Best Management Production Input Approach to High Yielding Alfalfa

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Introduction

There continues to be questions with alfalfa production about what inputs may best improve yield and profitability. The following research trial was conducted to provide insight into some of these best management practices.

Materials and Methods

The research site was a Tripoli silty clay loam, 3.5 percent organic matter. Individual plot size was 5 × 40 ft in a randomized complete block design with four replications. The eight production input treatments were:

1) 100% of ISU recommended P and K fertilizer rate (100%)+0.3 oz/acre MustangMax insecticide (Ins)
2) 100%+Ins+foliar fertilizer of 1.5 qt/acre Nachurs (Ffert)
3) 125% of P and K fertilizer rate (125%)+Ins
4) 125%+Ins+Ffert
5) 125%+Ffert
6) 125%+Ins+Ffert+8 oz/acre Bioforge (B)
7) 125%+Ins+Ffert+Foliar fungicide (Ffung)
8) 125%+Ins+Ffert+B+Ffung

Soybean was the previous crop in 2011. Soil samples were collected in the fall of 2011, followed by application of sufficient lime and fertilizer to meet treatment requirements for the beginning of the study. Alfalfa growing degree days (GDD) are shown in Table 1. Monthly precipitation by year is shown in Table 2. The site was field cultivated in the spring of 2012 and direct seeded with DKA43-22RR alfalfa at 17 lb/acre with a Brillion seeder. Roundup PowerMax was applied at 32 oz/acre at third trifoliate stage. All treatments received annual applications of phosphorus (P) and potassium (K) fertilizer in 2012, 2013, 2014, and 2015 to meet treatment requirements. Sulfur (S) fertilizer was applied each spring at 25 lb/acre according to Iowa State University (ISU) recommendations. Foliar treatments were applied at 6–8 in. of regrowth in early spring, and 4–6 in. of regrowth for second, third, and fourth crops.

Two harvests were taken in 2012, but no data were collected for the seeding year. Plots were harvested four times per season in 2013-2015 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 harvests for forage quality analysis. Data was collected on plants/ft^2 and stems/ft^2 each spring and fall. Soil tests were collected at the beginning and end of the research trial.

Results and Discussion

Soil tests. There was no yield advantage of the initial high soil test level and 125 percent annual P and K fertilizer rates over the initial optimum soil test level and 100 percent annual fertilizer rates. ISU Extension P and K fertilizer recommendations are based on economic response to fertilization of low, optimum, or high soil test levels and suggest if soil test levels are in the optimum range to fertilize for crop removal. If soil test levels are in the high range, no fertilizer is recommended. The research results support these guidelines. The ISU Extension P and K fertilizer recommendations are intended to maintain or slightly increase soil test levels over time. If starting at optimum soil test levels and fertilizing for crop removal, expect soil test levels to be similar or slightly higher over the next few years. This trial validated that intended response.

Stand assessment. Recommended plants/ft^2 for first, second, and third year established stands following the seeding year are ≥12, ≥8, and ≥6, respectively. Recommended stems/ft^2 for each year to maximize yield potential is ≥55. The first and second year stands in this trial had adequate plants/ft^2 and stems/ft^2 (Table 3). The winter of 2014-2015 caused some injury to the stand resulting in lower than optimum stands/ft^2 and stems/ft^2, but there was no difference in stand assessment among the different treatments (Table 3).

Insecticide treatment. The research protocol had insecticide applied to all crops regardless of insect economic threshold levels. Treatments 4 vs. 5 offer a direct comparison with and without the use of an insecticide. There was an economic advantage of insecticide use to second, third, and fourth crop in 2013, only third crop in 2014, and no crops in 2015 (Table 4). Overall, there was an economic advantage using an insecticide in this trial, but the advantage would likely have been greater if insecticide was only used when scouting warranted it.

Foliar fertilizer treatment. Treatments 1 vs. 2 and treatments 3 vs. 4 offer direct comparisons with and without the use of foliar fertilizer. Neither comparison showed a yield or economic advantage (Table 4).

Bioforge treatment. Treatments 4 vs. 6 and treatments 7 vs. 8 offer direct comparisons with and without the use of Bioforge. Neither comparison showed a yield or economic advantage (Table 4).

Fungicide. Headline fungicide was applied ahead of first, second, and third crops in all three years. Treatments 4 vs. 7 and treatments 6 vs. 8 offer direct comparisons with and without the use of Headline. Both comparisons provided a yield and economic advantage each year (Table 4). Individual crop harvest data found a yield advantage 17 out of 18 harvests, and an economic advantage four out of 18 harvests. The four with an economic advantage were two of the six first crop harvests, one of the six second crop harvests, and one of the six third crop harvests. Three of the four harvest comparisons with an economic advantage occurred in the wetter-than-normal 2013 season.

Forage quality. Forage quality testing was only conducted for first crop harvests, and these were composite samples so no statistical analysis is available. On average over the three years, there was no difference in first crop forage quality between any of the treatments. This is represented by pounds of milk/ton (Table 4). Because of the yield advantage from the use of fungicide in Treatments 7 and 8, discussed in the previous section, these treatments appear to have produced more pounds of milk/acre compared with the other treatments (Table 4).

Conclusion

A summary of the eight treatments based on profit per acre favors Treatments 1, 2, 7, and 8 (Table 4). When comparing the results of all harvests from all eight treatments, the most profitable management would be the following:

1) Use ‘normal’ ISU Extension soil fertilizer recommendations (100% rate). The higher rate (125%) did not provide a yield advantage, or an overwintering advantage following stand injury from the winter of 2014-2015.
2) Use foliar insecticide based on scouting and economic thresholds, not prophylactically with every regrowth. Its use in this trial with an application for every regrowth reduced its economic value.
3) Consider foliar fungicide applications in wetter, more disease prone situations, favoring its use ahead of first crop. Its use in this trial with an application for every regrowth reduced its economic value.
4) The trial did not find an economic advantage when using foliar fertilizer or Bioforge.

Acknowledgements

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Table 1. Monthly alfalfa GDD base 41°F.

	Normal	2013	2014	2015
April	285	189	154	326
May	546	557	543	597
June	828	819	852	829
July	971	952	823	906
Aug	894	908	921	828
Sept	637	722	590	803
Total	4,161	4,147	3,883	4,289

Table 2. Monthly precipitation in inches.

	Normal	2013	2014	2015
April	3.8	6.4	7.2	4.3
May	4.4	9.9	2.9	3.5
June	5.3	8.2	10.4	5.8
July	4.7	2.7	1.4	4.0
Aug	4.3	3.3	3.8	4.6
Sept	2.8	1.1	2.8	2.6
Total	25.3	31.6	28.5	24.8

Table 3. Average dry matter yield for 2013, 2014, and 2015, and calculated profit/acre per year over harvest costs.[a]

	Plant counts, spring			Stem counts, spring			Soil fertility and pH levels					
Trt	2013	2014	2015[b]	2013	2014	2015[b]	Spring 2013			Spring 2015		
	- - - - - - per ft^2 - - - - - - - -			- - - - - - - per ft^2 - - - - - - -			pH	P	K	pH	P	K
1	19.8 ab	8.3 a	4.5 a	> 55 a	> 55 a	37.4 a	7.0	27	174	7.3	33	203
2	19.8 ab	8.8 a	4.6 a	> 55 a	> 55 a	37.9 a	6.9	28	177	7.3	33	208
3	20.0 ab	9.0 a	4.4 a	> 55 a	> 55 a	37.8 a	6.8	38	224	7.2	52	307
4	20.8 a	8.5 a	4.4 a	> 55 a	> 55 a	36.8 a	7.0	35	220	7.3	51	231
5	20.8 a	8.8 a	4.5 a	> 55 a	> 55 a	34.6 a	7.0	35	230	6.8	55	291
6	19.3 ab	9.0 a	4.4 a	> 55 a	> 55 a	37.8 a	7.0	35	221	7.0	56	281
7	19.0 a	9.0 a	4.7 a	> 55 a	> 55 a	39.8 a	6.9	36	231	7.0	50	246
8	19.3 ab	9.0 a	4.5 a	> 55 a	> 55 a	38.9 a	7.0	36	223	7.1	57	261
LSD$^b_{0.05}$	1.8	1.0	0.6			6.5						

[a]LSD = Least significant difference. Differences by one LSD or more are significant with 95% certainty.
[b]Significant winter injury occurred to the stand during the 2014-2015 winter.

Table 4. Average dry matter yield for 2013, 2014, and 2015, and calculated profit/acre per year over harvest costs.[a]

	Harvest total			Profit/acre over Treatment 1[a]				First harvest forage quality	
Trt	2013	2014	2015	2013	2014	2015	Total	2013-2015	2013-2015
	- - - - - - ton/acre - - - - - -			- - - - - - - $/acre - - - - - - -				lb of milk/ton	lb of milk/acre
1	6.83 ab	7.47 ab	7.03 a	0.00 b	0.00 a	0.00 a	0.00 a	2,678	5,783
2	6.80 ab	7.53 ab	7.02 a	-12.00 bc	3.00 a	-7.50 a	-16.50 a	2,695	5,825
3	6.91 b	7.53 ab	7.13 a	-25.20 c	-32.20 cd	-26.20 b	-83.60 b	2,621	5,788
4	6.82 ab	7.58 b	7.04 a	-49.20 d	-30.70 c	-45.70 c	-125.60 c	2,704	5,916
5	6.61 a	7.28 a	6.85 a	-67.20 e	-51.70 e	-50.20 c	-169.40 d	2,685	5,712
6	6.81 ab	7.51 ab	7.05 a	-57.20 de	-47.20 de	-50.20 c	-154.60 cd	2,707	5,931
7	7.51 c	8.14 c	7.60 b	22.80 a	-12.70 ab	-27.70 b	-17.60 a	2,686	6,317
8	7.54 c	8.12 c	7.64 b	22.80 a	-21.70 bc	-27.70 b	-26.60 a	2,668	6,418
LSD$^b_{0.05}$	0.23	0.27	0.30	13.32	16.42	17.33	29.57		

[a]Treatment costs/harvest: The 125% fertilizer rate = $10.30/acre/harvest higher than the 100% fertilizer rate; Insecticide = $6.00/acre/harvest; Nachurs foliar fertilizer = $1.50/acre/harvest; Bioforge = $1.50/acre/harvest; Headline = $22.00/acre//harvest for first, second and third crops, not applied to fourth crop; Application cost of foliar products = $6.00/acre. Hay value used on a dry matter basis = $200/ton in 2013 and $150/ton in 2014-2015.
[b]LSD = Least significant difference. Differences by one LSD or more are significant with 95% certainty.