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Soybean Chlorosis Management

Four management ideas that make it possible to grow soybeans on alkaline soils are covered here.

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Chlorosis (yellowing) in soybeans can be a problem wherever soybeans are grown on alkaline soils in Nebraska. Serious chlorosis is likely to occur when the pH of these alkaline soils is 7.5 or higher.

Soybean chlorosis problems occur in the Platte and Elkhorn River Valleys and, to a lesser extent, in the Republican and Loup River Valleys, and on high lime soils in central and western Nebraska. Not all high pH soils cause chlorosis of soybeans even though they are alkaline.

Soil tests of the surface soil in chlorotic and non-chlorotic soybean areas of a field often are similar; however, the subsoils may be greatly different, particularly at the 16-24 inch depth. Subsoils in the chlorotic soybean area usually are poorly drained, are higher in pH, contain soluble salts and excess lime (carbonates), and may 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 (high sodium) or saline (salty) to grow soybeans, even with the best management practices. Many alkaline soils, however, can produce good soybeans with proper management.

Chlorosis in soybeans occurs in spots in fields and usually in a random pattern, depending on soil chemical and physical differences in the field. *Figure 1* is an example of a field in the Eastern Platte Valley where chlorosis usually occurs when the field is planted to soybeans. Corn is not affected in this field.

Figure 2 shows a close view of chlorosis in soybeans. The interveinal yellowing of the leaves distinguishes lime-induced chlorosis from other problems due to disease or chemical injury. Chlorosis does not occur in the cotyledons (seed leaves) or the unifoliolate (single leaflet) leaves. It will first appear in the trifoliolate (three leaflet) leaves as seen in *Figure 2*.

Figure 1. Field view of chlorosis in soybeans in the Platte Valley near Fremont

Figure 2. Typical chlorosis (interveinal yellowing) of trifoliolate leaves of soybeans and the normal green color in the unifoliolate (single) leaves

Occasionally, chlorosis may not be evident until the second, third, or later trifoliolate leaves emerge. Also, the intensity of chlorosis may increase or diminish during the growing season, depending on growing conditions and the soil chemical and physical changes. Changes in soil moisture content and temperature are thought to be the important factors.

Research has been directed at four areas of soybean production management: (1) variety selection, (2) seeding density, (3) materials applied with the seed, and (4) foliar treatment.

Variety Selection

Soybean growers in the Platte Valley have known for many years that some soybean varieties are more sensitive to high pH soils than are other varieties. During the last 10 years, varieties have been developed that are more tolerant to alkaline soil conditions.

In 1980, a trial was established in Dodge County to screen varieties that might be tolerant. In that trial, one variety yielded significantly higher than the other 15 varieties in the test. Since then, 177 varieties have been screened for tolerance to high pH soils in Nebraska. These tests were conducted in farmer fields in the Platte and Elkhorn Valleys. One method of screening soybean varieties is to give them a numeric chlorosis score based on leaf color. Readings were made six and eight weeks after planting using the following as a guide:

Figure 3. Chlorotic soybean plants displaying various leaf colors.

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

Seed yield, the primary screening method, was determined at maturity and yield was compared to chlorosis score. Chlorosis score, six or eight weeks after planting, and seed yield are highly correlated; the performance of a variety can be predicted soon after planting when the trifoliolate leaves emerge.

Research data show a 25-30 percent reduction in seed yield (10-13 bushels per acre) for each unit increase in chlorosis score as the degree of chlorosis increases from near normal to severely chlorotic. Some loss in seed yield occurs even when chlorosis is mild but may not be detected by producers.

Soybean varieties that have demonstrated tolerance to lime-induced chlorosis are listed alphabetically in *Table I*. All varieties listed in this table have tolerance to chlorosis. Those in the top part of the table gave the most consistent performance and are not significantly different in terms of seed yield.

Table I. Soybean varieties with demonstrated chlorosis tolerance as determined by seed yield during three or more years of field testing.

*Top 2/3rds of the varieties in the top yield group every year in test.**			
BRAND	**ENTRY**	**BRAND**	**ENTRY**
Dekalb-Pfizer	CX283	Ohlde	2193
Golden Harvest	H1285	Profiseed	PS1350
Jacques	J103	S Brand	S46D
Jacques	J231	Stine	2330
McCubbin	Taylor	Superior	SPB308
NC+	2D90+		
*Varieties not significantly different in terms of seed yield.			
Rest of varieties with chlorosis tolerance but not in the top 2/3rds every year in test.			
BRAND	**ENTRY**	**BRAND**	**ENTRY**
Asgrow	A2187	Northrup King	S29-20
Asgrow	A3427	Profiseed	PS1152
Fontanelle	F4545	S Brand	S44A
Hoegemeyer	205	S Brand	S47B
Horizon	H25	Stine	2050+
Horizon	H29	Stine	2920
Northrup King	S23-03		

Table II lists those varieties that have been evaluated for only one or two years. Again, the varieties are listed alphabetically. Those varieties in the top part of the table are judged to have the greatest potential on high pH soils. The varieties in the lower portion of *Table II* were in the top group but were not in the upper two-thirds of the top group. All varieties listed in *Table II* need further evaluation to determine their long-term performance.

Table II. Soybean varieties with potential chlorosis tolerance based on seed yield for one or two years of field testing.

Top 2/3rds of the varieties in the top yield group.

BRAND	ENTRY	BRAND	ENTRY
Dahlgren	DS-3285*	Jacobsen	J824
Dekalb-Pfizer	CX174	Lynks	8280*
Fontanelle	F4201*	SOI	226*
Horizon	H21		
Rest of varieties in top yield group.			
BRAND	**ENTRY**	**BRAND**	**ENTRY**
Hoegemeyer	150*	Stine	2070*
NC+	2K40*	Superior	SPB308T
S Brand	S46J*		
*One year data only			

Table III lists the other varieties that have been evaluated but did not have adequate tolerance to alkaline soil conditions or do not have seed available.

New varieties will continue to be developed, and some will have good tolerance to high pH soils. Producers should compare new varieties against those varieties listed in Table I.

Table III. Soybean varieties that have been evaluated on high pH soils, but are not adequately tolerant to chlorosis or seed is not available for production.

BRAND	ENTRY	BRAND	ENTRY
__	Amcor	Dekalb-Pfizer	CX264
__	Amsoy 71	Dekalb-Pfizer	CX290
__	BSR 101	Dekalb-Pfizer	CX324
__	Calland	Dekalb-Pfizer	CX350
__	Century		
__	Century 84	Diamond	Eagle
__	Corsoy 79	Diamond	D220
__	Cumberland	Diamond	D310
__	Elf	Diamond	83-32
__	Elgin	Diamond	TC204A
		Ferry Morse	GT1310
__	Fremont	Ferry Morse	GT1380
__	Hack		
__	Harper	Fontanelle	F3850
__	Hobbit	Fontanelle	F4646
__	Hoyt	Fontanelle	F4747
__	Lakota	Fontanelle	X5003

__	Logan	Funk Seed	12213
__	Mead	Funk Seed	12227
__	Nebsoy		
		Golden Harvest	Cherokee III
__	Pella	Golden Harvest	H1233
__	Platte	Golden Harvest	H1276
__	Wayne	Golden Harvest	X257
__	Weber	Golden Harvest	X277
__	Will	Golden Harvest	X308
__	Williams	Golden Harvest	X360
__	Williams 79		
__	Williams 82	Hoegemeyer	200
__	Winchester	Hoegemeyer	264
__	Zane	Hoegemeyer	281
		Hoegemeyer	350
Agripro	AP225C		
Agripro	AP250	Hofler	Censoy
Agripro	AP350	Hofler	Gem
Americana	Clinton	Hofler	Topaz
Asgrow	A2234	Horizon	H28
Asgrow	A2575	Hy-Vigor	Rotunda
Asgrow	A2680	Hy-Vigor	900
Asgrow	A3127		
Jacobsen	679	Northrup King	S4044
Jacobsen	771	Northrup King	S4501
Jacobsen	799	Northrup King	X735028
Jacobsen	972	Northrup King	X8821
Jacques	J105		
Jacques	J201	Ohlde	2188
Jacques	J271	Ohlde	2190
		Ohlde	3000
Land O'Lakes	L2330		
Land O'Lakes	L2456	Pioneer	1082
Land O'Lakes	L3145	Pioneer	9181
Land O'Lakes	L3665	Pioneer	9271

Land O'Lakes	L4106	Pioneer	9292
Land O'Lakes	L4207	Pride	B216
Land O'Lakes	Exp79-1746	Pride	B220
Land O'Lakes	Exp79-3068	Riverside	4041
Latham	650	S Brand	S47A
Latham	1010	S Brand	S48
Lynks	5234	S Brand	S50a
Lynks	8165	S Brand	S67
Lynks	8252		
		Sexauer	SX2080
McCubbin	Exp.40510	Sexauer	SX2090
McCubbin	Troy	SOI	166
Midwest Oilseeds	328	SOI	268
Midwest Oilseeds	397	SOI	285
MSR/Agri-gold	Royal	SRF	200
MSR/Agri-gold	Royal II	SRF	Matsoy
MSR	6666		
MSR	X5557	Stine	3500
		Stock Seed	SS462A
NAPB	Exp.9649	Stock Seed	SS500
NC+	2A34	Stock Seed	SS793
NC+	2D90		
NC+	3H49	Superior	SPB289
New Harvest	270	Superior	SPB340
Northrup King	S2596	Superior	X250
Northrup King	S27-10	Valley	778
Northrup King	S30-31	Valley	1178

Seeding Density

Seeding density has an influence on how well a soybean variety tolerates an alkaline soil. Research shows that even with tolerant varieties, seeding density is important. Chlorosis is more severe when plant density is low. Therefore, the suggested seeding rate is 12 viable seeds per foot of row, regardless of row spacing. Row spacings of less than 20 inches are not practical because the suggested seeding density within the row results in an excessive plant population.

The seeding rates suggested here are excessive for most varieties grown on normal soils. Also, solid seeding or drilling soybeans, even though it is a good management practice in other soils, is not suggested in high pH or alkaline soils where chlorosis is a problem. The in-row density of plants is not adequate in drilled soybeans for the plants to tolerate alkaline soil conditions.

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. The application of the iron chelate Fe-EDDHA directly with the seed at planting time has been the most effective and consistent treatment. Fe-EDDHA is a very stable chelate in high pH soils, and it has been the most effective available material found to date. Chelate stability at high pH (7.5 or above) appears to be necessary. Other high pH stable chelates may be an option.

Iron chelate use is suggested in those soils where variety selection and seeding density are not able to overcome the chlorotic conditions. The amount needed depends on the degree of chlorosis; however, the common use rates is between one and four pounds of product per acre. Fe-EDDHA is a dry powder that mixes easily with water. The amount to be used per acre should be dissolved in 20-25 gallons of water and applied directly with the seed in the seed furrow. No fertilizer or other materials should be added.

Since this treatment can be expensive ($10-$50 per acre), only those areas where variety tolerance is inadequate should be treated. Application equipment needs to be set up on the planter so it can be turned on or off as needed while the field is being planted. Also, there are soils where even the best varieties at proper seeding densities and treated with Fe-EDDHA will not grow. If other crops such as corn, grain sorghum, or alfalfa do not grow well, soybeans probably will fail, also.

Foliar Treatment

The application of iron-containing materials to the foliage of soybeans can be effective in correcting chlorosis; however, results are often too inconsistent. Failure to correct high pH induced chlorosis with foliar treatment is usually due to application made too late. Chlorosis that has advanced beyond the stage shown in *Figure 2* is not likely to be corrected by foliar treatments.

Foliar applications made at times when air temperature and winds reduce leaf absorption are not effective. Usually more than one application is needed. Treatment needs to begin as soon as chlorosis first becomes visible (before a rating score of 3), and repeated at 7-10 day intervals until new growth is normal in color.

Spray chlorotic plants with a 1.0 percent solution of iron sulfate. Two pounds of ferrous sulfate ($FeSO_4$) or 4 pounds of ferrous sulfate heptahydrate ($FeSO_47H_2O$) in 25 gallons of water makes a 1 percent solution. Using a concentration greater than 1 percent usually results in excessive leaf burning. Iron chelates can be used, also. Follow directions on the product container.

Adding a commercial wetting agent or a cup of mild household detergent to 100 gallons of spray solution improves plant coverage. The addition of five pounds of urea fertilizer to 100 gallons of spray solution also may improve performance of the foliar spray.

Apply the solution as soon as yellowing begins, and repeat every 10 days until newly emerged leaves remain green. Spray must be directed over the row to the foliage because only the material intercepted by the leaves can be effective.

Field experience shows that foliar spray applied on hot, windy days is not effective or may cause severe leaf burn; applications need to be made in early morning or late evening when air temperature is cool, humidity is higher, and winds are calm.

Summary

Planting a soybean variety that has tolerance to alkaline soils is the first step to producing soybeans on high pH soils. A planting rate of 12 viable seeds per foot is necessary even for tolerant varieties. A pH stable iron chelate such as Fe-EDDHA should be applied with the seed when the planting of a tolerant variety is not adequate. Foliar treatment with an iron solution is a last resort and is suggested only as a rescue treatment.

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