GMO VERSUS NON-GMO LOW LIGNIN TRAITS: WHAT'S THE DIFFERENCE?

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Introduction

Alfalfa has long been recognized as a forage crop with high nutritive value, digestibility, and intake potential to support high milk production. Because of this and many other agronomic characteristics, such as tolerance to drought and nitrogen fixation, it has been quoted as the 'queen of forages' and 'dairy's most nearly perfect feed'. As close as alfalfa is to a perfect forage, there is room for progress. Decades of breeders' experience in traditional plant breeding and advances in biotechnology have allowed for new opportunities. The achievement of reduced lignin alfalfa is certainly one of the milestones in forage quality research. Significant advances have been reached in alfalfa production and forage quality by increasing forage digestibility through reduction, not elimination, of lignin in plant tissue. Given the relatively recent presence in the market and the ongoing incorporation of this trait into commercial varieties, only time will confirm the reach of this innovation whether through biotech or traditional breeding methods. This leads to a few questions: What have been the approaches to reducing lignin in germplasm? What is the difference between genetically modified (GMO) or biotech alfalfa, and non-GMO or non-biotech? Can these technologies co-exist? The information presented highlights the distinction between these two types, their applications, and importance.

Difference between GMO and non-GMO low lignin traits

There have been two approaches to reducing lignin in alfalfa. The first approach is a genetically engineered alfalfa that uses manipulation of the plant's DNA. The new varieties thus obtained are then genetically modified organisms (GMO) or transgenic. Commercialization of genetically engineered alfalfa must meet government deregulation from environmental risk status (McGinnis et al., 2012).

Lignin, with contents of 6 to 9%, has long been recognized as one of the major factors limiting digestibility of cell walls in alfalfa. Lignin reduces availability of nutrients due to negative associations in chemical, physical, and nutritional occurrences (Marten et al., 1988). As the plant matures, this complex organic natural polymer forms in the cell wall mainly from three primary precursors. These have been identified as coniferyl, sinapyl, and p-coumaryl alcohols (Jung and Deets, 1993). Several enzymes associated with the different precursors are involved in the natural biosynthesis of lignin. Through genetic engineering, the goal toward reduced lignin has been to down-regulate segments of the enzymatic pathways thus partially suppressing some of these enzymatic pathways. The product is the reduced lignin trait called HarvXtra^{tm}. The HarvXtra^{tm} trait is stacked with the glyphosate tolerant trait (Roundup Ready®) in current commercial varieties from industry [Forage Genetics International, Pioneer (S&W), Monsanto, and partnering technology companies, and research foundations]. Genetic modification is a long-standing method used by some breeders and plant scientists to improve agricultural products. The integration of the reduced lignin trait into multiple proprietary breeding lines is the ultimate goal.

The second approach to reduced lignin alfalfa is through conventional breeding efforts. Through this methodology, a 7 to 10% reduction in lignin has been reported. The development of new improved varieties does not rely on genetic engineering, but rather on the use of field population improvement programs and selection cycles to obtain parent plants with the desired

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reduced lignin and other desired agronomic traits. In addition to reduced lignin, other traits include high yield, and disease resistance against main alfalfa diseases like anathracnose, aphanomyces, bacterial wilt, fusarium wilt, verticillium wilt, and phytophotora root rot. Because this process does not use transgenics, this reduced lignin product is regarded as a non genetically modified technology (NON GMO) that can be used in organic production operations, and also in grass mixtures. The major marketer of this reduced lignin NON GMO technology is Alforex Seeds (DowAgroSciences, Woodland, CA). They have worked and produced reduced lignin lines with dormancy 3 (Hi-Gest 360) and dormancy 6 (Hi-Gest 660).

Can these technologies co-exist?

Because alfalfa is an obligate outcrossing crop and a bee-pollinated plant, the use of GMO alfalfa raises several concerns associated with technical, legal, environmental and public perceptions (Putnam and Orloff, 2013). There are limitations and risks associated with the new GMO alfalfa, whether it is the Roundup Ready® or the HarvXtra^{tm} trait. One of such concerns is the transfer of an unwanted trait from a field growing GMOs to a field growing organic crops or NON GMOs. For example, gene flow is a concern during seed production from small alfalfa hay fields to seed production farms. To mitigate this possibility, best management practices (BMP) have been suggested that establish isolation distances that match the travelling distances of bees. Another suggested BMP is to grow only one type (GMO or NON GMO seed) to guarantee the lack of gene flow from flowering hay to seed field.

Sensitive export markets and rejections of GMO use by organic producers bring another limitation to the GMO technologies. The sensitive export markets and organic producers appreciate the NON GMO condition (Putnam et al., 2016). The risk of losing certification from organic producers is legitimate as is the sensitive export markets. Many of the reasons that set limitations for GMO like the use of glyphosate tolerant trait preferred by many growers, are the justification for other growers to prefer the NON GMO alfalfas. Within this paradigm, respect for diverse alfalfa production is a must, and the process of coexistence has been advocated among different producers. Through coexistence a mutual respect for diverse agricultural systems is acknowledged, and this requires communication and scientific knowledge.

Reduced lignin alfalfa through either technology offers the direct benefits associated with high digestibility, high yield, and flexibility of harvest. Each technology has advantages and disadvantages for growers.

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