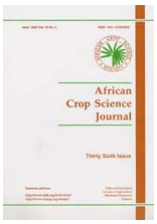

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Identification of superior pearl millet by napier hybrids and napiers in Zimbabwe

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ABSTRACT

During 1988 and 1989, over 200 pearl millet [*Pennisetum glaucum* (L.) R. Br.] by napier grass (*Pennisetum purpureum* Schum) hybrids were developed by SADC/ICRISAT in Zimbabwe to provide superior pearl millet by napier hybrids especially for semi-arid rainfed regions. Eighteen such pearl millet by napier hybrids (SDPN), 20 napiers (SDPP), and two checks, Bana grass (pearl millet x napier hybrid), and Green Gold Harare (*Panicum* sp.) were evaluated at Aisleby (irrigated) and Lucydale (rainfed) locations during 1990/92. There were six cuttings (over 12 months) at Aisleby, and seven cuttings (over 16 months) at Lucydale. Among pearl millet by napier hybrids, SDPN 29 produced the highest total dry matter (DM) yield over cuttings at both locations. SDPN 29 produced 38 t total DM yield ha^-1 (38% more than the best check, Bana grass) at Aisleby, and 12.5 t total DM yield ha^-1 at Lucydale (39% more than the best check, Bana grass). Based on green fodder yield, DM yield, crude protein %, and in-vitro DM digestibility, two hybrids, SDPN 3 and SDPN 29 were selected and the cuttings were supplied to several hundred farmers in Zimbabwe. Among napiers, SDPP 19 and SDPP 10 were the highest yielding entries. During the dry period (April to October) at Lucydale, both SDPNs and SDPPs plants continued to grow and some entries produced DM yields of over 600 kg ha^-1 per cut. This is the period when the forage is most needed. There were no significant differences for total DM yield over cuttings between highest yielding SDPP and highest yielding SDPN at both locations. The variation in napiers for different traits suggests that the napiers can be improved for forage quality and yield.

Key Words: Elephant grass, napier grass, pearl millet x napier hybrid, *Pennisetum* sp.

RESUME

En 1988 et 1989, plus de 200 hybrides du mil [*Pennisetum glaucum* (L.) R.Br.] issus du croisement mil x hybrides de l'herbe elephant (*P. purpureum* Schum) etaient produits par le Programme SADC/ICRISAT au Zimbabwe. Ces hybrides etaient crees dans le cadre des experimentations visant a produire des hybrides de mil superieurs destines particulirement aux regions pluviales semi-arides. Au cours des annees 1990-92, on a evalue 18 hybrides du mil issus du croisement avec des hybrides de l'herbe a elephant (SDPN), 20 avec de l'herbe a elephant (SDPP), et deux temoins, l'herbe Bana (mil x hybride de l'herbe a elephant) et Green Gold Harare (*Panicum* sp) a Aisleby (irriguee) et a Lucydale (pluvial). Il y avait six coupes (au cours de 12 mois) a Aisleby et sept coupes (au cours de 16 mois) a Lucydale. Parmi les hybrides issus du croisement avec des hybrides de l'herbe a elephant, SDPN 29 a produit le rendement le plus eleveen matiere seche totale sur l'ensemble des coupes dans les deux localites. SDPN 29 a produit 38 t de rendement en matire seche totale par hectare (39% plus que le meilleur temoin, herbe Bana). Sur la base de rendement en fourrage verte, en matire sche, proteine brute (%), et digestibilite in vitro de la

matire sche, proteine brute (%), et digestibilite in vitro de la matire seche, deux hybrides (SDPN 3 et SDPN 29) ont ete selectionnes et les coupes ont ete fournies a plusieurs centaines de paysans au Zimbabwe. Parmi les hybrides issus du croisement avec l'herbe a elephant, SDPP 19 et SDPP 10 ont ete les plus perfomants. Pendant la saison sche (avril a Octobre), a Lucydale, les plants SDPN et SDPP se sont bien comportes et certains de ces plants ont produit des rendements en matire seche de plus de 600 kg par hectare par coupe. C'est la periode ou le besoin de fourrage est maximum. Il n'y a pas eu de difference significative pour le rendement en matire seche totale sur l'ensemble des coupes entre le SDPP et le SDPN les plus performants dans les deux localites. La variation dans les herbes a elephant pour des caracteres differents suggere que ces herbes peuvent etre ameliorees pour la qualite fourragre et le rendement.

Mots Cles: Herbe a elephant, mil x hybride de l'herbe a elephant, *Pennisetum* sp.

INTRODUCTION

Pearl millet, *Pennisetum glaucum* (L.) R. Br. (2n=14), is a coarse annual bunch grass and is grown in Asia and Africa primarily for grain and in the Americas for feed and forage. Napier or elephant grass (Napier), *P. purpureum* Schum. (2n=28), is a robust perennial grass grown for forage mainly in tropical areas of Africa, Asia, south and central America. The hybridisation between pearl millet and napier is known to occur naturally since these are protogynous and cross pollinate. Burton (1944) showed that these two species readily cross and that the resultant interspecific hybrids are more vigorous than the parent species and are highly sterile (2n=21). Thus it can be propagated as a forage plant without danger of becoming a weed as is the case with napiers.

The interspecific hybrids between pearl millet and napier are primarily established by planting stem and root cuttings. It can also be sown by seed. Commercial hybrid seed production is possible by using cytoplasmic male-sterile line of pearl millet as a female parent and napier as pollinator (Powell and Burton, 1966). Aken'ova and Chheda (1983) produced 317 g F1 seed from a plot of 358 m^2 in spite of losses caused by *Claviceps* sp. The F1 seed was produced by growing pearl millet male-sterile line 'Maiwa' between rows of six napier ecotypes that combine well with Maiwa.

The potential for improvement in yield and quality of pearl millet x napier hybrids over napiers has been reported by several workers (Gupta and Bhardwaj, 1975; Ogwang and Mugerwa, 1976; Sidhu and Gupta, 1973). Chheda *et al*. (1973) reported that the dry matter (DM) yield of hybrids from the cross Maiwa millet x napier were comparable with napier and superior to those of pearl millet 'Tift 23A' napier hybrids. Maiwa is a short-day photoperiod-sensitive pearl millet, and this trait is expressed in Maiwa x napier hybrids. Hanna and Monson (1980) showed that of the three female parents (Tift 23D2A1, Tift 23A1, and Tift 239D2A2) tested, Tift 23A1 produced the highest yielding pearl millet x napier hybrids and that much variability for maximising yield exists among the napier clones used as male parents in the hybrids.

In southern Africa, the Bana grass, an interspecific hybrid between babala (pearl millet) and napier developed by Gildenhuys (1950), is grown by farmers under irrigation. The parental materials of both pearl millet and napier have now been improved worldwide, making it possible to develop better hybrids in terms of quality and yield. During 1988 and 1989, several napiers were introduced and over 200 pearl millet x napier hybrids were developed by the Southern African Development Community (SADC)/International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Sorghum and Millet Improvement Programme (SMIP) at Matopos, Zimbabwe. The purpose of this study was to identify superior pearl millet x napier hybrids and napiers especially for semi-arid rainfed areas of Zimbabwe.

MATERIALS AND METHODS

The trial consisted of 40 entries including 18 pearl millet x napier hybrids (hybrids), 20 napiers, and two checks, Bana grass and Green Gold Harare (Table 1. These entries were planted in a randomised complete block design with six replications at two locations - Aisleby (irrigated) and Lucydale (rainfed), both near Bulawayo, Zimbabwe. Planting was done by hand using mature rooted splits of napier and its hybrids with pearl millet. One irrigation was given to establish the experiment at Aisleby on 19 November 1990; at Lucydale planting was done immediately after first good rain on 8 December 1990. The soils were sandy at both locations.

TABLE 1

The plot size was a single row of 9 m long, 100 cm apart at Aisleby and 150 cm apart at Lucydale. The plant to plant spacing was 75 cm at Aisleby and 100 cm at Lucydale. The net plot was 8.25 m^2 at Aisleby and 12 m^2 at Lucydale, i.e., leaving one border plant at each side.

At both locations, the plant establishment was complete. All entries survived equally well from plant establishment until the completion of experiments, i.e., from 1991 to 1992. The regrowth within plots was also quite uniform.

At Lucydale, a basal dose of 32 kg N, 56 kg P2O5, and 28 kg K2O ha^-1 was applied at sowing. After the first cut on 18

February 1991, 52 kg N ha^-1 was applied as top-dressing. Fertilizers were not applied at Aisleby as the soils were rich in nutrients due to application of sewage slurry. The trial at Aisleby was irrigated with sewage water and it was rainfed at Lucydale. Weeding was done four times at Lucydale and six times at Aisleby. The date of cutting and the total amount of water received between cuts at Aisleby (including rain and irrigation) and Lucydale are given in Table 2.

TABLE 2

Green fodder yield of each net plot harvested was recorded in the field. Representative 500 g samples (whole plants) from each plot in three replications were taken, chopped, weighed before and after drying to a constant weight in a ventilated oven at 55 C for the determination of DM perce-ntage. The mean DM percentage over three replications for each entry was used to calculate the DM yield from green fodder yield. The dried samples were ground in a high speed laboratory mill with a 1 mm sieve and stored in sealed plastic bottles. The ground samples from three replications were used to determine crude protein % (N x 6.25) by the macro-Kjeldahl method, and in-vitro dry matter digestibility (IVDMD) using the two stage technique of Tilley and Terry (1963).

Total green fodder and DM yields were obtained by pooling the data over all cuttings at each location. Crude protein % (CP) and IVDMD data were obtained by averaging over the 2nd and 3rd cuts. Analysis of variance for each location was carried out separately using PROC ANOVA (SAS Institute, 1985). The DM yield was also analysed for each cut separately for napiers, and pearl millet x napier hybrids. No data was recorded on diseases such as rust and blast as there was no incidence of diseases in these trials.

RESULTS AND DISCUSSION

The DM yields obtained during the cuts in rainy season were higher than during the cuts in winter at both locations (Table 2). The highest DM yield was obtained in the 6th cut, and the lowest yield in the 4th cut under irrigation at Aisleby (Table 2). The regrowth between 3rd and 4th cuts (15 May 1991 to 15 July 1991) at Aisleby occurred during winter, and the low yield could be due to low temperature. At Lucydale (rainfed), the lowest DM yield was obtained during the 4th cut both for napiers (0.46 t ha^-1) and hybrids (0.56 t ha^-1). The regrowth for the 4th cut was on residual moisture and at low temperature.

Both hybrids and napier plants continued to grow at Lucydale on residual moisture, and some entries produced DM yield of over 0.6 t ha^-1 per cut (Table 2). Similar results were obtained at Louisiana, USA, where napier and pearl millet x napier hybrid continued to grow and produce forage until frost (Cuomo *et al*., 1996). Therefore, these hybrids and napiers have the potential to fill the winter forage deficit in southern Africa.

Total green fodder yield, total DM yield, CP, and IVDMD are presented in Table 3 (Aisleby) and Table 4 (Lucydale). There were significant differences among entries for all the four traits except for IVDMD at Lucydale. Among pearl millet x napier hybrids, the highest yielding entry, SDPN 29 produced 42% more total green fodder yield, and 38% more total DM yield (37.97 t ha^-1) as compared to the best control, Bana grass at Aisleby. There was no significant difference between SDPN 29 and Bana grass in respect of CP, and IVDMD. Two other hybrids, SDPN 3 and SDPN 1, produced significantly higher total green fodder yield, total DM yield, and CP, than Bana grass but had similar IVDMD to Bana grass. Similar DM yields (38.5 to 43.6 t ha^-1 year^-1) were reported by Jeyaraman (1990) while evaluating three pearl millet hybrids at Madurai, India.

TABLE 3

TABLE 4

Both SDPN 3 and SDPN 29 selected at Aisleby also performed well at Lucydale (**Table 4**). Among hybrids, SDPN 3 produced the highest total green fodder yield (63 t ha^-1) and SDPN 29 produced the highest total DM yield (12.5 t ha^-1). SDPN 3 gave 55% more total green fodder yield and 30% more total DM yield than Bana grass. SDPN 29 produced 38% more total green fodder yield and 39% more total DM yield than Bana grass. SDPN 3 had the highest CP (62% more than Bana grass) followed by SDPN 1. In addition to these two hybrids, nine other hybrids produced significantly more total DM yield than Bana grass at Lucydale.

Positive heterosis over napier parents was observed for total green fodder yield and total DM yield (Tables 3 and 4). At both locations, SDPN 29 was superior to its parent SDPP 12 in terms of total green fodder yield (30-32%) and total DM yield (27-33%). SDPP 5 is the napier parent for hybrids SDPN 21, and SDPN 31. These two hybrids did not differ significantly from SDPP 5 in terms of total green fodder yield and total DM yield at both locations. SDPN 7 produced more total green fodder and DM yields than its napier parent (SDPP 48) only at Lucydale.

Among napiers, SDPP 19 produced the highest total green fodder yield (213 t ha^-1) and total DM yield (40.4 t ha^-1) followed by SDPP 10 at Aisleby (Table 3), whereas SDPP 26 had the highest CP, it produced less than half total green fodder yield and total DM yield than SDPP 19. SDPP 7 had the highest IVDMD, but produced significantly less total green fodder yield, and

total DM yield than SDPP 19. At Lucydale, SDPP 10 produced the highest total green fodder yield (57.4 t ha^-1) and total DM yield followed by SDPP 7, whereas SDPP 47 had the highest CP, but less total DM yield than SDPP 10 (Table 4). The variation in napiers for different traits suggests that the napiers can be improved for forage quality and yield. Schank *et al*. (1993) reported genetic improvement in napiers for biomass and energy by following both intraspecific and interspecific hybridisation with pearl millet at Gainesville, USA. Cheng *et al*. (1992) obtained napier strain 7262 (late flowering and widely adaptable) from an open-pollinated population of cultivars A146, A148 and A149 and produced 20-40% higher yields than its parents. To improve quality, the dwarf strain 7768 (few hairs on leaf, few and late flowers) was selected from the cross 85DA x Mott. Improved strains such as 7734 and 7728 were obtained by selfing and selection in napier variety Mott.

The performance of napiers vs. pearl millet by napier hybrids varied during the different cuttings. At both locations, average DM yield of hybrids was significantly higher than that of napiers in each cut during the first four cuttings, except for the 4th cut at Aisleby, where the difference was not significant (Table 2). These results suggest that during the establishment, and dry period at Lucydale, hybrids produced more DM yields than napiers. However, with the increase in moisture content in the soil, i.e., during the 5th and 6th cuts, napiers performed better than hybrids in respect of DM production at both locations (Table 2). Again with the decline in rains, i.e., during the 7th cut at Lucydale, mean DM yield of hybrids was higher than that of napiers. Ramasamy *et al*. (1993) reported a decrease in regrowth rate between later cuts while comparing 11 pearl millet x napier hybrids during 8 cuts at 60 days intervals at Coimbatore, India. This is consistent with our results at Lucydale, where the DM yields were high only in the first two cuttings and lower between later cuts (Table 2).

There were no significant differences for total DM yield between the highest yielding napier and highest yielding hybrid at both locations (Tables 3 and 4). At Aisleby, the highest yielding hybrid and napier produced 38 t (SDPN 29) and 40.4 t (SDPP 19) DM ha^-1, respectively, whereas at Lucydale, the highest yielding hybrid and napier produced 12.5 t (SDPN 29), and 12.4 t (SDPP 10) DM ha^-1. Elsewhere at Hsinhua, Taiwan, Sheng (1983) reported 10% higher DM yield in napier x pearl millet hybrid 7001 as compared to best napier A146 during their three year study. Hybrid also had higher CP and lower crude fibre contents as compared to napier A146.

There was significant variation among entries for CP at both locations (Tables 3 & 4). At Aisleby, the highest CP was in SDPP 26 (17.5%) among napiers and SDPN 19 (17.3%) among pearl millet by napier hybrids. Similar results were obtained at Lucydale. However, Cuomo *et al*. (1996) reported higher CP (13.6%) in napier, than pearl millet (12.7%), or the pearl millet x napier hybrid (12.3%). These results suggest that the napiers with high CP could be selected. Based on total green fodder yield, total DM yield, CP, and IVDMD, two hybrids - SDPN 3 and SDPN 29, and two napiers - SDPP 10 and SDPP 19 were selected, and the cuttings of these two hybrids were supplied to several hundred farmers in Zimbabwe.

The hairs cause itching at the time of manual harvesting. The hybrids with no or less hairs are likely to be more popular among peasant farmers. The hybrids SDPN 3, SPPN 18, and SDPN 1 had less hairs than Bana grass.

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