SOIL/WATER RESEARCH
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A Summary of Soil Test Results (July 2007 - June 2008)

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INTRODUCTION

Soil tests provide the best basis for making sound, profitable fertilizer recommendations. They are an indication of soil fertility levels. Summaries of soil tests can be used to a) provide information about soil fertility of soils in a general area; b) show differences in fertility from one area to another; and c) follow changes in soil fertility levels for a period of years. The objectives of this progress report are to summarize soil tests over regions and over the state as a whole.

The results of any soil test summary must be used with caution. These numbers should not be used in place of an actual analysis. The numbers shown here are means and therefore individual tests can vary widely from field to field.

PROCEDURE

The soil test program was significantly changed in 1992. A tri-state (MN, ND, SD) nutrient recommendation and reporting system was adopted. In this system, crop nutrient recommendations are identical between the states and all states report phosphorus and potassium soil tests in parts per million (ppm). The SDSU Soil Testing Laboratory had been reporting these nutrients in lbs/acre. To convert lbs/acre to ppm divide by 2 or take ppm x 2 = lbs/acre.

Another change made in 1992 was the calculation of nitrate-nitrogen. Previously, it was assumed that a 6-inch furrow slice weighed 1,800,000 pounds, which was changed to a figure of 2,000,000 in 1992. The change was made for consistency because almost all other calculations use the latter figure. The difference amounts to a 10% increase in NO_3-N. This difference is very small when considering crop N recommendations and is inconsequential in the calibration and interpretations used with the NO_3-N test.

The standard P test for SDSU was the Bray #1 test. However, with some high pH soils, the Olsen test (sodium bicarbonate phosphorus test) extracts P better than the Bray test. Therefore the SDSU Soil Testing Laboratory changed to the Olsen test on July 1, 1995. The average Olsen test is about 0.66% of the Bray value.

The organic matter test was dropped as part of the routine tests on July 1, 1998, and is now an optional test.

The laboratory switched to a database soil test program on September 1, 1999. This was significantly revised in January 2004, when summaries were programmed.

This summary is based on soil tests received at the South Dakota State University Soil Testing Laboratory from July 1, 2007 through June of 2008.

Soil tests representing farmer/rancher fields were used. Most of these samples were taken for the 2008 crop season. Garden, lawn, ornamental and greenhouse samples were excluded from the summary, except where noted. They represent 451, or about 6482 of the total surface samples received.

The soil tests of nitrate-nitrogen, sulfate-sulfur, and chloride, to two feet, phosphorus, potassium, pH, zinc, organic matter and soluble salts (surface soil) were summarized. The nitrate-nitrogen was extracted with a dilute salt solution and determined by electrode (1). Phosphorus was extracted with a 0.5 M sodium bicarbonate (Olsen) solution and determined colorimetrically (1). Potassium was extracted with 1N ammonium acetate and determined by flame emission (1). The soil pH is water extractable and determined by electrode (1). Soluble salts are estimated from a conductivity cell from a 1:1 soil to water extract (1). Chloride

is extracted with a 0.01m calcium nitrate solution and determined colorimetrically by mercury thiocyanate. Sulfate-sulfur is extracted with 0.008M calcium phosphate solution and determined turbidimetrically using barium chloride. Zinc is extracted with a DTPA solution and determined with atomic absorption (1). Organic matter is determined by weight loss (LOI) at 360^{o}C for 2 hours (2). Organic matter was previously determined by a modified Walkley-Black procedure. It was changed to LOI on July 1, 1989.

Nitrate-nitrogen, sulfate-S, and chloride are reported as pounds per acre in a two-foot depth. Phosphorus is reported only to 250 ppm. Soluble salts are recorded as 16.0 mmho/cm for any value found greater than this value.

The regions of the state were divided according to Figure 1. The letters NE, SE, NC, SC, and WR designate the Northeast, Southeast, North Central, South Central and West River regions, respectively.

RESULTS AND DISCUSSION

The total number of Ag field samples summarized varied with each test. The total number of samples with phosphorus, pH, potassium and soluble salts was about 6480. The totals for potassium and soluble salts are about 6370 (Table 1). Of these samples, about 43, 17, 16, 18, and 6 percent came from the NE, SE, NC, SC, and WR regions, respectively.

A total of 5,198 surface samples were received that had the deep sample for nitrate analysis (Table 1). This is 80% of the total surface samples (~6400). The percent of the total surface samples that included a deep sample by region are: NE = 81%, SE = 73%, NC = 91%, SC = 70% and WR = 97%. The percentage that had a deep NO_3-N test is slightly lower than last year. The proportion of total surface samples that had a zinc analysis requested has increased substantially over the last years with 29% in 2001 and 57% in 2008 (Table 1) .

NITRATE-NITROGEN

Average carryover fall nitrate levels for 2008 (50 lb/A) are 6 lb/A lower than the fall of 2007and higher than the long term average of 57 lb/a (Table 2 and Figure 2). Carryover N from corn and corn silage was higher than after any other crop (Table 2A). Corn is the most heavily fertilized crop in SD. Soybean effectively utilizes available soil N as can be seen by its relatively low carryover levels. Nitrate-N carryover for all wheat acres was about 66 lb/a. This is about 10 lb/A lower than last year. Alfalfa and grass have smaller carryover levels because they are permanent crops with little mineralization relative to uptake. Nitrate-N after fallow averaged 48 lb/a more than after a crop. This difference indicates the N mineralization potential of a tilled soil.

PHOSPHORUS

The 2008 phosphorus soil test summary is shown in Table 3. The phosphorus test summary is displayed in categories of very low, low, medium, high and very high. In general, few yield responses to fertilizer phosphorus are obtained above a test of 16 ppm and fertilizer recommendations are not made above this level. The results indicate high average test values of phosphorus. However, the percent of samples falling in the medium or below categories average 59% statewide. This indicates that a large number of soils of the state are very responsive and need additional phosphorus for high yields. Approximately 29% of the soil tests statewide do not need added phosphorus fertilizer. The statewide average test is similar to last year and has increased in the last few years. This could be because more soils are being tested that have had manure applications and are usually very high in phosphorus.

POTASSIUM

The potassium soil test summary is shown in Table 4. The categories used for this test are considered very low, low, medium, high and very high. Responses to added potassium are infrequent with a test of 160 ppm or greater. The average test values show very high levels of soil test potassium for all regions of the state. There are about 28% of the state soils that are considered responsive to added K. The NE and SE regions contain the most soils that may be responsive to additional potassium.The statewide average potassium test was 14 lb/a lower than last year.

pH

The pH summary numbers are displayed in Table 5. The categories for pH are rather

arbitrary. However, pH values between 6.0 and 7.5 are generally considered very good for plant growth. Below pH 6.0 some crops may require lime to eliminate some growth problems. Above pH 7.5 some micronutrients can become limiting. As seen from the table, the average soil test for all regions is between 6.6 and 7.0. This is considered a neutral pH. In addition, very few soils have a pH low enough to be limed. However, about 12% of the states' samples are below 6.1 pH. This value is similar to last year. About 10% of the total statewide samples had pH values greater than 7.5.

SOLUBLE SALTS

The summary of the soluble salt tests is presented in Table 6. The values listed are numbers of samples and not percents. Generally any salt value below 3.0 mmho/cm presents little problem for growing crops. As values become higher, more problems in plant growth can result. As indicated by the results, over 99% of the samples summarized indicated little problem with soluble salts. This is very similar to previous years. There are some soils that do have salt problems. These are usually isolated areas within a field and not concentrated over a total field.

ZINC

The zinc soil test summary results are shown in Table 7. The categories designate low, medium, high and very high levels. Yield response to added zinc is very infrequent if test levels are over 0.75 ppm. In fact, research has shown few yield responses in the 0.50-0.75 soil test level even though deficiency symptoms are visible.

The average zinc soil test level is in the high or very high range for all regions of the state. There is an average of only 15% of the soils tested for zinc that are in the low or very low category. These soils would need additional fertilizer zinc for responsive crops. The average zinc test is similar to last year.

ORGANIC MATTER

Soil organic matter has not proven to be a useful soil test in determining if nitrogen fertilizer is needed for a crop growing on that soil. It does provide a useful guide, however, for herbicide application and also indicates the general tilth of a soil although not necessarily its productivity. The results of the organic matter summary are given in Table 8. As expected, organic matter is higher in the eastern part of the state (3.8) compared to the central (3.4). The statewide average organic matter content is slightly higher than last year's value.

CHLORIDE

The SDSU Soil Testing Laboratory has offered the chloride soil test to a depth of two feet since the spring of 1986. Research results indicated that the chloride soil test is a valuable tool in predicting if a yield response to added fertilizer chloride would occur.

The research data indicates that at a low soil test, response can be expected 70% of the time; whereas, only 30% of the sites responded to added chloride with a medium test. No response was received for those sites testing above 60 lb/acre for 2 feet.

The results from Table 9 indicate 469 samples had chloride results from the two-foot sampling depth. Most were from the NE & NC area. About 83% of the total fields tested would require additional chloride for wheat and barley.

SULFATE-S

The sulfur summary includes 2476 soils (Table 10) that had a 2 foot test. There were 36% of the requested tested fields with sulfur contents less than 40 lb/a (potentially responsive). However, less than 20% of these potentially responsive fields actually respond to sulfur. The reason is because of plant available sulfur sources besides soil test sulfur (SO_4-S). Additional sources of sulfur can include organic matter mineralization, precipitation and deep (>2 feet) sulfur. Above the 40 lb/A test shows no significant yield response to sulfur has been measured at over 100 corn and soybean test sites.

MANURED SOILS

A summary from manured and non-manured samples can be found in Table 11. Manured fields have substantially higher levels of nitrate-N, P, and zinc levels as compared to non-manured soils.

GARDEN AND LAWN SAMPLES

A summary of garden and lawn soil tests is compared to non-garden/lawn samples in Table 12. Garden/lawn concentrations of P, K, and OM are substantially higher than non-garden soils. Average garden/lawn soil pH is higher than non garden soils. Garden soils are much higher in nutrients than either lawn or ornamental samples (data not shown).

REFERENCES

1. Skroch, K., C.Hoffman, C.Morris, L. Ulvestad, and R.Gelderman. 2006. Soil Testing Procedures in Use at the South Dakota State Soil Testing and Plant Analysis Laboratory. South Dakota Agric. Expt. Sta. Plant Sci. Pamphlet 25.

2. Combs, S.M., and M.V. Nathan. 1998. Soil Organic Matter. Pg. 53-58. In Recommended Chemical Soil Test Procedures for the North Central Region. No. 221 (Revised). Missouri Ag. Expt. Sta., SB 1001, Columbia, MO.

Table 1. Number of soil tests included in 2008 summary by test and region.

Region	NO_3-N	P	K	pH	Soluble Salts	O.M.	Zinc
	---------- Number of samples ----------						
NE	2254	2790	2725	2734	2717	522	1749
SE	808	1101	1079	1079	1082	474	801
NC	943	1032	1026	1032	1032	226	588
SC	842	1197	1170	1168	1168	83	571
WR	351	362	362	363	362	147	18
SD Totals	5198	6482	6362	6376	6361	1452	3727

Table 2. Nitrate-N soil test summary[1] for cropped soils, South Dakota, fall 2008.

Region	Avg. Test	No. of Samples	Soil Test Level lb/Acre, 2 ft.							
			0-20	21-40	41-60	61-80	81-100	101-150	151-200	>200
	lb/A-2'		% of samples							
NE	56	1567	7	37	27	13	6	6	2	2
SE	64	967	4	35	23	14	10	10	3	2
NC	69	231	3	27	24	17	13	11	3	2
SC	55	427	6	42	21	14	8	7	3	0
WR	56	216	21	29	14	12	11	9	1	3
SD Totals	59	3408	7	36	24	13	8	8	2	2

[1]From July 1 – December 30, 2008.

Table 2A. Soil nitrate-N levels as influenced by previous crop for fall[1] of 2008.

Previous crop	Average nitrate-n,
	lb/a in two feet
Corn silage	105
Corn	78
All Wheat	66
Oats	64
Soybean	43
Alfalfa	46
CRP (Grass)	14
Fallow	105
All cropped	59

[1] From July 1 – Dec. 30,2008.

Table 3. Phosphorus soil test summary, South Dakota, 2008

Region	Avg. Test	Soil Test Level - ppm				
		0-3 VL	4-7 L	8-11 M	12-15 H	16+ VH
	ppm	% of samples				
NE	14	9	22	26	12	30
SE	15	12	23	24	12	28
NC	15	7	25	29	13	27
SC	14	8	22	28	14	29
WR	17	4	24	25	14	33
SD Totals	15	9	23	27	13	29

Table 4. Potassium soil test summary, South Dakota, 2008.

Region	Avg. Test	Soil Test Level – ppm				
		0-40 VL	41-80 L	81-120 M	121-160 H	>160 VH
	ppm	% of samples				
NE	208	0	3	13	24	60
SE	230	0	2	12	26	60
NC	408	0	0	1	3	96
SC	324	0	1	4	9	86
WR	437	0	1	2	2	94
SD Totals	278	0	2	9	17	73

Table 5. pH soil test summary, South Dakota, 2008.

Region	Avg. Test	Soil Test Level				
		<6.1	6.1-6.5	6.6-7.0	7.1-7.5	>7.5
		% of samples				
NE	6.72	14	28	28	20	11
SE	6.58	22	26	28	17	7
NC	6.76	8	29	34	21	8
SC	6.90	6	19	34	28	12
WR	7.03	5	22	21	32	20
SD Totals	6.69	12	26	30	22	10

Table 6. Soluble salt soil test summary, South Dakota, 2008.

Region	Avg. Test	Soil Test Level – mmho/cm				
		0-2.0	2.1-3.0	3.1-5.0	5.1-10.0	>10.0
	mmho/cm	Number of samples				
NE	0.38	2709	4	2	1	1
SE	0.40	1076	2	1	3	0
NC	0.56	1015	11	3	2	1
SC	0.45	1164	2	0	2	0
WR	0.53	361	1	0	0	0
SD Totals	0.43	6325	20	6	8	2

Table 7. Zinc soil test summary, South Dakota, 2008.

Region	Avg. Test	Soil Test Level - ppm				
		0-0.25 VL	0.26-0.50 L	0.51-0.75 M	0.76-1.00 H	>1.00 VH
	ppm	% of samples				
NE	1.18	0	12	20	17	51
SE	1.19	0	11	18	19	51
NC	1.05	0	14	21	23	41
SC	0.88	3	21	26	20	29
WR	0.92	0	11	33	28	28
SD Totals	1.11	1	14	21	19	46

Table 8. Organic matter soil test summary, South Dakota, 2008.

Region	Avg. Test	Soil Test Level - %				
		<2.1 VL	2.1-3.0 L	3.1-4.0 M	4.1-5.0 H	>5.0 VH
		% of samples				
NE	3.93	3	15	38	37	7
SE	3.68	5	18	47	26	4
NC	3.41	7	30	38	19	6
SC	3.28	5	49	30	13	2
WR	2.87	41	29	12	7	10
SD Totals	3.62	8	22	38	26	6

Table 9. Chloride soil test summary[1], South Dakota, 2008

Chloride			
Relative Level	Soil Test Level	Number of Samples	Percent of Total
	lb/acre, 0-2 ft.		%
Low	0-30	251	54
Medium	31-60	134	29
High	> 60	84	18

[1]469 total samples. Number of samples: West River=25; East River-NE & NC=343, SE & SC=101.

Table 10. Sulfate-Sulfur soil test summary, South Dakota, 2008.

---------- Sulfate-S ----------			
Relative Level	Soil Test Level	Number of Samples	Percent of Total
	lb/acre, 0-2 ft.		%
Very Low	0-9	91	4
Low	10-19	251	10
Medium	20-29	269	11
High	30-39	269	11
Very High	40-80	610	25
Very High	> 80	986	40
Total		2476	

Table 11. Average soil tests from manured and non-manured fields, 2008 crop year, Soil Testing Lab – SDSU

Category	nitrate-N	P	K	Zn	pH	sol. salts
	lb/a, 2 feet	ppm	ppm	ppm		mmho/cm
No manure	68	14	278	1.08	6.76	0.44
Manure[1]	111	25	277	1.82	6.53	0.40
[1]Number of manure samples	158	257	257	198	257	257

Table 12. Soil test summary (averages) from Garden and Lawn Samples, 2008 crop year – SDSU Soil Testing Lab

Category	No. of Samples	nitrate-N	P	K	O.M.	pH	sol. salts
		lb/a, top 6”	------ppm----		%		mmho/cm
Non-garden/lawn	6133	23	15	279	3.6	6.76	0.44
Garden	451	51	52	529	5.0	7.46	0.91

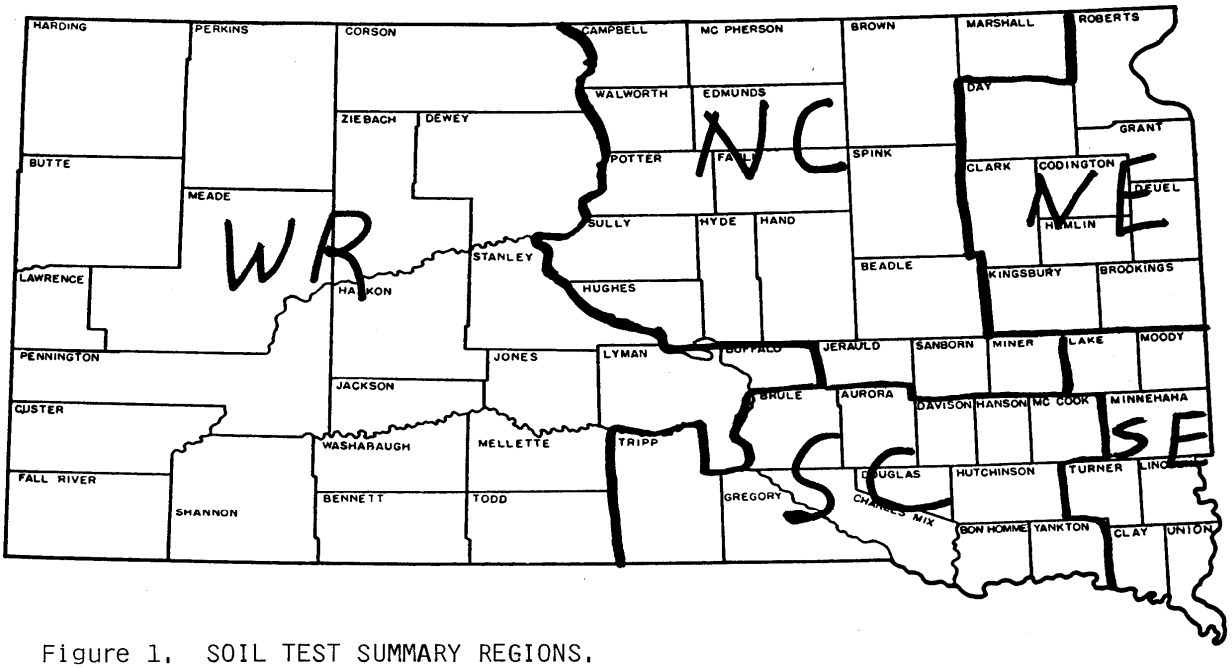

Figure 1. SOIL TEST SUMMARY REGIONS.