

ADVANCES IN DEVELOPING BETTER ALFALFA VARIETIES

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INTRODUCTION

Alfalfa breeders continue to actively pursue the development of varieties that will bring more benefits to farmers. Yield and better persistence are our highest priorities. Other traits under selection can make alfalfa easier and cheaper to grow, better and safer for livestock and more attractive to livestock

The goal of this paper is to update you on the types of alfalfa research going on in the U. S., time tables on when you may expect to see these new developments and how they may help you in your operation.

Tolerance to grazing and wheel traffic

In my 32 years of breeding alfalfa there have been a number of important breakthroughs, most of these in disease resistance. None has been more exciting to me and as potentially useful to you as the discovery of wheel traffic tolerance. It all started back in the 1980's when Dr. Joe Bouton allowed cattle to abusively graze his alfalfa plots in Georgia. Very few plants survived but by repeated selection he was able to find enough tolerant plants to form the variety AlfaGraze. This variety was released in 1990 with enough seed for on-farm strip trials in Kentucky and a few other states under the direction of Warren Thompson. AlfaGraze quickly proved itself on farms under all types of management and mismanagement, just as it had done previously in small test plots. No variety could compare with it on the farm whether it was grazed, hayed or a combination of the two. It just had the ability to survive under all types of farm conditions.

In the mid 1990's we sent a sample of AlfaGraze along with two ABI experimental alfalfas to northern Japan where farmers were having problems maintaining stands in the areas where harvest equipment ran. After running a tractor over the plots three times after each harvest for three years only AlfaGraze and the two experimentals remained. The conventional alfalfas were gone. Thus was born the realization that breeding for tolerance to constant cattle grazing and defoliation conferred tolerance to wheel traffic. In 2000 the first plots were seeded to study and confirm this phenomenon in America.

The traffic tolerance studies seeded at the University of Wisconsin and by ABI in Iowa in 2000 started producing interesting results in the first year. By growing 20 varieties in side by side replicated trials it was easy to see the difference in re-growth.

Re-growth on plots that were run over by an 8,600 pound tractor five days after harvest was noticeably shorter than on plots that received no traffic. We were exposed to the real world. Wheel traffic in the process of putting up alfalfa does damage new growth, opens up the crown to invasion of disease and compacts the soil.

It amazes me that we have been breeding and testing alfalfa in such an artificial way for decades without the influence of normal on farm wheel traffic or the traffic of the grazing animal. In many ways we have treated alfalfa more like a row crop. Following are results of tests to date.

Wheel Traffic Test Results

Three year average reduction in trafficked plots (20 varieties).

Iowa 2000 seeding	28%
Wisconsin 2000 seeding	11%

Two year average reduction in trafficked plots (16 – 24 varieties).

Iowa 2001 seeding	23%
Wisconsin 2001 seeding	10%
Minnesota 2001 seeding	28%
New York 2002 seeding	24%

Fourteen trial year average yield reduction with traffic applied.

21%

\$100/ton at 6 tons/acre = \$126

Traffic trials were also seeded in Kentucky, Oklahoma and South Dakota in 2002. Good stands were obtained but very dry conditions resulted in low and erratic yields. These results will not be reported here. Useful data will be obtained next year.

Test results say you can save over \$100 a year by not driving on your fields, or by not grazing them. Obviously this is not possible, so you look for ways to manage around it.

In the two 3-year traffic trials in Wisconsin and Iowa varieties developed under hoof traffic yielded 7% more than the conventional varieties. At a 5.5 ton yield level and \$100 hay that is \$40 per year.

Now that we know more about the impact wheel traffic can have on yield and persistence we can recommend ways to reduce the losses.

Things to consider / Ways to reduce traffic losses:

- 1) Use varieties with proven traffic and grazing tolerance
- 2) Graze whenever possible
- 3) Wheel compaction effects are greater on wetter soils

- 4) Traffic effects are greater the longer you wait after harvest
- 5) Use small equipment when possible
- 6) Combine operations when possible (fewer trips)
- 7) Drive less to retrieve bales
- 8) Putting up haylage may reduce traffic effects
- 9) Set up lanes to drive in
- 10) Stay off alfalfa when harvesting adjacent crops, moving cattle, etc.
- 11) Don't apply manure to fields you want to keep

Hybrid Alfalfa

Dairyland Seed has conducted research aimed at commercializing hybrid alfalfa for over 20 years. Unlike corn and some other crops alfalfa presents additional challenges for achieving successful hybrid production and significantly greater yields at a reasonable cost. Hybrids have not yielded greater than conventional varieties in Kentucky yet but, dry conditions this year prevented expression of the genetic potential of all varieties. Nationwide University and private trials have given mixed results. In some trials the hybrids have ranked high and in others in the middle of the pack. I believe that if not now, eventually hybrids can give significant increases in yield. There are still production practices and other factors including bee management that can help result in higher yields of hybrids.

'Roundup Ready' Alfalfa

Monsanto and Forage Genetics collaborative effort to incorporate RR technology into alfalfa is inching closer to reality. Cleaner fields are on the way with 2004 – 2005 the predicted date for passing the last regulatory hurdles. Farmers should find this trait very useful just as they have in soybeans and other crops. The additional cost of seed will be noticeable but, well worth it for many farmers.

Other traits via biotechnology, transformation etc.

'Roundup Ready' will be the tip of the iceberg so to speak in the succession of useful improvements brought about by the new technology.

FORAGE QUALITY. Improvements in forage quality are already on the drawing board. The digestibility of alfalfa will likely be improved quite dramatically as the fiber content is lowered. We know alfalfa as the best source of protein but lacking in energy. That could change as work under way to increase fatty acids, soluble carbohydrate, and starch content progresses.

BLOAT. The Granddaddy of all dreams and hopes for graziers and alfalfa breeders alike is bloat free alfalfa. I am convinced that non-bloating alfalfa will be a reality in less than 10 years. A likely source is the transformation of genes from non-bloating legumes such as birdsfoot trefoil or sanfoin that regulate production of condensed tannins in the plant. These tannins drastically reduce foaming action in the rumen. Some future quality improvements mentioned earlier may also contribute to reduced

bloat. Bloat needs to be an all or none trait. Low bloat alfalfa would be dangerous to use.

TOLERANCE TO ACID SOILS. The difficulty and cost of liming some soils is a major deterrent to improving the productivity of millions of acres. Unlike many traits breeders have worked with in the past, tolerance to low pH does not seem to exist in the world collection of alfalfa germplasm. Despite extensive searches especially by Dr. Bouton's team in Georgia it appears doubtful that enough genetic exists to exploit it alone in a breeding program. At this time in Georgia and Minnesota groups are attempting to work together employing "new technology" to come up with the answer to making acid soils more productive with alfalfa.

OTHER TRAITS LIKELY OBTAINABLE WITH THE "NEW TECHNOLOGY". Increases in winter survival are possible using genes from other species including fish. The Canadians already have lines of alfalfa with genes inserted.

Research toward using alfalfa to grow vaccines is increasing. In fact a Canadian firm is spending over \$10 million per year to transfer genes into alfalfa to produce oral vaccines for humans. It will also be possible to produce alfalfa varieties that administer animal vaccines through the feed. Resistance to major insect pests like alfalfa weevil and potato leafhopper will be possible in the next 10 years as well. These are just a few of the exciting probabilities in the next few years using the rapidly advancing "new technology". The research costs involved in breeding traits obtainable only by biotech means are enormous so seed will have to be more expensive.

Alfalfa to Generate Electricity or as Fuel

Producing electricity using forage or tree biomass has been studied extensively and this will continue. Switchgrass and some other non-legumes are mentioned as possible sources for burning. The U. S. D. A. recently gave the go ahead to pursue burnable alfalfa giving the University of Minnesota a long term grant in this area. It makes much more sense to use alfalfa and other legumes as burnable energy sources. Grasses including corn are inefficient for such purposes because of their requirement for nitrogen fertilization.

Summary

Tremendous progress in improving alfalfa has been made in the past 30 – 35 years at reasonable costs. We are nearing the end of significant alfalfa improvement without the aid of biotechnology. This will escalate research expenses in the neighborhood of 5 – 10 fold. Seed costs will by necessity be significantly higher. Benefits will more than offset higher seed costs for good managers.