# Best Management Production Input Approach to High Yielding Alfalfa

## A.S. Leaflet R3068

Brian Lang, ISUEO Extension Agronomist;
Ken Pecinovsky, Superintendent Northeast Research Farm

**Summary and Implications**

Eight alfalfa production inputs were evaluated on best profit per acre. Iowa State University (ISU) fertilizer recommendations proved to be more profitable than for using a higher fertilizer rate. Additional inputs of foliar fertilizer and Bioforge applied to every regrowth did not improve profitability. Select use of foliar insecticide when pest levels exceeding thresholds appeared to be profitable, but prophylactic applications to every regrowth did not improve overall profitability. Foliar fungicide applications improved profitability for some harvests, but not all. Most profitable use appears to be to apply in late April to benefit first crop yield.

**Introduction**

There continues to be questions with alfalfa production as to 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% organic matter. Individual plot size was 5x40 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 Nachures Fortified (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. 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 ISU recommendations. Foliar treatments were applied at 6-8 inches of regrowth in early spring, and 4-6 inches of regrowth for second, third and fourth crops.

Two harvests were taken in 2012, but no data was 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.

**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 | 3.7 | 6.3 | 3.5 | 4.3 |
| May | 4.4 | 10.1 | 3.0 | 3.5 |
| June | 5.1 | 7.1 | 9.4 | 5.8 |
| July | 4.7 | 2.5 | 1.2 | 4.0 |
| Aug | 4.3 | 3.1 | 4.7 | 4.4 |
| Sept | 2.8 | 1.1 | 1.8 | 2.5 |
| Total | 25.0 | 30.2 | 23.6 | 24.5 |

**Results and Discussion**

*Soil tests*. There was no yield advantage of the initial high soil test level and 125% annual P and K fertilizer rates over the initial optimum soil test level and 100% 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 that if soil test levels are in the optimum range to just 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 warrant 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 both 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 they 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 to 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 or economic advantage in the study, or a winter survival 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 from using foliar fertilizer or Bioforge.

## Acknowledgements

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**Table 3. Average spring plant and stem counts and soil fertility and pH level for 2013, 2014 and 2015, [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 percent 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/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 percent certainty.