College of Tropical Agriculture
and Human Resources
University of Hawai'i at Mānoa

Pasture and Range Management
February 2014
PRM-6

Sugarcane Crosses as Potential Forages for Ruminants: Selection Criteria

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Introduction

The growing "Slow Food" trend is taking root in Hawai'i and extending its influence to beef marketing. The sub-tropical climate of the Hawaiian Islands is ideal for the production of grass-finished beef. This sustainable concept has been championed by the Cooperative Extension Service of the College of Tropical Agriculture and Human Resources (CES/CTAHR) for two decades. However, cattle raising in Hawai'i has been hampered by persistent drought over the past decade.[1] The United States Department of Agriculture declared the counties of Maui and Hawai'i as drought zones in January 2013.[2] The two counties contribute 88% of the beef cattle population in the state.[3] Concurrently, beef cow inventory decreased 17% between 2009 and 2013.[4]

In Hawai'i, the cow–calf operation constitutes the majority of the business model for the ranchers. However, more than 80% of the calves are shipped out of the state for growing and fattening shortly after weaning. Forage quality and quantity are vital for the budding grass-finished beef enterprise. Hence, the choice of forages that can withstand drought and return to robust growth in the presence of rain is crucial for all ranchers. Recent efforts in breeding and selection of sugarcane varieties for a bio-fuel project presented a unique opportunity to identify some of the new varieties that could potentially be used for ruminant feed. This is the first opportunity in more than 30 years for selection of tropical forages in Hawai'i. A vast variation in plant taxonomy was observed in the field plantings.

Objectives

There is no information on the selection of sugarcane species for cattle feed. Hence this paper is an attempt to document the selection criteria we used and the rationale behind these choices. Hopefully it will set the platform for future discussion of forage selection. The objectives are a) to document the selection criteria for sugarcane species for potential forage production, and b) to provide the rationale that the selections set forth are for grazing operations (not cut-carry systems).

Nutrient analyses for the selections will be performed pending fund availability. The selection criteria listed below are based on visual and tactile characteristics and on over 50 years of combined experience working with cattle forages in the grazing systems in sub-tropic and tropical ecosystems.

Materials and Methods

Recent interest in biofuel production has led to the breeding of sugarcane species by the Hawai'i Agriculture Research Center (HARC) for its major client, Hawaiian Commercial and Sugar Company, Maui (HC&S). Seedlings were then transferred for growing in the field in Maui (N20° 53'36.5", W156°24'04.2", 284 ft. elevation). Two sets of seedlings, approximately 9,800 and 25,000 seedling crosses, were established and available for selection. Plantings were in clusters of each cross of sugarcane, grown in furrows and irrigated by drip irrigation. Vast variation of plant and stem structures was observed in the cross breeding. Hence, this offered a tremendous opportunity to make selections for forages for grazing operations.

Criteria

1. *High leaf to stem ratio*. High leaf to stem ratio (Figure 1a vs 1b) is desirable because of the greater digestibility and nutrient density of leaves versus stems. In general, green leaves have greater (65%) digestibility, which is desirable.[5] Stems contain more lignin, and their digestibility can be lower (<45%). In addition, leaves have higher concentrations of protein and lower concentrations of cell-wall material.[6]

2. *Tactile softness of the grass*. Grasses that have softer tactility are more desirable. This physical characteristic reflects the digestible portion of the forage. Brittleness or a cracking sound when the hand is wrapped around the leaves indicates a higher composition of less digestible components of fiber (Figure 2). Such would result in gut fill and slower rate of passage in the reticulorumen and would affect voluntary dry matter intake, as discussed in the review by Allen (1996).[7]

3. *Resistance to rust*. Many of the crosses are susceptible to rust. Leaf rust has been found to alter composition of cereal forages (oats) and to decrease yield and increase susceptibility to pests.[8] Selection of rust-resistant grasses would ensure higher productivity per acre, longevity of grass stand, and reduction of the risk of the pasture as a reservoir for this fungal disease, which can be detrimental to other plants (Figure 3).

4. *Absence of trichomes on the stems*. The trichomes, or hair-like structures (Figure 4a), present in many of the crosses were also undesirable. Many were of the hirsute (coarse hair outgrowth) or hispid (bristly hair) nature, and these have been reported to interfere with palatability and feeding, especially with small ruminants. While trichomes are advantages against insect herbivores, they are generally high in lignin, hence indigestible for the most part to ruminants. In some plants, toxins have been reported in the trichomes. Hence, selection against trichomes was preferred (Figure 4b).

5. *Stand or size of crown*. Robust crown size or stand was preferred over thin, weak crowns of grasses. All the seedlings were planted at the same time and provided with similar amount of water and nutrients via drip irrigation (Figures 5a and 5b).

6. *Midrib size on the leaf blades*. Midribs in tropical grasses are known to reduce voluntary dry matter intake and contribute to lower digestibility.[9] Hence, selection emphasis was placed on plants with wider leaf blades, softer tactility, and small or fine midribs (Figure 6a) vs. those with a thick or wide midrib in the leaves (Figure 6b).

7. *Ability to ratoon*. The ability for grasses in a grazing system to ratoon is important, as this feature can lead to increased density of plants per square meter. Plants with this ability can better withstand trampling, support a higher stocking rate over time, and increase yield of dry matter per acre. However, sub-surface rhizome traits (Figure 7a) are more desirable over stem ratooning (Figure 7b). The latter results in lodging characteristics that can potentially interfere with animal gait and/or with the use of machinery for fertilizing or weeding activities.

8. *Leaf width*. Since most of the nutrients (sugars and protein) are found in the leaves, selection for plants with wide leaf blades (Figure 8) was also one of the criteria employed. Further studies have shown that even at the same level of digestibility, animals when given a choice prefer leaves over stems (46% greater intake).[10]

9. *Growth habit*. From the grazing management perspective, upright stands for sugarcane grasses are preferred. Unlike rhizomotous grasses such as kikuyu, star, and

Figure 1a and 1b. Example of a high leaf:stem ratio (top) and a low leaf:stem ratio (above).

Figure 2. Leaf blades are flexible and soft, despite the large mid-rib.

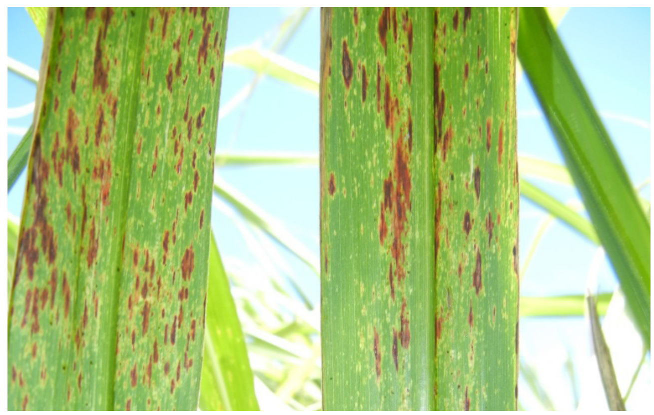

Figure 3. Leaf blades infected with rust fungus.

Figure 4a (left). High amounts of trichome on the stems. Figure 4b (right). More desirable, lower levels of trichome.


Figure 5a (left). A larger and more robust crown size. Figure 5b (right). A much sparser, smaller crown size. Both selections were planted at the same time.


Figure 6a (left). Soft, fine mid-ribs. Figure 6b (right). Much thicker mid-ribs are more difficult for cattle to chew.


Figure 7a (left). Stems sprout from sub-surface rhizomes. Figure 7b (right). Stems exhibit ratooning, less desirable for its tendency to impede movement of animals and machinery.

pangola, sugarcane species have thicker stems, and so lodging (lying flat on the ground while growing) would make it difficult for calves and older animals to graze (Figure 9a vs 9b).

10. *Leaf sheath*. The presence of a long, wide leaf sheath (Figure 10) was considered undesirable.[9] Akin and Burdick (1975) have shown that the tropical grass sheath is more rigid and its subsequent degradation by microbes was slower.[11]

11. *Rind on the stem*. Sugarcanes are notorious for having a tough, fibrous, woody outer rind on the stem (Figure 11). In a grazing situation, animals would avoid such a plant structure. Hence, the presence of rind on the stem of the forages was considered negative, as it would affect voluntary dry matter intake. However, it is noted that under the rind, the cane stores a large amount of sugar, and it has been established that sugarcane stems have higher brix than leaves.[12]

12. *Overall plant vigor*. Seedlings from each selected cross were planted in a single row and managed the same manner. Hence it was easy to compare individual selections for the various criteria, such as crown size, height of plants, and plant vigor (Figure 12).

Summary

For the first time in three decades the opportunity to introduce new forage sources that could be used by local ranchers for grass-finished beef presented itself via collaboration with investigators for bio-fuels. The criteria set forth in this publication were based on available scientific information in the literature. We are cognizant that the visual and physical criteria must undergo further evaluation of dry matter yield and nutrient analyses, prior to any field introduction. The chemical analyses are totally dependent on future funding. Nevertheless, the rationale for the selection of sugarcane species for forage purposes has set the platform for future work.

Acknowledgments

This project is part of extension project 14-220 and 20-023, and is additionally funded by FY13-15 Supplemental Fund for Research and Extension, College of Tropical Agriculture and Human Resources, University of Hawai‘i at Manoa. The primary authors wish to thank the management of HC&S Company for their generous invitation to participate and the in-kind support of the project in collaboration with the project entitled “Development of High Yield Tropical Feedstocks and Bioenergy Conversion Technology for Renewable Energy Projection and Economic Development, U.S. Department of Energy,” Award no. DE-FG36-08GO88037.

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Figure 8. Examples of narrow leaf blades (left) and wide leaf blades (right).

Figure 9a (top). Stems standing upright. Figure 9b (above). Stems lying on the ground while growing.

Figure 10. Leaf sheath.

Figure 11. Sugarcane with a thick outer stem layer, or culm.

Figure 12. Selections were planted at the same time and under the same environmental conditions; however, the selection on the left shows a more vigorous and robust growth compared to the selection on the right.