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Bana Grass (*Pennisetum purpureum*): A possible forage for ruminants in Hawai'i

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Introduction

In Hawai'i as elsewhere, there is growing interest in locally produced fruits, vegetables, meat, and eggs (Toth-Fox 2015, Cox 2010). The movement is about sustainability, self-sufficiency, supporting the local economy, and eating a healthier product. Besides grocery stores, local chefs and restaurants have led the way by featuring locally produced foods on their menus and at special events (Oshiro 2011, Stewart 2012, Eckardt 2016). These citations are only the tip of the mountain of news coverage concerning the locavore movement in Hawai'i.

Figure 1. Purple bana grass in field 601 of HC & S, Maui.

The local beef industry is positioned to benefit from this focus on eating local. Its farm-gate value is now more than $64 million (NASS 2014). The industry is transitioning from shipping wean-off animals to the U.S. mainland for growing out and fattening to grass-finished beef. Many factors contribute to the decision-making processes involved in locally produced beef. Feed, cattle prices, weather conditions (droughts), and the carrying capacity of the ranch were some of the items identified (Yager 2014). This manuscript attempts to address one of the factors identified, feed. The study was part of the research to evaluate the potential of sugarcane varieties for ruminant feed (Lee et al. 2014). Two varieties of bana grass were used in the study, green and purple (see Fig. 1). This grass is commonly known as elephant grass, king grass, Napier grass, or cane grass. There are many cultivars of Napier grass. The high dry-matter yields of this grass (Orodho 2006, Cook et al. 2005) make it enticing as a forage source in an island setting where land is a limiting factor.

The family of grasses to which *Pennisetum purpureum* (also called *Cenchrus purpureus*) belongs has been in Hawai'i since before 1934 (Wilsie and Takahashi 1934). The purple cultivar was introduced into Hawai'i in the early 1980s. Today bana grass is used here primarily as a windbreak in truck-crop farming. There are many varieties or cultivars of this species of grass all over the tropical and sub-tropical world, many of which have a high potential for invasiveness. However, the purple cultivar has never been observed to flower in Hawai'i, negating this concern. Bana grass was assessed for invasiveness by Daehler et al. (2012) and found unlikely to be a serious weed in Hawai'i.

Objectives

Besides animal genetics and management, quality forages and yield are essential elements for a successful

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ranching or grass-fed beef operation. Hence, the objectives are to evaluate a) the nutritive value of bana grass (*Pennisetum purpureum* Schumach) and b) its productivity in Hawai‘i.

Materials and Methods

Two rows of bana grasses (one purple and one green) were planted along with a selection of 36 variations of sugarcane crosses. Vegetative cuttings were planted on July 7, 2014, at an elevation of 86.6m above sea level in the fields of Hawaiian Commercial and Sugar Company (HC & S; N20° 53’36.5”, W156°24’04.2”), Maui. Each planting is 0.38m wide x 3.4m long (single row) and drip irrigated. Fertilization (20-0-0) was provided after the first harvest for each season via drip irrigation at a rate of 0.86 kg/gallon, 2.6 gallons per plot.

The plants were “cut back” to 33–35cm above ground on October 2014, and the number of stems/tillers was counted. The regrowth was harvested at 6-week intervals; then it was weighed, and 1 kg. of wet (field) weight was sampled for drying. The dried samples were weighed and ground for nutrient analysis as described in Lee et al. (2015). All analyses were done by Dairy One Lab utilizing Near Infra-Red (NIR) technology.

The winter growing period was from October 15, 2014, to March 31, 2015, and the summer growing period was from May 1, 2015, to August 31, 2015.

Statistical Analyses

A 2-way analysis of variance (ANOVA) was performed using Prism 6 software (Graphpad, CA, USA) for the nutrient profile between the two grasses. For data reflecting time of harvest, a 3-way analysis of variance (ANOVA) was performed using the same software.

Results and Discussion

Figure 1 shows the temperature for the study periods. The average daytime temperature for the winter months (October 15–March 31) was 22.29 $\pm$ 0.14^{0}C, while the temperature for the summer months was 24.85 $\pm$ 0.14^{0}C. The difference in daily temperatures between the two seasons was 2.56^{0}C.

Figures 1 and 3 show the planting of grasses in field 601 of the HC & S Company in central Maui.

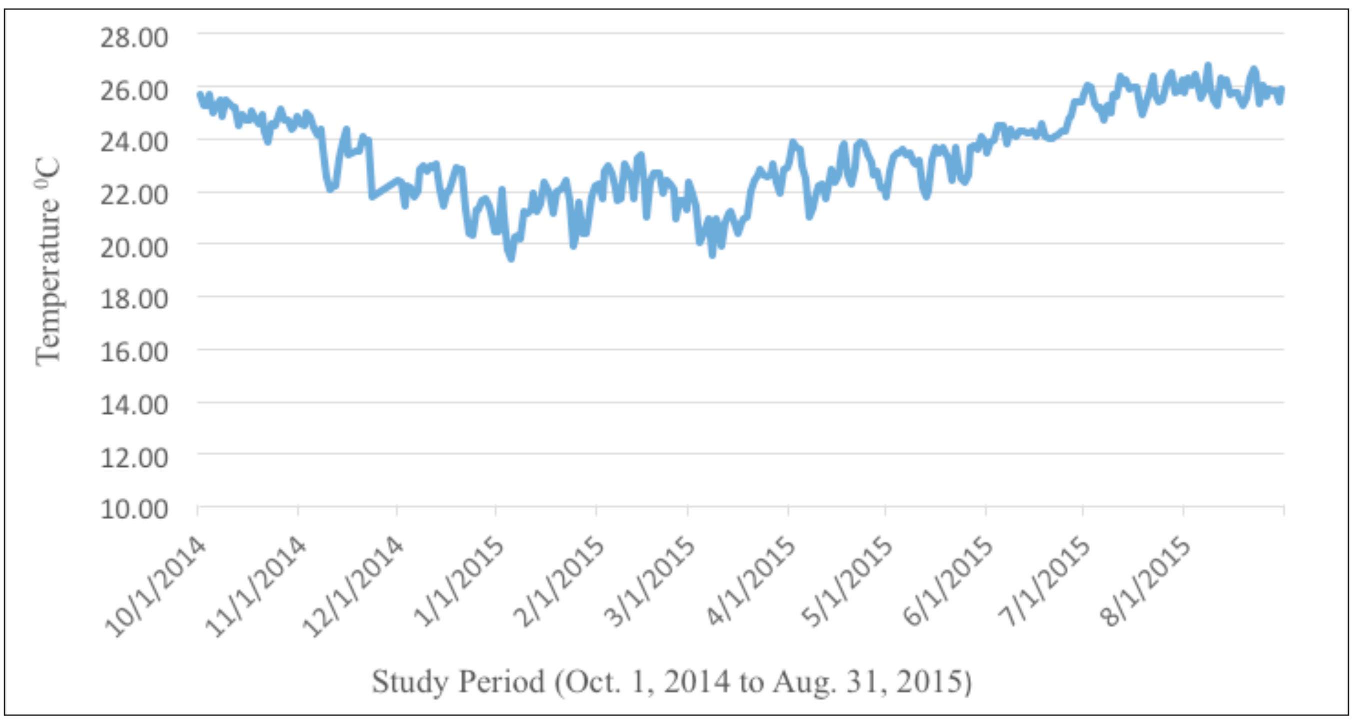

Figure 1. The ambient temperature at the field site where the grass grew. The growing periods after cut-backs were October 15, 2014–March 31, 2015 for the winter months and May 1, 2015–August 31, 2015 for the summer months.

The green and purple bana grasses were next to each other. Figure 4 shows the harvesting and counting of tillers. Harvesting was done to 33–35cm above ground. Jorgensen et al. (2010) reported that harvest at 10cm decreased dry-matter yield for five Napier cultivars they studied. Tillers were counted at the time of the first cut-back in October 2014 and at the end of the last harvest in August 2015.

Table 1a shows the dry-matter yield and the macronutrient analyses for the grasses. There were no statistical differences in the dry-matter yield (DM), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), non-fibrous carbohydrates (NFC), total digestible nutrients (TDN), and relative feed values (RFV). This is probably due to the small sample size. However, the analyses implied a numerical advantage for the purple bana, which had higher estimated DM yield per hectare per year and is more nutritious due to higher CP, lower ADF, higher NFC, and better RFV. The DM yields for both grasses, >1 ton/ac., are impressive, and the CP meets the nutrient requirements for cow–calf operations and even growing beef animals. The CP, ADF, NDF, and TDN values put the nutritive values of this grasses within the range of full bloom and mature alfalfa hay (Preston 2007).

There was also no difference between the green and purple bana in terms of minerals and essential amino acids (Table 1b). The information suggests that the levels of these nutrients in the forages should also support mid-level production for milk, 15–22kg/day, with the addition of some concentrate/grain supplementation. The nutrient values meet the needs of cow–calf operations and should support a decent average daily gain in growing cattle. Napier grasses (especially various dwarf varieties) are commonly used as a dairy forage in Africa (Jorge 2013, Orodho 2006) and for other livestock in Malaysia (Halim et al. 2013).

In the current study, the purple bana grass had higher yield than the green bana (3257.8kg/ha vs 2918.4kg/ha). This may be due to its hardiness and adaptability in the environment; we noticed new growth/shoots emerging from the harvested portion piled on the side, which was not observed with the green bana variety. The high biomass also makes this grass attractive for those who are interested in biofuels (Morais et al. 2009, Flores et al. 2012). In addition, this species of grass is drought tolerant, requires minimum fertilization, and is very efficient in fixing atmospheric CO_2 (Andrade et al. 2005).

Figure 5 shows the number of tillers/stems at the start and the end of the sampling season. Initially, the green bana had only 27 total tillers, while the purple bana had 127 tillers, a difference of 100 tillers, or 470%. By the end of the study period, ~10 months later, the green bana had 119 stems, a 340.7% increase. The purple bana stem count increased from 127 to 187 for the same period, a 47% increase. The data suggest that both varieties were tolerant to the 6-week harvest interval and that harvesting at 6-week intervals did not retard growth for either variety. In fact, the data sug-

Figure 3. Green bana grass in field 601 of HC & S, Maui.

Figure 4. Harvesting the grasses and counting the tillers/stems in a crown.

Table 1a. The dry-matter (DM) yield and nutrient analysis for bana grass grown in Maui (avg. ± SE), n = 6 for each cultivar.

Bana grass	DM kg/ha	Est. DM yield kg/ha/yr	CP (%)	ADF (%)	NDF (%)	NFC (%)	TFN(%)	RFV (%)
Green	2,918.4	25,302.5	12.42	39.6	66.8	6.18	59.0	81.2
±	600.2		1.4	1.0	1.4	0.8	0.9	2.7
Purple	3,257.8	28,234.3	15.68	37.25	62.78	6.62	60.3	89.0
±	464.1		1.2	1.2	1.6	1.0	0.8	3.5

Table 1b. Selected mineral and amino-acid analyses for bana grass grown in Maui (avg. ± SE), n= 6 for each cultivar.

Bana grass	Ca	P	K	Mg	S	Cl	Methionine	Lysine
Green	0.30	0.35	3.30	0.31	0.23	1.31	0.18	0.44
±	0.02	0.03	0.2	0.04	0.04	0.10	0.02	0.07
Purple	0.37	0.35	3.47	0.30	0.27	1.25	0.22	0.56
±	0.03	0.04	0.3	0.02	0.03	0.03	0.02	0.07

gest that cutting enhanced the growth of new stems, as demonstrated by the higher stem counts at the end of the sampling period in August 2015. Manyawu et al. (2003) and Omolo (2010) indicated that a 6- to 7-week harvest interval produced the most desirable nutrient levels and dry-matter yield. Longer harvest intervals provided higher dry-matter yield, but the quality of the forage decreased with age (Ansah et al. 2010, Omolo 2010).

The water-soluble carbohydrates (WSC) and the non-fibrous carbohydrates (NFC) were both affected by the time of harvest. In both cases, the late-afternoon harvest (1530h) yielded the highest concentration (Figure 6 and Figure 7). The studies on sugarcane “grasses” reported in our laboratory earlier showed a similar phenomenon (Lee et al. 2015). This information is important for those who practice the “cut-and-carry” system of livestock operation and those who intend to make silages from this forage. The higher carbohydrate content in the feed has been shown to contribute to greater intake and higher milk yield (Mayland et al. 2005, Burns et al. 2005, Huntington et al. 2005).

Impact

The high yields and hardiness of bana grass in Hawai‘i conditions should provide ranchers and other livestock producers with an alternative feed source that has not been tapped. The Islands have year-round growing conditions. In addition, managing the time of harvest will likely contribute to increased digestibility and intake in confinement operations. This forage can potentially reduce feed costs for ruminant producers. The current price for good-quality alfalfa hay in California is $110–142 per ton (Rankin 2016). Such hay imported from the mainland and transported to the farm site would be closer to $300 per ton due to handling and shipping costs. This suggests an estimated value of $3,600.00 per acre per year of feed at a farm site or import replacement.

Summary

The study showed that bana grass is vigorous in growth and at six-week harvest intervals yields desirable nutrients and dry matter for livestock. Under irrigation and some fertilizer application, it is possible to produce a

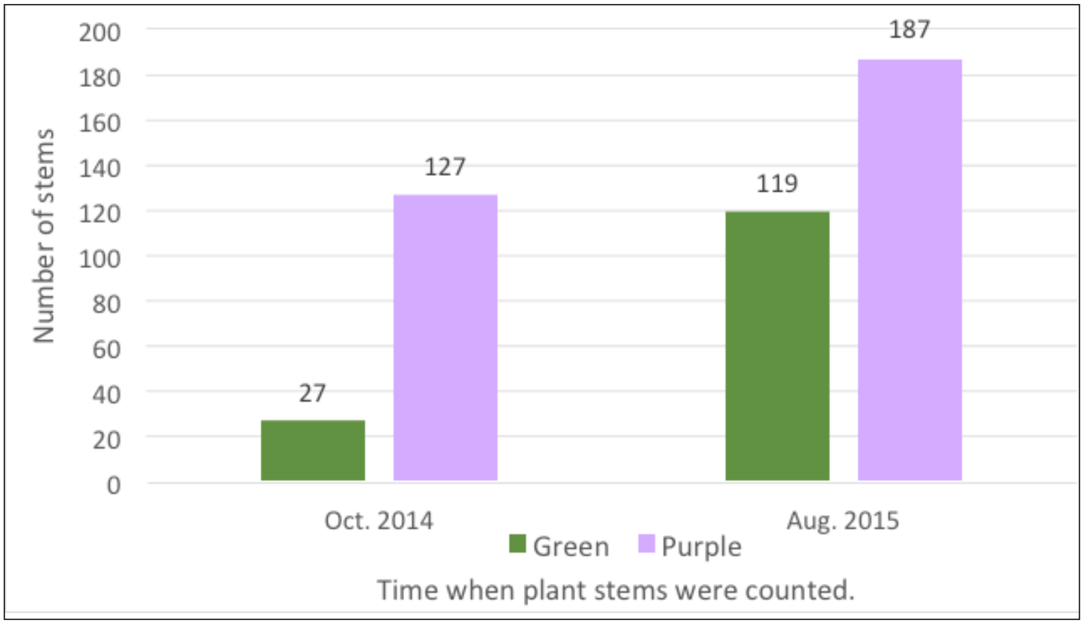

Figure 5. The number of tillers for green and purple bana grass at the start of the sampling period (Oct. 2014) and the end of the sampling period (Aug. 2015).

Values indicated by different superscripts differ (P<0.05)

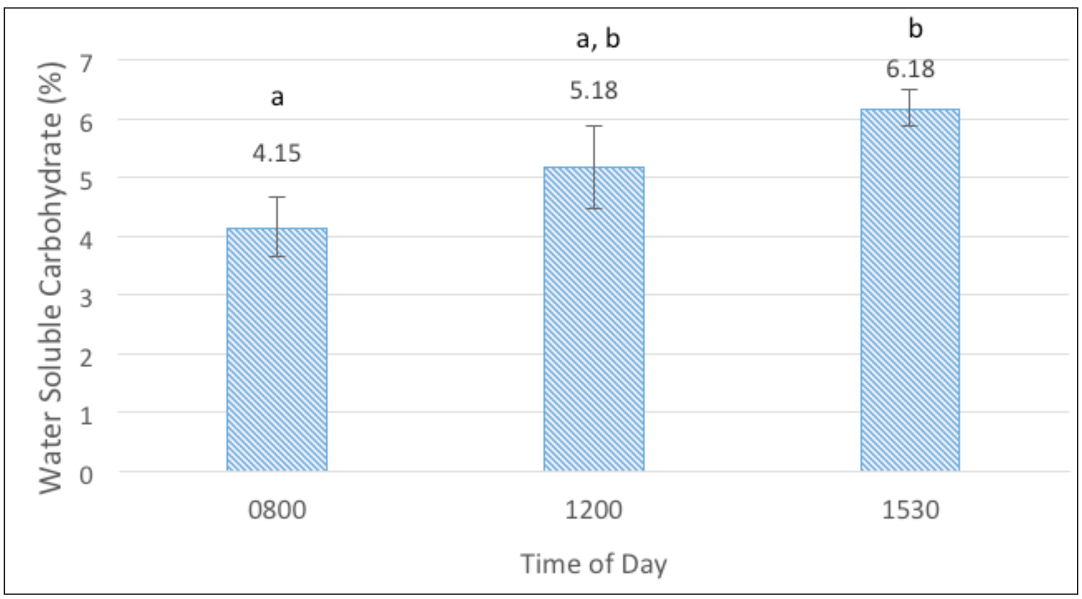

Figure 6. The amount of water-soluble carbohydrates was influenced by the time of harvest (n=4). Mean values are provided.

Values indicated by different superscripts differ (P<0.05)

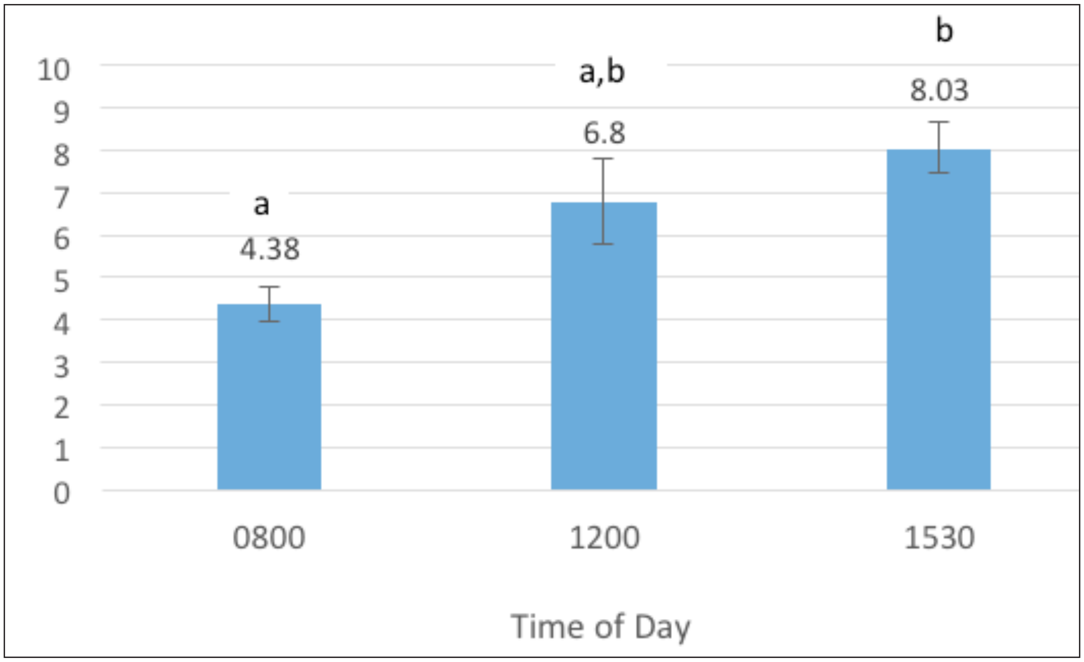

Figure 7. The amount of non-fibrous carbohydrates was influenced by the time of harvest (n=4). Mean values are provided.

ton of dry matter per month as feed. This grass has the potential to mitigate one of the limiting factors identified for grass-fed beef in Hawai'i. Other varieties of Napier grass, especially the dwarf cultivars, also should be examined and considered for grazing conditions.

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