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# Dry and wet season performance of selected herbaceous legumes in Uganda

P. LUSEMBO[1], C. EBONG[1], E.N. SABIITI[2], MOHAMED-SALEEM[3], ABATE TEDLA[3] AND J. NDIKUMANA[4]

[1] *Namulonge Agricultural and Animal Production Research Institute, Kampala, Uganda*
[2] *Department of Crop Science, Makerere University, Kampala, Uganda*
[3] *International Livestock Research Institute, Addis Ababa, Ethiopia*
[4] *African Feed Resources Network, Nairobi, Kenya*

## Abstract

The dry matter production of 9 herbaceous legume species was evaluated over 3 years for their suitability as forage species in the subhumid regions of Uganda. Dry matter production of *Centrosema pascuorum* (6774), *Chamaecrista rotundifolia* (Wynn), *Clitoria ternatea* (9291), *Macroptilium atropurpureum* (Siratro), *Stylosanthes guianensis* (Cook), *S. guianensis* (163), *S. hamata* (Verano), *S. scabra* (441) and *S. scabra* (Seca) was assessed after 3-,6-,9- and 12-weeks regrowth in the wet season and after 6- and 12-weeks regrowth in the dry season. The *Stylosanthes* species were most productive in both wet and dry seasons. Appropriate seed production technologies need to be developed to make seed available for further studies and for distribution to farmers.

## Introduction

In Uganda, natural grasslands provide fodder for more than 90% of ruminant livestock (Bareeba *et al.* 1993). The productivity of these grasslands is highly seasonal and too low to support animal production, especially in the dry seasons (Dzowela 1993). There is a need for species that can improve the forage quality of the natural grasslands and have a high dry season production. Introduction of adapted species of forage legumes overcomes this constraint (Otim 1975; Tothill 1986). Preliminary studies have identified adapted accessions with acceptable qualitative traits (Sabiiti and Lusembo 1990; Lusembo *et al.* 1995). However, the ability of these accessions to maintain productivity over time and seasons has not been evaluated. These studies investigated seasonal production patterns of promising species and accessions of herbaceous legumes in a subhumid zone of Uganda.

Correspondence: Dr P. Lusembo, Namulonge Agricultural and Animal Production Research Institute, PO Box 7084, Kampala, Uganda

## Materials and methods

The trials were conducted at Namulonge Agricultural and Animal Production Research Institute (0°32′N, 32°35′E; 1150 m above sea level). The soils are ferralitic sandy clay loams, low in phosphorus (4 ppm P, Bray I) with pH ($H_2O$) of 5.4–6.0. The area receives bimodal rainfall with peaks in March–May and September–November (Table 1). Hence, it has 2 growing seasons in a year. The trials were laid down at the beginning of 1993, with the species and accessions as indicated in Table 2. Plot size was 5.0 m × 2.5 m. Planting was done as a continuous flow of seed in 4 rows, 0.5 m apart, at a seeding rate of 5 kg/ha for all species except *C. ternatea*, where the seeding rate was 10 kg/ha, due to the large seed size. Triple superphosphate (35 g/$m^2$) was incorporated into the soil just before planting at a rate equivalent to 70 kg/ha $P_2O_5$. The evaluation process was divided into 2 periods: the establishment and production phases.

During the establishment phase, the trial was arranged in a completely randomised block design with 3 replications. The parameters recorded were: number of plants per $m^2$; percentage plot cover; mean plant height (cm); and spread (cm) at 4, 8 and 12 weeks after sowing. Number of plants per unit area was determined by counting plants in a 1 $m^2$ frame randomly placed over the central 2 rows. Mean plant height

**Table 1.** Mean monthly meteorological data during time of experiment (1993–1995).

| | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameter | J | F | M | A | M | J | J | A | S | O | N | D |
| Rainfall (mm) | 34 | 50 | 126 | 126 | 171 | 76 | 41 | 48 | 101 | 110 | 141 | 100 |
| Maximum temp (°C) | 29 | 30 | 29 | 28 | 27 | 28 | 28 | 28 | 28 | 28 | 28 | 28 |
| Minimum temp (°C) | 16 | 16 | 16 | 17 | 16 | 16 | 16 | 16 | 16 | 16 | 17 | 16 |

and spread were measured. The plants were left to grow uninterrupted for one wet and one dry season before they were mown off prior to evaluation of regrowth.

In the production phase, the trial was arranged in a randomised complete block design in split plots. The main plots were the species or accessions. The subplots were the regrowth ages after the standardisation cut. Two independent climatic periods were identified during the production phase: a period of 15 weeks during the wet season; and a period of 12 weeks during the dry season. Each of the periods started with a pre-evaluation standardisation cut at a stubble height of 5–10 cm for prostrate species (*M. atropurpureum*, *C. rotundifolia, S. hamata* and *Centrosema pascuorum*) and 10–15 cm for erect and semi-erect species (*S. scabra*, *S. guianensis* and *Clitoria ternatea*).

At the beginning of the wet season, a general standardisation cut was done on all species. A sample area of the innermost 4 $m^2$ was divided into 1 $m^2$ subplots which were sampled at the regrowth ages of 3, 6, 9 and 12 weeks. At 15 weeks after the standardisation cut, all subplots were cut again, at which date the regrowth of the original 3-, 6-, 9- and 12-week subplots was 12-, 9-, 6- and 3-weeks-old, respectively. Parameters measured were: fresh matter yield ($g/m^2$); percentage dry matter; and total dry matter yield ($g/m^2$). Herbage was cut using scissors and immediately weighed. Dry matter concentration was determined using fresh samples (100–200 g) dried in the oven at 60°C for 48 hours.

During the dry season, the 4 $m^2$ sample area was subdivided into $2m^2$ subplots which were sampled at 6 and 12 weeks after the standardisation cut. The harvested samples were treated in the same way as the wet season samples. Statistical analyses were performed with the MSTAT C (1986) statistical software package. The data are reported as averages over 6 wet and 6 dry seasons over a period of 3 years.

## Results and discussion

During the establishment phase, all planted species and accessions developed an extensive vegetative framework and, by the 12th week after planting, all except *S. scabra* had achieved more than eighty percent plot cover (Table 2). This was due to the plants spreading and forming dense swards despite the different growth characteristics and seeding rates of the species used. Good weather conditions (Table 1) and planting at the beginning of the rainy season were partly responsible for the fast development. Under such conditions, this type of growth would be expected because it was partly on the basis of such characteristics (Lusembo *et al.* 1995) that the species were selected for further evaluation in this study. The creeping and prostrate species like *C. pascuorum* and *M. atropurpureum* provided soil cover at a faster rate than that of the erect species. Such species could be useful, especially for establishing pastures in newly cultivated seed beds and in reseeding denuded areas, as they are likely to check land degradation by reducing the time of exposure of bare soil to the environment. Although the germination and number of plants per unit area were high for the *S. scabra* accessions, percentage plot cover was low. This was attributed to the erect growth characteristics of the species. Despite the relatively low number of plants per unit area of *S. hamata* (a semi-erect and/or prostrate species), its leafiness and vigour afforded the species almost the same percentage plot cover as that of the trailing species. However, the percentage plot cover of *S. guianensis* cv. Cook at 12 weeks was significantly less than that of the other accession, ILCA 163, despite the prostrate nature of *S. guianensis*. Although anthracnose had not set in during this period, the vigour and spread of this accession appeared to be low. Among the tested species, Siratro seemed to have performed best for the assessed attributes (except number of plants per unit area) during the establishment phase (Table 2).

**Table 2.** Forage yield characteristics of herbaceous legumes at 12 weeks during the establishment phase.

| Species | Cultivar name/ Accession no. | No. of plants per m$^2$ | Plot cover | Sward/Plant height | Spread |
|---|---|---|---|---|---|
| | | | (%) | (cm) | (cm) |
| *Centrosema pascuorum* | ILCA 6774 | 8 | 100 | 30 | 179 |
| *Chamaecrista rotundifolia* | Wynn | 13 | 95 | 28 | 88 |
| *Clitoria ternatea* | ILCA 9291 | 9 | 86 | 69 | 106 |
| *Macroptilium atropurpureum* | Siratro | 5 | 100 | 98 | 207 |
| *Stylosanthes guianensis* | Cook | 20 | 83 | 39 | 57 |
| *Stylosanthes guianensis* | ILCA 163 | 17 | 98 | 34 | 76 |
| *Stylosanthes hamata* | Verano | 34 | 98 | 28 | 63 |
| *Stylosanthes scabra* | ILCA 441 | 48 | 68 | 37 | 35 |
| *Stylosanthes scabra* | Seca | 37 | 60 | 49 | 31 |
| CV (%) | | 24.33 | 8.81 | 19.80 | 10.62 |
| LSD (P=0.05) | | 2.39 | 3.78 | 5.42 | 17.25 |

**Table 3.** Average dry matter yield (g/m$^2$) of 3-, 6-, 9- and 12-week regrowth of herbaceous legumes during 6 rainy seasons at Namulonge.

| Species | | Regrowth age (weeks) | | | | |
|---|---|---|---|---|---|---|
| | | 3 | 6 | 9 | 12 | Mean |
| *Centrosema pascuorum* (6774) | | 13 | 46 | 140 | 243 | 111 |
| *Chamaecrista rotundifolia* (Wynn) | | 22 | 78 | 163 | 256 | 130 |
| *Clitoria ternatea* (9291) | | 30 | 84 | 190 | 321 | 156 |
| *Macroptilium atropurpureum* (Siratro) | | 36 | 120 | 191 | 286 | 158 |
| *Stylosanthes guianensis* (Cook) | | 14 | 87 | 227 | 400 | 182 |
| *Stylosanthes guianensis* (163) | | 19 | 134 | 328 | 550 | 258 |
| *Stylosanthes hamata* (Verano) | | 22 | 122 | 324 | 504 | 243 |
| *Stylosanthes scabra* (441) | | 27 | 71 | 410 | 683 | 298 |
| *Stylosanthes scabra* (Seca) | | 37 | 192 | 475 | 700 | 294 |
| Mean | | 24 | 104 | 272 | 438 | |
| SEM for species | = | 5.54 *** | | | | |
| SEM for regrowth age | = | 8.31 *** | | | | |
| SEM for species × regrowth age | = | 16.62 *** | | | | |

Dry matter yield (DMY) of the species when harvested at 3, 6, 9 and 12 weeks during the wet season is shown in Table 3. At 3 weeks of regrowth, all species and accessions yielded almost similar quantities of dry matter. This was attributed to the phenomenon known as the lag phase experienced in cutting experiments, where the initial leaf area is low as a result of defoliation (Grof *et al.* 1970; Stur *et al.* 1994). Most of the species had the bulk of their foliage removed and new leaf growth had to be supported initially by stored carbohydrate reserves. Consequently, it was some weeks before new foliage could support maximum growth, after which time genotype differences were expressed. These genotype differences were most apparent 9 and 12 weeks after cutting. *S. scabra* accessions yielded the highest dry matter with no significant differences between the commercial cultivar, Seca, and ILCA 441. Verano yielded high DMY at most regrowth stages. This cultivar was particularly productive in West Africa and formed the basis of "fodder banks", especially for dry season feeding (Mohamed-Saleem and Adeoti 1989). Such a cultivar may prove useful for forage development programs in Uganda, in place of *S. guianensis* cv. Cook, which has been threatened by anthracnose. It is worth noting that DMY of the commercial cultivar Cook of *S. guianensis* was significantly less than that of a recently collected accession, which has not yet been released as a commercial cultivar (Kidest Shenkoru *et al.* 1991). The low yield of Cook was attributed to infestation by anthracnose, which was prevalent on the cultivar during most seasons. However, the infestation became less severe with time and subsequent herbage harvests. This difference in susceptibility to anthracnose by the 2 *S. guianensis* accessions is consistent with preliminary results at Namulonge (Lusembo *et al.* 1995). The apparent resistance of *S. guianensis* ILCA 163 has been consistent since its introduction to Uganda in

1988 (Sabiiti and Lusembo 1990). Although *C. ternatea* had shown promise in previous studies, its production in the current trials was below expectation. Similarly, the performance of *C. pascuorum* and *C. rotundifolia* in terms of DMY was the lowest. However, such species should be included in other forage evaluation programs, as they may prove more productive under different sites and cropping systems in Uganda.

Dry matter yield at 6- and 12-weeks regrowth during the dry season is shown in Table 4. It is evident from the figures that *M. atropurpureum, S. guianensis* and *S. scabra* accessions maintained productivity through the dry season, while many of the other species performed relatively poorly. Termite damage on *S. scabra* accessions during the dry season did not drastically reduce productivity. DMYs of the 2 accessions of *S. guianensis* during the dry season were similar. This study, conducted over a number of seasons, revealed that, despite susceptibility to anthracnose, Cook maintained a number of desirable characteristics. Hence, it should be retained in forage programs until sufficient seed of tolerant lines has been produced. Based on the high animal production levels achieved by incorporating *S. guianensis* in pastures in Uganda in the late 1960s (Otim 1975) and the recent reduction in stylo (Cook) herbage yields that have been attributed to anthracnose, it is recommended that animal production studies be carried out on the new accession to determine whether it could provide feed as valuable as Cook before it succumbed to anthracnose.

**Table 4.** Average dry matter yield (g/m$^2$) of 3-, 6-, 9- and 12-week regrowth of herbaceous legumes during 6 rainy seasons at Namulonge.

| Species/ILCA No. | Regrowth age (weeks) 3 | 6 | Mean |
|---|---|---|---|
| *Ce. pascuorum* (6774) | 13 | 42 | 28 |
| *Ch. rotundifolia* (Wynn) | 13 | 46 | 29 |
| *Cl. ternatea* (9291) | 21 | 84 | 53 |
| *M. atropurpureum* (Siratro) | 48 | 137 | 92 |
| *S. guianensis* (Cook) | 27 | 117 | 72 |
| *S. guianensis* (163) | 27 | 129 | 78 |
| *S. hamata* (Verano) | 12 | 80 | 46 |
| *S. scabra* (441) | 22 | 117 | 69 |
| *S. scabra* (Seca) | 32 | 150 | 91 |
| Mean | 24.0 | 100.1 | |
| SEM for species = | ±8.61 *** | | |
| SEM for regrowth age = | ±3.89*** | | |
| SEM for species × regrowth age = | ±11.66* | | |

Agronomic merits have identified Seca, Verano and *S. guianensis* ILCA 163 as species with high forage potential. These species are highly productive in terms of DMY but information on animal response when fed these species is lacking. Validation trials are also warranted on the compatibility of the high yielding species in this experiment with grasses recommended for use in Uganda. Lack of seed is one of the major constraints to pasture establishment in Uganda (Lusembo 1993). It is further recommended that appropriate seed production technologies for the high yielding *Stylosanthes* spp. be developed in order to provide seed for further animal production studies and for on-farm testing of the species.

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