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## A MAKUENI GUINEAGRASS SELECTION SHOWS POTENTIAL AS A SUMMER FORAGE OR ENERGY CROP

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### Abstract

Selected clones of Makueni guineagrass (Panicum maximum) were grown for two years at Davis, California. Yields were 37 metric tons per hectare during the 8.5 month growing season in 1981. Guineagrass is a potential source of both forage or energy biomass, and its productivity compares favorably with other highly productive species.


### Introduction

The most common improved pasture grasses of the humid tropics and subtropics are cultivars of guineagrass. The guineagrasses are especially noted for their high yields, persistence under grazing, ease in planting by seed, and low seed cost. Cultivars have been selected for adaptation to many climates. "Colonial guineagrass" is popular in Brazil, while "common guineagrass" and "green panic" are widely used in Australia. Certain types are weeds in California and Florida.

Makueni guineagrass was collected in the Makueni district of Kenya. Plants were transferred to Kitale, Kenya in 1962 and given the Grassland Research Station introduction number K6221. Makueni was introduced into Australia in 1965 as CPI 37910 where it has undergone extensive evaluation in north eastern Australia (Anon. 1974). Makueni seed from Australia was evaluated at the Instituto de Pesquises IRI, Matao, Sao Paulo, Brazil. Seed from IRI was introduced into California in 1978.

Makueni guineagrass has attracted attention in the subtropics because its growth is not concentrated exclusively in the warm season, since it is also productive in the cooler parts of the year. Cultivation of Makueni guineagrass has spread in Australia and Brazil where other guineagrasses grow but where their productivity is limited by cool weather. It extends the useful climatic range of guineagrass to cooler areas.

Makueni guineagrass was introduced to California because it had the potential to produce forage over a long growing season including spring and fall months when night time temperatures are cool but above freezing. Winter forage production was not contemplated since temperatures of 0 C burn the leaves. Seed from Brazil was planted in a greenhouse at Davis

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and transplanted to the field in July 1979. Most of the plants died during the winter of 79-80. In the spring of 1980 the three surviving plants were increased, and no plant death was observed during the mild winter of 1980-81.

Makueni yield trial

An area of 4.5 x 20 m of Makueni guineagrass was planted vegetatively in 1980 from the survivors of the winter of 1979-80. The planting was made in rows 91 cm apart and 30 cm between plants. No fertilizer was used that season. The area was harvested twice during the growing season, but it was managed for the harvest of seed and not for biomass.

Growth ended in mid-November of 1980. Resprouting started in mid-March 1981, and appreciable growth occurred after mid-April. Growth of seedling volunteers was prolific within and outside of the experimental area in the spring. None of the established plants died over the winter period (Table 1).

Table 1. Dates and temperatures at or below 0 C at the Agronomy Farm at UC Davis during the winter of 1980-81. These temperatures killed none of the plants that had survived the previous winter.

| Date | Temperature (C) |
|---|---|
| November 14 | -2 |
| 20 | 0 |
| 25 | 0 |
| 26 | -2 |
| 27 | -1 |
| 28 | 0 |
| December 1 | -1 |
| 6 | -1 |
| 9 | -1 |
| 10 | -2 |
| 11 | -2 |
| 12 | -2 |
| 13 | -3 |
| 14 | -3 |
| 15 | -1 |
| 16 | 0 |
| January 25 | 0 |
| February 1 | 0 |
| 3 | 0 |

The area received eight irrigations and one fertilization, 200-50-0 ($N-P_2O_5-K_2O$) during the growing season. Harvests of forage were made on June 13, September 29, and November 27 with five replicates and dried at 70 C. At each harvest the grass was clipped back to 20-cm height. A 20-cm stubble was retained even at the final harvest to enhance survival. Short clipping heights have been shown to dramatically decrease guineagrass productivity (Grof and Harding, 1970). An adequate border was maintained around the sampled plot areas.

## Results

Yields were high and well-distributed over the growing season. However, little biomass was produced during the final two months (Table 2). Dry matter yields were 1.03 $kg/m^2$ for the first three months, 2.29 $kg/m^2$ for the next 3.5 months and 0.39 $kg/m^2$ for the final two months of 1981 growing season (Figure 1) or a total of 37 metric tons DW/ha. Forage quality has not yet been determined.

The forage height was 1.4 m, 1.6 m and 1.2 m respectively at the three harvests. At the first harvest flowering was just starting, at the second harvest seeds were maturing, and at the third harvest no flowering was evident.

Table 2. Yields of Makueni guineagrass at Davis, California (1981). The grass was clipped 3 times at 20-cm height.

| Replicate | June 13 | Harvest Dates<br>Sept. 29 | Nov. 27 | Total |
|---|---|---|---|---|
| | | DW $kg/m^2$ | | |
| 1 | 1.10 | 2.47 | 0.57 | 4.14 |
| 2 | 1.13 | 2.20 | 0.37 | 3.70 |
| 3 | 1.14 | 2.36 | 0.29 | 3.80 |
| 4 | 1.03 | 2.18 | 0.30 | 3.51 |
| 5 | 0.75 | 2.12 | 0.40 | 3.37 |
| Av. | 1.03 | 2.29 | 0.39 | 3.70 |
| s.d. | 0.16 | 0.12 | 0.11 | 0.30 |

## Makueni yields compared with sorghum

Makueni planted in this trial outyielded recorded results for forage sorghum in California. Sumner (1963) reported maximal yields of 27 metric tons DW/ha among several sudangrass lines or hybrids. Worker (1964) reported maximal yields of 28 metric tons DW/ha among sudan types in the Imperial Valley. Later Worker (1976) demonstrated that yields as high as

32 metric tons DW/ha could be obtained with hybrid sudangrass, if there was only one harvest. Forage quality declines with increasing interval between harvests. To adequately compare Makueni guineagrass with sudangrass, both yields and quality would have to be compared over a period of years at any location.

## Yields compared with other locations

Guineagrass has been shown to produce 26 tons DW/ha-yr in Puerto Rico with 440 kg N/ha-yr (Vicente-Chandler et al. 1959). Using various guineagrasses in Queensland, Australia, Grof and Harding harvested 16 to 27 kg DW/ha-yr depending on the cultivar. The Makueni cultivar produced 23 kg DW/ha-yr with 220 kg N/ha applied. When the clipping frequency is extended to 90 days Vicente-Chandler et al. (1974) showed that guineagrass yields can reach 41 tons DW/ha-yr. These yields were achieved with a 12-month growing season and 220-0-220 kg/ha-yr of $N\text{-}P_2O_5\text{-}K_2O$ fertilization. The yield of 37 tons DW/ha achieved at Davis in a 8.5 month growing season may be related to the fertile soil, high summer light intensities, low summer night temperatures (reducing respiration), and timely irrigation. Also at Davis during the same period George, Shock, and Sands (unpublished) harvested 21 tons DW/ha in 1980 and 18 tons DW/ha in 1981 from small plots. The latter plots were seeded with plant material that had not been screened for survival at Davis and had poor plant stands. The greater cold tolerance by the lines used in this study has not been conclusively proved.

## Makueni as an energy crop

Tropical grasses have been suggested as potential sources of biomass for energy production. The biomass yields reported here would be comparable to the best recorded for a long season crop at this latitude. Energy production from agriculture may not be commercially feasible due to competition for scarce land, fertilizer, and irrigation water by other uses. Assuming that energy production from agriculture may be possible, various studies have been conducted to evaluate crops which are sources of starch, sugar, or other easily hydrolyzed carbohydrates for ethanol production. All the energy costs of production and energy requirements of distillation of the ethanol need to be included in the energy budgets for these crops. Alternatively when enzymes become available fiberous carbohydrates may be hydrolyzed to simple sugars for alcohol production. Another approach would be to produce low cost photosynthetically efficient plant material and convert the entire biomass to methanol as a liquid fuel. The comparative efficiencies of these approaches are not known.

Since efficient methanol production methods are available (Kohan and Barkhordar, 1979), 37 tons/ha of grass with an energy content of 4 kcal/g can be converted to 19,900 liters/ha of methanol. Using the conversion factor of 3.785 liters/gallon, the production would be 5,260 gallons/ha of methanol. Methanol has only 75.4% of the fuel value of ethanol so this would be equivalent to 3,970 gallons/ha of ethanol (Williams, 1980).

## Conclusion

A clonal selection of Makueni guineagrass has demonstrated the yield potential of a subtropical grass as cut forage or biomass energy source in California. Productivity of this grass is very favorable compared with alternative species in use or under study. A thorough screening of subtropical grasses for use in California may uncover several promising grasses like Makueni guineagrass.

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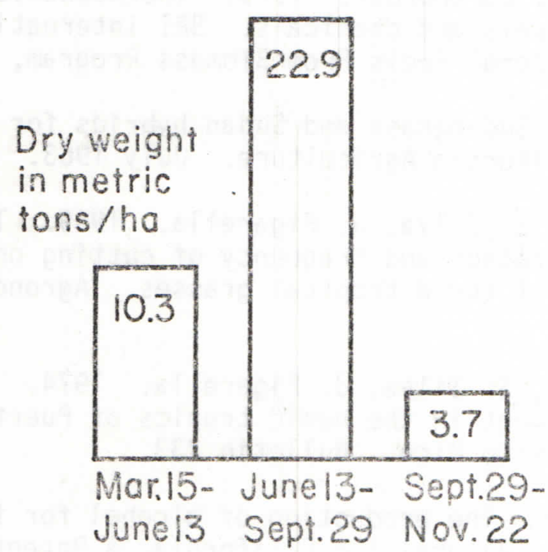


Figure 1. Yield distribution of Makueni guineagrass during the 1981 growing season at Davis, California.