Cropping Systems and Variety Effect on Iron Deficiency Chlorosis

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INTRODUCTION

Iron Deficiency Chlorosis (IDC) is a problem for producers worldwide. In 2012, IDC was estimated to have cost U.S. farmers over $260 million in revenue losses (Peiffer et al., 2012). Chlorosis is a condition caused when a plant does not acquire the required nutrients to synthesize chlorophyll thus causing the leaves of the plant to appear yellow instead of green. A combination of several factors may cause chlorosis including a mineral deficiency in the soil or a soil pH that inhibits the roots from absorbing minerals. For instance, soils with a high pH (>7.0) prevents iron from becoming water-soluble thus preventing iron from being absorbed by the roots (Koenig & Kuhns, 2010). While many factors, such as soil compaction or poor drainage, can indirectly cause plants to become iron deficient, the plant's inability to absorb the essential nutrients needed to produce chlorophyll and carry out photosynthesis is the direct cause (Kuhns & Koenig, n.d.). This study will look at how these in-direct causes can be alleviated through the use of cropping systems. While tolerant varieties have been proven to increase yield, treatments proven to decrease the severity of IDC combined with tolerant varieties may actually produce even greater yields (Kaiser & Bloom, 2018). The purpose of this study is to determine the effects that cropping systems and soybean variety has on IDC symptoms.

METHOD

In 2019, seven cropping systems combined with six soybean varieties from three brands were evaluated to determine their effect on IDC. On April 30th, six soybean varieties were planted on raised beds (stale) on a Catalpa silty clay loam soil with a John Deere 1700 planter. The treatments were replicated four times. Main plot was the cropping systems and variety was the split plot. Plot size was two 38" rows (6.33 ft) by 20 foot long. On March 21st, an application of Cornerstone (32.0 oz/A) + Leadoff (1.5 oz/A) + Grizzly (1.0 oz/A) was applied as a burndown and pre-emergence. On May 1st, an application of Makaze (32.0 oz/A) + Sonic (4.0 oz/A) + Dual II Magnum (16.0 oz/A) was applied. On July 9th, an application of Roundup Maxx (32.0 oz/A) + First Rate (0.3 oz/A). An application of Makaze (32.0 oz/A) was applied on August 15th. The study was harvested on October 14th.

RESULTS

Choosing the best cropping system along with an IDC-tolerant variety are two very important factors when trying to maximize yield in an IDC-susceptible soil. Of all the treatments, the cropping system, "utilizing 2018 corn stubble and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate," produced 6 of the top 11 yields (Table 1). When averaged across varieties, the cropping system also produced the highest yield at 33.3 bushels/A (Table 2) despite having the 5th worst IDC rating of 3.67 when averaged across varieties (Table 3). Other cropping systems were similar to one another when averaged across variety in terms of yield. Variety selection also affected yield as Terral 4927X produced the highest yield when averaged across cropping systems (Table 4). Terral 4927X also had the best IDC rating when averaged across cropping systems (Table 5). Five of the top seven highest-yielding treatments belonged to the variety Terral 4927X (Table 1).

TABLES

Table 1. Treatments ranked by yield.

Rank	Cropping System	Variety	Yield (bu/A)
1	Utilizing 2018 corn stubble and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Asgrow 52X9	38.9 a[1]
2	Utilizing 2018 corn stubble and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Delta Grow 4670 RR2	38.8 a
3	Utilizing 2018 corn stubble and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Terral 4927X	36.1 ab
4	Utilizing 2018 soybean stubble, small grain cover, plus a roller/packer and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Terral 4927X	32.9 abc
5	Utilizing 2018 soybean stubble plus small grain cover and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Terral 4927X	31.9 a-d
6	Utilizing 2018 corn stubble plus small grain cover and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Terral 4927X	31.5 a-e
7	Utilizing 2018 soybean stubble and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Terral 4927X	30.7 a-f
8	Utilizing 2018 corn stubble and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Terral 4679X	29.1 a-g
9	Utilizing 2018 corn stubble and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Delta Grow 46X25 RR2X	28.7 a-h
10	Utilizing 2018 corn stubble plus small grain cover and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Delta Grow 4670 RR2	28.3 a-h
11	Utilizing 2018 corn stubble and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Asgrow 53X9	28.0 b-h
12	Utilizing 2018 soybean stubble and a roller/packer and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Terral 4927X	25.5 b-i
13	Utilizing 2018 corn stubble plus small grain cover and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Delta Grow 46X25 RR2X	24.8 b-j
14	Utilizing 2018 soybean stubble and a roller/packer and 38" row spacing for soybeans in 2019 @ 115,000 seeding rate	Terral 4927X	24.4 c-j
15	Utilizing 2018 soybean stubble and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Delta Grow 4670 RR2	23.7 c-k
16	Utilizing 2018 soybean stubble plus small grain cover and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Delta Grow 46X25 RR2X	22.6 c-k
17	Utilizing 2018 corn stubble plus small grain cover and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Asgrow 52X9	21.9 c-m
18	Utilizing 2018 soybean stubble and a roller/packer and 38" row spacing for soybeans in 2019 @ 115,000 seeding rate	Delta Grow 4670 RR2	20.9 d-m

19	Utilizing 2018 soybean stubble, small grain cover, plus a roller/packer and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Delta Grow 4670 RR2	20.6 d-m
20	Utilizing 2018 soybean stubble and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Asgrow 52X9	19.9 e-m
21	Utilizing 2018 soybean stubble and a roller/packer and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Asgrow 52X9	19.7 f-m
22	Utilizing 2018 soybean stubble and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Asgrow 53X9	19.4 f-m
23	Utilizing 2018 soybean stubble plus small grain cover and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Delta Grow 4670 RR2	19.4 f-m
24	Utilizing 2018 soybean stubble plus small grain cover and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Asgrow 52X9	19.0 g-n
25	Utilizing 2018 soybean stubble, small grain cover, plus a roller/packer and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Asgrow 52X9	18.7 g-n
26	Utilizing 2018 soybean stubble and a roller/packer and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Delta Grow 4670 RR2	18.5 g-n
27	Utilizing 2018 soybean stubble and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Delta Grow 46X25 RR2X	18.5 g-n
28	Utilizing 2018 soybean stubble, small grain cover, plus a roller/packer and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Delta Grow 46X25 RR2X	17.6 g-n
29	Utilizing 2018 soybean stubble and a roller/packer and 38” row spacing for soybeans in 2019 @ 115,000 seeding rate	Asgrow 52X9	17.3 h-n
30	Utilizing 2018 corn stubble plus small grain cover and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Asgrow 53X9	17.1 h-n
31	Utilizing 2018 soybean stubble and a roller/packer and 38” row spacing for soybeans in 2019 @ 115,000 seeding rate	Delta Grow 46X25 RR2X	15.3 i-n
32	Utilizing 2018 soybean stubble, small grain cover, plus a roller/packer and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Terral 4679X	15.2 i-n
33	Utilizing 2018 soybean stubble plus small grain cover and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Terral 4679X	14.8 i-n
34	Utilizing 2018 corn stubble plus small grain cover and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Terral 4679X	14.8 i-n
35	Utilizing 2018 soybean stubble plus small grain cover and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Asgrow 53X9	14.4 i-n
36	Utilizing 2018 soybean stubble and a roller/packer and 38” row spacing for soybeans in 2019 @ 160,000 seeding rate	Delta Grow 46X25 RR2X	14.0 j-n
37	Utilizing 2018 soybean stubble and a roller/packer and 38” row spacing for soybeans in 2019 @ 115,000 seeding rate	Asgrow 53X9	12.9 k-n
38	Utilizing 2018 soybean stubble and a roller/packer and 38” row spacing for soybeans in 2019 @ 115,000 seeding rate	Terral 4679X	12.5 k-n

39	Utilizing 2018 soybean stubble and a roller/packer and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Terral 4679X	12.5 k-n
40	Utilizing 2018 soybean stubble, small grain cover, plus a roller/packer and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Asgrow 53X9	11.1 lmn
41	Utilizing 2018 soybean stubble and a roller/packer and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Asgrow 53X9	10.7 mn
42	Utilizing 2018 soybean stubble and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	Terral 4679X	7.1 n

[1]Numbers with the same letter are not significantly different according to Fisher's Protected LSD (P=0.05).

Table 2. Averaged cropping system yield across varieties.

Rank	Cropping System	Yield (bu/A)
1	Utilizing 2018 corn stubble and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	33.3 a[1]
2	Utilizing 2018 corn stubble plus small grain cover and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	23.1 b
3	Utilizing 2018 soybean stubble plus small grain cover and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	20.4 b
4	Utilizing 2018 soybean stubble and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	19.9 b
5	Utilizing 2018 soybean stubble, small grain cover, plus a roller/packer and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	19.4 b
6	Utilizing 2018 soybean stubble and a roller/packer and 38" row spacing for soybeans in 2019 @ 115,000 seeding rate	17.2 b
7	Utilizing 2018 soybean stubble and a roller/packer and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	16.8 b

[1]Numbers with the same letter are not significantly different according to Fisher's Protected LSD (P=0.05).

Table 3. Averaged IDC rating across varieties.

Rank	Cropping System	IDC Rating[1]
1	Utilizing 2018 soybean stubble and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	2.50 d[2]
2	Utilizing 2018 soybean stubble and a roller/packer and 38" row spacing for soybeans in 2019 @ 115,000 seeding rate	3.17 c
3	Utilizing 2018 soybean stubble and a roller/packer and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	3.25 c
4	Utilizing 2018 corn stubble plus small grain cover and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	3.67 b
5	Utilizing 2018 corn stubble and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	3.67 b
6	Utilizing 2018 soybean stubble, small grain cover, plus a roller/packer and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	3.75 ab
7	Utilizing 2018 soybean stubble plus small grain cover and 38" row spacing for soybeans in 2019 @ 160,000 seeding rate	4.08 a

[1]Scale = 0 - 9 with 0 = no chlorosis visible and 9 = plant death.
[2]Numbers with the same letter are not significantly different according to Fisher's Protected LSD (P=0.05).

Table 4. Averaged variety yield across cropping systems.

Rank	Variety	Yield (bu/A)
1	Terral 4927X	30.4 a[1]
2	Delta Grow 4670 RR2	24.3 b
3	Asgrow 52X9	22.2 bc
4	Delta Grow 46X25 RR2X	20.2 c
5	Asgrow 53X9	16.2 d
6	Terral 4679X	15.2 d

[1]Numbers with the same letter are not significantly different according to Fisher's Protected LSD (P=0.05).

Table 5. Averaged IDC rating across cropping systems.

Rank	Variety	IDC Rating[1]
1	Terral 4927X	1.29 e[2]
2	Delta Grow 4670 RR2	2.07 d
3	Delta Grow 46X25 RR2X	3.79 c
4	Asgrow 53X9	4.29 b
5	Asgrow 52X9	4.57 ab
6	Terral 4679X	4.64 a

[1]Scale = 0 - 9 with 0 = no chlorosis visible and 9 = plant death.
[2]Numbers with the same letter are not significantly different according to Fisher's Protected LSD (P=0.05).

CONCLUSION

While there is no single factor that creates chlorosis in soybeans, two of the factors have been addressed by this study. If soybeans in a certain soil have a history of being iron deficient, choosing an IDC-tolerant variety along with a proven cropping system may help alleviate the problem. This study has proven that the proper selection of variety and cropping system has the potential to increase yield.