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YIELD ATTRIBUTES OF SOME SPECIES AND ECOTYPES OF CENTROSEMA IN NORTH QUEENSLAND

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SUMMARY

Seasonal and total production of selected introductions of *Centrosema pubescens* Benth. from New Guinea, Costa Rica, Guatemala and Mexico, *Centrosema brasilianum* Benth. from Brazil and *Centrosema plumieri* Benth. from Colombia were compared with standard centro in a sward trial at South Johnstone, North Queensland.

Annual yields of dry matter of four of the *Centrosema* accessions were significantly greater than that of the standard centro. *C. brasilianum* Q8216, a species previously not recorded in agrostological literature, gave the highest annual yield, the post-west period yield contributing mainly to this.

***C. pubescens* Q8333, an introduction from Costa Rica, outyielded standard centro and all other centro lines in the cool season of 1968 and again in 1969. It was very little affected by Cercospora leaf spot and red spider (*Tetranychus* sp.) attacks. At high intensity of defoliation, cut at crown level five times per annum, this ecotype had a 95% survival. The other ecotypes and species were reduced to 70, 57 and less than 50% survival.**

I. INTRODUCTION

The genus *Centrosema* contains about 70 recorded species (Ducke 1949), mainly tropical Central and South American in origin. The only two species of note are *C. pubescens* Benth. and *C. plumieri* Benth., both of which are used in the tropics as green manure and cover crops (Whyte, Nilsson-Leissner and Trumble 1953).

C. pubescens, commonly known as centro, has been developed within recent times as a pasture legume in association with *Panicum maximum* Jacq., *Brachiaria mutica* Stapf and *Pennisetum purpureum* Schum. in North Queensland and other humid tropical regions (Schofield 1941; Graham 1946; Walsh 1959; Moore 1962; Horrell and Newhouse 1965).

C. pubescens is a truly tropical species adapted to high-rainfall, frost-free environments. While it is highly persistent in grazed swards, a limiting feature of the variety used in North Queensland is that it is sensitive to low temperatures.

Bowen (1959) studied the nodulation and growth rate of centro at two sites in Queensland—Ormiston (latitude 27° S.) and Ayr (latitude 19·5° S.). He found a very distinct periodicity in growth rate and nodulation, also that both decline or cease when the minimum screen temperature is below 55°F and the maximum screen temperature less than 78°F.

During this period of slow growth, which extends from June to September, commercial centro is also very susceptible to attack by plant pathogens (e.g. Cercospora leaf spot) and red spider (*Tetranychus* sp.), which cause severe leaf deterioration. This seasonal decline of legume growth has obvious disadvantages in a mixed pasture, reducing symbiotic activity, overall pasture yield and quality.

The experiment reported here attempted to identify a line of centro that would produce better dry-matter yields than standard centro during the critical cool-season period, without prejudicing production in other seasons.

These investigations were carried out at South Johnstone Research Station of the Queensland Department of Primary Industries (latitude 17° 36′ S.) on the humid tropical coast of North Queensland. This area has a mean annual temperature of 73·2°F. The maximum temperature rarely exceeds 90°F during the summer months; temperatures may fall as low as 40°F in winter. Mean temperature maxima for June, July and August are 74·7°F, 74·5°F and 75·8°F respectively. Mean minimum temperatures are 60·0°F, 56·7°F and 57·1°F for the three winter months. Absolute minimum temperatures recorded during the experimental period were 42·4°F in July 1968 and 46·0°F in August 1969. The mean annual rainfall is 127 in.

The soil of the experimental site is a silty clay loam; the surface 6 in. has a pH value of 4·9 and contains 25 p.p.m. available phosphorus and 0·30 m-equiv. % potassium.

II. MATERIALS AND METHODS

Some 34 lines of *C. pubescens* were earlier introduced and were under observation at the Research Station between 1953 and 1964. A low level of variation was observed among all these early introductions of *C. pubescens,* which emanated mostly from the Far East. They were mainly summer productive and morphologically similar types to standard centro. This paucity of variation in the material from the East suggests a narrow genetical base and possibly a common source of origin of commercially used centro in those regions.

Plant collection in the high-rainfall tropical regions of South and Central America in 1964-65, with the specific objective of finding new forms and ecotypes of tropical legumes, resulted in the introduction of 25 lines of *Centrosema.* On

TABLE 1

ORIGIN OF *Centrosema* ACCESSIONS SELECTED FOR TRIAL AT SOUTH JOHNSTONE

Accession No.	Species or Line	Origin or Source	Altitude (ft)	Annual Rainfall (in.)
Standard commercial	*C. pubescens* ..	Imported commercial	Sea level to 1,000	80–150
C.P.I. 23086*	*C. pubescens* ..	New Guinea ..	Sea level to 1,000	80–150
Q8333**	*C. pubescens* ..	Costa Rica ..	2,000	117
Q8397	*C. pubescens* ..	Guatemala ..	2,200	80
Q8399	*C. pubescens* ..	Mexico	600	160
Q8216	*C. brasilianum* ..	Brazil, Instituto Agronomico do Norte, Belem	30	108
Q8274	*C. plumieri* ..	Colombia ..	4,100	156

* C.P.I.—Commonwealth Plant Introduction number.

** Q—Queensland Department of Primary Industries Introduction number.

the basis of their performance in space-planted nursery plots, four accessions of *C. pubescens,* including an earlier introduction C.P.I. 23086, one of *C. brasilianum* and one of *C. plumieri,* were selected for a sward trial to compare their productivity with standard centro. Selection criteria were cool-season and early spring vigour coupled with strong stoloniferous development. The lines chosen for comparative testing are listed in Table 1.

Rainfall during the trial period was generally favourable but the prewet season was characterized by a severe moisture stress. The rainfall recorded during this period was the lowest for 22 years. Seasonal distribution of rainfall during the trial period is shown in Table 2.

TABLE 2

RAINFALL RECORDED DURING THE TRIAL PERIOD AT SOUTH JOHNSTONE

Season	Rainfall (in.)	
	Average All Years (32)	Trial Period 1968–69
1968		
Cool (June, July, August)	13·55	9·49
Spring (September, October) ..	6·40	4·14
Prewet (November, December) ..	12·88	2·30
1969		
Wet (January, February)	43·97	50·42
Post-wet (March, April, May) ..	50·42	41·53
Cool (June, July, August)	13·55	30·52

The experiment was set out in a randomized block design with four replications. Inoculated and mechanically scarified seed of seven centro lines was sown in plots measuring 50 lk x 10 lk on January 31, 1968. The legumes were sown alone with a single-row hand planter in drills 2 lk apart at the rate of 10 lb/ac for all lines except the large-seeded *C. plumeri,* which was planted at 20 lb/ac. Superphosphate (9·6%P) at the rate of 500 lb/ac was applied at planting and 50 lb/ac of a compound fertilizer (14N:3·5P:12K) was applied 6 weeks after seedling emergence.

Dry-matter yields were obtained by harvesting three sample quadrats per plot each 5 lk x 2 lk. The full sample was dried at 95°C until constant weight. After each harvest, the plots were cut at crown level with an Autoscythe.

A complete ground cover was present when the equalizing cut was taken on June 6, 1968. Of all lines included in the trial, *C. plumieri* showed the fastest establishment and the highest yield on this occasion. Including the equalizing cut, seven harvests were taken between June 1968 and September 1969.

At the end of the trial period, sward composition was determined by hand-separation of constituents into sown legume and miscellaneous weeds and expressed as percentage on the dry-weight basis. Simultaneously, leaf damage caused by insects and pathogens was estimated by four independent observers. Damage scores were allotted on a 0-5 scale. A score of five meant that 75% or more of the foliage was affected.

III. RESULTS

On the basis of total annual yield of dry matter (Table 3), four accessions—*C. brasilianum* Q8216, *C. pubescens* Q8399, Q8397 ($P<0\cdot01$) and Q8333 ($P<0\cdot05$)—significantly outyielded standard centro. Seasonal yields (Table 4) revealed a consistent pattern of production in all lines. With the exception of Q8333, all centro lines were mainly summer productive. The distribution of herbage dry matter yields of Q8216, Q8399, Q8397 and C.P.I. 23086 accessions showed a similar pattern to standard centro over the spring, prewet and wet seasons. These four accessions and standard centro produced 62·6–69·2% of their total annual dry-matter yields from September to March. There was no significant difference between standard centro and the same four accessions at the spring and prewet season sampling dates.

TABLE 3

ANNUAL YIELDS OF DRY MATTER OF SIX *Centrosema* ACCESSIONS AND STANDARD CENTRO IN THE 1968–69 SEASON

Accession No.	Species or Line	Dry-matter Yield (Total of five cuts) (lb/ac)
Q8216	*C. brasilianum*	12,588·4
Q8399	*C. pubescens*	11,693·7
Q8397	*C. pubescens*	11,609·2
Q8333	*C. pubescens*	11,476·9
C.P.I. 23086	*C. pubescens* standard ..	10,271·7
Standard Commercial ..	*C. pubescens*	10,040·2
Q8274	*C. plumieri*	6,803·1
L.S.D. 1%	1,512·8	
L.S.D. 5%	1,107·1	
C.V.	6·98%	

TABLE 4

YIELDS OF OVEN-DRY MATTER OF *Centrosema* SPECIES AND LINES

Accession No.	Sept. 6, 1968—Nov. 6, 1968 Spring		Nov. 6, 1968—Jan. 6, 1969 Prewet		Jan. 6, 1969—March 10, 1969 Wet		March 10, 1969—June 9, 1969 Post-wet	
	Yield (lb/ac)	Rank	Yield (lb/ac)	Rank	Yield (lb/ac)	Rank	Yield (lb/ac)	Rank
Q8333	2,836·1	1	1,320·9	6	2,886·2	4	2,052·1	2
Q8216	2,597·8	2	2,414·1	2	2,867·8	5	2,836·6	1
Q8399	2,472·9	3	2,489·4	1	2,886·2	3	1,848·2	6
Q8397	2,463·7	4	2,285·5	4	2,963·4	2	1,932·2	4
Standard centro ..	2,065·0	5	2,325·9	3	2,553·7	6	2,004·4	3
C.P.I. 23086 ..	1,940·1	6	2,149·5	5	2,990·9	1	1,910·7	5
Q8274	1,159·3	7	1,293·4	7	1,960·3	7	1,376·1	7
L.S.D. 1%	773·6		551·6		497·8		403·6	
L.S.D. 5%	564·6		402·7		363·4		294·6	

C. pubescens Q8333 produced better ($P<0\cdot05$) than standard and C.P.I. 23086 centro lines from September to November but it was outyielded ($P<0\cdot01$) by standard centro, Q8216, Q8399, Q8397 and C.P.I. 23086 accessions in the prewet season.

Cumulative yields recorded during the summer wet season were generally high for all accessions as well as standard centro. Yield differences were non-significant between C.P.I. 23086, Q8397, Q8399, Q8333 and Q8216 lines; only C.P.I. 23086 and Q8397 yielded better ($P<0\cdot05$) than standard centro.

Of the mainly summer-growing *Centrosema* lines, Q8216 continued active growth well into the post-wet season and at the June or post-wet season sampling date Q8216 was significantly ($P<0\cdot01$) better than all other lines in the trial.

Q8333 and to a lesser extent Q8216 were outstanding at the cool-season sampling dates, especially in 1969 (Table 5).

TABLE 5

COOL-SEASON PRODUCTION OF OVEN-DRY HERBAGE OF *Centrosema* SPECIES AND LINES

Accession No.	June 6, 1968—Sept. 6, 1968		June 9, 1969—Sept. 9, 1969	
	1968 Yield (lb/ac)	Rank	1969 Yield (lb/ac)	Rank
Q8333	2,381·0	1	2,112·8	1
Q8399	1,997·0 *	2	744·1	4
Q8397	1,964·0 *	3	712·8	5
Q8216	1,872·1	4	1,102·3 **	2
C.P.I. 23086	1,280·5 **	5	755·1	3
Standard centro ..	1,091·3	6	681·6	6
Q8274	1,014·1	7	413·4	7
L.S.D. 1%	479·2		443·7	
L.S.D. 5%	349·8		323·9	

Q8333 outyielded bracketed values ** 1% level; *5% level.

Standard centro and other summer-growing types, Q8397, Q8399 and C.P.I. 23086, showed a marked decline in production in the cool season.

In the first year of the experiment, Q8333, Q8216, Q8397 and Q8399 yielded significantly better ($P<0\cdot01$) than standard centro during the cool months from June to September.

Q8333 also outyielded ($P<0\cdot05$) Q8397 and Q8399 and it was superior ($P<0\cdot01$) to Q8216 and C.P.I. 23086.

In the cool season of 1969, Q8333 outyielded ($P<0\cdot01$) all other lines. Again Q8216 produced better ($P<0\cdot05$) yields than standard centro, Q8397, Q8399 and C.P.I. 23086.

TABLE 6

PERCENTAGE WEEDS OF TOTAL OVEN-DRY YIELD OF *Centrosema* AND WEEDS ON SEPT. 9, 1969, AFTER SEVEN SEASONAL CUTS, AND LEAF DAMAGE SCORES

Accession No.	Yield of *Centrosema* and weeds (lb/ac)	Weeds (Mean % on dry-weight basis)	Leaf damage (Scale 0–5)
Q8333	2,228·5	5·4	0·5
Q8216	1,602·0	30·7	3·0
C.P.I. 23086 ..	1,545·1	43·3	2·7
Q8399	1,491·8	50·9	3·0
Q8274	1,438·5	52·5	4·4
Standard centro ..	1,309·9	52·7	2·8
Q8397	852·5	54·1	4·1
L.S.D. .. 1%	479·7	20·8	
L.S.D. .. 5%	350·1	15·2	

The percentage of sown species (Table 6) was reduced to 45·7, 47·3, 47·5, 49·1, 56·7 and 69·3 in Q8397, standard, Q8274, Q8399, C.P.I. 23086 and Q8216 respectively by the end of the trial period and they were replaced by miscellaneous weeds. Q8333 had least weeds, maintained the highest yield, and showed a sown species content of 94·6%. It also displayed the best resistance to leaf disease (*Cercospora* sp.) and insect attack (*Tetranychus* sp.).

C. plumieri Q8274 was found unsuited to high intensity of defoliation and apart from its establishment yield this species produced the lowest yield at each cut.

IV. DISCUSSION

The poor growth of centro during the cool-season months is considered to limit animal production from guinea grass/centro pastures.

The results presented in this paper show that the genus *Centrosema* contains species and ecotypes, previously not recorded or tested as forage plants, which are capable of greater total and seasonal production than standard centro.

It is also indicated that considerable progress can be made in tropical pasture development by exploiting the naturally occurring ecotypes of forage legumes through introduction from the high-rainfall tropics of South and Central America.

The existence of an appreciable component of growth during cool weather in *C. pubescens* Q8333 and *C. brasilianum* suggests one method of overcoming seasonal fluctuations of legume dry-matter yield and animal production. *C. brasilianum* Q8216, with the highest annual and post-wet season yields and the second highest yield in the second cool season, is complementary to Q8333. The strongly stoloniferous habit of Q8333 suggests good associative ability with vigorous grass species. Q8333 was set back in the prewet season as a result of abnormally dry conditions. This ecotype appears to be dependent on a continuous favourable soil moisture in spring/early summer if it is to express its full growth potential.

In terms of their distribution of yield, seasonal and overall production, *C. pubescens* Q8333 and *C. brasilianum* Q8216 would seem to offer a high potential for replacing the current standard centro. Experimental work on the evaluation of these two promising lines in grazed swards, each in combination with the sward-forming *Brachiaria decumbens* Stapf and the tall bunch grass *Panicum maximum,* is in progress and will be reported at a later date.

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REFERENCES

BOWEN, G. D. (1959).—Field studies in nodulation and growth of *Centrosema pubescens* Benth. *Qd J. agric. Anim. Sci.* 16:253.

DUCKE, A. (1949).—Notas sobre a flora Neotropica II. *Bolm. tec. Inst. Agron. N.*:212.

GRAHAM, T. G. (1946).—Grassland development in tropical coastal areas. *Qd agric. J.* 63:261.

HORRELL, C. R., and NEWHOUSE, P. W. (1965).—Yields of sown pastures in Uganda, as influenced by legumes and by fertilizers. *Proc. IX int. Grassld Congr., Sao Paulo, Brasil* 2:1133.

MOORE, A. W. (1962).—The influence of a legume on soil fertility under a grazed tropical pasture. *Emp. J. exp. Agric.* 30:239.

SCHOFIELD, J. L. (1941).—Introduced legumes in North Queensland. *Qd agric. J.* 56:378.

WALSH, S. R. (1959).—Improved pastures will fatten cattle in the far north. *Qd agric. J.* 85:576.

WHYTE, R. O., NILSSON-LEISSNER, G., and TRUMBLE, H. C. (1953).—Legumes in agriculture. *F. A. O. Studies* No. 21.

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