Refining Soil Test Recommendations for Corn

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Objectives:

1. Test the performance of current University of Missouri soil test recommendations for predicting corn response to P and K in a statewide network of experiments.
2. Explore the possibility that subsoil test values, soil type, or soil region could be used to improve our fertilizer recommendations and make them more site-specific.
3. Evaluate corn response to S, Zn, and B in Missouri, and evaluate factors (including soil test values) that might help predict where responses to these nutrients are likely.

Methods:

- Experiments were carried out alongside an existing statewide network of corn hybrid performance trials conducted by the University of Missouri in 2001 and again in 2002. Variety testing personnel planted and harvested the experiments, as well as controlling weeds.
- Thirteen experiments were conducted in 2001 and twelve in 2002, however two experiments were not harvested each year due to problems including Roundup drift, missed N applications due to miscommunication, and stand problems. Over the two-year period a total of 21 experiments were conducted, harvested, and analyzed. Experiments were distributed across the corn-growing areas of Missouri (Figure 1).
- Fields used in 2002 were different than fields used in 2001, though mostly on the same farms.
- P, K, S, Zn, and B fertilizers were hand-applied to separate plots at rates of 100 lb P_2O_5, 100 lb K_2O, 20 lb S, 10 lb Zn, and 1 lb B/acre. These rates should be high enough to produce full yield response.
- Two unfertilized check plots were used in each replication.
- Five replications were used.
- Soil samples were taken at depths of 0 to 6, 6 to 12, 12 to 24, and 24 to 36 inches in each experiment and analyzed for pH, P, K, S, Zn, and B.
- One well-adapted hybrid was used at each location (Tables 1 and 2).
- Due to promising results with zinc in the 2001 experiments, zinc treatments were also added to 13 fall N experiments around Missouri in 2002. Zinc treatments were hand-applied, and these plots were hand-harvested and shelled.

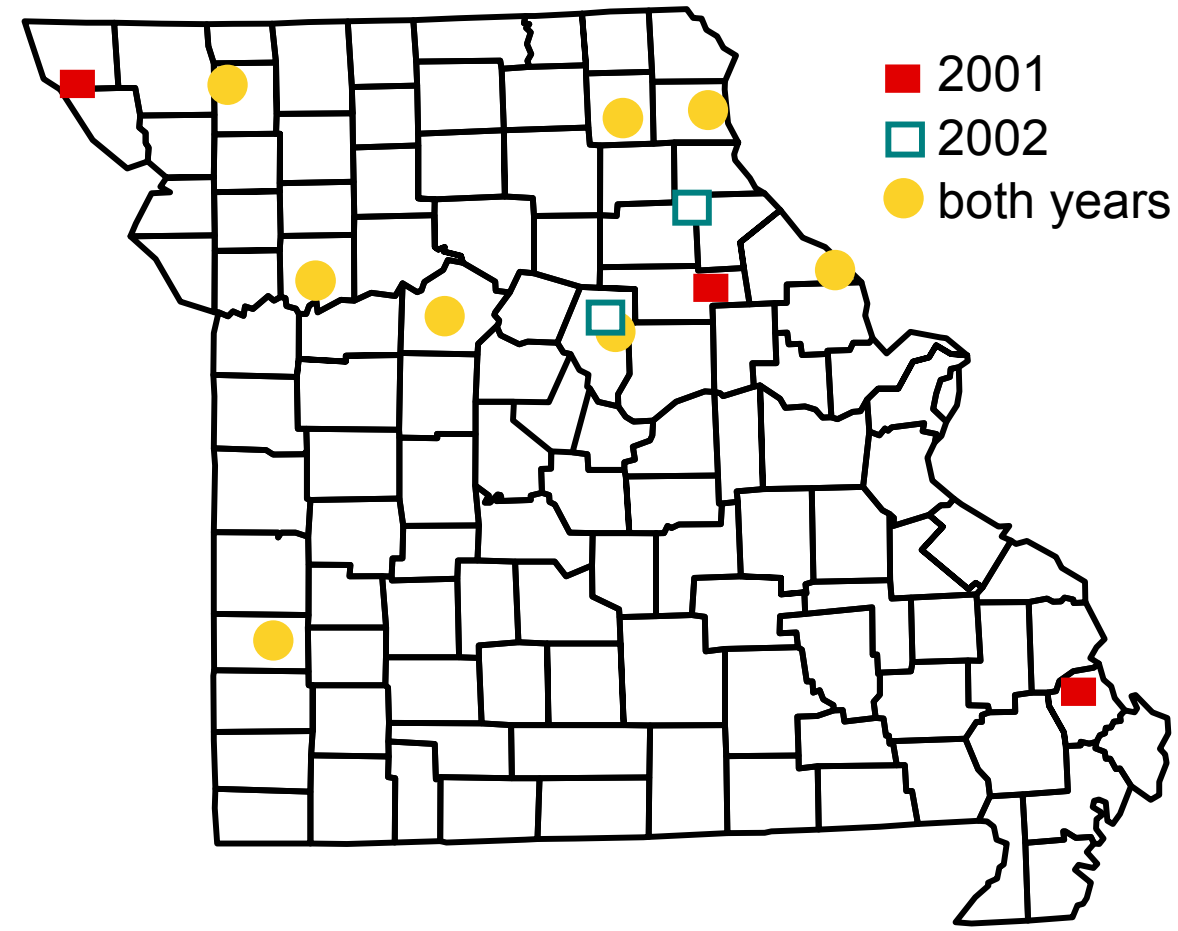

Figure 1. Locations of corn fertility experiments in 2001 and 2002. Only experiments that were harvested and analyzed are shown.

Table 1. 2001 EXPERIMENTAL LOCATIONS FOR CORN FERTILITY TRIALS

LOCATION	COUNTY	SOIL SERIES	HYBRID
Osborn	DeKalb	Grundy Silt Loam	Pioneer 33P67
Novelty	Knox	Putnam Silt Loam	Burrus 56
Annada	Pike	Tice Silt Loam	Novartis N7070
Truxton	Montgomery	Mexico Silt Loam	Mycogen 2833
Marshall	Saline	Joy Silt Loam	Mycogen 2833
Henrietta	Ray	Aholt Clay	Golden Harvest 9533B
Laddonia	Audrain	Putnam Silt Loam	Mycogen 2833
Oran	Scott	Commerce Silty Clay Loam	Mycogen 7821 BT
Lamar	Barton	Barden Silt Loam	Mycogen 7821 BT
Corning	Atchison	Salix Silty Clay Loam	
Albany	Gentry	Grundy Silt Loam	NK N67-H17
La Grange	Lewis	Westerville Silt Loam	Golden Harvest 922
Columbia	Boone	Mexico Silt Loam	Novartis 67-T4

Table 2. 2002 EXPERIMENTAL LOCATIONS FOR CORN FERTILITY TRIALS

LOCATION	COUNTY	SOIL SERIES	HYBRID
Novelty	Knox	Kilwinning Silt Loam	Asgrow 730YG
Annada	Pike	Tice Silt Loam	Mycogen 2833
Truxton	Montgomery	Mexico Silt Loam	Asgrow 730YG
Marshall	Saline	Joy Silt Loam	Pioneer 33P67
Henrietta	Ray	Haynie Silt Loam	Asgrow 730YG
Lamar	Barton	Parsons Silt Loam	Dekalb 65-26
Albany	Gentry	Grundy Silt Loam	Asgrow 730YG
La Grange	Lewis	Westerville Silt Loam	Mycogen 2833
Coumbia 1*	Boone	Mexico Silt Loam	Dekalb 65-26
Columbia 2	Boone	Mexico Silt Loam	Dekalb 65-26

*Columbia 1 is non-irrigated, Columbia 2 is irrigated.

Results:

- Average yield across all locations was 179 bu/acre in 2001, 147 bu/acre in 2002. Drought stress limited yields at several locations in 2002. Overall, yield levels were representative of good production practices and conditions for Missouri.
- Soil test levels were also representative of good production practices.
  - Soil test P was medium in 7 fields and high in 14 fields according to MU soil test interpretations (of the 21 experiments harvested).
  - Soil test K was low in 1 field, medium in 10 fields, and high in 10 fields.
  - The target soil test level for MU fertilizer recommendations is at the border between medium and high, so equal numbers of fields testing medium and high is considered ideal.
- Only one of eleven locations harvested in 2001 had statistically significant (90% confidence) yield response to fertilizer treatments (Table 3). This was at the Pike County site, where responses to both potassium (16 bu/acre) and boron (15 bu/acre) were observed. Soybean yield also responded to boron in a nearby field. Soil test potassium was medium at this location, and soil test boron was higher than at most other locations. Interpretations are not well-established for the boron soil test and it is generally not considered very reliable.
- Three of 10 locations harvested in 2002 had statistically significant (90% confidence) yield response to fertilizer treatments (Table 4), including responses to K, S, and B.
- All results that follow come from analyzing 19 experiments together. The Columbia 2001 and Henrietta 2002 experiments were excluded from these analyses because yield variability was extremely high.

Response to P

- Averaged over all 19 locations, there was no yield response to P.
- No statistically significant responses (90% confidence) to P were seen at any of the individual locations. However, there was a 9 bu/acre response to P at Columbia (dryland) in 2002 with 83% confidence (Table 4).
- Soil test P was not a significant predictor of the yield difference between check plots and P-fertilized plots.
  - Two-thirds of the experimental locations tested high for P according to University of Missouri soil test interpretations. If the interpretations are correct, we would expect no response to P at these locations, and possibly one or two responses to P in the locations that tested medium.
  - This definitely shows that current University of Missouri recommendations for P are high enough to support good corn yields.
  - We did not find any regions of the state or soil types where P recommendations might need to be higher.
  - These experiments can't answer the question of whether current University of Missouri recommendations for P are higher than is economically optimum for corn production.

Response to K

- Averaged over all 19 locations, there was no yield response to K.
- Statistically significant responses (90% confidence) to K were seen at three locations out of 19. Corn yield responded to K at the Annada location in both years (16 bu/acre in 2001, 10 bu/acre in 2002), and at the Columbia dryland location in 2002 (13 bu/acre).
- We saw weak evidence that soil test K was related to yield response.
  - For the two locations with soil test potassium < 200 lb/acre, the average yield difference between check plots and K-fertilized plots was 9 bu/acre. Because there were only two locations in this category, no statistical test can be run.
  - When soil test potassium was above 200 lb/acre, no yield response was seen.
  - This definitely shows that current University of Missouri recommendations for K are high enough to support good corn yields. The MU target value for soil test K depends on soil cation exchange capacity, but is around 300 lb/acre for most Missouri soils.
  - These experiments can't answer the question of whether current University of Missouri recommendations for K are higher than is economically optimum for corn production.
- Yield response to K may also be related to soil pH. The average yield difference between check plots and K-fertilized plots was 10 bu/acre for the three locations with the lowest pH values. However, this may be a coincidence since two of the three locations with the lowest pH values were the two Annada fields.
- Recent research at Iowa State has found quite a few yield responses when soil test K is high. Low soil test K in the subsoil is one factor that helps them to predict when high-testing soils will give yield responses. Our results did not follow this pattern. We did not see many yield responses when soil test K was high, and subsoil fertility was not helpful in predicting where we saw yield responses.

Response to S

- Averaged over all 19 locations, there was no yield response to S.
- One of the 19 locations (Annada 2002) had a significant (90% confidence) 9 bu/acre yield response to S, while another was near significance (Lagrange 2002, 9 bu/acre with 87% confidence). Both of these fields are located in the flood plain of the Mississippi River. However, neither location responded to S in 2001.
- We were not able to identify any factors that helped to predict the yield difference between check plots and S-fertilized plots.

Response to Zn

- Averaged over all 19 locations, there was a 3 bu/acre response to Zn (97% confidence). This suggests a slight yield limitation due to zinc deficiency occurring in many fields.
- However, there is also evidence that this is not the case. Due to promising results with zinc in the 2001 experiments, zinc treatments were also added to 13

fall N experiments around Missouri in 2002 in order to test zinc response over a larger range of fields. Yield response to zinc was not seen in these fields, and averaged over 32 total locations there was no response. The results from the additional 13 experiments are not as reliable because only three replications were used, compared with five replications in the 19 original experiments.

- When analyzed individually, none of the experiments showed a significant (90% confidence) yield response to Zn.
- We were not able to identify any factors that helped to predict the yield difference between check plots and Zn-fertilized plots.

Response to B

- Averaged over all 19 locations, there was no yield response to B.
- Statistically significant responses (90% confidence) to B were seen at two locations out of 19. Corn yield responded to B at the Annada location in 2001 (15 bu/acre) and the Lagrange location in 2002 (10 bu/acre). In similar experiments with soybeans, yield responses to B were seen at Annada and at Novelty in 2001. All of these locations are in the northeastern part of Missouri, and three of the four are in the Mississippi River floodplain, possibly indicating greater potential for response to B in these areas.
- Soil test values were not useful in predicting response to B.

Summary and Conclusions:

- Overall our results indicate that MU current soil test target levels are high enough so that when they are maintained, as in most of these fields, response to P and K fertilizer additions is minimal. This is the intent of the recommendations, which are built on a philosophy of long-term management. Even at the very high yield levels in some of these fields, and in a wide range of soil types, the P- and K-supplying capacity of these well-maintained soils was adequate to supply crop needs.
- Averaged over all locations, yield responses to S, Zn, and B were not seen. Statistically significant yield responses to S and B were seen at two locations each, but these responses could not be predicted from soil test values (either shallow or deep samples). Responses to B were all in northeastern Missouri for both corn and soybean (soybean response to B was measured in a separate set of experiments).

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Table 3. Yields From Corn Fertilizer Trials 2001

LOCATION	COUNTY	YIELD WITH FERTILIZER					
		UNFERTILIZED CHECK	P	K	S	ZN	B
Albany	Gentry	82	87	73	77	88	82
Annada	Pike	181	184	197*	182	188	196*
Columbia	Boone	146	135	154	139	123	121
Corning	Atchison/Holt	125	116	124	114	127	130
Henrietta	Ray	210	204	210	212	221	220
Laddonia	Audrain	238	246	236	227	227	225
LaGrange	Lewis	177	177	183	180	177	179
Lamar	Barton	189	175	172	194	193	172
Marshall	Saline	190	189	193	196	205	193
Novelty	Knox	176	183	177	175	178	171
Oran	Scott	265	258	246	239	261	255

*This yield is greater than the yield of the unfertilized check with greater than 95% confidence.

Table 4. Yields From Corn Fertilizer Trials 2002

LOCATION	COUNTY	YIELD WITH FERTILIZER					
		UNFERTILIZED CHECK	P	K	S	ZN	B
Albany	Gentry	77	73	62	81	84	72
Annada	Pike	187	193	197†	196†	189	188
Columbia-Dry	Boone	112	121§	125*	119	116	107
Columbia-Irr	Boone	208	215	209	217	211	210
Henrietta	Ray	174	177	156	139	177	168
LaGrange	Lewis	170	167	‡	179§	169	180†
Lamar	Barton	93	99	100	98	97	95
Marshall	Saline	209	215	207	201	208	204
Novelty	Knox	161	162	153	152	161	159
Truxton	Montgomery	77	76	82	83	82	82

*This yield is greater than the yield of the unfertilized check with greater than 95% confidence.

†This yield is greater than the yield of the unfertilized check with 90 to 95% confidence.

§This yield is greater than the yield of the unfertilized check with 80 to 90% confidence.

‡ K treatments were not applied at the LaGrange location due to an accidental broadcast K application to the experimental area.