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Evaluation of Soybean Varieties for Iron-deficiency Chlorosis

Pamela Rzodkiewicz and William Schapaugh

Introduction

Iron-deficiency chlorosis is a physiological disease caused by decreased iron in the soybean plant. Iron chlorosis is common when soybeans are grown on calcareous soils found in Kansas. Iron is required for formation of chlorophyll, the green pigment found in plants. When iron is limiting, iron chlorosis symptoms may be expressed in soybean plants. Interveinal chlorosis is the most common symptom, in which the leaves become yellow, with the veins remaining green. In severe cases, the leaves become white or necrotic, with stunted plant growth. Seed yield loss is a function of the severity of yellowing that occurs to the plant.



Figure 1. Differences due to iron-deficiency chlorosis between resistant and susceptible soybean varieties

Planting soybean varieties with resistance to iron-deficiency chlorosis represents an effective method to protect against losses to the disease (Figure 1). Resistant varieties increase protection for the younger leaves and the growing point, decreasing death rates and improving chances for recovery. Screening soybean varieties for iron-deficiency chlorosis is critical. Soybean growers need updated information on the chlorosis response of soybean varieties to Kansas soil and growing conditions. To address this need, this research evaluated currently grown commercial soybean varieties for resistance to iron-deficiency chlorosis.

Procedures

Two hundred thirty five soybean varieties, with three checks [resistant checks A14 and A15; susceptible check KS4202RR] with known responses were planted on July 1, 2005, in a greenhouse at Kansas State University to observe their chlorosis response to soil with a high pH. The soybean varieties were grown in soil collected, 0 to 6 inches deep, from an agricultural field near Zeandale, Kansas.

Plants expressing chlorosis have been observed growing in this field in the past. The soil type for this field was Haynie sandy loam with a soil pH of 7.8. To enhance plant growth, phosphorus, zinc, and copper solutions were added to the soil. A .5 quart container was filled with approximately



Figure 2. Soybean varieties growing in containers at the Kansas State University greenhouse in July 2005.

one pound of this amended soil, and 5 seeds of each entry were planted approximately 1 inch below the soil surface, and thinned to 2 plants after emergence (Figure 2). After emergence, the containers were placed in large, black plastic flats for bottom watering with a sodium nitrate solution.

Iron uptake values were recorded as chlorophyll (greenness) measurements with a Minolta SPAD-502 Chlorophyll Meter. Ratings were averaged from three plots for each entry. Chlorophyll concentrations were taken when the first and second trifoliolate leaves were fully expanded, 12 and 17 days after emergence, respectively. The chlorophyll concentrations were taken on the center leaflet of the fully expanded trifoliolates of two plants per container.



Figure 3. Soybean leaves reflecting the broad chlorophyll spectrum. Chlorophyll readings (L to R) were: 37.8, 35.0, 23.1, 18.2, 11.6, 5.1, and 0.70.

Results

Chlorophyll concentrations differed among the 235 varieties evaluated (Table 1). A wide range of chlorophyll concentrations were observed during this experiment (Figure 3). Average chlorophyll concentration across the two growth stages was 21.0 SPAD. The chlorosis-resistant checks, A14 and A15, possessed mean chlorophyll

scores of 27.7 and 28.7, respectively. The score of 28.7 was the highest average reading among the entries evaluated. Germplasm lines A14 and A15 were released in 1987 for parent stock in soybean breeding and genetics programs. These checks were identified after seven cycles of selection for improved resistance to iron-deficiency chlorosis on calcareous soils in the field. In previous research, the iron-chlorosis-resistant check A15 had been shown to do well in defending against iron-deficiency chlorosis in Kansas soils. Although both A14 and A15 possess superior chlorosis resistance, they are not adapted varieties for Kansas conditions.

No commercial variety possessed resistance significantly greater than these two checks. But out of the 235 varieties tested, 34 commercial varieties possessed average chlorophyll readings that were not significantly lower than the A15 resistant check. These 34 varieties are adapted to Kansas and possess a variety of agronomic characteristics sought by soybean producers.

This study has successfully identified commercial soybean varieties that possess resistance to iron-deficiency chlorosis. Producers are encouraged to use these results with information from seed companies/dealers to select varieties to help eliminate or reduce yield losses from iron-deficiency chlorosis.

Table 1. Evaluation of soybean varieties for iron chlorosis tolerance.

Brand	Name	Chlorophyll Reading (SPAD)	Brand	Name	Chlorophyll Reading (SPAD)
ISU	A15	28.7	ADVANCED GENETICS	AG3833NRS	15.8
ISU	A14	27.7*	AGSOURCE	9383	19.7
DYNA-GRO	DG 39G43	28.4*	AGSOURCE	9436	18.8
DYNA-GRO	DG 36M49	26.3*	ASGROW	AG3005	27.0*
DYNA-GRO	DG 33A37	25.7*	ASGROW	AG3905	25.3*
DYNA-GRO	DG 35D33	25.0*	ASGROW	AG3906	23.2
DYNA-GRO	DG 37R39	25.0*	ASGROW	AG3602	22.6
DYNA-GRO	DG 33B52	23.7	ASGROW	AG4903	19.9
DYNA-GRO	DG 32C38	22.0	ASGROW	AG3505	19.4
DYNA-GRO	DG 35P29	20.1	ASGROW	AG5301	19.1
DYNA-GRO	DG 3468NRR	19.3	ASGROW	AG4801	18.8
DYNA-GRO	DG 39M53	18.1	ASGROW	AG5501	18.0
DYNA-GRO	SXO5138	16.1	ASGROW	AG3305	17.6
KSU	K1631RR	25.9*	ASGROW	AG4703	17.3
KSU	KS4202	24.8*	ASGROW	AG3802	17.3
KSU	K1630RR	23.2	ASGROW	AG4503	16.4
KSU	K4602RR	22.3	ASGROW	AG4404	16.4
KSU	KS4704RR	21.7	ASGROW	AG5605	13.7
KSU	K1623RR	21.3	ASGROW	AG4403	12.7
KSU	K5502RR	21.1	CROPLAN GENETICS	RT3555	26.2*
KSU	KS5004N	19.6	CROPLAN GENETICS	RC4013	23.9
KSU	K4202RR	18.4	CROPLAN GENETICS	RC3732	23.6
KSU	KS4404RR	17.4	CROPLAN GENETICS	RC4095	22.4
KSU	K1463RR	14.5	CROPLAN GENETICS	RC3735	22.1
ADVANCED GENETICS	AG3722NRR	26.3*	CROPLAN GENETICS	RC4655	21.6
ADVANCED GENETICS	AG4040NRR	25.6*	CROPLAN GENETICS	RC5455	21.2
ADVANCED GENETICS	AG5005NRR	25.4*	CROPLAN GENETICS	RC4455	17.2
ADVANCED GENETICS	AG4880NRS	24.1	CROPLAN GENETICS	RC3636	16.8
ADVANCED GENETICS	AG4559NRS	24.0	DEKALB	DKB36-52	23.1
ADVANCED GENETICS	AG4444NRR	22.2	DEKALB	DKB34-51	19.3
ADVANCED GENETICS	AG5440NRS	20.0	DEKALB	DKB44-51	18.8
ADVANCED GENETICS	AG5333NRR	19.7	DEKALB	DKB38-52	16.4

Brand	Name	Chlorophyll Reading (SPAD)	Brand	Name	Chlorophyll Reading (SPAD)
DEKALB	DKB42-51	15.7	MFA MORSOY	RT 4485N	20.8
DEKALB	DKB46-51	13.6	MFA MORSOY	RT 3804N	20.5
DELTAPINE	DP3861RR	25.8*	MFA MORSOY	RTS 4824	17.4
DELTAPINE	DP4331RR	19.1	MFA MORSOY	RT 5154N	16.5
DRUSSEL SEED	3772RR	25.7*	MFA MORSOY	RT 4731N	15.2
DRUSSEL SEED	3902RR	20.1	MIDLAND	MG9A373NRR	26.0*
GARST	2834RR	26.1*	MIDLAND	MG9B395NRR	26.0*
GARST	4212RR/STS/N	25.8*	MIDLAND	MG4406NRS	23.9
GARST	3212RR/N	25.6*	MIDLAND	MG9A485XRR	20.5
GARST	2721RR/N	25.1*	MIDLAND	MG9A385NRS	22.8
GARST	3624RR/N	24.5	MIDLAND	MG4106NRR	21.3
GARST	4612RR/N	24.0	MIDLAND	MG9A375XRR	21.3
GARST	3512RR/N	22.4	MIDLAND	MG9A545NRS	20.9
GARST	D484RR/N	22.0	MIDLAND	MG4806NRS	20.8
GARST	5412RR/STS/N	21.6	MIDLAND	MG9A432NRS	20.8
GARST	3712RR/N	19.6	MIDLAND	MG9A402NRR	20.0
GARST	4999RR/N	17.9	MIDLAND	MG4506NRR	19.6
GARST	3812RR/N	17.9	MIDLAND	MG3806RR	18.4
GARST	4512RR/N	17.8	MIDLAND	MG9A462NRS	18.0
GARST	3824RR/N	16.0	MIDLAND	MG3826NRR	18.0
HAMON	AG4604N	18.1	MIDLAND	MG3816NRS	17.5
KRUGER	K-473RR/SCN	24.4	MIDLAND	MG9A494XRR	16.2
KRUGER	K-328RR	23.8	MIDLAND	MG9A355XRR	16.1
KRUGER	K-399RR/SCN	20.6	MIDLAND	MG4807XRR	15.3
KRUGER	K-349RR	22.3	MIDLAND-PHILLIPS	346NRR	26.3*
KRUGER	K-361RR/SCN	22.3	MIDLAND-PHILLIPS	366NRS	22.1
KRUGER	K-333RR/SCN	21.8	MIDLAND-PHILLIPS	374NRR	21.5
KRUGER	K-404RR	21.2	MIDLAND-PHILLIPS	385NRS	19.6
KRUGER	K-311RR/SCN	21.1	MIDLAND-PHILLIPS	333RS	19.2
KRUGER	K-433RR/SCN	18.3	MIDLAND-PHILLIPS	354RS	18.5
KRUGER	K-373RR/SCN	19.4	MIDWEST SEED	GR4454	25.1*
KRUGER	K-355RR/SCN	19.4	MIDWEST SEED	GR4154	24.5
KRUGER	K-389RR/SCN	18.8	MIDWEST SEED	GR5231	20.7
KSOY	KS4602N	27.6*	MIDWEST SEED	GR3633	19.9
KSOY	KS5502N	20.3	MIDWEST SEED	GRX48-01-5	19.2
LEWIS	4010	24.7*	MIDWEST SEED	GR4752	16.7
LEWIS	3716	22.8	M-PRIDE	AxRR53116	26.0*
LEWIS	3853	22.5	M-PRIDE	AxRR53976	25.6*
LEWIS	3822	21.9	M-PRIDE	AxRR53776	23.9
LG SEEDS	C3031RR	21.0	M-PRIDE	AxRR53386	22.2
MARYLAND	MANOKIN	21.4	M-PRIDE	MPV4905NRR	22.0
MFA MORSOY	RT 4845N	25.3*	M-PRIDE	AxRR53057	19.0
MFA MORSOY	RT 5043N	24.2	M-PRIDE	MPV5505NRR	18.7
MFA MORSOY	RT 4225N	23.3	M-PRIDE	MPV4404NRR	17.9

Brand	Name	Chlorophyll Reading (SPAD)	Brand	Name	Chlorophyll Reading (SPAD)
NK	S35-F9	24.3	PIONEER	94M80	16.6
NK	S37-N4	23.5	PRAIRIE BRAND	PB-5083NRR	26.2*
NK	S57-P1	23.1	PRAIRIE BRAND	PB-4583NRR	22.6
NK	S29-C9	22.1	PRAIRIE BRAND	PB-3894NRR	20.2
NK	S46-W8	22.0	PRAIRIE BRAND	PB-3905RR	20.1
NK	S32-G5	21.8	RENZE	R3996RRcn	23.2
NK	S42-P7	21.4	RENZE	R3814RR	23.0
NK	S49-Q9	21.0	RENZE	R4836SRcn	21.8
NK	S39-Q4	20.6	RENZE	R4486RRcn	20.7
NK	S40-R9	19.8	RENZE	R3686RRcn	20.7
NK	S43-B1	19.7	RENZE	R4695RRcn	19.9
NK	X428R	17.5	RENZE	R3835SRcn	18.9
NK	S52-U3	17.2	RENZE	R3726RR	15.5
NK	S39-K6	15.1	STINE	S3942-4	25.5*
OHLDE	O-3522NRR	25.0*	STINE	S3932-4	23.0
OHLDE	O-3882NRR	22.5	STINE	S3832-4	22.5
OHLDE	O-3334NRR	22.0	STINE	S4532-4	22.3
OHLDE	O-3494	21.4	STINE	S4102-4	21.5
OHLDE	O-3932NRR	20.6	STINE	S4842-4	21.4
OHLDE	O-4595	20.1	STINE	S3600-4	20.6
OHLDE	O-3727NRS	19.9	STINE	S4302-4	19.4
OHLDE	O-4292	19.5	STINE	S3532-4	19.2
OHLDE	O-3712NRR	16.2	TAYLOR	427RRS	24.8*
PHILLIPS	385NRS	23.9	TAYLOR	EXP3960-5RR	24.2
PHILLIPS	432NRS	22.5	TAYLOR	353RR	20.7
PHILLIPS	436NRS	21.5	TAYLOR	387RR	20.4
PHILLIPS	366NRS	21.2	TAYLOR	398RRS	18.3
PHILLIPS	465NRR	19.4	TAYLOR	EXP4400-5RR	19.6
PHILLIPS	376NRR	18.2	VIRGINIA	HUTCHESON	24.9*
PHILLIPS	486NRS	18.1	WILLCROSS	RR2486N	25.7*
PHILLIPS	374NRR	17.8	WILLCROSS	RR2355N	23.9
PIONEER	93M80	23.8	WILLCROSS	RR2335N	22.7
PIONEER	93B85	23.7	WILLCROSS	RR2385NSTS	20.8
PIONEER	93B36	23.2	WILLCROSS	RR2383N	20.7
PIONEER	94B73	22.7	WILLCROSS	RR2386NX2	19.4
PIONEER	94M30	21.8	WILLCROSS	RR2484N	19.0
PIONEER	92M91	21.7	WILLCROSS	RR2386	18.4
PIONEER	93M51	19.1	WILLCROSS	RR2432N	18.4
PIONEER	95M50	19.9	WILLCROSS	RR2544NSTS	17.2
PIONEER	93M92	19.8	WILLCROSS	RR2525N	16.7
PIONEER	94M50	19.5	WILLCROSS	RR2446N	13.8
PIONEER	93M11	18.3		Mean	21.0
				LSD (0.05)	4.0

* entries not significantly different from A15.

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