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SUMMARY:

The morphological and agronomic variation of 58 accessions of the tropical legume *Clitoria ternatea* was examined at Lansdown (19° 40S′) in North Queensland. Agronomic performance in terms of dry matter production and seed yield over two growing seasons appeared to be independent of the morphological characteristics measured. The best accession overall was CPI 47187 previously reported as having produced the highest dry matter yield under irrigation at Kimberley Research Station (15° 39S′) near Kununurra, Western Australia.

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AN EVALUATION OF A COLLECTION OF *CLITORIA TERNATEA* FOR FORAGE AND GRAIN PRODUCTION

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INTRODUCTION

Clitoria ternatea is a twining perennial legume of Old World origin which now occurs throughout the lowland tropics of the world both naturally and as an escape from cultivation (Fantz 1977). It has been examined in a number of countries as a potential pasture plant but as yet no improved or named cultivars have been developed (Crowder 1974). It is one of the few potential forage legumes that are adapted to clay soils (Parbery 1967; Bogdan 1977; Blunt and Chapman 1978), a characteristic already shown in both north and north-western Queensland (Bishop 1973; R. Clem, pers. comm.). As well as being a potential forage plant the seed yields of this species are sufficiently high to warrant consideration as a grain legume. Seed of *C. ternatea* has been reported as having a crude protein content of 43.8% with a high lysine content (2.9%), but with a crude fibre content of 14.2% (Bravo 1971). The oil content has been reported as 10.07% which is lower than many other oilseed crops (Vianni *et al.* 1971).

Before this current evaluation some 16 accessions had been examined at the CSIRO Lansdown Research Station. All these accessions persisted under grazing in plant introduction nurseries and exhibited sufficient promise to be considered as an alternative species for Siratro. A wider collection of genotypes has consequently been assembled to assess the range of morphological and agronomic variation within the species.

MATERIALS AND METHODS

Fifty-eight accessions were obtained mainly from research stations in both the Old and New World Tropics (Table 1), including an accession naturalised in the Townsville area.

The experiment was established in January 1974 at the Lansdown Research Station (19° 40'S) near Townsville, North Queensland and continued until September 1975. The soil on the site was a homogeneous weak red podzolic developed on alluvium. Annual rainfall was 1083 mm in 1974 and 600 mm from January to September in 1975. The area received 375 kg/ha superphosphate just before establishment and was kept weed free during the experiment.

The seeds were scarified by hand, inoculated with Rhizobium strain CB 929 and sown in peat pellets. When the seedlings were about 10 cm high they were transplanted 0.4 m apart within rows spaced 2 m apart. All plants were checked for successful nodulation before being transplanted. Each plot contained eight plants per accession. The number of replicates varied from one to four depending on the availability of seed. There were 108 plots in all.

The morphological characteristics recorded for each plant were flower colour, pod vestiture, growth habit, presence of five or seven leaflets per leaf (or both) and whether the plant was single or double flowered. Agronomic observations were made on the date of the first flower and the presence of the first ripe seed. Dry matter yield per plot was determined from a fixed quadrat comprising two plants harvested in May each year. Seed yield was determined similarly on another two plants per plot in June each year. Leaf length and width were measured at the time of the first harvest. The remaining four plants in each plot were used for observations on the ability of the accession to retain green leaf in the dry season and to make regrowth at the beginning of the second wet season (December 1974). Estimates were made of the amount of seed shed before the first harvest and all harvested plants were rated for regrowth after cutting.

STATISTICAL METHODS

Analyses of variance were carried out on each of the morphological and agronomic (or performance) variables to test for differences between accession means. The logarithms of dry matter yield for years 1 and 2, total dry matter yield, and seed yield for years 1 and 2, were used in order to equalise the error variances. Further investigations were made regarding the inter-relationships between the attributes and the possible grouping of accessions, using pattern analysis techniques. Analyses of variance were then carried out to test for differences in agronomic performance among the groups.

RESULTS AND DISCUSSION

Table 1 summarises the agronomic performance and morphological characteristics of the 58 accessions ranked in order of total dry matter yield over the two harvests. Two accessions proved to be heterogeneous with both blue and white flowers occurring. *C. ternatea* has a diploid chromosome number of 2n = 16 (Darlington and Wylie 1955). Growth habit and number of leaflets per leaf differed among the replicates of some accessions. Some accessions had five leaflets/leaf, some seven leaflets, while 12 of the accessions had a combination of both. No plant had nine leaflets/leaf, as has been recorded elsewhere (Crowder 1974). The accessions with five leaflets/leaf had larger leaves than the others.

Dry matter yield at both harvests of the top eight accessions was significantly ($P < 0.05$) higher than that of the bottom eight accessions. The 42 middle-ranking accessions were not significantly different in dry matter yield. There were no significant differences in dry matter yield among the eight best performers. CPI 49726 and CPI 37195 yielded significantly less ($P < 0.05$) than all others, except CPI 50974 and CPI 46379. There were no significant differences among accessions in regrowth following either harvest (data not shown).

Shedding of seed was highly variable and significant differences between accessions could not be detected although the proportion of seed shed ranged from 1 - 40%.

When means of the agronomic variables over all plots were compared for each of the six morphological characteristics it appeared that individual morphological attributes were in general not good indicators of potential performance. However seed yield at the first harvest was significantly ($P < 0.05$) associated with growth habit, with erect and semi-prostrate plants yielding more seed than the prostrate ones. With regard to pod vestiture, the lone tomentose accession was a poor yielder of dry matter and seed but more accessions of this type would need to be observed before any firm conclusions concerning the relationship between pod vestiture and yield can be made.

Seed yields of the best lines (CPI 49706 and 61151) under the wide row spacing and low plant population of this trial (1.2 plants m^{-2}) were equivalent to about 1200 kg ha^{-1}. This compares favourably with world average yields of other legume grain crops (Harding *et al.* 1978). Also because the species is a perennial, multiple harvests can be taken.

To investigate whether some combination of morphological characteristics could be a useful guide to performance, the classification programs MULTCLASS and GROUPER (Lance *et al.* 1968) were used to form six morphological "groups". Analyses of variance indicated that there were no significant differences among these groups in terms of agronomic performance.

Table 2 gives the correlations between each pair of agronomic characteristics. There was good consistency in performance over the two harvests. The correlation coefficients for DM 1 with DM 2, and for seed yield 1 with seed yield 2 were 0.97 and 0.93 respectively. There was also a significant relationship between DM yield and seed yield. On average the top performing accessions tended to flower earlier than the poor performers.

Plants flowered from 47–80 days after sowing, and flowers appeared throughout the year whenever rainfall conditions were suitable for growth. Pod development was not uniform, with seed maturing at irregular intervals; however most seed matured at the end of each wet season.

The accession with the highest DM yield was CPI 47187 and it is interesting to note that this accession also gave the highest total dry matter yield under irrigation in a cutting experiment comprising 22 accessions of *C. ternatea* in the Ord Valley, and was superior to four genotypes tested earlier in the area by 18–41 percent (Blunt and Chapman 1978). One of the four genotypes was CPI 30121 which was included in our group of worst performers.

Whilst it is doubtful that *C. ternatea* would persist under continuous heavy grazing because of its high palatability, it may have a place under rotational grazing. Under grazed nursery conditions at Lansdown it combines well with *Urochloa mosambicensis* but its D.M. yield is only two-third that of Siratro. Also it may find a place as a perennial dryland hay crop as it establishes readily, is fairly competitive with weeds, and the erect forms are easy to harvest.

CONCLUSIONS

From this evaluation of 58 accessions of *C. ternatea*, CPI 47187, 49706 and 61151 were the most promising in terms of dry matter yield and seed production. CPI 20733, 29061, 49963, 50973 and Q7006 equalled them in dry matter yield but produced less seed. The two poorest accessions were CPI 37195 and 49726. The six morphological variables observed in this study did not provide a guide to agronomic performance. This indicates that either more morphological characteristics should be recorded or that performance of *C. ternatea* is relatively independent of morphology.

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TABLE 1. Origin, morphological characteristics and mean agronomic performance for a collection of 58 accessions of *Clitoria ternatea*, ranked in order of total dry matter yield. Dry matter and seed yields are the total for two plants.

Accession No.	Origin*	No. of reps.	a Flower colour	b Pod vestiture	c Growth habit	No. leaflets/ leaf	d Flower type	Leaf length (cm)	Leaf width (cm)	Time to flower (days)	DM 1 (g)	Seed yield 1 (g)	Seed shed 1 (%)	DM 2 (g)	Seed yield 2 (g)	Total DM (g)
CPI 47187	Sudan	2	B/W	2	2	7	1	5.3	4.0	55	851	181	38	789	182	1640
CPI 49963	Brazil	2	B	2	2	5&7	1	6.5	4.0	57	739	159	6	714	124	1453
CPI 20733	Kenya	2	B	2	2	7	1	5.0	3.5	54	735	67	25	711	74	1446
CPI 29061	Sudan	2	B	2	2/3	7	1	4.6	3.6	55	732	141	6	636	118	1368
Q 7006	Brazil	2	B	2	2/3	7	1	8.0	6.0	60	651	180	20	682	153	1333
CPI 49706	Brazil	2	B	2	3	5&7	1	6.8	4.5	60	663	207	1	659	185	1322
CPI 61151	Venezuela	1	B	2	3	5&7	1	8.6	5.0	63	643	207	1	624	189	1267
CPI 55715	Brazil	2	B	2	2/3	5&7	1	7.0	5.0	69	624	164	6	636	155	1260
CPI 49962	Brazil	1	B	2	2	7	1	3.5	2.2	50	630	161	4	619	143	1249
CPI 38284	Venezuela	2	B/W	2	2/3	5&7	1	6.3	3.8	57	626	103	10	623	104	1249
CPI 51380	Honduras (via Florida)	2	B	2	3	7	1	6.0	4.5	60	633	133	21	602	117	1235
CPI 48337	Tanzania	2	B	2	3	7	1	6.1	4.0	57	579	64	13	632	86	1211
CPI 50973	Senegal	1	V	2	3	7	1	6.0	4.0	63	612	161	10	598	137	1210
CPI 50973	Senegal	1	B	2	3	7	1	6.0	4.0	63	613	110	2	596	84	1209
CPI 50969	Senegal	2	B	2	2	5	1	4.8	3.0	57	587	91	13	591	89	1178
CPI 30196	India	2	W	2	2	5	1	5.0	3.5	60	582	156	1	581	135	1163
CPI 41015	Fiji	1	B	2	2	5	1	6.5	5.0	63	576	122	30	582	131	1158
CPI 30001	Malaysia	2	B	2	2	7	1	7.0	4.5	54	562	87	13	570	88	1132
CPI 51625	Ghana	1	B	2	3	5&7	1	7.0	4.5	57	555	106	1	559	121	1114
CPI 46600	Senegal	2	B	2	1/2	5&7	1	5.0	2.5	52	538	63	20	571	99	1109
CPI 41015	Fiji	1	W	2	3	7	1	5.5	3.0	75	562	70	40	539	66	1101

TABLE 1 – continued.

Accession No.	Origin*	No. of reps.	a Flower colour	b Pod vestiture	c Growth habit	No. leaflets/leaf	d Flower type	Leaf length (cm)	Leaf width (cm)	Days to flower	DM 1 (g)	Seed yield 1 (g)	% Seed shed 1	DM 2 (g)	Seed yield 2 (g)	Total DM (g)
CPI 50972	Senegal	2	B	2	2/3	7	1	5.0	3.5	60	507	84	23	588	103	1095
CPI 49721	Virgin Isles	2	B	2	2	7	1	6.5	3.5	54	548	47	35	542	77	1090
CPI 46379	Cuba	1	B	2	3	5	1	7.5	5.0	57	542	167	1	546	143	1088
CPI 49664	Panama	2	B	2	3	7	2	5.5	4.1	60	507	96	5	553	90	1060
CPI 49705	Brazil	2	B	2	2	7	1	6.0	3.5	63	526	150	14	530	133	1056
CPI 61596	Mexico	2	W	2	3	7	1	4.5	3.0	63	529	129	23	512	115	1041
CPI 50970	Senegal	2	B	2	2	7	1	6.0	4.0	50	521	111	30	517	109	1038
CPI 37195	Honduras	1	B	2	2	7	1	4.0	2.5	63	504	162	1	519	137	1023
CPI 15523	Sudan	2	B	2	2	7	1	5.0	3.0	54	511	145	4	507	140	1018
CPI 55717	Venezuela	2	B	2	2/3	5	1	7.2	4.5	52	501	93	12	512	93	1013
CPI 49959	Brazil	4	B	2	2/3	7	1	7.8	4.5	57	500	114	4	505	112	1005
CPI 38284	Venezuela	4	B	2	2/3	5&7	1	8.0	5.0	55	507	159	11	496	139	1003
CPI 61595	Mexico	2	W	2	3	7	1	4.5	3.0	60	484	130	8	510	119	994
CPI 49961	Brazil	2	B	2	2	7	1	4.8	3.0	57	499	138	14	485	122	984
Q 5455	Australia (Gayndah)	2	B	2	2/3	5&7	1	4.0	3.5	63	442	134	6	536	146	978
CPI 34723	Brazil	2	B	2	2/3	7	1	4.2	3.0	63	474	97	8	498	85	972
CPI 46600	Senegal	2	V	2	2	7	1	6.0	4.2	49	471	135	10	497	125	968
CPI 50794	Netherlands	3	W	2	1/2	7	1	6.1	5.2	57	472	75	6	488	103	960
CPI 34582	Brazil	2	B	2	3	5&7	1	7.2	5.2	57	485	148	1	466	130	951
CPI 53673	Ivory Coast	2	B	2	2	7	1	5.0	3.0	60	468	62	28	473	82	941

TABLE 1 – continued.

Accession No.	Origin*	No. of reps.	Flower colour[a]	Pod vestiture[b]	Growth habit[c]	No. leaflets/ leaf	Flower type[d]	Leaf length (cm)	Leaf width (cm)	Days to flower	DM 1 (g)	Seed yield 1 (g)	% Seed shed 1	DM 2 (g)	Seed yield 2 (g)	Total DM (g)
CPI 37456	Brazil	2	B	2	3	5&7	1	6.0	4.5	63	457	157	9	475	134	932
CPI 46600	Senegal	2	W	2	1/2	7	1	5.5	3.5	53	420	191	20	487	154	907
CPI 50971	Senegal	2	B	2	2	7	1	8.0	5.0	57	432	71	1	470	52	902
CQ 389	Australia (N. Territory)	4	B	2	2/3	7	1	7.0	5.2	54	436	109	22	447	114	883
CPI 50975	Senegal	2	B	2	2	7	1	5.7	3.0	60	430	93	2	446	113	876
CPI 49960	Brazil	2	B	2	2	7	1	6.2	4.3	57	409	74	25	423	79	832
Naturalised Line 1	Australia (Townsville)	2	B	2	2	7	1	3.0	2.5	57	413	127	4	399	95	812
CPI 28110	Venezuela	2	B	2	3	7	1	5.5	3.5	60	416	80	30	392	72	808
CPI 55716	Venezuela	2	W	2	2/3	7	1	7.5	4.0	69	320	100	6	404	92	724
CPI 30121	Ceylon	2	B	2	1/2	5	1	8.1	4.6	72	332	47	30	388	76	720
CPI 50970	Senegal	2	W	2	1/2	7	1	4.5	4.0	54	325	65	25	360	84	685
CPI 61596	Mexico	2	B	2	2/3	5	1	7.5	4.5	63	316	144	1	320	117	636
CPI 53218	Hong Kong	1	B	2	2	7	1	6.2	4.8	63	280	144	10	312	124	592
CPI 50974	Senegal	1	W	2	2	7	1	7.8	5.2	80	188	104	1	276	85	464
CPI 46379	Cuba	1	B	2	2	5	1	7.5	5.0	80	228	85	1	235	90	463
CPI 49726	Kenya (via Florida)	1	W	1	1	5&7	1	4.2	2.5	50	161	25	1	202	47	363
CPI 37195	Honduras	1	B	2	2	7	1	4.0	2.5	80	155	55	30	201	62	356

* Either naturally occurring location or research establishment. Location of original collection is obscure in many instances.

a Flower colour B = Blue, W = White, V = Violet

b Pod Vestiture 1 = tomentose, 2 = glabrous

c Growth habit 1 = prostrate, 2 = semi-prostrate, 3 = erect

d Flower type 1 = single, 2 = double

TABLE 2. Correlation coefficients for the agronomic variables based on the performance of a collection of 58 accessions of *Clitoria ternatea.*

	1	2	3	4	5	6	7	8	9	10	11
1. Time of First Flower	1.00										
2. Time of First Seed	0.09	1.00									
3. DM 1	-0.41**	0.11	1.00								
4. Seed Yield 1	-0.08	0.04	0.44**	1.00							
5. % Seed Shed	0.02	-0.08	0.11	-0.34**	1.00						
6. Regrowth 1	-0.24	0.09	0.36**	0.06	-0.10	1.00					
7. Leaf length	0.09	-0.23	-0.09	0.06	-0.04	-0.40**	1.00				
8. Leaf width	0.04	-0.17	-0.05	0.14	-0.05	-0.38**	0.91**	1.00			
9. DM 2	-0.39**	0.13	0.97**	0.43**	0.10	0.32*	-0.07	-0.03	1.00		
10. Seed Yield 2	-0.14	0.15	0.49**	0.93**	-0.24	0.04	0.12	0.20	0.50**	1.00	
11. Regrowth 2	-0.09	-0.04	0.32*	0.07	-0.21	0.81**	-0.18	-0.17	0.28*	0.00	1.00

* $P < 0.05$

** $P < 0.01$