

Reduced or Low Lignin Alfalfa: Advantages for Hay and Grazing

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Lignin is an essential structural component of all land plants. It fills spaces in the cell wall between cellulose, hemicellulose, and pectin. Lignin provides the strength to plants from giant Sequoia trees to alfalfa growing in hay fields. A good analogy is that lignin is like the steel reinforcing rods in concrete. Life on earth would not be possible without lignin to allow plants to grow upright. The limitation for livestock is that lignin is indigestible. Forage breeders have long realized that the quickest way to improve forage quality would be to reduce lignin concentration, but if lignin is reduced too much then the stand will lodge. When the brown-midrib (BMR) trait was discovered it provided the first practical way to breed reduced lignin forages. Varieties of corn, sorghum, and sorghum-sudangrass with the BMR trait showed reduced lignin and improved digestibility. Although the first BMR varieties had improved digestibility, but they were also more prone to lodging. Further developments have resulted in BMR corn and sorghum that provide high yield, improved digestibility and no greater lodging potential than traditional varieties. In recent years, forage breeders have also developed reduced lignin alfalfa varieties. These varieties have often been called low-lignin alfalfa, but in the term “Reduced Lignin” is preferred because it is essential that enough lignin remains in the alfalfa stems to prevent lodging.

Reduced or Low-lignin Alfalfa

Alforex and Forage Genetics International have taken different approaches to developing reduced lignin alfalfa varieties. Alforex developed its Hi-Gest lines by conventional plant breeding methods. They released Hi-Gest in 2014 and limited amounts of seed were available for planting that spring. Forage Genetics developed HarvXtra by down regulating the pathways of lignin synthesis. In other words, they genetically modified the plant so that it did not produce as much lignin. They then combined the low-lignin trait with the Roundup Ready trait to produce a transgenic variety. HarvXtra will be available on a very limited basis this spring.

In the tables below the results are summarized from a 2015 experiment at the Forage Genetics research farms in West Salem, WI and Nampa, ID. The experiment had four replications and five cutting treatments, and the varieties were harvested and forage quality analyzed every 3-4 days over a 17 day period. Tables 1 and 2 summarize ADL (acid detergent lignin) and NDFD (neutral detergent fiber digestibility), respectively.

This experiment was designed to compare HarvXtra™ alfalfa versus other alfalfa varieties that have used conventional alfalfa breeding techniques by observing changes in forage quality over

advancing maturity for various variety types. The four types used in the experiment were: 1) HvX118 is a FD4 HarvXtra™ experimental alfalfa variety to be named and released in 2017, 2) LegenDairy XHD (LD XHD) is a FD3 alfalfa variety selected for improved forage quality via conventional breeding, released in 2012 by the CROPLAN® brand, 3) Hi-Gest 360 is a FD3 alfalfa variety selected for improved forage quality via conventional breeding, released in 2015 by Alforex, and 4) Pioneer 54R02 is a FD4 Roundup Ready® alfalfa variety with forage quality typical of varieties that have not been selected for improved forage quality during the breeding process, was released in 2011 and is sold by Pioneer HiBred Intl.

Table 1. Changes in ADL with Advancing Maturity of the Alfalfa Crop

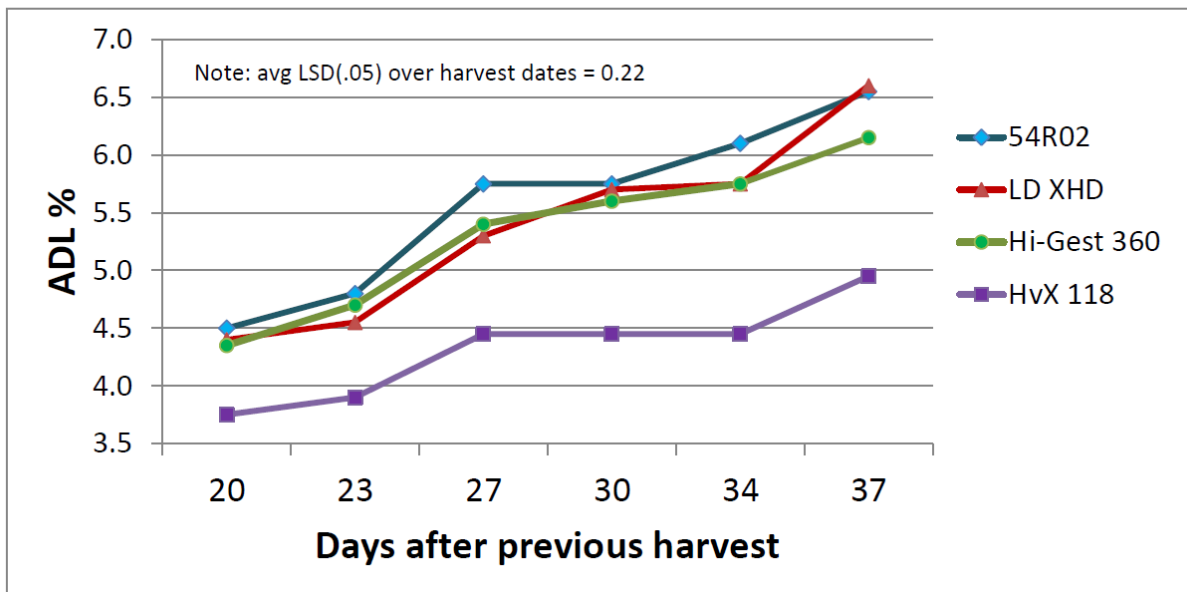
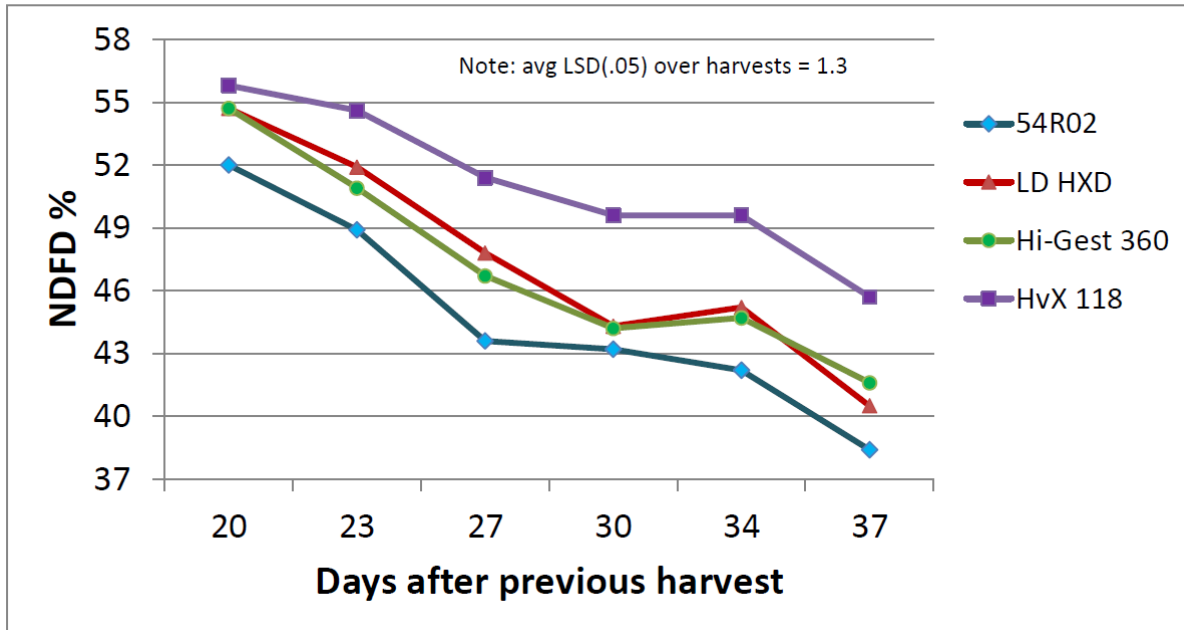


Table 2. Changes in NDFD with Advancing Maturity of the Alfalfa Crop



Discussion of Results

Lignin content generally increases as the alfalfa crop matures. Lignin is indigestible and binds with other cell wall components to limit their digestibility. As lignin increases, cell wall/fiber digestibility decreases. This experiment allows a comparison between the alfalfa variety types in how forage quality changes with advancing maturity. These results clearly show that the alfalfa variety types differ significantly in these quality changes. Although there may be an incremental improvement in these quality parameters related to a conventional breeding history for improved quality (e.g. LD XHD, Hi-Gest® 360) when compared to an unselected variety (e.g. 54R02), the new HarvXtra™ trait provided a marked, and statistically significant improvement over all commercial check varieties for both ADL and NDFD at every sampling date in this experiment ($p < 0.05$). Lignin (ADL) content in HarvXtra™ alfalfa was over two LSD units lower than the commercial checks at every sampling date, and more than 20% lower than any of the commercial check varieties at the last sampling date.

How to Use Reduced Lignin Varieties

Dr. Dan Undersander (Univ. of Wisconsin) gives three main benefits of reduced lignin alfalfa: 1) Higher quality forage (if harvested at same time), 2) Wider harvest window (if rain), and 3) Higher yield (if harvested later at same quality). Dr. Undersander believes the best approach will be to harvest reduced lignin alfalfa at the same time as standard for the first cutting. Current results indicate that reduced lignin varieties show no more lodging than conventional varieties. Since all varieties tend to lodge if left longer on first cutting then a good practice is to harvest all first cutting alfalfa at 28 inches. With reduced lignin, the later cuttings can be delayed 7 to 8 days and have the same quality. The improved quality of reduced lignin varieties will especially help with alfalfa/cool season grass mixtures on first cutting since grasses have a stem at this stage that results in reduced quality.

Feeding trials are being conducted at 3 to 4 universities over this winter period and there should be some actual feeding data in the spring of 2016. One of the greatest advantages of the reduced lignin alfalfa varieties is that alfalfa quality does not change as fast around harvest. This means that the window of harvest is lengthened and, if rain delays, the impact on quality will not be as great. Another advantage of delayed harvest is that it improves winter survival and rate of spring green-up the next year.

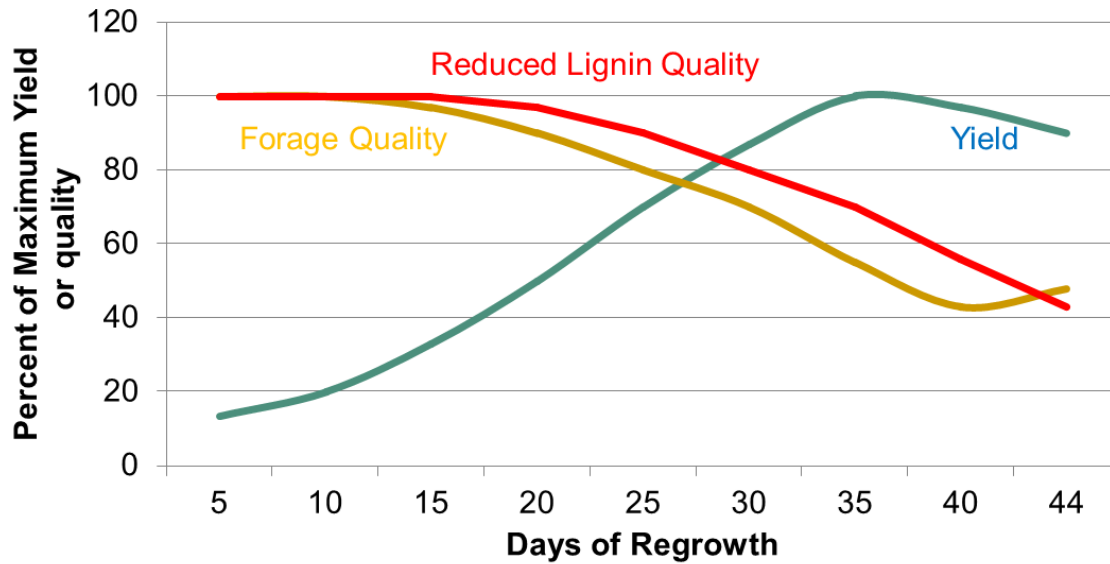
Yield Advantage of Low Lignin Varieties

Table 3 shows that delayed cutting improves yield. This experiment was conducted before the development of reduced lignin alfalfa, but it shows that with any variety delayed cutting will increase yield and surprisingly the 3 harvest system was even higher yielding for the season than the four harvest system. While these results were interesting when they were first presented in the mid-1990's, most producers continued with traditional harvest schedules because they could not afford the lower quality from delayed harvests. Now with the release of reduced lignin alfalfa, this practice may gain more widespread acceptance. Table 4 shows this same trend in graphical form.

Table 3. Comparing a 3 harvest vs. 4 harvest system (before September 1) on alfalfa yield in Arlington, Wisconsin from 1994-1996 (varieties included 2555ML, 3B21, 5246, DK127, Magnum III, Multiking 1, NG-330, and Proof).

		1 st cutting	2 nd cutting	3 rd cutting	4 th cutting	Season Total
2 nd year	3 cut	2.97	2.43	2.15	----	7.55
	4 cut	1.66	1.48	1.71	1.68	6.53
3 rd year	3 cut	2.32	1.53	1.24	----	5.09
	4 cut	1.31	1.18	0.75	0.83	4.07

Table 4. Yield and quality of alfalfa with traditional and with reduced lignin varieties.



Potential Advantage for Grazing

There are currently no published grazing studies with reduced lignin alfalfa, but the benefits of improved quality with delayed harvests should provide at least two important benefits for graziers. Longer grazing intervals will provide more flexibility with rotational grazing systems and grazing more mature alfalfa stands also reduces the potential for bloat.

Acknowledgements:

Dr. Dave Combs, University of Wisconsin, wrote a very good article on reduced lignin alfalfa varieties in the November 2015 edition of Hay and Forage Grower.

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