

Forage Potential of Photoperiod—Sensitive Millet (*Pennisetum Americanum* (Linn.) K. Schum.) in South- Western Nigeria

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SUMMARY

IN Nigeria, millet, an important cereal of the dry tropics, could be grown for forage in the low land forest zone where it is not normally cultivated and where the rainy season lasts eight or more months.

To determine its potential as an annual forage, 'maiwa', which is a short-day photoperiod-sensitive millet (*Pennisetum americanum* (Linn.) K. Schum.), was evaluated in 1972 along with the following promising genotypes of three perennial forage grasses, for comparisons: Nchisi variety of Guinea grass (*Panicum maximum* Jacq.) S. 112, elephant grass (*Pennisetum purpureum* Schum.) S. 12 a local selection, and F₁ *Pennisetum* hybrid No. 18 an interspecific hybrid of 'maiwa' millet and elephant grass. The perennial grasses were harvested every five weeks for dry matter (DM) yield estimation while 'maiwa' was first harvested five weeks after sowing and then every four weeks thereafter.

Both total and daily DM production of 'maiwa' were significantly lower than those of all the perennial grasses. Annual DM production, average daily DM production and average DM content of 'maiwa', Guinea grass, elephant grass and the F₁ *Pennisetum* hybrid were, respectively 10510, 18731, 16796 and 14900 kg/ha; 51.77, 89.19, 80.00, and 70.95 kg/ha; and 14.12, 19.32, 12.46 and 14.30%. However 'maiwa' contained significantly more leaf in the freshly cut herbage with 55% compared to 46, 43 and 43% for Guinea grass, elephant grass and F₁ *Pennisetum* hybrid No. 18 respectively. When cut at four and five weeks crude protein (CP) values of 'maiwa' were 17.41 and 15.78% of DM respectively and were higher than those of Guinea grass (10.94 and 10.14%), elephant grass (12.68 and 11.17%) and the F₁ *Pennisetum* hybrid (14.49 and 13.52%). Crude fibre (CF) values of 'maiwa' at four and five weeks were 26.06 and 27.95% of DM respectively while those of the perennial grasses ranged between 26.14 and 28.61% and 27.35 and 30.64%, respectively. Mortality of 'maiwa' stands increased from 6% early in the rainy season to 75% at the beginning of the dry season when the study was terminated. When grazed in 1975, 66.7% of 'maiwa' DM on offer was consumed.

The results indicated a superiority in quality of 'maiwa' forage. Improvement in the

level and seasonal distribution of 'maiwa' herbage production as well as quality can be realised through suitable agronomic practices as well as breeding.

INTRODUCTION

MILLET (*Pennisetum americanum* (Linn.) K. Schum., formerly *P. typhoides* S & H) is an important annual bunch grass widely cultivated for grain in the hot dry tropics such as the drier parts of northern Nigeria where it is a staple cereal in many areas. Millet, however, also produces good quality forage and in the south-eastern United States for example, it is the most important summer forage crop (Burton and Powell, 1968). Its lack of prussic acid at all stages of growth is one of the characteristics that have enhanced its forage value (Burton, 1962). Short-day photoperiod-sensitive millets which are late maturing give a better seasonal distribution of forage, are easier to manage, more persistent, leafier, higher in protein and more digestible than early ones (Burton, Gunnells and Lowrey, 1968; Burton and Powell, 1968).

In northern Nigeria the local short-day photoperiod-sensitive 'maiwa' millet has shown promise as a silage crop and it is also occasionally used for supplemental fodder (Foster and Mundy, 1961). Furthermore, in studies conducted in the forest zone of south-western Nigeria the superior quality of interspecific F₁ *Pennisetum* hybrids between 'maiwa' millet and elephant grass (*P. purpureum*) was attributed to the 'maiwa' parent (Aken'Ova, Chheda and Crowder, 1976). Its importance as a cereal would however continue to restrict the utilisation of millet for forage or fodder in the foreseeable future in northern Nigeria. On the other hand

there is a potential for the exploitation of millet for forage in the derived savanna and forest zones of the south where it is not normally cultivated and the rainy season lasts eight or more months. It could, for instance, be grown for grazing, silage or silage in a mixed farming system.

This study was therefore initiated in 1971 to determine the forage potential of 'maiwa' in terms of dry matter production, chemical composition, leafiness, persistence when cut regularly or grazed and acceptability to livestock. The information thus accumulated would provide a basis for future 'maiwa' forage breeding programmes.

MATERIALS AND METHODS

The following genotypes of three perennial bunch type forage grasses were included in this study for comparisons with 'maiwa' millet: (a) Nchisi variety of Guinea grass (*Panicum maximum* Jacq.) S. 112, obtained from the University of Ife, (b) elephant grass (*Pennisetum purpureum* Schum.) S. 13 a promising selection in the University of Ibadan collection and (c) F₁ *Pennisetum* hybrid No. 18 which is representative of the more promising interspecific F₁ hybrids of 'maiwa' and elephant grass.

The experimental site, on the University Teaching and Research Farm at Ibadan, was topdressed with 5t/ha of farmyard manure prior to land preparation. A randomised complete block layout with four replications was adopted. On September 8, 1971 crown splits of the perennial grasses were set in plots measuring 3.05 x 4.55m at 91 x 61cm spacing which is that usually utilised in the Department of Agronomy, University of Ibadan, when the grasses are grown for grazing. In mid-November the plants were pruned with machetes to about 45cm height to control flowering and aid uniform establishment. Plants were not cut in the ensuing dry season.

The perennial grasses were cut at 30cm above ground level in April 6, 1972 but no yield data were taken as herbage produced was taken to represent the preceding dry season's production. When

rainfall had stabilised, seeds of 'maiwa' were drilled thickly by hand on April 20 at the rate suggested by Burton and Powell (1968) of 11.2 kg/ha in rows 76cm apart. 'Maiwa' plots consisted of four rows 3.66m long and six such plots were established, four for herbage yield estimation and two for estimation of stand mortality.

Following the April 6 cut the perennial grasses were harvested every five weeks, the interval commonly employed by the Department of Agronomy, University of Ibadan in cutting these grasses to simulate grazing. At each harvest plants were cut 30cm above ground level and herbage from the nine stands in the inner rows was weighed for fresh yield. 'Maiwa' millet was cut also 30cm above ground level five weeks after sowing when a continuous canopy was established. Cut herbage from the middle two rows of each 'maiwa' plot was weighed for fresh yield. Subsequent harvests of 'maiwa' were carried out at four-week intervals. The choice of a four-week interval was made on the basis of studies and recommendations by Burton (1962) and Burton *et al* (1968). Plant height was measured just prior to each harvest of all entries, and records of flowering kept.

All plots were fertilized at an annual rate of 224kg N/ha as urea applied in equal split doses after each harvest except the last. 112 kg/ha each of K₂ as muriate of potash and P₂O₅ as triple superphosphate were also applied in two equal instalments, at the beginning and middle of the season.

At every harvest about 500g fresh sample of each entry was taken from each plot in all replicates and dried at 70°C to a constant weight in a forced air oven for percentage dry matter (DM) determination. Dried samples taken on July 20, when all four entries were harvested simultaneously, as well as on the following two harvests of each entry were milled and analysed for crude protein (CP) and crude fibre (CF) according to the A.O.A.C. (1970) methods of analysis. In order to obtain comparative data of chemical composition between 'maiwa' and the perennial grasses at similar growth stages samples for chemical analyses were taken from some border row plants of 'maiwa'

and the perennials five and four weeks respectively after the July 20 harvest.

About 1 kg fresh sample of cut herbage at each harvest was separated into leaf blades and stems which included the leaf sheaths and each portion weighed to determine the proportion of leaf in the herbage.

To facilitate the determination of stand number the 'maiwa' plots set aside for estimating plant mortality were thinned, two weeks after sowing, to leave one plant every 10 to 15 cm in each row. Cutting and fertiliser management practices on these and on plots for yield estimation were the same. A stand count was taken in the middle two rows of both plots at the first harvest and then at every harvest thereafter. The difference between each harvest and the first, expressed as a percentage of the number of stands at the first harvest, provided a measure of stand mortality.

The perennial grasses were harvested for the last time on November 2, 30 weeks after the first cut following the 1971 dry season and the experiment was terminated at the onset of the dry season after the final 'maiwa' harvest on November 9, 29 weeks after sowing. Analyses of variance and tests for significant difference among means, using Duncan's multiple range test, were conducted as described by Little and Hills (1972).

Rainfall data were obtained from records of the Department of Geography (1972), of the University of Ibadan.

In 1975 'maiwa' seeds were drilled at the rate of 11.2 kg/ha in rows 76 cm apart on a 0.04 ha plot on May 15. The plot was then grazed by a zebu dairy herd numbering 20, starting on June 19, at intervals ranging from three to five weeks depending on rate of plant regrowth. Thus, the plot was grazed five times during a 21-week period from planting to the final grazing on October 9. Plants were cut back to leave a stubble 30 cm in height after each grazing. At the third grazing the amount of herbage on offer as well as residual herbage after grazing were estimated by weighing, in each case, herbage

cut 30 cm above ground level from three randomly selected quadrats each measuring 2.28 m square. DM content was determined by oven-drying fresh samples and hence total DM on offer as well as residual DM. DM consumed was calculated as the difference between the estimated herbage on offer and residual herbage. This difference expressed as a percentage of herbage offered gave an estimate of utilisation.

After grazing on October 9 surviving plants were allowed to grow till flowering and open pollinated seeds were harvested to provide material for future 'maiwa' forage improvement programmes.

RESULTS

The total and average daily DM production of 'maiwa' millet were significantly lower than those of each of the perennial grasses which produced between 42 and 78% more total DM than 'maiwa' (Table 1). DM content of 'maiwa', Guinea grass, elephant grass and F₁ *Pennisetum* hybrid No. 18 averaged over all harvests were 14.12, 19.32, 12.46 and 14.30% respectively.

On an average, the perennials were significantly taller than 'maiwa' at the time of harvest (Table 1). However, plant height of each entry in the study appeared to closely parallel its herbage yield variations (Figure 1).

DM content, DM production and plant height varied among harvests, reflecting the physiological state of the plant during vegetative and flowering phases as well as seasonal changes in various environmental factors particularly soil moisture availability as influenced by rainfall (Figure 1). The rainfall data in Figure 1 show the amount of rainfall received in the interval before each harvest.

When averaged over all harvests, 'maiwa' had a significantly higher proportion of leaf in the freshly cut herbage than any other entry in the study, with 20% more leaf than Guinea grass the most leafy of the perennial grasses (Table 1).

Mortality of 'maiwa' stands increased progressively with each harvest from about 6% at the second harvest to 75% at the

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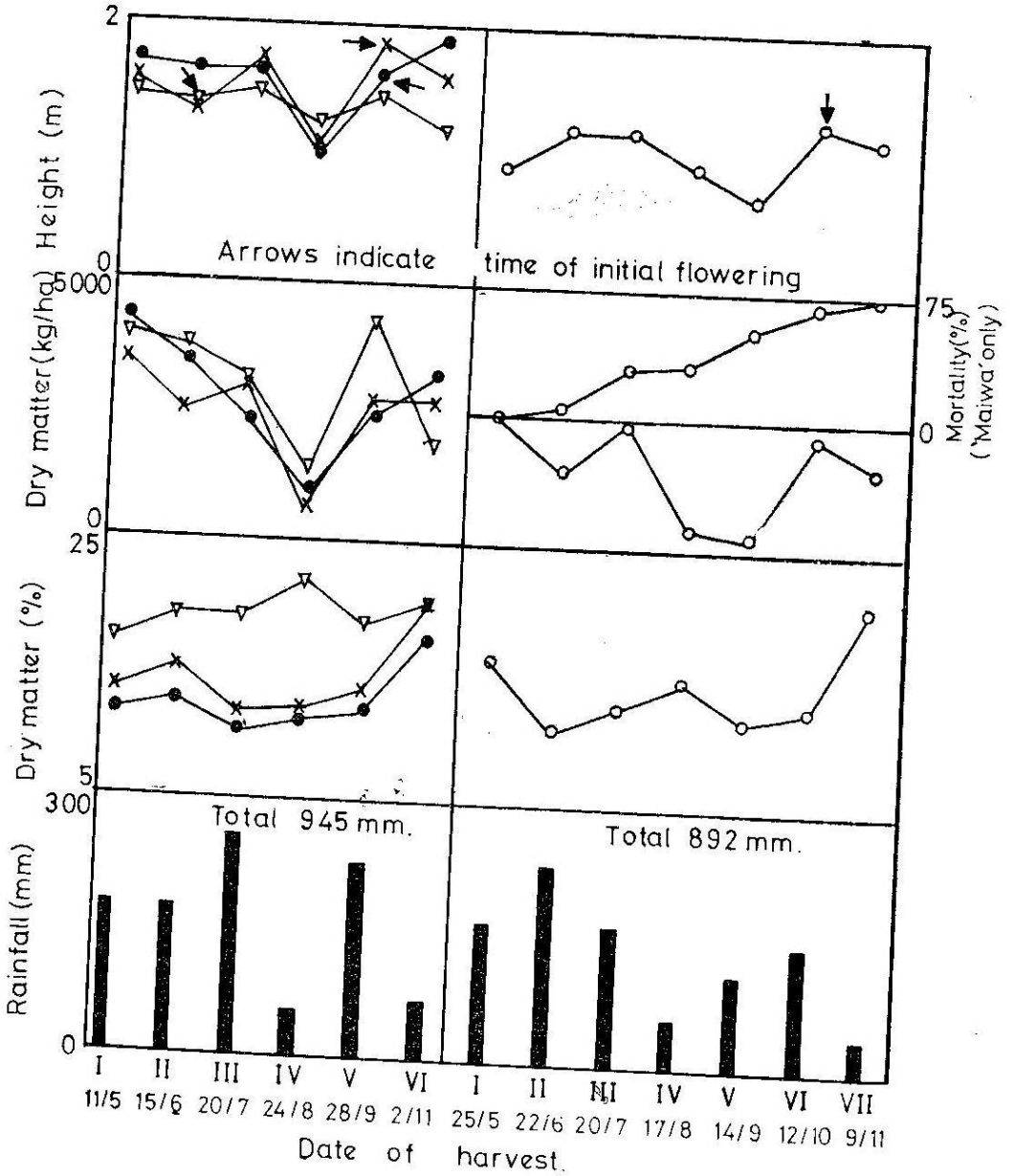


Figure 1: Seasonal variation of some characteristics of 'maiwa' millet (o), Guinea grass S.112 (V), elephant grass S.13 (o) and F₁ Pennisetum hybrid No. 18 (x) in 1972.

TABLE 1

Dry matter production, plant height and some quality characteristics of 'Maiwa' millet, compared with three perennial forage grasses in 1972.

Entry	DM in kg/ha*		Height* (m)	Leaves* (% fresh herbage)	CP (% DM) + when cut after:		CF (% DM) + when cut after:	
	Total	Daily			4 weeks	5 weeks	4 weeks	5 weeks
	'Maiwa' millet	10510c	51.77c	1.04c	55a	17.41a	15.78b	26.06a
Guinea grass S-112	18731a	89.19a	1.37b	46b	10.94b	10.14a	28.61b	30.64a
Elephant grass S-13	16796ab	80.00ab	1.58a	43c	12.68b	11.17a	26.14b	29.59a
F1 <i>Pennisetum</i> hybrid No. 18	14900b	70.95b	1.52a	43c	14.49b	13.52a	26.31b	27.35a

* Values in a column followed by a common letter do not differ significantly at the 5% level.

a Average of three harvests; b One harvest.

final harvest (Figure 1). Mortality of individual tillers but not of entire stands occurred among the perennial grasses.

F1 *Pennisetum* hybrid No. 18 contained more CP than the other perennial grasses when cut after either four or five weeks of growth (Table 1). However, 'maiwa' CP values were 20 and 17% higher than those of the F1 *Pennisetum* hybrid genotype at four and five weeks, respectively (Table 1). When cut after four weeks of growth the CF content of 'maiwa' was similar to those of elephant grass and the F1 *Pennisetum* hybrid but was about 9% lower than that of Guinea grass while after five weeks 'maiwa' and the F1 *Pennisetum* hybrid had the lowest CF values (Table 1). CP content of all entries decreased while their CF increased between four and five weeks of growth (Table 1), indicating the physiological changes that lead to the decline in forage quality commonly associated with increased age. 'Maiwa' CP fell and its CF increased by 9 and 7%, respectively compared to 7 to 12% and 4 to 13%, respectively among the perennial grasses. Elephant grass showed the greatest percent change among all entries in CP and CF content and F1 *Pennisetum* hybrid No. 18 the least.

'Maiwa', elephant grass and F1 *Pennisetum* hybrid No. 18 started flowering in late September towards the end of the rainy season while Guinea grass commenced in June (Figure 1).

Utilisation of DM by grazing cattle when estimated in 1975 was 66.7%

DISCUSSION

It is evident that the high plant mortality of 'maiwa' was an important contributory factor to its comparatively low DM production. High plant or tiller mortality is generally associated with frequent cutting, as employed for 'maiwa' in this study (Blaser, Brown and Bryant, 1966; Langer, 1963). However, as a cross-fertilized species, any unimproved 'maiwa' population, such as the one utilised in this investigation would be highly heterogeneous, containing different genotypes with widely divergent responses to the same cutting management practice. Thus selection within 'maiwa' should aid the development of more persistent and productive genotypes. Furthermore, although DM production of all entries declined sharply in August, partly in response to the low rainfall of the little dry season (Hopkins, 1965), the high stand mortality of 'maiwa' accentuated this decline so that production declined even further at the subsequent harvest in September despite increased rainfall (Figure 1). The sharp rise in 'maiwa' herbage production at the sixth harvest, in October (Figure 1), after the depressed yields of the previous two harvests can be largely ascribed to the onset of flowering. A stimulation of generative development is usually accompanied by an increased growth rate as plant height measurements in this study indicate (Figure 1) and, through genetic modifications to the duration of various growth phases in certain photoperiod-

sensitive crops, this relationship can be exploited to increase either vegetative growth (Huyskes, 1971; Parlevliet, 1967) or seed yields (Chang and Vergara, 1972). Whether herbage production of photo-period-sensitive 'maiwa' millet can be improved through such manipulations of its growth phases might be worth investigating.

The close relationship found between plant height and herbage yield in this study also exists among other forage grasses (Akinola, Chheda and Mackenzie, 1971). For a particular genotype plant height could therefore serve as an indicator of yield or performance, for example, in comparing responses to different cultural treatments.

With the exception of Guinea grass the average DM content of each entry was well below the 20% value McDowell (1972) suggested as a suitable minimum for the satisfactory performance of animals with high dietary requirements such as dairy cattle. However, the study of DM content in a breeding programme would depend on its influence on other nutritional factors such as intake and digestibility which, according to Sullivan (1962), is usually higher in forages with a relatively high moisture content.

Forage cut at relatively short intervals generally contains a higher proportion of leaves than that cut at longer intervals. Thus, although 'maiwa' contained a significantly higher proportion of leaves in the fresh cut herbage than the perennials, this result can be largely attributed to the shorter intervals between 'maiwa' harvests. For instance, in the present investigation, the proportion of leaves in 'maiwa' herbage is 28% more than that in elephant grass S.13, but only 4% more when this elephant grass selection was harvested every four weeks in another study under similar conditions (Aken'Ova, 1975). Although leafiness is often associated with superior quality, no consistent relationship has been found between this characteristic and other measures of quality such as intake and digestibility, in herbage utilised at relatively young stages as in this study (Aken'Ova, 1975; Haggard and Ahmed, 1970; Julen and Lager, 1966; Raymond, 1969). However, under gra-

zing, leafy herbage may be of greater value as leaves form the bulk of herbage consumed. Increased leafiness in 'maiwa' can be attained through selection or by the incorporation of dwarf genes (Burton and Powell, 1968).

The relatively high proportion of 'maiwa' utilised under grazing, its comparatively high CP content, which was well above the 7% level McDowell (1972) considered critical to the intake of tropical forages together with a rate of decline in CP with age which compared favourably with that among the perennials indicate a potential superiority in quality. Further evidence of this superiority in the present study, is the high CP content, in comparison with the other perennial grasses, of F₁ *Pennisetum* hybrid No. 18 which is a hybrid of 'maiwa' millet and elephant grass. The improvement in quality of F₁ *Pennisetum* hybrid genotypes in general, has been attributed to the 'maiwa' parent (Aken'Ova *et al.*, 1976).

Thus, 'maiwa' combines good quality with the ability to produce considerable quantities of forage throughout the rainy season and early in the dry season. Furthermore, it is fully established with sufficient herbage for relatively intense grazing in about five weeks after planting as compared to the eight weeks or more required for the vegetatively propagated perennial grasses used in this study (Aken'Ova, unpublished data). However, to attain even higher levels and better seasonal distribution of DM production appropriate agronomic practices must be devised along with selection and breeding for improved forage characteristics such as high regrowth potential and drought tolerance. That herbage yield and quality of millet can be improved through breeding has been demonstrated in the United States (Burton, 1968; Burton and Powell, 1968). Finally, the ease of 'maiwa' seed production in quantity, the possibilities of mechanised seeding and its ease of eradication further denote the considerable potential of 'maiwa' millet for forage.

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