CREDIBILITY IN SOIL TESTING: ANALYTICAL RESULTS

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In Illinois, soil testing to help farmers plan lime and fertilizer programs are done by commercial testing services. The Agronomy Department, University of Illinois participates in the State Soil Testing Program in research and coordinating roles. Recognizing that sources of error in the program may occur in FIELD SAMPLING, ANALYTICAL TESTING, INTERPRETATION OF TEST RESULTS, or FORMULATION OF RECOMMENDATIONS this paper focuses on ANALYTICAL TESTING.

Two quality assurance programs in ANALYTICAL TESTING are in use in Illinois. These are the monthly check testing and the biennial split soil comparison study. The monthly check testing involves the submission of six soil samples with their test results representing current testing activity in the different commercial services to the Agronomy Soil Testing Laboratory (ASTL) where the samples are check tested. This program has coordinated quality assurance since the inception of the Commercial Testing Programs in Illinois in the mid-1940's. Acceptable soil tests quality has been rated at + or - 0.2 pH unit for the water pH soil test, + or - 20% in the Bray P-1 phosphorus soil test and + or - 20% in the Bray P-1 phosphorus soil test and + or - 30 lbs/a in the potassium soil test. Premise of this program designates the ASTL as the referee laboratory. Generally this works well but experience over the years developed instances of disagreement between the two laboratories where the cause of test difference were not resolved.

Out of these differences, the split soil comparison study was developed. This program involves the preparation (i.e. drying, mixing, crushing and mixing) of six bulk soil samples having a range of test levels. A portion (2 oz. plastic container with lid) of each soil is sent to participating Commercial Soil Testing Services. Each Testing Service is assigned a Code Identification. The Testing Services return their test results to a central point where the results are tabulated and identified by their Code Identification. Further, the test results are sorted into an array arranged from low to high and a standard deviation calculated. An example report for the fall 1983 circulation is attached as pages 17, 18, and 19. The individual testing services can assess their standing among all participating services as the median is the desirable rating but fitting within a standard deviation is acceptable. Since the ASTL is the referee laboratory in the monthly program it is identified in this reporting.

This program started in 1982 and has been conducted biannually since then with generally a different set of soil samples each time but there have been some repeats of individual soil samples. Table 1 shows the number of participating Commercial Services has ranged from 74 to 54. At this time 12 sets or 72 soil samples have circulated.

Table 1. Number of Commercial Testing Services Participating in the Split Soil Sample Comparison Study.

Year	Number of Testing Services
1982	63
1983 Spring	65
1983 Fall	70
1984 Spring	72
1984 Fall	74
1985 Spring	67
1985 Fall	68
1986 Spring	65
1986 Fall	65
1987 Spring	62
1987 Fall	54
1988 Spring	54

Figures 1, 2 and 3 show the graphs of the relationship of standard deviations on the 72 soil samples for pH, P and K soil tests, respectively arranged from low to high.

Figure 1 shows a pH standard deviation of 0.1 pH unit on 19 of the 72 samples and 0.2 pH unit on 49, 0.3 pH unit on 2 and 0.4 pH unit on 2, with the greater standard deviation on the low and high testing soil pH levels.

Figure 2 shows standard deviation exceeding 20% on low P soil test levels reducing to less than 10% as soil tests increase to about 80 lbs/a but above that standard deviations increase markedly.

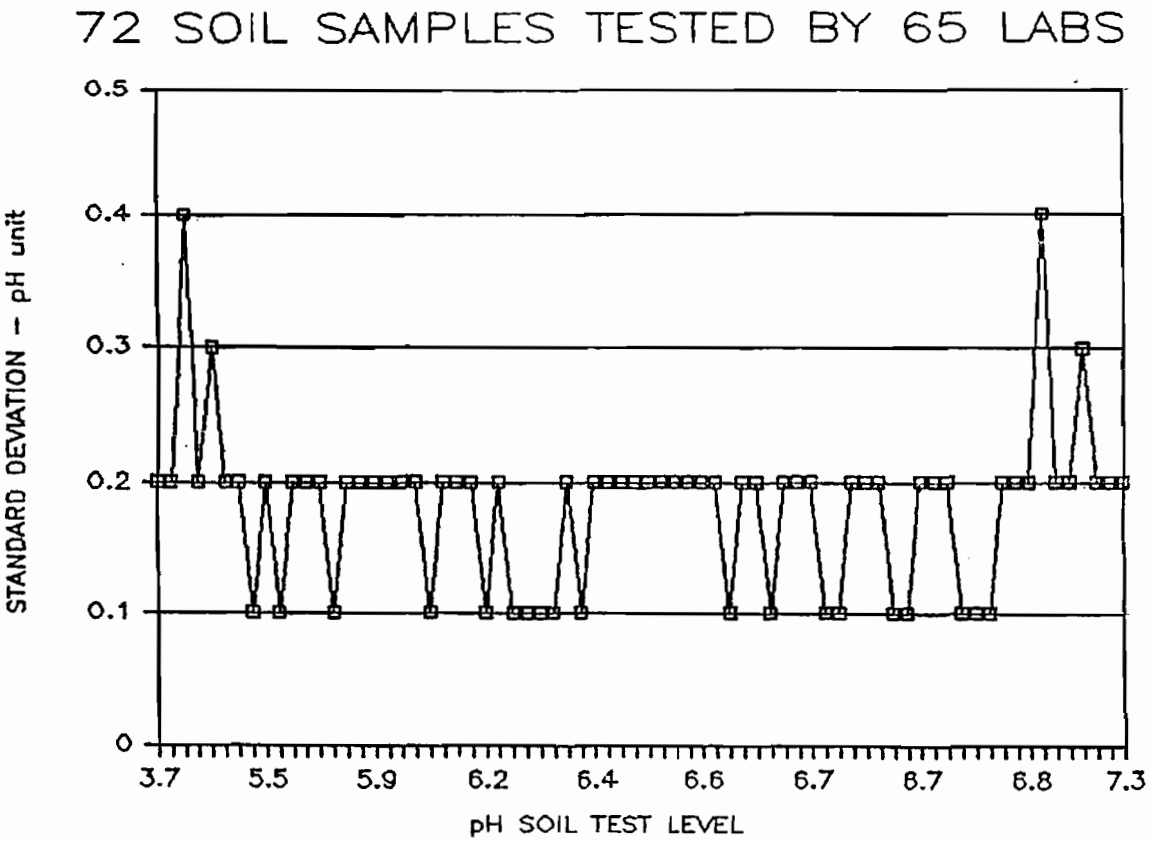
Figure 3 shows standard deviations in the 30 lbs/a range through K test levels of 400 lbs/a but increasing markedly above that.

Distribution of pH test values on three selected soils are shown in figures 4, 5 and 6. Figure 4 shows the distribution of test levels among 70 testing services on soil 83-8. The soil pH level for this soil has a strong central tendency with 31 testing service reporting a pH test level of 6.8. Among the 70 testing service the standard deviation is 0.1 pH unit. Figure 5 shows the distribution of pH test levels among the same 70 testing services on a different soil, 83-9, but circulated at the same time as soil 83-8. Soil 83-9 does not have a strong central tendency since 20 testing services report a pH of 5.8, 15 report a pH of 5.9 and 19 report a pH of 6.0. Among these testing services the standard deviation on soil 83-0 is 0.2 pH unit. Figure 6 shows the distribution of test levels among 63 testing services in soil 83-5. The normal distribution and standard deviation of 0.2 is more characteristic of the distribution of tests than either figures 4 or 5. Figures 7, 8, 9, and 10 show the distribution of the P soil test levels as the

absolute difference from the median for 4 selected soils to represent 4 different test levels.

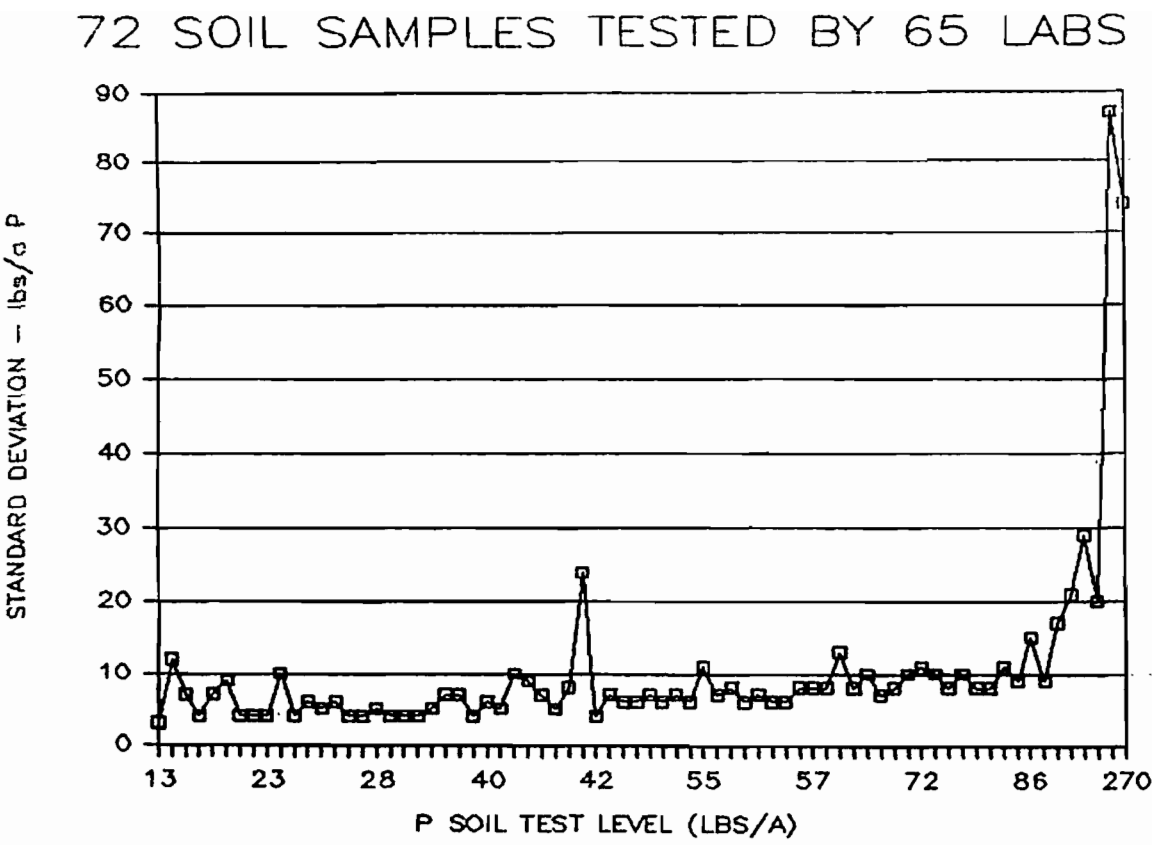
Figures 11, 12, 13, and 14 show the distribution of K soil test levels as the absolute difference from the median for 4 selected soils to represent 4 different test levels.

Soils with lower P and K test levels have stronger central tendency of test levels than soils with higher P and K test levels. A normal distribution appears to appropriately describe P and K test data.



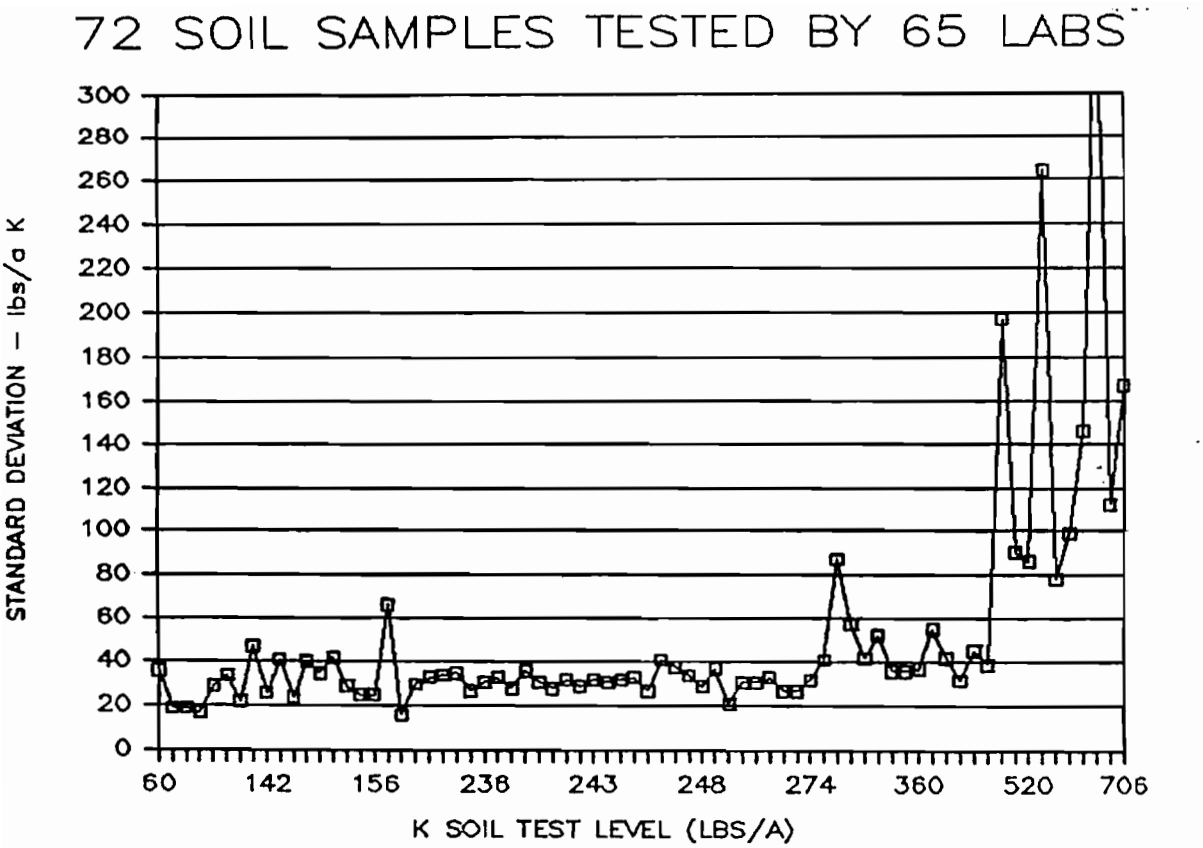
X axis tic mark values from left to right are:
3.7,4.5,4.5,4.6,5.1,5.5,5.5,5.5,5.5,5.7,5.7,5.8,5.9,
5.9,5.9,5.9,5.9,5.9,5.9,5.9,5.9,6.0,6.0,6.0,6.2,6.2,
6.3,6.3,6.3,6.3,6.4,6.4,6.4,6.5,6.5,6.5,6.5,6.5,6.5,
6.5,6.6,6.6,6.6,6.6,6.6,6.6,6.6,6.6,6.7,6.7,6.7,6.7,6.7,
6.7,6.7,6.7,6.7,6.7,6.7,6.8,6.8,6.8,6.8,6.8,6.8,6.8,
7.1,7.1,7.2,7.2,7.2,7.2,7.3

Figure 1. Distribution of standard deviations for water pH tests among 65 testing services on 72 soil samples.



X axis tic mark values from left to right are:
13,14,16,18,19,19,22,22,23,23,24,24,24,24,25,27,28,28,
30,36,37,37,38,40,40,40,40,40,40,41,41,41,42,42,45,50,
51,51,54,55,55,56,56,56,56,57,57,57,57,60,60,68,69,70,
70,71,72,74,76,78,80,82,84,85,86,86,86,90,170,170,179,
260,270

Figure 2. Distribution of standard deviations for Bray P tests among 65 testing services on 72 soil samples.



X axis tic mark values from left to right are:
60,72,98,99,100,113,137,137,142,145,145,150,152,152,15
156,156,156,165,205,209,224,224,235,236,237,237,238,24
240,240,242,243,243,244,244,244,244,248,248,248,250,25
251,267,269,270,273,274,276,285,288,320,336,354,356,36
361,373,379,384,384,498,510,520,600,624,644,646,651,66
706

Figure 3. Distribution of standard deviations for K test among 65 testing services on 72 soil samples.

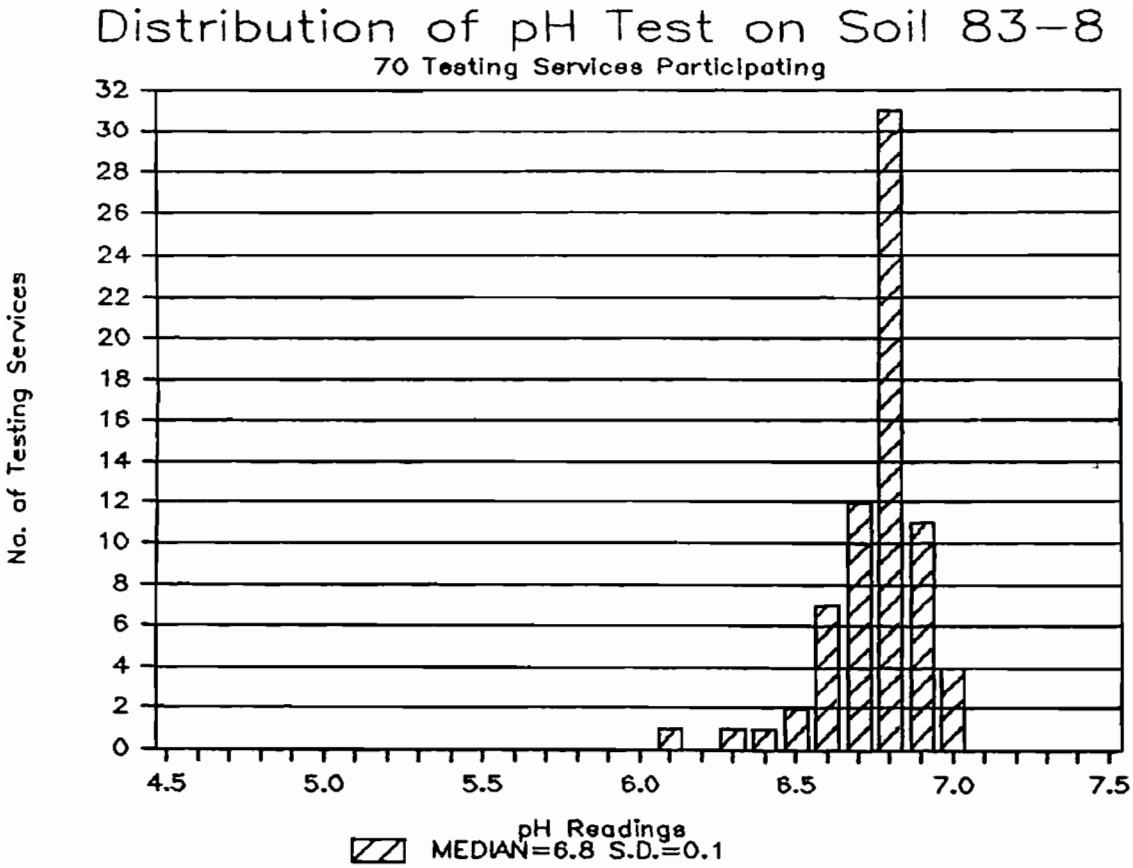


Figure 4. Distribution of water pH tests from 70 testing services on soil 83-8.

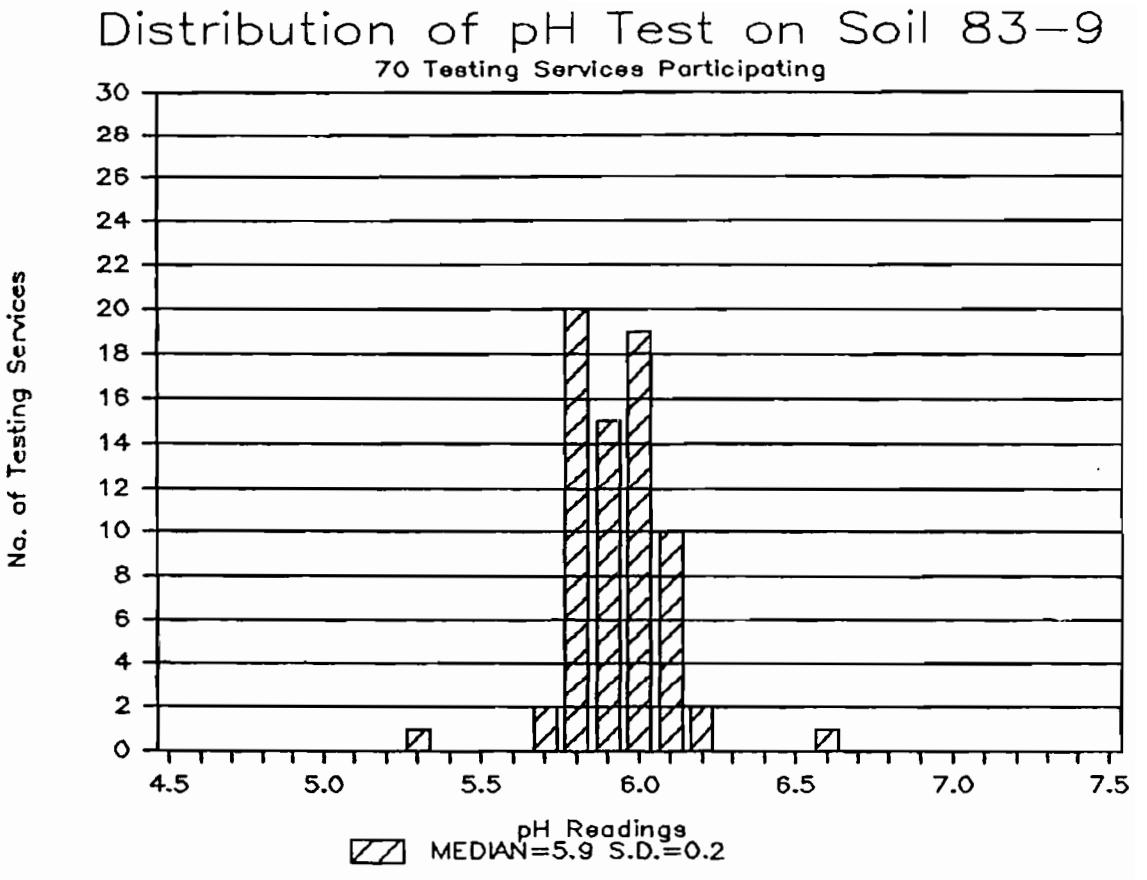


Figure 5. Distribution of water pH tests from 70 testing services on soil 83-9.

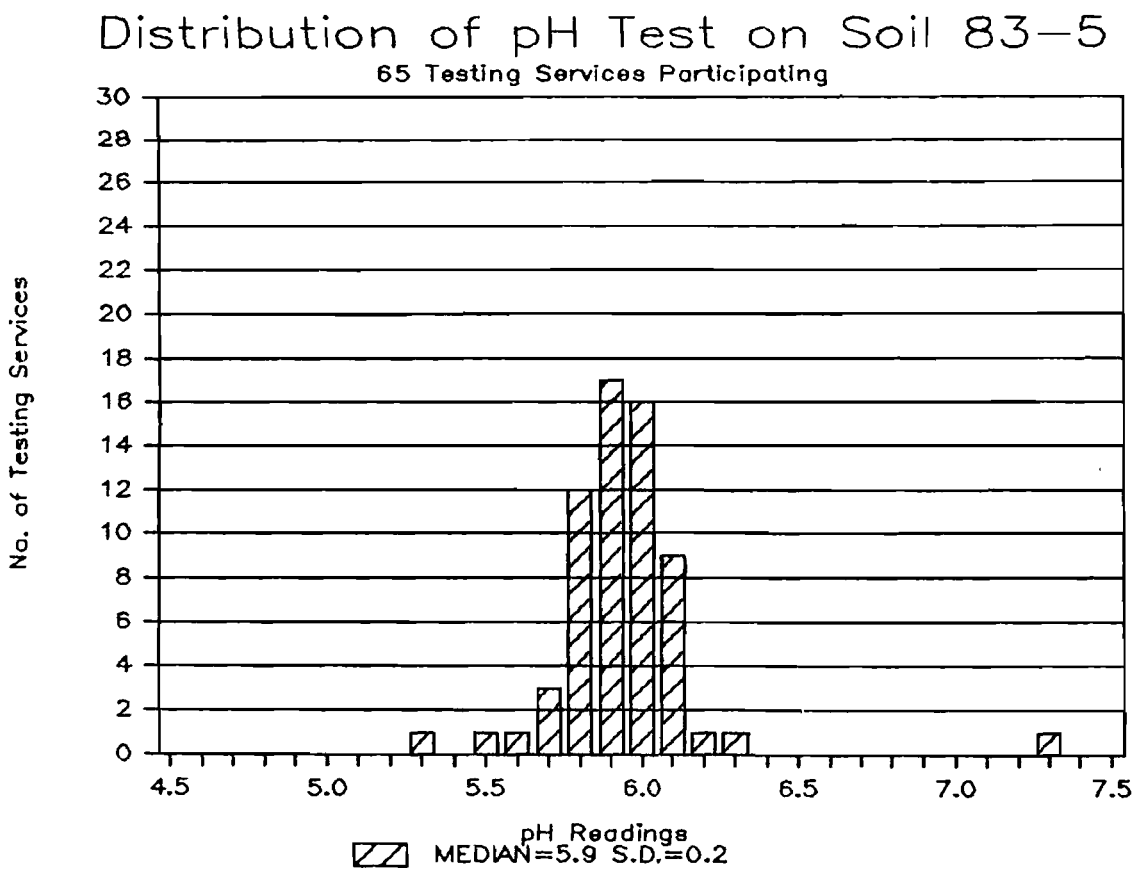
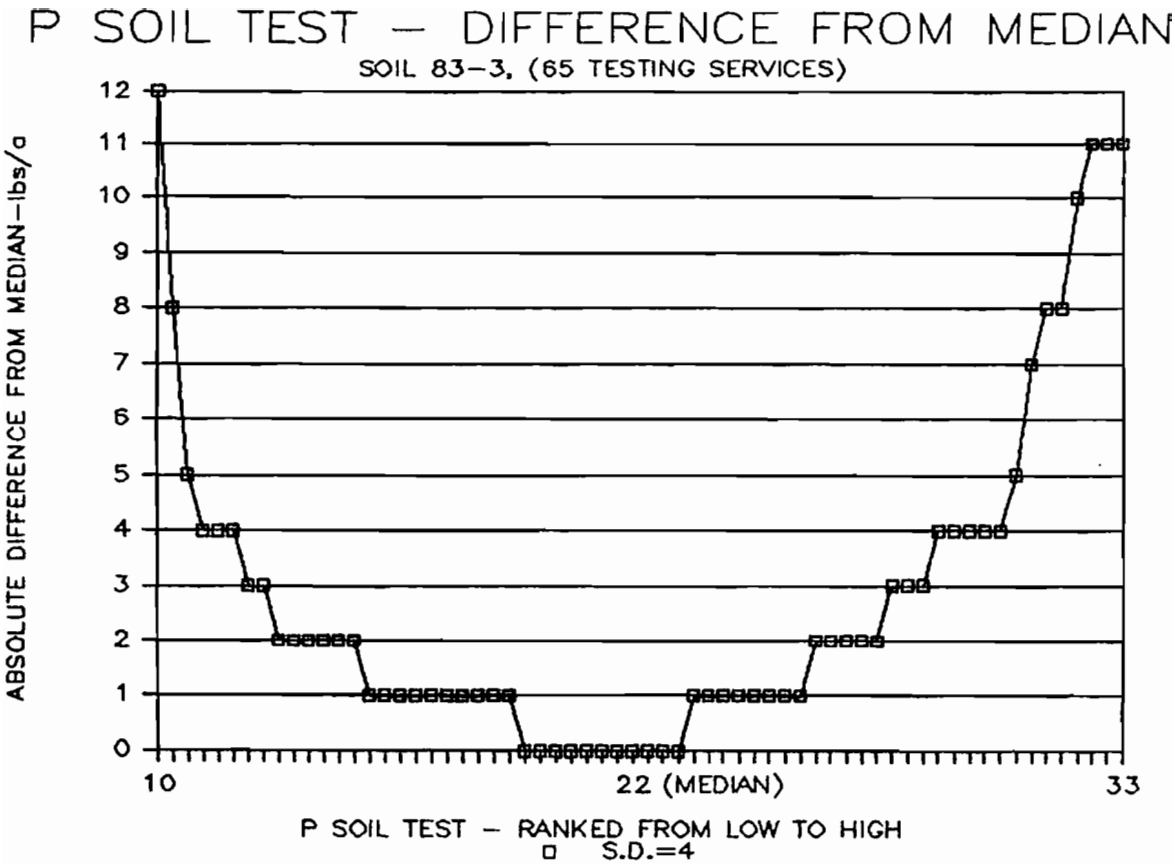
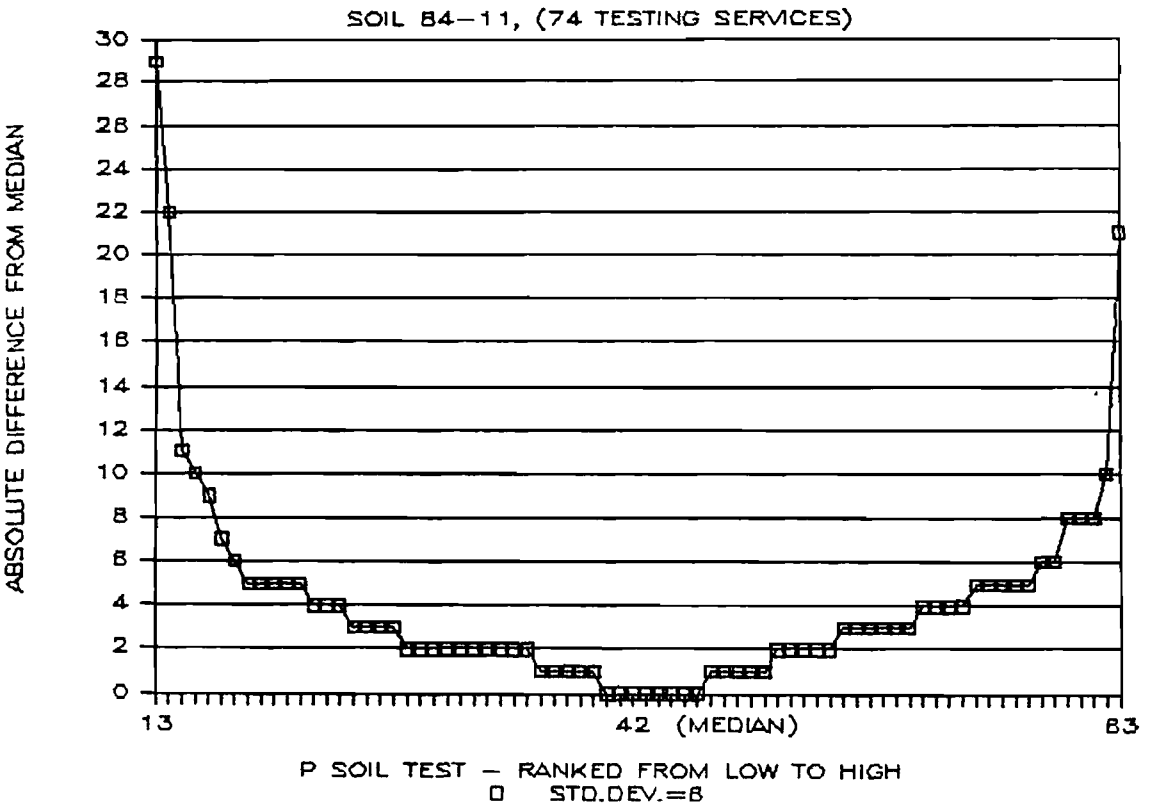


Figure 6. Distribution of water pH tests from 63 testing services on soil 83-5.



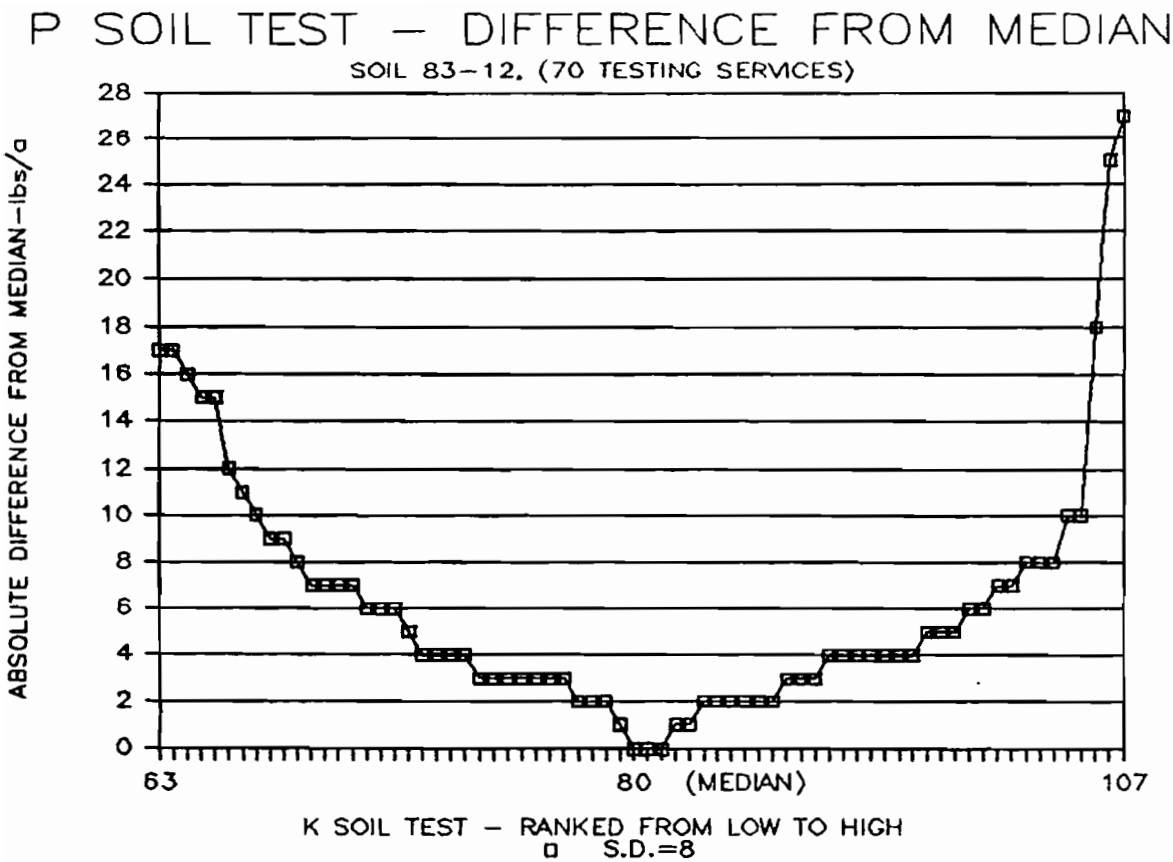
Square symbols represent the number of testing service deviating from the median by the value on the Y-axis.

Figure 7. Distribution of Bray P tests from 64 testing services on soil 83-3.



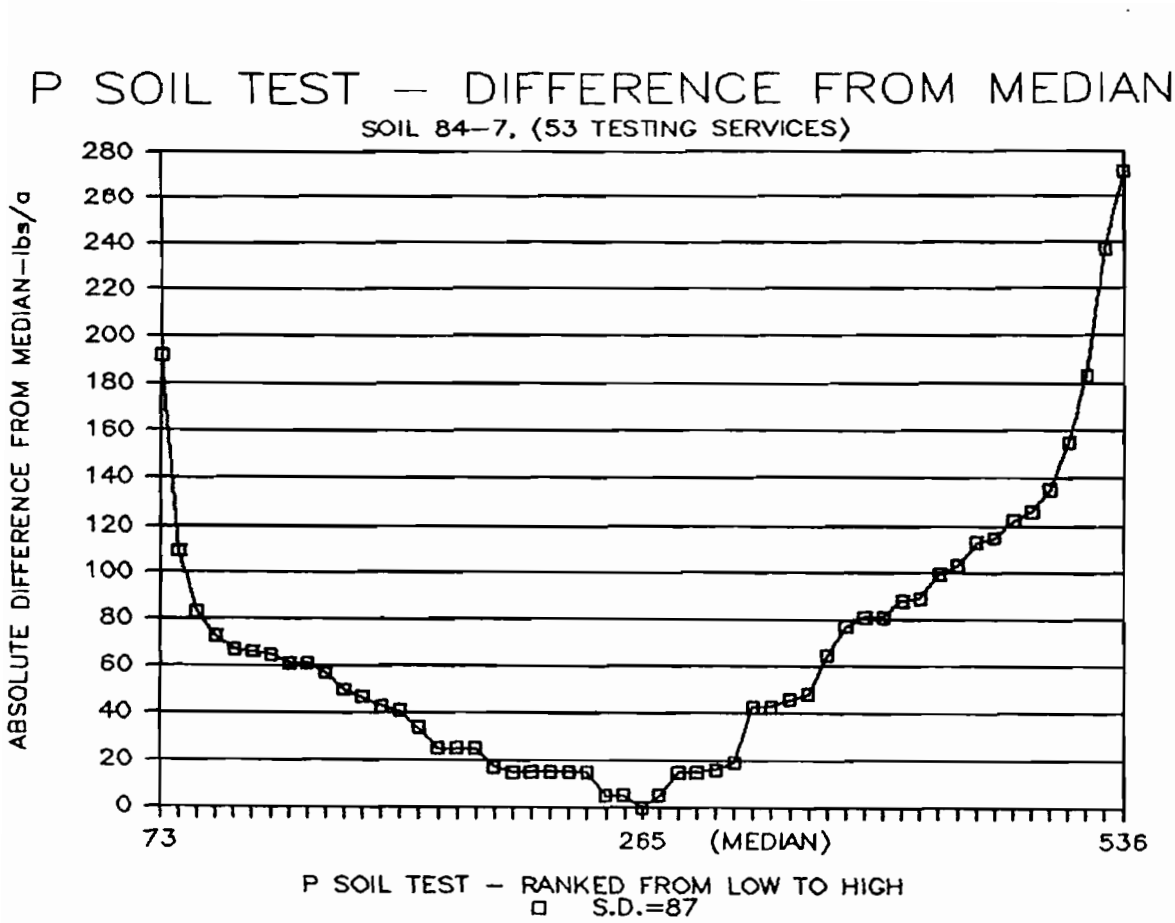
Square symbols represent the number of testing service deviating from the median by the value on the Y-axis.

Figure 8. Distribution of Bray P tests from 74 testing services on soil 84-11.



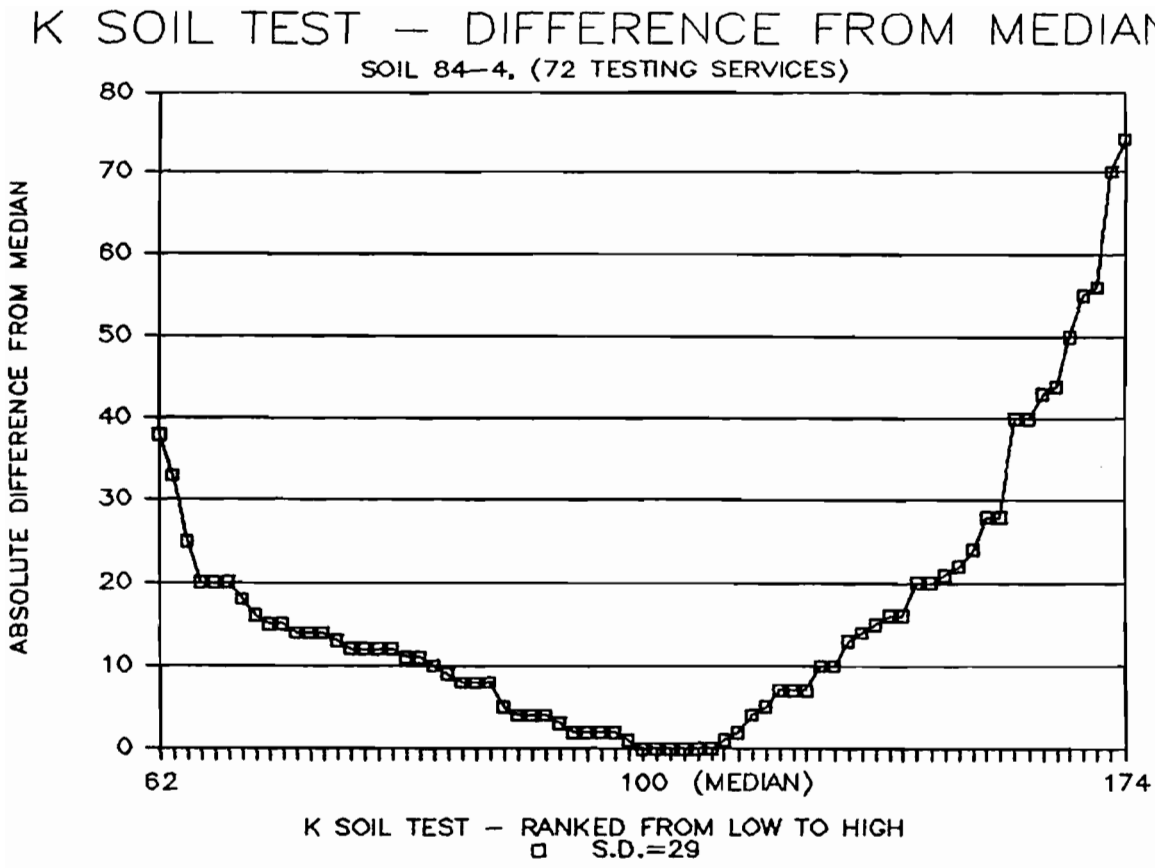
Square symbols represent the number of testing service deviating from the median by the value on the Y-axis.

Figure 9. Distribution of Bray P tests from 70 testing services on soil 83-12.



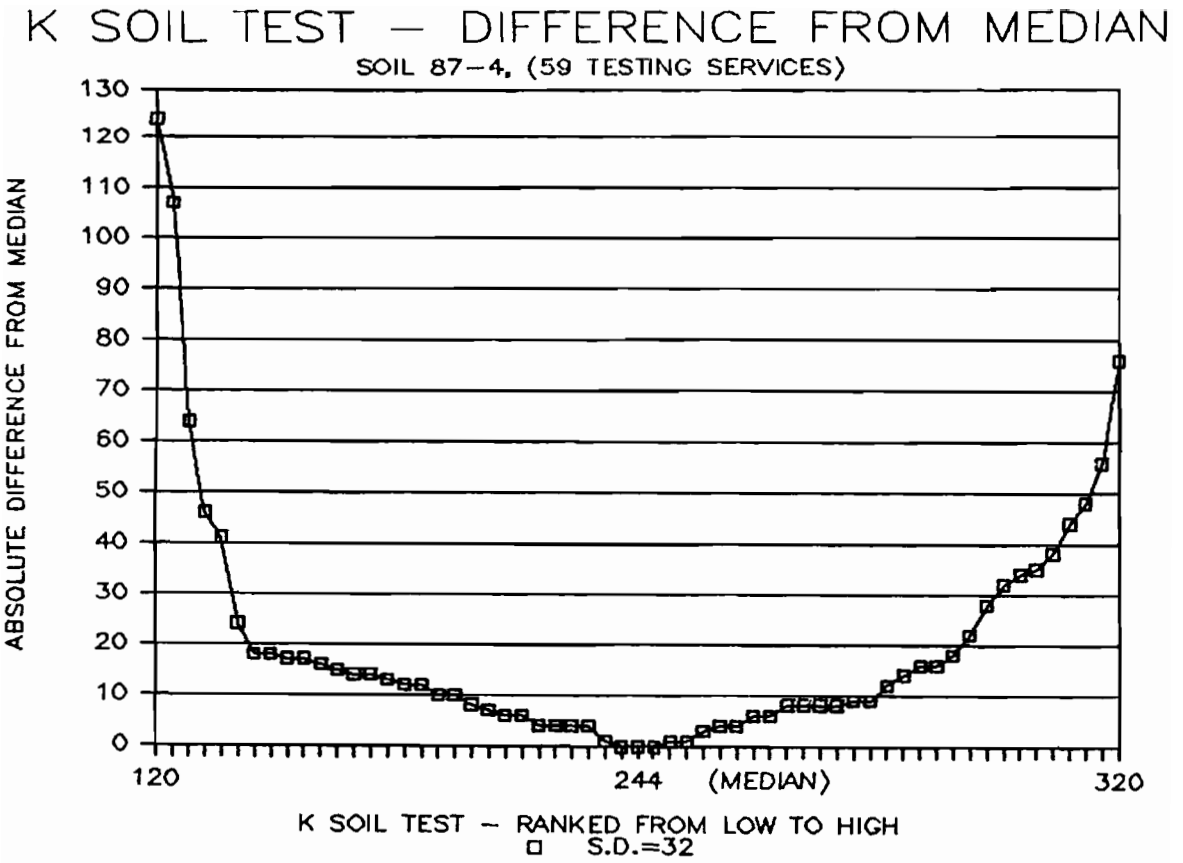
Square symbols represent the number of testing service deviating from the median by the value on the Y-axis.

Figure 10. Distribution of Bray P tests from 54 testing services on soil 84-7.



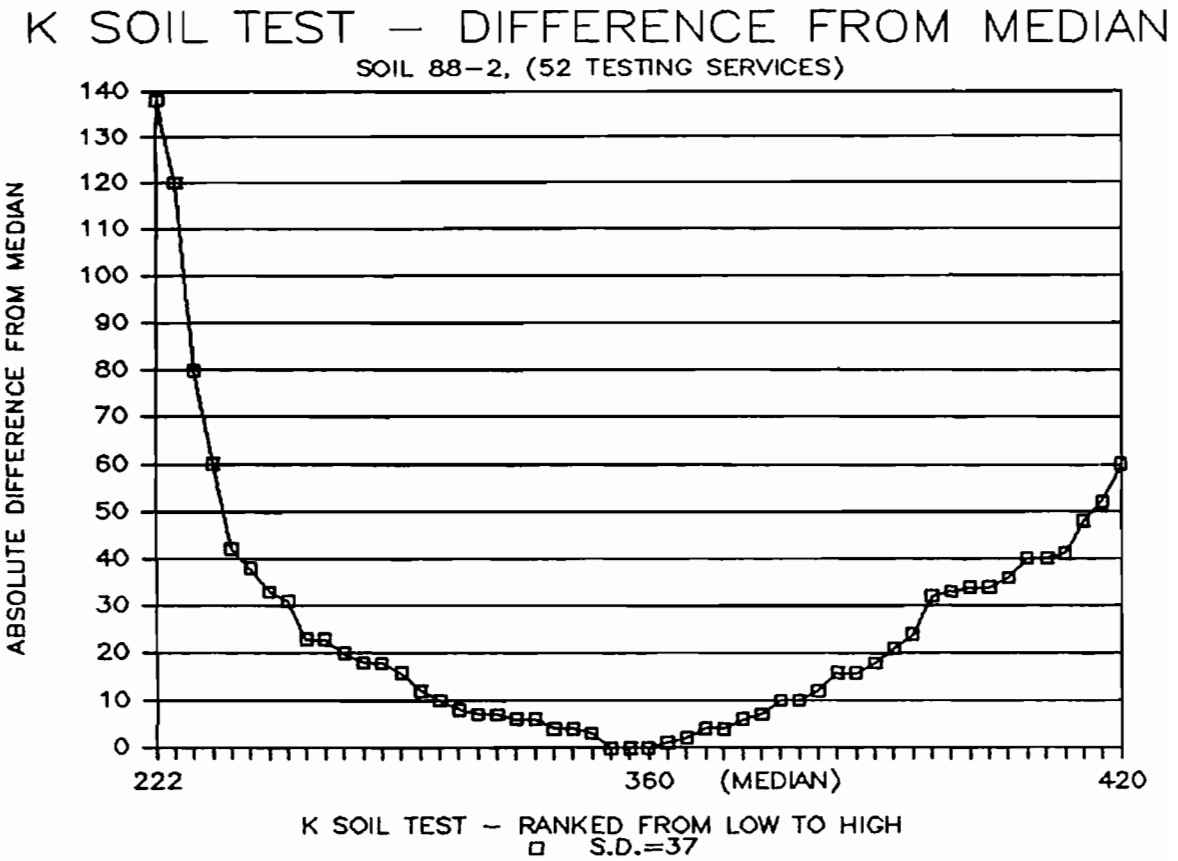
Square symbols represent the number of testing service deviating from the median by the value on the Y-axis.

Figure 11. Distribution of K soil tests from 72 testing services on soil 84-4.



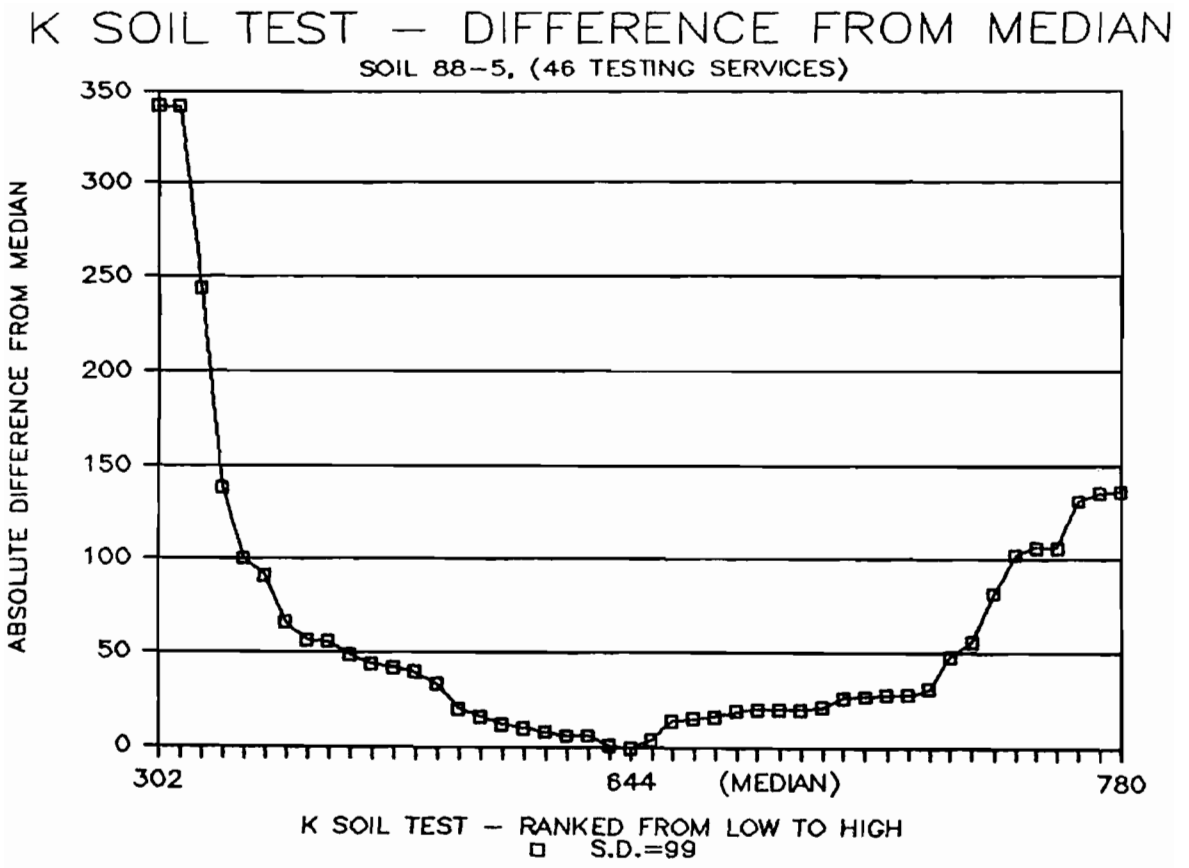
Square symbols represent the number of testing service deviating from the median by the value on the Y-axis.

Figure 12. Distribution of K soil tests from 59 testing services on soil 87-4.



Square symbols represent the number of testing service deviating from the median by the value on the Y-axis.

Figure 13. Distribution of K soil tests from 52 testing services on soil 88-2.



Square symbols represent the number of testing service deviating from the median by the value on the Y-axis.

Figure 14. Distribution of K soil tests from 46 testing services on soil 88-5.

SOIL TESTING SERVICES PARTICIPATING IN THE FALL 1983 SPLIT SOIL SAMPLE STUDY.
Soil Samples 83-7 thru 83-12

ASTL
Urbana, IL

Adams County Farm Bureau
Quincy, IL

Agra Soil Service
Lena, IL

Agrico-Chemical Co.
Washington Court House, OH

Agri. Labs Inc
Bremen, IN

A & L Great Lakes Agr. Lab.
Fort Wayne, IN

A & L Midwest Agr. Lab.
Omaha, NB

Alvey Laboratory
Belleville, IL

Amax Coal Co., Midwest Lab.
Evansville, IN

A.S.M. Service
Champaign, IL

Brandt's Fertilizer Service
Pleasant Plains. IL

Brookside Research Lab.
New Knoxville, OH

Bruch Laboratory
Granville, IL

Gary Carter Trucking
Catlin, IL

Cepheus Industries
Marion, IL

Chemical & Technical Services
Mt. Pleasant, IA

Christian Co. Farmers Supply
Taylorville, IL

CLC Labs.
Westerville, OH

Coles County Soil Service
Mattoon, IL

Dalby Agricultural Service
West Lafayette, IN

DeKalb County Farm Bureau
DeKalb, IL

Eastern Ill. Soil Testing
Rossville, IL

Edwards County Farm Bureau
Albion, IL

Edwards Farm Supply
Cisco, IL

Effingham Equity
Effingham, IL

Farm Clinic
West Lafayette, IN

Farmers Laboratory
Freeport, IL

Farmers Soil Lab
Wyanet, IL

Fayette County Soil Test Lab.
Ramsey, IL

Geophyta
Vickery, OH

G.M.S. Laboratory
Cropsey, IL

Graymont Co-op Assoc.
Graymont, IL

Greene County Farm Bureau
Carrollton, IL

Grundy County Farm Bureau
Morris, Il

Hamilton County Soil Testing
McLeansboro, IL

Harris Laboratories, Inc
Lincoln, NB

Max Hutchens Fertilizer
Assumption IL

I.M.C. Agonomic Service Lab.
Terre Haute, IN

Indiana Farm Bureau
Indianapolis, IN

Kaiser Chemical Co.
Sullivan, IL

Kaskaskia Soils Lab.
Shelbyville, IL

LaSalle County Farm Bureau
Ottawa, IL

Macoupin County Farm Bureau
Carlinville, IL

Midwest Soil Testing Service
Danforth, IL

Mississippi Valley Soil Testing
Hamilton, IL

NaChurs
Marion, OH

Mowers Soil Testing
Toulon, IL

Perry Agricultural Lab.
Bowling Green, MO

Professional Ag. Service
Beardstown, IL

Rich-Law Service Co.
Olney, IL

Scottland Soil Service
Chrisman, IL

Sharp's Soil Testing
Elwood, IL

Shields Soil Service
Dewey, IL

Skiles Soil Service
Astoria, IL

Sohigro Soil Lab.
Lima, OH

Soil Lab. Inc.
Tuscola, IL

Southern Ill. Farm Fdn.
Vienna, IL

Sparks Soil Testing
Lincoln, IL

Spoon River F.S.
Ellisville, IL

S.S.T. Laboratory
Monticello, IL

Standard Laboratories
Goodfield, IL

Stringer's Soil Lab.
Assumption, IL

Top Soil Testing Service
Frankfort, IL

Twin County Service C.
Murphysboro, IL

Volk's Fertilizer Service
Newton, IL

Warren County Farm Bureau
Monmouth, IL

Washington Co Service Co.
Nashville, IL

WDHIC Soil & Forage Center
Bonduel, WI

Whiteside County Farm Bureau
Morrison, IL

Zeller Laboratory
Dixon, IL

Tabulation of responses in the order received of the 3rd Round Robin SPLIT SOIL SAMPLE TEST LEVEL COMPARISON STUDY. Only the Agronomy Department, University of Illinois Soil Testing Laboratory is identified with their test results.

Lab. code No.	Sample 83-7 pH	P lbs/a	K	Sample 83-8 pH	P lbs/a	K	Sample 83-9 pH	P lbs/a	K	Sample 83-10 pH	P lbs/a	K	Sample 83-11 pH	P lbs/a	K	Sample 83-12 P lbs/a	K
ASTL	5.9	23	252	6.8	59	240	6.0	23	240	6.6	38	140	6.2	26	128	6.3	82	260
63	5.8	28	207	6.6	57	222	5.9	26	255	6.4	38	174	6.1	38	180	6.2	77	246
6	5.9	28	236	6.9	60	232	6.0	25	232	6.7	40	148	6.3	30	136	6.4	84	280
31	5.8	23	264	6.7	57	260	5.9	23	236	6.5	39	156	6.1	29	148	6.2	73	260
89	5.9	34	236	6.9	65	200	6.1	25	212	6.7	45	124	6.2	36	136	6.4	87	228
32	5.8	21	265	6.8	53	240	6.0	22	245	6.6	35	160	6.3	25	135	6.3	71	288
94	6.1	23	219	6.9	50	233	6.1	21	236	6.7	38	145	6.4	51	140	6.4	80	267
10	5.8	32	260	6.8	58	260	5.8	24	240	6.5	39	160	6.1	28	150	6.2	83	290
50	5.9	25	264	6.8	63	252	6.0	27	246	6.6	43	164	6.3	31	138	6.3	77	287
58	5.9	25	280	6.8	55	286	6.1	25	280	6.6	42	175	6.3	32	165	6.4	77	296
53	5.0	31	332	6.8	57	209	5.8	27	337	6.5	47	134	6.0	40	126	6.0	107	244
20	5.6	23	227	6.6	51	219	5.7	22	215	6.4	35	122	5.9	26	108	6.0	73	240
92	5.9	26	333	6.9	54	210	5.8	25	215	6.6	38	131	6.2	25	110	6.3	75	235
35	5.8	33	248	6.7	59	236	5.8	24	220	6.5	43	144	6.1	29	148	6.2	83	274
72	6.2	33	353	6.9	56	+400	6.1	28	350	6.6	43	196	6.2	34	218	6.4	88	353
34	5.8	24	216	6.7	60	300	5.8	23	265	6.4	42	193	6.1	30	186	6.2	84	+300
61	6.2	21	179	6.8	57	248	6.2	21	216	6.7	35	161	6.5	27	155	6.6	69	277
13	5.8	21	248	6.8	63	260	5.8	23	268	6.5	43	190	6.0	33	160	6.2	87	346
45	6.0	24	268	7.0	58	256	6.1	23	240	6.7	35	148	6.4	34	152	6.4	78	260
65	5.7	29	245	6.7	58	232	5.8	28	236	6.6	43	148	6.2	32	132	6.2	84	257
93	5.3	21	284	6.1	57	288	5.3	22	280	5.9	41	172	5.5	27	180	5.7	83	296
17	5.7	20	280	6.6	50	264	5.8	19	268	6.5	36	276	6.2	26	156	6.2	68	280
1	6.2	24	216	6.9	57	300	6.2	22	288	6.7	40	200	6.4	30	193	6.4	76	+300
11	5.7	22	264	6.6	51	229	5.8	21	244	6.3	35	155	6.0	25	159	6.1	82	248
28	6.0	34	264	7.0	59	280	6.1	60	280	6.8	34	180	6.3	25	140	6.5	63	289
69	6.2	26	256	6.8	56	249	6.0	27	246	6.6	43	152	6.2	34	145	6.3	86	266
23	6.0	23	282	6.8	45	272	6.0	23	268	6.5	38	180	6.2	28	184	6.3	63	286
76	5.8	22	233	6.7	49	254	6.6	22	243	6.5	32	193	6.3	29	166	6.4	73	300
77	5.9	23	236	6.8	57	220	6.0	23	232	6.6	39	138	6.2	29	126	6.3	74	254
26	6.0	26	276	6.7	66	+300	6.0	28	300	6.5	45	254	6.3	36	233	6.2	82	+300
88	5.8	25	227	6.7	59	213	5.7	25	210	6.4	43	137	6.0	33	114	6.1	80	232
66	5.8	30	232	6.8	62	+307	5.8	28	295	6.5	47	232	6.1	34	184	6.2	85	+307
79	5.9	24	248	6.8	58	236	5.9	22	232	6.5	36	148	6.1	31	152	6.3	81	280
42	5.8	22	205	6.8	54	224	5.9	22	217	6.6	38	142	6.2	24	124	6.2	88	230
91	5.9	37	227	6.7	68	240	5.8	30	198	6.4	46	140	6.1	33	142	6.2	105	210
83	5.9	26	268	6.9	64	234	6.0	25	236	6.6	38	150	6.3	30	145	6.3	88	276
68	5.9	24	280	6.9	57	248	6.0	28	252	6.7	46	140	6.2	33	128	6.4	82	260
4	6.1	29	269	6.8	54	264	6.0	25	263	6.6	38	162	6.2	28	141	6.4	77	302
82	5.8	22	238	6.8	55	228	6.0	22	228	6.6	37	134	6.2	25	120	6.3	71	243
46	5.9	26	302	6.7	58	286	5.8	25	278	6.5	45	179	6.1	30	148	6.3	86	298
30	5.8	28	252	6.8	61	240	5.9	24	236	6.6	39	148	6.2	27	144	6.3	77	268
14	5.8	30	260	6.5	63	224	5.8	28	240	6.5	48	140	6.1	37	123	6.2	98	254
56	5.9	22	228	6.8	62	234	5.8	22	250	6.5	41	156	6.1	28	140	6.2	76	260
47	5.9	22	270	7.0	60	270	5.9	19	270	6.6	40	165	6.3	24	130	6.3	72	300
64	5.9	23	214	6.8	60	300	5.9	22	295	6.5	40	214	6.2	27	207	6.2	85	+300
48	5.8	24	254	6.4	59	244	5.8	26	248	6.2	40	174	5.9	31	147	6.1	79	273
27	5.9	34	278	6.5	55	235	5.8	26	248	6.2	40	149	5.8	29	131	6.1	90	294
81	5.9	24	248	6.9	44	240	6.0	26	225	6.6	38	135	6.2	32	115	6.3	64	259
67	5.7	33	244	6.3	69	252	5.8	29	228	6.8	43	148	6.2	35	136	6.2	90	264
12	6.2	21	208	6.8	53	276	6.1	22	254	6.6	39	184	6.4	26	192	6.4	74	300
70	6.0	28	246	7.0	60	244	6.0	32	240	6.6	46	184	6.3	34	180	6.3	80	260
25	5.8	21	200	6.8	62	288	5.9	24	288	6.5	35	192	6.2	27	184	6.2	70	-300
75	5.9	20	216	6.8	55	277	6.1	22	248	6.6	36	186	6.3	29	193	6.4	84	310
74	6.1	59	155	6.9	57	235	6.1	28	235	6.7	41	169	6.3	31	155	6.2	82	288
19	5.7	23	228	6.6	54	252	5.9	22	222	6.5	37	145	6.2	31	133	6.3	77	264
39	5.8	25	272	6.6	59	276	5.9	25	268	6.3	43	172	6.0	31	156	6.1	76	304
78	5.7	27	240	6.8	52	235	5.9	23	230	6.6	41	140	6.1	26	125	6.3	85	245
15	6.0	21	284	6.8	49	226	6.0	22	304	6.5	33	158	6.1	38	142	6.3	65	316
59	6.0	26	294	6.8	60	275	6.1	28	286	6.7	38	196	6.5	32	184	6.5	73	323
29	5.9	23	310	6.7	56	260	5.9	21	258	6.4	42	187	6.1	30	161	6.2	82	298
36	5.7	24	246	6.8	59	240	5.8	23	244	6.5	39	151	6.1	29	136	6.2	77	269
37	5.7	24	227	6.8	58	227	6.0	24	227	6.6	40	145	6.3	28	124	6.4	84	240
33	6.1	29	232	6.8	56	234	6.0	26	236	6.6	41	141	6.2	31	140	6.4	78	256
57	5.7	26	229	6.8	29	241	5.9	26	220	6.6	42	136	6.2	29	116	6.3	78	252
60	6.1	24	264	6.8	48	244	6.0	20	240	6.6	35	152	6.2	26	136	6.4	76	281
49	5.9	31	233	6.6	64	242	5.8	32	242	6.4	45	137	6.1	35	129	6.1	81	267
3	5.8	22	264	6.7	58	240	5.8	23	224	6.5	39	128	6.1	30	120	6.2	65	256
95	6.0	26	252	6.9	60	240	6.0	24	236	6.6	42	138	6.2	29	128	6.3	84	261
41	5.8	22	241	6.8	59	222	5.9	24	215	6.6	39	135	6.2	28	128	6.3	74	249
55	5.8	25	262	6.7	56	254	5.9	23	242	6.5	39	160	6.1	27	144	6.2	84	274

Fall 1983 Split Soil Sample test results arranged from low to high. Test results near the median values are desirable while test results with high rankings are out of line among the laboratories participating in this comparison.

Rank	Sample 83-7			Sample 83-8			Sample 83-9			Sample 83-10			Sample 83-11			Sample 83-12	
no.	pH	P	K	pH	P	K	pH	P	K	pH	P	K	pH	P	K	pH	P	K
		lbs/a			lbs/a			lbs/a			lbs/a			lbs/a			lbs/a	
34	5.0	20	155	6.1	29	200	5.3	19	198	5.9	32	122	5.5	24	108	5.7	63	210
33	5.3	20	179	6.3	44	209	5.7	19	210	6.2	33	124	5.8	24	110	6.0	63	228
32	5.6	21	200	6.4	45	210	5.7	20	212	6.2	34	128	5.9	25	114	6.0	64	230
31	5.7	21	205	6.5	48	213	5.8	21	215	6.3	35	131	5.9	25	115	6.1	65	232
30	5.7	21	207	6.5	49	219	5.8	21	215	6.3	35	134	6.0	25	116	6.1	65	235
29	5.7	21	208	6.6	49	220	5.8	21	215	6.4	35	134	6.0	25	120	6.1	68	240
28	5.7	21	214	6.6	50	222	5.8	21	216	6.4	35	135	6.0	25	120	6.1	69	240
27	5.7	21	216	6.6	50	222	5.8	22	217	6.4	35	135	6.0	26	123	6.1	70	243
26	5.7	21	216	6.6	51	224	5.8	22	220	6.4	35	136	6.0	26	124	6.1	71	244
25	5.7	22	216	6.6	51	224	5.8	22	220	6.4	35	137	6.1	26	124	6.2	71	245
24	5.7	22	219	6.6	52	226	5.8	22	222	6.4	36	137	6.1	26	125	6.2	72	246
23	5.7	22	227	6.6	53	227	5.8	22	224	6.4	36	138	6.1	26	126	6.2	73	248
22	5.8	22	227	6.7	53	228	5.8	22	225	6.5	36	138	6.1	26	126	6.2	73	249
21	5.8	22	227	6.7	54	229	5.8	22	227	6.5	37	140	6.1	27	128	6.2	73	252
20	5.8	22	227	6.7	54	232	5.8	22	228	6.5	37	140	6.1	27	128	6.2	73	254
19	5.8	22	228	6.7	54	232	5.8	22	228	6.5	38	140	6.1	27	128	6.2	74	254
18	5.8	22	228	6.7	54	233	5.8	22	230	6.5	38	140	6.1	27	128	6.2	74	256
17	5.8	23	229	6.7	55	234	5.8	22	232	6.5	38	140	6.1	27	129	6.2	74	256
16	5.8	23	232	6.7	55	234	5.8	22	232	6.5	38	141	6.1	27	130	6.2	75	257
15	5.8	23	232	6.7	55	234	5.8	22	232	6.5	38	142	6.1	28	131	6.2	76	259
14	5.8	23	233	6.7	55	235	5.8	22	235	6.5	38	144	6.1	28	132	6.2	76	260
13	5.8	23	233	6.7	56	235	5.8	23	236	6.5	38	145	6.1	28	133	6.2	76	260
12	5.8	23	236	6.7	56	235	5.9	23	236	6.5	38	145	6.1	28	135	6.2	76	260
11	5.8	23	236	6.7	56	236	5.9	23	236	6.5	38	145	6.1	28	136	6.2	77	260
10	5.8	23	236	6.8	56	236	5.9	23	236	6.5	38	148	6.1	28	136	6.2	77	260
9	5.8	23	238	6.8	56	240	5.9	23	236	6.5	39	148	6.1	29	136	6.2	77	260
8	5.8	24	240	6.8	57	240	5.9	23	236	6.5	39	148	6.1	29	136	6.2	77	261
7	5.8	24	241	6.8	57	240	5.9	23	236	6.5	39	148	6.2	29	136	6.2	77	264
6	5.8	24	244	6.8	57	240	5.9	23	240	6.5	39	148	6.2	29	138	6.2	77	264
5	5.8	24	245	6.8	57	240	5.9	23	240	6.5	39	148	6.2	29	140	6.2	77	266
4	5.8	24	246	6.8	57	240	5.9	23	240	6.5	39	149	6.2	29	140	6.2	78	267
3	5.8	24	246	6.8	57	240	5.9	23	240	6.5	39	150	6.2	29	140	6.3	78	267
2	5.9	24	248	6.8	57	240	5.9	24	240	6.5	39	151	6.2	29	140	6.3	78	268
1	5.9	24	248	6.8	57	241	5.9	24	240	6.6	39	152	6.2	29	141	6.3	79	269
Median	5.9	24	248	6.8	57	242	5.9	24	242	6.6	40	152	6.2	30	142	6.3	80	273
1	5.9	24	248	6.8	58	244	5.9	24	242	6.6	40	155	6.2	30	142	6.3	80	274
2	5.9	25	252	6.8	58	244	5.9	24	243	6.6	40	156	6.2	30	144	6.3	80	274
3	5.9	25	252	6.8	58	244	5.9	24	244	6.6	40	156	6.2	30	144	6.3	81	276
4	5.9	25	252	6.8	58	248	6.0	24	244	6.6	40	158	6.2	30	145	6.3	81	277
5	5.9	25	254	6.8	58	248	6.0	25	245	6.6	40	160	6.2	30	145	6.3	82	280
6	5.9	25	256	6.8	58	249	6.0	25	246	6.6	40	160	6.2	30	147	6.3	82	280
7	5.9	26	260	6.8	58	252	6.0	25	246	6.6	41	160	6.2	31	148	6.3	82	280
8	5.9	26	260	6.8	59	252	6.0	25	248	6.6	41	161	6.2	31	148	6.3	82	280
9	5.9	26	262	6.8	59	252	6.0	25	248	6.6	41	162	6.2	31	148	6.3	82	281
10	5.9	26	264	6.8	59	254	6.0	25	248	6.6	41	164	6.2	31	150	6.3	82	286
11	5.9	26	264	6.8	59	254	6.0	25	250	6.6	41	165	6.2	31	152	6.3	83	287
12	5.9	26	264	6.8	59	256	6.0	25	252	6.6	42	169	6.2	31	152	6.3	83	288
13	5.9	26	264	6.8	59	260	6.0	25	254	6.6	42	172	6.2	31	155	6.3	83	288
14	5.9	26	264	6.8	59	260	6.0	26	255	6.6	42	172	6.2	32	155	6.3	84	290
15	5.9	27	264	6.8	59	260	6.0	26	258	6.6	42	174	6.2	32	156	6.3	84	294
16	5.9	28	265	6.8	60	260	6.0	26	263	6.6	42	174	6.2	32	156	6.3	84	296
17	5.9	28	268	6.8	60	264	6.0	26	265	6.6	43	175	6.3	32	159	6.3	84	296
18	6.0	28	268	6.8	60	264	6.0	26	268	6.6	43	179	6.3	33	160	6.4	84	298
19	6.0	28	269	6.8	60	270	6.0	26	268	6.6	43	180	6.3	33	161	6.4	84	298
20	6.0	29	270	6.8	60	272	6.0	27	268	6.6	43	180	6.3	33	165	6.4	84	300
21	6.0	29	272	6.9	60	275	6.0	27	268	6.6	43	184	6.3	33	166	6.4	85	300
22	6.0	29	276	6.9	61	276	6.0	27	270	6.6	43	184	6.3	34	180	6.4	85	300
23	6.0	30	278	6.9	62	276	6.1	28	278	6.6	43	186	6.3	34	180	6.4	85	300
24	6.0	30	280	6.9	62	277	6.1	28	280	6.6	43	187	6.3	34	180	6.4	86	302
25	6.0	31	280	6.9	62	280	6.1	28	280	6.7	43	190	6.3	34	184	6.4	86	304
26	6.1	31	280	6.9	63	286	6.1	28	280	6.7	45	192	6.3	34	184	6.4	87	310
27	6.1	32	282	6.9	63	286	6.1	28	286	6.7	45	193	6.3	35	184	6.4	87	316
28	6.1	33	284	6.9	63	288	6.1	28	288	6.7	45	193	6.3	35	184	6.4	88	323
29	6.1	33	284	6.9	64	288	6.1	28	288	6.7	45	196	6.3	36	186	6.4	88	346
30	6.1	33	294	6.9	64	300	6.1	28	295	6.7	46	196	6.4	36	192	6.4	88	353
31	6.2	34	302	6.9	65	300	6.1	29	295	6.7	46	200	6.4	37	193	6.4	90	+300
32	6.2	34	310	7.0	66	300	6.1	30	300	6.7	46	214	6.4	38	193	6.4	90	+300
33	6.2	34	332	7.0	68	300	6.2	32	304	6.7	47	232	6.4	38	207	6.5	98	+300
34	6.2	37	333	7.0	69	307	6.2	32	337	6.8	47	254	6.5	40	218	6.5	105	+300
35	6.2	59	353	7.0	80	400	6.6	60	350	6.8	48	276	6.5	51	233	6.6	107	+307
Median excluding plus test values																		
	5.9	24	248	6.8	57	242	5.9	24	242	6.6	40	152	6.2	30	142	6.3	80	268
Average excluding plus values																		
	5.8	26	251	6.8	57	251	5.9	25	249	6.5	40	162	6.2	30	149	6.3	80	273
Standard deviation excluding plus values																		
	0.7	6	33	0.2	6	30	0.2	5	29	0.1	4	29	0.2	4	26	0.1	8	27

PROCEEDINGS OF THE EIGHTEENTH

NORTH CENTRAL EXTENSION - INDUSTRY SOIL FERTILITY WORKSHOP

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Program Chairman:

K. A. Kelling

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CREDITS

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