

Evaluation of tropical pasture legumes for fodder banks in subhumid Nigeria. 2. Accessions of *Aeschynomene histrix*, *Centrosema acutifolium*, *C. pascuorum*, *Stylosanthes guianensis* and *S. hamata*

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Abstract

Five accessions, comprising *Aeschynomene histrix*, *Centrosema acutifolium*, *Centrosema pascuorum* and *Stylosanthes guianensis* together with *Stylosanthes hamata* cv. Verano were evaluated over 2 years for use in fodder banks in subhumid Nigeria.

The most promising accession was *A. histrix* I12463 with yields of more than 6 t/ha dry matter (DM) in the second growing season, good drought tolerance, ability to compete with the native vegetation and high nutritive value. *C. pascuorum* cv. Cavalcade and *C. acutifolium* cv. Vichada did not persist in competition with the native vegetation.

At the end of the wet season, crude protein concentrations (whole plant) ranged from 10–17% DM and phosphorus concentrations from 0.08–0.19% DM. *A. histrix* fell in the middle of the range. This species should be evaluated along with other promising accessions in pasture mixtures in the region.

Introduction

As outlined by Mohamed Saleem and Otsyina (1986), Tarawali *et al.* (1988) and Peters *et al.* (1993), fodder banks (fenced legume pastures)

are a viable option for improving dry season feed quality in a tropical, subhumid environment. Peters *et al.* (1994) reported on the performance of some alternative forage legume accessions to *Stylosanthes hamata* cv. Verano being evaluated in a special project for the evaluation of tropical pasture legumes for subhumid West Africa (Tarawali *et al.* 1989). The experiment described in this article reports on further legume accessions with special emphasis on their ability to compete with the native vegetation.

Materials and methods

Site

The experiment was conducted at ILCA's research site, Kurmin Biri, in the Kachia Grazing Reserve, Kaduna State, Nigeria (10°10'N and 7°55'E). A short description of the climate, soil and ecology of the experimental site has been given by Peters *et al.* (1994). Annual rainfall during the time of the experiment was 1205 mm in 1989 and 1694 mm in 1990. Chemical properties of the surface soil (0–20 cm) are described by Peters *et al.* (1994). The soil was an acidic sandy loam with low total nitrogen and available phosphorus.

The experimental design follows the procedure described in Peters *et al.* (1994). Accessions tested together with respective CSIRO and/or CIAT numbers are summarised in Table 1.

The accessions were arranged in a randomised complete block design with 3 replications. Each accession was planted in 2 plots per replication, one being weeded throughout the experiment (hereafter referred to as W) and one left unweeded (hereafter referred to as NW). *Stylosanthes hamata* cv. Verano, the cultivar presently used in fodder banks, and a sward with

Table 1. Accessions used in the trial.

Species	ILCA	Accession		
		CIAT	CSIRO	Cultivar
<i>Aeschynomene histrix</i>	I12463 (= I149)	CT9690	CPI87993	
<i>Centrosema acutifolium pascuorum</i>	I5593 I9857 (= I14972)	CT5277 CT5924	CPI94327	Vichada Cavalcade
<i>Stylosanthes guianensis</i>	I163 I164	CT136 CT184		Pucallpa Pia Hua Dou Verano
<i>hamata</i>	I75		CPI38842	

no legume introduction (further referred to as grassland) were included as "controls". Plot size was 2 m × 3 m.

Seed rates were 5 kg/ha; except for Verano where the seed rate was increased to 10 kg/ha (including pods) because of the poor quality of the seeds. Planting date was June 17, 1989. Plant samples for analyses of crude protein (CP) and phosphorus (P) concentrations were taken at the end of the wet season in the establishment year. A detailed description of the materials and methods can be found in Peters *et al.* (1994).

Results

Establishment and regeneration

Establishment was generally good, with the exception of *Centrosema acutifolium* cv. Vichada. The companion vegetation in the unweeded plots (NW) did not affect germination. Plant densities were between 70–110 plants/m² for the *Stylosanthes* accessions and *Aeschynomene histrix* I12463, 36 plants/m² for *Centrosema pascuorum* cv. Cavalcade and < 10 plants/m² for Vichada. Although none of the accessions was inoculated, all nodulated readily with the native rhizobia.

Regeneration from seeds in the following year was also good, with average plant densities of 105–135 plants/m² for *Stylosanthes guianensis* I163, 139–157 plants/m² for *S. guianensis* I164, 170–200 plants/m² for *A. histrix*, 60–75 plants/m² for Cavalcade and 340–603 plants/m² for Verano. Vichada did not produce any germinable seeds under field conditions. Grass competition had no major effect on regeneration except for Verano where plant numbers in the

NW plots were lower than in W plots (340 vs 600 plants/m²).

Flowering

Verano flowered first towards the end of the rainy season (beginning of September) and continued to flower until the early dry season. *A. histrix* flowered mainly in the transition between the wet and dry seasons. The *S. guianensis* accessions and Cavalcade started to flower in October, and *S. guianensis* flowered sporadically over the whole dry season whereas Cavalcade flowered only in October–November. Vichada did not flower under the prevailing conditions at the experimental site.

Seed production

In the establishment year, Verano, *A. histrix* and Cavalcade had peaks of seed production at the beginning of November (1st half of the dry season). Seeds of the *S. guianensis* lines reached maturity some weeks later in December, although a few seeds ripened sporadically over the whole dry season. Vichada did not set any seeds.

Drought tolerance

Vichada remained green throughout the dry season, although no measurable growth was observed. About 30–40% of *S. guianensis* and *A. histrix* plants stayed green over the dry period. The *S. guianensis* lines retained some dried leaves throughout the dry season, whereas *A. histrix* dropped most of its leaves from mid-January (middle of the dry season). Cavalcade dried off

as early as mid-December. Only a few Verano plants (about 10%) had any green leaves after the end of December; as soon as the leaves dried they were dropped. The greatest number of plants surviving the dry season was observed in *A. histrix* with 31 plants/m² in the NW plots and 19 plants/m² in the W plots. Comparable figures for the *Stylosanthes* species were 5 and 13 plants/m² respectively and one and 7 plants/m² for Vichada. Cavalcade plants did not survive the drought period.

Disease and pest incidence

Throughout the experimental period no major disease and pest incidences were recorded. Cavalcade showed minor leaf lesions but these were largely restricted to the peak of the rainy season and did not seem to inhibit legume development.

Dry matter yield

1989. In the establishment year, total DM yield of the grassland control exceeded yields of the

Vichada, *A. histrix* and Verano plots, but was slightly lower than that of the other accessions (Figure 1). The unweeded legume plots (NW) produced less grass than the grassland control ($P < 0.05$).

Highest legume yields were achieved in the *S. guianensis* and Cavalcade plots, and Vichada had the lowest legume yields. Competition from the native vegetation in unweeded plots lowered legume yields by 43–47% for Cavalcade, *A. histrix*, and *S. guianensis* accessions, 62% for Verano and 94% for Vichada.

1990. In the second growing season, total DM yield of the grassland control was 40% higher than in the establishment year, and only *A. histrix* outyielded the grassland control (Figure 2). As the legume almost disappeared from the unweeded *Centrosema* plots, total DM yields were similar to the grassland control although the grass proportion was higher in the legume plots. In all other accessions and treatments total DM yield was below that of the grassland. Weeding generally lowered total DM yields

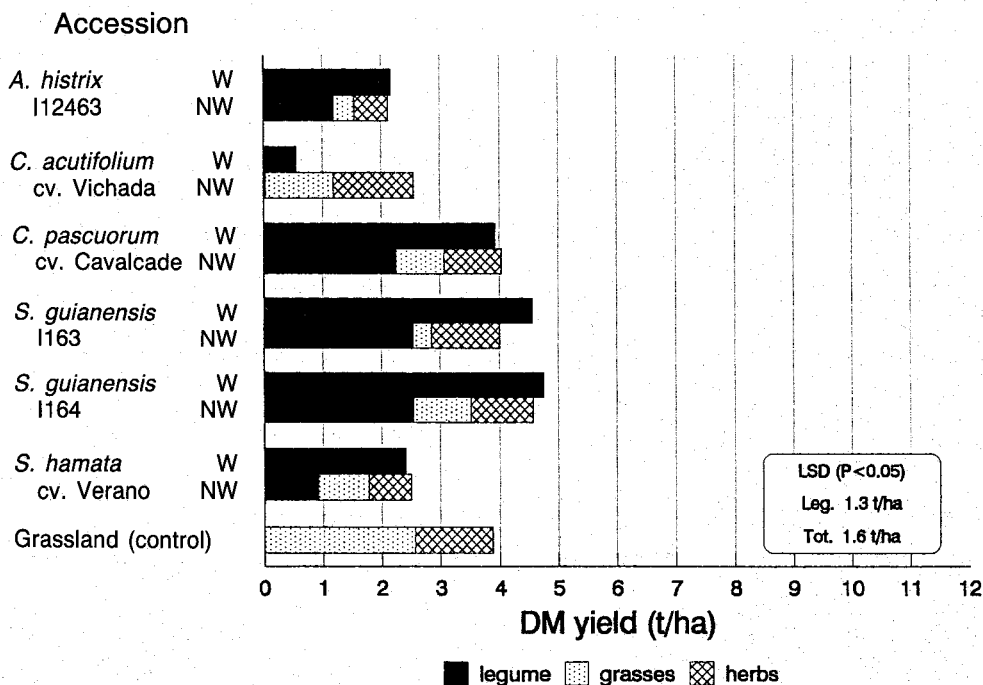


Figure 1. Dry matter yields (t/ha) of different legume accessions and the companion vegetation in the establishment year, 1989.

Leg. = legume Tot. = total dry matter
W = weeded NW = not weeded

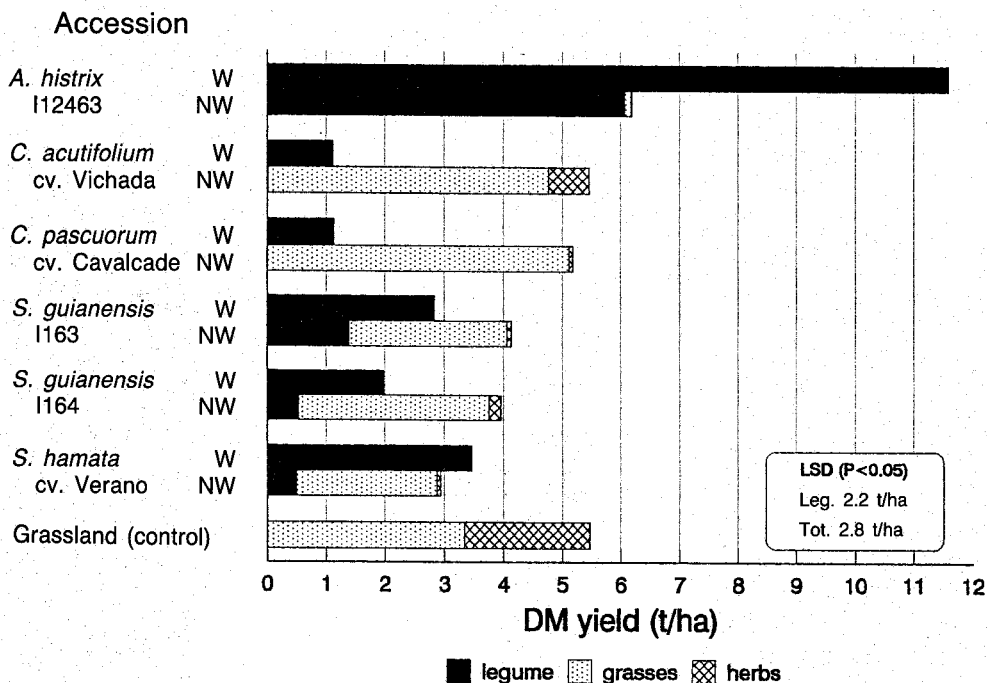


Figure 2. Dry matter yields (t/ha) of different legume accessions and the companion vegetation in the second growing season, 1990.

Leg. = legume Tot. = total dry matter
 W = weeded NW = not weeded

although the reverse was the case with *A. histrix* ($P < 0.05$). *A. histrix* appeared to suppress grass growth ($P < 0.05$). Herb yields were generally higher ($P < 0.05$) in the grassland control than in the unweeded legume plots (NW).

Yields of Cavalcade and *S. guianensis* were considerably lower than in the establishment year, whereas *A. histrix* and the pure stand (W) of *S. hamata* produced much higher yields. *A. histrix* produced more than 11 t/ha DM in pure stands and 6 t/ha in unweeded plots, whereas *Centrosema* accessions produced about 1 t/ha in pure stands. In comparison to the pure stands, legume yields in unweeded plots were 52% for *A. histrix*, 49% for *S. guianensis* I163, 27% for *S. guianensis* I164 and 14% for Verano. Vichada and Cavalcade did not persist under sward conditions.

Nutritive value

Leaf:stem ratio. For most legume accessions, leaf constituted 53–59% of available DM, although Cavalcade had 64% leaf.

Crude protein and phosphorus concentrations. Crude protein (CP) concentrations in legumes ranged from 10.7–16.4% with highest values in Vichada (Table 2). Phosphorus (P) concentrations ranged from 0.09–0.18% with Vichada again producing the highest levels. Sown legumes had no effect on the nutritional value of the companion vegetation. However grass infestation in the NW plots tended to reduce CP concentrations of the legumes, especially in Verano and Vichada.

Crude protein concentrations in leaf samples of legumes ranged from 16.1–22.8% and in stem from 6.4–7.7%. Phosphorus concentrations were 0.11–0.20% in leaf and 0.06–0.14% in stem.

Discussion

Of the legume accessions evaluated, *A. histrix* I12463 was the most promising for use in fodder banks in view of its high legume yields and high competitive ability in the second growing season. The authors are not aware of published results

Table 2. Crude protein (CP) and phosphorus (P) concentrations of legume accessions (whole plant) in pure stands (W) and in competition with the native vegetation (NW) and of the grasses and herbs on the grassland at the end of the wet season.

		Accession								
		<i>Aeschynomene</i> <i>histris</i>	<i>Centrosema</i>		<i>Stylosanthes</i>					
			<i>acut.</i> cv.	<i>pascuorum</i> cv.	<i>guianensis</i>	<i>hamata</i> cv.				
		I12463	Vichada	Cavalcade	I163	I164	Verano	grasses	herbs	
		(% DM)								
CP	W	13.4	18.3	12.6	12.8	11.1	11.4			
	NW	13.2	14.6	12.4	11.9	10.2	9.9			
	\bar{x}	13.3 ^{b1}	16.4 ^a	12.5 ^c	12.4 ^c	10.7 ^d	10.7 ^d	4.1 ^f	7.2 ^e	
P	W	0.12	0.16	0.08	0.11	0.11	0.10			
	NW	0.12	0.19	0.10	0.10	0.09	0.11			
	\bar{x}	0.12 ^b	0.18 ^a	0.09 ^d	0.11 ^c	0.10 ^c	0.10 ^c	0.07 ^e	0.10 ^e	

¹Within rows, means followed by a common letter are not significantly different ($P > 0.05$).

on the competitive ability and persistence of *A. histris*, but in trials in the Côte d'Ivoire the species suppressed the companion vegetation (Cissé Morifere, personal communication). Although persistence was followed only for one year and thus results have to be interpreted with care, the greater ability to perennate in the presence of the companion vegetation is promising. The only drawback of this accession was its slow early development/establishment and faster establishing accessions and/or methods to facilitate ease of establishment are needed.

All other accessions competed poorly with the native vegetation. In other situations (Haggar *et al.* 1971; Thomas & Grof 1986; Tarawali and Pamo 1992) *S. guianensis* has competed favourably with the native vegetation, but large differences in the competitive ability of different accessions have been reported (McIvor 1978; Oram 1990). The competitive abilities of *C. pascuorum* and *S. hamata* have been discussed in Peters *et al.* (1994). This study confirmed difficulties of *C. pascuorum* in establishment and lack of persistence in competition with the native vegetation. The lack of persistence of *C. acutifolium* cv. Vichada in competition with the native vegetation contrasts with its high competitive ability and persistence in grass-legume mixtures in South America (Grof 1986, 1991; Lascano *et al.* 1989). However, rainfall was higher and the dry season less pronounced in South America than at the experimental site. Despite its ability to remain green in the dry season, Vichada is not well adapted to the environmental conditions in drier, subhumid Nigeria. This is unfortunate in view of its higher crude protein and phosphorus levels at the end of the wet season.

As in the experiment described in Peters *et al.* (1994), disease and pest incidence were of no importance in the early period of evaluation. However, it has to be noted that, with the exception of Verano, all accessions are recent introductions into the environment.

The limited differences in leaf:stem ratio and nutritive value between most accessions at the end of the rainy season indicate that this is not a major issue when choosing between legume accessions. All compared favourably with Verano, the current choice for fodder banks. The lower CP concentrations in the plots with companion vegetation (NW) in comparison with the pure stands (W) are in accordance with Peters *et al.* (1994). As discussed there, the differences are probably more a result of the earlier senescence of the legumes when competing for growth factors than of uptake of nutrients by the grasses. CP concentrations of the legumes were well above the minimum requirement for ruminants of 6–8% CP as defined by Minson (1981) and Van Soest (1982).

This study has shown that *Aeschynomene histris* has the potential to complement or replace *Stylosanthes hamata* cv. Verano for fodder banks in subhumid West Africa. This adds to the *Chamaecrista rotundifolia* cv. Wynn and *Centrosema brasilianum* identified by Peters *et al.* (1994). With regards to the various farming systems and environmental conditions in subhumid West Africa, such variability is of particular importance. In view of the threat from diseases and pests, species not closely related are of particular interest. Legume mixtures might be a viable option, with greater flexibility in varying farming systems and environmental conditions

and could increase yield stability. In such legume mixtures, accessions of *Centrosema pascuorum* and *Stylosanthes guianensis* might have some value at least in the establishment year. Trials with legume mixtures seem warranted.

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