

Influence of Ironite and Phosphorus on Wheat and Barley on the Safford Agricultural Center, 1999

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Abstract

Ironite and phosphorus were applied to plots seeded to hard red wheat and barley to find their effect on crop yield and nutrient uptake at various stages of crop development. Phosphorous caused significant increases in yield in both wheat and barley, where Ironite caused few changes in yield. Ironite caused significant increases in percent of nutrients stored in barley grain, but generally had little effect on nutrient uptake by plants at boot or milk stage. Phosphorous tended to decrease the percent nutrient uptake by plants.

Introduction

Ironite is a soil amendment commonly added to crops in alkaline soils to solve problems of iron uptake. Phosphorus availability is also affected by alkaline soils and phosphorous fertilizer is many times added to help root development in cold season seeded crops. A randomized split plot experiment was designed to test four levels of Ironite and two levels of phosphorus to find their effect on yield and nutrient uptake. It is understood that the effect of Ironite and phosphorous are dependant on soil conditions being high in salts and low in available phosphorous or the effects would not be manifest. A soil analysis taken at planting (Table 1) would indicate that effects would be expected to be seen from Ironite, but perhaps marginal for phosphorous.

Materials and Methods

The study was implemented on a field that had been in cotton the two previous years and no phosphorous fertilizers were applied. Following the last cotton crop the ground was prepared using a Pegasus unit that incorporated the cotton stubble into a trench directly under the center of the bed. Before planting the beds were dressed with a Lilliston and firmed with a ring roller. Seed was planted with an International 12 foot grain drill with a fertilizer attachment over four 3-foot beds. The crop history follows:

Crop History:

Elevation: 2954 feet above sea level

Soil type: Grabe clay loam/Pima clay loam variant

Planting date: 22 December 1998 Seeding rate: 200 pounds per acre

Herbicide: 2,4-D on 3-29-99 to control broad-leaf weeds

Fertilizer: 200 lbs/ac urea on 2-19-99, 150 lbs/ac urea on 3-31-99 Phosphorous was applied at rates of 0 and 200 lbs/ac of 16-20 to appropriate plots

Ironite: Applications of 0, 50, 100 and 200 pounds per acre were applied to appropriate plots

Insecticides: None

Irrigation: Furrow, watered up plus 10 irrigations for a total of ca. 40 acre inches

Rainfall during the growing season: 0.9 inches Calculated leaching: 2.95 inches

Plot size: 12 feet by 45 feet

Replicates: Four

Harvest dates: Barley - 6-22, Wheat - 6-29 Heat units (40 to 81 °F) from planting to maturity (6-15) = 3244

The entire plots were harvested with a Gleaner Combine with a 13 foot header. Individual plots were weighed using a hanging scale and samples were taken to determine moisture, bushel weight and 1000 kernel weights.

Plant heights were measured just prior to harvest and stems per square foot were counted after harvest.

A soil samples was taken at planting time and submitted for chemical analysis. The results of the soil tests are found in Table 1.

Plant samples were taken at boot stage and milk stage in the following manner: The entire above ground portion of the plant was taken from one square foot area of each plot. The samples were dried and weighed, ground, dry ashed and dissolved in dilute acid prior to analysis on the ICP. The grain samples were dried, ground and processed in the same manner as the plant samples.

Results and Discussion

Table 1 shows the soil analysis which indicates that the soil is a Saline-Sodic soil since the Electro-Conductivity (EC) is > 4 and the Exchangeable Sodium Percentage (ESP) is $> 15\%$. The soil pH of 8.2 would reduce the availability of phosphorous (P) to about its minimum point and the availability of iron (Fe) to about one half of its potential. Interestingly though, P at 14 ppm was considered in the medium range and Fe at 6.1 ppm was in the very high range.

Yields and other agronomic data for the wheat are shown in Table 2. The 2-way analysis of variance table looks at the Ironite effects across the phosphorous treatments and the phosphorous effects across Ironite treatments. The addition of Ironite slightly increased the yield from the check up to 100 pounds per acre of Ironite, then inexplicably the yield dropped at the highest rate. The phosphorous effect was strong with an 1800 yield advantage where 40 pounds per acre of P_2O_5 was applied. Ottman (1) indicated that it is not likely to see an increase from applied P if the soil available P is >12 , but our companion study(2), on a similar soil showed the same yield trend. Of the other agronomic measurements, not many had statistically significant differences, but differences or trends of interest are the following: a plant height increase with P added and % moisture increase in grain with added Ironite.

Table 3 shows yield and agronomic data from the barley study. As with the wheat study a strong yield effect was seen with the addition of the P, but all the Ironite treatments yielded less than the check plot. Again, the P plots were taller than those without the 40 pounds of P_2O_5 per acre, but no other trends were seen.

Table 4 contains the dry matter data from both wheat and barley harvested at boot and milk stages. At the boot stage on wheat, all of the dry matter weights for the Ironite treatments were higher than the check plot. The weights, however, declined with ironite rates. At the milk stage on wheat there were no trends indicating that Ironite was beneficial. On barley, dry matter accumulation was highest for the highest rate of Ironite application, but there was no strong trend in the data to support that view.

Tables 5 and 6 have the nutrient analyses of wheat and barley plants harvested at boot stage. The first half of the table, from nitrogen (N) to sodium (Na) are in percent (%) whereas the remainder of the table, from iron (Fe) to boron (B) are in parts per million. Where statistical differences are seen the high values in a column are shaded to draw attention to the value. Over the Ironite treatments the potassium (K) showed an increased uptake on wheat and calcium (Ca) and sodium on barley. It is interesting to note that the lower rates of Ironite caused increases in iron uptake over the check but the high rate decreased the uptake for both wheat and barley. On the bottom part of the tables, where phosphorous effects are shown, the addition of P decreased the percentage uptakes of most of the

nutrients, excepting Na and P. It should be noted, however, that the total nutrient uptake from the soil was increased by the use of P because the percentages are multiplied by higher yields.

Tables 7 and 8 have the nutrient analyses at the milk stage for wheat and barley. From the Ironite effects, increased uptake percentages were noted on K and Na on wheat and N, K and sulfur (S) on barley, but the higher uptakes were noted in the middle Ironite treatments and decreases in uptake were noted at the high rate of Ironite. Again, the highest rate of Ironite tended to decrease the Fe uptake. On the part of the table that lists phosphorous effects, percent uptakes were decreased by added P, except for N and P on wheat and Na on barley.

Nutrient analyses of grain collected from each plot are shown in Tables 9 and 10. Not much notable in seen in the wheat, Ironite had very little effect on the uptake of the nutrients analyzed and only minor differences with S, manganese (Mn) and copper (Cu) were seen in the plots with P added. Barley grain was a different story. Ironite treatments increased the percent of nutrient storage in the grain with all nutrients excepting N. As seen with the harvested plants, addition of P to the soil decreased the percent uptake of several of the nutrients.

It is concluded from the study that the addition of phosphorous to the soil at planting was extremely beneficial to yields of both wheat and barley. Its presence generally decreased the percent storage of many nutrients in the plant tissue and in the seed, but because of the increased yields, the uptake from the soil was increased. The effects of Ironite being added to the soil was somewhat mixed. Yields were generally not increased and in some cases the higher applications caused decreased yields, compared to the check plots. Nutrient uptake by the plants were increased in very few cases and decreased in Fe uptake were seen with the highest rate of application. Notable increases in nutrient storage in barley grain were observed, however.

References

1. Ottman, M.J., S.H. Husman and B.R. Tickes. 1997. Barley and durum response to phosphorus at Buckeye, Maricopa and Yuma, 1997. Forage and Grain, A College of Agriculture Report, The University of Arizona, Tucson, AZ. Series P-110, pp. 125-129
2. Clark, L.J. and E.W. Carpenter. 1999. Small grain response to pre-plant phosphorous at Safford Agricultural Center, 1999. *In this publication.*

Table 1. Initial soil analyses from the experimental field (G1) at the Safford Agricultural Center, 1999.

pH	Calcium (ppm)	Mg (ppm)	Sodium (ppm)	Potash (ppm)	Fe (ppm)	Zn (ppm)	Mn (ppm)
8.2	6400 VH	388 VH	1500 VH	490 VH	6.1 H	0.95 M	5.6 VH
EC	Cu (ppm)	NO ₃ -N (ppm)	P (ppm)	ESP	S (ppm)	B (ppm)	Free Lime
6.2 VH	24.0 VH	113.4 VH	14.0 M	15.2	210 VH	1.2 M	M

Table 2. Yield and other agronomic data on hard red wheat treated with ironite and phosphorous as soil amendments.

Treatment	Yield/acre 10% M	Bushel Weight	% Moisture	Plant Height	Stems/Sqft	1000 Kernal wt
Ironite effects across phosphorus treatments						
Check	3425.1 ab	63.3 a	9.33 a	23.5 a	43.4 a	42.1 ab
50# ironite	3491.3 a	63.5 a	9.21 a	23.3 a	63.4 a	45.5 a
100# ironite	3510.8 a	63.5 a	9.68 a	22.4 a	68.5 a	42.6 ab
200# ironite	3158.9 b	63.4 a	9.80 a	23.0 a	53.9 a	40.4 b
LSD(05)	311.5	0.53	0.66	1.37	21.2	3.75
Phosphorus effects across ironite treatments						
Check	2503.4 b	63.3 a	9.60 a	22.0 b	57.5 a	41.6 a
200# P ₂ O ₅	4289.7 a	63.5 a	9.41 a	24.1 a	59.1 a	43.7 a
LSD(05)	220.3	0.38	0.47	0.97	15	2.65
Average	3396.5	63.4	9.5	23	58.3	42.7
CV(%)	8.8	0.8	6.7	5.7	35	8.5

Table 3. Yields and other agronomic data from barley treated with ironite and phosphorus as soil amendments.

Treatment	Yield/acre 10% M	Bushel Weight	% Moisture	Plant Height	Stems/Sqft	1000 Kernal wt
Ironite effects across phosphorus treatments						
Check	5343.5 a	54.1 a	10.5 a	21 a	51.1 a	39.9 a
50# ironite	4604.6 a	54.3 a	11.0 a	21.1 a	56.9 a	43.4 a
100# ironite	5272.0 a	53.9 a	10.3 a	21.6 a	56.0 a	41.3 a
200# ironite	5298.4 a	54.1 a	10.6 a	22.4 a	43.7 a	40.1 a
LSD(05)	813.4	0.6	0.8	1.7	16.4	3.7
Phosphorus effects across ironite treatments						
Check	4413.8 b	54.1 a	10.7 a	20 b	48.0 a	42.1 a
200# P ₂ O ₅	5845.4 a	54.1 a	10.5 a	23.1 a	55.9 a	40.3 a
LSD(05)	575.2	0.4	0.6	1.2	11.6	2.6
Average	5129.6	54.1	10.6	21.6	51.9	41.2
CV(%)	15.2	1.1	7.5	7.6	30.4	8.6

Table 4. Dry matter weights of wheat and barley plants cut in the field at boot and milk stages on the Safford Agricultural Center, 1999.

Treatment	Wheat Dry Matter (lbs/ac)		Barley dry Matter (lbs/ac)	
	Boot Stage	Milk Stage	Boot Stage	Milk Stage
Ironite effects across phosphorus treatments				
Check	6799 a	18062 a	4536 a	16467 ab
50 # Ironite	7593 a	16995 a	4511 a	16935 ab
100 # Ironite	7277 a	18278 a	4438 a	14620 b
200 # Ironite	6904 a	16983 a	5420 a	18290 a
LSD (05)	1404	3052	1486.3	2918
Phosphorus effects across ironite treatments				
Check	5498 b	14008 b	2802 b	13253 b
40# P ₂ O ₅	8818 a	21150 a	6850 a	19903 a
LSD (05)	993.1	2158.1	1051.0	2063
AVG	7143.0	17579.3	4826.0	16578
CV (%)	18.9	16.7	29.6	16.9

Table 5. Elemental analysis of nutrients contained in hard red wheat plants harvested at the boot stage on the Safford Agricultural Center, 1999.

Treatment	%N	%P	%K	%Ca	%Mg	%S	%Na	Fe	Zn	Mn	Cu	B
Ironite effects across phosphorus treatments												
Check	2.8 a	0.25 a	2.7 b	0.23 a	0.19 a	0.26 a	0.11 a	128 a	39.1 a	112.8 a	6.38 a	6.38 a
50 # Ironite	2.7 a	0.25 a	2.7ab	0.22 a	0.18 a	0.25 a	0.12 a	129 a	39.0 a	110.9 a	6.13 a	6.63 a
100 # Ironite	2.7 a	0.24 a	2.6 b	0.23 a	0.18 a	0.24 a	0.08 a	138 a	39.8 a	110.0 a	6.00 a	6.38 a
200 # Ironite	2.8 a	0.25 a	2.9 a	0.22 a	0.19 a	0.25 a	0.11 a	121 a	43.3 a	112.8 a	6.63 a	6.13 a
LSD (05)	0.27	0.03	0.24	0.02	0.02	0.03	0.07	42.52	6.46	11.84	0.77	1.22
Phosphorus effects across ironite treatments												
Check	2.7 a	0.24 a	2.7 a	0.23 a	0.19 a	0.27 a	0.09 a	135 a	45.3 a	110.8 a	6.25 a	6.88 a
40# P ₂ O ₅	2.7 a	0.25 a	2.8 a	0.22 a	0.18 a	0.24 b	0.12 a	123 a	35.3 b	112.3 a	6.31 a	5.88 b
LSD (05)	0.19	0.02	0.17	0.02	0.01	0.02	0.05	30.06	4.57	8.37	0.54	0.86
AVG	2.7	0.25	2.7	0.23	0.19	0.25	0.11	129	40.3	111.5	6.28	6.38
CV (%)	9.59	10.02	8.54	9.07	9.72	11.04	65.16	31.69	15.43	10.21	11.73	18.35

Table 6. Elemental analysis of nutrients contained in barley plants harvested at the boot stage on the Safford Agricultural Center, 1999.

Treatment	%N	%P	%K	%Ca	%Mg	%S	%Na	Fe	Zn	Mn	Cu	B
Ironite effects across phosphorus treatments												
Check	3.4 a	0.2 a	3.3 a	0.3ab	0.2 a	0.5 a	0.8 b	114 a	43.4a	123 a	8.4 a	9.6 a
50 # Irnit	3.3 a	0.2 a	3.3 a	0.3 b	0.2 a	0.5 a	0.8 b	126 a	45.6a	123 a	8.1 a	9.6 a
100 # Irnit	3.5 a	0.2 a	3.4 a	0.3ab	0.2 a	0.5 a	0.8 b	129 a	45.5a	121 a	9.0 a	10.6 a
200 # Irnit	3.5 a	0.2 a	3.4 a	0.4 a	0.2 a	0.5 a	1.0 a	89 a	42.4a	120 a	8.1 a	10.9 a
LSD	0.35	0.03	0.31	0.03	0.1	0.1	0.2	41.9	5.21	14.6	1.88	1.79
Phosphorus effects across ironite treatments												
Check	3.4 a	0.2 b	3.3 a	0.3 a	0.2 a	0.6 a	0.7 b	128 a	49.6a	128 a	7.9 a	10.4 a
40# P ₂ O ₅	3.5 a	0.3 a	3.4 a	0.3 a	0.2 a	0.5 b	1.0 a	101 a	38.9b	116 b	9.1 a	9.9 a
LSD (05)	0.2	0.02	0.22	0.02	0.1	0.1	0.1	29.6	3.69	10.3	1.33	1.27
AVG	3.4	0.2	4.29	0.3	0.1	0.5	0.8	114	44.6	122	8.5	10.2
CV (%)	9.74	12.1	127	9.6	9.16	13.7	17.9	35.2.	11.3	11.6	21.	16.98

Table 7. Elemental analysis of nutrients contained in hard red wheat plants harvested at the milk stage on the Safford Agricultural Center, 1999.

Treatment	%N	%P	%K	%Ca	%Mg	%S	%Na	Fe	Zn	Mn	Cu	B
Ironite effects across phosphorus treatments												
Check	1.50a	0.14 a	1.38b	0.26 a	0.19 a	0.19 a	0.05ab	140 a	28.1 a	74.9 a	6.00 a	19.5 a
50 # Irnit	1.49a	0.14 a	1.54a	0.28 a	0.19 a	0.20 a	0.05 a	154 a	27.9 a	81.8 a	5.75 a	17.8 a
100 # Irnt	1.46a	0.14 a	1.38b	0.27 a	0.20 a	0.18 a	0.03bc	145 a	28.9 a	73.8 a	5.63 a	18.6 a
200 # Irnt	1.46a	0.15 a	1.34b	0.28 a	0.21 a	0.19 a	0.03 c	130 a	33.0 a	77.8 a	6.53 a	22.1 a
LSD (05)	0.11	0.02	0.14	0.06	0.03	0.02	0.01	30.1	5.88	18.5	1.35	7.21
Phosphorus effects across ironite treatments												
Check	1.40b	0.14 b	1.41a	0.28 a	0.20 a	0.21 a	0.04 a	141 a	35.1 a	74.2 a	6.44 a	21.7 a
40# P ₂ O ₅	1.56a	0.15 a	1.41a	0.27 a	0.20 a	0.17 b	0.04 a	143 a	23.8 b	79.9 a	5.56 a	17.4 a
LSD (05)	0.1	0.01	0.1	0.04	0.02	0.01	0.01	21.6	4.16	13.1	0.95	5.1
AVG	1.48	0.14	1.41	0.27	0.2	0.19	0.04	142	29.5	77	6	19.5
CV (%)	7.22	13.0	9.6	21.6	14.8	12.2	32.8	20.4	19.2	23.1	21.4	35.5

Table 8. Elemental analysis of nutrients contained in barley plants harvested at the milk stage on the Safford Agricultural Center, 1999.

Treatment	%N	%P	%K	%Ca	%Mg	%S	%Na	Fe	Zn	Mn	Cu	B
Ironite effects across phosphorus treatments												
Check	1.7 b	0.11 a	1.8ab	0.33 a	0.14 a	0.36 b	0.59 a	137.5 a	26.0 a	92.6 a	6.00 a	16.9 a
50 # Irnit	1.6 b	0.11 a	1.8ab	0.29 a	0.13 a	0.35 b	0.52 a	130.0 a	26.6 a	84.4 a	5.88 a	14.9 a
100 # Irnt	1.9 a	0.11 a	2.0 a	0.32 a	0.14 a	0.45 a	0.59 a	128.5 a	27.6 a	89.6 a	6.13 a	17.4 a
200 # Irnt	1.6 b	0.11 a	1.7 b	0.33 a	0.14 a	0.33 b	0.53 a	128.4 a	25.1 a	89.8 a	5.63 a	16.6 a
LSD (05)	0.2	0.11 a	0.3	0.05	0.01	0.08	0.14	24.5	4.24	14.1	0.95	3.38
Phosphorus effects across ironite treatments												
Check	1.8 a	0.11a	1.9 a	0.33 a	0.15 a	0.47 a	0.49 b	142.3 a	30.6 a	92.5 a	5.88 a	18.8 a
40# P ₂ O ₅	1.5 b	0.12 a	1.7 b	0.30 b	0.13 b	0.27 b	0.62 a	119.9b	22.1 b	85.7 a	5.94 a	14.1 b
LSD (05)	0.1	0.01	0.3	0.031	0.01	0.06	0.1	17.3	3	9.95	0.67	2.39
AVG	1.7	0.11	1.8	0.32	0.14	0.38	0.56	131.1	26.3	89.1	5.91	16.4
CV (%)	11.1	12.2	13.6	13.7	8.1	21.7	23.4	18	15.5	15.2	15.5	19.8

