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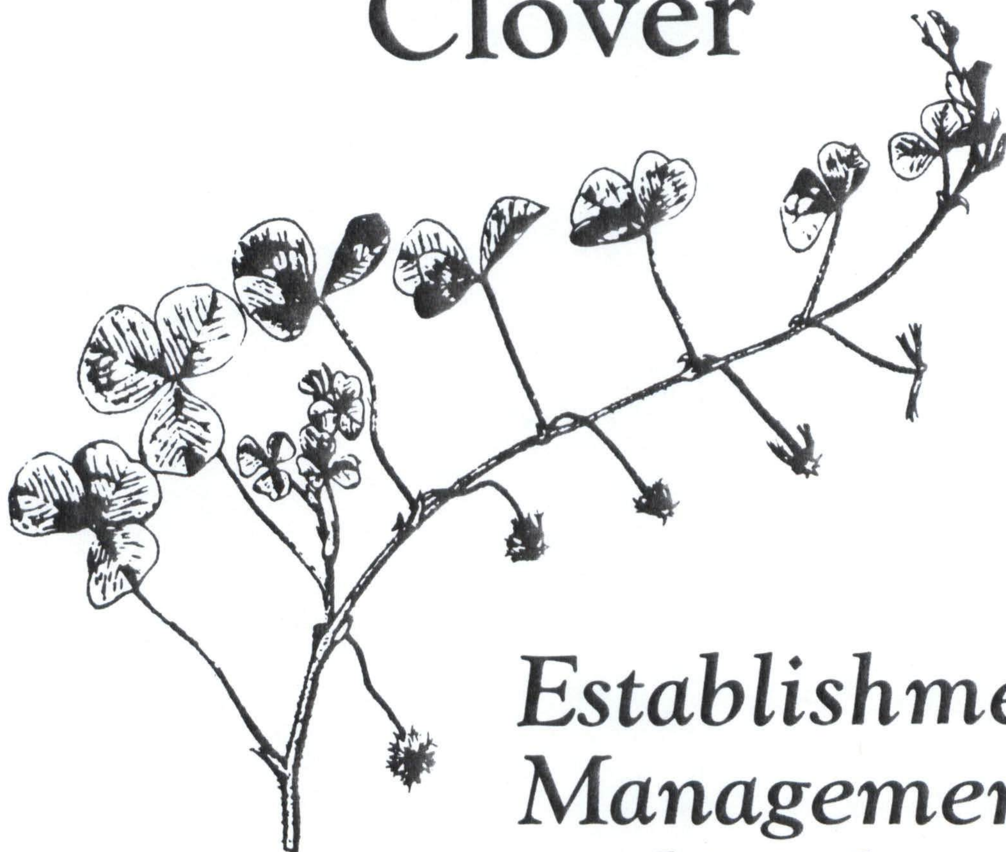
Subterranean Clover



Establishment, Management, and Utilization in Texas

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CHAPTER 1

History, Adaptation, and Improvement of Subterranean Clover

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Subterranean (sub) clover is the common name applied to three clover species, *Trifolium subterraneum* L., *T. yanninicum* Katzn. and Morley, and *T. brachycalycinum* Katzn. and Morley (14). Subclover is a winter-annual forage legume with prostrate, nonrooting stems. The inconspicuous subclover flowers are white or white with pink veins and arise from leaf axils. After self-fertilization, the flower stem (peduncle) bends toward the ground as a burr develops around the seed pods. Subclover seed matures in the burr at or below the soil surface which allows seed production under moderately intensive grazing. Subclover is native to the Mediterranean region and western Europe and is well-adapted to the corresponding climate of cool, wet winters and hot, dry summers. The three species differ in their edaphic adaptation. On sandy, slightly acid soils, *T. subterraneum* is well adapted, but as the soil pH shifts to neutral or alkaline, *T. brachycalycinum* is predominant. *Trifolium yanninicum* is widely distributed on water-logged soils. Several excellent review articles on subclover are available which provide additional information on these species (16, 17).

History

Subclover was described as an annual by Linnaeus in the 1753 edition of *Species Plantarium;* however, Michel Gandoger listed subclover as a perennial in 1875 (15). As early as the 1830's, subclover was introduced to Australia most likely as a contaminant in grass seed or hay (17). It was not until the late 1800's that subclover was agronomically used as a forage crop for improved pastures in Australia. The first subclover seed to be grown in Texas is credited to Robert Nicholson (Dallas) who secured the seed from Australia and forwarded seed to the Texas Agricultural Experiment Station (TAES) on May 3, 1921 (15). This first seed was identified as TS 6035; however, all plantings from this source failed to produce a stand. In October 1921, a sample of subclover seed (TS 6466) was received from the USDA Plant Introduction Office. Additional seed (TS 6644) were received from the USDA in September 1922. These introduced seed were planted and evaluated as natural reseeding stands from 1922 through 1924 at College Station, Nacogdoches (Substation No. 11), Beaumont (Substation No. 4), and Angleton (Substation No. 3). As a result, a TAES circular (No. 37) was published in 1925 and reported that subclover had given good results in southeastern Texas and that it was "a very promising new grazing-crop plant." It also stated that "nothing is known as to the presence of the proper strain of nitrogen-fixing bacteria inoculation in our soils . . . but the USDA supplied us with material . . . and our clover was well supplied with nodules."

Adaptation and Improvement

Currently, more than 39 million acres of subclover are grown in Australia (4) where it is a major component of livestock production systems and an important source of nitrogen for non-leguminous forage and cereal crops (3). The current registered Australian varieties of subclover are described in Table 1 (3, 4, 19).

Breeding and variety development of subclover in Australia is organized under the National Subterranean Clover Improvement Program where breeding objectives vary according to species and intended use (4). Early maturing varieties are selected with seed production, hard-seededness, and burr burial as primary traits. These early varieties must be capable of regenerating under cereal rotations and low rainfall. Disease resistance is important in mid-season and late maturing subclover grown in higher rainfall areas. Clover scorch, caused by *Kabatiella caulivora*, and root rots, caused by *Pythium* and/or *Fusarium* species, are the primary subclover disease problems in Australia. Improved seed production and high hard-seededness are also important goals in development of early mid-season subclover varieties. A high level of hard-seededness is not considered important in mid-season to late maturing subclover varieties. Breeding and evaluation of *T. brachycalycinum* is aimed toward earlier flowering, and higher levels of hard-seededness. An additional evaluation parameter that has been considered is that of the level of phytoestrogens present in subclover varieties. Isoflavone phytoestrogens are found at varying levels in subclover. Varieties of subclover with high (>0.2 percent DM) formononetin content have been shown to cause reproductive problems in sheep (1, 2). However, in Australia, no reproductive problems have been noted for cattle grazing subclover. Low formononetin content is a requirement for all new Australian subclover varieties.

The primary objective of the TAES Clover Breeding Program located at Overton, in regard to subclover, is development of productive, reseeding germplasm with low isoflavone content. Subclover plant introduction (PI) lines (obtained from the USDA Regional Plant Introduction Station, Experiment, GA) have been evaluated at Overton beginning in 1976 (20). One hundred and seventy-four subclover PI's were evaluated for stand establishment and vigor in 1981-82. Fifteen lines were identified with forage potential equal to or better than check varieties (23) and were included in replicated yield trials in 1982-83 at Overton (26) and Angleton (7). Sampling and analysis methods, using high performance liquid chromatography, were developed at Overton to quantify isoflavone phytoestrogens in subclover (29). Elite subclover PI lines and check varieties were assayed for isoflavone

Table 1. Registered Australian Varieties of Subterranean Clover

Variety	Species[1]	Days to flowering at Perth	Release date	Relative[2] hard-seededness	Estrogenic activity
Nungarin	S	77	1977	10	low
Northam	S	78	1977	8	low
Dwalganup	S	83	1929	7	very high
Geraldton	S	97	1958	8	high
Daliak	S	97	1967	6	low
Dalkeith	S	98	1985	8-9	low
Uniwager	S	103	1967	5	low
Yarloop	Y	109	1939	4	very high
Seaton Park	S	110	1967	5	low
Trikkala	Y	112	1976	3	low
Dinninup	S	113	1962	7	very high
Enfield	S	118	1984	1-2	low to moderate
Esperance	S	120	1978	5	low to moderate
Junee	S	128	1985	6	low
Green Range	S	128	1985	5	low
Clare	B	129	1950	3	low
Woogenellup	S	130	1959	3	low
Howard	S	93-135	1964	3	high
Bacchus Marsh	S	131	1937	1	low
Karridale	S	136	1985	3	low
Mt. Barker	S	137	1906	1	low
Larisa	Y	142	1977	2	low
Nangeela	S	143	1961	1	low
Meteora	Y	148	1981	8	moderate
Tallarook	S	163	1935	1	high
Koala[3]	B				

[1]S = *T. subterraneum*, Y = *T. yanninicum*, B = *T. brachycalcinum*.

[2]Scale of 1 to 10: 1 = Little or no hard-seededness; 10 = Very high level of hard-seededness (as determined under Australian conditions).

[3]Registration information unavailable.

levels in 1984-85. Fourteen lines were identified with very low (<0.11 percent DM) levels of formononetin (28). Isoflavone analysis is now a routine part of subclover germplasm screening in Texas and research is currently in progress at the Texas A&M University Agricultural Research and Extension Center at Overton to determine the effects of isoflavones on cattle reproduction (5).

Since 1921, most of the registered subclover varieties have been evaluated for forage production at Angleton, (6, 7, 8), Beeville (10, 11, 18), Yoakum, College Station (12), Stephenville (13), or Overton (21, 22, 26, 27), Texas. Forage production ranges from 1 to 3 T DM/A for the mid- and late-season subclover varieties. On sandy-loam, acid soils in east and southeast Texas, the varieties Mt. Barker, Woogenellup, and Tallarook have been extensively tested and generally found to be highly productive. Newer varieties such as Esperance, Larisa, and Meteora also show promise in these areas. Clare, Koala, and other *T. brachycalycinum* lines appear to be better adapted to alkaline soils of southcentral Texas than other subclovers (personal comm. W. R. Ocumpaugh). Subclover varieties are available with a broad range of maturity dates (Table 1). In Texas the production of late subclover varieties, like Tallarook, is often skewed into late April and May with less early yield in February and March than mid-season varieties. The very early subclover varieties such as Nungarin or Northam usually mature seed and cease forage production by late March in Texas. Forage production distribution for subclover in Texas is summarized in Table 2. In 1985, 29,000 acres of subclover were estimated to be in production in Texas (9). Major subclover production areas were concentrated in east and southeast Texas.

Table 2. Distribution of Subterranean Clover Forage Production Averaged Over Multiple Environments in Texas

Variety	No. of[1] environments	February	March-mid-April	Mid-April-May
		— percent of total yield —		
Tallarook	5	17.3	35.8	46.7
Mt. Barker	5	24.3	39.7	35.8
Woogenellup	5	30.1	44.5	25.1
Nungarin	3	48.1	51.9	0.0

[1]Environments = locations or years.

If subclover is to be a significant component in Texas pastures, natural reseeding is a critical characteristic needed by this species. Production of hard seed capable of persisting through Texas summers and generating reliable fall stands is a highly desirable trait, but sometimes questionable in subclover varieties otherwise adapted to Texas. Seventy-three single plant subclover selections were made in 1982 for the evaluation of the genetic control of hard seed development. Hard seed of these lines at harvest ranged from 11 to 60 percent (24). Seventeen of these lines were evaluated for hard seed persistence over three seed production years at Overton. Three subclover breeding lines were identified that had more persistent hard seed than the check varieties (25). Seed production environment set the upper limit for hard seed level but plant genotype determined rate of seed softening. Hard seed levels were lower in 1986 than in 1984 and 1985, likely due to poor drying conditions during seed maturation. More detail on subclover reseeding is included in a separate chapter.

Future subclover breeding efforts at Overton will include continued emphasis on germplasm acquisition and evaluation, antiquality components, and reliable reseeding.

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