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Foliar Micronutrients, Growth Regulator, Lime and Calcium Applications for Alfalfa Production

Brian Lang
Iowa State University, bjlang@iastate.edu

Kenneth Pecinovsky
Iowa State University, kennethp@iastate.edu

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Abstract
Persistent claims in the market place on alfalfa production requiring micronutrients, growth regulators, or high rates of calcium spurred interest from the Northeast Iowa Agricultural Experimental Association to conduct a research trial with some of these products.

Keywords
Agronomy

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Foliar Micronutrients, Growth Regulator, Lime and Calcium Applications for Alfalfa Production

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Brian Lang, extension agronomist
Ken Pecinovsky, farm superintendent

Introduction

Persistent claims in the market place on alfalfa production requiring micronutrients, growth regulators, or high rates of calcium spurred interest from the Northeast Iowa Agricultural Experimental Association to conduct a research trial with some of these products.

Materials and Methods

The research site was cropped to soybean in 2010, field cultivated in the spring of 2011, and direct seeded to alfalfa at 15 lb/acre with a Brillion seeder. Soil samples were collected in the spring of 2011. All treatments received phosphorus (P) and potassium (K) fertilizer prior to tillage in 2011, and twice a season in 2012 and 2013 to maintain optimum soil test levels based on Iowa State University (ISU) recommendations. Sulfur (S) fertilizer was applied each spring at 30 lb/acre according to ISU recommendations. Lime was applied in 2011 prior to tillage for those treatments receiving lime. The two high-rate calcium treatments were applied as calcium sulfate ($CaSO_4$) at 1,000 lb/acre prior to tillage in 2011, and in early spring in 2012 and 2013. Calcium sulfate, also known as gypsum, is a source of Ca and S. It does not affect soil pH.

The seven treatments included 1) no lime, 2) lime, 3) lime plus 1,000 lb/acre $CaSO_4$, 4) no lime plus 1,000 lb/acre $CaSO_4$, 5) lime plus 3 pints/acre MAX-IN® Ultra ZMB® applied to foliar during each regrowth on a six to eight in. canopy, 6) Treatment 5 plus 1 pint/acre MAX-IN® Boron (B), 7) Treatment 6 plus 3.2 ounces/acre Ascend® (a plant growth regulator).

Two harvests were taken in 2011, but no data was collected for the seeding year. In 2012 and 2013, treatment comparisons on yield, quality, and plant analysis were collected. Plots were harvested four times/season with a self-propelled flail chopper. Dry matter yield was determined from subsamples collected at harvest and oven dried. Composite samples were collected for each treatment from first and third harvests for forage quality and plant analysis. Insect pests were controlled on the entire trial as needed, based on scouting and thresholds.

Results and Discussion

Soil test results are provided in Tables 1 and 2 for 2012 and 2013, respectively. Optimum soil test levels from ISU or the University of Wisconsin are provided at the bottom of the tables. Boron was the only deficient nutrient.

Alfalfa yield by harvests within treatments were similar for 2012 and 2013, so each harvest is presented as an average yield of both years (Table 3). Limed treatments had higher yields than non-limed treatments. The cost of lime was prorated over the life of the stand. The most profitable treatment was treatment two.

Plant analysis showed B deficient in third harvest, but not first harvest. The availability and uptake of some nutrients may be somewhat different under different environments. One would assume a foliar application of B would correct the deficiency and provide a yield response, however, although the B application increased B levels in the plant analysis, there was no significant yield response. Even so, when B deficiencies are defined by properly conducted soil or plant testing, a B application may be warranted. The only other nutrient of concern was Mg, with low plant analysis levels in first harvest in both years. Low Mg levels in feed could contribute to tetany in livestock. It is common to find lower Mg levels in forages growing under cool environments, but as long as forages are tested, livestock nutritionists can properly adjust the rations. In this case, Mg levels in whole plant forage quality analysis still were close to normal for alfalfa.

Treatments of gypsum or Ascend did not affect forage yield or quality. The added costs of these treatments resulted in significantly lower profitability than for the other treatments.

Conclusions

Other than meeting the lime requirement based on soil test recommendations, no other treatment added significant profit to alfalfa production in this trial. Research still is limited on defining soil test and plant analysis levels to provide a reasonable probability of an economic return to B fertilization of alfalfa.

Acknowledgements

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Table 1. Soil test levels of treatments in 2012.

Trts	pH	buffer	P	K	S	Ca	Mg	Zn	B
			- - - - - - - - - - ppm						- - - - - - - - - -
1	6.1	6.7	24	152	6.7	1910	270	5.4	0.4
2	6.9	- -	22	180	6.7	2410	250	5.5	0.4
3	5.8	6.7	26	162	6.7	2100	260	5.4	0.4
4	6.6	- -	25	195	5.8	2040	290	5.3	0.4
5	6.5	6.9	29	154	7.5	2430	280	5.1	0.4
6	6.6	- -	29	166	6.7	2480	260	5.3	0.3
7	6.6	- -	26	150	8.3	2540	270	5.4	0.3
Opt levels	6.6-6.9		21-25	161-200		600-1000	101-500	>0.9	0.9 1.5
Source	IA	IA	IA	IA		WI	WI	IA	WI

Table 2. Soil test levels of treatments in 2013.

Trts	pH	buffer	P	K	S	Ca	Mg	Zn	B
			- - - - - - - - - - ppm						- - - - - - - - - -
1	5.8	6.7	31	200	3.8	1860	230	2.3	0.7
2	6.5	7.0	33	187	5.0	2270	220	2.2	0.5
3	5.6	6.7	31	176	6.5	2160	180	2.2	0.7
4	6.4	7.0	34	182	5.0	2480	170	2.0	0.5
5	6.4	7.0	32	181	6.7	2320	230	2.4	0.8
6	6.5	7.0	31	196	5.0	2120	200	2.4	0.7
7	6.5	7.0	34	176	5.8	2150	200	2.2	0.8
Opt levels	6.6-6.9		21-25	161-200		600-1000	101-500	>0.9	0.9 1.5
Source	IA	IA	IA	IA		UW	UW	IA	UW

Table 3. Average dry matter yields/year by harvest and seasonal total for 2012 and 2013, and calculated profit/acre/year compared with ISU recommendations represented by Treatment 2.

Trt	Harvest (average for 2012 and 2013) 1	2	3	4	Total yield	Total value at $150/ton	Treatment costs[a]	Gross profit	Profit/ac/yr vs. Trt 2
	- - - - - - - - - - - - - - ton/ac			- - - - - - - - - - - - -		- - - - - - - - - - $/ac		- - - - - - - - - -	
1	2.22 a	1.64 a	1.42 a	1.35 ab	6.63 a	995	0	995.00	-$14.00 b
2	2.26 a	1.73 b	1.45 a	1.39 ab	6.83 b	1,025	16.00	1009.00	0.00 a
3	2.21 a	1.63 a	1.40 a	1.34 a	6.58 a	987	50.00	937.00	-$72.00 e
4	2.27 a	1.74 b	1.43 a	1.39 ab	6.83 b	1,025	66.00	959.00	-$50.00 d
5	2.23 a	1.75 b	1.44 a	1.42 b	6.84 b	1,026	48.00	978.00	-$31.00 c
6	2.27 a	1.73 b	1.46 a	1.41 ab	6.87 b	1,031	59.00	972.00	-$37.00 c
7	2.24 a	1.75 b	1.47 a	1.41 ab	6.87 b	1,031	81.40	949.60	-$59.40 d
$LSD^{b}_{0.05}$	0.11	0.09	0.08	0.08	0.19				10.20

[a]Treatment costs/harvest: Lime prorated at $4/acre; 1,000 pounds $CaSO_4$ prorated at $12.50/acre; MAX-IN Ultra ZMB at $8.00/acre; MAX-IN Boron at $2.75/acre; Ascend at $5.60/acre; Foliar application at $6.00/acre.

[b]LSD = Least significant difference. Differences by one LSD or more are significant with 95 percent certainty.

Table 4. Plant analysis from first harvest, 2012.

Trts	N	P	K	S	Ca	Mg	Zn	B
	- - - - - - - - - - - % - - - - - - - - - - -						- ppm -	
1	4.5	0.33	2.33	0.34	1.42	0.19	33.0	24.7
2	4.5	0.32	2.32	0.36	1.43	0.19	29.5	30.8
3	4.2	0.31	2.24	0.38	1.39	0.18	32.9	24.9
4	4.5	0.32	2.39	0.37	1.38	0.17	28.9	29.8
5	4.4	0.34	2.25	0.33	1.33	0.18	36.7	25.1
6	4.4	0.33	2.36	0.34	1.40	0.18	37.7	30.4
7	4.3	0.33	2.24	0.33	1.37	0.19	35.5	30.0
Opt levels	2.5-4.0	0.26-0.45	2.26-3.40	0.26-0.50	0.7-2.5	0.26-0.70	20-60	26-60

Source of optimum levels, University of Wisconsin.

Table 5. Plant analysis from third harvest, 2012.

Trts	N	P	K	S	Ca	Mg	Zn	B
	- - - - - - - - - - - % - - - - - - - - - - -						- ppm -	
1	4.9	0.36	2.18	0.40	1.57	0.31	43.6	12.8
2	4.9	0.35	2.37	0.45	1.78	0.26	36.0	13.1
3	4.7	0.37	2.21	0.42	1.58	0.27	44.2	10.7
4	5.0	0.37	2.44	0.44	1.62	0.25	36.8	11.0
5	4.9	0.37	2.45	0.46	1.70	0.28	63.2	14.1
6	4.4	0.39	2.53	0.43	1.54	0.27	66.4	20.3
7	4.9	0.34	2.48	0.41	1.57	0.26	55.1	18.3
Opt levels	2.5-4.0	0.26-0.45	2.26-3.40	0.26-0.50	0.7-2.5	0.26-0.70	20-60	26-60

Source of optimum levels, University of Wisconsin.

Table 6. Plant analysis from first harvest, 2013.

Trts	N	P	K	S	Ca	Mg	Zn	B
	- - - - - - - - - - - % - - - - - - - - - - -						- ppm -	
1	4.6	0.37	2.58	0.33	1.39	0.21	32.8	34.2
2	4.4	0.38	2.72	0.31	1.29	0.22	34.5	37.4
3	4.5	0.38	2.69	0.37	1.36	0.22	30.7	39.2
4	4.5	0.37	2.71	0.33	1.24	0.20	34.5	29.3
5	4.3	0.37	2.47	0.35	1.29	0.23	32.1	33.5
6	4.3	0.37	2.61	0.33	1.29	0.22	35.9	39.7
7	4.4	0.38	2.79	0.35	1.32	0.22	41.7	42.7
Opt levels	2.5-4.0	0.26-0.45	2.26-3.40	0.26-0.50	0.7-2.5	0.26-0.70	20-60	26-60

Source of optimum levels, University of Wisconsin.

Table 7. Plant analysis from third harvest, 2013.

Trts	N	P	K	S	Ca	Mg	Zn	B
	- - - - - - - - - - - % - - - - - - - - - - -						- ppm -	
1	5.9	0.45	2.58	0.44	1.69	0.31	31.9	24.9
2	6.0	0.46	2.42	0.47	1.48	0.29	41.2	25.6
3	5.9	0.47	2.82	0.51	1.57	0.26	38.1	25.9
4	5.9	0.47	2.68	0.47	1.62	0.30	38.1	23.2
5	5.8	0.46	2.75	0.46	1.64	0.28	40.4	24.7
6	6.1	0.50	2.73	0.47	1.55	0.30	46.0	30.7
7	5.9	0.48	2.45	0.45	1.56	0.29	43.6	32.4
Opt levels	2.5-4.0	0.26-0.45	2.26-3.40	0.26-0.50	0.7-2.5	0.26-0.70	20-60	26-60

Source of optimum levels, University of Wisconsin.

Table 8. Forage quality from first harvest, 2012.

Trts	CP	RFV	P	K	S	Ca	Mg
	%		- -- - - - - - - - - - % - - - - - - - -				
1	20.1	140	0.36	2.34	0.24	1.41	0.23
2	21.4	147	0.38	2.98	0.25	1.43	0.24
3	20.9	141	0.39	2.76	0.26	1.40	0.23
4	20.9	143	0.38	2.25	0.26	1.40	0.25
5	19.1	131	0.36	2.48	0.24	1.37	0.25
6	19.0	131	0.37	2.75	0.24	1.39	0.27
7	19.2	136	0.38	2.50	0.25	1.42	0.26

Table 9. Forage quality from first harvest, 2013.

Trts	CP	RFV	P	K	S	Ca	Mg
	%		- -- - - - - - - - - - % - - - - - - - -				
1	20.4	117	0.35	3.37	0.24	1.33	0.27
2	21.9	127	0.38	3.60	0.25	1.33	0.29
3	21.2	126	0.36	3.30	0.24	1.35	0.28
4	22.1	127	0.36	3.45	0.25	1.38	0.30
5	19.8	120	0.34	3.46	0.24	1.35	0.27
6	21.0	130	0.36	3.13	0.25	1.35	0.28
7	21.4	129	0.37	3.41	0.26	1.33	0.28

Table 10. Forage quality from third harvest, 2012.

Trts	CP	RFV	P	K	S	Ca	Mg
	%		- -- - - - - - - - - - % - - - - - - - -				
1	23.5	167	0.39	2.17	0.31	1.58	0.30
2	24.3	174	0.40	2.15	0.33	1.64	0.34
3	23.2	163	0.39	1.94	0.30	1.48	0.33
4	23.8	173	0.39	2.08	0.32	1.58	0.32
5	23.0	170	0.38	1.97	0.32	1.55	0.32
6	23.6	172	0.39	2.04	0.32	1.50	0.31
7	23.1	175	0.38	2.06	0.35	1.68	0.36

Table 11. Forage quality from third harvest, 2013.

Trts	CP	RFV	P	K	S	Ca	Mg
	%		- -- - - - - - - - - - % - - - - - - - -				
1	24.4	159	0.39	3.39	0.32	1.47	0.31
2	25.8	173	0.41	3.59	0.35	1.51	0.32
3	24.4	156	0.39	3.51	0.25	1.47	0.30
4	25.0	173	0.42	3.43	0.33	1.42	0.31
5	24.7	163	0.39	3.45	0.31	1.40	0.29
6	24.8	162	0.41	3.58	0.32	1.44	0.30
7	24.5	159	0.39	3.70	0.30	1.49	0.29