Aglime for Corn and Soybean Production[1]

Regis Voss
Extension Agronomist
Iowa State University

Liming acid agricultural soils has been a long-time proven practice to maintain/improve crop yields, particularly forage legumes, and to favorably affect soil chemical, biological and physical properties.

Summaries of soil test results from the Iowa State University Soil Testing Laboratory for the past 35 years have shown a consistent 2 to 3 percent of soil samples with a soil pH below 5.5 and 14 to 16 percent with soil pH between 5.6 and 6.0. There has been an increasing percentage (from 21 to 35%) of soil samples from northwest Iowa with a soil pH below 6.0 during the past 35 year period. This is apparently due to tracts of land being in corn more frequently, increasing rates of fertilizer N, and lack of limestone applications as a production practice during this period of time. The effect of fertilizer N on soil pH after 30 years of continuous corn is shown in Table 1. Application of agricultural limestone in northwest Iowa is expensive at approximately $18 per ton applied due to transportation costs. A normal recommendation would cost $50 to $70 per acre.

Traditional lime rate studies have bracketed a normal recommended rate, frequently in the range of 3,000 to 6,000 lb. of effective calcium carbonate equivalent (ECCE) per acre, because the objective was to evaluate the effect on yield by increasing soil pH to the "proper" range. An example of such work is shown in Table 2. A series of eleven lime-rate experiments on continuous corn were initiated in 1967 with the objective to determine the "proper" soil pH for corn and to obtain a measure of corn yield response to limestone additions. Data from a responsive site with an initial soil pH of 5.70 are shown in Table 3. General conclusions based on the responsive sites were that liming to a soil pH of 6.0 to 6.5 appeared to be feasible for well-fertilized continuous corn when the soil pH was 5.70 or lower and particularly if the pH deeper in the root zone is not substantially higher.

A lime-rate study for a corn-soybean sequence was initiated in 1966 on a Moody silt loam soil in northwest Iowa. The yield results of the study, which permits both crops to be grown each year, are shown in Table 4. At this location moisture frequently limits yields as shown for the 1966-69 period. Apparently, there has to be a yield potential for corn above 100 bu/acre and for soybean above 40 bu/acre before there is a probability of a yield increase. Although both corn and soybean yields are somewhat erratic, the data do suggest that adjusting soil pH by limestone additions would be profitable.

---

[1]Presented at the twenty-first North Central Extension-Industry Soil Fertility Conference, November 13-14, 1991, St. Louis, MO.

In 1984 a lime-rate study for a corn-soybean sequence in which only one crop per year can be grown was initiated on a Kenyon loam soil in northeast Iowa. The limestone additions were made in the spring of 1984, and it was decided to not make yield measurements the initial year with the reason that an allowance should be made for subsequent tillage to mix the limestone in the soil and for time for acid neutralization to take place. As shown in Table 5 there was a response to the first increment of 1000 lb ECCE/acre for corn and soybean the first three years. When yield potential decreased due to moisture stress, the response to lime additions and/or adjustment of soil pH decreased.

Because of the crop yield response to the lowest rate of limestone addition shown in Table 5 and because of the promotional material for other physical forms of limestone, e.g., pelletized limestone, lime-rate studies were established in western Iowa. A study was initiated on a Primghar silty clay loam soil in Plymouth County in 1988. Rates of limestone for pelletized and fluid lime were 250 and 500 lb/acre and aglime was applied at 500, 1000, 2000, 4000, and 6000 lb ECCE/acre. The effect of these materials on soil pH is shown in Table 6. As expected, the effect on soil pH is directly related to the amount of material as ECCE applied. The initial buffer pH (Ohio buffer) was 6.38 and the recommendation to increase soil pH to 6.5 was 3,620 lb ECCE/acre for a 6-inch soil depth. The data show that this may be too low for this soil. The tillage practices were a chisel plow and field cultivator, which is the reason for the soil pH shown for a 0-3 inch soil depth. Severe drought in 1988 limited corn yields such that no yields were obtained. Moisture shortages in 1989 limited soybean yields and no yield response occurred. In 1990 corn yields, although erratic, suggest that a corn yield response occurred to a lime treatment, irrespective of the rate.

In 1990 another study was initiated on a Marshall silty clay loam soil in Crawford County in western Iowa with identical treatments as the previous study in Plymouth County. The Marshall soil had an initial soil pH that ranged from 5.6 to 5.85 for individual plots. The average buffer pH was 6.40 and the recommendation to increase soil pH to 6.5 was 3500 lb ECCE/acre for a 6-inch soil depth. Treatments were applied in April, 1990 and soybean yields and soil samples were taken in October, 1990. A yield response occurred to lime treatments irrespective of rate (Table 7). The low rates of limestone had little effect on soil pH and there was no difference among sources.

Summary

Corn and soybean do respond to limestone additions to acidic soils. Low rates of limestone regardless of source have little effect on soil pH. The indication that corn and soybean respond to low rates of limestone, even though soil pH is affected little, is of interest because of the profit potential for crop producers in areas where limestone costs are high. Research is needed at a number of locations to evaluate the frequency of response to low-rate additions of limestone before it can be recommended as an acceptable practice.

Table 1. Effect of fertilizer N rate on soil pH after 30 years of continuous corn grain grown on a Moody silty clay loam soil (Udic Haplustoll) in northwest Iowa.

Annual N rate	Soil pH 1956	Soil pH 1986
lb/acre		
0	6.46	6.40
50	6.48	6.23
100	6.50	5.83
150	6.45	5.53

Table 2. Crop yields as influenced by rates of limestone on a Grundy silty clay loam soil (Aquic Argiudoll).

Limestone rate[1]		1970	1967-74 Average		
1949	1966	Soil pH	1st Yr. Corn	2nd Yr. Corn	Soybeans
- - tons/acre - -			- - - - - - - - bu/acre - - - - - - - - -		
0	0	6.0	115	112	39
3	3/4	6.4	114	119	38
6	1 1/2	7.1	121	121	38
10	2 1/2	7.4	119	125	40

[1]1949 rates were tons of ground limestone; 1966 rates were tons of ECCE.

Table 3. Continuous corn yields as influenced by rates of agricultural limestone on a Floyd loam soil (Aquic Hapludoll) in northeast Iowa.

ECCE applied 1967	Soil pH 1968	Soil pH 1970	Soil pH 1974	1967-74 Average[1] Corn Yield
lb/acre				bu/acre
0	5.65	5.65	5.68	117
1,000	5.70	5.90	5.83	121
2,000	6.05	6.10	6.18	123
4,000	6.10	6.55	6.47	125
8,000	6.20	6.85	7.02	126
16,000	6.35	7.25	7.45	120
24,000	6.70	7.45	7.75	128
32,000	6.75	7.55	7.80	126

[1]Annual fertilizer applications were 200 + 115 + 90 lb/acre for N + P_2O_5 + K_2O, respectively.

Table 4. Yields of a corn-soybean sequence as influenced by rates of agricultural limestone on a Moody silty clay loam (Udic Haplustoll) with an initial soil pH of 6.2.

ECCE applied 1966	Soil pH 1972	Soil pH 1986	Average yields for each period[1] 1966-1969	1970-1972	1973-1975	1976-1979	1980-1982	1983-1985	1986-1988	1966-1988
			Corn, bu/acre							
0	6.1	5.9	68	96	97	99	117	134	108	101
1,000	6.3	6.0	70	98	95	97	123	135	109	102
2,000	6.5	5.9	73	94	99	98	124	129	116	103
4,000	6.9	6.1	68	103	103	103	127	139	105	105
8,000	7.4	6.3	69	106	105	105	123	140	114	107
16,000	7.8	6.7	66	94	98	98	128	135	116	103
			Soybean, bu/acre							
0			23	32	40	41	45	43	37	37
1,000			23	32	40	45	46	44	38	38
2,000			24	33	45	43	47	45	39	39
4,000			25	32	45	43	42	50	39	39
8,000			25	32	45	43	47	51	40	40
16,000			25	30	44	46	47	51	40	40

[1]Annual fertilizer additions to corn were 80 + 46 + 24 and to soybean 0 + 46 + 24 lb/acre for N + P_2O_5 + K_2O, respectively.

Table 5. Yields of a corn-soybean rotation as influenced by rates of agricultural limestone on a Kenyon loam soil (Typic Hapludoll) with an initial soil pH of 5.50.

ECCE Applied 1984	Soil pH Fall-1987	Corn Yield 1985	Corn Yield 1987	Corn Yield 1989	Soybean Yield 1986	Soybean Yield 1988	Soybean Yield 1990
lb/acre		bu/acre					
0	5.62	146	173	111	43	29	60
1,000	5.98	157	179	109	49	30	61
2,000	6.27	154	178	114	51	31	61
4,000	6.78	156	175	109	52	29	65
6,000	6.85	156	175	117	53	30	64
8,000	7.03	152	173	117	53	31	61
12,000	7.08	152	180	117	53	31	64
16,000	7.17	151	181	115	51	31	64

Table 6. The effect of aglime sources and rates on soil pH and crop yields on a Primghar silty clay loam soil (Aquic Hapludoll) with an initial soil pH of 5.33.

Treatment[1] April, 1988	Aglime Source	Soil pH, 0-3 in. 4/89	4/90	10/90	Soybean 1989	Corn 1990
					- - bu/acre	- -
0	--	5.12	5.42	5.16	33	94
250	Pellet	5.27	5.56	5.31	33	100
500	Pellet	5.23	5.50	5.58	33	108
250	Fluid	5.27	5.57	5.24	33	104
500	Fluid	5.45	5.64	5.52	31	98
500	Aglime	5.37	5.68	5.41	29	97
1000	Aglime	5.44	5.77	5.59	32	105
2000	Aglime	5.73	5.95	5.76	35	106
4000	Aglime	6.27	6.67	6.22	32	99
6000	Aglime	6.48	7.00	6.55	35	106

[1]Rates of pelletized and fluid lime sources were reapplied in April, 1990.

Table 7. The effect of aglime sources and rates on soil pH and crop yields on a Marshall silty clay loam (Typic Hapludoll).

Treatment April, 1990	Aglime[1] Source	Soil pH, 0-3 in. 4/90	10/90	Soybean 1990
				bu/acre
0	--	5.73	5.67	43
250	Pellet	5.74	5.70	48
500	Pellet	5.73	5.73	47
250	Fluid	5.77	5.73	50
500	Fluid	5.73	6.03	50
500	Aglime	5.72	5.77	50
1000	Aglime	5.78	6.10	48
2000	Aglime	5.72	6.22	49
4000	Aglime	5.72	6.62	49
6000	Aglime	5.68	6.61	47

[1]ECCE was 1131, 1768 and 1594 lb/ton of material for pelletized, fluid and aglime sources, respectively.

PROCEEDINGS OF THE TWENTY-FIRST

NORTH CENTRAL EXTENSION - INDUSTRY SOIL FERTILITY CONFERENCE

November 13-14, 1991, Holiday Inn St. Louis Airport

Bridgeton, Missouri

Volume 7

Program Chairman:

Randy Killorn

Department of Agronomy
Department of Agronomy
Iowa State University
Ames, IA 50011