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R.M. Jones, A.H.D. Brown and J.N. Coote

CSIRO Tropical Agriculture, 306 Carmody Road, St Lucia, Qld 4067, Australia

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R M Jones[1], A.H.D. Brown[2] and J. N. Coote[1]

[1]CSIRO Tropical Agriculture, Cunningham Laboratory, St. Lucia, Qld. 4067, Australia

[2]CSIRO Centre for Plant Biodiversity, Division of Plant Industry, Canberra, ACT 2601, Australia

Summary

Glycine latifolia (Benth.) Newell & Hymowitz is an herbaceous legume endemic to Australia. It occurs over a wide area of subcoastal and inland New South Wales and Queensland, primarily on clay soils. A selection of this species has been registered as cv. Capella under Australian PBR. Eighteen accessions of the species, collected from over this geographical range, were grown in southeast Queensland under glasshouse conditions and for three years under field conditions. Only three accessions came from subcoastal areas east of the Great Dividing Range. These three accessions and one other were similar; they had narrower leaves, smaller seeds and were lower yielding than inland accessions in the field trial. There were only minor differences between the remaining lines in morphological characters, though the most widely evaluated accession, cv. Capella, tended to have the highest herbage yield. Most lines, including cv. Capella, showed symptoms of infection by Alfalfa Mosaic Virus, but two other higher yielding accessions showed no symptoms.

Keywords: variation, *Glycine latifolia,* Alfalfa Mosaic Virus

Introduction

Glycine latifolia (Benth.) Newell & Hymowitz is an endemic Australian legume, usually confined to clay soils, occurring over a wide range of inland New South Wales and Queensland (Figure 1). It is a trailing stoloniferous perennial herb, resembling the related species *G. tomentella* Hayata (syn. *G. tomentosa* Benth.), *G. tabicina* (Labill.) Benth. and *G. microphylla* (Benth.) Tind. The features that distinguish it from *G. tomentella* are its stoloniferous habit, its broader leaflets, the lack of rust-colouring in the hairs on stems and a longer raceme than in *G. tomentella* (Hacker 1990). Unlike *G. tomentella*, the nodes of *G. latifolia* have one or more rootlet buds in the leaf axil of each node (Costanza and Hymowitz 1987). These buds can develop into roots in favourable moist soil or surface litter. The name *G. latifolia* is synonymous with *G. tabacina* var. *latifolia* as described by Bailey (1900). The species is more tomentose than typical *G. tabacina* (Newell and Hymowitz 1980) and its leaflets, typically elliptical to rhomboid, are broader than those of *G. microphylla*.

Cameron (1982) compiled extracts from published literature on selected legumes that were native to Queensland and northern New South Wales. There were several comments on the presence of *G. tomentella* or *G. tomentosa* on black earths or downs soils of the Central Highlands of Queensland. It is probable that many of these refer to the species now known as *G. latifolia*. Comments included "*G. tomentosa* has attracted attention as a plant of great potential value on the Mitchell - blue grass downs" and, that "it is important in the Springsure-Clermont area".

However, there has been no agronomic evaluation of different accessions of *G. latifolia*. The only detailed agronomic research on various *Glycine* species for forage was that carried out by G.P.M.

Wilson (personal communication). This resulted in two lines being carried forward into a multi-site evaluation study on light textured soils in coastal regions of Queensland and northern New South Wales. However, their performance was not especially encouraging (Cameron *et al.* 1989) and there has been no further evaluation of them.

In 1982 an accession of *G. latifolia* was collected on Donovan's farm, east of Capella, by M. C. Rees. It was subsequently evaluated at two sites on clay soils in the Darling Downs as CQ3368, together with a wide range of introduced tropical legumes (Rees *et al.* 1993; Rees *et al* 1995; Jones and Rees 1997). The promising results from these experiments led to this line being submitted for registration for Plant Breeders Rights as cv. Capella (Anon 1994).

As part of the evaluation process leading to registration of cv. Capella, its morphological and agronomic attributes were compared with those of 17 other representative accessions of the same species. Here we report the results of this comparison.

Methods

Field Experiment

Seventeen accessions of *G. latifolia* were selected from the collection held by the CSIRO Division of Plant Industry to span the natural geographic and morphological range of the species (Table 1 and Figure 1). Forty seedlings of each of these accessions and of Capella were germinated in petri dishes and planted in peat cups in a glasshouse. The seedlings were then planted into a black earth soil at Gatton, west of Brisbane, on January 9, 1991. Ten seedlings of each accession were planted 1 m apart in a row and there were four replicates in a randomised block layout. Seed supplies of 5 lines (G1460, G2134, G2125, G2115 and G1160) were limited and only about 20 plants were available, so rows of these lines contained fewer plants. The rows were 2 m apart and were kept separate by a combination of herbicide and rotary hoeing of a 50 cm strip between rows. The trial was irrigated during periods of severe moisture stress and weeds were controlled by herbicides and hand weeding. The rows of glycine were not cut at any stage.

In the first year, measurements of runner length and a record of the date of first flowering were made on individual plants within each row. In subsequent years, individual plants could not be recognised with certainty as they had grown into each other within the row. Measurements of leaves or pods were made by taking samples along the rows.

Measurements were made of the following attributes:

Stolon length. The length of an average stolon on each plant was measured on the 26/3/91 and 24/6/91, 76 and 166 days after planting.

Date of first flowering. Date of first flowering on each plant was recorded in the year of establishment (1991).

Yield rating. The yield of each accession was rated on a 1 - 10 scale, where a rating of 10 was for the highest yielding row in the trial. This was done on four occasions from January 1992 to November 1993 (Table 2). In two of the four samplings (9/1/1992 and 13/111992), the yield of legume was similarly estimated in five quadrats, spanning the range of yields, and these samples were then cut, dried and weighed.

Mottling. Periodically, most accessions had a characteristic yellow leaf mottle which is caused by Alfalfa Mosaic Virus (Horlock *et al.* 1993; 1997). The percentage of leaves with some yellowing was estimated for each row on three occasions from January 1992 to November 1993.

Table 1. Approximate locality, latitude, longitude, altitude and average annual rainfall (AAR) of the collection site of 18 accessions of *Glycine latifolia*. Site number refers to sites marked on Figure 1.

Acc.[1]	Site	Locality	Lat	Long	Alt	AAR
G1137	7	Delungra NSW	29°38`	150°50`	600	740
G1160	15	Warwick Qld	28°13`	152°02`	480	630
G1213	1	Burren Junction NSW	30°02`	149°01`	150	600
G1426	2	Warialda NSW	29°32`	150°35`	340	630
G1460	3	Razorback Range	29°54`	152°12`	860	1000
G1497	4	Jackadgery NSW	29°34`	152°32`	140	1100
G1534	5	Capella Qld.	23°05`	148°01`	250	600
G1909	6	Coonabarrabran NSW	31°02`	150°03`	450	630
G2115	17	Rolleston Qld	24°46`	148°22`	250	640
G2117	8	Springsure Qld	24°14`	148°06`	340	640
G2125	9	W of Emerald Qld	23°39`	147°11`	500	580
G2126	10	Mitchell Qld	26°29`	147°56`	350	540
G2128	11	Macalister Qld	27°03`	151°05`	320	620
G2134	12	Carnarvon Gorge Qld	25°03`	148°12`	420	510
G2545[2]	16	Gragin NSW	29°13`	150°45`	670	630
G2633	13	Kilcoy Qld	27°07`	152°33`	170	970
G2756	14	Capella Qld	23°19`	148°07`	250	600
Capella[3]	18	Capella Qld	23°05`	148°02`	250	600

[1] Accessions with the prefix "G" are from the *Glycine* collection of the CSIRO Division of Plant Industry.

[2] Also known as SCS2105A (SCS indicates Soil Conservation Service of NSW)

[3] Also known as CQ3368 or G2820 (CQ indicates a CSIRO (Queensland) number)

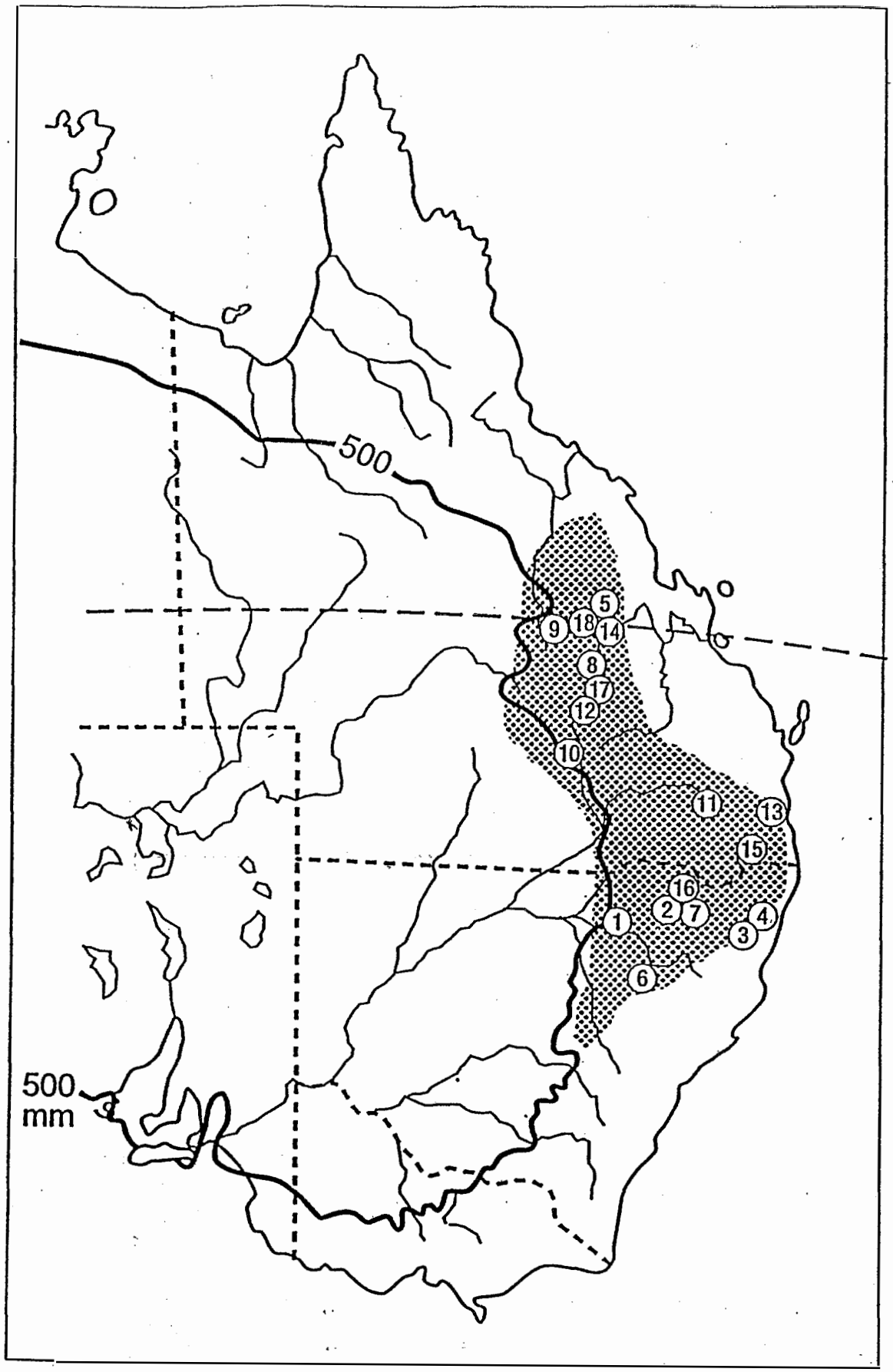

Figure 1. The natural range of *Glycine latifolia* in eastern Australia and the collection sites for the accessions listed in Table 1 (authors' unpublished data).

Leaflet shape. The length and breadth of the terminal leaflet was measured on six representative leaves along each row in March and on four leaves along each row in November 1992.

Pod size. In autumn 1991, 2-3 dry pods were collected from each row. Measurements were made of pod length, breadth, seeds per pod and seed weight.

Forage quality. Separate samples of leaf and 30 cm of the terminal stem were collected in late autumn 1994 from each replicate of the nine lines still surviving in the field. Equal dry weights of ground material from replicates 1 and 2 were bulked and also from replicates 3 and 4. These were analysed for acid detergent fibre (ADF) and nitrogen.

Observations. All lines were visually assessed for obvious differences in factors such as insect damage and morphological characters such as growth habit.

Glasshouse experiments

Eighteen lines were grown under glasshouse conditions for seed increase. The following measurements were taken:

Flower colour. The colour of the wings and standard of every accession except G1460 was rated in spring 1993 using the Royal Horticultural Society's Colour Charts (RHS 1966). Assessments were taken at a standard time of 0900 hours on flowers that had opened that morning. As there was minor variation in flower colour down the length of the raceme, only flowers in the middle of the raceme were rated.

Forage quality. Samples of leaf and the terminal 40 cm of stem were collected from Capella and seven other lines which were higher yielding in the field trial. The samples were separated into leaf and stem and analysed for *in-vitro* digestibility, using the pepsin-cellulase technique (McLeod and Minson 1982), and for nitrogen.

Results

Field Experiment

Leaflet size and shape. There were significant differences between accessions in the shape of the terminal leaflet and these differences were similar when measured in spring (November) and autumn (March) (Table 2). Four lines (G1460, G1497, G2633 and G2115) had a leaflet length/width ratio of >2.0 on both dates. G1213 had the lowest length/width ratio on both occasions. This accession, together with G1460, had the shortest leaflets (Table 2).

Pod size and seed weight. The four lines with the highest length:width ratio, together with G2134, had the smallest seeds (Table 2). There was a significant ($P<0.05$) linear relationship between pod length in mm (L) and number of seeds per pod (N) ($N=0.37+0.17L$).

Table 2: Variation among 18 lines of *Glycine latifolia* in terminal leaflet dimensions (March, November 1992) and pod characteristics (autumn 1991).

Line	Leaflet						Pod			
	Length		Width		Length/width		Length	Width	Seeds/pod	Seeds/g
	Mar	Nov	Nov	Mar	Nov	Mar				
		(mm)	(mm)				(mm)	(mm)		
					(mm)					
G1137	24.6	35.4	16.2	21.5	1.53	1.66	22.7	4.0	4.1	90
G1160	30.4	41.1	22.2	30.8	1.37	1.34	24.0	4.0	4.7	80
G1213	20.4	26.5	18.2	21.1	1.12	1.27	22.1	4.4	4.3	100
G1426	32.0	37.5	22.2	28.0	1.44	1.35	23.8	4.0	4.5	80
G1460	16.8	22.4	6.6	9.3	2.56	2.49	17.2	3.0	4.1	150
G1497	26.4	26.0	11.2	11.9	2.37	2.22	24.1	3.0	5.0	150
G1534	28.2	32.5	16.2	22.1	1.74	1.47	17.2	4.0	3.1	80
G1909	28.2	29.6	22.4	23.8	1.25	1.26	22.0	5.0	3.9	100
G2115	29.8	30.0	14.8	10.6	2.01	2.84	19.2	4.0	3.8	150
G2117	25.4	29.5	19.4	20.8	1.31	1.42	21.8	4.0	4.0	100
G2125	37.0	38.9	25.4	25.1	1.48	1.55	23.0	4.0	4.0	80
G2126	28.6	33.0	18.4	23.3	1.56	1.42	19.9	5.0	3.2	85
G2128	28.0	33.3	16.6	21.0	1.69	1.59	20.2	4.5	3.6	85
G2134	29.8	38.0	18.0	22.9	1.66	1.70	25.7	4.0	5.3	150
G2545	29.8	32.0	21.8	24.0	1.37	1.33	18.8	4.0	3.7	100
G2633	21.2	23.9	10.0	11.4	2.13	2.12	18.2	3.0	3.7	150
G2756	33.8	37.4	21.4	24.1	1.59	1.56	19.7	4.0	4.1	80
Capella	35.0	44.1	22.8	28.8	1.54	1.54	24.9	4.8	4.6	80
LSD (P=0.05)	4.3	4.3	3.1	2.9	0.14	0.18	1.2	0.09	0.46	-
LSD (P=0.01)	5.7	5.7	4.1	3.9	0.18	0.24	1.6	1.12	0.61	-

Table 3: Variation among 18 lines of *Glycine latifolia* in bulk (1-10 rating), stolon length, leaf mottling and date of first flowering.

	Stolon length		Bulk (1-10 rating)				Mottle			Date 1st Flower
Line	26/3/91	24/6/91	9/1/92	29/6/92	13/11/92	18/11/93	9/1/92	13/11/92	18/11/93	1991
	(cm)							(%)		(Jan 1 = 1)
G1137	64	110	6.0	5.0	4.5	3.8	0	5	3	22
G1160	68	115	8.5	6.5	9.3	6.3	<1	0	0	54
G1213	64	130	5.8	7.3	6.8	5.3	18	28	20	54
G1426	37	86	4.8	5.0	6.3	4.5	15	11	5	21
G1460	38	88	3.5	3.3	1.3	2.0	0	0	4	37
G1497	39	84	3.5	4.3	1.0	2.3	6	1	4	26
G1534	29	47	1.0	2.8	3.8	2.3	6	5	9	13
G1909	69	121	8.5	6.0	4.8	4.3	0	<1	0	57
G2115	68	123	6.0	4.0	1.0	0	6	0	-	30
G2117	71	120	5.5	7.0	6.8	4.5	14	29	20	59
G2125	35	75	4.1	6.6	7.0	2.5	13	15	5	26
G2126	71	119	6.8	5.5	8.0	5.0	6	3	4	53
G2128	64	110	4.8	4.5	5.8	3.8	9	6	8	52
G2134	72	115	3.3	6.8	3.0	4.8	11	11	16	33
G2545	68	114	7.0	6.0	5.8	5.0	5	3	16	50
G2633	40	83	3.3	3.9	1.0	3.3	0	0	2	51
G2756	68	112	6.5	6.8	8.0	5.5	0	0	3	53
Capella	77	132	7.0	7.3	9.5	6.5	9	16	19	56
LSD (P=0.05)	3	10	0.8	0.8	0.9	1.7	3	3	3	4
LSD (P=0.01)	4	13	1.1	1.0	1.2	2.2	4	4	5	5

Stolon length. There was a three-fold difference in stolon length of accessions on 24/6/91, 166 days after planting at Gatton (Table 3). Six lines had stolons less than 100 cm long and three of these were from the group of four lines with the narrow leaflets.

Yield. The four lines with the narrowest leaflets were always among the lower yielding lines (Table 3). Capella was the highest yielding line in the last 3 ratings, but not significantly higher than the next best line (G1160). On the two occasions when the yield ratings were calibrated, a rating of 10 was equivalent to *c.* 5000 kg/ha. On both occasions, there was a highly significant relationship between the rating and measured yield of the check quadrats ($R^2 = 0.98$). As the rows were not cut back, these yields were cumulative over time and represent the balance between growth and senscence.

Mottle %. The ranking for yellow mottling in leaves was similar on the three dates, which spanned a 22 month period (Table 3). The lines with the highest percentage of leaves showing mottling were G1213 and G2117, followed by Capella. Two lines, G1160 and G1909, had no mottling on two out of the three occasions and only a very low level on the remaining occasion when the yellowing could have been due to factors other than Alfalfa Mosaic Virus.

Date of first flowering. There was a 46 day range in the date to first flowering in the establishment year (Table 3). There was no apparent relationship between flowering date and latitude of origin or leaflet length/width.

Forage quality. There was very little variation in the ADF and N% in either leaf or stem of the nine lines (Table 4).

General observations. Excluding the group of accessions with narrower leaves, which were lower yielding, the remaining accessions showed little variation. All were low growing and, with time, formed a dense mat, typically up to some 25 cm deep. All had strong root development from stolons on the soil surface and a dense leaf pubescence. There were no obvious differences in other attributes such as flower morphology, pubescence or internode length.

Glasshouse measurements

Flower colour. With two exceptions, all accessions had a rating of 84A V for the standard and 82A (or 82B) P/V for the wings. One accession (G1497) had slightly darker standards (81A P/V) and another (Capella) had slightly lighter wings (84A V).

Forage quality. Analyses of samples collected from glasshouse conditions indicated that the quality of Capella, in terms of predicted *in-vivo* digestibility, was typical of the 7 other accessions (Table 4)

Table 4. Concentrations of acid detergent fibre (ADF), and nitrogen (N) and predicted *in-vivo* digestibility (IVD) in the leaves and terminal 30 cm of stem in cv. Capella, together with the maximum and minimum levels measured in other lines of *G. latifolia*. The ADV and N samples were from material grown in the field and the IVD analyses from material grown in the glasshouse.

Attribute	Plant part	Capella	Other accessions	
			Minimum	- maximum
ADF	Leaf	23.4	24.1	24.8
ADF	Stem	36.2	35.9	38.5
N	Leaf	3.38	3.34	3.40
N	Stem	2.01	1.99	2.0
IVD	Leaf	70	68	73
IVD	Stem	47	46	53

Discussion

Field evaluation of this limited number of accessions highlights the fact that *G. latifolia*, as currently circumscribed, is a variable taxon. This conclusion parallels that from a study of cpDNA variation which included seven of the accessions studied here (Doyle *et al.* 1990). However, the most distinctive cpDNA was that of G1534, whereas the cpDNA of G1497 with narrow leaflets, was identical with G1160 and other lines with broad leaflets.

Only three of the 18 lines (G1460, G1497 and G2633) came from subcoastal areas east of the Great Dividing Range and all 3 were in the group of 4 with narrower leaflets and lower yield. The remaining line in this group (G2115) came from the Queensland Central Highlands. However, five other accessions from this region were of the higher yielding type with the broader leaflets. The remaining accession from this region, G2134, was intermediate between the two groups.

Cv. Capella was generally the highest yielding line. Since it has persisted at two sites in southern Queensland for 7-8 years (Jones and Rees 1997), it was decided to procede with more widespread testing of this accession. Current indications are that Capella may be better suited to basaltic soils than to clay soils which formerly supported brigalow (*Acacia harpophylla*) (R.L. Clem and M.J. Conway, personal communication).

Although the forage quality of *G. latifolia*, in terms of ADF and N, is lower than that of temperate legumes such as white clover (*Trifolium repens*), it is typical of tropical legumes in general (authors' unpublished data).

However, one drawback with this line was the periodic development of a yellow mottling. This mottling

has been shown to be due to Alfalfa Mosaic Virus, which is common in Australia and world-wide (Horlock *et al.* 1993, 1997). Experience to date suggests that the severity of symptoms on Capella is more extreme at Gatton than at other field sites. This would be expected, as lucerne is widely grown in the Gatton district. In some sites where Capella is being evaluated, yellowing has never been seen. However, two lines (G1160 and G1909) which had no yellowing or negligible yellowing at Gatton could not be artificially infected with Alfalfa Mosaic Virus (Horlock *et al.* 1993, 1997). The yields of G1160 were also not significantly lower than those of Capella. Consequently, seed of these lines is being increased for further evaluation.

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