Large-Scale Evaluations of In-Season Liquid NPK Applications to Push Alfalfa Production

Terry A. Tindall, Ph.D., Director of Agronomy,
and Galen Mooso, Ph.D., Agronomy Manager

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Abstract

Forages are coming into their own in North America and especially in the 11 Western states and the four Western provinces of Canada. Alfalfa (Medicago Sativa) is the most common forage produced and has the highest production acre as well as the greatest yield potential of the commonly grown forages in this part of North America. Although the area of alfalfa production may not be increasing, the importance of forages in general is becoming more widely accepted because of the increasing demand for livestock production by not only North America, but the developing economies of China and other Pacific Rim countries where meat and dairy production are on the increase. The increased needs in forage production coupled with the ever-increasing size of dairy herds in the Western U.S. are pushing the value of alfalfa and turning attention to improved quality of hay being produced. Because of the increased demand, alfalfa value on a per ton basis has increased by over 200%. This type of value increase has led to a desire to increase production within a given field, but not expand actual acreage. Nutrient management is a key to high production with good quality. If water management is maintained then proper nutrients are a key component to not limiting production. Field evaluations were conducted within a large farm setting beginning in 2012 and continuing during 2013. In-season applications of liquid low-salt NPK fertilizers were applied at certain growth stages. Alfalfa was commercially harvested from the field at 65% moisture with each treatment selectively measured and yields determined. Yields were increased by more than 1 ton/acre of alfalfa for each of the years, indicating the potential for these types of in-season management strategies. Subsamples were collected from each harvested load (truck) with NPK and relative feed value determined. This report describes in detail the advantages observed from making these in-season nutrient applications.

Introduction

Alfalfa has gained a renewed prominence in Western North America with increased demands coming from changes that are occurring within our own geography as well as influences from overseas markets. As the population increases, a need arises for more food to be produced as well as for improved diets for developing Pacific Rim countries and especially China and Japan. The affluence of America, Canada, and Mexico has been accompanied by increased demand for protein and dairy products. It is little wonder that other developing countries with more dispensable income want to improve their own diets with similar protein-based foods of meat and dairy. Because of these emerging trends, demand for forages and especially alfalfa is on the increase. New, larger dairies are being constructed in the Western U.S. and when coupled with a tremendous export market for hay allows prices for that commodity to increase substantially, reaching a 200% increase in value over the last 10 years.

There does not seem to be any additional land used for growing the crop, but there is an interest in increasing the production coming off the land and certainly improvements in alfalfa quality. Nutrient management along with irrigation water, when possible, are key inputs within a successful alfalfa management strategy. Alfalfa is a marvelous crop and when one considers the stress from drying down the fields to support harvest equipment in harvest preparation, the cutting process, and rapid regrowth that occurs with each subsequent cutting, it is truly amazing. A great portion of the crop's success and grower demand for higher yield are directly related to nutrients being applied and managed. However, yields/quality may not always be the amount of nutrients applied, but quite often nutrient timing or the form of the fertility inputs. This paper explores these types of in-season management of nutrients in the hope of understanding an improved production strategy as growers "push" yields beyond their current production goals. Alfalfa production from 1919 to 2013 has increased from 4 million to 7 million acres within the 11 Western states. The largest geographic increase has come from Montana, with a 4 to 5 times increase, with a current production of almost 1.7 million acres. Idaho, where this study was completed, currently ranks alfalfa at a 3 in level of importance based on acres of production with about 1.1 million. The only crop that would have a higher ranking in Idaho is wheat.

The principal nutrient of application within an alfalfa production system is phosphorus (P). Potassium (K) removal is higher, but in my past experience P nutrition needs to be satisfied prior to expecting a K response. Currently many of the soils where alfalfa is being produced have inadequate soil level P and K and many of these are being supplemented with both NPK either as inorganic fertilizers or with applications of manure or compost or both. In the past it has been recommended that large applications of P fertilizer be applied for a long-term stand of alfalfa. These recommendations were developed on the understanding that broadcast preplant applications would increase efficiency of the P by incorporation. The challenge with these recommendations is the soil retention of the P fertilizer being applied. It is now more commonly appreciated that the longer a soluble source of P is in contact with the highly calcareous soils of the Intermountain West the greater the soil retention is with calcium (Ca), magnesium (Mg), and other antagonistic cations that significantly reduce the solubility of the P fertilizer being applied. Therefore, one of the primary objectives of this study is to determine if in-season applications of an NPK liquid fertilizer could supplement a portion of the NPK nutrient needs of alfalfa with applications between each cutting. An alternative objective would be to evaluate NPK uptake for each cutting and relate changes back to yield, and to nutritive value for the alfalfa where these applications are being targeted. The final objective would be to determine economic viability of these types of in-season applications as they relate to Simplot's operational needs.

Materials and Methods

Large-scale field demonstration trials were established in the spring of 2012 and 2013 on established alfalfa. The 2012 plots were located on a field called Bryant 13. These trials were done in cooperation with property owned and managed by the J.R. Simplot Company with support from the farm manager Matthew Clements and his very capable crew. Bryant 13 field soil is calcareous in nature and would be classed as an aridisol with organic matter of < 1% and a soil test P concentration of 12 ppm. The field was located about a half mile above the Snake River on an alluvial terrace. The field was rectangular in shape and irrigated by wheel lines. The uniformity of the field should be noted as well as the irrigation design. These factors were important in allowing this project to move forward and with large-scale commercial machines. The application of foliar materials in 2012 involved an NPK low-salt liquid with an analysis of 3-18-18, and applied with a commercial applicator when each of the regrowth was 6–8 inches tall. The treatments were as follows:

1) Grower Standard Practice—no foliar applications
2) 3-18-18 @ 1.25 gallons/ac
3) 3-18-18 @ 2.5 gallons/ac
4) 3-18-18 @ 2.5 gallons/ac with a surfactant
5) 3-18-18 @ 5 gallons/ac

Each of these treatments represented two acres and were replicated twice in a random fashion. Each of the treated areas of the field were laid out with GPS and separated from the other treatments with a physical line both to avoid cross-contamination for nutrients being applied and to ensure an accurate harvest. Treatments were made between each cutting of alfalfa (second and third). The field was allowed to dry for harvest to limit compaction. After harvest, the field including the treatment areas was then irrigated to stimulate regrowth and dried once more to avoid compaction from the commercial sprayer applying the foliar treatments. Harvest was initiated at 20% bloom in an attempt to maximize commercial tonnage from each of the treatments.

Harvest was completed using commercial swathers that cut and windrowed the alfalfa across the entire field. At about 65% moisture each of the treatments was green-chopped and placed (blown) into commercial open trucks. Prior to leaving the fields each of the trucks had a color-coordinated tag that represented treatment, field name, and date. Each truck was weighed at a scale house as a basis for determining yield. The alfalfa was then dumped into a silage pit where 10 sub samples were collected into a single composite sample that was tagged, placed in a cooler, and then taken for laboratory analysis that included total moisture, NPK, as well as relative feed value. This same procedure was repeated for the third cutting of alfalfa as well.

Responses to treatments were positive enough that after meeting with both the farm management crew and their accountants it was decided to expand the trial for 2013. However, because of concerns with drying out the field prior to treatment foliar applications it was decided to use center pivots and larger fields for an expanded study into 2013. Therefore, three alfalfa fields were selected, each under pivot irrigation, all having been in production for at least two years, and all of the same variety. Field locations were unique in that they occupied the same geomorphic terrace with very similar soil (silt loam) and slope, and were adjacent to each other. This helped decrease some of the concerns associated with soil, geography, irrigation, and age of the stand (Figure 1—Field locations)

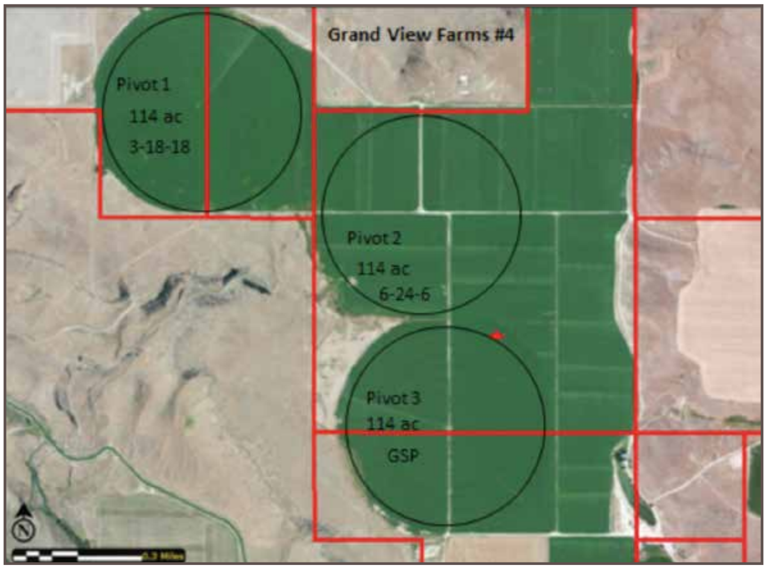


Figure 1. Field locations for 2013 in-season applications of low-salt NPK fertilizers. Located in Grand View, Idaho, on highly calcareous aridisols.

Each of the three pivots contained a total of 120 acres; it was decided to treat the entire field, but only harvest and monitor the crop within the first wheel track. This provided 114 acres for each treatment, and allowed marginal land and non-uniform irrigation to be less of a factor when determining yields and feed quality. It would be a good decision for anyone managing a similar trial to consider. Treatments were assigned to the fields at random, but the same treatments were applied to the same fields during the entire growing season.

The 2013 treatments were as follows: (1) Grower Standard Practice (GSP) with no additional in-season applications of NPK liquids, (2) 3-18-18, and (3) 6-24-6. Treatments 2 and 3 were applied at rates of 3, 5, and 5 gallons/ac depending on the cutting, with the first cutting having a lower application rate. Timing of application was consistent with regrowth from 2012 and was targeted at a height of 6–8 inches. A change in evaluation consisted of the 3-18-18 to be applied by aircraft. This was necessary to avoid both drying out the field for topical application as well as any concerns with compaction during the season or damage to the alfalfa from heavy equipment. The trial was also expanded to include treatment 3 of the 6-24-6, which was applied "water-run" through the pivot. The alfalfa growth stage of 6–8 inches was the same as treatment 2. Irrigation was stopped for 24 hours to allow drying for the 3-18-18 application. The 6-24-6 applied through the irrigation water is considered a soil application.

At maturity (>10% bloom) the treated fields were allowed to dry to decrease compaction potential from harvest equipment that entered the fields. Each field was cut and put into windrows with commercial equipment and allowed to dry to about 65% moisture. Harvesting was accomplished under a contracted professional group that involved three New Holland forage harvesters that "green-chopped" each of the treated fields (everything inside the first wheel-tracks) into 10- and 14-wheeled open trucks. These trucks were tagged with a corresponding ticket handed to each driver who then took the ticket to the scale house where each load was weighed and recorded. The alfalfa was dumped into a silage pit (as part of the J.R. Simplot Livestock operations where we have almost 100,000 head of feeder cattle in a single feedlot) and several random samples were collected and a composite sample from six trucks was collected to determine moisture content, NPK, and relative forage quality. This procedure was repeated for each of the 114 acres evaluated, and involved several days of sampling with a total number of trucks weighed and sampled of about 600 over the three harvests, which included 1,026 acres for the three treatments.

Results and Discussions

Differences in yield from the 2012 field studies from the Bryant 13 location were recorded and expressed at a green-chop weight of 65% moisture. Increases in application rates compared to the GSP with no 3-18-18 provided higher yield values. Grower Standard Practice was 12.2 tons/ac and increases in production for the in-season treatments were as follows: 13.1, 12.9, and 14.6 tons/ac for the corresponding application (total amounts applied) rates of 2.5, 5.0, and 10 gallons/ac (Figure 2).

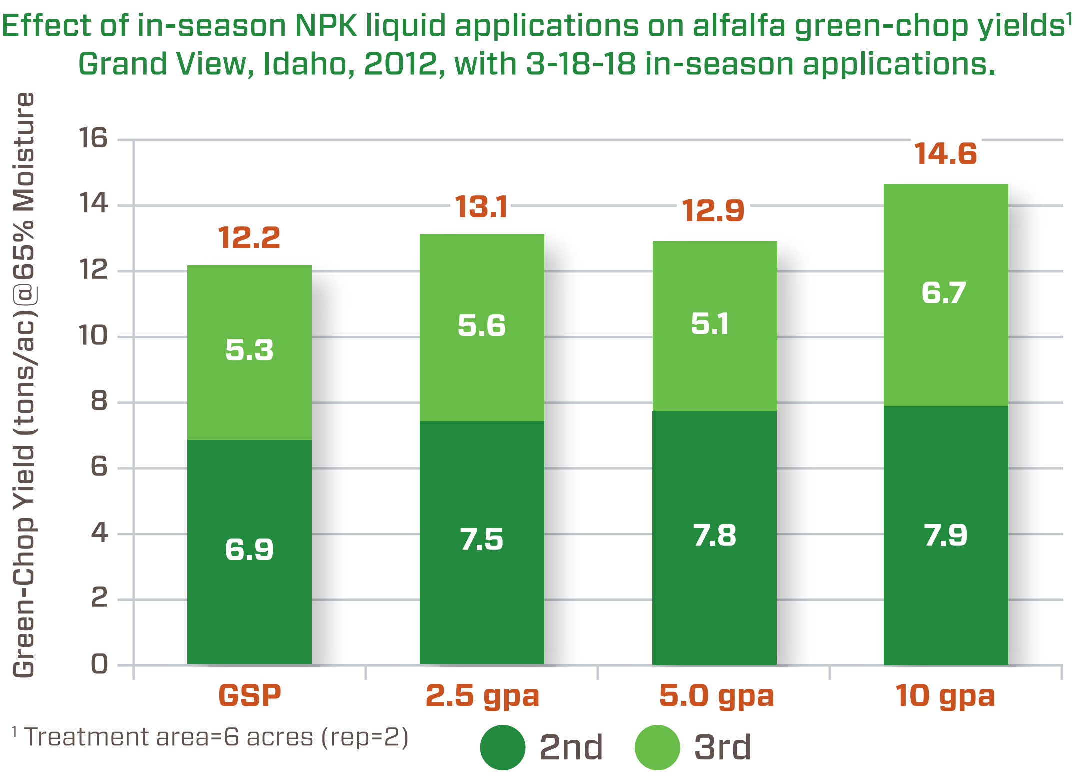


Figure 2. Alfalfa yield from Bryant 13 fields expressed at 65% moisture and as the means for second and third cuttings for 2012.

Based on the economics of the green-chop alfalfa and the cost associated with treatment, the benefit to cost ratio was about 2:1. Even though there were challenges with drying the fields out, the Simplot Farm Manager was encouraged enough with the results to support expansion of the trials into 2013.

At the end of the season and after weighing almost 600 trucks, improvements in yield were observed for both foliar NPK in-season applications of either 3-18-18 or 6-24-6 (Figure 3).

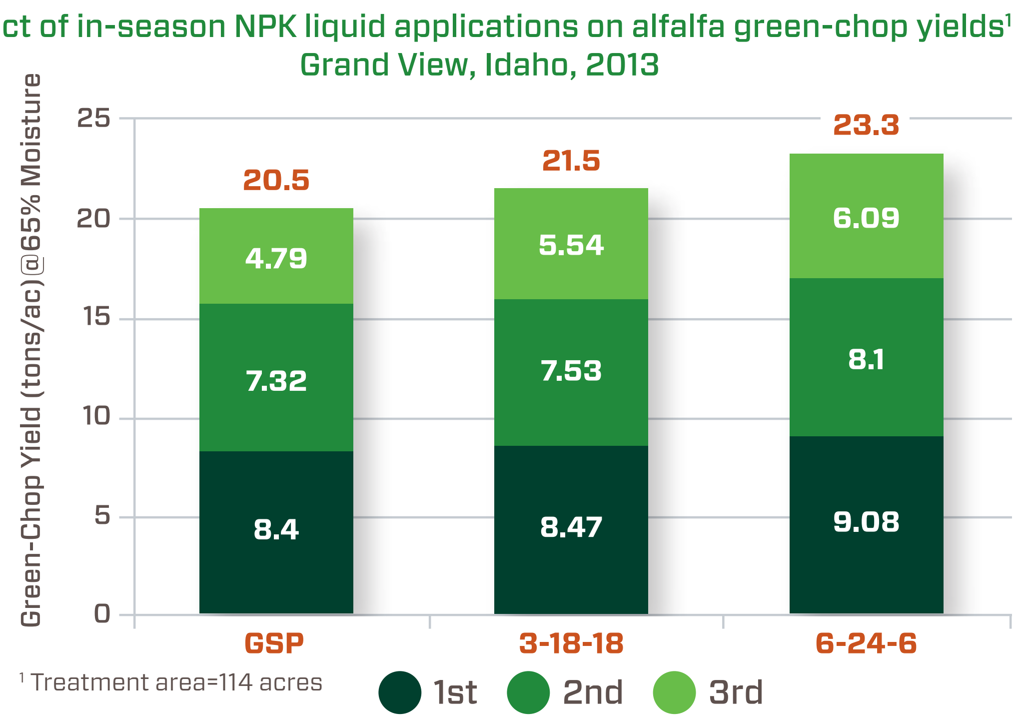
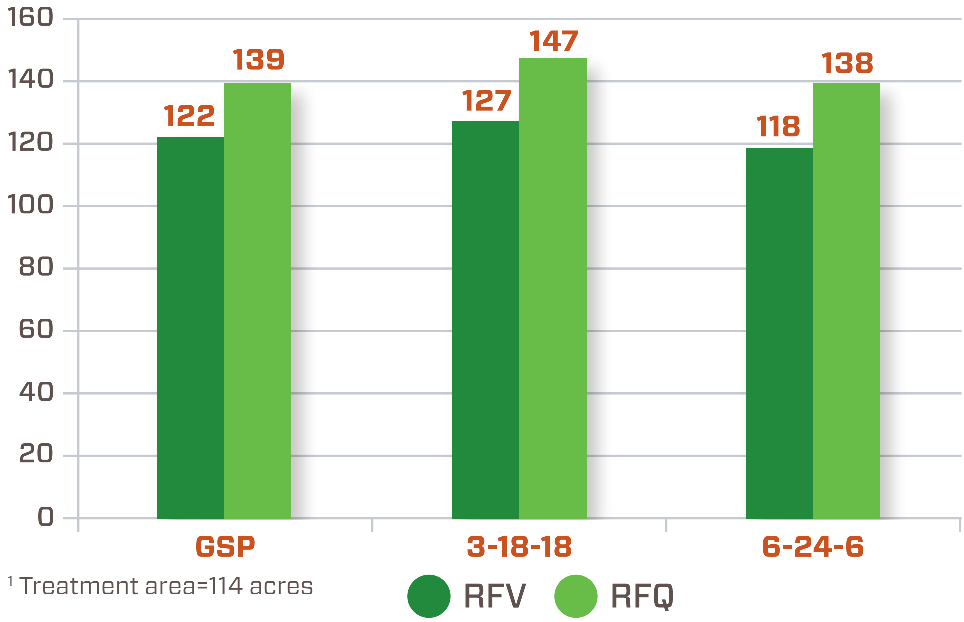


Figure 3. Harvested yields for each of the three cuttings of alfalfa from Simplot Farm Four during the 2013 growing season. Weights are based on the mean of 114 acres and for each corresponding cutting.

Numeric yield improvements for 2013 were observed for each of the treatments as compared to each other and the GSP. The highest increase in production was attributed to 6-24-6 applications through the irrigation water. As predicted the first cutting was the highest yield, but the increases attributed to 6-24-6 applications continued through all three cuttings.

An additional measurement of interests for livestock production (feedlot estimates) is the relative feed value (Figure 4). Numeric increases were observed for the 3-18-18 applications, but a decrease with the 6-24-6. The reason why is unclear, but additional analysis indicates an increase in K uptake associated with the foliar-applied 3-18-18 (data not shown). The increase of K over the GSP for this treatment was 94 lbs/ac removed. These large amounts of K removed compared to the rates of K applied were also of interest. It would appear that K uptake was stimulated by the amounts of 3-18-18 applied even though the K rate was far below removal rate.

Effect of in-season NPK liquid applications on mean alfalfa relative feed value and relative forage quality.[1] Grand View, Idaho, 2013.



[1] Treatment area=114 acres

Figure 4. Relative feed value for alfalfa with in-season NPK liquid fertilizers produced on Simplot Farm Four. These values are made up of acid detergent fiber and neutral detergent fiber and reflect production values for livestock.

Conclusions

Alfalfa production is increasing in the Western U.S. and is now either the primary or secondary crop in many of these states. As a result of the value of forage production, growers have a keen interest in pushing yield as well as quality of alfalfa being produced. Our responses across these large areas of production support the use of in-season applications of liquid NPK materials of either 3-18-8 or 6-24-6. The highest yield improvements came with 6-24-6 being applied through irrigation water and, in our case, applied through a center pivot. Feed value was also increased above the GSP although this was not the focus of our field evaluations. We would recommend that others working with alfalfa consider this report as a basis for making their own set of evaluations. It is the intent of the authors to use 6-24-6 for the 2014 growing season to continue to verify the results obtained from this study. The J.R. Simplot Company's farming operations will also begin to incorporate the 6-24-6 applications through their irrigation systems beginning in 2014.

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