Industry Perspectives, Challenges, and Opportunities to Enhance Alfalfa in Warm Climates

Bouton, J.H.*
*Institute of Plant Breeding, Genetics, and Genomics, University of Georgia, and Bouton Consulting Group, LLC

Key Words: Seed sales; high rainfall region; variety development; traits; unique uses

Abstract. Alfalfa (*Medicago sativa* L.; aka lucerne) acreage is low in comparison to perennial grasses in warm humid regions. This includes the tropics and subtropics, and in the USA, the Southeastern states. The alfalfa seed industry therefore saw few reasons to target sales and marketing in these regions. This overlooked logical opportunities. In this paper, these opportunities are examined for Southeastern USA. The Southeast contains a majority of beef herd, a high percentage of the dairy herd, and millions of acres suitable for conversion to alfalfa. Alfalfa is also now viewed as the best crop to solve problems inherent with the region's perennial grass systems. These include interplanting alfalfa to enhance these grasses' nutritive value and reduce their nitrogen fertilizer costs. Development of grazing tolerant and herbicide resistant varieties extended seasonal production and allowed use as high quality, grazed pasture. Alfalfa is also now used as a rotation crop with corn silage for dairies and an integral component of polyculture mixes for pastures and wildlife plots. Direct marketing and sales efforts by the seed industry needs to substantially increase. Research and extension efforts along with varietal development targeted for warm, humid production systems also needs to continue. This makes regions such as the Southeastern USA an important target to increase alfalfa acreage and seed sales.

Introduction

"But let him who longs for milk bring with his own hand lucerne and lotus in planting and salted herbage to the stalls". Virgil

Warm, humid climates are found throughout the world with alfalfa acreage usually low within these climatic zones especially in the tropics and subtropics. For example, alfalfa acreage in the warm, humid Southeastern USA (especially the Gulf of Mexico and Atlantic coastal areas) is low in comparison to those in the warm, dry Southwestern USA even at similar latitudes. Acreage in the tropics and subtropics is lower still. The reasons why are unique to these warm humid regions. Therefore, tens of millions of forage acreages are planted to perennial grasses, that in many cases, were established by grandparents and still used today. The most persistent alfalfa stands seldom, if ever, fit that longevity model.

In warm, humid regions, diseases and insects are plentiful and soils are normally acidic and aluminum toxic and required lime and fertilizer additions are seen as problems (Bouton 2012). When compared to grasses, where nitrogen fertilizer and rain produce dependable forage, alfalfa was seen as high risk. The alfalfa seed industry adopted a self-fulfilling prophecy that sales in warm, humid regions would not increase substantially so there was little incentive to invest heavily in research and marketing efforts. This position is puzzling as these regions generally contain the majority of a nation's beef herd, a substantial percentage of a nation's dairy herd, and millions of acres of agricultural land suitable for conversion to alfalfa and therefore an obvious target for alfalfa acreage and sales growth. This paper will examine these issues and future opportunities for alfalfa using the Southeastern USA as an example.

Perennial Grasses Have Limitations That Only Alfalfa Can Solve

The Southeast's perennial grass base is plagued with poor nutritional quality, confined seasonal production, toxicities (fescue), and need for a lot of expensive N fertilizer. Success of past marketing and

sales effort in the Southeast such as the "Alfagraze - Hay It or Graze It" program, and more recently, the "GotBermudagrass?" initiative increased seed sales and acreage substantially and demonstrated what can be done. "Alfalfa in the South" workshops are also promoting alfalfa to solve grass limitations and are well attended. Finally, designing and promoting unique alfalfa management systems, even in minor acreages for short durations, are now creating new opportunities for the alfalfa seed industry.

Traits and Unique Uses Create New Opportunities for the Alfalfa Seed Industry

Southeastern forage-livestock producers are traditionally grazers. Those who did not want to harvest alfalfa so often (up to 8 times per year in coastal locations), or worried about unpredictable rainy weather, now practice targeted grazing with grazing tolerant varieties. Persistent weed problems are overcome by herbicide resistant varieties, and in some cases, grazing tolerance was combined with herbicide resistance.

Grazing tolerant and herbicide resistant varieties

Alfalfa grazing tolerance is defined as 'the maintenance of adequate plant numbers in the grazing system desired by the grazer to produce the desired productivity of animal gains or hay or silage yields for an economically sustainable timeframe' (Bouton 2012). The procedure to develop the grazing tolerant variety 'Alfagraze' selected the genotypes to be used as parents for new synthetics, or to composite the next population for further selection, after intensive grazing with continuous stocking by beef cattle (Bouton et al. 1991). Alfagraze demonstrated excellent grazing tolerance and animal gains in both on-farm trials and research paddocks with heavy grazing pressure, respectively (Table 1).

Table 1. Summary of grazing persistence data from alfalfa on-farm demonstrations conducted in 27 different USA states (W.C. Thompson, 1997, Unpublished) and animal (beef steers) production in research paddocks with high grazing pressure (from Hoveland et al 1993).

	Alfalfa Persistence (On-Farm Demos; 27 States)			Steer Gains*		
Variety	% Stand	Plants m^{-2}	Stems m^{-2}	Steers ha^{-1}	Daily Gain (kg d^{-1})	Gain ha^{-1} (kg)
Alfagraze	54	43	430	5.7a	0.64a	430a
Best Check	34	33	258	5.6a	0.57b	409b

*Different letters within columns show significant differences (P<0.05).

Figure 1. Grazing tolerant, Roundup Ready alfalfa variety sprayed with Roundup herbicide (left side of photo) or not sprayed (right side) during establishment of an on-farm paddock.

Other grazing tolerant varieties were developed using these same selection and testing protocols across a range of fall dormancies and pest resistances (Bouton 2012). This protocol is accepted as a standard test for grazing tolerance by North American Alfalfa Improvement Conference (NAAIC)

(http://www.naaic.org/stdtests/updated/pdfs/GrazingTolerance.pdf) and its use was recently confirmed in warm, humid tropical Brazil (Pedreira et al. 2020). Addition of the Roundup Ready trait (RR) also provides some varieties with both grazing tolerance and herbicide resistance that have proved beneficial for producers especially during establishment (Figure 1).

Interplanting into the Grasses Reduces N Fertilizer Use and Improves Forage Nutritional Value

Alfalfa easily forms compatible mixtures with many grass species. These mixtures enhance nutritive value of the grass hay, reduce nitrogen fertilizer costs without harming grass persistence, and extend seasonal forage production.

Bermudagrass (*Cynodon dactylon* L.) was consistently found to be very compatible with alfalfa. Burton (1976) reported on research in the early 1950s that interplanting 'Coastal' bermudagrass with alfalfa "blended nicely with the grass" and produced excellent yields in a southern Georgia location (5-year dry matter averages of 8,720 to 9,859 kg ha^{-1} depending on P and K application levels). Brown and Byrd (1990) in a northern Georgia location in the 1980s found yields of an alfalfa-bermudagrass mixture to average 9.7 Mg ha^{-1} and were similar in yield to bermudagrass fertilized with 200 kg N ha^{-1}. Hendricks et al. (2020) working at the same location as Burton, found mixture yields for 3 years (2016 to 2018) to range from 14,755 to 22,654 kg ha^{-1} while bermudagrass alone with 336 kg N ha^{-1} to range from 7,877 to 11,788 kg ha^{-1} depending on the year.

How much nitrogen fertilizer is replaced and how much forage quality is increased by interplanting bermudagrass with alfalfa? Brown and Byrd (1990) reported at least 200 kg N ha^{-1} are replaced. By comparing bermudagrass yields at increasing nitrogen fertilizer levels with alfalfa mixture in replicated plots, Stringer et al. (1994 and 1996) demonstrated that at least 224 kg N ha^{-1} is replaced in an alfalfa-bermudagrass stand (with recommended P and K levels and 20 cm row spacing) versus fertilizing pure stand bermudagrass (Table 2; data shown for only one location). It was also found that only the mixture attained the highest crude protein concentration (Table 2).

Table 2. Summary of two studies in Pendleton, South Carolina USA comparing bermudagrass-alfalfa mixtures with bermudagrass fertilized with increasing rates of nitrogen fertilizer.

	Bermudagrass				Bermudagrass-Alfalfa Mix
	----------Nitrogen Fertilizer Rates (kg N ha^{-1}) ----------				
	0	**112**	**224**	**448**	**0**
Herbage Yield (Mg ha^{-1}) †					
Year 1*	8.37	11.07	12.08	14.86	12.50
Year 2*	8.41	12.21	14.28	17.66	14.90
Crude Protein (g kg^{-1}) ‡					
Year 1*	133	141	140	144	215
Year 2*	115	118	125	144	184

†From Stringer et al. 1994; ‡From Stringer et al. 1996

*Significant Linear Contrast for the bermudagrass N treatments ($P<0.05$).

Extends Seasonal Forage Production

Winters in the warm Southeast are mild and the alfalfa growing season is long, especially in coastal areas. Burton (1976) first reported that alfalfa substantially increased the production season of Coastal bermudagrass in southern Georgia. Later, at the same location, Hendricks et al. (2020) reported alfalfa growth begins in February/March and extends through November supplying high quality baleage (and possible supplemental grazing) when grasses are low yielding and even dormant. A northern Florida dairyman reported that an alfalfa stand planted with a nondormant variety in December was first harvested the following March and harvesting not terminated until September of the following year (D. Bennink, personal communication, 2015). Therefore, 18 harvests were realized with a total silage yield of 14 tons dry matter per acre containing an average crude protein content of 26%.

Still the Best Rotation Crop with Corn

Large herd dairies are now common in the region and corn silage is their main, on-farm crop of choice. However, dairymen who planted a silage corn crop after corn crop on the same land are seeing lost productivity and are finding that alfalfa is still the best rotation crop to solve this problem.

Small Acreage Uses and Other Opportunities

Alfalfa is now an integral part of small acreage polycultures for both pastures and wildlife plots. These blends allow local seed dealers to substantially increase their forage seed sales. Better storage opportunities with baleage wrapping and newer preservative formulations for dry hay also overcome harvesting and storage issues created by the region's high rainfall climate. One must also not forget the opportunities to increase alfalfa use in the tropics and subtropics where the need for this legume remains high and unfulfilled (Bouton 2012).

Conclusions

Alfalfa is not used solely as traditional pure stand hay and silage in the warm, humid regions like the Southeastern USA. It is becoming an important part of the region's forage-livestock systems by serving unique roles (e.g., direct grazing, a perennial grass management tool, rotation crop with corn, multi-species pasture and wildlife mixes). This makes warm humid regions, especially the Southeast, an important target area for the industry to increase seed sales. What is needed now is 1) for the industry to commit to marketing and sales efforts in these regions emphasizing alfalfa's unique traits and use opportunities, 2) for alfalfa breeders to continue to develop better varieties that overcome inherent problems (e.g., soil acidity), and 3) for researchers and farmers to continue to find ways to incorporate and manage the crop's use across the region's varied livestock production systems.

References

Bouton, J. 2012. Breeding lucerne for persistence. *Crop and Pasture Science*. 63:95-106.

Bouton, J.H., S. R. Smith, Jr., D. T. Wood, C. S. Hoveland, and E. C. Brummer. 1991. Registration of 'Alfagraze' alfalfa. *Crop Science*. 31:479.

Brown, R.H., and Byrd, G.T. 1990. Yield and botanical composition of alfalfa-bermudagrass mixtures. *Agronomy Journal*. 82:1074-1079.

Burton, G.W. 1976. Legume nitrogen versus fertilizer nitrogen for warm-season grasses. In: Hoveland, C.S., Knight, W.E., and Marten, G.C. (eds.). *Biological N fixation in forage-livestock systems*. ASA Special Publication Number 28. American Society of America, Madison, WI.

Hendricks, T.J., Tucker, J.J., Hancock, D.W., Mullenix, M.K., Baxter, L.L., Stewart, R.L. Jr., Segers, J.R., and Bernard, J.K. 2020. Forage accumulation and nutritive value of bermudagrass and alfalfa–bermudagrass mixtures when harvested for baleage. *Crop Science*. 2020;1–10. DOI: 10.1002/csc2.20222.

Hoveland, C.S., M.A. McCann, J. H. Bouton, and N.S. Hill. 1993. Pasture botanical changes and steer gains on continuously grazed hay-type and grazing-tolerant lucerne cultivars at three grazing pressures. p. 852-853. Proc. XVII International Grassland Congress, 8-11 February 1993. Palmerston North, New Zealand.

Pedreira, C.G.S., Silva, V.J., Ferragine, M.D.C., Bouton, J.H., Tonato, F., Otani, L., and Basto, D.C. 2020. Validating the NAAIC alfalfa grazing tolerance standard test and assessing physiological responses to grazing in a tropical environment. *Crop Science*. 2020;1–9.

Stringer, W.C., Khalilian, A., Undersander, D.J., Stapleton, G.S., and Bridges, W.C. Jr. 1994. Row spacing and nitrogen: Effect on alfalfa—bermudagrass yield and botanical composition. Agronomy Journal. 86:72-76.

Stringer, W.C., Morton, B.C., and Pinkerton, B.W. 1996. Row spacing and nitrogen: Effect on alfalfa-bermudagrass quality components. *Agronomy Journal*. 88:573-577.