New Reduced Lignin Alfalfa Varieties — A Potential Forage Quality Breakthrough

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Alfalfa is an important forage crop that provides feed to livestock as well as environmental benefits. Alfalfa forage is a good source of protein and fiber, but its digestibility and intake have been limited by low cell wall digestibility. Cell walls compose about 40-50% of harvested forage and are composed of cellulose, hemicellulose, lignin, pectin, and protein. Cell wall digestibility is variable and is negatively related to lignin concentration. Lignin is an indigestible phenolic polymer linked with cellulose, hemicellulose, and pectin in the cell wall. It constitutes about 6-9% of the dry weight of the whole alfalfa plant and about 20% of the cell wall (Hatfield et al., 2007). Within the plant, lignin strengthens cell walls that are the structural building blocks to support the stems and leaves. Cell walls also act as tubing for the vascular system that transports water and nutrients throughout the plant. However, lignin's close association with cellulose and hemicellulose in alfalfa cell walls limits its rumen microbe degradation.

There have long been efforts to improve alfalfa forage quality through conventional plant breeding, but until now significant progress in forage quality improvement has not been made. Recently, three alfalfa breeding companies announced development of varieties with reduced lignin content (Holin, 2014). A transgenic, reduced-lignin alfalfa, branded as HarvXtra, was developed in a cooperative effort between Forage Genetics International (FGI), the Samuel Roberts Noble Foundation, and the U.S. Dairy Forage Research Center (www.foragegenetics.com/forage-innovation/harvxtra%E2%84%A2-alfalfa.aspx). The new alfalfa was produced by deactivating enzymes in a lignin synthesis pathway. It contains about 12-18% less whole plant lignin and has improved cell wall digestibility (Undersander et al., 2009; Holin, 2014). Dairy cow feeding trials with this transgenic low-lignin alfalfa forage as a portion of the ration showed increased milk production of 2.6 lbs/head/day compared to forage from conventional alfalfa controls (Mertens and McCaslin, 2008; Undersander et al., 2009).

A new reduced lignin alfalfa variety developed through conventional plant breeding, Hi-Gest, has been released by Alforex Seeds (www.alforexseeds.com/alfalfa-product/hi-gest-360/). Hi-Gest contains 7-10% less lignin than conventional alfalfa varieties and in research trials had about 12% greater total tract digestibility (Total Tract NDFdigestibility as estimated by NIR analysis) than conventional varieties (Alforex, 2014). Another alfalfa breeding company, DuPont Pioneer, has also developed an alfalfa variety, 54Q14, with about 5% less lignin (Holin, 2014).

Use of new reduced lignin alfalfa varieties has potential to be very advantageous to growers depending on the level of lignin reduction. At any given maturity stage, reduced lignin alfalfa will have greater cell wall digestibility and greater feeding value than conventional varieties (Figure 1). In addition, the new technology also provides growers management flexibility to delay harvest to a later stage of maturity. It provides a wider harvest window without loss of digestibility. For example, harvesting three times at first flower has potential to provide the same quality as four cuttings at bud stage while providing greater yields. In trials at Minnesota and Wisconsin, yields from an early flower harvest regime were from 15-40% greater for delayed harvests after bud stage. Less frequent harvests (e.g., 3 vs. 4 times) result in lower harvest costs and less exposure of the crop to risk of poor weather conditions. A 3-time harvest system with alfalfa flowering also results in less traffic and less stress on the alfalfa stands than a 4-time harvest system with alfalfa at bud. As a result, alfalfa stand persistence will likely be increased.

Although the changes in lignin concentration in the new reduced lignin alfalfas may seem small, the new alfalfas have potential to greatly increase the feeding value of alfalfa because lignin concentration is so highly correlated with digestibility of the forage. However, the level of reduction varies among the new alfalfas, so we should also expect variable effects on forage digestibility. The new low lignin trait was incorporated into highly productive, winterhardy, and disease-resistant varieties of each company, so yields and persistence should be similar. Producers will need to evaluate this new technology in their harvest and cattle feeding systems to determine its benefits to their farming operations. Unfortunately, seed supplies will be very limited until 2016.

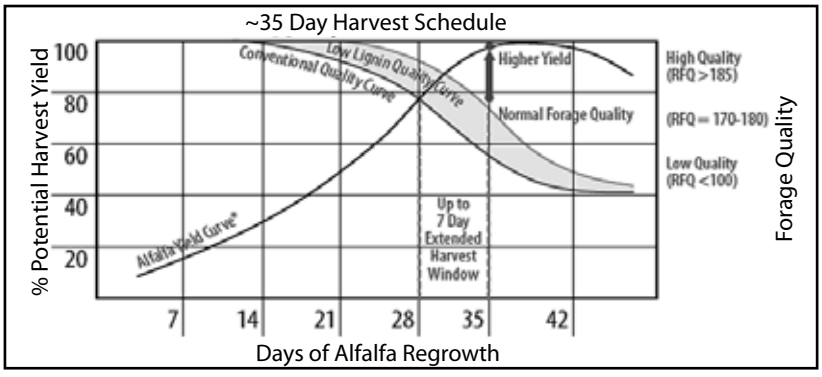

Figure 1. Relative potential changes in alfalfa forage yield and quality during regrowth by a conventional and a reduced lignin alfalfa variety. Reducing lignin concentration of alfalfa varieties (reduced lignin curve) will result in higher quality at all typical harvest times. In this example, growth of an alfalfa variety with reduced lignin concentration will allow ~7-day delay (28-35 days) in harvest and growers will achieve greater forage yields while harvesting the same forage quality as for a 28-day harvest schedule. This graph assumes a conventional alfalfa with about 7% lignin. The extent of increase in forage quality and the harvest window extension will be dependent on the level of lignin reduction, which varies with alfalfa variety. Figure provided by Alforex Seeds.

For more reading, see these references and links:

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