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Combining the grazing tolerance trait with forage production in non-dormant alfalfa

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SUMMARY – Combining grazing tolerance with the non-dormant growth habit in lucerne (*Medicago sativa* L.) would be ideal for pasture based livestock production in areas with mild winters. Grazing tolerant, non-dormant lucerne cultivars were developed with a screening and selection process relying on overgrazing of parental populations. One of our objectives was to determine the performance of these cultivars when used in management systems recommended for lucerne such as haying or rotational grazing. As expected, cultivars developed with selection after overgrazing showed the highest survival in plots exposed to continuous overgrazing. These same entries also showed the highest survival in rotationally grazed and hay harvest treatment areas during the same time period. Yield was not different among entries during the first year, but grazing tolerant cultivars were higher yielding in the second year. In another set of experiments, we evaluated grazing tolerant lucerne as supplemental grazing for a perennial, warm-season grass-based beef cow-calf production system. Grazing tolerant, non-dormant cultivars showed better stand survival and less weed encroachment when compared to a grazing intolerant check. An increase in milk production was found for cows with access to lucerne over those with no access, but no improvement in calf weight gain resulted from lucerne supplemental grazing. Post-weaning performance of calves with access to lucerne was comparable to contemporaries fed hay and grain post-weaning. For calves with access to lucerne post-weaning, performance of animals with prior experience with grazing alfalfa was greater than those without prior experience. Therefore, supplemental grazing lucerne provided a reliable alternative source of supplementation. In summary, the value of non-dormant cultivars with the grazing tolerant trait, even using mechanical harvest or rotational grazing, was evident by increased stand survival, better yield, and less weed encroachment over comparable cultivars without grazing tolerance.

Key words: Alfalfa, grazing tolerance, lucerne, *Medicago sativa.*

RESUME – *"Combinaison de la tolérance au pâturage avec la production de fourrage chez des luzernes non-dormantes". La combinaison de la tolérance au pâturage avec un caractère de croissance non dormante en hiver serait idéale chez la luzerne (*Medicago sativa *L.) pour les productions animales basées sur le pâturage dans des zones à hiver doux. Des cultivars de luzerne tolérants au pâturage et non dormantes ont été développés par un procédé d'évaluation et sélection reposant sur le surpâturage des populations d'origine. L'un de nos objectifs a été celui de déterminer les performances de ces cultivars lorsqu'ils étaient employés dans des systèmes de gestion recommandés pour la luzerne, tels que la fenaison ou le pâturage avec rotation des soles. Comme l'on s'y attendait, les cultivars développés par la sélection suivant le surpâturage ont montré la survie la plus haute dans des parcelles soumises au surpâturage continu. Les mêmes cultivars ont aussi montré dans la même période la plus haute survive dans d'autres parcelles pâturées en rotation ou fauchées. La production n'était pas différente parmi les cultivars pendant la première année, mais pendant la seconde année les cultivars tolérants au pâturage ont eu une production plus haute. Dans un différent groupe d'essais, nous avons évalué la luzerne tolérante au pâturage en tant que pâture supplémentaire pour un système de production vache-veau à viande basé sur une graminacée vivace à croissance estivale. Les cultivars de luzerne tolérants au pâturage et non dormants ont montré une meilleure survie de la couche herbeuse et une infestation de mauvaises herbes plus basse par rapport à une variété de contrôle non tolérante au pâturage. L'on a trouvé une augmentation de la production de lait chez les vaches qui pouvaient accéder à la luzerne par rapport à celles qui ne le pouvaient pas, mais le pâturage supplémentaire de luzerne n'a pas permis une amélioration du gain de poids des veaux. Les performances après le sevrage des veaux qui pouvaient accéder à la luzerne étaient comparables à celles des veux alimentés dans la même période avec du foin et des céréales après le sevrage. Parmi les veaux qui pouvaient accéder à la luzerne après le sevrage, les performances des animaux qui avaient eu une précédente expérience sur le pâturage de luzerne étaient meilleures que celles des animaux sans cette expérience. Pour tout cela, la luzerne en tant que pâture supplémentaire a fourni une source sûre alternative d'intégration alimentaire. En résumant, la valeur des cultivars non dormants tolérants au pâturage, même quand récoltés mécaniquement ou pâturés en rotation, a paru évidente pour leur survie augmentée de la couche herbeuse, meilleure production, et plus basse infestation de mauvaises herbes par rapport à des variétés comparables mais dépourvues de tolérance au pâturage.*

Mots-clés : *Alfalfa, tolérance au pâturage, luzerne,* Medicago sativa.

Introduction

Fall dormancy in lucerne is the ability to cease growth during the autumn of the year. Lucerne cultivars can be grouped into dormant, semi-dormant, or non-dormant growth patterns (Melton *et al.*, 1988). Dormant cultivars produce little autumn growth and are needed in areas with long, cold winters. Non-dormant types can be used where winters are mild and high autumn through early spring growth is possible. This growth pattern is ideal in areas with mild winters such as the southern USA and the Mediterranean region of Europe and should give non-dormant cultivars more value for forage production than either dormant or semi-dormant types in these regions.

Lucerne, whether dormant or non-dormant, is generally not used for direct grazing due to rapid stand loss. However, the development of 'Alfagraze' lucerne demonstrated that grazing tolerance could be added as a primary trait to dormant germplasm (Bouton *et al.,* 1991). Alfagraze was developed as a grazing tolerant cultivar using a fairly novel approach – selection of the parents used to produce the cultivar was based on their ability to survive continuous overgrazing by beef cattle (*Bos* sp.) (Bouton *et al.*, 1991; Bouton *et al.*, 1993). Alfagraze was found to be extremely persistent under continuous grazing, even in mixtures with grasses, yet still possessed good seed and forage yield (Smith and Bouton, 1989, 1993; Smith *et al.,* 1989, 1992; Bates *et al.,* 1996). Smith and Bouton (1993) further demonstrated that selection for plant survival under heavy grazing pressure and continuous stocking, as was done with Alfagraze, could be used to develop grazing tolerant germplasm across an array of fall dormancy groups.

Selection for survival after exposure to continuous, heavy stocking was then used to develop two non-dormant, grazing tolerant lucerne cultivars which were released under the commercial names ABT 805 (Bouton *et al*., 1997a) and AmeriGraze 702 (Bouton *et al.*, 1997b). When tested for survival and forage yield under heavy grazing pressure with continuous stocking by beef cattle, these grazing tolerant, non-dormant cultivars persisted under heavy grazing pressure as well as Alfagraze, but demonstrated plant survival superior to other non-dormant cultivar checks (Bouton *et al*., 1998). All entries survived in control areas that were clipped at an early flowering stage. The yield of non-dormant cultivars was better during late autumn through early spring than Alfagraze. Some winter damage occurred in one of the four years of testing for the non-dormant germplasms and cultivars, which did not occur with Alfagraze.

A standard test to screen lucerne cultivars for grazing tolerance was included in the NAAIC *Standard Tests to Characterize Alfalfa Cultivars* manual (Bouton and Smith, 1996). The test relies on overgrazing during screening and is not intended as a grazing recommendation for producers. Moreoever, as stated above, re-selection and inter-mating of surviving plants from non-tolerant germplasms after overgrazing showed increased grazing tolerance as measured by procedures identical to the standard test (Smith and Bouton, 1993; Bouton *et al.,* 1998). However, the question arose of whether cultivars specifically selected and tested using overgrazing are useful in management systems more typical for lucerne.

The ability of Alfagraze to maintain better stands provided higher animal performance when compared to an intolerant cultivar used as fattening pasture for beef stocker animals (Bates *et al.*, 1996). These data are extremely important because the value of grazing tolerance is shown to result in more saleable animal product for the producer – it is the crux of what can be achieved with a grazing tolerant cultivar. However, perennial grasses are the predominant pasture species in many areas of the world. These grasses, especially sub-tropical species such as bermudagrass (*Cynodon dactylon* L.), provide very dependable and long lived grazing systems, but have two major limitations: (i) an off-season when they have limited or no production; and (ii) poor nutritional value during most of their growing season. Using non-dormant, grazing tolerant lucerne as supplemental grazing for grass pastures has potential to reduce these limitations because it possesses a long growing season in areas with mild winters and also has high nutritional quality.

To further assess the value of the grazing tolerance trait in non-dormant lucerne germplasm, this paper presents the results of two studies: (i) testing non-dormant cultivars and germplasms selected under overgrazing against their parental germplasm in different management conditions (e.g. grazing with continuous stocking, grazing with rotational stocking, and standard hay harvesting); and (ii) experiments evaluating the value of the grazing tolerant, non-dormant lucerne cultivars used as supplemental pasture in a grass-based beef production system.

Materials and methods

Value of grazing tolerant trait in different management conditions:

The experimental design was a split plot arranged in 6 blocks with management conditions of continuous grazing, rotational grazing, and hay harvest as main plot treatments and lucerne entries as sub-plot treatments. Main plots measured 10 6 m and each sub-plot 1.5 4.5 m. 'Florida 77', ABT 805, a grazing tolerant cultivar essentially derived from Florida 77 (Bouton *et al.*, 1997b), 'Diamond', Diamond GZ2, a grazing tolerant germplasm from Diamond, along with Alfagraze and Apollo, the grazing tolerant and intolerant checks from the standard test, respectively, were the lucerne entries. The experiment was established within a 0.5 ha grazing paddock containing 2-4 beef steers. Land preparation, liming, fertilization, and pest control for establishment and maintenance are the same as used previously (Bouton *et al.*, 1998). Step-in electric fence was used around each main plot to control the desired management conditions with all animal excluded from the hay main plots at all times, animals allowed access to the rotational grazing area for 5-7 days then excluded for 28 days, and animals allowed access to the continuously grazed main plots at all times from April until October in each of 2 years.

Supplemental grazing experiments

Twenty British breed cows, their calves and one bull during the breeding season, had access to either 8 ha of 'Tifton 85' bermudagrass pasture alone or 8 ha of Tifton 85 bermudagrass plus 0.8 ha of lucerne in an adjacent, but easily accessible paddock. Large (10 70 m), replicated (4) strips of four cultivars comprised the lucerne area. These cultivars included AmeriGraze 702 and ABT 805 (non-dormant, grazing tolerant) plus the checks Alfagraze (dormant, grazing tolerant) and Florida 77 (non-dormant, grazing intolerant). In each of two years, cows and calves were limit grazed from approximately April 1 to June 15, followed by creep access into the lucerne for calves until weaning. Limit grazing involved morning access to lucerne for several hours 3-5 days per week, depending on forage availability. The lucerne field was also split in half with electric fence across the cultivar strips. Rotational access helped maintain leaf area at levels sufficient to stimulate lucerne growth. Rotational access continued during summer while only calves had continuous access to the lucerne area through a small gate. Hay cutting or mob grazing with cows was used to remove excess lucerne forage, preventing excessively mature forage. Calves were returned to bermudagrass pasture and had continuous access to lucerne following weaning.

Results and discussion

Value of grazing tolerant trait in different management conditions

It was found previously that genotypes surviving overgrazing show increased decumbency, crown size, and numbers of fall buds while their carbohydrate storage and use became very conservative (Brummer and Bouton, 1991, 1992; Smith and Bouton, 1993). Actually, there is a population shift toward increased fall dormancy to where the recommendation for selection is to use a parental population more non-dormant than the desired dormancy of the final selected population (Bouton *et al.,* 1998). Therefore, a practical question involves what other traits may be lost when selecting in overgrazing conditions which will be needed for lucerne in recommended management systems such as hay making and controlled rotational grazing systems? For the non-dormant cultivars this is even more important because the traits changed by overgrazing as described above are counter to the non-dormant habit of growth, which generally expresses itself with narrow crowns and rapid use of carbohydrates for regrowth. These studies therefore were designed to show whether there is a practical loss of performance for non-dormant cultivars whose grazing tolerance was achieved with selection after overgrazing.

Each cultivar showed increased plant survival as management moved from continuous grazing to rotational grazing to hay harvesting (Table 1). As expected, cultivars developed with selection after overgrazing (Alfagraze, ABT 805 and Diamond GZ2) showed the highest survival rate after 2 years in plots stocked continuously (essentially the standard test). These same entries showed the highest survival rate in the rotational grazing and hay harvest treatment areas during the same time period. Therefore, in all management treatments, grazing tolerant populations possessed significantly better plant survival than the parental population from which it was derived.

Table 1. Survival and yield of lucerne cultivars under different grazing and hay management conditions

Cultivar	% Plant survival under different grazing systems			Annual yield (kg/ha)	
	Continuous	Rotational	None (hay)	1997	1998
Alfagraze	41	63	81	8377	6986
Diamond GZ2	33	48	63	8472	8084
ABT 805	33	64	83	7779	8998
Apollo	17	39	48	7894	6492
Florida 77	14	45	61	7985	8511
Diamond	9	19	43	7233	6266
Mean	25	46	63	7957	7556
LSD ($p < 0.05$)	14	20	19	NS	1197

In the hay management area, yield was not different among all entries during the first year, but the grazing tolerant populations produced higher yields during the second growing season; probably due to higher plant numbers (Table 1). The most interesting effect was the advantage in autumn through winter yield for grazing tolerant cultivars with the non-dormant growth habit as demonstrated by ABT 805 (non-dormant) over Alfagraze (dormant) (Fig. 1). This provides a good example of the value of the non-dormant habit of growth when combined with grazing tolerance for areas with mild winters.

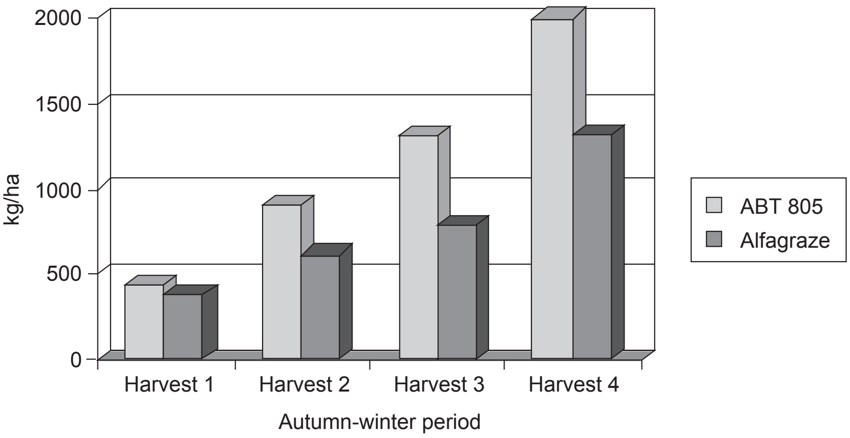

Fig. 1. Cumulative dry matter yield of lucerne cultivars during the autumn-winter period (1997-1998).

Supplemental grazing experiments

After two grazing seasons, the grazing tolerant cultivars, Alfagraze, AmeriGraze 702 and ABT 805, showed better stand survival and less weed encroachment compared to the grazing intolerant check, Florida 77 (Table 2). These results are consistent with previous findings for the same cultivars (Table 1; Bouton *et al*., 1998) and demonstrate the reliability of the grazing tolerance trait. Autumn, winter, and early spring growth was also observed to be higher on all the non-dormant cultivars than Alfagraze (data not shown) and would have allowed more grazing during that time if they were the sole source of lucerne forage.

Generally, a numerical, but statistically non-significant, increase in milk production was found for cows with access to lucerne (Fig. 2). No differences in cow or calf weight gain were measured between the two systems. Response may have been minimized since these animals were from a high performing breeding herd and by the use of the Tifton 85 bermudagrass cultivar as the base pasture. Tifton 85 is a highly productive F1 hybrid cultivar known to support excellent animal performance (Hill *et al*., 1993) even for cow-calf production systems (Hill *et al.,* 1999). It is more likely that animals grazing supplemental lucerne while on grass pasture typical in the region, mixtures of common bermudagrass and bahiagrass (*Paspalum notatum* Flugge), would benefit from the protein and energy supplied by the lucerne.

Table 2. Stand survival (plants/m^2) of different lucerne cultivars after supplemental grazing for 2 years

Cultivar	Initial stands	Final stands	Weeds
Alfagraze	89.3	60.3	5.4
AmeriGraze 702	86.1	57.0	4.3
ABT 805	85.6	54.9	9.5
Florida 77	81.2	32.1	18.2
LSD ($p < 0.05$)	NS	7.2	5.6

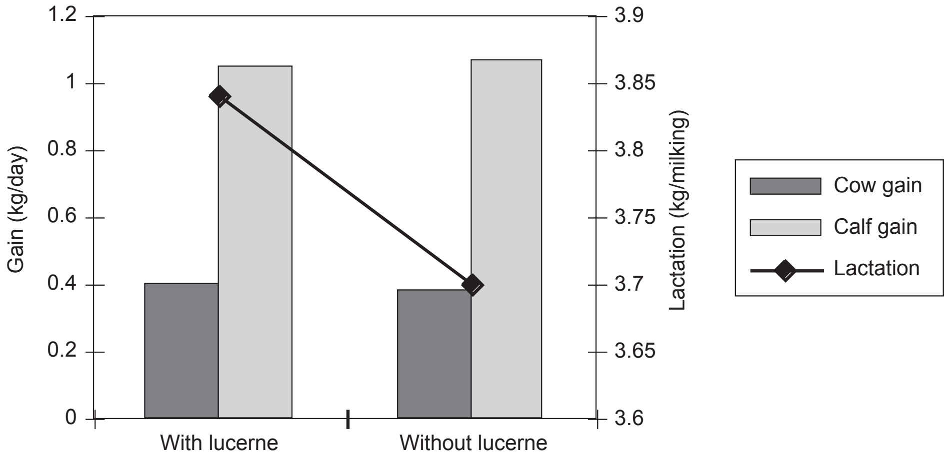

Fig. 2. Performance of beef cows and calves on bermudagrass pasture with or without lucerne as supplemental grazing.

When producers retain ownership of calves after weaning, the normal future for them would be to remain on bermudagrass pasture, but receiving supplemental hay and grain for upwards of 100 days until high quality winter grazing becomes available from cereals such as wheat (*Triticum aestivum* L.) or rye (*Secale* spp.). In these current studies, the post-weaning performance of calves grazing bermudagrass, along with supplemental grazing of lucerne, especially those calves who had a pre-weaning history of using lucerne in this way, was comparable to control animals fed a conventional hay and grain ration (Table 3). The hay and grain supplementation represents a substantial cost to producers for which a grazing tolerant, non-dormant lucerne may substitute at lower cost.

Table 3. Performance (kg/day) of weaned calves during autumn on bermudagrass with supplemental lucerne grazing compared to control group on hay and grain

Bermudagrass with lucerne supplemental grazing (postweaning)		Control group (postweaning)
Lucerne supplemental grazing (preweaning)	No lucerne supplemental grazing (preweaning)	Hay and grain supplementation
0.30	0.14	0.35

Another interesting finding, however, was the performance of animals with prior exposure to grazing lucerne was greater than those without prior experience (Table 3). It is not known if this response was due to digestive adaptation of these animals or simply improved intake because of familiarity with grazing lucerne.

Conclusions

These studies indicate that grazing tolerance, achieved using overgrazing during selection, results in non-dormant cultivars with better plant survival in any recommended management regime. The value of non-dormant cultivars with the grazing tolerant trait, even using rotational grazing, was evident with increased stand survival and less weed encroachment than non-dormant cultivars without the grazing tolerant trait yet more autumn through winter production over dormant, grazing tolerant cultivars. The supplemental grazing system with lucerne used in these experiments also has potential to provide an inexpensive dependable source of supplemental protein and energy for cow/calf producers.

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