Genetic Resources Communication

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SUMMARY

Forty-eight accessions of annual *Trifolium* species were evaluated in single nursery rows at Grafton Agricultural Research and Advisory Station in 1978, 1982 and 1985. In general, it appeared unlikely that any of these species would regenerate as reliable ley pastures on the NSW north coast as the seed yields were often low and variable. However some of the species are worthy of further investigation for annual fodder crops and short-term leys: *T. alexandrinum, T. clypeatum, T. desvauxii, T. dubium, T. eriosphaerum, T. israeliticum, T. isthmocarpum, T. pratense* and *T. resupinatum*.

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Introduction

The genus *Trifolium* includes approximately 300 annual and perennial species, commonly called clovers. Twenty five species are significant as food for grazing animals and of these about 10 are important (Taylor, 1985). Many of the lesser regarded species have received little attention in Australia; however, by understanding the nature of their adaptation to particular environments, their value to Australian agricultural systems could be realised. Although little breeding of clovers has been carried out until recently, the evaluation and conservation of the genetic resources of *Trifolium* species could be important to clover improvement in the future.

The aim of looking at these annual species was to find a "subterranean clover replacement" for the north coast of NSW. In the 1950's and 1960's work carried out by NSW Agriculture and the University of Sydney searched for legumes that could be sod-seeded into dormant tropical pastures (Arthur and Jenkins, 1955, 1956). Subterranean clover showed promise but eventually failed. This failure was blamed partly on the prevalence of the Amnemus weevil (*Amnemus quadrituberculatus*) and partly on poor management, which did not promote seed set. There was also a problem of germination over summer and loss of seed in this summer rainfall environment. Subterranean clovers were replaced with vetches, such as Namoi Woolly pod vetch, but these also failed due to disease problems. The *Trifolium* collection at Grafton was investigated to find regenerating annuals, with a wider maturity range, that might fill this gap.

The north coast of NSW lies between a latitude of 28°S and 32°S and extends to the escarpment of the Great Dividing Range. The climate varies from subtropical to warm temperate. Rainfall is high (800 to 1800mm) and falls mainly in the summer and autumn (64% summer dominant at Grafton). Short duration frosts are experienced throughout the region.

Methods

In 1978 the total *Trifolium* collection at Grafton (1025 accessions, see Appendix 1) was grown out. From that, 48 accessions that had high seed yields for their particular species were selected to be grown out for a further two years (1982 and 1985). These accessions were evaluated for timing and amount of seed set, disease and pest resistance and general observations were made on plant vigour and usefulness.

In 1978 seeds were germinated in flat trays in a potting mixture consisting of 0.75m^3 fumigated sand: 0.25m^3 peat moss: 2700g Dolomite: 1500g Superphosphate: 1200g UF 38 (slow-release N fertiliser): 700g lime: 800g Gypsum: 360g Potassium sulphate. These trays were placed in the glasshouse on 11.4.78 and seedlings were transplanted to the nursery

rows on 11.5.78. The glasshouse nutrient mix was successful until the stage where those plants which did not nodulate ran out of nitrogen. In 1982 and 1985 seedlings of 48 selected accessions were raised as individuals in trays of commercial "Quick pots" from the 17.4.82 and 10.5.85 respectively. The seedlings were then transplanted into nursery rows a month later in both years. Seedlings were inoculated with commercial strains of *Rhizobium* (Table 2).

Seedlings were transplanted into single rows in the nursery area at Grafton Research and Advisory Station. These rows were 1m apart and 50 seedlings were transplanted per 5m row. Irrigation was applied to establish the seedlings but they then survived under rainfed conditions. Nitrogen was added in the field to rows of plants which did not nodulate. The rows were hand weeded.

The soil at this site is a sandy clay loam, pH (water) 4.8, Phosphorous (Colwell) 90 ppm. This soil has a hardsetting surface when dry. The climatic data for this site is given in Table 1.

The plants were observed for pest and disease damage, flowering and seeding dates were recorded and seed was harvested and weighed at the end of each season. In 1985 the seed which was collected was stored at 5°C and 60% RH and later germination tested for the percentage of hard seed in 1987. Observations were also made on plant vigour, morphology and phenology. Subterranean clover was grown each time as a control species, but not the same cultivar in each year. That data is not included in the results.

Results and Discussion

Although seed yields were generally higher in 1978 than the following years, some lines were consistently high yielders: *T.campestre* (CQ 1170), *T. clypeatum* (CPI 14925), *T. echinatum* (CPI 14941), *T. hybridum* (CPI 46668), *T. pratense* (CPI 16895), *T. pilulare* (CPI 44751) and *T. scutatum* (CPI 44799). Many lines had very variable seed yields, either highly inflated in 1978 or else very low in 1982 compared to the other two years (Table 3). This could have been due to different disease incidence or variation in rainfall. In 1982, for example, there was high spring rainfall which may have prevented seed set for certain species (Table 1).

Early flowering (June/July) accessions were *T. alexandrinum* (CPI 18742), *T. campestre* (CPI 22744), *T. dubium* (P 15296), *T. eriosphaerum* (CPI 34551), *T. israeliticum* (CPI 12621 and CPI 28092), *T. pilulare* (CPI 44751). These were not high seed yielding species. However there is an advantage to early flowering types in the north coast environment, where spring droughts could prevent seed set of late flowering accessions altogether. Some species also had a short period between first flower and seed maturity which would also be an advantage in this environment.

Late flowering (October/November) was only noted in 1978 from *T. angustifolium* (CPI 45742), *T. glomeratum* (CQ 1182) and *T. purpureum* (CPI 32833.1 and CPI 44757) but this was not demonstrated in 1982 and 1985 (except *T. glomeratum* which flowered in October 1985). Most accessions flowered in August/September in all years.

Those that set high amounts (above 70%) of hard seed were *T. arvense* (CQ 1168), *T. bocconei* (CPI 31907), *T. cherleri* (CPI 44722), *T. glomeratum* (CQ 1182), *T. hybridum* (CPI 46668), *T. israeliticum* (CPI 12621), *T. isthmocarpum* (P15051) and *T. lucanicum* (CQ 1363). Those that set less than 20% hard seed (not included were those where most of the seed was dead) were *T. angustifolium* (CPI 45742), *T. argutum* (CPI 34576), *T. incarnatum* (CPI 46149) and *T. pratense* (CPI 16895). There appeared to be no relationship between flowering time and hard seed percentage. High levels of hard seed are an advantage in the north coast region and enhance survival, particularly of aerially seeding species like *T. glomeratum*. For example, the failure of the cultivar Maral (Persian clover) in rainfed permanent pastures can be attributed to a complete lack of hard seed (Crawford, 1985).

Disease problems in Australia may make some of these species impossible to use even when their growth and seed yields are reasonable (Table 2). Disease was responsible for an observed loss in forage yield and quality and a reduction in seed production, as well as shortened longevity of many plants. Powdery mildew (*Erysiphe polygoni*) and viruses such as Alfalfa Mosaic Virus, as well as others as yet unidentified, were common. There is obviously a need to look for greater pest and disease resistance. *Trifolium* species with greater disease tolerance are evident in certain habitats around the world and these may need to be exploited.

Of note is that both *T. hybridum* and *T. pratense* have recorded cases of photosensitisation of stock in Australia. Compounds associated with haemorrhagic disease have also been found in *T. pratense* although this is not a major problem. *T. affine* and *T. arvense* contain levels of tannins which make them "bloat safe". There is also a reputed better tolerance of hollow stemmed plant species, compared to solid stemmed species, to extremes of frost damage (Crawford, 1985). This could also warrant further investigation, particularly within those species that grow well in this warm north coast environment but are susceptible to damage by cold.

Conclusions

This work was only a superficial examination of the annual *Trifolium* species in nursery plots. Their role as annual fodder crops, short-term leys or as a cool season component of permanent pastures needs to be further studied as this is their greatest potential (Table 4). However these studies did enable lines that warrant further evaluation to be selected, although dry matter yields were not taken and this is still a major gap in the knowledge of the species.

There is the possibility of selecting for earlier flowering in certain groups such as *T. resupinatum*, which has a wide range in maturity. Obviously some species are suited to the region (although they may not be suitable for development for agriculture) as *T. dubium* is already naturalised along most of the north coast and *T. arvense* and *T. campestre* in the southern part of the region.

Testing of a more restricted range of European and Mediterranean species (*T. alexandrinum*, *T. cherleri*, *T. clypeatum*, *T. desvauxii*, *T. hirtum*, *T. glomeratum*, *T.*

incarnatum, *T. pauciflorum*, *T. pilulare* and *T. vesiculosum* in southern Queensland suggested that they had more potential on lighter textured soils derived from granite and traprock (Clarkson, 1986) than on heavier textured soils (Jones and Rees, 1972) such as the Grafton nursery soil. In both the Queensland studies *T. hirtum* had the highest ranking of those accessions investigated.

It appears unlikely that any of these annual *Trifolium* species would regenerate reliably on the NSW north coast as seed set in most years was low and variable. However there may be special purpose areas where they could play a role, such as between tree crops or rows of vines. Therefore some priority groupings can be made from these results as to which species would be worth considering further. Those species that could be considered as useful to north coast agriculture and worthy of further evaluation are *T. alexandrinum*, *T. clypeatum*, *T. desvauxii*, *T. dubium*, *T. eriosphaerum*, *T. israeliticum*, *T. isthmocarpum*, *T. pratense* and *T. resupinatum*.

Those that appear to have some useful attributes but are unlikely to prove very successful are *T. angustifolium*, *T. batmanicum*, *T. bocconei*, *T. campestre*, *T. cherleri*, *T. echinatum*, *T. globosum*, *T. glomeratum*, *T. hirtum*, *T. hybridum*, *T. incarnatum*, *T. lappaceum*, *T. lucanicum*, *T. pauciflorum*, *T. pilulare*, *T. purpureum*, *T. scutatum* and *T. vesiculosum*.

Those species that are not worth investigating further at this stage are *T. affine*, *T. argutum*, *T. arvense*, *T. billardieri*, *T. boissieri*, *T. dasyurum*, *T. dichroanthum*, *T. palaestinum* and *T. stellatum*.

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Table 1. Monthly rainfall (RF: mm) and average temperature (T: °C) at Grafton Research Station for 1978, 1982 and 1985.

Year		Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1978	RF	130.2	70.2	172.2	72.2	40.4	23.0	19.8	32.8	108.2	86.4	16.6	86.6	858.6
	T	24.9	25.2	23.7	20.4	17.3	13.9	13.4	13.7	16.3	18.1	21.3	23.5	
1982	RF	236.4	92.6	119.4	143.2	25.6	5.4	21.8	30.0	80.8	164.6	51.0	128.0	1098.8
	T	24.7	24.2	23.2	20.1	17.1	13.2	12.3	14.9	16.8	18.9	21.6	23.9	
1985	RF	56.2	166.5	169.7	114.4	145.4	23.6	155.2	25.5	19.3	143.7	48.2	144.1	1211.8
	T	25.2	23.2	22.7	19.9	17.2	13.2	13.5	14.1	17.5	19.4	21.5	23.8	

Table 2. Characteristics of annual *Trifolium* species sown at Grafton in 1978, 1982 and 1985.

Key: BGA = effected by Blue-green aphids, V = effected by a virus or powdery mildew. The (*) after a name indicates a perennial which acts an annual in this environment. Origin = the general region from which that species/accession came. Rhizobium: commercial cultures are identified by B (white, red, alsike and strawberry clover group) and C (subterranean rose, cupped and crimson clover group).

Species	Accession Number	Common Name	Origin	Pest or Disease	Rhizobium
T.affine	CPI 45740		Turkey	V	B/C
T.alexandrinum	CPI 18742	Berseem clover	France		B
T.angustifolium	CPI 13934	Narrow leaf clover	Europe	BGA	B
T.angustifolium	CPI 45742	Narrow leaf clover	Europe	BGA	B
T.argutum	CPI 34576		-	V	B
T.arvense	CQ 1168	Haresfoot clover	Europe	BGA, V	B/C
T.batmanicum	CPI 45824		-	V	C
T.batmanicum	CPI 46307.1		-	V	B/C
T.billardieri	CPI 22740		-		B/C
T.bocconei	CPI 31907	Boccone's clover	Morocco	V	B
T.boissieri	CPI 45892		Greece	V	B
T.campestre	CPI 22744	Hop clover	Germany	BGA, V	B
T.campestre	CQ 1170	Hope clover	Germany	BGA, V	B
T.cherleri	CPI 13930	Cupped clover	Cyprus		C
T.cherleri	CPI 44722	Cupped clover	Turkey		C
T.clypeatum	CPI 14925	Helmet or Oriental clover	Mediterranean	BGA, V	C
T.dasyurum	CPI 45084		Greece	BGA, V	B
T.desvauxii	CPI 13816	Purple clover	Bulgaria		B
T.dichroanthum	CPI 34549		Israel	BGA, V	B
T.dubium	P 15296	Suckling clover	England	V	B
T.echinatum	CPI 14941		Italy	V	B
T.eriosphaerum	CPI 34550		Israel	BGA, V	C
T.eriosphaerum	CPI 34551		Israel	BGA, V	C
T.globosum	CPI 44736	Globe clover	Cyprus		C
T.glomeratum	CQ 1182	Cluster clover	Europe	V	B
T.hirtum	CPI 13949.1	Rose clover	Crimea	V	C
T.hybridum (*)	CPI 46668	Alsike clover	Sweden		B
T.incarnatum	CPI 10609	Crimson clover	Italy/France	BGA, V	C
T.incarnatum	CPI 46149	Crimson clover	Italy/France	BGA, V	C

Species	Accession Number	Common Name	Origin	Pest or Disease	Rhizobium
T.israeliticum	CPI 12621	Israel sub clover	Israel		B/C
T.israeliticum	CPI 28092	Israel sub clover	Israel		B/C
T.isthmocarpum	P 15051		Mediterranean	V	B
T.lappaceum	CPI 14766	Burr or Lappa clover	Mediterranean	V	B
T.lucanicum	CQ 1363		Europe	BGA	B
T.palaestinum	CPI 32828	Palestine clover	Israel		B/C
T.pauciflorum	CQ 1231		Aegean	BGA, V	C
T.pilulare	CPI 44751	Pill clover	Israel		C
T.pratense (*)	CPI 16895	Red clover	Europe	BGA	B
T.purpureum	CPI 32833.1	Purple clover	France	BGA, V	B
T.purpureum	CPI 32835	Purple clover	Israel	BGA, V	B
T.purpureum	CPI 44757	Purple clover	France	BGA, V	B
T.resupinatum	CPI 26202	Shaftal or Persian clover	Mediterranean	BGA, V	B/C
T.resupinatum	CPI 31102	Persian clover	Morocco	BGA, V	B/C
T.resupinatum	CPI 45069	Persian clover	Mediterranean	BGA, V	B/C
T.scutatum	CPI 44799	Rough clover		BGA, V	B/C
T.speciosum	CPI 46369		Mediterranean	BGA	B/C
T.stellatum	CPI 14929	Star clover	Mediterranean	BGA, V	B/C
T.vesiculosum	CPI 44797	Arrowleaf clover	Italy	V	B/C

Table 3. Seed harvest times and seed yields of annual *Trifolium* species from nursery rows: Sowing dates were 11.5.78, 17.4.82 and 10.5.85. Seed harvested in 1985 was tested for hardseed content in October 1987 after storing at 5°C and 60% RH.

Key: FF = Date of first flower, SH = Date of seed harvest, Y = Seed yield for individual sowings (kg/ha), MDF = Mean days to first flower over 3 years, MDS = Mean days from first flower to seed harvest over 3 years, MY = Mean seed yield for 3 years, %HS = % Hard seed., %D = % dead seed.

Species & Accession Number	FF 1978	SH 1978	Y	FF 1982	SH 1982	Y	FF 1985	SH 1985	Y	MDF	MDS	MY	% HS
T. affine *CPI 45740*	24.9	28.11	65	6.9	17.11	30	2.9	18.11	14	139	72	36	29%
T. alexandrinum *CPI 18742*	12.7	13.10	111	21.7	24.10	17	28.7	21.10	113	91	90	80	1% 50%D
T. angustifolium *CPI 13934*	4.9	11.10	218	23.8	F	F	15.7	23.10	132	101	66	176	11% 80%D
T. angustifolium *CPI 45742*	3.10	11.12	242	28.9	26.11	1	15.9	18.11	5	153	64	124	8%
T. argutum *CPI 34576*	30.6	20.10	306	3.8	18.10	42	6.6	21.10	68	65	115	208	12%
T. arvense *CQ 1168*	29.9	14.11	89	17.9	8.11	83	28.9	21.10	2	156	36	57	84%
T. batmanicum *CPI 45824*	22.9	13.11	295	3.9	13.10	1	2.9	23.10	40	138	48	168	21%
T. batmanicum *CPI 46307.1*	22.9	13.11	40	7.9	21.10	54	10.9	23.10	2	128	45	48	25%
T. billardieri *CPI 22740*	11.9	19.10	49	3.9	18.10	29	2.9	23.10	83	135	44	81	64%
T. bocconei *CPI 31907*	4.9	28.11	592	17.8	25.10	30	26.8	11.10	8	126	61	315	77%
T. boissieri *CPI 45892*	4.9	19.10	293	17.8	13.10	80	18.8	18.10	258	107	56	211	38%
T. campestre *CPI 22744*	13.7	19.10	123	25.7	29.9	57	1.7	28.10	108	95	100	96	75%
T. campestre *CQ 1170*	22.9	19.10	255	9.9	2.11	551	11.9	28.10	387	144	43	397	56%
T. cherleri *CPI 13930*	18.8	12.10	60	3.8	5.10	60	13.8	16.10	147	129	60	89	46%
T. cherleri *CPI 44722*	22.9	26.10	160	4.9	27.10	28	12.9	29.10	104	135	45	146	90%
T. clypeatum *CPI 14925*	2.8	13.10	822	3.8	5.10	264	11.7	14.10	834	91	81	640	33%
T. dasyurum *CPI 45084*	11.9	19.10	90	3.9	13.10	44	27.8	9.10	9	132	41	44	54%

Species & Accession Number	FF 1978	SH 1978	Y	FF 1982	SH 1982	Y	FF 1985	SH 1985	Y	MDF	MDS	MY	% HS
T. desvauxii CPI 13816	22.9	28.11	408	6.9	8.11	57	3.9	18.11	310	136	70	258	30%
T. dichroanthum CPI 34549	12.9	14.11	283	12.9	2.11	19	11.9	6.11	52	142	56	118	68%
T. dubium P 15296	30.7	6.10	28	9.7	29.9	104	1.7	21.10	258	79	93	130	68%
T. echinatum CPI 14941	18.8	26.10	215	27.8	21.10	194	11.7	23.10	688	101	83	366	26%
T. eriosphaerum CPI 34550	2.8	28.9	238	2.7	24.9	71	24.6	24.9	280	74	81	196	35%
T. eriosphaerum CPI 34551	13.7	19.9	101	2.7	24.9	41	17.6	24.9	126	66	87	56	62%
T. globosum CPI 44736	4.9	19.10	326	23.8	13.10	15	17.8	16.10	309	123	54	116	35%
T. glomeratum CQ 1182	3.10	14.11	278	24.9	25.10	52	2.10	1.11	96	146	33	142	84%
T. hirtum CPI 13949.1	2.8	6.10	377	21.7	1.10	61	25.7	15.10	155	95	75	197	25%
T. hybridum CPI 46668	8.8	13.11	106	23.8	3.11	209	24.8	28.10	202	104	64	172	94%
T. incarnatum CPI 10609	25.9	9.11	180	19.9	18.10	87	24.9	29.10	75	139	36	114	2% 59%D
T. incarnatum CPI 46149	15.9	26.10	39	3.9	13.10	35	9.9	22.10	240	125	41	105	15%
T. israeliticum CPI 12621	13.7	19.10	151	12.7	5.10	115	15.7	8.10	14	82	88	93	78%
T. israeliticum CPI 28092	13.7	19.10	173	12.7	5.10	7	1.7	15.10	114	75	98	98	61%
T. isthmocarpum P15051	6.9	6.11	172	16.9	2.11	5	26.8	23.10	11	132	56	63	82%
T. lappaceum CPI 14766	12.7	9.11	351	12.8	27.10	169	30.7	29.10	96	97	94	205	62%
T. lucanicum CQ 1363	15.9	6.11	310	28.8	13.10	26	28.8	21.10	87	132	51	141	70%
T. palaestinum CPI 32828	18.9	23.10	84	10.9	18.10	2	11.9	21.10	20	143	38	29	29%
T. pauciflorum CQ 1231	4.9	6.11	223	17.8	18.10	44	31.7	22.10	32	113	72	100	37%
T. pilulare CPI 44751	28.7	28.11	462	19.7	24.9	116	11.7	1.10	291	86	89	290	46%
T. pratense CPI 16895	2.8	15.11	320	17.8	24.11	1095	27.8	19.11	436	118	93	617	13%
T. purpureum CPI 32833.1	4.9	7.11	93	28.8	21.10	7	19.8	28.10	286	125	49	128	36%
T. purpureum CPI 32835	28.8	27.10	34	17.8	8.10	1	23.7	24.10	90	107	74	41	0% 86%D

Species & Accession Number	FF 1978	SH 1978	Y	FF 1982	SH 1982	Y	FF 1985	SH 1985	Y	MDF	MDS	MY	% HS
T. purpureum CPI 44757	20.9	15.11	136	11.9	25.10	2	2.9	24.10	38	139	51	58	0% 80%D
T. resupinatum CPI 26202	2.8	13.10	245	5.7	1.10	94	24.5	11.10	39	63	108	126	57%
T. resupinatum CPI 31102	2.8	13.10	113	6.8	1.10	43	11.7	11.10	38	92	78	64	49%
T. resupinatum CPI 45069	30.6	6.10	188	25.6	24.9	44	5.6	11.10	24	55	111	85	64%
T. scutatum CPI 44799	12.7	26.10	461	19.7	18.10	150	24.6	15.10	126	73	105	245	33%
T. speciosum CPI 46369	4.9	19.10	122	23.8	13.10	101	13.8	10.10	42	121	51	88	46%
T. stellatum CPI 14929	25.8	12.10	264	23.8	5.10	59	24.8	15.10	41	124	47	121	41%
T. vesiculosum CPI 44797	14.8	14.11	21	28.8	25.10	2	12.6	23.10	25	86	104	16	49%

Table 4. Agronomic characteristics of annual *Trifolium* species. Note: Maturity range comments have been made from growing out a number of accessions in other years besides those described in this paper.

Key: Fodder = dried material (hay), Forage = silage, green chop, Pasture = grazing herbage

Species	Noted weakness (e.g.) Disease susceptibility	Possible use	Comments
T. affine	Late maturity	Fodder	Productive, fine stemmed
T. alexandrinum	Seed head susceptible to grazing	Forage or late fodder	Tall
T. angustifolium	Late maturity, seed shattering	Temporary pasture/fodder	Very late spring growers
T. argutum		Rotational grazing/hay	Semi-erect, productive, fine stemmed, seedling germination noted
T. arvense		Fodder	Compact hairy plant
T. batmanicum		Low management pasture	Prostrate, wide maturity range, productive group
T. billardieri		Amenity	Short dense rosette
T. bocconei	Late maturity, Susceptible to mildew	Fodder	Productive
T. boissieri		Fodder	Fine stemmed, semi-erect
T. campestre		Fodder	Seedling germination noted
T. cherleri	Seed head susceptible to grazing	Low management pasture, Rotational grazing/hay	Prostrate to semi-erect, wide maturity range, productive group
T. clypeatum	Seed head susceptible to grazing	Rotational grazing/hay	Unimpressive stemmy type
T. dasyurum		-	
T. desvauxii		-	
T. dichroanthum		Amenity	
T. dubium		-	
T. echinatum	Very variable plant types	Temporary pasture/fodder	Wide maturity range, all short plants but prostrate to erect
T. eriosphaerum		Low management pasture	Prostrate, stemmy, moderately productive

Species	Noted weakness (e.g.) Disease susceptibility	Possible use	Comments
T. globosum	Seed head susceptible to grazing	Low management pasture	Prostrate, late spring producers, wide maturity range, productive group
T. glomeratum	Seed head susceptible to grazing, Susceptible to disease	Rotational grazing/hay	Semi-erect, wide maturity range
T. hirtum	Seed head susceptible to grazing	Rotational grazing/hay	
T. hybridum	Seed head susceptible to grazing	Temporary pasture/fodder	wide maturity range
T. incarnatum	Seed head susceptible to grazing	Temporary pasture/fodder	Leafy rosette,moderate stem thickness, leafy stem, productive
T. israeliticum		Low management pasture	Like early maturing, less productive stemmy sub clovers, burr burial
T. isthmocarpum	Seed head susceptible to grazing, Susceptible to mildew	Forage or late fodder	Thick stemmed, large leaf, seedling germination noted.
T. lappaceum	Seed head susceptible to grazing	Rotational grazing/hay	
T. lucanicum	Very late maturity	Temporary pasture/fodder	Prostrate to semi-erect, stemmy
T. palaestinum		-	
T. pauciflorum		Low management pasture	Productive group
T. pilulare		Low management pasture, Rotational grazing/hay	Very rapid seed development, prostrate, stemmy, wide maturity range, moderately productive
T. pratense	Open crown	Temporary pasture/fodder	Productive
T. purpureum	Seed head susceptible to grazing, seed shattering	Temporary pasture/fodder	Leafy stems and bases, fine to moderate stem, wide maturity range, productive, deep rooted
T. resupinatum	Seed head susceptible to grazing	Rotational grazing/hay, Temporary pasture/fodder	Small leaf, fine to moderate stem, prostrate to semi-erect, wide maturity range

Species	Noted weakness (e.g.) Disease susceptibility	Possible use	Comments
T. scutatum		-	Prostrate to semi prostrate, moderately productive, stemmy and hairy
T. speciosum		Amenity	
T. stellatum	Seed shattering	-	
T. vesiculosum	Seed head susceptible to grazing, late maturity	Temporary pasture/fodder	Very leafy rosettes, leaf stalks long and stemmy, productive, seedling germination noted

Appendix 1 Collection of *Trifolium* species which have been grown in the nursery at Grafton Agricultural Research and Advisory Station. The number of accessions in each speceis is shown in parentheses. African clovers are marked *.

T. affine (3)
*T. africanum (21)**
T. aintabense (33)
T. alexandrinum (27)
T. alpinum (1)
T. ambile (1)
T. ambiguum (1)
T. angustifolium (8)
T. apertum (2)
T. argutum (47)
T. armenium (1)
T. arvense (4)
T. aureum (1)
*T. baccarinii (3)**
T. badium (1)
T. balanse (5)
T. batmanicum (37)
T. bejariense (1)
T. berthyeum (3)
T. billardieri (1)
T. bocconei (3)
T. boissieri (2)
*T. burchellianum (12)**
*T. calocephalum (1)**
T. campestre (5)
T. canescens (1)
T. carmeli (1)
T. cernum (5)
*T. cheranganiensis (1)**
T. cherleri (52)
T. chilense (4)
T. ciliolatum (2)
T. clussi (11)
T. clypeatum (9)
T. constantinopolitanum (2)
*T. cryptopodium (1)**
T. curvisepalum (1)
T. dalmaticum (1)
T. dasyrum (11)
*T. decorum (1)**
T. desvauxii (1)
T. dicoranthum (2)
T. diffusum (5)
T. dubium (4)
T. echinatum (13)
T. elegans (1)
T. eriosphaerum (1)
T. filiforme (1)
T. fragiferum (6)
T. glanduliferum (2)
T. globosum (35)
T. glomeratum (8)
T. gracilentum (1)
T. heldreichianum (1)
T. hirtum 45)
T. hybridum (3)
T. incarnatum (10)
T. isodon (1)
T. israeliticum (3)
T. isthmocarpum (10)
T. lappaceum (12)
T. latinum (1)
T. laevigatum (1)
T. leucanthum (4)
T. ligusticum (1)
T. lucanicum (4)
*T. lugardii (2)**
T. lupinaster (1)
T. maritinum (1)
*T. masaiense (5)**
*T. mattirolianum (2)**
T. medium (1)
T. meduseum (2)
T. meneghenianum (1)
T. michelianum (3)
T. micranthum (2)
T. microdon (1)
T. miegeanum (1)
T. montanum (1)
T. muttistriatum (1)
T. mutabile (1)
T. nigrescens (1)
T. obscurum (6)
T. occidentale (1)
T. ochroleucon (2)
T. ornthopoides (1)
T. palaestinum (13)
T. pallidum (6)
T. pannonicum (2)
T. pauciflorum (28)
T. parviflorum (1)
T. patens (1)
T. physodes (5)
*T. pichi-sermolli (1)**
T. pilulare (35)
T. plebium (1)
*T. polymorphum (2)**
T. phleoides (2)
T. polystachyum (1)
T. pratense (18)
T. procumbens (1)
T. purpureum (20)
*T. quartinianum (1)**
T. repens (8)
T. resupinatum (50)
T. retusum (4)
T. rubens (1)
*T. rueppellianum (31)**
T. salmoneum (1)
T. scabrum (2)
T. scutatum (12)
T. smyrnaeum (1)
T. spadiceum (1)
*T. semipilosum (10)**
*T. simense (2)**
T. speciosum (1)
T. spumosum (63)
T. squarrosum (7)
T. stellatum (14)
T. stenophyllum (1)
*T. steudneri (3)**
T. strepens (1)
T. striatum (4)
T. strictum (44)
T. subterraneum (7)
T. suffocatum (4)
T. supinum (1)
T. sylvaticum (7)
*T. tembense (17)**
T. tenuifolium (2)
T. thalli (1)
T. tomentosum (8)
T. tridentatum (1)
T. tumens (1)
T. uniflorum (2)
*T. usambarense (5)**
T. vavilovii (3)
T. velivolum (1)
T. vernum (2)
T. vesiculosum (15)
*T. sp. (16, 1 only *)*