SOYBEAN CHLOROSIS MANAGEMENT PROGRAM

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Chlorosis in soybeans is a problem wherever soybeans are grown on high pH soils. In Nebraska, most of the soybeans are grown in the southeastern half of the state. Here the upland soils are neutral to moderately acid; however, many of the river valley soils are alkaline. Thus, chlorosis is a problem in the Platte and Elkhorn River Valleys and to a lesser extent, in the Republican and Loup River Valleys. Not all soils in the river valleys are prone to chlorosis OF soybeans even though many are alkaline in reaction. Table 1 shows a comparison of non-chlorotic and chlorotic soybean field sites. Soil test characteristics of the surface soil are very similar; however, the subsoils are greatly different, particularly in the 16-24 inch zone. Subsoils in the chlorotic area contain more salt and excess lime, and have a higher sodium saturation. It is estimated that approximately 250,000 acres of land exist in the river valleys of Nebraska where chlorosis is likely to be a problem. Some soils are too sodic to grow soybeans even with the best management practices; however, soils similar to the ones illustrated in Table 1 can produce good soybean crops with proper management practices. Research in Nebraska has been directed at four areas of soybean production management:

1. Variety selection
2. Seeding density
3. Materials applied with the seed
4. Foliar treatment

Table 1. Comparison of Non-Chlorotic and Chlorotic Soybean Field Sites

Site Description	Sample Depth (in.)	pH	Conductivity (mmhos)	CaCO3 Equivalent (%)	Sodium Saturation (%)
Non-Chlorotic	0-8	8.1	0.2	1.0	3
	8-16	8.3	0.2	2.7	2
	16-24	8.4	0.2	3.4	2
Chlorotic	0-8	8.2	0.2	1.4	4
	8-16	8.8	0.4	2.9	19
	16-24	9.1	1.0	4.9	37

VARIETY SELECTION

Soybean growers in the Platte Valley have known for many years that the variety Wayne is very sensitive to high pH soils; whereas, Calland is somewhat more tolerant. Neither variety is satisfactory, however. During the last ten years, varieties have been developed that will tolerate the alkaline soil conditions to a greater degree. In 1980, a trial was established in Dodge County to screen varieties that might be tolerant. In that trial, one variety (Midwest Oilseeds 2050, now sold as Stine 2050+) yielded significantly higher than the other 15 varieties in the test. In 1981 and 1982, the trials were expanded to two locations in Dodge County and the studies included 34 varieties in 1981 and 40 in 1982. These preliminary trials set the stage for financial support from the Nebraska Soybean Development, Utilization and Marketing Board to expand the studies to other counties. Data have been collected from 8 locations during 1983 and 1984. Four more locations will be harvested in 1985. A total of 119 varieties have been screened during 1980-85.

Table 2 shows the seed yields for 30 varieties grown at 8 locations during 1983 and 1984. Ten varieties (McCubbin Taylor through S Brand S47B) are in the top group in terms of yield under these high soil pH conditions. Seven varieties are in the bottom group. Inferior varieties are not included the second year if they are not tolerant to the soil conditions in the first year of testing. Table 3 shows the yield data for eleven varieties that were included in the test for five years. The seed yields of six varieties are significantly higher than for the other five varieties. Century and Mead are included as a standard for these tests.

Varieties included in these trials are given a numeric chlorosis score based on color. Readings are made eight weeks after planting using the following as a guide:

1. Normal; dark green
2. Near Normal; light green, no chlorotic leaves
3. Mild Chlorosis; interveinal yellowing in upper trifoliates
4. Chlorotic; interveinal yellowing in all trifoliates, necrotic leaf areas just beginning to show on some leaves
5. Very Chlorotic; pronounced interveinal yellowing, necrotic leaf
6. Severely Chlorotic; some plants dead, necrotic leaf tissue dominates

Figure 1 shows the relationship between chlorosis score and seed yield. Chlorosis score at eight weeks and seed yield are very highly correlated; thus, the performance of a variety can be predicted soon after planting.

SEEDING DENSITY

Seeding density has an influence on how well a soybean variety will tolerate an alkaline soil. Table 4 is a summary of three varieties planted at three seeding rates at five locations. Statistical analysis

TABLE 2. Seed Yields of 30 Soybean Varieties at 8 Sites, 1983-84

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	
VARIETY	29	11485.85	396.06	7.72	***
SITE	7	61095.92	728.00	170.12	***
V X S	203	11484.76	56.58	1.10	N.S.

GRAND MEAN = 23.52 BU./AC. C.V. = 30.0%

BRAND	ENTRY	MEAN	
McCUBBIN	TAYLOR	29.2	a 1/
DEKALB-PFIZER	CX283	26.7	ab
STINE	2920	26.7	ab
HOEGEMEYER	205	26.6	ab
NC+	2D90+	26.4	abc
GOLDEN HARVEST	H1285	26.1	abc
S BRAND	S46D/S47	26.0	abc
SUPERIOR	SPB308	25.8	abc
AGRI-GOLD	AG-ROYAL	25.6	abc
S BRAND	S47B	25.5	abc
STINE	2050+	25.2	bc
LAND O'LAKES	L4207	25.2	bc
STOCK	SS462A	24.4	bc
HOEGEMEYER	200	24.4	bc
JACQUES	J-103	24.3	bc
JACQUES	J-105	24.0	bcd
STOCK	SS793	23.8	bcd
---	CENTURY	23.5	bcd
FONTANELLE	F4545	23.5	bcd
SUPERIOR	SPB340	23.4	bcd
S BRAND	S44A	23.1	bcd
LAND O'LAKES	L4106	23.1	bcd
HOFLER	GEM	22.6	cde
DEKALB-PFIZER	CX350	20.6	def
---	MEAD	19.6	ef
HOEGEMEYER	264	19.4	ef
DIAMOND	TC204A	19.1	f
---	PLATTE	17.7	f
MIDWEST OIL	397	17.3	f
STOCK	SS500	17.0	f

1/ Means followed by the same letter not significantly different at 5% level of probability.

confirms that the five sites employed were different; however, the main effects were strong enough that an evaluation over sites is meaningful. In terms of chlorosis score, varieties and seeding densities were significantly different; however, there was no interaction between varieties and seeding rate. The lower portion of Table 4 shows the seed yield means for the five sites. Again, varieties and seeding densities are both significantly different and there is a significant variety by seeding density interaction. A dense seeding rate is more important with a semi-tolerant variety (Century) than with a tolerant variety (Stine 2920) and has limited benefits with the intolerant variety

TABLE 3. Seed Yield of 11 Soybean Varieties at 12 Sites, 1981-84

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	F VALUE	
VARIETY	10	2998.36	299.84	5.44	***
SITE	11	90053.39	8186.67	148.47	***
V * S	110	9987.96	90.80	1.65	***

GRAND MEAN 29.08 BU./AC. C.V. = 26%

BRAND	ENTRY	MEAN	
STINE	2050+	32.38	a 1/
S BRAND	S47B	31.02	a
LAND O'LAKES	L4207	31.00	a
FONTANELLE	F4545	30.31	a
JACQUES	J-105	30.30	a
S BRAND	S46D/S47	30.23	a
---	CENTURY	27.48	b
DIAMOND	TC204A	27.47	b
DEKALB-PFIZER	CX350	26.89	b
MIDWEST OIL	397	26.59	b
---	MEAD	26.23	b

1/ Means followed by the same letter not significantly different at 5% level of probability.

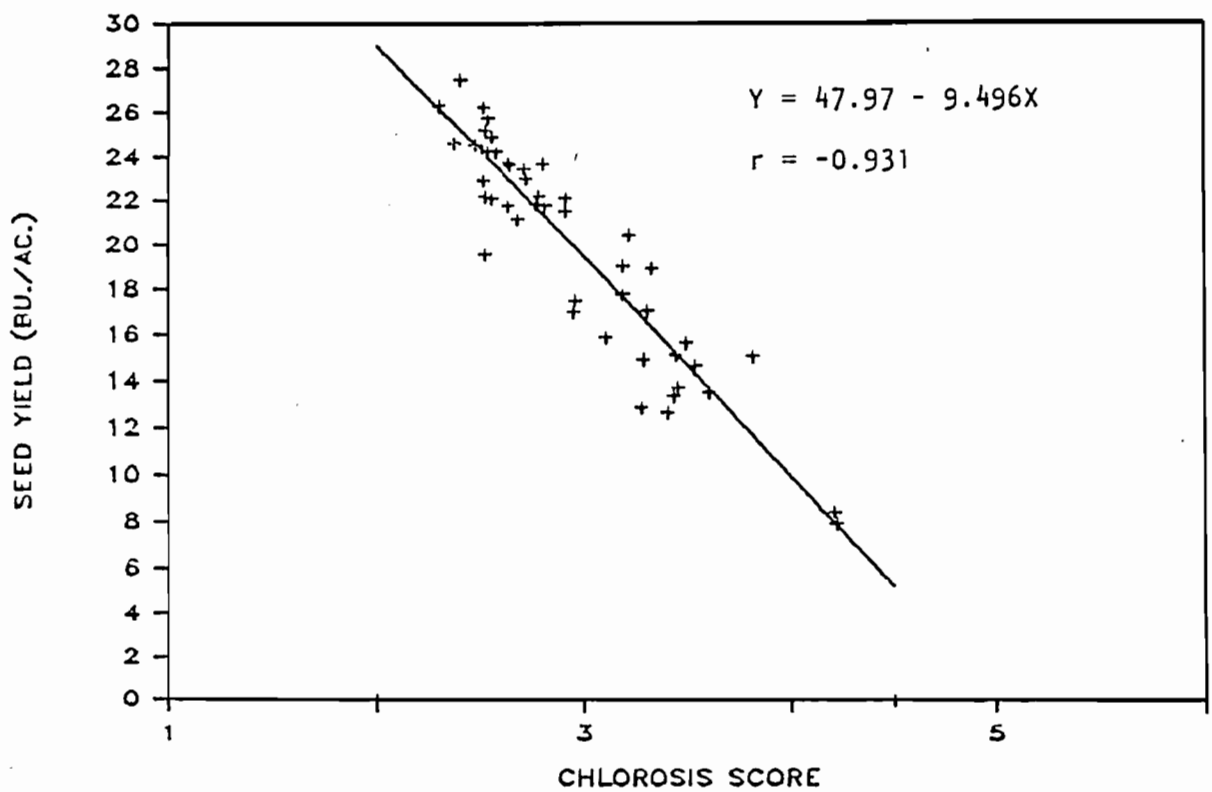


Figure 1. Relationship of soybean seed yield to chlorosis score at eight weeks after planting from five field sites, 1984.

Table 4. Influence of variety and seeding density on chlorosis score eight weeks after planting and seed yield, 5 sites, 1984.

CHLOROSIS SCORE

VARIETY		DENSITY, SEEDS/FT.			
		4.5	9.0	13.5	MEAN
---	CENTURY	3.30	3.02	2.63	2.99
---	NEBSOY	4.49	4.08	4.03	4.20
STINE	2920	2.96	2.38	2.18	2.51
	MEAN	3.58	3.16	2.94	3.23

SITE ***, VAR ***, DEN ***, S X V ***, S X D N.S., V X D N.S.

SEED YIELD

VARIETY		DENSITY, SEEDS/FT.			
		4.5	9.0	13.5	MEAN
---	CENTURY	12.1	17.1	24.8	18.0
---	NEBSOY	2.6	5.7	8.7	5.6
STINE	2920	13.4	22.7	27.3	21.2
	MEAN	9.3	15.2	20.3	14.9

SITE ***, VAR ***, DEN ***, S X V **, S X D ***, V X D ***

***, ** Significant at the 0.01 and 0.05 levels, respectively
N.S. = Nonsignificant.

(Nebsoy). The interactions of variety and density by site can be explained by the degree of chlorosis at each of the sites (data not shown).

MATERIALS APPLIED WITH THE SEED

Several materials and methods of application have been evaluated in terms of correcting chlorosis of soybeans grown on alkaline soils in the Platte Valley; however, most attempts have not been very successful. The application of chelates directly with the seed at planting time have been the most effective and consistant. Table 5 shows the influence of four materials applied with the seed on seed yield and chlorosis score. It is evident that Fe-EDDHA at a rate above 2 pounds per acre or Fe-DPS at the 20 pounds per acre rate were very effective in correcting chlorosis in the soybeans which resulted in a significant yield increase.

FOLIAR TREATMENT

The application of materials to the foliage of soybeans can be effective in preventing chlorosis; however, results have been very inconsistant. Lack of consistancy for eliminating high pH induced chlorosis is possibly due to site selection where chlorosis was short lived, application too late when chlorosis had advanced to 3 or 4 trifoliate leaves, or application at times when air temperature and winds reduced leaf absorption. A successful foliar treatment experiment is

Table 5. Influence of seed applied materials on seed yield and chlorosis score of soybeans (Peterson variety), 1980

Product Tested	Application Rate (lbs/A)	Seed Yield (bu/A)	Chlorosis Score 1/
Fe-EDDHA	8.4	49.6	1.47
Fe-EDDHA	4.2	44.6	1.52
Fe-DPS	20	43.0	1.70
Fe-EDDHA	17	41.1	1.28
Fe-EDDHA	1.8	30.2	2.35
Fe-Lignosulfonate	20	28.6	2.60
Acidified Jarosite	36	28.0	2.58
Check	---	23.1	3.12

L.S.D. .05 = 10.0; C.V. = 15.9%

1/ Average of six observations

Table 6. Effect of foliar applied materials on seed yield of soybeans.

Foliar Treatment	Amount of material applied per acre in a 20 gallon volume	Soybean Yield (bu/A)	
Fe-EDDHA	1 lb	57.7	a 1/
Fe-DPS	0.5 gal	43.1	b
Malic Acid	5 lbs	36.8	bc
CaSO4	0.4 lb	34.7	bc
Check	--	27.1	c

1/ Means followed by the same letter not significantly different at the 5% level of probability.

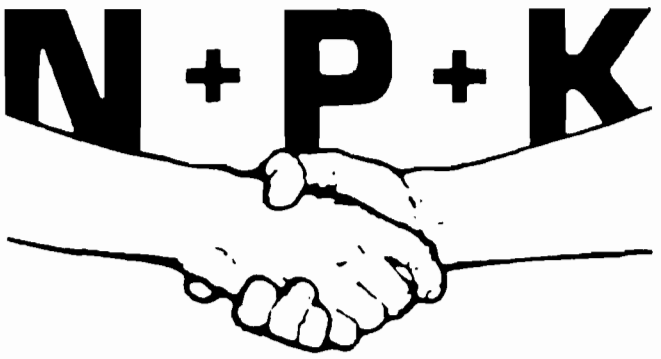
reported in Table 6. Fe-EDDHA increased the seed yield significantly. Fe-DPS, not know for consistant yield increases in chlorotic plants from foliar application, also increased the seed yield significantly. In other studies, FeSO4 has increased seed yields significantly; however, Fe-EDDHA is usually more effective when the two have been compared.

SUMMARY

Research results show that there are four management techniques that can make it possible to grow soybeans on some of the alkaline soils in the river valleys of Nebraska. First and foremost is the selection of a tolerant variety. Even with a tolerant variety, seeding rate should be at least 12 seeds per foot, regardless of row spacing. Solid seeding (rows spaced less than 20 inches) is not recommended. Placement of materials (particularly chelates) appears to enhance the performance of even the more tolerant varieties. Foliar application of materials appears to be a "last resort" approach, but may have some value if done timely with an effective material. For seed and foliar application, Fe-EDDHA has been the most consistant material identified to date.

PROCEEDINGS

OF THE FIFTEENTH
NORTH CENTRAL EXTENSION-INDUSTRY
SOIL FERTILITY WORKSHOP



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OCTOBER 30-31, 1985

HOLIDAY INN NORTH
BRIDGETON, MISSOURI