17	row-crop	pH, P, K, structure
1	woodlot	n/a
2	woodlot	n/a

Table 2. Soil test results for twenty-seven soybean fields in McLean County, KY¹.

Field ID	pH ²	Buffer pH	P ³ lbs/A	K lbs/A	Zn lbs/A	Mg lbs/A	C lbs/A	B lbs/A	OM %	SCN	Limiting Factor ⁴			
											pH	P	K	sum
1	5.5	6.6	45	295	3.3	171	2786	0.6	1.49	0	1	1		2
2	5.5	6.9	80	310	1.6	318	1866	0.5	1.53	0	1			1
3	6.4	6.9	95	386	3.1	375	3577	0.5	1.57	30				0
4	6.4	7.1	84	333	2.2	290	3906	0.5	1.72	120				0
5	5.9	7	57	405	4.1	157	2892	0.4	1.83	15	1			1
6	5.6	6.9	45	261	2	145	2154	0.6	1.38	30	1	1	1	3
7	6.9	7.1	71	171	3	353	3792	0.5	1.58	780	1		1	2
8	6.2	7	67	263	3.4	506	4451	0.5	1.73	240				0
9	6.6	7	161	553	8.4	917	7842	0.8	2.62	330				0
10	6.5	6.9	214	378	11.1	270	3670	0.7	2.30	810				0
11	6.9	7.1	101	312	2.9	554	6076	0.6	2.16	15	1			1
12	6.1	7	229	422	10.2	259	2907	0.8	2.07	30				0
13	6.6	7	49	174	4.4	365	3986	0.4	1.48	0			1	1
14	6.3	7	40	355	6.7	280	4358	0.4	2.00	30		1		1
15	6.0	6.8	49	208	2.3	496	4528	0.6	1.78	45	1		1	2
16	6.0	6.9	90	411	2.9	484	4104	0.8	2.03	0	1			1
17	6.1	6.8	80	386	3.6	912	5387	0.7	2.04	30				0
18	6.3	7.1	40	141	2.4	286	3037	0.4	1.25	0		1	1	2
19	6.3	6.8	154	519	4	575	5414	0.5	1.90	0				0
20	6.3	6.9	73	317	4.5	773	5631	1.3	2.74	60				0
21	6.3	6.9	71	216	4.4	392	4598	0.4	1.63	30			1	1
22	6.1	6.8	306	368	19.4	339	3413	0.7	2.13	90				0
23	6.2	6.8	133	347	3.6	127	2627	0.3	1.59	0				0
24	7.1	7.2	98	245	6.1	237	3761	0.4	1.70	180	1		1	2
25	5.8	6.9	152	315	5.6	384	2504	0.5	1.82	150	1			1
26	6.3	6.9	150	205	7.4	245	3202			30			1	1
27	6.8	7.1	174	440	6.7	847	6242			90	1			1

¹ Samples were taken during June of 2004.² Yellow: pH below 6.2; molybdenum at 1 to 2 oz of sodium molybdate (0.4 to 0.8 oz elemental molybdenum) per acre as a seed treatment or 1 lb sodium molybdate (6.4 oz elemental molybdenum) per acre broadcast in 20 to 40 gallons of water prior to planting; not more than 2 lbs molybdenum per acre should be applied within a 5 year period.³ Blue: nutrient levels are medium; small amounts of fertilizer recommended; Green: nutrient levels are low; large amounts of fertilizer recommended.⁴ Limiting Factor: If pH was limiting, then a score of 1 was given. Same for soil test P and K. The limiting factors were summed to give the final column on limiting factors.