Evaluation of *Chamaecrista rotundifolia* accessions as a fodder resource in subhumid Nigeria

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Abstract

Chamaecrista rotundifolia cv. Wynn has been identified as a promising forage legume for use in subhumid Nigeria. To establish if other accessions of this species have potential in the region, 21 accessions were evaluated for flowering, seed production, dry matter production, disease and pest incidence and drought tolerance. A number of later flowering accessions gave higher dry matter yields than cv. Wynn, although some (ILCA 15603 and 15604) showed susceptibility to anthracnose disease. One of the most promising accessions is ILCA 14167 which warrants further testing of nutritional qualities, palatability and potential in a pasture situation.

Introduction

Forage legumes have been evaluated in the subhumid zone of Nigeria by ILCA's subhumid research team based in Kaduna (Tarawali *et al.* 1989; Tarawali 1991). The main aim has been to identify forage legumes which could replace or complement *Stylosanthes hamata* cv. Verano, which has been used exclusively to supplement cattle in the form of dry season "fodder banks". During the evaluation program, *Chamaecrista rotundifolia* cv. Wynn was identified as one of the most promising accessions to be used in fodder banks (Tarawali 1991) and, more recently, as a potential species for use in mixed legume pastures (Peters *et al.* 1994a). It has good dry matter productivity, excellent seed production, persists well, has low disease incidence and can provide at least as much dry season supplement as Verano for grazing cattle (ILCA 1991; Peters 1992; Peters *et al.* 1994b).

Cultivar Wynn, though sown in Australia since its release there in 1984 (Oram 1984), may not necessarily be the best accession of *C. rotundifolia* in subhumid west Africa. Consequently, this paper describes the preliminary evaluation of 22 accessions of *C. rotundifolia.*

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Materials and methods

Site

The trial was established at ILCA's Kurmin Biri (7°55 'E, 10°10 'N) research site in Kaduna State, Nigeria on poor, tropical ferruginous soil with pH 5.4, phosphorus (Bray I) 2.2 mg/kg, nitrogen 0.06% and organic carbon 1.0%. Average annual rainfall (1985–1992) was 1413 mm, and annual rainfall during the experimental period was 1307 mm in 1991 and 1510 mm in 1992. There are distinct wet and dry seasons; typically, rains begin in April, are regular by June and finish in October.

Trial establishment

Twenty-two accessions of *Chamaecrista rotundifolia* were used, including cv. Wynn for comparison. These ILCA accessions are listed in Table 1, together with corresponding accession numbers from other gene banks.

On June 14, 1991, each accession was planted in a single 2.0 m row in the centre of a plot 0.5 × 2.0 m using 2 replications in a randomised complete block design. The soil was prepared to a fine tilth and seeds were scarified using sandpaper prior to sowing. One g of uninoculated seed was sown in each 2.0 m row. Single superphosphate (8% P) was applied at 150 kg/ha at sowing but there were no further fertiliser applications. The plots were kept weed free.

Table 1. Accessions of *Chamaecrista rotundifolia* used for preliminary evaluation trials. Corresponding numbers for other gene banks and sites of origin were obtained from Shenkoru *et al.* (1991).

Accession	Other number(s)[1]	Origin
6999	CPI 16358	
9288	N 77233	
10916	Q 10057	
10917	Q 9862	
14161	CPI 93018	Brazil
14162	CPI 93094	Brazil
14163	CPI 92931	Brazil
14164	CQ 1467	
14165	CPI 49713	Brazil
14166	CPI 90809	Mexico
14167	Q 9862	
14168	CPI 92968	Brazil
14169	CPI 86178	Mexico
14170	CPI 34719	Brazil
14171	CPI 86172	Mexico
14172	CPI 78916	Niger
14173	CPI 78355	Argentina
14174	CPI 52092	
14529	Q 10057	
15603	CIAT 8201, ILCA 11536	Colombia
15604	CIAT 8202, ILCA 11537	Colombia
cv. Wynn	From Australia, multiplied at Kaduna	

[1]Accession numbers as follows: CPI, CQ — Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia; N — ILCA, Mali; Q — Queensland Department of Primary Industries, Australia; CIAT — International Centre for Tropical Agriculture, Colombia.

Data collection

The numbers of seedlings per plot were recorded, 4, 8 and 12 weeks after sowing. At the same time, an estimate was made of the percentage of the plot area covered by the sown legume. These measurements were repeated in the second year (1992), 4, 8, and 12 weeks after the onset of the rains, when regrowing plants as well as new seedlings were counted.

In 1991 and 1992, the time when 50% of the plants had flowered was recorded. Subsequently, ripe seeds were collected every few days and then bulked to give monthly seed yields.

Disease and pest incidence were estimated at monthly intervals by recording the % of the plants on each plot showing symptoms (incidence) and the % damage to the affected plants (severity).

At the end of each wet season, half of each plot was harvested. The number of cut plants was recorded and then the cut material was weighed, subsampled and dried at 105 °C. Estimates of drought tolerance were made by estimating the % of the plot that remained green at 6-weekly intervals after harvest.

Results

For convenience, results have been presented as units/m^2, although it is recognised that results from a 2 m row with a nominal plot width of 0.5 m would not necessarily be the same as those per m^2 of a sward.

Establishment and regeneration

Seedling counts, 12 weeks after planting, ranged from 76 (ILCA 15603)-291 (ILCA 14164) with a mean of 169 seedlings/m^2. Most germination took place within the first 4 weeks, but up to 50% of the seedlings had died by 12 weeks. Nevertheless, 12 weeks after sowing, plot cover ranged from 42 (ILCA 14173)-94% (ILCA 14529); 16 accessions had a plot cover of over 70%. From then to the end of the wet season, 11 accessions maintained the same plant numbers while the accessions with the poorest survival had only 55% of plants surviving (Table 2). In general, a greater reduction in plant numbers at the end of the wet season was associated with high seedling counts at 12 weeks. However, correlation analyses between the numbers of seedlings at 4, 8 or 12 weeks after planting and the final number of plants at the end of the wet season revealed no significant relationships.

In the second year, all plots had 60% or more plant cover 4 weeks after the rains commenced, and by 12 weeks, 16 accessions had a plot cover of 95% or more. On average, 22% of the plants alive at the end of the first wet season perenniated and regrew in the following wet season. New seedling counts (7–70/m^2) were lower than in the first year, due to the fact that seeds had been collected in the first year. Germination continued throughout the 12-week monitoring period after the onset of the rains and the number of perenniating plants remained constant during this period. Subsequently, plant numbers at the end of the second wet season were 36–85% of those 12 weeks after the onset of the rains (Table 2). Correlation analyses between the numbers of old and new plants 4, 8, and 12 weeks after the onset of the rains, and between the total (old plus new)

Table 2. Plant survival (% of plants remaining) from the beginning to the end of 3 different intervals during the experiment and maximum ratings for anthracnose incidence and severity in 1991 and 1992.

Accession	% plants surviving			Maximum disease ratings (%)			
	1991 12 wk to end wet	1991-92 end wet to end dry	1992 12 wk to end wt	1991		1992	
				Inc.	Sev.	Inc.	Sev.
6999	100	17	45	25	25	25	10
9288	100	32	43	25	25	10	25
10916	78	17	58	25	25	5	10
10917	100	9	46	25	25	5	10
14161	70	34	54	25	25	10	10
14162	69	23	53	25	25	10	10
14163	100	13	83	25	25	25	10
14164	55	17	71	100	50	25	25
14165	54	37	52	10	25	25	10
14166	96	24	61	25	25	25	10
14167	100	9	67	25	25	10	10
14168	78	58	48	25	25	10	10
14169	100	13	58	25	25	10	25
14170	100	15	61	25	25	10	10
14171	87	15	71	25	25	25	10
14172	100	27	63	25	25	25	10
14173	81	30	52	25	25	25	10
14174	68	24	67	25	25	25	10
14529	68	26	36	25	25	5	5
15603	100	15	67	50	50	25	25
15604	100	10	85	25	50	25	25
Wynn	100	29	38	25	25	25	10
LSD (P = 0.05)	40	24	40				

plants on the plots at these times revealed a weak correlation between the total number of plants at 8 weeks (x) and the number of plants at the end of that wet season (y) ($y = 14.3 + 0.72x$; $r^2 = 0.12$; s.e.e. = 4.1).

Flowering, productivity and disease incidence

In the establishment year, the majority of the accessions (16), including cv. Wynn, flowered in July, 6–8 weeks after establishment (Table 3). Dry matter yields ranged from 0.8–10.5 g/plant (ILCA 14170 and 14529, respectively), and in general, higher dry matter yields were associated with the later flowering accessions. Yields in kg/ha followed a similar pattern to those in g/plant. Except for ILCA 10916 and 14529, all accessions had seed yields in excess of 250 kg/ha. Anthracnose was the most obvious disease affecting the species, with accessions ILCA 14164, 15603 and 15604 showing the worst symptoms (Table 2).

In the second year (1992), flowering patterns were similar to and dry matter yields exceeded those in the first year. Again, the earlier flowering accessions were associated with lower yields, with the exception of cv. Wynn which yielded almost as much as the highest yielding June-flowering accession (Table 4). The highest yields were from ILCA 15603 and ILCA 14167, both later flowering accessions. Again, the yields in kg/ha followed a similar pattern to those in g/plant. Seed yields ranged from 140–695 kg/ha. Disease incidence and severity were generally lower in the second year, but again anthracnose was the predominant disease (Table 2).

Drought tolerance

Two accessions (ILCA 10916 and 14529) showed poor drought tolerance with only 5% green leaf on the plots by the late dry season, and ILCA 14167 had 10%. Most accessions had 25–50% green leaf by this time with 2 accessions (ILCA 14161 and 14163) having 75% green leaf.

Table 3. Flowering time and dry matter and seed yields of *Chamaecrista rotundifolia* accessions (means of 2 replications) for 1991 (year of establishment). The accessions are sorted first on flowering time then on dry matter yield in g/plant. LSD values are presented for both the overall, and for the early-flowering (July) and late-flowering (October-November) groups.

Accession	Month of 1st flowering	Dry matter yield 1991		Seed yield 1991-92
		(g/plt)	(kg/ha)	(kg/ha)
14170	July	0.8	720	400
14174	July	1.1	860	540
14173	July	1.1	860	290
9288	July	1.2	590	660
14168	July	1.3	740	660
14164	July	1.5	1260	385
14161	July	1.6	1030	660
14172	July	1.7	1710	480
14163	July	1.9	1560	370
6999	July	2.1	1990	505
14162	July	2.3	970	495
14166	July	3.5	1820	1095
14169	July	3.7	3450	815
Wynn	July	3.9	2020	605
14171	July	4.0	2730	735
14165	July	5.1	2560	575
LSD (P = 0.05) (July)		3.8	1780	530
10917	October	3.8	3120	340
14167	October	6.0	6960	620
15603	November	2.5	3510	640
15604	November	2.6	3790	705
10916	November	3.1	2670	145
14529	November	10.5	7960	190
LSD (P = 0.05) (Oct-Nov)		7.3	4040	580
LSD (P = 0.05) (Overall)		4.5	2320	515

Table 4. Flowering time and dry matter and seed yields of *Chamaecrista rotundifolia* accessions (means of 2 replications) for 1992. The accessions are sorted first on flowering time then on dry matter yield in g/plant. LSD values are presented for both the overall, and for the early-flowering (May-July) and late-flowering (August-October) groups.

Accession	Month of 1st flowering	Dry matter yield 1992		Seed yield 1992-93
		(g/plt)	(kg/ha)	(kg/ha)
Wynn	May	7	2880	475
14170	June	2	610	345
14166	June	3	900	610
14172	June	3	1290	435
14174	June	3	1340	405
14168	June	4	1760	575
14162	June	4	1660	440
9288	June	4	1430	660
14164	June	5	2340	450
14173	June	5	2200	350
6999	June	6	2670	470
14163	June	6	3360	605
14169	June	6	2760	695
14165	June	8	3010	625
14161	July	3	1280	465
10917	July	25	7540	205
LSD (P = 0.05) (May-July)		6	2450	na[1]
14171	August	8	3070	370
10916	August	17	7170	140
14167	August	44	12820	280
14529	October	33	8270	170
15604	October	40	11120	440
15603	October	59	14080	360
LSD (P = 0.05) (Aug-Oct)		58	15750	na[1]
LSD (P = 0.05) (Overall)		26	7260	na[1]

[1]Not available.

Discussion

Whilst a 2-year evaluation on small plots may not be truly representative of sward conditions in a pasture situation, experience has shown that this is a reliable method of selecting promising material, which can then be tested under more realistic pasture conditions (see, for example, Tarawali *et al.* 1989; Tarawali 1991, 1994; Peters *et al.* 1994a, 1994b).

Our study indicates that some accessions of *Chamaecrista rotundifolia* have the potential for higher herbage yields than cv. Wynn in the sub-humid zone of Nigeria. Yields recorded for cv. Wynn during this evaluation are comparable with those obtained in other studies in the region (Tarawali 1991; Peters *et al.* 1994b), suggesting that the comparison of Wynn with the other accessions under these conditions is reasonable. Seed production of Wynn has ranged from 100–500 kg/ha in both Nigeria and Australia (Tarawali 1991; Partridge and Wright 1992; Kachelriess and Tarawali 1993); yields for Wynn in the present study were similar to those values but, in both years, other accessions had better seed yields than Wynn.

In the second year (1992), the fast regrowth of surviving plants at the start of the rains meant that flowering of all accessions was one month earlier than in the establishment year. Nevertheless, the pattern of flowering, in terms of early- and late-flowering accessions, was similar. Wynn was the first to flower (May) in 1992. The tendency for high yielding accessions to flower later could be expected, since these accessions had a longer period of vegetative growth. Although

plant density varied, ranking of accessions in yield/ha was similar to that in g/plant, suggesting that, in most cases, plant density was not so great as to cause excessive inter-plant competition.

The accessions with high dry matter yields in the present study can be considered as alternatives to Wynn in a fodder bank or mixed pasture situation; however, in order to select the most appropriate, it is necessary to consider other features. The late-flowering accessions ILCA 15603 and 15604 yielded well in both years but showed some susceptibility to anthracnose disease; this is a serious drawback, since disease problems frequently cause the loss of pasture species after just a few years (Lenne 1990). The other accessions with high dry matter yields (ILCA 10916, 14167 and 14529) had low tolerance of drought such that there was little green leaf left by the late dry season; this can cause a reduction in quality of the herbage (Peters 1992; Peters *et al.* 1994b). ILCA 10916 and 14529 also had low seed production. ILCA 14167 was marginally better in terms of drought tolerance than ILCA 14529 but had good seed production, and warrants further investigation. Drought tolerance of the selected accession could possibly be improved by grazing as reported for Wynn (Cook 1988), and wet season grazing of fodder banks is a recommended management practice (Otsyina *et al.* 1987). Although ILCA 14167 has a later and more determinate flowering habit than Wynn, its growth habit is similar, meaning that it may be used in a similar way to Wynn in pastures and fodder banks. Some investigation into the crude protein content, nutritive value and palatability would be worthwhile before further evaluation of this accession, since some reports have indicated instances of low palatability in the species. For instance, Blair-Rains (1963) reported that indigenous *C. rotundifolia* is unpalatable in Nigeria. However, in a grazing trial in Australia, Wynn, oversown into native pasture, comprised up to 16% of the diet of cattle and resulted in 40% more liveweight gain than from native pasture alone (Partridge and Wright 1992). Other nutritional studies have also confirmed that the species is free of noxious compounds (Strickland *et al.* 1985; Ahn *et al.* 1988).

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