PROCEEDINGS

2012 Idaho Alfalfa and Forage Conference

Best Western Burley Inn, Burley, Idaho
1-2 March, 2012

IDAHO HAY AND FORAGE ASSOCIATION, INC.

IHFA

University of Idaho Extension

Idaho Forage Team

Additional copies of these proceedings are available from:
http://www.extension.uidaho.edu/forage/
Kimberly Research & Extension Center
3806 N 3600 E
Kimberly, ID 83341
208.423-6678
gshew@uidaho.edu

Welcome

to the

2012 Idaho Hay & Forage Conference

Burley, Idaho, 1-2 March 2012

On behalf of the planning committee, we welcome you to this gathering of the state's leaders in alfalfa and forage production. This conference will start with an emphasis on alfalfa and forage crop management and conclude on the second day discussing corn and other forages. Our objectives are to: 1) extend research information; 2) provide continuing education on forage irrigation, export markets; forage pests, weeds, and diseases; new markets and genetics, organic forage production, and corn grasses, and silage issues; 3) learn from producers and consumers about effective ways of producing and using forages; 4) give an opportunity to the forage-related industries to provide information about equipment, products, and services they can provide; and 5) provide opportunity for the Idaho Hay & Forage Association to inform everyone about regulatory, political, and business issues affecting agriculture.

We express our appreciation to the speakers who provide this excellent program and proceedings. These people have generously taken the time to share their knowledge with you. We are also thankful to the many sponsors and exhibitors of the conference. Their contributions have made it possible to keep registration fees low and provide a quality program!

This is truly a cooperative effort between the Idaho Hay & Forage Association and the University of Idaho Extension System.

Welcome to the 2012 Idaho Alfalfa and Forage Conference!

Program and Planning Committee

Idaho Hay & Forage Association Board of Directors:

Dennis Strom, President
Will Ricks, Vice President
Ben McIntyre, Secretary/Treasurer
Jim Blanksma
Gary Chamberlain
D. Paul Dixon
Jay Fielding
Benjamin Kelly
Lynn Olsen
Glenn Meyer
Rick Pearson
Dan Safford
Glenn Shewmaker
Darren Sponseller
Chris Pratt
Michael Toone
Rick Waitley

University of Idaho:

Glenn Shewmaker, Extension Forage Specialist
Steve Hines, Extension Crops Educator
Christi Falen, Extension Crops Educator

EXHIBITORS AND SPONSORS

of the

2012 Idaho Hay and Forage Conference

We also express our appreciation and thanks to the following sponsors and exhibitors of the conference. Their contributions have made it possible to keep registration fees low and provide a quality program.

EXHIBITORS/SPONSORS

Ag Concepts Corp.
AgriSource Inc.
Anderson Hay & Grain
Auto Dry Track Systems Inc
Bridon Cordage
GrowGreen Northwest
Idaho Ag Credit
International Stock Food Corp
JCB of Idaho
LeBaron and Carroll Insurance
Liphatech
New Holland Agriculture
Northwest Seed
PolyExcel LLC
Progressive Forage Grower
Sloan-Leavitt Insurance Agency Inc.
Tenax Corporation
Western Ag Enterprises, Inc.
Agri-Service
Agsource Laboratories
Animal Fee Technologies – AFT
BMZ Biological
Forage Genetics International
Helena Chemical/America's Alfalfa
Idaho State Dept. of Agriculture
ITC Services Inc.
Jetko Distributing (Schaeffers Oil)
Legacy Seeds Inc.
Maz-Zee S. A. International
Northwest Farm Credit Services
Novozymes BioAg. Inc.
Producer's Choice Seed
R & A Equipment/Key Ag
Soils Alive / Midwestern Bio-Ag
Trans Agra International

VALUE OF BMR CORN SILAGE IN A DAIRY RATION

Richard J. Norell[1]

INTRODUCTION

Corn silage is commonly used in most Idaho dairy rations where producers feed about a third to two-thirds of the diet dry matter as corn silage. Many factors influence silage feeding rate, including: relative forage prices, available alternative forages, available alternative by-products, prevailing feed prices, milk prices, herd milk yield, and producer goals. Hybrid, agronomic practices, growing conditions, harvest time and method, fermentation and diet formulation all affect the feeding value of corn silage. This paper will focus on feeding value of brown mid-rib (BMR) corn silage, its positioning in dairy rations, and feeding management practices for successful results.

FEEDING VALUE OF BROWN MIDRIB CORN SILAGE

Nutrient composition of BMR silage is generally very similar to conventional hybrids with two very important differences: BMR is lower in lignin and has a significantly higher in-vitro NDF digestibility (Kung 2011; Grant and Contanch, 2011). Feeding value varies with advancing plant maturity, moisture content, harvest chop length, roller processing, and days in storage.

Maturity**.** NDF digestibility decreases as the BMR plant matures. High dry matter BMR silages are more mature and have significantly lower NDF digestibility than BMR silages harvested in the targeted moisture range (32 to 34%). Monitor moisture levels to optimize the harvest window for high fiber digestibility.

Chop length. The correct chop length will vary based on specific conditions on the farm. But, for starters, a general guideline is to chop BMR corn at a TLC of ¾ inch, longer if the corn will be processed.

Processing. There are two published studies that compare processed versus unprocessed BMR corn. In a Wisconsin study, unprocessed BMR corn was chopped at either ½" or ¾" TLC and processed was chopped at ¾" or 1-1/4" TLC with a roll spacing of 2mm (Schwab etal, 2002). All four silages fermented well and produced quality silage. Milk yield did not differ between silages but dry matter intake was less when feeding longer chopped silage (2.4 lbs. less with unprocessed and 1.8 lbs. with processed silage). Fat test was reduced by processing and there was no improvement with a longer chop length. NDF digestibility decreased and starch digestibility increased in these processed, moderately high dry matter BMR silages (37.6% to 43.9%).

In University of Delaware research (Ebling and Kung, 2008), three silages were compared: processed and unprocessed BMR corn plus processed non-BMR corn. Chop length was set at ¾" TLC and roll spacing was 2mm. Compared to unprocessed BMR corn silage, cows fed processed BMR silage had better starch digestibility, less than one-sixth the number of kernels in the manure, higher dry matter intake (+3 lbs), greater milk production(+4 lbs.) but lower butterfat test (-0.23%). Compared to processed non-BMR

[1] R. Norell, Dairy Specialist, University of Idaho, Idaho Falls R & E Center, 1776 Science Center Drive, Suite 205, Idaho Falls, ID 83402. Presented at the Idaho Alfalfa and Forage Conference, 1-2 March, 2012.

silage, cows fed processed BMR silage had greater milk production, but few other differences. Perhaps the most meaningful result in the study was a 6.4 lb. difference in milk production between cows fed processed BMR and processed control corn silage: 97.5 vs. 91.1 lbs./cow.

Days in storage. Recent research from the University of Delaware followed NDF and starch digestibility over time in storage with conventional and BMR silage. NDF digestibility decreased 3 to 5% during the first 60 days of storage and remained fairly stable through day 360 (der Bedrosian and Kung 2010). Starch digestibility was lower at harvest for the BMR silage than a conventional hybrid. Starch digestibility increased over time in storage for both hybrids but BMR silage remained lower than conventional hybrid throughout the study (der Bedrosian and Kung 2010).

Positioning BMR Corn Silage in Dairy Diets

High energy forages with highly digestible fiber are preferred by dairy nutritionists and can easily fit into rations for high producing lactating cows and for transition cows. Since 1999, there have been 17 published research trials in the Journal of Dairy Science where BMR silage was fed to lactating cows. In most cases, trials were conducted on cows that averaged around 50 to 100 days in milk at trial initiation and were fed high forage rations (55 to 60% forage % of DM). In the majority of the trials, the concentrate portion of the diet was similar with silage hybrid as the main difference between diets. Others, fed slightly more forage and less grain concentrate on the BMR diet (Bal et al 2000; Oba and Allen 2000) BMR silage typically accounted for 30 to 60 percent of the ration dry matter. Significant increases in dry matter intake (+2.9 lbs.) and milk yield (3.8 lbs.) were observed on average across the 17 studies (Gencoglu et al, 2008). Milk fat test decreased slightly (-0.08%) while protein test did not change (-0.1%).

Michigan State researchers evaluated animal response to BMR silage relative to the individual cow's pre-trial milk yield (Oba and Allen, 1999). Cows with high initial milk yield were more likely to have large milk responses than cows with more average milk yield at the start of the trial. Significant responses to BMR silage were observed when cows were fed diets with 29 and 38% NDF in the diet. However, yield responses were greater on the high NDF diet which suggests improvements when intake is limiting production (Oba and Allen, 2000). Intake can be limiting for diets fed to early lactation and high producing. Best bang for the buck will made by offering BMR silage to early lactation, high producing cows with an appropriately formulated ration.

Transition cows (cows within 3 weeks before and after calving) have benefited from research diets with BMR corn silage. Performance and health of fresh cows is improved by elevating feed intakes during this critical transition period. Santos et al. (2001a, 2001b) fed first lactation and older dairy cows three different diets: two based on conventional corn silage and one based on BMR corn silage. Forage to concentrate ratio was fixed at 55:45 or 65:45 on the conventional silage diets and was set at a 65:45 ratio for the BMR-based diet. The dietary treatments began about 23 days prior to calving and were continued for 33 days after calving. Dry matter intake and health events post calving were similar between treatments, but there was a tendency (P = 0.09) for increased milk yield (+4.8 lbs.) by the aged cows receiving the BMR diet.

Stone et al. (2008) fed BMR corn silage to close-up dry cows for three weeks pre-partum and three weeks post-partum and documented differences in dry matter intake (DMI) and energy corrected milk production. Dry matter intake was increased significantly on the BMR rations by 2.5 lb. pre-calving and 4.4 lb. post-calving. Energy corrected milk for the first 15 weeks of lactation averaged 95.3lbs for cows on the BMR ration and 89.5 lbs. for the control cows. Note, BMR was only fed for the first three weeks postpartum yet provided benefits through the first 15 weeks of lactation, illustrating the benefit of boosting peak milk.

For producers that are interested in trying BMR silage, it may easier to try it first with the transition cows since the required total amount of BMR silage is less than a ton per cow. However, feeding management during the transition is very critical so careful consideration is required as not all dairies are good candidates for more intensive transition cow programs.

Harvest and Feeding Management for Success

1) Grow the BMR silage separately from your main corn silage and store separately.
2) Plan your storage facility based on number of cows to be fed, silage feeding rate, and targeted silage removal rate from storage.
3) Base harvest decision on plant moisture content rather than on milk line location.
4) Use a chop length of ¾ to 1 inches and set processor roller spacing at 2 mm (if processed).
5) Collect feed samples for analysis, and run NDF digestibility and starch digestibility analysis on your silages. Run NDF digestibility on all forages for lactating cows.
6) Test all of your forages for NDF digestibility, using a common laboratory.
7) Target feeding BMR silage to cow groups most likely to respond (high producing cows, transition cows)
8) Have herd nutritionist use dynamic ration formulation software such as CPM or CNCPS to make best use of your highly digestible NDF forage.
9) Use care to avoid over processing forages in TMR mixer wagons.
10) BMR silage stimulates less cud chewing per unit of forage NDF than conventional silage or hays. Plan on feeding more forage fiber and more total ration fiber in the diet.

REFERENCES

Bal, M.A., R.D. Shaver, H. Al-Jobeile, J.G. Coors, and J.G. Lauer. 2000. Corn silage hybrid effect on intake, digestion and milk production by Dairy Cows. J. Dairy Sci. 83: 2849-2858.

Chase, L.E. 2010. Milk production and feed efficiency in dairy cows fed corn silage hybrids varying in fiber digestibility. J. Dairy Sci. Vol 93 (E-Suppl. 1): 755. Abstr.

Chase, L.E. 2011. High forage diets for dairy cattle—how far can we go? Proceedings of Four-State Dairy Nutrition and Management Conference. Dubuque, IA Available on-line: http://www.uwex.edu/ces/dairynutrition/documents/2011proceedings.pdf

der Bedrosian, M. C., L. Kung, Jr., K. E. Nestor, Jr. 2010. The effects of length of storage on the composition and nutritive value of corn silage. J. Dairy Sci. 93 (Suppl. 1):176. Abstr.

Ebling, T. L., and L. Kung. 2004. A comparison of processed conventional corn silage to unprocessed and processed brown midrib corn silage on intake, digestion, and milk production by dairy cows. J. Dairy Sci. 87:2519–2526.

Grant, R and K. Contanch. 2011. Feeding High Forage Diets: Miner Experiences with BMR Corn Silage. Proceedings of Crop Congress at Miner Institute. Chazy, NY Available on-line at: http://www.whminer.com/Outreach/2011%20Crop%20Congress%20Proceedings.pdf

Gencoglu, H., R. Shaver and J. Lauer. 2008. Brown midrib corn silage for lactating dairy cows: a contemporary review. University of Wisconsin. Dairy Science Department. Available online: http://www.uwex.edu/ces/dairynutrition/documents/BMRfeedingtrialreview2008web.pdf

Kung, L. 2011. BMR silage facts, fiction, and real world experience. Virginia State Feed Association and Nutritional Management Conference. Roanoke, VA. Slides available at: http://www.vtdairy.dasc.vt.edu/pub-pres/docs/cow-colleges/2011-cowcollege/20-bmr-kung-slides.pdf

Oba, M. and M. S. Allen. 1999. Effects of brown midrib 3 mutation in corn silage on dry matter intake and productivity of high yielding dairy cows. J. Dairy Sci. 82:135–142.

Oba, M., and M. S. Allen. 2000. Effects of brown midrib 3 mutation in corn silage on productivity of dairy cows fed two concentrations of dietary neutral detergent fiber: 1. Feed behavior and nutrient utilization. J. Dairy Sci. 83:1333–1341.

Santos, H.H.B., V.R. Moreira, Z. Wu and L.D. Satter. 2001a. Brown midrib-3 corn silage as the major forage for transition cows. J. Dairy Sci. 84 (Suppl. 1):346. Abstr.

Santos, H.H.B., V.R. Moreira, Z. Wu and L.D. Satter. 2001b. Brown Midrib-3 Corn Silage As the Major Forage for Transition Cows. USDA Forage Research Center Update. Available on-line: http://www.ars.usda.gov/research/publications/publications.htm?seq_no_115=128487

Schwab, E.C., R.D. Shaver, K.J. Shinners, J.G. Lauer, and J.G. Coors. 2002. Processing and chop length effects in brown-midrib corn silage on intake, digestion, and milk production by dairy cows. J. Dairy Sci. 85:613–623.

Stone, W.C., L.E. Chase, T.R. Overton, J.L. Lukas, and K.E. Nestor. 2008. Brown midrib silage for transition cows. Proceedings of 70th Annual Cornell Nutrition Conference for Feed Manufacturers.

UNIVERSITY OF IDAHO EXTENSION 2011 SILAGE VARIETY TRIALS

Steven L. Hines[1]

ABSTRACT

In 2011, Idaho producers planted approximately 225,000 acres of corn for silage. In 2009, a corn silage variety trial program was started through the University of Idaho Twin Falls County Extension office. 2011 was the third year of the silage trial program. The data from these trails can be combined with industry data to help producers choose the best corn varieties for their growing conditions and management objectives. The full trial report can be found on the University of Idaho Twin Falls County Extension website.

Keywords: Corn, silage, variety trials, yield, quality

INTRODUCTION

The 2011 corn variety trial was conducted by the University of Idaho Twin Falls County Extension office. The trial location was the University of Idaho Kimberly Research and Extension Center farm located near Kimberly, Idaho. Table 10 lists the silage varieties. Hybrids ranged between 79-109 days relative maturity (RM).

METHODS

The trial was a randomized complete block design with 4 replications. Silage varieties were split into 3 separate trails based on RM (79-90, 92-100, and 102-109). Individual plots for silage were 4-30" rows x 20' in length. The center two rows were harvested and evaluated for yield and quality.

Silage Analysis

Silage quality analysis was determined by NIRS (Near Infrared Spectral) analysis and wet chemistry on a composite sample of fresh silage by first combining a subsample from each individual varietal replication and then selecting a sample for analysis. The quality traits are:

1. IVTD 24 hr= In vitro digestible dry matter. A measure of digestibility at 24 hrs in the rumen. Higher value is more desirable
2. CP= Crude protein. Higher protein levels indicate less need for more expensive supplements in the ration
3. TDN=Total Digestible Nutrients. The sum of the digestible protein, digestible non-fiber carbohydrates, digestible NDF and 2.25X the digestible fat.
4. ADF= Acid detergent fiber. As measure of the less digestible components in the forage. Lower is more desirable. Higher ADF values are generally related to more mature plants.
5. NDF= Neutral detergent fiber. A measure of the fiber content of the silage. Relates to intake level in livestock. Lower values are more desirable.
6. Starch= Starch. A measure of the energy portion of the silage. Higher is more desirable.
7. NFC=Non-fiber carbohydrates. Non-cell wall carbohydrates consisting of starch, sugar, pectin and fermentation acids that serve as energy sources for the animal.
8. NEL= Net energy for lactation. An energy measurement used in estimating amount of energy available for milk production. Higher is more desirable.

---

[1] S. Hines, Extension Educator, University of Idaho, Twin Falls County Extension, 246 3rd Ave E., Twin Falls, ID 83301. Presented at the Idaho Alfalfa and Forage Conference, 1-2 March, 2012.

Agronomic Information

The field is located approximately 1 ½ miles north east of Kimberly Idaho. Soils are Portneuf silt loam and Bahem silt loam. The farm is approximately 3880 feet in elevation. Irrigation is by furrow application. The trials followed a sorgum-sudan grass green manure crop. The trials were amended with 450 lbs/acre 46-0-0. No additional phosphorus or potassium was added. Surpass was applied at the rate of 2 pts/acre pre plant incorporated. No additional herbicides were used in the trials. No insecticides were used. The plots were planted May 13th with an Almaco Twin Plate 2 vacuum planter. Silage varieties were harvested with a John Deere #35 two row forage harvester and weighed. Spider mite infestations became heavy in August. Late in the season aphids were very evident across the trials. Very few western corn root worm adults, *Diabrotica virgifera virgifera*, were observed. Black bird feeding was severe on the 79 and 85 day RM varieties. That feeding damage is evident in the quality results in the silage starch. Early maturing sweet corn was planted around the borders of the trial. The sweet corn attracted much of the feeding away from the trials and bird damage was less severe than in previous years. The summer of 2011 started off cool and corn throughout the region was two to three weeks behind the normal growth schedule. The month of May was well below the 10 year average of base 50 growing degree days (GDD's). June was slightly below normal but the months of July -September were hot and above the average for GDD's. The 79-90 and 92-100 day RM plots were harvested September 29th and accumulated 2033 growing degree days (GDD), base 50. The remaining silage plots, 102-107 RM, were harvested on October 4th and accumulated 2122 GDDs.

RESULTS

Silage samples were analyzed fresh. Starch and In vitro 24 hr digestibility was not available on the wet chemistry standard test and values are not given for those in the tables below. The varieties are ranked by milk lbs/acre based on NIRS data in tables 2, 5 and 8. The wet chemistry data is in the tables 3, 6, and 9 following the respective NIRS data. The quality results for silage were not replicated and thus no comparative statistics are shown for quality. Many factors influence yield and quality of a given crop and these results are given for comparison only. Actual production results will vary. NIRS analysis was completed by GHC Consulting of Filer, ID and wet chemistry analysis was completed by CVA Analytical, Maugansville, MD.

Table 1. Yield results for 79-90 RM silage varieties.

Variety	Corrected Yield T/A (32% DM)	Stand Density	Test Means Separation-Yield
MC 4050	37.7	35991	A
FDS HDS 90-22	29.8	31789	B
FDS HDS 85-30	29.1	25538	B
Eur X1058	27.4	29956	B
Eur X1098	26.6	33621	B
Mean	30.1	31,379	
LSD (.05)	6.2	6180	
CV%	13.3	12.8	

Table 2. Quality results for 79-90 RM silage varieties **(NIR).**

Treatment	Moisture Corrected Yield 32%	Crude Protein % DM	TDN %DM	ADF %DM	NDF %DM	Starch % DM	Non Fiber CHO % DM	NEL Mcal/lb	Milk lbs/acre
MC 4050	38	6.8	67.0	24.0	40.8	36.4	46.0	0.70	45695
FDS HDS 85-30	29	8.0	69.0	21.9	35.9	35.6	48.1	0.73	35208
FDS HDS 90-22	30	8.6	66.0	24.5	42.4	25.6	44.5	0.74	34214
Eur 1098	27	7.4	64.0	26.9	43.1	27.0	41.3	0.65	28619
Eur 1058	27	7.4	59.0	26.5	41.7	24.2	44.0	0.61	28567

Quality results not replicated. Only ranked by milk lbs/acre

Table 3. Quality results for 79-90 RM silage varieties **(Wet Chemistry).**

Treatment	Relative Maturity	Harvest Moisture %	Moisture Corrected Yield 32%	Crude Protein % DM	TDN %DM	ADF %DM	NDF %DM	Non Fiber CHO % DM	NEL Mcal/lb
MC 4050	90	63	38	6.3	70.8	23.9	38.3	47.1	0.74
FDS HDS 85-30	85	67	29	7.0	71.4	23.0	34.3	50.4	0.74
FDS HDS 90-22	90	68	30	5.8	69.0	25.1	38.9	46.2	0.72
Eur 1098	79	67	27	7.1	67.4	25.3	40.5	42.3	0.70
Eur 1058	85	64	27	6.9	68.0	25.0	41.3	42.8	0.71

Table 4. Yield results for 92-100 RM silage varieties**.**

Variety	Corrected Yield T/A (32% DM)	Stand Density	Test Means Separation-Yield
Eur X1031	29.3	32974	A
MC 4280	29.1	33513	A
MC 4560	28.3	29525	A
Eur ES 7201	26.8	31681	A
DL Stealth 3195Q	25.2	32112	A B
FDS HDS 95-90*	18.5	14655	B
Mean	26.2	29077	
LSD (.05)	7.2	4973	
CV%	18.2	11.4	

*organic variety w/ no seed treatments

Table 5. Quality results for 92-100 RM silage varieties **(NIR).**

Treatment	Moisture Corrected Yield 32%	Crude Protein % DM	TDN %DM	ADF %DM	NDF %DM	Starch % DM	Non Fiber CHO % DM	NEL Mcal/lb	Milk lbs/acre
Eur X1031	29	7.7	70.0	24.7	41.6	31.7	44.4	0.72	33510
MC 4280	29	7.3	64.0	24.8	40.4	27.9	44.6	0.67	32280
MC 4560	28	7.5	65.0	24.4	40.7	28.3	45.0	0.67	31000
DL Stealth 3195Q	25	6.9	68.0	26.1	44.1	29.5	42.8	0.70	29015
Eur ES 7201	27	7.3	62.0	26.7	42.5	25.1	43.7	0.64	25637
FDS HD 95-90	19	7.7	68.0	23.3	38.8	30.4	47.2	0.72	21171

Quality results not replicated. Only ranked by milk lbs/acre

Table 6. Quality results for 92-100 RM silage varieties **(Wet Chemistry).**

Treatment	Relative Maturity	Harvest Moisture %	Moisture Corrected Yield 32%	Crude Protein % DM	TDN %DM	ADF %DM	NDF %DM	Non Fiber CHO % DM	NEL Mcal/lb
Eur X1031	99	68	29	6.3	70.2	25.3	39.4	46.4	0.73
MC 4280	92	67	29	6.4	70.4	25.1	39.0	46.2	0.73
MC 4560	95	67	28	6.3	71.1	23.5	38.8	47.3	0.74
DL Stealth 3195Q	95	67	25	6.0	68.2	26.6	42.8	42.6	0.71
Eur ES 7201	100	70	27	5.7	69.9	24.9	40.4	46.2	0.73
FDS HD 95-90	95	68	19	7.0	72.3	22.0	37.9	48.2	0.75

Table 7. Yield results for 102-109 RM silage varieties.

Variety	Corrected Yield T/A (32% DM)	Stand Density	Test Means Separation-Yield
Eur X1151	35.2	35021	A
MC 5250	34.3	34375	A
MC 527	32.5	33297	A
FDS HDS 102-44	31.8	28987	A
DL Hi DF 3702-9	31.4	33405	A
Eur X1190	31.3	36099	A
Eur X9049	30.3	33836	A
Eur X1050	29.6	37392	A
MC 535	29.6	34698	A
Mean	31.8	34123	
LSD (.05)	5.6	2291.5	
CV%	12.2	4.6	

Table 8. Quality results for 102-109 RM silage varieties **(NIR).**

Treatment	Moisture Corrected Yield 32%	Crude Protein % DM	TDN %DM	ADF %DM	NDF %DM	Starch % DM	Non Fiber CHO % DM	NEL Mcal/lb	Milk lbs/acre
MC 5250	34	6.3	72.0	22.3	37.6	37.9	50.2	0.76	39930
Eur X1151	36	6.6	66.0	23.2	40.7	30.4	46.9	0.68	37778
FDS HDS 102-44	32	6.2	70.0	23.5	39.7	34.8	47.1	0.73	36198
MC 527	33	6.6	68.0	23.8	40.7	33.0	45.2	0.70	35996
Eur X1190	31	6.3	66.0	25.3	41.7	30.3	46.1	0.68	34608
Eur X1050	30	6.5	26.2	41.9	40.4	29.0	45.6	0.67	31508
DL Hi DF 3702-9	31	6.8	67.0	24.3	41.4	31.0	44.8	0.70	31474
Eur X9049	30	6.9	66.0	23.3	38.8	31.6	48.8	0.69	31122
MC 535	30	6.4	67.0	23.8	39.6	31.6	47.1	0.70	31033

Quality results not replicated. Only ranked by milk lbs/acre

Table 9. Quality results for 102-109 RM silage varieties **(Wet Chemistry).**

Treatment	Relative Maturity	Harvest Moisture %	Moisture Corrected yield 32%	Crude Protein % DM	TDN %DM	ADF %DM	NDF %DM	Non Fiber CHO % DM	NEL Mcal/lb
MC 5250	102	68	34	5.6	71.4	23.3	37.9	48.9	0.74
Eur X1151	109	70	36	6.0	70.6	24.4	39.7	47.4	0.73
FDS HDS 102-44	102	69	32	5.6	71.2	25.2	39.6	47.7	0.74
MC 527	105	70	33	6.0	70.5	24.8	38.2	47.9	0.73
Eur X1190	104	67	31	5.6	69.6	25.0	39.9	46.3	0.72
Eur X1050	106	69	30	5.5	68.7	26.9	43.0	43.2	0.71
DL Hi DF 3702-9	102	72	31	6.9	70.0	26.0	40.7	44.7	0.73
Eur X9049	106	70	30	6.1	71.6	24.8	38.4	48.7	0.75
MC 535	107	71	30	5.7	70.1	25.0	40.0	46.5	0.73

SUMMARY

The 2011 University of Idaho silage trials yielded above the regional average of 25 T/A. The five highest yielding varieties in the trial were Masters Choice 4050 yielding 37.7 T/A, Eureka X1151 yielding 35.2 T/A, Masters Choice 5250 yielding 34.3 T/A, Masters Choice 527 yielding 32.5 T/A, and Foundation Direct Seed HDS 102-44 yielding 31.8 T/A. The top five varieties for average milk/acre were Masters Choice 4050 at 45,695, Masters Choice 5250 at 39,930, Eureka at 37,778, Foundation Direct Seed HDS 102-44 at 36,198, and Masters Choice 527 at 35,996.

Table 10. Index of silage varieties.

Variety*	RM
Eur 1098	79
Eur 1058	85
FDS 85-30	85
FDS 90-22	90
MC 4050	90
MC 4280	92
DL 3195	95
FDS 95-90	95
MC 4560	95
Eur 1031	99
Eur ES 7201	100
DL Hi DF 3702-9	102
FDS 102-44	102
MC 5250	102
Eur 1190	104
MC 527	105
Eur 1050	106
Eur 9049	106
MC 535	107
Eur 1151	109

DL= Dairyland Seed Company
DKC= DeKalb-Monsanto Company
Eur= Eureka Seed
FDS= Foundation Direct Seed
MC= Masters Choice

Acknowledgements:
Glenn Shewmaker-University of Idaho, Extension Forage Specialist
Bradford Brown- University of Idaho, Extension Crop Management Specialist
Farm Crew-University of Idaho, Kimberly Research and Extension Center
Megan Satterwhite-University of Idaho, Scientific Aide

To enrich education through diversity the University of Idaho is an equal opportunity/affirmative action employer and educational institution. University of Idaho and U.S. Department of Agriculture Cooperating.

PLANT TOXINS THAT CONTAMINATE HAY AND OTHER PREPARED FEEDS IN THE WESTERN UNITED STATES

Bryan L. Stegelmeier[1]

ABSTRACT AND INTRODUCTION

Livestock poisoning by toxic plants is a relatively common problem in pastures and rangelands and it has been estimated to cost the animal industry more than 200 million dollars annually.[1] When adequate and acceptable alternative forages are available, grazing livestock generally avoid eating poisonous plants. However, feeding pressure, palatability and subsequent poisonings are much different when toxic plants that contaminate prepared and stored feeds. Alternatively, some forages, that are generally safe, can, under certain conditions, produce and accumulate toxins. Both toxic plants and other plant associated toxins can result in costly disease and reduced production. Contaminated forages may result in additional much larger economic losses due to decreased product quality and loss domestic and international markets. Identifying toxic plants and recognizing when forages may be toxic is essential in avoiding these problems. The objectives of this review are to introduce several toxins and poisonous plants that are likely to contaminate feed in the western United States; to identify the conditions when feeds are likely to be contaminated; and to outline how to collect, identify and analyze forage for samples to ensure the quality and safety of prepared and stored forages.

Sampling and Plant Identification

Hays and other forages are most often contaminated with poisonous plant when undesirable plant populations expand, invade pastures and fields, and are harvested with the desired forage. These plants are weedy in nature, their growth is not uniform, and the subsequent contamination is patchy. Additionally, the nature of harvesting and storing forages smashes, fractures and cooks fragile plant parts resulting in destruction of many of the characteristic plant structures that are essential for identification. To overcome these problems, adequate sampling is essential. Multiple samples may need to be examined to identify the 4 or 5 contaminated bales from a field of hay.

In most circumstances preemptive or preventative measures are most effective. Identifying poisonous plants in the field, before the forage is harvested and processed, is relatively easily. Certainly knowing all potentially toxic plants can be challenging. Local extension agents and veterinarians are good sources as they are often familiar with local plants and problems. Unknown plants may be collected and sent to a local laboratory, plant taxonomist or herbarium. Positive identification is more likely if an entire plant is submitted. Flowers and seed pods are often essential for making a definitive identification. If a local herbarium is not available, the sample should be dried and pressed by placing it between newspapers pressed down under a couple of large books for two to three days. The plant can then be taped to a piece of cardboard, or placed in a folder, and mailed to the appropriate laboratory (see Table 1).

Some plants, even within the same species, may or may not be poisonous as the types of toxins and their concentrations vary. Such plants might need to be analyzed chemically to confirm they present a risk. For chemical analysis potentially toxic plants can be collected green and frozen, if they can be maintained frozen until analysis. If that is not possible, most plants can be dried before shipment. Forages that have the potential to become toxic can easily be sampled and analyzed. As these toxins may also not be relatively homogenously distributed throughout the feed, numerous representative samples will need to be

[1] B.L. Stegelmeier, DVM, PhD Diplomat ACVP, USDA/ARS Poisonous Plant Research Laboratory, 1150 East 1400 North, Logan UT 84341; Telephone: 435-752-2941, Email: bryan.stegelmeier@ars.usda.gov, Internet Page: www.pprl.ars.usda.gov

analyzed. Most laboratories have specific submission requirements and it is best to check with them to ensure the submission is complete, collected and shipped properly, and that the laboratory will be ready to receive the package (see Table 2).

Table 1: List of potential references and resources

	Phone Number	Web Page
Local Extension Agent		http://www.csrees.usda.gov/Extension
USDA/ARS Poisonous Plant Research Laboratory	435-752-2941	http://www.pprl.ars.usda.gov
State Animal Disease Diagnostic Laboratory		http://www.aavld.org/mc/page.do?sitePageId=33930&orgId=aavld (Laboratories Accredited by American Association of Veterinary Diagnostic Laboratories)
Local Herbarium		http://herba.msu.ru/mirrors/www.helsinki.fi/kmus/botmus.html (List of public herbaria throughout the world)
Microscopic analysis of feces and ingesta to detect toxic plant parts- Texas Veterinary Medical Diagnostic Laboratories	888-646-5623	http://tvmdlweb.tamu.edu

Diagnosis of Poisoned Livestock

If animals are poisoned, clinical studies and post mortem examination if any die are essential to obtain a definitive diagnosis. As many nutritional, genetic and infectious diseases can cause clinical diseases and lesions similar to those produced by toxic plants, collection of appropriate samples for chemical analysis and microscopic analysis that are often essential to identify the actual cause. (see Tables 1 and 2). Consulting and collaboration with local veterinarians and animal diagnostic laboratories is essential to make the proper sample collection, preservation and submission. For example, the ocular fluid is relatively protected within the sclera and other eye tissues so that it changes very slowly after the animal dies. Subsequently elevated ocular nitrates are excellent post mortem indicators of plant-associated nitrate poisoning. Sometimes it is difficult to obtain a definite diagnosis, but these post moretem investigations are still useful as they can be used to generate a list of potential causes. This with local field studies can be used to identify the most likely cause. Then appropriate action can be taken to avoid future problems or minimize the impact of that particular toxic plant.

Table 2: Partial list of tests, samples, sample size and preferred method of shipping for investigation of potential poisoning by plant toxins.*

Test	Sample	Size	Shipping
Blood counts	EDTA containing blood tube (often a purple topped tube)	3-5 ml	Chilled shipped on ice
Serum biochemistries	Clot tube (often a red-topped tube)- contains no anticoagulant. The serum is separated from the cellular portions after clotting.	5-10 ml	Chilled on ice or frozen for extended delievery
Microscopic evaluation of tissues	Various tissues (liver, heart, lung, kidney, GI tract, brain, and any lesions)	2X2X4 cm pieces	Fixed in formalin
Post mortem or necropsy	Dead or moribund animal	Whole animal	Fresh
Chemical evaluation of serum, blood, eye fluid, urine or milk	Serum, whole blood, urine or milk. The whole eye is the best sample to send if nitrate poisoning is suspected.	20 ml	Stored in tubes or plastic bags and shipped on ice or frozen
Chemical evaluation of tissue	Various tissues	2X2X4 cm pieces	Stored in plastic bags and shipped frozen
Chemical evaluation of feces or gastrointestinal contents	Feces or ingesta	1 kg (about a sandwich bag full)	Stored in plastic bags and shipped frozen
Plant identification	Whole plant	Whole plant including flowers, pods, leaves, stems and roots	Fresh if delivered that day, dried if hand delivered later, pressed and dried if sent through the mail
Plant chemical analysis	Whole plants	5 or 6 whole plants	Fresh if delivered that day, dried if mailed or frozen if they can be maintained frozen during shipping
Hay for weed contamination and weed identification	Stored baled hay	5 or 6 bales	Dry
Hay for nitrate analysis	Hay	Several representative samples. These can be core samples. 0.5-1 kg	Dry
Prepared feeds	Feeds	Representative feed samples such as cubed feed, 0.5-1 kg	Dry
Silage or green chopped feed	Feeds	Representative feed samples- 3-5 kg	Frozen

***Be sure to check with the laboratory as they often require specific sampling, sample preparation and shipping. Label all materials with indelible ink; provide date, owner, location and contact information.**

Specific Poisonous Plants and Plant Associated Toxins

The following are some of the most common toxins and poisonous plants that commonly contaminate feeds and are likely to cause problems in the western United States. Additional texts, reviews and web pages contain additional information on these and other toxic plant problems.[2,3]

<u>Bloat and Rumen Acidosis:</u> Bloat is probably the most common fatal result of plant poisoning. It is a common name for increased rumen pressure or tympany and it probably the most common plant

associated toxicity relating to prepared feeds. Bloat has various causes, but the type associated with lush green forages is commonly called frothy bloat. Common plants that are commonly associated with bloat include alfalfa, ladino clover, red and white clover, green cereal crops, rape, kale and others that contain soluble and quickly digested protein, saponins and hemicelluloses. These compounds that are speculated to alter rumen surface tension and stabilize surface foam.[4] Other tannin containing legumes such as sainfoin, crown vetch, milk vetch, fenugreek, and birdsfoot trefoil have similar proteins, but they are more slowly digested and rarely cause bloat.[5] Recently much work has been done to develop bloat resistant cultivars of desirable species to minimize the incidence and severity of this disease. Bloat is most often seen when animals are allowed to graze rapidly growing lush pastures, but it can also been seen when animals are fed high quality hay. Frothy bloat can also been seen in animals fed grain diets. The cause in these cases is probably related to both rapid fermentation, acidosis, and microbial production of foam stabilizing compounds.[6]

Clinically bloat is seen as marked distension of the abdomen with prominent rumen distension seen in the left paralumbar fossa. This distension and pressure results in dyspnea (labored breathing) seen as grunting and open mouthed breathing, extension of the neck, and regurgitation of rumen contents. If untreated, most animals quickly die. Death may occur within an hour of exposure, but most cases develop within three to four hours of exposure. Emergency treatment is to relieve the pressure via a trocar, cannula, or rumenotomy. In less severe cases rumen pressure can be relieved using a stomach tube. Antifoaming agents such as vegetable and mineral oils with various surfactants such as poloxalene are commonly used. Preventing bloat is difficult and most strategies only reduce the incidence. Supplemental feeding, mixed seeding, and strip grazing can be used to limit the doses of quickly growing legumes to less than 30% of the diet. Antifoaming agents mixed with minerals can be used to reduce the risk. Timed release rumen capsules containing ionophores are also helpful.

Rumen acidosis is a complex disease involving the interaction of feed and rumen microflora. Simplistically it results when forages or mixed rations include quickly fermentable carbohydrates causing expansion of fermenting rumen microflora, production of lactic acid, and subsequent damage to the rumen mucosal structure and function. Many cases are fatal and non-fatal animal may develop secondary septicemia and hepatic abscessation. Treatment is symptomatic and most poisoning can be avoided by controlling feed rations, allowing cattle time to adapt to concentrate rations, and the use of ionophores and antibiotics to modulate rumen microflora.[7]

Nitrate-nitrite poisoning: Another relatively common toxicity occurs with certain pasture and cultivated forages accumulate toxic concentrations of nitrates. In ruminants nitrates are quickly reduced to nitrite which is absorbed and oxidizes hemoglobin producing methemoglobin. Methemoglobin will not bind oxygen and is nonfunctional. In monogastric animals such as horses the nitrates are not so easily reduced and much higher doses are required to be toxic. Signs of nitrite poisoning include weakness, trembling, brown or cyanotic mucous membranes, dyspnea, brown discolored blood, abortion and death. Poisoning is cumulative and all other potential sources such as water, and feed additives should be considered. Nitrates accumulate in all plant parts but may be especially high in stalks and leaves. Seeds or grains are generally safe. Plants predisposed to accumulate toxic nitrate concentrations (>0.5%) are listed in Table 3 and Figure 1.[8] Nitrate accumulation is provoked by nitrogen fertilization, drought or frost stress and some herbicide treatments. Water may be contaminated with fertilizer, silage-pit or feedlot runoff.

Poisoned animals may be treated with intravenous methylene blue (8 mg/kg in cattle). As methylene blue is rapidly cleared treatment may need to be repeated every 2 hours. Other suggested treatments include oral gavage with mineral oil, antibiotic and vinegar to reduce nitrite production and enhance toxin movement through the gastrointestinal tract. In most cases the animals die quickly precluding treatment. The diagnosis postmortem is best made analyzing the eye for nitrates. The whole globe should be submitted as the nitrates in this tissue are slow to be altered by autolysis and saprophytic bacteria (see Table 2).

Nitrate poisoning can be prevented by recognizing crops, weeds, and forages that are likely to accumulate nitrates and avoiding contact with susceptible species. Forage nitrate concentration of >0.5% and water concentrations >200 ppm should be considered dangerous. Contaminated forages can still be used if they are diluted with good feed or fed to less susceptible species.

Table 3: Partial list of plants predisposed to accumulate toxic nitrate concentrations (>0.5%) that may contaminate hay and prepared forages.[8]

Sudan grass (*Sorghum bicolor)*	Fescue (*Festuca* spp.)	Dock (*Rumex cripus)*
Johnson grass (***Sorghum halepense)***	**Alfalfa (*Medicago sativa)***	**Nightshade (*Solanum* spp.)**
Sorghum (***Sorghum* spp.)**	**Sweet clover (*Melilotus officinalis)***	**Soybean (*Glycine max)***
Fireweed (*Kochia scoparia)*	Flax and linseed (*Linum* spp.)	Pigweed (*Amaranthus* spp.)
Beets (*Beta* spp.)	Lambsquarter (*Chenospdium album)*	
Rape (*Brassica* spp.)	Canadian thistle (*Cirsium arvense)*	
Corn (*Zea* spp.)	Jimson weed (*Datura stramonium)*	
Rye (*Secale cereal)*	Wild sunflower (*Helianthus* spp.)	
Wheat (*Triticum* spp.)	Cheeseweed (*Malva parviflora)*	
Oats (*Arena sativa)*	Smartweed (*Polygonum* spp.)	

Pyrrolizidine alkaloid (PA) containing plants: This group of plants is large and distributed worldwide where it includes over 6000 species that may contain over 650 different toxins. In the United States the list is shorter, but PA containing plants can be found in every state. As a group they are not very palatable, but when they are included in hay or other prepared forages, they are readily accepted and eaten. The PA toxins primarily damage the liver, resulting in non-specific but suggestive histological changes (liver necrosis, fibrosis, biliary hyperplasia and megalocytosis). These lesions are dependent on the dose and duration of poisoning. High doses produce extensive damage or necrosis of the liver. This is seen clinically as acute liver failure with jaundice (icterus), coagulopathy and hepatic encephalopathy. Lower doses are more common and also damage the liver. However, in these cases the liver damage is less severe, but often results in compromised animals with reduced hepatic function. Such animals may decompensate and develop clinical liver disease months and even years after the initial exposure. Clinical disease in these animals includes icterus, photosensitivity, weight loss and poor production. Such liver failure is often precipitated by a stressful event such as pregnancy, lactation, poor nutrition or bad weather. This delayed onset of disease complicates diagnosis as the causative contaminated feed is gone and cannot be examined.

Most PA containing plants are invasive noxious weeds of varying toxicity making it difficult to predict the risk and the extent or effect of poisoning. Animal and individual susceptibility to poisoning also differs. Horses and cattle are more susceptible than sheep and goats. Young animals are often much more susceptible than mature animals and there are reports of transmammary neonatal poisoning without clinical of maternal toxicity.[9] Selected PA containing plants (Table 4), include hound's tongue (*Cynoglossum officinale*- Figure 2*)*, and several different *Senecio* species (See tansy ragwort- *Senecio jacobea*- Figure 3). PA containing plants are the poisonous plant most likely to contaminate grain and herbal products. Consequently human poisonings and deaths have been reported.[10] PA containing plants remain toxic in prepared feeds and food with minimal degradation in most ensiling processes.[11] Cereals products can be contaminated by dust alone when they are co-harvested with PA containing plants. PAs have also been identified in honey, milk and animal tissues.[12]

As most animals that develop clinical disease die, treatment of poisoned animals is limited. Though little is known about sub-clinically poisoned animals, it is speculated that they have permanent loss of hepatic function and are not likely to perform to their full potential. Consequently avoiding exposure is the suggested treatment. As with many other toxic plants, the best way to ensure feed quality is to inspect the fields for invasion by these plants prior to harvest.

Table 4: Partial list of pyrrolizidine alkaloid containing plants that have poisoned livestock and may contaminate hay and prepared forages.[12]

Senecio douglasii var. longilobus	Woody groundsel
S. glabellus	Butterweed
S. intergerrium	Lamb's tongue groundsel
S. jacobaea	Tansy ragwort
S. plattensis	Prairie ragwort
S. riddellii	Ridell's ragwort
S. spartioides	Broom groundsel
S. vulgaris	Common groundsel
Crotalaria retusa	Wedge leaf rattlebox
C. sagittalis	Rattlebox
C. spectabilis	Showy crotalaria or rattlebox
Amsinckia intermedia	Fiddleneck, tarweed
Cynoglossum officinale	Hound's tongue
Echium vulgare	Blue weed, Viper's bugloss
Symphytum officinale	Comfrey

Poison hemlock- *Conium maculatum*: Poison hemlock (Figure 4) is an introduced biennial or perennial plant that grows along roads, ditches and fences. It commonly invades into adjacent fields and pastures. Animals most often avoid eating poison hemlock unless there are no other forages available. The toxins (conine and gamma-coniceine) affect poisoned animals similarly to nicotine, causing muscle tremors, salivation, incoordination, dyspnea, increased defecation and urination and death. If not acutely fatal, abortions and birth defects also occur.

The leaves and stems are toxic and may contaminate hay and silage. The seeds are highly toxic and can contaminate cereal grains. Fortunately, these toxins are not as stable as many other plant toxins and they degrade over several months in most hay and prepared feeds. However, this degradation may not be uniform, resulting in some portions of the prepared feed having residual toxicity. Nearly always the fresh plant material is uniformly toxic and most poisonings occur when animals are fed contaminated fresh, chopped forages.[13]

There are no specific treatments for poison hemlock poisoning and most animals recover if they are removed from the source of the toxins and allowed to recover with minimal stress. Supportive care might include a cathartic or administration of activated charcoal to minimize absorption.

Black nightshade *(Solanum nigrum)*, jimson weed (*Datura stramonium)* and henbane (*Hyoscyamus niger)*: Black nightshade (Figure 5) is found along fences and roads throughout North America. It contains several glycoalkaloids, including solanine, hyoscine and hyoscamine. These toxins are similar to atropine and alter the function of the autonomic nervous system. Consequently they alter salivation and decrease gastrointestinal motility. Under some conditions this can result in epidemic incidences of colic. Similar problems have been documented to occur when grains contaminated with jimson weed seeds were fed to horses in the Midwest.[14] Nightshade toxins are stable and if they are included in forages they remain toxic. They are especially bothersome to the racehorse industry as these toxins can cross react in the drug screens that are used test race horses. In most of these cases, identifying contaminating plants in feeds is difficult. Consequently, such false positives usually result in disqualification of those animals.[15]

Henbane is a noxious weed that also grows along fences, roadsides and waterways. It can invade fields and pastures and can contaminate hay and other prepared forages. The henbane toxins (hypscyamine, hyoscine and atropine) are similar to those in black nightshade and jimson weed, so cause similar diseases to these plants. Henbane is generally not palatable unless it is included in prepared forages.

Milkweeds (*Asclepias* spp.) and other cardiac glycoside containing plants: Milkweeds (Figure 6) can be found throughout the world as they grow along roadsides, waterways and in disturbed areas. Most species contain cardenolides or cardiac glycosides, but the concentrations of these vary between the species and plants. These toxins are similar to digoxin (the toxin in foxglove, *Digitalis lannata*) that is widely used to treat congestive heart failure. Cardenolides inhibit the sodium-potassium pumps on myocardial membranes resulting in altered conduction and contractility. Similar toxins can also be found in oleander (*Nerium oleander*), lily of the valley (*Convallaria majalis),* dogbane or Indian hemp (*Apocynum cannabinum),* and pheasant's eye (*Adonis microcarpa)).* Milkweeds are most toxic when in the vegetative stage and they remain toxic when included in hay and other forages.

Signs of poisoning are usually sudden death, dyspnea or labored respiration, pulmonary edema, muscular tremors and a weak rapid pulse. As no specific treatment is available in large animals, prevention is essential. As milkweeds tend to grow in small patches they can be manually removed or treated with various herbicides.

Cyanogenic glycosides containing plants: More than 2000 plants throughout the world have been shown to contain cyanogenic glycosides. Only a handful of these have been associated with poisoning in livestock in the Western United States and several of these are often used as chopped green forage and to make hay. Johnson grass (*Sorghum halapense),* Sudan grass (*Sorghum vulgare),* forage sorghums (*Sorghum* spp.), and arrowgrass (*Triglochin* spp. Figure 7) are generally used as hay. Other cyanogenic plants such as chokecherry (*Prunus virginiana* Figure 8) and service berry (*Amelanchier alnifolia)* often grow along fences and field margins and can inadvertently be included.

To be toxic cyanogenic glycosides must be hydrolyzed to cyanide or prussic acid. This conversion is facilitated when the plant is damaged as by crushing, chewing, freezing, or wilting. Drying or ensiling the plants decreases the cyanogenic potential as the cyanide is slowly degraded and released over time. The concentration of cyanogenic glycosides in plants varies and can be higher in young plants growing rapidly in cold moist weather; when heavily fertilized; when frosted or drought stressed; or when the plants are treated with certain herbicides.

Treatment of cyanide poisoning is difficult as most animals quickly die. As cyanide is quickly dissipated from tissues, tissues such as liver, muscle and rumen contents must be collected within a couple of hours of death, frozen in sealed, air tight containers and quickly analyzed. If poisoned animals are found, recommended treatments include intravenous sodium nitrite (22 mg/kg) and sodium thiosulfate (600 mg/kg). These oxidize hemoglobin forming methemoglobin. Methemoglobin avidly binds cyanide protecting the cytochrome oxidase system of cellular respiration from its effects. The best treatment is to avoid harvesting and feeding these plants when they are likely to be toxic. Potential toxic feeds can be tested for their cyanogenic potential.

Russian knapweed (*Rhaponticum repens)* and yellow star thistle (*Centaurea solstitialis*): Russian knapweed (Figure 9*)* and yellow star thistle (Figure 10*)* produce a unique disease that is specific for horses. These plants are both invasive species that grow in disturbed areas, pastures and paddocks throughout the western United States. Though several toxins have been identified and proposed, none have been definitively confirmed as the cause of this disease. This is largely due to the extended duration of exposure that is required to produce the disease. All parts of the plants are toxic and they remain toxic when dried and included in hay. Poisoning is seen after the horses have eaten the plant for between 30 and 60 days. Affected animals lose the ability to prehend and chew food and to drink water. The lesions are degeneration and necrosis of specific locations in the brain known as the substancia nigra and the globus pallidus, resulting in the morphological description of negropallidal encephalomalacia. No other disease or toxin has been shown to have such a site specific effect.

There is no effective treatment for poisoning. Once clinical signs begin, poisoning is nearly always fatal. Affected horses may be treated and maintained with liquids and oral liquid diets, but they do not recover and nearly always continue to deteriorate until they must be euthanized. [16] The best treatment is management to control the plants to minimize exposure and prevent them from contaminating forages.

SUMMARY

Many poisonous plants remain toxic and can poison animals when they are included in hay or prepared feeds. Hay fields should be closely inspected and potentially poisonous plants should be excluded from harvesting. Other, presumably safe, forages may accumulate saponins, highly soluble carbohydrates, nitrates or cyanogenic glycosides and this potential should be recognized. Such forage may be tested and treated accordingly to minimize the risk of poisoning.

REFERENCES

James LF, Ralphs MH, Nielsen DB. *The ecology and economic impact of poisonous plants on livestock production.* Boulder: Westview Press, 1988.

Knight AP, Walter RG. *A Guide to Plant Poisoning of Animals in North America.* Jackson WY: Teton NewMedia, 2001.

Burrows GE, Tyrl RJ. *Toxic Plants of North America.* Iowa State Press, 2001.

Kahn C, Line S, Atello S: 2011, Bloat (Ruminal Tympany). *In*: *The Merck Veterinary Manual,* ed. Anonymous. 10th ed., pp. 205-209. Kendallville IN: Courier Kendallville Inc.

Lees GL: 1992, Condensed tannins in some forage legumes: their role in the prevention of ruminant pasture bloat. *Basic Life Sciences* 59:915-934.

Cheng KJ, McAllister TA, Popp JD, et al.: 1998, A review of bloat in feedlot cattle 1. *J Anim Sci* 76(1):299-308.

Underwood WJ: 1992, Rumen lactic acidosis .1. epidemiology and pathophysiology. *Compend Cont Educ Pract Vet* 14(8):1127.

Burrows GE, Tyrl RJ: 1989, Plants causing sudden death in livestock. *Veterinary Clinics of North America - Food Animal Practice* 5(2):263-289.

Small AC, Kelly WR, Seawright AA, et al.: 1993, Pyrrolizidine alkaloidosis in a two month old foal. *Zentralbl Veterinarmed A* 40(3):213-218.

Huxtable RJ: 1989, Human health implications of pyrrolizidine alkaloids and herbs containing them. *In*: *Toxicants of Plant Origin,* ed. Cheeke PR, ed., pp. 41-86. Boca Raton FA: CRC Press.

Candrian U, Luthy J, Schmid P, et al.: 1984, Stability of pyrrolizidine alkaloids in hay and silage. *Journal of Agricultural and Food Chemistry* 32(4):935-937.

Stegelmeier BL, Edgar JA, Colegate SM, et al.: 1999, Pyrrolizidine alkaloid plants, metabolism and toxicity. *J Nat Toxins* 8(1):95-116.

Panter KE, Keeler RF, Baker DC: 1988, Toxicoses in livestock from the hemlocks (*Conium* and *Cicuta* spp.). *J Anim Sci* 66(9):2407-2413.

Vanderhoff BT, Mosser KH: 1992, Jimson weed toxicity: management of anticholinergic plant ingestion. *American Family Physician* 46(2):526-530.

Respondek F, Lallemand A, Julliand V, et al.: 2006, Urinary excretion of dietary contaminants in horses. *Equine Vet J Suppl*(36):664-667.

Selfero NA, Merlassino JL, Audisio S: 1989, Treatment of *Centaurea solstitialis* poisoning in horses. *Therios* 13(61):42-44.

Figure 1: Kochia (*Kochia scoparia)* is an annual weed originally introduced from Asia. It is a rapidly growing, branching plant, with alternate hairy leaves. It can grow up to 2 m tall and it is commonly found in disturbed areas of fields, pastures and rangelands. In some parts of the world it is used as forage, but in North America it has been associated with liver disease, photosensitivity, polioencephalomalacia, and nitrate poisoning. Other than nitrate poisoning, the toxin or mechanism of toxicity has never been proven for kochia.

Figure 2: Hound's tongue (*Cynoglossum officinale)* is a biennial noxious weed originally from Euroasia that has spread throughout North America. The leaves of the first year rosette are long (40+ cm) and broad, hence the common name. In its second year the plant produces flowering stems that are about 0.5 m tall and topped with reddish purple flowers that ripen into small 8-10 mm nutlets that are coverd with hooked barbs that easily attach to hair and clothing.

Figure 3: Tansy ragwort (*Senecio jacobaea)* is a noxious weed that is a native of the British Isles that has spread into Western Europe, South Africa, Australia, New Zealand and North America. It commonly invades fields and pastures in the Pacific Northwest. In spite of extensive control efforts using chemical and biologic agents, it continues to be a problem. Tansy ragwort is a tall (0.5-1.5 m), erect plant that is unbranched except at the inflorescence. Poisoning occurs when plants contaminate feeds, when grazing animals cannot easily differentiate the early rosette from grasses and clovers, or when no other forages are available. *S. jacobaea* contains six major alkaloids of which several have been shown to cross the placenta and to be secreted in milk.

Figure 4: Poison hemlock (*Conium maculatum)* is an erect biennial that grows up to 2 m tall. Originally from Europe, it now grows throughout North America and it is commonly found along ditches and roads where the ground is moist. The stems are smooth and hollow and they often have purple spots. The leaves are carrot-like, alternate, pinnately dissected and coarsely toothed. The inflorescence is a flat topped umbel with multiple small white flowers.

Figure 5: Black nightshade (*Solanum nigrum)* is a spineless erect or trailing annual plant that grows along fences and roads and on the disturbed margins of fields. It has a small white flower that ripens into a 0.5 to 1 cm round smooth green fruit that contains the toxin, solanine. When the fruits turn black, they are edible.

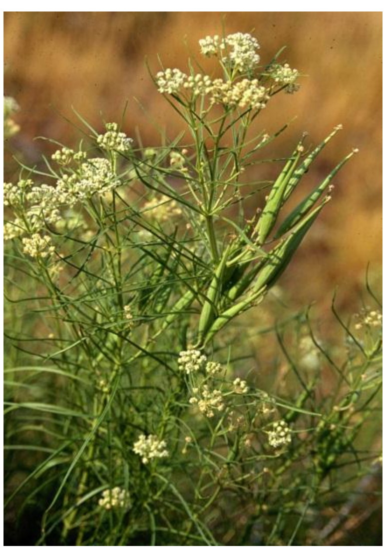

Figure 6: Milkweed (*Asclepias subverticillata)* - Milkweeds are found throughout the world along road, waterways, and in disturbed areas on the margins of fields and pastures. They are erect perennials that generally have broad veined leaves. Most contain milky sap or latex and the flowers are usually terminal umbels colored from greenish white to red.

Figure 7: Chokecherry (*Prunus virginiana)* is a small tree or shrub that grows in thickets and along waterways. It can grow up to 5 m tall and the leaves are ovate to obovate with serrate margins. The bark is grey with obvious lenticles. The inflorescence is a cylindrical raceme of white fragrant flowers that ripen into dark purple round fruits. The fruit is the only edible portion.

Figure 8: Arrowgrass (*Triglochin maritima)* is found throughout North America in moist marshlands and pastures. It is a perennial grass-like plant and the leaves are between 15 and 30 cm long, linear, unjointed and sheathed at the base. The flower is composed of a pediceled raceme that may grow up to 1.5 m tall. The greenish flowers are inconspicuous and ripen into greenish fruitsCyanide is highly toxic to all animals as it inhibits cellular respiration. Affected animals cannot use oxygen and develop "cherry red" tissues and blood. Low, non-lethal doses of cyanide have been associated with lathyrism-like disease, goiter, birth defects such as arthrogryposis, and spinal cord degeneration and cystitis. The mechanism of many of these changes is due to damage to nerve coverings called myelin sheaths.

Figure 9: Russian knapweed (*Centaurea repens)* is a Russian plant that has invaded many parts of the world. It is a perennial erect plant whose branches can grow to about 1 m tall. The leaves are altenate with toothed margins. The thistle like flowers are 1-2 cm in diameter and range from lavender to white. The seeds are white with bristles on one end.

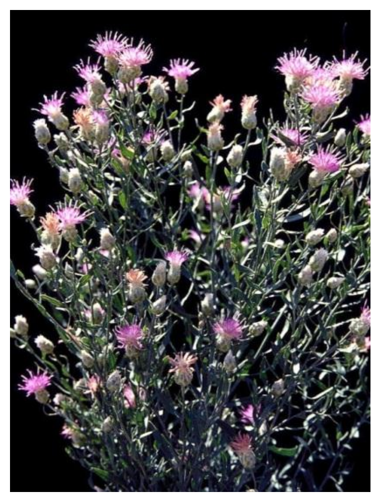

Figure 10: Yellow star thistle (*Centaurea solstitialis)* is a noxious weed from the Mediterranean that is well established in the western United States. It grows in disturbed areas along fields, roads and waste areas. It is an annual branching herbaceous weed that grows about 30 cm tall. The leaves vary from deeply lobed at the base to linear and entire on the stems. The flowers are yellow and the bracts are tipped with stiff yellow spines (10-20 mm).

UNCONVENTIONAL ANNUAL FORAGE YIELD AND QUALITY: EXTENDED GRAZING POTENTIAL

C. L. Falen[1], G. Shewmaker, L.A. Hunter, and S. Hines

ABSTRACT

Annual forages can be used for many purposes in cropping and livestock systems. This article focuses on forage yield and quality of unconventional annual forages and their potential for extending the livestock grazing season. Winter cereals offer good yields and good quality forage options for livestock grazing. Sorghum, sorghum sudangrass, and pearl millet provide higher forage yields. However, turnips, peas, rapeseed (canola), and vetch provide higher quality forage. To start using annual forages for summer and fall grazing, this spring consider planting spring cereals, or spring cereal/vetch. To start this summer, consider planting sorghum sudangrass, teff, pearl millet, vetch/teff or pearl millet, or a rapeseed/teff or pearl millet combination in June. Graze these during the summer, or stockpile in the field for fall/early winter grazing. In late summer, consider turnips or rapeseed/winter cereals for a late fall/early winter grazing, plus grazing the following spring, and potentially again on summer cereal re-growth.

INTRODUCTION

Annual forages can be used for many purposes in cropping and livestock systems. They can be used as the primary harvested feed for livestock, as a rotation crop between alfalfa, as a double crop with cereal grains, as a green manure for nutrients or pest prevention, as a cover crop for erosion or weed control, and/or for extending the grazing season for livestock. The forage species choice will depend on the desired outcome. This article is focused on forage yield and quality of unconventional annual forages and their potential for extending the livestock grazing season.

On-farm evaluations and research trials on forages to extend the grazing season in southern Idaho look promising for: 1) spring grazing of winter cereals; 2) summer and/or fall grazing of sorghum sudangrass, pearl millet, teff, cereals, vetch or rapeseed combinations; and 3) fall/early winter grazing of turnips or rapeseed with stockpiled pasture/pearl millet/cereals combinations. Utilizing cereals, annual forages, stockpiled tall fescue, perennial pasture, and Management-intensive Grazing (MiG) allowed a Lincoln County Idaho producer to nearly triple livestock and farm production on the same acreage, compared to previous management. One forage choice will not fit every operation and each producer will have to choose the practice that makes the most economic sense for their operation.

METHODS

Annual forages were grown at the University of Idaho Kimberly Research and Extension Center under sprinkler irrigation. The forages were planted in mid-June and harvested in early to mid-September during 2010-11. The field is located 1 ½ miles north east of Kimberly, Idaho at approximately 3,380 feet in elevation. The soil is a Portneuf silt loam. A randomized complete block design with four replications was utilized. Individual plots (5 x 30 ft) were planted with a press-wheel drill with double disk openers.

[1]C. Falen, University of Idaho (UI) Extension – Lincoln County, cfalen@uidaho.edu, 208-886-2406.
Published **In**: Proceedings, Idaho Hay and Forage Conference 1-2 March 2012, Burley, Idaho, UI Extension.

Fertilizer applications were determined based on soil analysis. In 2010 50 lb/acre of nitrogen (N) and 40 lb/acre of phosphorous (P) were applied, no potassium (K) was necessary. In 2011 80 lb/acre of nitrogen was applied (50 lb/acre dry and 30 lb/acre through irrigation) and no P or K were necessary. Since the species were very diverse, weed control was problematic. Weed control was done by small sprayers on individual plots where there were chemicals labeled and on border areas. 2,4-D was applied to the oats and corn, and Basagran was applied to the peas. Otherwise hand weeding was required in most of the smaller biomass production forages. Forage yield was determined by hand clipping 2 frames (2 ft^2) per plot, or the entire plot harvested with a sickle bar mower with scales. Frame yields are reported for 2010. Because of weed pressure reduction in the stand in 2011, poor stand forages (canola, hairy vetch, chickling vetch, peas) are reported from frame harvests. Machine yields are reported for the corn, sorghum, SS, millet, cereals, and teff in 2011. Frame samples for each forage were shredded and a composite sample for each forage across all four reps was analyzed. Forage quality was determined by Near Infrared Reflectance Spectroscopy (NIR) or wet chemistry for outliers to the curves by Rock River Lab in Wisconsin.

Partial results from other research and demonstration trials will be utilized in this article for discussion purposes regarding practical applications of unconventional annual forages for extended grazing. The complete methods and details of the other trials will not be included. Winter cereal forages and annual forages have been evaluated on producer fields in Lincoln County under furrow irrigation for livestock grazing. A two year replicated trial on winter cereals (2007-08, 2009-10) was previously completed at the UI Kimberly R & E Center that can also be utilized to evaluate annual forage potential for extended grazing.

RESULTS

Winter Cereal Crops

Natural precipitation reduces irrigation costs and cattle do most of the work to harvest winter cereals grown for forage. To reduce hay costs, producers can look to increasing grazing days on winter cereals during spring, summer or fall. Consider raising and selling alfalfa on more productive farm ground, while using more marginal ground for winter cereals to feed your own livestock.

High feed costs and irrigation shortages negatively impact livestock operator finances. Higher water use and input costs for corn silage and alfalfa necessitate assessment of other forage. In 2008, winter triticale, Willow Creek winter wheat (WCWW) and a beardless winter barley blend were harvested on May 22 and again July 1 for use as silage or hay. WCWW provided a longer interval for grazing, harvesting for hay, or silage, since it did not head out until at least 20 days after triticale.

Relative Feed Value (RFV) has been used historically as an index for pricing and quality assessment of forages. Relative Forage Quality (RFQ) is the newer index that provides a more comprehensive quality evaluation. Barley RFQ was highest in May and July. WCWW and triticale RFQ’s were similar. As forages head out, the quality decreases rapidly. The disadvantage with WCWW was in lower yields when compared to triticale. Beardless barley offered quality advantages, but yields were below those of triticale.

Winter cereals planted the previous fall can be utilized for early spring or mid-summer grazing. Winter cereals harvested in May had RFQ’s ranging from 157 to 199 and when compared to alfalfa cost and forage quality, winter cereals offered cheaper forage (Figure 1). The re-growth in early July ranged from 109-170 RFQ. In July, the 30-hour digestibility was better for WCWW and beardless barley than triticale. The higher the digestibility, the better cattle can obtain needed nutrition. If the re-growth is captured for forage, the only additional cost is a few irrigations.

Winter cereals planted in August could be grazed in the fall, and again in the spring, as well as mixed with turnips or legumes like hairy vetch to increase the forage quality for fall/winter grazing. For very minimal seed costs and a little irrigation water you can have a winter cereal/turnip combination that could extend the grazing season into December.

If winter cereals don't fit your operation, then substitute **spring cereal crops** like oats, beardless barley, or wheat for extended summer and fall grazing.

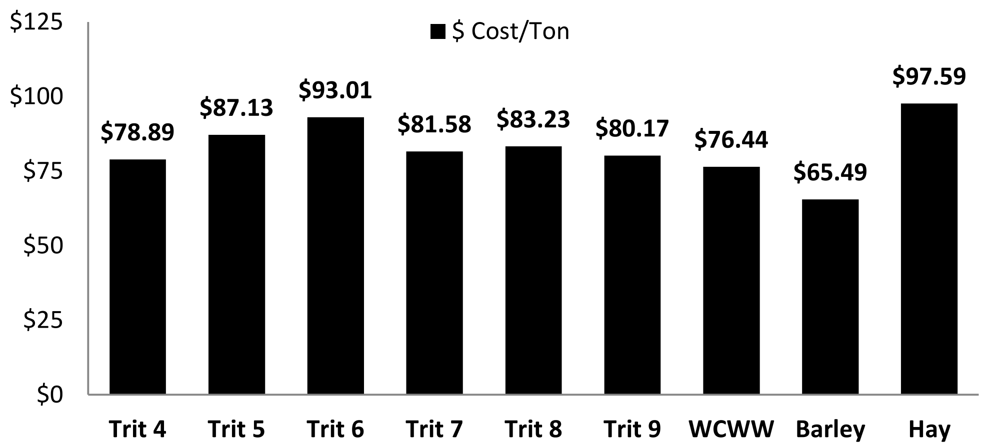

Figure 1. Cost to purchase winter cereal forages compared to alfalfa on May 22, 2008; standardized to 17% crude protein and 143 RFQ (140 RFV). Trit 4-9 = different winter triticale varieties. Feed values will naturally vary as the price of alfalfa hay changes, since that is the base for standardization. Alfalfa Fair Quality prices from 2003-2009 for May ($97.59 100% DM) were averaged and used as the baseline to standardize for value, CP and RFQ.

Warm Season Annuals

Sorghum, sorghum sudangrass (SS), teff and pearl millet show promise for low-cost rotational forage between stands of alfalfa or pasture, as hay, or to stockpile for extending the grazing season. Planted after all danger of frost was past, these warm season forages grew well during hot summer months in southern Idaho. Sorghum sudangrass grew fast and tall and was able to compete well against weeds. The forage yield and quality for 2010-11 are shown in Table 1-3.

The sorghums, SS and pearl millet had good yields in the research trials at Kimberly. In comparison to silage corn, SS, sorghum and pearl millet required minimal N and irrigation for large biomass production. All of these forages yielded higher than the vetch, rapeseed, turnips and peas, however their forage quality was less (Table 2-3). In 2011 the pearl millet, SS and sorghum ranged from 0.31 – 0.35 mcal/lb net energy for gain livestock, and had RFQ's from 114-131 (Table 3). Care must be exercised in monitoring the prussic acid and nitrate content of the sorghum or SS when grazing during the summer, especially if it is stressed, i.e. lack of irrigation. After SS is ensiled, or is frosted in the fall and left in the field, the prussic acid concern for livestock disappears.

Pearl millet can be used for summer, fall or winter grazing. The forage quality is the highest in the vegetative stage before it heads out. The average yield for both years combined at Kimberly was 8.7 tons/acre on a 100% dry matter (DM) basis (Table 1), but the RFQ fluctuated from 131 in 2011 to 79 in 2010. Harvest was done in early to mid-September both years, but the plants were more mature in 2010, hence the forage quality decline. Similar results were observed on a Lincoln County farm where the pearl millet RFQ declined from 175 to 91 in a month, in the same field. Careful attention to repeat grazing when forage quality is high will result in the greatest benefit for livestock weight gain. For this farmer the pearl millet required less fertilizer and water compared to silage corn. It was planted in mid-June after winter triticale and only received small amounts of liquid nitrogen applied through the pivot. The field was planted back to triticale in the fall.

Table 1. Unconventional annual forage yield (100% DM tons/acre) at Kimberly, Idaho in September (planted mid-June). DM = dry matter. Different letters within a column denote statistical difference at p = 0.05 level.

Forage Species	2010		2011		2010-11 Combined	
Special Effort SS WMR			15.7	a		
Grazing corn			11.5	b		
Greentreat Plus sorghum	9.7	a	11.2	b	10.4	a
Cadan SS			10.1	bc		
Bundle King BMR sorghum	11.2	a	8.5	cd	9.9	ab
Pearl millet	9.6	a	7.5	de	8.7	b
Sweeter N Honey sorghum	11.4	a	7.2	def	9.3	ab
Nutri-Plus SS			7.2	def		
Athena winter canola			7.0	defg		
Arvika peas			6.6	defgh		
Oats	5.1	b	6.5	defgh	5.8	c
German foxtail millet			6.2	efghi		
Bonar rapeseed	3.7	bcd	5.3	fghi	4.5	cd
Montech peas			5.1	fghij		
Chickling vetch	4.3	bc	4.9	ghij	4.6	cd
Horse candy teff	3.9	bcd	4.8	hij	4.3	cd
Purple top turnips	2.7	cd	4.6	hij	3.6	de
Tiffany teff	5.1	b	4.3	ij	4.8	cd
Apin turnips	2.8	cd	4.2	ij	3.5	de
Hairy vetch	2.1	d	3.0	j	2.6	e

SS = sorghum sudangrass, BMR = brown mid-rib, WMR = white mid-rib

On another farm, pearl millet was left in the field until December for extended grazing. The pearl millet was strip grazed to reduce trampling by livestock. Pearl millet was chosen because of its limited nitrate and prussic acid poisoning concerns for livestock. The forage stood 5-6 feet tall and stayed upright in the snow. A large biomass of forage (up to 6.7 tons/acre on a 100% DM basis) was produced during a short growing season (June to September). Protein supplements were fed along with pearl millet because the available protein was 4.5%, which was below expectations. Pearl millet RFQ was 135-145 in October and decreased to an RFQ of 58-83 in December. Even with supplement costs, grazing pearl millet was less expensive than feeding hay.

At Kimberly teff had RFQ's ranging from 74-101 (Table 2-3). In farm trials, teff RFQ ranged from 78 to 120. Feed quality decreases with maturity, so harvest timing is important. Repeat harvests are necessary for higher forage quality. Teff provides a viable option for grazing during July and August when cool season grass has slowed due to hot weather. Grazing teff during this time can allow perennial pastures to rest and re-grow.

Table 2. Forage quality at Kimberly, Idaho September 12, 2010 (no statistical analysis can be completed; composite samples for reps).

Forage Species	[1]CP%	[2]ADF %	[3]aNDF%	[4]48 hr Trad. dNDF%.	[5]RFQ	[6]NE Gain Mcal/Lb
Apin Turnips	14.5	25.6	32.9	73.0	223	0.44
Bonar Rapeseed	16.5	25.8	33.2	70.0	215	0.44
Hairy Vetch	19.0	30.7	40.9	55.2	141	0.35
Chickling Vetch	17.2	31.5	41.8	51.2	128	0.33
Tiffany Teff	6.6	42.2	63.4	66.0	101	0.26
Horse Candy Teff	7.7	43.8	65.1	65.6	96	0.23
Green Treat Sorghum	6.2	40.5	71.0	68.3	93	0.21
Sweeter N Honey Sorghum	5.4	34.7	72.4	65.3	86	0.19
Bundle King BMR Sorghum	4.7	34.9	72.7	65.3	85	0.19
Pearl Millet	5.3	39.2	72.9	62.8	79	0.16
Oats	8.9	38.4	67.8	47.3	54	0.05

[1]CP = Crude Protein: AOAC Official Method (CP= Nitrogen X 6.25). Other N conversions are more appropriate for specific protein sources.

[2]ADF = Acid Detergent Fiber: Residue remaining after boiling a forage sample in acid detergent solution. ADF contains cellulose, lignin and silica, but not hemicellulose. AOAC Official method.

[3]aNDF = Amylase-treated Neutral Detergent Fiber: Residue left after boiling sample in neutral detergent solution with amylase. The NDF in forges represents the indigestible and slowly digestible components in plant cell walls (cellulose, hemicellulose, lignin, and ash). AOAC Official Method using both amylase and sodium sulfite.

dNDF = Digestible Neutral Detergent Fiber expressed as %DM: The portion of the neutral detergent fiber digested by animals at a specified level of feed intake, expressed as a percent of the dry matter:

[4]dNDF = NDF X NDF Digestibility: The dNDF of feeds may be determined by in vivo feeding trials or estimated by lignin analysis, in vitro or in situ digestibility, or by near infrared reflectance analysis. Indicate the time (hours) of digestion, e.g. dNDF, 48h.

[5]RFQ = Relative Forage Quality: An index for ranking all forages based on intake of TDN calculated by estimating digestible portions of protein, fatty acids, fiber (NDF), and non fibrous carbohydrate.

Formulas:
RFQ = dIntake potential*dTDN/1.23
Where:
dTDN = TDN (defined below) with NDFD.
dIntake potential for legumes =(120/NDF) + (NDFD-45) *0.374*1350/100
dIntake potential for grasses = $-2.318 + 0.442*CP - 0.0100*CP^2 - 0.0638*TDN + 0.000922*TDN^2 + 0.180*ADF – 0.00196*ADF^2 - 0.00529*CP*ADF$
Digestible fiber should be based on a 48-hr in vitro estimate. The higher the RFQ, the better the quality. It is used to compare varieties, match hay/silage inventories to animals, and to market hay.

[6]2001 Net Energy Gain (NEg in Mcal/Lb): An estimate of the energy value of a feed used for body weight gain above that required for maintenance. 2001 refers to the energy prediction equations in the 2001 Nutrient Requirements of Dairy Cattle, published by the National Research Council

Table 3. Unconventional annual forage quality at Kimberly, Idaho September 6, 2011.

Annual Forage Species	CP%	ADF%	aNDF%	dNDF%	RFQ	Lb Milk/Ton	NE gain Mcal/Lb
Purple top turnips	24.9	20.1	21.4	86.4	372	4013	0.54
Apin turnips	26.0	21.9	23.7	90.7	352	4054	0.53
Montech peas	17.5	23.1	31.5	78.3	262	4276	0.54
Hairy vetch	23.4	28.7	37.0	71.1	211	3537	0.44
Athena winter canola	22.1	25.4	34.7	62.0	201	3339	0.39
Grazing corn	8.3	31.0	51.7	89.3	197	4289	0.51
Arvika peas	16.6	27.8	38.1	68.1	189	3902	0.45
Oats	11.1	28.3	43.1	73.9	189	4277	0.51
Bonar rapeseed	20.5	22.7	32.7	55.5	182	3434	0.37
Chickling vetch	16.8	33.4	43.2	58.3	152	3223	0.35
Pearl millet	9.1	40.2	60.5	75.6	131	3643	0.35
Nutri-Plus SS	8.8	40.5	60.0	74.7	127	3511	0.32
Bundle King BMR Sorghum	8.9	41.4	63.7	76.1	125	3553	0.33
Greentreat Plus Sorghum	7.9	41.4	65.0	75.8	122	3504	0.31
Special Effort SS WMR	7.5	40.9	63.3	71.7	119	3586	0.32
Sweeter N Honey Sorghum	8.4	43.3	64.8	72.7	115	3490	0.30
Cadan SS	7.0	42.7	64.2	70.8	114	3569	0.31
Horse candy teff	8.6	43.8	65.2	65.0	94	3187	0.23
German foxtail millet	7.5	45.0	69.2	63.3	82	2965	0.15
Tiffany Teff	8.2	44.2	70.7	60.0	74	1458	0.14

Table 4. Perennial forage legume quality to compare with annual legumes from Kimberly, Idaho September 22, 2010. These were planted in 2009 and overwintered.

Perennial Forage	CP%	ADF%	aNDF%	48 hr dNDF%	RFQ	NE Gain Mcal/Lb
Double Cut Clover	19.78	24.95	34.97	64.66	218	0.43
Single Cut Clover	17.67	26.58	36.90	65.80	213	0.44
Starfire Clover	17.91	26.65	37.26	64.41	203	0.41
Norcen Birdsfoot Trefoil	23.66	21.92	31.03	54.50	193	0.41
Hairy Vetch	20.51	29.02	35.80	59.58	175	0.39
Vernal Alfalfa	20.97	30.63	41.70	49.33	144	0.29

Forage Combinations

A combination of forage species is a good option for maximizing forage production and quality. Turnips, peas and rapeseed had equal or higher forage quality in comparison to perennial forage legumes (Table 3 and 4). However, some are high enough quality without the fiber that they should not be fed to livestock alone. Consequently, combinations with other higher yielding, lower quality forages could be beneficial.

In a farm trial, the RFQ in August was 183 for pearl millet/turnips, and 155 RFQ for turnips/oats. Turnips planted in August, then strip grazed with stockpiled perennial pasture provided high quality forage well suited for late fall/early winter grazing. The feed quality of turnips alone can be too high for maintenance livestock diets. In September, turnip RFQ in Kimberly was 223 to 372 (Table 2-3). When nitrogen is applied, forage nitrate turnip concentrations should be monitored. Rapeseed (or canola) at Kimberly resulted in an RFQ range of 201-215. So turnips and rapeseed should be mixed with teff, pearl millet or cereals and the nitrate levels monitored.

Legumes (hairy and chickling vetch) resulted in excellent forage quality. In September, at Kimberly, hairy vetch RFQ ranged from 141-211 and chickling vetch had an RFQ of 128-152. Available crude protein was 19-23% for hairy vetch and 17% for chickling vetch. They are both high quality forages that can be mixed with cereals, teff or pearl millet to increase yields, while keeping the forage quality balanced to meet livestock maintenance and weight gain requirements.

Instead of combining the different forage species in the same field, another option is to grow vetch, turnips, or rapeseed adjacent to a field of perennial pasture, cereals or pearl millet, and then setup the electric fencing so the livestock strip graze both fields at once.

CONCLUSIONS

Extended grazing with unconventional annual forages provides an opportunity to produce a larger quantity of adequate quality forage at a lower cost than purchasing alfalfa. Producers may increase overall farm/ranch profitability, while meeting their livestock's nutritional needs with extended grazing. To start using annual forages for summer and fall grazing, this spring consider planting spring cereals, or spring cereal/vetch.

To start this summer, in June consider planting SS, teff, pearl millet, vetch/teff or pearl millet, or a rapeseed/teff or pearl millet combination. Graze these during the summer, or stockpile in the field for fall/early winter grazing. Sorghum, SS, and pearl millet required minimal N and irrigation for large biomass production. All of these forages yielded higher than the vetch, rapeseed, turnips and peas, however their forage quality was less. SS had high yields and competed well against weeds with its rapid growth. Care must be exercised in monitoring the prussic acid and nitrate content of the sorghum or SS when grazing during the summer, especially if it is stressed, i.e. lack of irrigation. After SS is ensiled, or is frosted in the fall and left in the field, the prussic acid concern for livestock disappears. Pearl millet can be used for summer, fall or winter grazing. The forage quality is the highest in the vegetative stage before it heads out. Teff provides a viable option for grazing during July and August when cool season grass has slowed due to hot weather. Grazing teff during this time can allow perennial pastures to rest and re-grow. Teff and pearl millet can both be grazed during the summer with minimal concerns for any nitrate or prussic acid concerns, unlike sorghums and SS. The yields and great forage quality of arvika peas, athena winter canola, montech peas and chickling vetch encourage incorporation of them. Turnips and hairy vetch had lower yields, but their quality was great.

In late summer to early fall, consider turnips or rapeseed/winter cereals for a late fall/early winter grazing, plus grazing the following spring, and potentially again on summer cereal re-growth. For very minimal seed costs and a little irrigation water you can have a winter cereal/turnip combination that could extend the grazing season into December.

MINIMIZING FORAGE PRODUCTION LOSSES DUE TO ALFALFA DISEASES

Dr. Donald R. Miller[1]

BEST TREATMENT OPTIONS

Limiting the potential economic damage from alfalfa diseases to a production field are normally accomplished by a combination of two factors; **genetics** and **cultural practices**.

SUPERIOR GENETICS: FIRST LINE OF DEFENSE

Much progress has been made by alfalfa breeders in the last 30 years improving the genetic resistance of alfalfa varieties to diseases. Utilization of these genetic advances in the selection of adapted resistant varieties is still the best and most economical means of insuring maximum yield, quality, and stand life. Variety selection should be based on knowledge of which alfalfa diseases are most prevalent in a grower's field and are historically known to reduce yield and stand life. Knowledge of any potential new diseases reported in the area should be also considered in the selection of a variety with disease resistant traits

Selecting a good disease resistant variety, adapted to his or her farm, is the **cheapest** and best line of defense against disease incurred production losses. It is hard not to over emphasis this point. The variety choice the grower makes in the beginning, will often determine the extent and severity of any future disease outbreaks, and more importantly the length of time that field will remain profitable. Growers often become fixated on the initial cost of the alfalfa seed, but often fail to realize that the choice they make in the beginning, will determine the profitability of that field for many years. A poor choice can actually cost them money in the form of lost yield and/or quality due to stand losses and the resulting weed encroachment. These factors often result in the grower having to prematurely take fields out of production and unexpected replanting costs. **These costs are significantly more than what he would have paid in seed costs for a better disease resistant variety**. Picking a low cost inferior disease susceptible variety often results in the grower having to fight an uphill battle to optimizing forage production in those fields. For the most part, once a variety is planted, there are only a limited amount of options available to the grower to prevent or eliminate pathogens from damaging an established field. Insect pests, you can often spray with a chemicals to eliminate a problem, however that's not the case with the major alfalfa diseases. Chemical control is generally considered uneconomical for disease control in alfalfa with the exception of seed treatments that limit damping off problems under abnormally wet planting conditions. **None of the major alfalfa diseases can be economically controlled by any chemical treatment once a field is planted.**

Many farmers don't realize that even a variety that performed well for his father 10-15 years ago, may not as be productive or competitive in today's environment.. Many pathogens we combat today, were not issues a few years back. Over time diseases can evolve, and we now see new races of existing diseases developing (Aphanomyces Race 2). Also due to our global economy, we are now exposed to new diseases that we didn't have in the past. Verticillium Wilt, formally a European alfalfa disease, didn't even exist in North American until the 1970's. Now it is present in every major production area.

---

[1] Dr. Donald R. Miller, Producer's Choice, Longbranch Station, Suite 114, 16 12th Avenue South, Nampa, ID 83651. Published **In**: Proceedings, Idaho Hay and Forage Conference 1-2 March 2012, Burley, Idaho, UI Extension.

Seed of older popular public alfalfa varieties such as Vernal or Ranger is often cheaper than buying newer disease resistant varieties. However even though the grower may save money on the initial seed cost , the long term costs can be significantly greater, in the form of reduced production and/or shorter stand life. Even a half ton yield savings resulting from better disease resistance will more than offset the additional seed cost of a new modern variety. A poor variety choice at planting, can severely limit a grower's potential profit for the remainder of the rotation.

Selecting an **adapted** variety that has genetic resistance to the major diseases, combined with proper cultural practices, is the grower's best defense in minimizing disease incurred production losses.

IDENTIFYING HEALTHY AND DISEASED ALFALFA PLANTS

One of the simplest tools a grower has at his disposal for gauging the health of his alfalfa field is his shovel. Once or twice a year, dig up 20-30 plants and look at the crown and taproots. Slices open the roots with your knife. The inside of a healthy alfalfa root should be relatively white. Any brown or red discoloration is an indication that the root system is suffering from a disease infection. The severity of the damage tends to get worse with age, and often these plants don't survive the winter.

If you are not sure if there is a disease problem, take the plant sample into your nearest extension agent and he can help you with the identification. (see photo).

CULTURAL PRACTICES FOR DISEASE MANAGEMENT

Cultural practices for disease management should use a two pronged approach (1) **<u>Disease Prevention</u>** and (2) **<u>Practices that limit disease build-up and severity</u>**.

PREVENTING DISEASE OUTBREAKS

As mentioned earlier, the first line of defense in preventing disease outbreaks is planting an adapted variety with a disease rating of **High Resistance** (HR) or a **Resistant** (R) for those diseases known to occur in the region. After selecting the proper variety, the commonly used management practices include the following; (2) Buy certified disease free seed; (3) avoid spreading disease spores from old fields into newly planted fields, cut new fields before older fields to reduce disease infection. ; (4) Disinfect equipment by washing or spraying with a 10% Clorox solution before moving between fields to prevent diseased soil and/or plant residue transfer from older infected fields.(5) Use tiling to reduce excess water in fields (6) In irrigated regions; use land preparation and irrigation practices that limit excess water conditions.(i.e. land leveling, sprinkler vs. flood irrigation. If using furrow or flood irrigation , shorten irrigation time and/or distances to avoid water logged conditions. Avoid reuse of excess irrigation water from diseased fields. (7) Minimize traffic and /or excessive cultivation in established fields. .This often results in damaged or wounded plants and increased disease infection. . All of these should all be considered in a proper management plan to reduce the economic effect of alfalfa diseases.

SELECTING AN ADAPTED VARIETY THAT HAS GENETIC RESISTANCE TO THE MAJOR DISEASES, COMBINED WITH PROPER CULTURAL PRACTICES, IS THE GROWERS BEST DEFENSE IN MINIMIZING DISEASE INCURRED PRODUCTION LOSSES.

MAJOR ALFALFA DISEASES AND CONTROL MEASURES

Crown Rot Complex
(Complex of various pathogens: Fusarium, Pythium, Rhizoctonia, Phoma , and Stagonospora)

Optimal disease conditions **-** Can occur in most soil types but damage can be more severe in the presence of nematodes or root feeding insects that create sites for entry into root system. Recent studies have shown that crown rots may be more severe as they result of crown damage due to livestock grazing and/or wheel traffic. Crown rot diseases are more common in warm climates, but are known to occur in almost all production areas. .
Symptoms - Stunting of plants; Red to reddish brown discoloration inside the root that becomes more severe with age of stand.

Control **-** Resistant varieties; Root knot nematode resistance may also be desirable, to complement Fusarium wilt resistance. This reduces exposure of the plant to the pathogen by nematode feeding on the roots. Variety selection for grazing and/or wheel traffic tolerance may also reduce severity of crown rots that are the result of mechanical crown damage.

Phytophthora root rot *(Phytophthora megasperma f. sp. medicaginis)*

Optimal disease conditions **-** Occurs most often in soils with poor drainage, or where water stands for an extended amount of time. (> 24 hours)

Symptoms **-** Stunting and/or plant death in low areas of field where water stands. Damaged plants may have taproot girdled at same depth as water table in soil. Damaged roots may be brown in color. Top growth may be wilted due to poor water uptake from damaged roots.

Control **-** Resistant varieties; cultural practices that promote better drainage i.e. deep plowing, tiling, laser leveling,and planting on beds .

Bacterial wilt *(Clavibacter michiganense subsp insidiosum)*

Optimal disease conditions – Damage can occur in most soil types but damage is most severe in conditions were crowns and/or roots are damaged due to insects, grazing, wheel traffic or excessive cultivation.   Bacterial wilt is more common in cold climates.

Symptoms **-** Stunting of plants; Yellowish to brown discoloration inside the root that becomes more severe with age of stand.

Control **-** Resistant varieties. Cultural practices that limit crown/root damage resulting from excessive cultivation, grazing, or repeated wheel traffic damage.

Fusarium wilt *(Fusarium oxysporum f.sp. medicaginis)*

Optimal disease conditions **-** Can occur in most soil types but damage can be more severe in the presence of nematodes or root feeding insects that create sites for entry into root system. Fusarium wilt is more common in warm climates.

Symptoms **-** Stunting of plants; Red to reddish brown discoloration inside the root that becomes more severe with age of stand.

Control - Resistant varieties; Cultural practices that limit crown/root damage resulting from cultivation, grazing, or repeated wheel traffic damage.

Anthracnose *(Colletotrichum trifolii)*
Optimal disease conditions - Occurs most often in spring or fall and spreads rapidly under warm wet conditions from spores produced on lower stems of infected plants.
Symptoms - Early stages may appear as individual straw colored stems on plants that display a curved top "Shepherds Crook". Diamond shaped lesions will occur on lower part of the stem. Advanced stages will be seen in the crown tissue as a dark black or coal color. Plant death usually occurs at this stage.

Control - Resistant varieties; Growers should avoid spreading spores from plant debris on harvest equipment to uninfected fields. 10% Clorox wash sprayed on harvest equipment or cutter bars may be advisable when moving from severely infected fields into new fields.

Verticillium wilt *(Verticillium albo-atrum)*

Optimal disease conditions - Thought to occur only in cooler northern climates until it was identified in the late 1980's in parts of Southern California. The pathogen can be spread by dry or fresh plant material on harvest equipment. Cutter bar blades of mowing equipment are extremely effective in spreading the pathogen spores. Manure from infected hay can also have viable disease spores unless composted.

Symptoms - Stunting of plants; **Yellow 'V' shape at the tip of leaves.** Leaves may curl along midrib and turn a pinkish color. Stems will remain green after leaves die.

Control - Resistant varieties; Clean farm equipment between fields, and mow younger fields before older to prevent spore transfer on mower blades. Cutter bar sanitation with 10% bleach has been shown to be effective in limiting plant infection.

SUMMARY

A grower's first line of defense against alfalfa diseases should always be the variety he plants. A superior varieties built in genetic protection is the best insurance policy a grower can get against yield losses due to diseases. Whenever conditions occur that are favorable for disease buildup that genetic protection is always there and doesn't have to be applied by the farmer. Purchasing a variety with **lacking adequate** resistance, may result in a uphill battle to prevent disease buildup and the eventual yield and stand loss. Alfalfa is a perennial crop, so a poor variety choice at planting time, is one that the farmer will have to live with for many years.

Following the selection of a good adapted disease resistant variety, the grower should use good common sense agronomic practices to prevent the introduction of pathogens on his farm, or those practices that limit their buildup.

Idaho State Department of Agriculture Noxious Weed Free Forage and Straw Program

Daniel J. Safford[1]

ABSTRACT

The United States Forest Service (USFS) enacted a law in 1996 that requires all forage, straw, and mulch possessed on their Idaho lands to be certified noxious weed free. In 2011, the Bureau of Land Management (BLM) enacted the same requirement on their lands. The purpose of these laws is to prevent the introduction and spread of noxious weeds onto these public lands. Noxious weed seeds can be spread onto public lands through non-certified forage and straw, and through animal manure that contain noxious weed seeds. The Idaho State Department of Agriculture (ISDA) is the certifying agency for the Noxious Weed Free-Forage and Straw (NWFFS) program in Idaho. The USFS gives funds to the ISDA to administer this program so that equine users and revegetation managers can be in compliance of these laws. Participation in producing NWFFS is voluntary. Products that can be certified include any type of forage bale, forage cubes, and straw. ISDA certifies County Weed Superintendents and/or their employees to be inspectors who conduct the actual field inspections.

The first step in participating in the NWFFS program is contacting your local weed superintendent. Interested growers should meet with their weed superintendent two to three weeks prior to harvest to fill out an application that includes maps of the prospective field(s). At that time, the grower should give an approximate date of harvest. The inspector will inspect the crop for the presence of noxious weeds prior to harvest; however, no sooner than ten days prior to harvest. The cost to have the field inspected is $3 per acre, with a $30 minimum charge (10 acres or less). If the field meets the minimum requirements, bales must be tagged with an ISDA certified tag (5 cents each) or baled with a certification (two-color) twine (slightly more expensive than non-certified twine) to show that certification has been issued. The inspector will provide the tags or certification twine.

Growers can advertise their certified hay or straw at no cost on the Idaho Weed Awareness Campaign and the ISDA NWFFS websites. Another option is to sell directly to feed stores, outfitters, or BLM Wildhorse holding facilities. Growers typically can garner a $1 per bale premium over non-certified hay of equal quality. Demand for certified forage commences with the use of horses and mules in the mountains in early summer and peaks during big game hunting season. Demand for certified straw can come at any time for highway district and utility construction re-vegetation work; however, the biggest demand comes from public land (primarily the USFS and BLM) fire rehabilitation work, which can be cyclic.

Additional information can be obtained by contacting the author of this abstract and or visiting the ISDA NWFFS website by typing "ISDA weed free hay" at a website search engine.

---

[1] D. Safford, Idaho State Department of Agriculture, P.O. Box 790, Boise, ID 83701, dan.safford@agri.idaho.gov; 208-332-8592. Published **In**: Proceedings, Idaho Hay and Forage Conference 1-2 March 2012, Burley, ID

CONSIDER THE VALUE OF PLANT NUTRIENTS IN YOUR HAY AND CORN SILAGE

Glenn E. Shewmaker[1]

ABSTRACT

Alfalfa and corn silage are major crops in acreage and economic importance for the Pacific Northwest and are marketed for and used by dairy cows, beef cattle, and other livestock. With the large increases in fertilizer prices, the value of nutrients in a ton of hay or corn silage can no longer be considered insignificant! How many pounds of nutrients are you exporting? What is the cost to replace the major nutrients? This paper describes a process and uses some current values to determine the magnitudes, sustainability, and economics of nutrient export.
Keywords: nutrient uptake, nutrient export, alfalfa hay, corn silage, fertilizer prices

INTRODUCTION

There are published values for nutrient uptake and crop use of nutrients. You can download a document "Nutrients Removed in Harvested Portion of Crop" from International Plant Nutrition Institute (IPNI) (http://www.ipni.net/ International Plant Nutrition Institute, 2012). Although IPNI has some values, I wanted to use more local crops and concentrations and include sulfur (S) to estimate nutrient export and cost.

METHODS

I used a series of spreadsheets to generate data. Thus the results are "book values" and actual nutrient analyses of crops exported would provide more accurate results. However, the magnitudes of nutrients exported should be within 30% of these values. I focused this study on the macro-minerals nitrogen (N), phosphorus (expressed on the fertilizer analysis form of available phosphoric acid or phosphate, P_2O_5), potassium (expressed as the water soluble potash form, K_2O), and sulfur (S). Certainly other nutrients such as calcium (Ca), magnesium (Mg), and micro nutrients such as copper (Cu), zinc (Zn), manganese (Mn), etc. are also exported and will have to be replaced eventually. Replacement of some of the nutrients comes from the weathering or mineralization of soil particles, but the time required is long-term, and there is a limit to the soils ability to mineralize nutrients.

Nutrient Concentrations in Crops

I used a feed mineral table in a spreadsheet to generate the data:

Table 1 (Feed Mineral Table 2008.xls) uses selected feeds from Table 11-1 Means and SD for Composition Data of Feeds Commonly Used in Beef Cattle Diets, in the Nutrient Requirements of Beef Cattle, 2000, by the National Research Council. I have substituted some values from forage quality databases from University of Idaho research because they should be more reflective of actual soil, environmental, and agronomic management in Idaho.

---

[1] G. Shewmaker, University of Idaho Kimberly R&E Center, 3608 N 3600 E, Kimberly, ID 83341. Published **In**: Proceedings, Idaho Hay and Forage Conference 1-2 March 2012, Burley, ID, University of Idaho Extension.

Nutrients Removed in Crops

Table 2 (Nutrients Removed Table 2012.xls) is used to calculate the value of nutrients exported in various crops. The P and K concentrations must be converted to the oxide form by multiplication of 2.29 * P = P_2O_5 and 1.2 *K = K_2O. Yield is multiplied by the nutrient concentration of each crop to determine nutrients removed in the crop.

Cost of Replacement of Nutrients Exported in Crops

This step calculates the cost of replacing nutrients exported in crops by applying nutrients as commercial fertilizers. Average fertilizer prices for southern Idaho are summarized by Patterson and Painter (2011) and shown in Table 3. Fertilizer prices should be compared on the basis of cost per pound of nutrient, not on the cost per pound of fertilizer material. I calculated the price of fertilizer on a multiple nutrient basis to fairly compare fertilizers (Table 4). The following process compares mixed blends of fertilizer sources:

1. First calculate the pounds of nutrients in a ton of fertilizer. To do this, add the percentage of nutrients together and multiply a ton by the sum.
   (2,000 lb. per ton x total percent nutrients = pound of nutrients in a ton of fertilizer.)

   Example 1: Urea (46-0-0-0)
   2,000 lb./ton x (0.46 + 0+ 0+0) = 920 lb. of nutrients in a ton of Urea.

   Example 2: Mono-ammonium phosphate, MAP (11-52-0-0)
   2,000 lb./ton x (0.11 + 0.52 + 0 + 0) = 1,260 lb. of nutrients in a ton of 11-52-0-0.

   There is quite a difference in the amount of nutrients you receive per ton of fertilizer. What does this mean economically?

2. I calculated fertilizer nutrient prices on the “Fert Price Multiple” sheet with data from Patterson and Painter 2011: Idaho Crop Input Price Summary for 2011. The cost per pound of nutrients in each fertilizer is calculated by dividing the cost per ton of fertilizer by the pounds of nutrients per ton.
   (Cost per ton ÷ pounds of nutrient per ton = cost per pound of nutrient.)

   Example 1: Urea (46-0-0-0)
   $555 per ton ÷ 920 lb. of nutrient per ton = $0.60 per lb. of nutrient.

   Example 2: Mono-ammonium phosphate (11-52-0-0)

   $725 per ton ÷ 1,260 lb. of nutrient/ton = $0.58 per lb. of nutrient for N and P_2O_5.

   In this example, 11-52-0-0 would be the better value if you need both N and P_2O_5. This method works as a basic comparison of multiple nutrient fertilizers, but does not take into account any difference in price between the different nutrients, as all nutrients have an equal value. This method can also be used to compare single nutrient fertilizers.
3. I used the price of N from urea and P_2O_5 from MAP for fertilizer products that are currently available in Idaho. The crop nutrient utilization data from IMC was also used as a comparison.

4. The lowest price of each nutrient (dollars/lb nutrient) is multiplied by the pounds of nutrient removed in the crop, which produces the value of nutrients in dollars/acre.

RESULTS

Amount of Nutrients Removed in Crops Each Year

The concentrations of nutrients in crops generally decline with plant maturity—especially forages where the whole plant 3 inches or more above the soil is harvested. For example, Figure 1 shows the nutrient concentrations of alfalfa forage as a function of growth stage. Soil type, fertility management, irrigation management, and harvest management also affect the nutrient composition of forages. Some nutrients are mobilized as grass crops senesce resulting in low concentrations in the straw, e.g. barley and wheat straw. We have focused on the mature stages of forages because yield and crop removal are maximized.

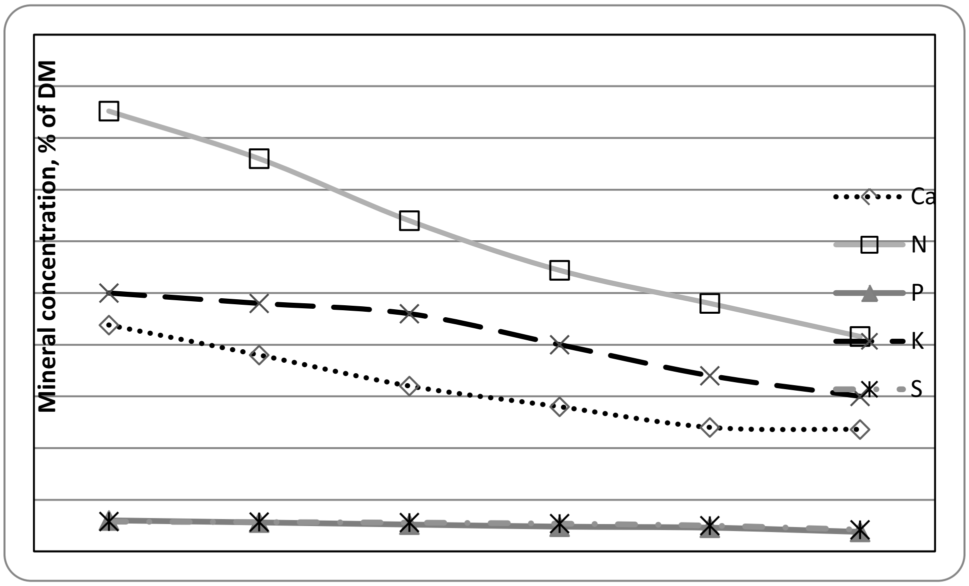

Figure 1. Mineral concentrations of alfalfa on a dry matter (DM) basis as a function of plant maturity or growth stage when harvested.

Yield is the largest variable in mineral removal that we can manage. The higher the yield, the higher the amount of nutrients removed. Alfalfa removes the most nutrients (913 lbs/acre) followed by corn silage at 809 lbs/acre, then barley silage at 295 lbs/acre (Table 2). The grain crops remove smaller amounts of nutrients (193 to 314 lbs/acre) but still important amounts in the long term.

The largest amount of N is removed in alfalfa. However, since alfalfa is a legume it uses the *Rhizobia* bacteria in the nodules to fix atmospheric N into the plant, and can leave up to 200 lbs N which can be mineralized and available to crops in the year following rotation out of alfalfa, even with the forage removed. This is called a N credit and considering this credit is a good nutrient management practice, especially in organic operations. Although alfalfa at bud stage removes 456 lbs N/acre and at full bloom 384 lbs N/acre, we can assume that N concentrations in the soil are not negatively affected. Peas and beans are also legumes which fix N, but less is available for a N credit in the year after production. Corn silage removes the second most N at 282 lbs/acre, and those pounds need replacement.

Phosphate removal is mostly a function of yield at sufficient or higher soil levels of P, since plant maturity doesn't affect the concentration much. There are some differences between crops. The largest amount of P_2O_5 removed is in corn silage, 116 lbs/acre at 11 tons DM yield or about 32 tons fresh silage/acre. Alfalfa at bud stage removes 84 lbs P_2O_5/acre at 8 tons/acre.

Potassium (K_2O) is the largest amount of nutrient removed with 456 lbs K_2O/acre in barley silage, 346 lbs K_2O/acre for alfalfa, and 385 lbs K_2O/acre for corn silage. Although most of our Idaho soils have had adequate soil levels of K_2O historically, 100 years of crop removal have mined the soils and we are seeing more soil test levels below 200 ppm K_2O (or 166 ppm K). Corn, alfalfa and other crops can take up more K than necessary for plant growth. This is called luxury consumption and will export more K if soil levels are high, often from high rates of manure application. Animal nutritionists do not want high K concentrations in forages because an improper ratio of K /(Ca + Mg) causes problems with milk fever and grass tetany.

Value of Nutrients Removed Each Year in Crops

Table 5 shows the value of nutrients removed each year in crops. Since the N removed in alfalfa is not a negative in the soil, we will deduct the N value from the total, resulting in $228 value of nutrients removed in alfalfa. Corn silage removes nutrients valued at $438/acre, followed by barley silage at $424/acre. Barley grain and straw combined removes nutrients valued at $313/acre. Corn grain removes nutrients valued at $163/acre. Grass hay removes much N and K which results in nutrients removed at $231/acre.

RECOMMENDATIONS

The removal of nutrients by crops, especially forage crops, should cause producers to consider the long term mining of nutrients from the soil. How sustainable is your nutrient management? In 100 years corn silage could remove over 22 tons of nutrients per acre from your soil. It should also be considered when marketing forage crops. With current fertilizer prices, how long can you afford to sell hay and corn silage and not get some of the nutrients back from the dairy or feedlot? It may be unreasonable in the short term to market forage crops based totally on nutrient removal because you would need to sell alfalfa hay at $38/ton and grass hay at $58/ton just to replace the N, P, K, and S (Table 5). Corn silage would require $40/ton DM or about $11/ton fresh corn silage to recover nutrient costs.

I recommend negotiating with your forage crop consumer to get back some of the nutrients in the form of manure, if you are close to the consumer, or compost if you are further away. That is simply good nutrient management and benefits both parties.

Table 1. Feed Mineral Table: Selected feedstuffs and nutrient concentration on a dry matter basis.

Feedstuff	DM	CP	Ash	Ca	N	P	K	S
	%	%	%	%	%	%	%	%
Alfalfa, bud stage	90	21	7	1.90	3.80	0.28	2.4	0.29
Alfalfa hay full bloom	88	16	8	1.20	2.40	0.23	1.7	0.25
Barley hay	90	9	8	0.30	1.44	0.28	1.6	0.19
Barley silage	35	12	9	0.46	1.92	0.30	2.4	0.22
Barley straw	90	4	7	0.33	0.64	0.08	2.1	0.16
Barley grain	89	13	3	0.06	1.92	0.38	0.6	0.16
Corn fodder	80	9	7	0.50	1.44	0.25	0.9	0.14
Corn stover mature	80	5	7	0.35	0.80	0.19	1.1	0.14
Corn silage mature	34	8	5	0.28	1.28	0.23	1.1	0.12
Corn grain whole	88	9	2	0.02	1.44	0.30	0.4	0.13
Grass hay	88	10	6	0.60	1.60	0.21	2.0	0.20
Meadow hay	90	7	9	0.61	1.12	0.18	1.6	0.17
Oat hay	90	10	8	0.40	1.60	0.27	1.6	0.21
Oat straw	91	4	8	0.24	0.64	0.07	2.4	0.22
Oat grain	89	13	4	0.05	2.08	0.41	0.5	0.20
Pea straw	89	7	7	0.60	1.12	0.15	1.1	0.15
Peas cull	89	25	4	0.15	4.00	0.45	1.1	0.26
Potatoes cull	21	10	5	0.03	1.60	0.24	2.2	0.09
Sorghum stover	87	5	10	0.49	0.80	0.12	1.2	
Sorghum silage	32	9	6	0.48	1.44	0.21	1.7	0.11
Sudangrass hay	88	9	10	0.50	1.44	0.22	2.2	0.12
Timothy hay full bloom	88	8	5	0.43	1.28	0.20	1.8	0.13
Triticale hay	90	10	8	0.30	1.60	0.26	2.3	
Triticale silage	34	14	7	0.58	2.24	0.34	2.7	0.28
Wheat straw	91	3	8	0.16	0.48	0.05	1.3	0.17
Wheat grain	89	14	2	0.05	2.24	0.43	0.4	0.15
Wheatgrass crested hay	92	10	7	0.33	1.60	0.20	2	

Table 2. Nutrient concentrations and mass of nutrients removed in selected crops.

Field Crops		**Nutrient concentration**				**Nutrients removed in crop**				
	Yield	**N**	**P_2O_5**	**K_2O**	**S**	**N**	**P_2O_5**	**K_2O**	**S**	**Sum**
	ton/ac	lb/ton dry matter basis				- - - - - - lb/acre - - - - - -				
Barley grain	3.1	38.4	17.4	19	3.2	120	54	59	10	243
Corn grain	5.0	28.8	13.7	13	2.6	145	69	66	13	293
Oat Grain	2.4	41.6	18.8	16	4.0	100	45	38	10	193
Wheat Grain	3.9	44.8	19.7	13	3.0	175	77	51	12	314
Forage Crops										
Alfalfa hay at bud *	6	76	13	58	5.7	456	77	346	34	913
Alfalfa hay full bloom	8	48	11	41	5.0	384	84	326	40	835
Barley hay	6	29	13	51	3.8	173	77	306	23	578
Barley silage	6	38	14	76	4.4	230	82	456	26	795
Barley straw	4	13	4	66	3.2	51	15	264	13	343
Corn stover mature	7	16	9	35	2.8	112	61	245	20	438
Corn silage mature	11	26	11	35	2.4	282	116	385	26	809
Grass hay	4	32	10	63	4.0	128	38	252	16	434
Meadow hay	5	22	8	51	3.4	112	41	255	17	425
Oat hay	5	32	12	51	4.2	160	62	255	21	498
Oat straw	4	13	3	76	4.4	51	13	304	18	386
Pea straw	1	22	7	35	3.0	22	7	35	3	67
Timothy hay full bloom	4	26	9	57	2.6	102	37	228	10	378
Triticale hay	3	32	12	73	3.0	96	36	219	9	360
Triticale silage	2	45	16	85	5.6	90	31	170	11	302
Wheat straw	2	10	2	41	3.4	19	5	82	7	113
* Legumes obtain most of their N from the air.										

Table 3. Current and historical fertilizer component prices for southern Idaho: 2009 – 2011 and percentage change from 2010 to 2011 (Patterson, 2011).

Source	Nutrient concentration	2009	2010	2011	Change
	(N-P_2O_5-K_20 %)				
Dry nitrogen	(46-0-0)	$0.50	$0.47	$0.61	30%
Liquid nitrogen	(32-0-0)	$0.56	$0.48	$0.70	46%
P_2O_5 dry	(11-52-0)*	$0.46	$0.34	$0.57	68%
P_2O_5 liquid	(10-34-0)*	$0.63	$0.50	$0.76	52%
K_2O	(0-0-60)	$0.69	$0.43	$0.51	19%
Sulfur		$0.19	$0.17	$0.22	29%

*Nitrogen in 11-52-0 and 10-34-0 was valued at the price of N in urea and Solution 32, respectively

Table 4. The value of fertilizer nutrients as commercial fertilizer.

Product	Fertilizer cost		Nutrient concentration				Total nutrients	Nutrient cost[1]			
			N	P_2O_5	K_2O	S		N	P_2O_5	K_2O	S
Nitrogen:	$/ton	$/lb	%	%	%	%	lb/ton	$/lb	$/lb	$/lb	$/lb
Ammonium sulfate	$410	$0.21	20	0	0	24	880	$0.47	--	--	$0.47
Urea	$555	$0.28	46	0	0	0	920	$0.60	--	--	--
Anhydrous ammonia	$945	$0.47	82	0	0	0	1640	$0.58	--	--	--
Solution 32 liquid	$445	$0.22	32	0	0	0	640	$0.70	--	--	--
Thio Sul liquid	$345	$0.17	12	0	0	26	760	$0.45	--	--	$0.45
Phosphate:											
16-20-0	$550	$0.28	16	20	20	0	1120	$0.49	$0.49	$0.49	--
11-52-0 (MAP)	$725	$0.36	11	52	0	0	1260	$0.58	$0.58	--	--
10-34-0 (liquid)	$657	$0.33	10	34	0	0	880	$0.75	$0.75	--	--
3-30-0-4	$575	$0.29	3	30	0	4	740	$0.78	$0.78	--	$0.78
11-37-0	$600	$0.30	11	37	0	0	960	$0.63	$0.63	--	--
Potash:											
Muriate of potash	$615	$0.31	0	0	60	0	1200	--	--	$0.51	--
Sulfate of potash	$680	$0.34	0	0	50	17	1340	--	--	$0.51	$0.51
Liquid potash	$180	$0.09	0	0	13	0	260	--	--	$0.69	--
Sulfur:											
Elemental (90%)	$390	$0.20	0	0	0	90	1800	--	--	--	$0.22

Table 5. The value of nutrients removed in selected crops. Nutrient values used were: N at \$0.60/lb, P_2O_5 at \$0.58/lb, K_2O at \$0.51/lb, and S at \$0.22/lb.

Field Crops		**Value of nutrients exported**					
	Yield	**N**	**P_2O_5**	**K_2O**	**S**	**Total**	
	ton/ac	Dollars/acre					\$/ton
Barley grain	3.1	72	31	30	2	136	\$ 44
Corn grain	5.0	87	40	33	3	163	\$ 32
Oat Grain	2.4	60	26	20	2	108	\$ 45
Wheat Grain	3.9	105	45	26	3	178	\$ 46
Forage Crops							
Alfalfa hay at bud *	6	274	45	176	8	228	\$ 38
Alfalfa hay full bloom	8	230	49	166	9	224	\$ 28
Barley hay	6	104	45	156	5	309	\$ 52
Barley silage	6	138	48	233	6	424	\$ 71
Barley straw	4	31	9	135	3	177	\$ 44
Corn stover mature	7	67	35	125	4	232	\$ 33
Corn silage mature	11	169	67	196	6	438	\$ 40
Grass hay	4	77	22	129	4	231	\$ 58
Meadow hay	5	67	24	130	4	225	\$ 45
Oat hay	5	96	36	130	5	267	\$ 53
Oat straw	4	31	7	155	4	197	\$ 49
Pea straw	1	13	4	18	1	36	\$ 36
Timothy hay full bloom	4	61	21	116	2	201	\$ 50
Triticale hay	3	58	21	112	2	192	\$ 64
Triticale silage	2	54	18	87	2	161	\$ 81
Wheat straw	2	12	3	42	1	58	\$ 29
* Legumes obtain most of their N from the air.							

REFERENCES CITED

NRC (National Research Council). 2000. Nutrient Requirements of Beef Cattle Update 2000. National Academy Press, Washington, DC.

Patterson, Paul E., and Kathleen M. Painter. 2011. Idaho Crop Input Price Summary for 2011. Agricultural Economics Extension Series No 2011-04, University of Idaho. http://www.cals.uidaho.edu/aers/PDF/AEES/2011/AEES110411.pdf

IDAHO ALFALFA VARIETY TRIALS 2011

Glenn Shewmaker[1], Greg Blaser, and Ron Roemer

INTRODUCTION

Alfalfa is the most productive and widely adapted forage species. Idaho alfalfa acreage was 1 million acres in 2011 (NASS 2012) which was down 130,000 acres from 2010, and down from about 1.25 million acres in 2003. Production was 4.3 million tons with an estimated gross value of $958 million in 2011, second in the US. Forage yield and quality vary widely across Idaho environments and operations. The Idaho Agricultural Experiment Station (IAES) conducts alfalfa variety performance trials at several sites in southern Idaho including the Kimberly Research and Extension Center. Over 300 alfalfa varieties are available to US producers, and these performance trials are designed to assist producers in choosing their varieties.

Alfalfa varieties are tested for forage yield for at least three production years on irrigated sites. All trials are planted as randomized complete block experiments, with four or six replications. Trials receive adequate fertilization, irrigation, and weed control for optimum production. The 2008 Kimberly Alfalfa variety trial was planted on September 2, 2008 at the University of Idaho's Kimberly Research and Extension Center. A 2011 trial was planted in May 2011 at the Kimberly R&E Center, and in August at the Brigham Young University-Idaho farm in Rexburg, ID in cooperation with Greg Blaser, agronomist BYU-Idaho. Seedling-year production results are limited in value for predicting future performance.

The seed industry contributes significantly to the variety trials. Besides donating the seed, they pay a significant fee to offset our costs of doing the work. The Plant, Soil, and Entomological Science Department of the University of Idaho also contributes significantly in salary and equipment—the 5-ft forage harvester purchased for our use costs as much as a big machine.

OBSERVATIONS

1. Forage variety trials give **potential yields**. The yields are measured on fresh forage with a moisture percentage of about 75%. Yields are corrected to 100% dry matter but there is very little harvest loss in our trials. Harvest losses for raking, baling, and stacking dry hay can be as much as 20% of the total dry matter production. We also intensely manage the plots and we don't have traffic on the plots 5-9 days after cutting. Thus I would expect realistic hay yields about 80 to 90% of these, however, green chop or haylage yields would be closer.

2. Phosphate and potash fertilizer was applied pre-planting.

3. Varieties are listed in rank of highest average yearly yield. This year yields were not statistically different, so LSD values are not given. There is a page full of good varieties!

4. Don't put too much emphasis on 1-year's data from one location. I suggest looking at results from the Intermountain region of Northern California, Utah State University trials, and others similar in climate.

---

[1] G. Shewmaker, Univ. of Idaho, Twin Falls R&E Center, P.O. Box 1827, Twin Falls, ID 83303-1827.
Published **In:** Proceedings, Idaho Hay and Forage Conference, 1-2 March 2012, Burley, ID, University of Idaho Extension

5. The forage quality data is ranked from highest to lowest neutral detergent fiber digestibility (NDFD). Digestibility is inversely related to yield, so 'Vernal' had the highest NDFD at 57.0%. The "LSD" statistic given at the bottom of the table tells us that varieties with differences less than that value in that column are not significantly different. The LSD for NDFD was 2.3 so Vernal was not different for all varieties in order through 54.7% NDFD, or 'WL363HQ'.

6. Kimberly Trial: This was the third production year. The spring and summer was unusually cool with average daily air temperatures 3 to 5 degrees below normal for May 2011. First cutting produced an average of 3.0 tons/acre in 2011 compared to 3.24 ton/acre in 2010 and to 3.68 ton/acre average in the years from 2003-2008. The 2^{nd}, 3^{rd}, and 4^{th} cuttings were near normal yields. The stands are good.

7. Check Varieties: Vernal is a public check variety used in all trials. Vernal should yield near the bottom of the list, however this year at Kimberly it yielded near the middle, probably a result of the lower fall dormancy and adaptation to cool weather. Check 1 and check 2 are several year old commercial varieties.

Yield is the most important economic factor for alfalfa profitability. Average yield over a period of years and at several locations is a good measure of disease resistance and plant persistence. Generally, the top yielding 1/3 of the varieties are not significantly different for yield. University trials offer neutral testing of varieties but will not test blends--if the source is different every year, there is no point to test it. Industry data can be valuable because it usually is for a longer period of time, but you should ask for the complete data from the trial, not just a section of it. Avoid data with only one year or a single harvest.

Forage Quality--Plant more than one variety, especially if you have large acreage and are seeking dairy-quality hay. Varieties with different maturities will reach the cutting time up to about a week apart, allowing you to cut more hay at the pre-bud or bud stage. Harvesting at the correct maturity and agronomic practices (proper irrigation and weed control) has a larger effect on quality than does variety.

Variety selection is important but not the only factor affecting yield and quality. Soil fertility management, irrigation management, weed control, and harvest management may affect your profit more than variety. However, almost all newer varieties will yield more and be more resistant to pests and diseases than the old public varieties!

Sources of Variety Information

University of Idaho Forage Extension: http://www.extension.uidaho.edu/forage/

Idaho Hay and Forage Association: http://www.idahohay.com/

National Alfalfa Alliance's: http://www.alfalfa.org

North American Alfalfa Improvement Conference: http://www.naaic.org/

Montana State University Extension: http://www.animalrangeextension.montana.edu/Forage/forage.htm

University of California, Davis: http://alfalfa.ucdavis.edu/

University of Idaho: Alfalfa Variety Trials, 2011						
Harvesting Date: May 25, July 12, August 12, October 15, 2011						
Kimberly Variety Test						
Planted: September 2, 2008						
2011 Forage Dry Matter Yield						
	2009-2011	2011 Forage dry matter yield				
	3 Year	Year				
	Average	total	1st	2nd	3rd	4th
Cultivar	Tons/Acre	- - - - - - - - - - - - - - Tons/Acre - - - - - - - - - - - - -				
Rebound 5.0	8.41	8.48	3.07	2.46	1.57	1.38
54V09	8.28	8.82	3.33	2.52	1.64	1.33
DKA43-13	8.26	8.58	2.99	2.55	1.76	1.28
SunDance II	8.24	8.62	3.09	2.44	1.71	1.38
TS 4028	8.23	8.17	3.04	2.33	1.58	1.23
06KH17B	8.21	8.51	3.16	2.49	1.59	1.28
Vernal	8.20	8.37	3.02	2.45	1.67	1.23
FSG528SF	8.14	8.24	2.99	2.36	1.52	1.37
eXalt	8.14	8.19	2.93	2.44	1.54	1.28
eXceed	8.14	8.42	3.12	2.35	1.62	1.33
Phoenix	8.12	8.37	3.12	2.39	1.47	1.40
FSG639ST	8.02	8.29	3.04	2.23	1.69	1.34
Withstand	8.01	8.32	3.01	2.27	1.52	1.52
243	7.99	8.06	2.90	2.38	1.54	1.25
WL343HQ	7.99	8.11	2.99	2.27	1.50	1.36
WL363HQ	7.99	8.23	2.87	2.32	1.76	1.28
Oneida	7.96	7.88	2.93	2.17	1.61	1.17
DKA450-18	7.91	8.17	2.86	2.46	1.58	1.28
TS5026	7.90	8.08	2.99	2.28	1.62	1.19
LightningIV	7.89	8.07	2.93	2.30	1.55	1.29
Check 1	7.88	8.12	2.99	2.31	1.56	1.26
FSG429SN	7.83	8.02	2.92	2.30	1.47	1.33
PGI459	7.81	8.06	2.86	2.32	1.54	1.35
Mountaineer 2.0	7.81	7.95	2.94	2.29	1.57	1.15
Mean	8.06	8.25	3.0	2.4	1.6	1.3
LSD (.05)	NS	NS	NS	NS	NS	NS
CV %	13.6	6.6	10.1	8.5	11.9	11.9

University of Idaho: 2011 Alfalfa Variety Trials

Kimberly Research & Extension Center

Forage Quality Harvested: May 25, 2011--Trial Planted Sept. 2, 2008

Entry	1st Cut	CP	ADF	NDF	$dNDF_{48}$	Lignin	Ash	Fat	NE_L	NE_m	NE_g	RFV	NDFD	NFC	TDN1	RFQ	Milk/ Ton	Milk/ Acre
	Tons/A	(%)	(%)	(%)	(%)	(%)	(%)	(%)	Mcal/lb	Mcal/lb	Mcal/lb	Index	(%)	(%)	(%)	Index	lb/T	lb/A
Vernal	3.0	22.9	25.5	29.6	16.9	6.5	11.16	1.83	0.74	0.76	0.49	218	57.0	36.6	67.6	242	2695	8668
LightningIV	2.9	23.0	25.0	29.3	16.6	6.3	10.78	1.78	0.75	0.77	0.49	220	56.7	37.2	68.0	244	2729	8368
TS5026	3.0	22.5	26.3	30.4	17.0	6.6	10.67	1.80	0.73	0.75	0.48	210	56.0	36.7	67.5	234	2699	8334
DKA450-18	2.9	22.9	25.4	29.4	16.4	6.2	10.77	1.84	0.74	0.77	0.49	219	55.8	37.1	67.7	241	2726	8191
Check1	3.0	22.0	26.2	30.6	17.1	6.3	10.26	1.79	0.73	0.75	0.48	209	55.8	37.3	67.7	233	2723	8161
Rebound 5.0	3.1	22.3	26.5	31.0	17.2	6.6	10.52	1.72	0.73	0.75	0.47	205	55.5	36.5	67.2	228	2677	8975
WL343HQ	3.0	22.6	27.1	31.2	17.2	6.7	10.44	1.77	0.72	0.74	0.46	202	55.4	36.1	67.1	226	2679	8088
DKA43-13	3.0	22.5	26.3	30.7	17.0	6.5	10.46	1.81	0.73	0.75	0.47	208	55.4	36.6	67.4	231	2701	8448
Oneida	2.9	21.9	26.8	31.1	17.2	6.3	10.76	1.76	0.73	0.75	0.47	204	55.3	36.5	66.9	225	2654	7843
FSG639ST	3.0	22.9	26.3	30.2	16.6	6.5	10.51	1.83	0.73	0.75	0.47	211	55.0	36.6	67.4	233	2712	8349
Mountaineer 2.0	2.9	22.5	26.6	30.4	16.7	6.5	10.45	1.92	0.73	0.75	0.47	209	55.0	36.8	67.5	232	2720	8139
243	2.9	22.3	26.0	29.9	16.4	6.8	10.48	1.86	0.74	0.76	0.48	214	54.8	37.6	67.6	236	2732	8423
Withstand	3.0	21.7	28.7	33.1	18.1	6.8	10.45	1.73	0.70	0.71	0.44	188	54.8	35.2	66.3	211	2613	7789
WL363HQ	2.9	22.0	26.4	30.8	16.8	6.6	10.13	1.74	0.73	0.75	0.47	207	54.7	37.4	67.4	229	2716	7370
FSG528SF	3.0	21.9	26.8	31.1	17.0	6.7	10.35	1.77	0.72	0.74	0.47	204	54.6	36.9	67.1	225	2686	8419
PGI459	2.9	22.8	25.8	29.8	16.3	6.5	10.64	1.69	0.74	0.76	0.48	216	54.6	37.1	67.2	236	2698	7892
Sundance II	3.1	22.7	25.2	29.8	16.2	6.4	10.93	1.81	0.74	0.76	0.48	216	54.4	36.9	67.1	235	2689	8126
06KH17B	3.2	22.8	25.7	29.9	16.3	6.3	10.72	1.85	0.74	0.76	0.48	215	54.4	36.8	67.2	234	2703	8966
eXalt	2.9	22.4	26.6	30.1	16.4	6.5	11.73	1.80	0.73	0.75	0.47	211	54.4	35.9	66.1	229	2604	7948
TS 4028	3.0	22.3	26.4	30.9	16.8	6.6	10.83	1.79	0.73	0.75	0.47	207	54.4	36.3	66.7	225	2654	8105
FSG429SN	2.9	23.0	26.5	30.8	16.7	6.5	10.78	1.78	0.73	0.75	0.47	207	54.3	35.8	66.7	226	2657	8200
Phoenix	3.1	22.4	26.7	32.0	17.0	6.4	10.31	1.68	0.73	0.74	0.47	201	53.9	36.1	66.6	220	2656	8313
eXceed Brand	3.1	22.2	26.8	31.1	16.7	6.8	9.84	1.90	0.73	0.74	0.47	204	53.7	37.0	67.5	225	2734	8914
54V09	3.3	22.3	27.7	32.0	17.1	6.8	10.36	1.73	0.71	0.73	0.45	196	53.6	35.7	66.3	216	2640	9031
Mean	3.0	22.4	26.4	30.6	16.8	6.5	10.6	1.79	0.73	0.75	0.5	208	55.0	36.6	67.2	230	2687	8294
LSD (.05)	NS	0.85	1.09	1.37	0.75	0.28	0.83	0.10	0.01	0.02	0.02	11.60	2.30	1.14	1.31	14.70	NS	NS
CV %	10.1	2.7	2.9	3.2	3.2	3.1	5.6	3.8	1.3	1.6	2.4	4.0	3.0	2.2	1.4	4.6	2.3	9.9
Pr>F	0.77	0.12	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.35	0.01	0.30	0.00	0.12	0.50

CP = Crude Protein: AOAC Official Method (CP= Nitrogen X 6.25). Other N conversions are more appropriate for specific protein sources.

ADF = Acid Detergent Fiber: Residue remaining after boiling a forage sample in acid detergent solution. ADF contains cellulose, lignin and silica, but not hemicellulose. AOAC Official method.

aNDF = Amylase-treated Neutral Detergent Fiber: Residue left after boiling sample in neutral detergent solution with amylase. The NDF in forges represents the indigestible and slowly digestible components in plant cell walls (cellulose, hemicellulose, lignin, and ash). AOAC Official Method using both amylase and sodium sulfite.

dNDF = Digestible Neutral Detergent Fiber expressed as %DM: The portion of the neutral detergent fiber digested by animals at a specified level of feed intake, expressed as a percent of the dry matter:

> dNDF = NDF X NDF Digestibility: The dNDF of feeds may be determined by in vivo feeding trials or estimated by lignin analysis, in vitro or in situ digestibility, or by near infrared reflectance analysis.   Indicate the time (hours) of digestion, e.g. dNDF, 48h.

Lignin: Undigestible plant component, giving the plant cell wall its strength and water impermeability.

Ash: An estimate of the total mineral content; the residue remaining after burning a sample at 550^{o}C.

Fat : NIR prediction of fatty acids (FA) determined by gas chromatography not including the glycerol of the triglycerides.

NE_L = Net Energy, Lactation (Mcal/Lb): An estimate of the energy value of a feed used for maintenance plus milk production during lactation and for maintenance plus the last two months of gestation for dry, pregnant cows.

NE_m = Net Energy, Maintenance (Mcal/Lb): An estimate of the energy value of a feed used to keep an animal in energy equilibrium, i.e., neither gaining nor losing weight.

NEg = Net Energy, Gain (Mcal/Lb): An estimate of the energy value of a feed used for body weight gain above that required for maintenance.

RFV = Relative Feed Value: An index for ranking cool season grass and legume forages based on intake of digestible energy. RFV is calculated from ADF and NDF as follows:

> RFV = [(120/NDF) * (0.889- (0. 779 * ADF))] / 1.29

NDFD = NDF Digestibility (%NDF): In vitro NDF digestibility of forages are evaluated by incubating forage in buffers and live rumen fluid, at body temperature, under anaerobic (no air) conditions.

> NDFD = dNDF/NDF*100
>
> See Digestible Neutral Detergent Fiber (dNDF) above.

NFC = Nonfibrous Carbohydrate (%DM): An estimate of the rapidly available carbohydrates (primarily starch and sugars) in a forage. This value is calculated from one of the following equations:

> NFC = 100% - (CP% + NDF% + EE% + Ash%)

or, if corrected for NDFCP,

NFC% = 100% - [CP% + (NDF% - NDFCP%) + EE% + Ash%]

dTDN= TDN1XSum = Total Digestible Nutrients, 1X maintenance level of intake, NRC 2001 refers to the Dairy NRC 2001 summative equation:

The sum of digestible crude protein, fat (multiplied by 2.25), non-fibrous carbohydrates, and digestible NDF.

TDN= [(NFC*.98) + (CP*.93) + (FA*.97*2.25) + (NDF * NDFD)] – 7

RFQ = Relative Forage Quality: An index for ranking all forages based on intake of TDN calculated by estimating digestible portions of protein, fatty acids, fiber (NDF), and non-fibrous carbohydrate.

RFQ = dIntake potential*dTDN/1.23

Where:

dTDN = TDN (defined above) with NDFD.

dIntake potential for legumes =(120/NDF) + (NDFD-45) *0.374*1350/100

dIntake potential for grasses = $-2.318 + 0.442*CP -0.0100*CP^2 - 0.0638*TDN + 0.000922*TDN^2 + 0.180*ADF – 0.00196*ADF^2 - 0.00529*CP*ADF$

Digestible fiber should be based on a 48-hr in vitro estimate. The higher the RFQ, the better the quality. It is used to compare varieties, match hay/silage inventories to animals, and to market hay.

Milk/Ton = Milk per Ton, milk 2006 (lb milk/ton DM): An index for comparing forage quality based on milk produced per ton using National Research Council and UW equations.

Milk/Acre = The product of Milk/Ton and the dry matter yield (Tons/Acre) which gives lbs milk/Acre.

Entry information for Kimberly Trials

Marketer	Variety	FD	WS	Bw	Vw	Fw	An	PRR	SAA	PA	BAA	SN	NRKN
Allied Seed, LLC	Withstand	4	2	HR	HR	HR	HR	HR		HR			
Allied Seed, LLC	Phoenix	5	4	HR	HR	HR	HR	HR		HR		HR	MR
AgSeeds	eXalt	4	2	HR	HR	HR	HR	HR	R	R		R	HR
Tri-West Seed	SunDance II	4		HR	HR	HR	HR	HR		R	MR	R	HR
Calwest Seeds	CW044031	5		HR	R	HR	HR	HR		R	MR		
AgSeeds	eXceed	4	2	HR	HR	HR	HR	HR		R		HR	HR
Producer's Choice Seed	PGI459	4	2	HR	HR	HR	HR	HR		R		HR	HR
Monsanto	DKA43-13	4	2	HR	HR	HR	HR	HR		R		R	R
Cropland Genetics	Rebound 5.0	4	2	HR	HR	HR	HR	HR		R			
Cropland Genetics	Mountaineer 2.0	5		HR	R	HR	HR	HR	R			HR	
Monsanto	DKA50-18	5	2	HR	HR	HR	HR	HR					
W-L Research	WL343HQ	4	1	HR	HR	HR	HR	HR	R	HR	MR	R	MR
W-L Research	WL363HQ	5	2	HR	HR	HR	HR	HR	R	R	MR	HR	R
Farm Science Genetics	FSG528SF	5	2	HR	HR	R	HR	R		R			
Farm Science Genetics	FSG639ST	6	3	HR	R	HR	R	HR		R		HR	HR
Farm Science Genetics	FSG429SN	4	2	HR	HR	R	HR	HR	R	HR		HR	R
FFRL, Logan UT	06KH17B												
Target	TS 4028	4	2	HR	HR	HR	HR	HR					
Target	TS-5026	5	3	HR	HR	HR	HR	HR					
Eureka Seed	LightningIV	4.3	1.5	HR	HR	HR	HR	HR		R			HR
Public--std check	Vernal	2											
Public--std check	Oneida												
Pioneer	54V09	4		HR	HR	R	HR	HR		HR		HR	HR
Mystery check	Check1	4	2	HR	R	HR	R	HR	R	R		HR	MR

Ratings for Alfalfa Varieties	
Code	**Description**
FD	Fall dormancy
WS	Winter survival
Bw	Bacterial wilt
Vw	Verticillium wilt
Fw	Fusarium wilt
An	Anthracnose race 1
PRR	Pytophthora root rot
SAA	Spotted alfalfa aphid
PA	Pea aphid
BAA	Blue alfalfa aphid
SN	Stem nematode
NRKN	Northern root knot nematode
MLE	Multi-foliate expression
GT	Continuous grazing tolerance

Resistance Ratings		
% Resistant plants	**Resistance class**	**Class abbreviation**
0-5%	Susceptible	S
6-14%	Low resistance	LR
15-30%	Moderate resistance	MR
31-50%	Resistance	R
>50%	High resistance	HR

Winter Survival Ratings		
Category	**Check variety**	**Score**
Superior	ZG 9830	1
Very good	5262	2
Good	WL325HQ	3
Moderate	G-2852	4
Low	Archer	5
Non winter-hardy	Cuf 101	6

Fall Dormancy Ratings	
Check variety	**Rating**
Maverick	1
Vernal	2
5246	3
Legend	4
Archer	5
ABI 700	6
Dona Ana	7
Pierce	8
CUF 101	9
UC-1887	10
UC-1465	11

HARVEST TEC DEW SIMULATOR

Jeffrey S. Roberts[1]

Background: Baling Alfalfa at the correct moisture (13%-16%) will maximize leaf retention leading to higher quality and increased bale weight. Leaf loss as a percent of total plant material will be 22% at 10% moisture compared to leaf loss of 12% at 15% moisture due to mechanical shatter (2). Mechanical handling losses occur at the baler's pick-up, stuffer chamber and from the plunger and compression doors.

Dew Simulation process: The Harvest Tec Dew Simulator is run thru a prepared windrow of alfalfa ten to thirty minutes prior to baling. A reel with sixty tines delivers water into the windrow at high pressure to simulate the particle size of natural dew in a fine mist (20 micron droplet size). The tines are controlled by valves so that they spray only while inside the windrow and they are guided by a cam track that is oriented to keep the tines in a vertical position as they enter and exit the windrow. The tines travel down thru the windrow to within two inches of the ground evenly distributing the water thru all of the alfalfa. Water is added to the windrow to bring the moisture up from its current condition to as close to 15% as possible. Calibration of the water rate is set by a control valve. Four gallons of water will raise the moisture of one ton of hay by one moisture point. If the hay is initially 10% moisture, 20 gallons of water per ton will increase the moisture to the ideal 15% level. By bringing the moisture level of the alfalfa up, additional leaves are retained and both bale weight and quality are increased.

Test procedures: The recent development of baler-mounted scales that can be tied into a Harvest Tec Moisture and Bale Monitoring System has made evaluation of the Dew Simulator more precise. The Bale Monitoring System measures moisture thru two opposing star wheels, records the average moisture for the bale and high moisture for the bale. Moisture information is combined with the bale weight and stored in a data chart that can be downloaded from the System.

Results: On Field LF322, Fort Sumner New Mexico, the first nine bales were treated by the Dew Simulator. The Dew Simulator pulled out of the windrow for the next six bales. The treated bales averaged 12.9% moisture and had an average weight of 1830 pounds. The untreated bales had an average moisture of 8.3% and average weight of 1630 pounds as seen in figure 1.

[1]Jeffrey S. Roberts, President, Harvest Tec, Inc. , P.O. Box 63, Hudson, Wisconsin 54016, e-mail: jefroberts@harvesttec.com. Presented at the Idaho Hay and Forage Conference, 1-2, March, 2012.

FIGURE 1: Comparison of 9 bales treated before baling with the Harvest Tec Dew Simulator to 6 bales that were not treated.

----------------------------------BALE DATA--------------------------------------						
BALE #	FIELD	AVG MC%	HI MC%	BALE WT	DATE/TIME	
7	LF322	11	14	1720	05 AUG 09 08:06	
8	LF322	13	18	1850	05 AUG 09 08:10	
9	LF322	15	17	1870	05 AUG 09 08:11	
10	LF322	14	18	1910	05 AUG 09 08:17	
11	LF322	11	16	1820	05 AUG 09 08:19	
12	LF322	13	18	1810	05 AUG 09 08:21	
13	LF322	15	17	1880	05 AUG 09 08:24	
14	LF322	14	18	1840	05 AUG 09 08:25	
15	LF322	10	15	1780	05 AUG 09 08:26	
16	LF322	8	11	1710	05 AUG 09 08:28	
17	LF322	6	10	1640	05 AUG 09 08:31	
18	LF322	9	11	1610	05 AUG 09 08:32	
19	LF322	10	12	1630	05 AUG 09 08:35	
29	LF322	8	11	1610	05 AUG 09 08:36	
30	LF322	9	12	1640	05 AUG 09 08:38	

Dew simulated bales: average moisture= 12.9%; average weight=1831 #
untreated bales: average moisture=8.3%; average weight=1640#

=Treated with the Dew Simulator

(2) Mechanical Properties Affecting Leaf Loss in Alfalfa"; Raghavan and Bilanski; CANADIAN AGRICULTURAL ENGINEERING, VOL 15, NO. 1, June, 1971.

SOIL FERTILITY MANAGEMENT WITH DAIRY COMPOST IN AN ORGANIC, HIGH-ELEVATION ALFALFA SYSTEM

Lauren A. Hunter[1], Christi L. Falen, Cindy, A. Kinder, Amber Moore, and Anita Falen

ABSTRACT

Researchers examine mineralization of nitrogen (N) and plant available phosphorus (P) and potassium (K) from applied dairy compost in a high-elevation, dryland, organic alfalfa system over two growing seasons. Mineralization results for N and plant available P and K reveal similar nutrient value trends under different application rates, 0, 5, and 10 tons/acre of dairy compost. With further analysis of dairy compost mineralization and plant available nutrients, growers will have better information to help match crop nutrient demand to compost nutrient release.

INTRODUCTION

Organic acreage in Idaho has tripled from 1998 to 2008. Additionally, the value of Idaho organic products has grown from $4.1 to $10.6 million. The majority of organic production occurs in south-central Idaho with both Blaine and Camas Counties being major producers of organic alfalfa and malting barley (ISDA, 2009). A limited yield environment, with higher elevations and a shorter growing season (USDA zone 4b-5b), increases the incentive for farmers to grow organically in order to receive higher price premiums. However, these producers evaluating costs and benefits of organic production lack adequate information regarding integration of dairy compost into their cropping system.

Organic nutrient sources such as dairy compost can be an effective soil fertility management tool for providing soil macro- and micro-nutrients, as well as soil organic matter (OM). Increasing OM has numerous additive benefits that help improve overall soil quality and structure (Seyedbagheri, 2010). In organic farming systems, compost can be the primary source of soil nutrients. Soil mineralization, with the help of soil microbes, converts organic nutrient sources into a plant available form (Munoz et al., 2004). The mineralization of nutrients in dairy compost essentially acts as a slow-release fertilizer for organic cropping systems (Seyedbagheri, 2010). The nutrient benefits of dairy compost are not always understood due to variability in compost nutrient composition and the site-specific mineralization rates that help determine when nutrients are made plant available. Different methods used in the composting process can create variability in the source compost composition (Gagnon and Simard, 1999), which therefore might limit grower adoption due to uncertainty in compost nutrient quality and optimal application rates.

More research is needed to understand the process of mineralization of dairy compost to help organic growers match nutrient release to crop nutrient demand (Seyedbagheri, 2010). Although there has been research done on N mineralization in southern Idaho, little to no studies have looked at plant available P and K during the growing season. In general, P contribution from composted manure and plant uptake is less understood (Gagnon and Simard, 1999). In this study, researchers look at rates of soil mineralization of N and plant available P and K from dairy compost applications, 0, 5 and 10 tons/acre. The mineralization study will help determine how nutrients from dairy compost are broken down in this high-elevation growing area where a concentration of organic production occurs.

[1]L. Hunter, Univ. of Idaho Blaine County Extension, 302 First Avenue South, Hailey, ID 83333, lhunter@uidaho.edu. Published **In**: Proceedings, Idaho Hay and Forage Conference 1-2 March 2012, Burley, Idaho, UI Extension.

METHODS

On a producer field, dairy compost was fall applied on an organic, dryland alfalfa stand in 2009, 2010, and 2011. The research site near Picabo, ID is considered a high-desert farming system, with a relative elevation of 5,000 ft. Compost was applied at three application rates, 0, 5, and 10 tons/acre, on 50' x 350' randomized plots, replicated four times. Compost was applied with a commercial, calibrated compost spreader truck.

Mineralization of plant available N, P, and K were monitored for the 2010 and 2011 growing season using the buried bag technique outlined by Westermann and Crothers (1980). A total of three mineralization bags were buried in 2010 and four bags were buried in 2011. Mineralization bags were pulled on average every 46 days during the growing season.

Soil analyses included nitrate (NO_3^-), ammonium (NH_4^+; data not shown), and available P and K. The available P and K were measured using the Olsen's extracting solution, 0.5M sodium bicarbonate buffered at pH 8.5 (Olsen and Sommers, 1982). The P and K solutions were analyzed using an inductive coupled plasma (ICP) spectrometer (iCAP 6000) instrument. The Olsen extraction method is useful with calcareous, alkaline or neutral soils. The method of extraction for NO_3^- and NH_4^+ were 2M potassium chloride (KCl) and the analyses performed used an automated flow injection analysis (FIA). The resulting color intensity for both NO_3^- and NH_4^+ were determined by the amount of inorganic N present (Keeney and Nelson, 1982).

RESULTS AND DISCUSSION

In general, plant available P and K had the highest values in the 10 tons/acre for both the 2010 and 2011 growing season. In 2010, plant available soil P had the highest value of 28 ppm at 39 days of decomposition in the 10 tons/acre application rate compared to less than 20 ppm of P in the control. In 2011, the highest value of 26 ppm of plant available P was found at 34 days of decomposition in the 10 tons/acre compared to a very low value of 9 ppm of soil available P in the control (Figure 1). Alfalfa removes large quantities of P from the soil (8-16 lb P_2O_5 removed per ton of hay at 88% dry matter; Koenig et al., 2009).On this particular organic site, any application of dairy compost is ideal to maintain adequate soil P levels. With much of the P from compost already in a mineral and plant available form, the results indicate that the little organic P added as compost is not mineralizing. If organic P was being mineralized, researchers would expect to see an increase in soil P throughout the growing season. The mineral P added from the compost is likely making the initial soil P concentration higher, rather than the conversion of organic P to a mineral P.

Available soil K in 2010 also had the highest value of 169 ppm at the second buried bag interval (day 39) in the 10 tons/acre compared to 119 ppm of plant available K in the control plots (Figure 2). The 2011 soil available K showed a different pattern with the highest value of soil K (194 ppm) found at the beginning of the growing season in the 10 tons/acre replicated plots. The control also had its highest value in the beginning of the season at 81 ppm. A range of 160 to 200 ppm of soil K is ideal for optimal alfalfa growth. Potassium deficiencies are uncommon in Idaho soils but can develop with fields planted with alfalfa for many years (Stark, Brown, & Shewmaker, 2002). Most of the K in compost is already plant available (mineral K), therefore little fluctuation is expected throughout the growing season in terms of soil available K. The differences seen in soil K between 2010 and 2011 might be from variations in compost nutrient content from year to year.

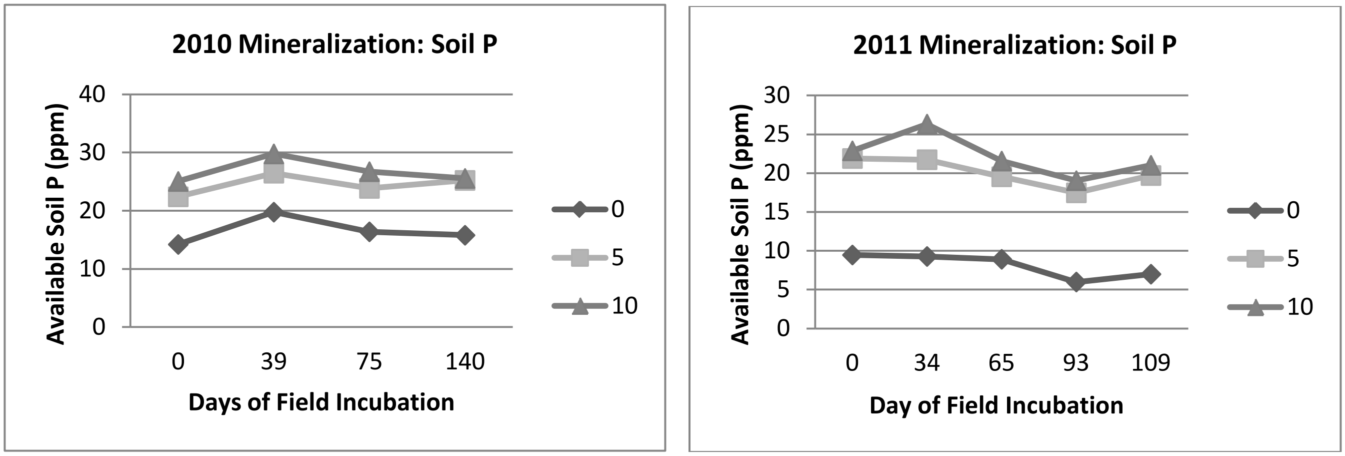

Figure 1. Mineralization of plant available P over the 2010 and 2011 growing season in the replicated 0, 5, and 10 tons/acre compost plots.

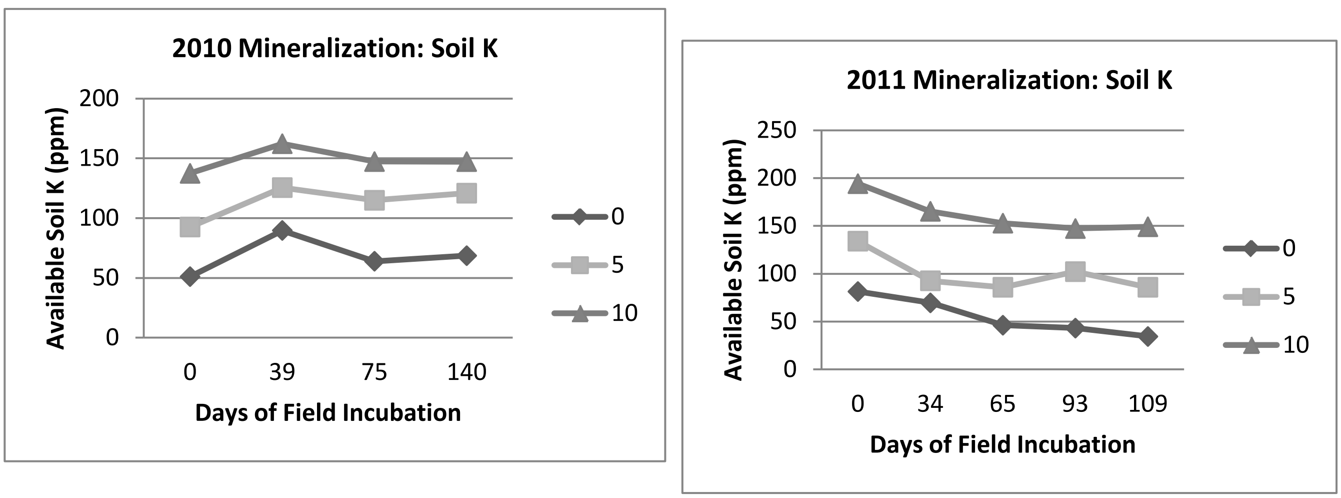

Figure 2. Mineralization of plant available K over the 2010 and 2011 growing season in the replicated 0, 5, and 10 tons/acre compost plots.

Mineralization of soil N increased over the 2010 growing season (around 40 ppm), but there was no significant difference between application rates (Figure 3). With alfalfa being a N-fixing crop, N mineralization is primarily a concern when evaluating soil N levels for crop rotation needs and when seeding a new stand of alfalfa, especially in an organic system (Stark, Brown, & Shewmaker, 2002).

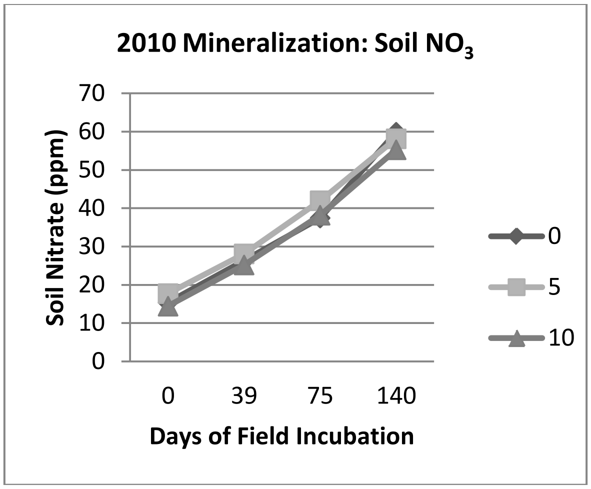

Figure 3. Nitrogen (nitrate) mineralization over the 2010 growing season.

CONCLUSIONS

The preliminary analyses reveal that the 10 tons/acre application rate showed the greatest amount of plant available P and K. A further look at the data will help indicate optimal application rates between the 5 and 10 tons/acre for increasing soil P and K and ultimately helping to build soil residual P and K levels. Differences in available soil P and K between growing years might indicate variation in compost quality. Researchers will continue to take a closer look at mineralization and its relationship with building soil residual nutrients and possible effects of source compost quality from year to year.

Dairy compost and its ability to add soil nutrients and increase OM may offer a sustainable practice to both organic and conventional producers in southern Idaho. With Idaho being the second highest value US producer of alfalfa hay (NASS, 2011), organic producers will need more information on how best to utilize a local organic nutrient source for soil fertility and crop yield management.

ACKNOWLEDGEMENTS

Thanks to Jodi Johnson-Maynard for soil analyses funding and research support as part of a USDA Tri-State Organic Grant.

REFERENCES

Gagnon, B., and R., Simmard. 1999. Nitrogen and Phosphorus Release from On-Farm and Industrial Composts. Canadian Journal of Soil Science. April, 481-489.

ISDA. [Organic Agriculture in Idaho]. Unpublished raw data. 2008.

Keeney, D. R. and D. W. Nelson. 1982. Nitrogen-Organic Forms. *In* Page, Al. L., R. H. Miller, and D. R. Keeney (eds.), Methods of Soil Analysis, Part 2. ASA No. 9, pp 643-693.

Koenig, R.T., D. Horneck, T. Platt, P. Petersen, R. Stevens, S. Fransen, and B. Brown. 2009. Nutrient Management Guide for Dryland and Irrigated Alfalfa in the Inland Northwest. Pacific Northwest Extension Publication. PNW0611.

Munoz, G.R., K.A., Kelling, J.M., Powell, and P.E., Speth. 2004. Comparison of Estimates of First-Year Dairy Manure Nitrogen Availability or Recovery Using Nitrogen-15 and Other Techniques. Journal of Environmental Quality. 33:719-727.

Olsen, S. R., and L. E. Sommers. 1982. Phosphorus Soluble in Sodium Bicarbonate. *In* Page, Al. L., R. H. Miller, and D. R. Keeney (eds.), Methods of Soil Analysis, Part 2. ASA No. 9, pp 24-54.

Seyedbagheri, M.M. 2010. Compost: Production, Quality, and Use in Commercial Agriculture. University of Idaho, College of Agricultural and Life Sciences. CIS 1175.

Stark, J., B., Brown, and G., Shewmaker. 2002. Southern Idaho Fertilizer Guide: Irrigated Alfalfa. University of Idaho, College of Agricultural and Life Sciences. CIS 1102.

NASS. 2011. Crop Values 2011 Summary. USDA. [Online] Available at http://www.nass.usda.gov/Publications/Todays_Reports/reports/cpvl0212.pdf. (Verified February 2012).

Westermann, D.T., S.E., Crothers. 1980. Measuring Soil Nitrogen Mineralization Under Field Conditions. Agronomy Journal. 72 (Nov-Dec):1009-1012.