CHANGES IN AGRONOMIC CHARACTERISTICS WITH MATURITY OF ERIANTHUS IK-76-110

P. Mislevy[1], F. G. Martin[2], M. B. Adjei[3], and J. D. Miller[4]
[1] Range Cattle Research and Education Center, University of Florida, Ona, Florida 33865, USA;
[2] Dept. of Statistics, University of Florida, Gainesville, Florida 32611, USA;
[3] Agricultural Experiment Station, University of the Virgin Islands, St. Croix, USVI 00850;
[4] USDA-ARS, Sugarcane Field Stn., Canal Point, FL 33438

ABSTRACT
Optimal production of energy from biomass necessitates the identification and management of high yielding plant entries. *Erianthus arundinaceum* (Retz) Jesw. IK-76-110 was tested to determine the influence of harvest treatments at heights of 1.2, 2.5, and 3.7 m and mature in October (4.9 m), and mature in December (4.9 m and in flower) on agronomic characteristics from 1987 to 1990. All treatments received 25 kg ha^{-1} P and 93 kg ha^{-1} yr^{-1} K in one spring application and 336 kg ha^{-1} N in split applications applied prior to the growth of each harvest. An additional October treatment at the mature stage received similar P and K but only 168 kg ha^{-1} N. Plants repeatedly harvested (4 yr) at the 1.2 m height produced low dry biomass (DB) yields (5.2 Mg ha^{-1}) and had a 100% plant stand loss, whereas plants harvested at mature stage December had a 51.5 Mg ha^{-1} average yield with no plant loss. Leaf area index was maximum (17) at 3.1 m plant height. Nitrogen concentration and IVOMD in plant tissue decreased with maturity. Harvesting Erianthus at 2.5 m and up to maturity produced high DB yields with extended stand longevity.

KEYWORDS
Biomass, tall grass, energy.

Introduction
The oil embargo during 1973 has given rise to the development of an alternative energy program. Alternative fuels can be produced from domestic feedstocks (Lynd *et al*., 1991) thereby reducing the need for foreign oil. Tropical and subtropical regions of the world have favorable climates for extended plant growth and high yields, with lignocellulosic biomass as the most attractive renewable energy source. These warm regions support grass plants with an efficient C_4 metabolic system that returns 4-5 units of energy for each unit used (Bassham, 1993). Erianthus is tolerant to most plant pests and has the ability to produce high biomass yields with limited fertility, cultural practices, and moisture. This genera will also tolerate saturated soil conditions, making it adaptable to tropical lowlands. The purpose of this research was to determine change in dry biomass (DB) yield, ratoon success, leaf area index, and quality of biomass, as influenced by harvest maturity stage.

METHODS
The experiment was conducted from 1987 to 1990 at the University of Florida, Range Cattle Research and Education Center, Ona, FL (27° 25' N, 81° 55' W). The soil was an Ona fine sand (sandy, siliceous, hyperthermic, Typic Haplaquod). The experiment was established using rooted crowns planted 0.8 m apart within the row and 0.9 m between rows. Harvest treatments were initiated on well established plants 1.5 yr after planting. Treatments were harvested when plants attained heights of 1.2, 2.5, and 3.7 m, (plants measured at crest of recent expanded leaf), two mature stages in October (4.9 m) and mature stage in December (4.9 m, in flower) for DB yield and ratoon success. All treatments received 25 kg P ha^{-1} and 93 kg K ha^{-1} plus 11.2, 2.8, 1.0, 0.5, and 0.5 kg ha^{-1} of S, Fe, Mn, Cu and B in a single spring application and 336 kg N ha^{-1} in a single or split application prior to regrowth (Table 1). Treatments not split (Table 1) received total N in March. One October treatment received similar P and K but only 168 kg N ha^{-1} yr^{-1}. Field plot layout was a randomized complete block with six harvest treatments and four replications. Each treatment was 4.5 x 4 m with a 3 m border. A strip of biomass was harvested to a 10-cm stubble, weighed, and a 1 kg subsample was chopped and dried at 60 °C for percentage DB determination and yield. A subsample was ground to pass a 1-mm stainless-steel screen and analyzed for total N, (Gallaher *et al*., 1975; Hambleton, 1977) and IVOMD (Moore and Mott, 1974). Leaf Area Index (LAI) was determined during 1987 and 1988 (Mislevy *et al*., 1992).

RESULTS AND DISCUSSION
Dry biomass production. Harvest treatments for DB yields were not consistent over years, resulting in a significant (P<0.05) treatment x year interaction. Harvesting Erianthus IK-76-110 each time plants attained 1.2 m, resulted in low average DB yield yr^{-1} (5.2 Mg ha^{-1}) and a 100% yield reduction after two ratoon years of harvest (Table 1). A similar yield reduction was obtained for energycane entries (Mislevy *et al*., 1995; Mislevy *et al*., 1992). All harvest treatments from the 2.5 m height and above averaged high DB yields ranging from 30.0 to 51.5 Mg ha^{-1}. This results in a 5- to 10-fold increase when compared with average yield from the 1.2 m treatment. The removal of a single harvest at the mature stage in October or December produced the highest (P<0.05) average DB yield ranging from 46.8 to 51.5 Mg ha^{-1}, respectively.

These harvest treatments with the exception of the 3.7 m treatment, had little or no plant stand loss (0 to 2%) after three years of ratoon harvest. Unlike energycane (Mislevy *et al*., 1995; Mislevy *et al*., 1992) the third ratoon crop for three of the five most mature treatments yielded equal or more DB than the initial harvest year. Decreasing total N from 336 kg ha^{-1} to 168 kg ha^{-1} for the October harvest resulted in a decrease (P<0.05), with a 4 yr average of 46.8 and 34.7 Mg ha^{-1}, respectively. All harvest treatments except the 1.2 and 2.5 m treatments had a decrease (P<0.05) in DB yield during the first (1988) and second (1989) ratoon years. Unlike the energycane (Mislevy *et al*., 1995; Mislevy *et al*., 1992) Erianthus had a DB yield increase (P<0.05) in the third ratoon year for most treatments.

The LAI determined at 0.6 m increments increased quadratically to 17.3 (3.1 m plant ht) followed by a decrease as plants attained a height of 4.3 m (Fig. 1). The LAI for Erianthus is about 4 units higher than for energycane entries (Mislevy *et al*., 1992; Mislevy *et al*., 1993).

Nitrogen concentration and IVOMD (estimate of soluble cell solids). Nitrogen concentration and IVOMD of whole plants was year dependent. Harvesting plants at the 1.2 m stage, had the highest N concentration (14 g kg^{-1}) and IVOMD (446 g kg^{-1}), compared with the more mature treatments. Delaying harvests from 2.5 m (7.0 g kg^{-1} N; 344 g kg^{-1} IVOMD) to mature December (3.0 g kg^{-1} N; 250 g kg^{-1} IVOMD), resulted in a decrease (P<0.05) in both N and IVOMD. The major drop in DB quality was between the 3.7 m and mature October treatments, decreasing 73% in N and 38% in IVOMD.

In conclusion, DB production and N concentration of Erianthus is similar to selected energycane entries referenced earlier, however LAI in Erianthus is significantly higher and IVOMD is significantly lower.

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Figure 1
Influence of *Erianthus arundinaceum* IK-76-110 plant height on leaf area index (LAI) during 1987 and 1988.

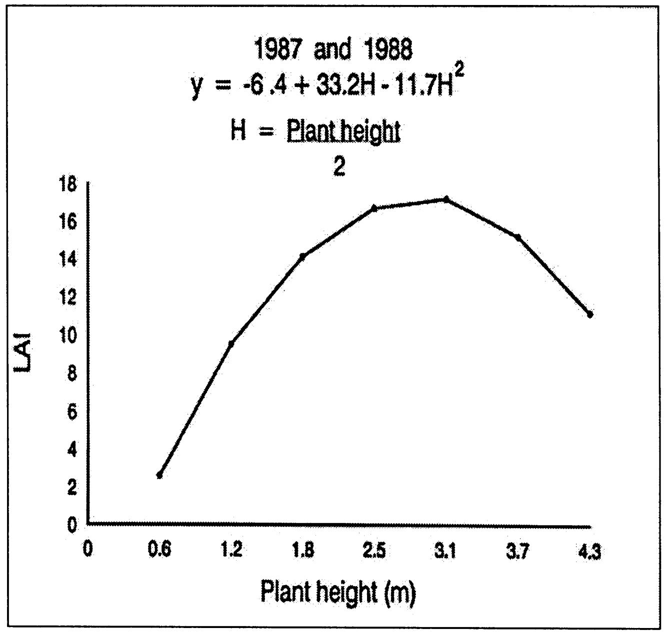

Table 1
Influence of harvest height/date on dry biomass (DB), average yearly DB, yield reduction and plant stand loss of Erianthus IK-76-110, following 4 yr of harvest.

Harvest treatment	Initial harvest year 1987	Ratoon years 1988	1989	1990	Average DB yr^{-1}	After 3-ratoon yr: Yield reduction	Plant stand loss
	Mg ha^{-1}						
1.2 m (336,4)[z]	12.8 e A	6.5 c A	1.6 c A	0.0 d A	5.2 d	100	100 a
2.5 m (336,2)	34.6 d A	28.5 b A	21.6 b AB	35.3 c A	30.0 c	0	2 c
3.7 m (336,1)	45.5 cd A	22.1 b B	27.2 b B	55.1 ab A	37.5 b	0	30 b
Mature, Oct[y] (336,1)	64.9 a A	32.9 ab B	45.5 a B	43.7 bc B	46.8 a	33	2 c
Mature, Oct (168,1)	47.3 bc A	29.1 ab B	28.2 b B	34.1 c AB	34.7 bc	28	0 c
Mature, Dec (336,1)	59.8 ab A	40.3 a B	46.4 a B	59.4 a A	51.5 a	1	0 c

a, b, c Means within columns (a, b, c) and rows (A, B, C) not followed by a common letter are significantly different at the 5% level (Waller-Duncan k-ratio, k=100).
[z] Indicates total N applied yr^{-1} (kg ha^{-1}), number of N applications yr^{-1} to obtain total applied.
[y] Indicates month treatment harvested.