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Strains of Subterranean Clover in Western Australia

By B. J. QUINLIVAN, B.A., B.Sc. (Agric.), Botanist, Weeds and Seeds Branch

The use of subterranean clover as a pasture plant in Australia dates back to 1889, for it was then that A. W. Howard, at Mt. Barker, in South Australia, recognised its value. However, despite his efforts to popularise the use of this clover, it remained unappreciated for many years. The first sale of commercial seed took place in 1906, but the area sown to subterranean clover showed no upward trend until 1920.

Subterranean clover was introduced to Western Australia as an impurity in other agricultural seed, about the year 1890 and by 1900 it was being cultivated in the Bridgetown district.

Mr. A. B. Adams of the W.A. Department of Agriculture was the first to record the presence of strains in subterranean clover in Western Australia (1).

By 1924 he had separated three distinct types—

(i) “Early” Dwalganup strain from Boyup Brook.
(ii) “Midseason” Mt. Barker strain from South Australia, and the
(iii) “Late” Wenijup strain from Bridgetown.

By 1940, however, Aitken and Drake were able to list a total of 50 separate strains growing under trial in Victoria (2).

Since then the number has been added to considerably. A total of 24 strains are known to be growing under natural field conditions in this State, 12 of which have been located since 1940.

THE ORIGIN OF THE STRAINS

Evidence as to the origin of strains is difficult to obtain. The normally accepted explanation for the development of distinct strains of cross-pollinated plants is that the environmental factor operates on a mixed genetic population following cross-pollination, natural selection takes place and strains adapted to the particular environment are produced. This process would not apply to any degree to subterranean clover which is a self-fertilised plant.

The plant itself occurs naturally over the whole of Southern Europe and North Africa; it is also recorded from England and Germany. In its natural habitat a considerable variation within the species has been recorded. Many of the strains recognisable in Europe are similar in major characteristics to Australian strains.

Subterranean clover strains have shown a remarkable lack of variation in botanical characteristics even when grown mixed with other strains over a number of years.

Bud mutations are known to have occurred. The “white-seeded” Dwalganup strain, which is a common impurity in the normal stands of Dwalganup is known to have arisen in this manner. Plants of the normal black-seeded Dwalganup have been located, which have one burr containing white seeds. These white seeds have bred true to type the following season.

Although the origin of the majority of the Australian strains can be traced back to their counterparts in Europe, the possibility of new strains arising, as a result...
of natural cross-pollination under field conditions, cannot be ruled out altogether. Although there is no direct evidence, instances of new intermediate types being found in paddocks containing mixed strains are known. In a pasture at Manjimup two strains of clover have been growing mixed together for a number of years. They are the Mt. Barker strain with a hairy runner and red-banded calyx and the Pearsons strain with a hairless runner and white calyx. Over the last two years two intermediate forms have appeared, one with a hairy runner and a white calyx and the other with a hairless runner and a red-banded calyx.

**STRAINS OCCURRING NATURALLY IN WESTERN AUSTRALIA**

The majority of the certified commercial strains growing in this State are of Eastern States origin. Two types, the Dwalganup and Yarloop, strains originated in this State. The 24 strains which are known to occur are almost certainly by no means a complete list. Although the established strains are remarkably constant, variants within them occasionally do occur. The variants differ from the strain in only minor characteristics and are probably not sufficiently distinct to warrant classing as a new strain.

Most of the known Australian and European strains plus a considerable number of cross-bred types are on trial at Research Stations in this State, but it is only intended to cover in this article those which are known to occur naturally under field conditions. Four strains which have no recognised common name are not included.

Of those growing under field conditions eight may be considered commercial strains in that certified seed is either at present available on the market or should be available in the next few years. The other 12 strains which are described are those which have little economic significance and are normally found only as admixtures with the commercial types.
COMMERCIAL STRAINS

At present in this State six strains of subterranean clover are certified and recognised as commercial strains; they are as follows:

Dwalganup—Early maturing.
Yarloop—Early maturing white seeded.
Clare, Bacchus Marsh—Early midseason.
Mt. Barker—The standard midseason variety.
Tallarook—Late maturing.

In addition to the above, two other strains—Geraldton and "Pearsons"—may shortly reach the stage of commercial production. The Geraldton strain was isolated by Dr. A. J. Millington of the Institute of Agriculture at the University of W.A. and is being used in the breeding programme being carried out at that Institute (3). This strain flowers slightly later than Dwalganup but the seed matures much faster. For this reason, it may be useful in areas which have a shorter growing season than that required for the Dwalganup strain.

Pearsons strain has been known to occur as an admixture in Mt. Barker strain pastures for a number of years. It is particularly prominent at Greenbushes, Mt. Barker, Capel and Manjimup. Its vigorous growth habit has attracted the attention of a number of farmers. It has been harvested for sale commercially over the last few years and is becoming increasingly popular.

A number of other strains such as Daliak and Mulwala have been tried commercially on a limited scale but have never become popular with growers.

In order of maturity the present commercial strains are as follows:

Dwalganup.—The most widely grown of all clovers in this State. It is the earliest flowering of all varieties, originating from Mr. P. D. Forrest's "Dwalganup" property at Boyup Brook and is thought to have been accidentally introduced with ryegrass seed about 1890. Commercial seed has been available since about 1929. It is noted for its early maturity, good winter growth and heavy seed setting. This State is a large producer of Dwalganup seed. In 1956 a total of 1,600 tons was certified (Fig. 2.)

Geraldton.—The strain, as mentioned earlier, was collected by Dr. A. J. Millington at Geraldton in 1950 and has been under trial at a number of research
stations and other centres since that time. Although flowering a few days later than Dwalganup it matures a week or more earlier, and thus could be a useful clover for the drier areas. Seed stocks are at present being built up by the Institute of Agriculture and commercial certified seed should be available within a few years. (Fig. 3.)
Yarloop.—This strain is also known as “White Seeded” or “Albino” clover. It was known to occur in the Yarloop district some 20 years ago. Its peculiar adaptability to wet water-logged areas made it very popular in the Harvey-Brunswick district. It makes good winter growth and is early maturing, flowering about a week later than Dwalganup. It is now widely grown over the whole of the Great Southern and South-West. Certified seed first became available in 1948, and total production has increased rapidly ever since. This is the only State which produces the seed in any quantity; last year a total of 276 tons was harvested. (Fig. 4.)
Bacchus Marsh.—As its name implies, this clover originates from the Bacchus Marsh district in Victoria. It is an early midseason type flowering normally towards the middle of September. It was first grown in the Kojonup district in 1945. Since 1950, large areas of this strain have been planted on the Land Settlement projects along the South Coast and at Esperance. The rainfall in these districts is sufficient for Bacchus Marsh, but not quite extended enough for the Mt. Barker strain. Production of certified seed in this State commenced in 1948. Total pro-
duction has never been higher than 20 tons and for this reason it has been necessary to import most of the State's requirements. (Fig. 5.)

Clare.—A South Australian strain, which has come into prominence over the last few years. It is grown commercially on a limited scale in the Eastern States. Several producers in this State have established small plots of the strain for seed production. Its maturity is approximately the same as Bacchus Marsh. It is strikingly distinctive from other strains by its brown anthocyanin-patterned upper leaf surface. It appeared to compare favourably with strains of similar maturity when under comparative trials in the Eastern States. (Fig. 6.)

Pearsons.—This clover was first noticed on Mr. L. Pearson's property at Benger in 1948 when a paddock was being examined under the certification scheme. It has also been known as “White Flowered Mid” but its more generally accepted name is “Pearsons.” Since its original discovery at Benger, it has been found growing at Mt. Barker, Greenbushes, Manjimup and Capel. It has come into prominence in the last few years and a number of farmers, particularly at Greenbushes and Woogenellup, are interested in establishing it commercially. Although no detailed trials have so far been carried out it is noted for its good winter production and its general vigorous growth habit. It flowers at approximately the same time as Bacchus Marsh.

All commercial lines of seed at present available contain a varying proportion of the Mt. Barker or Dwalganup strains. A few producers are at present building up pure stands with a view to harvesting certified seed in a few years time. (Fig. 7.)

Mt. Barker.—This is the original strain from Mt. Barker in South Australia. It was introduced into this State about 1900 and has become the basic pasture plant in most of the South-West and lower Great Southern. It is also grown in the Esperance district. In 1951 over 600 tons of certified seed were produced, since then production has fallen to approximately 150 tons per annum. (Fig. 8.)

Tallarook.—This is a Victorian strain originating from the Tallarook district in that State. It is a late maturing type flowering normally about mid October. It has a very leafy growth habit and is an excellent clover for parts of the South-West in association with the Mt. Barker strain. It was introduced to this State about 1940 and is becoming increasingly popular, although as yet, is not widespread. Certified seed has been produced.
on a limited scale since 1944 but the production has never exceeded 10 tons in any one year. (Fig. 9.)

OTHER MINOR STRAINS

As mentioned earlier 16 minor strains of little or no economic significance are also known to occur under natural field conditions. Some of these have been commercialised to a limited extent while others are found growing only in small patches in certain districts. A number of these minor strains have been useful in cross breeding work both here and in the Eastern States. A brief mention only of the named strains will be made. These in order of maturity are as follows:

Dwalganup (White Seeded).—This strain is commonly found as an impurity in the normal Dwalganup pastures. It is found in all districts but is particularly prevalent in the Tambellup and Cranbrook areas.

Williams.—A strain of about the same maturity as Dwalganup from which it can be readily distinguished by its distinctly red banded calyx and indented outer leaf margin. It is found growing on a number of properties close to Williams. (Fig. 10.)

Northam Strains.—Four distinct strains of clover known respectively as Northam A, B, C and D, have been found growing at Northam. Two of these were first noticed growing at the golf links as early as 1930. They are all early maturing, being from 3 to 7 days later than Dwalganup. They are not sufficiently different from Dwalganup to warrant a detailed comparative trial. (Figs. 11-14.)

Daliak.—This strain was first noticed growing on Mr. Monger’s “Daliak” property at York about 1929. It is characteristic in having no leaf markings and a deep red calyx. It is an early maturing clover flowering normally a few days later than Dwalganup. Some interest has been shown in this strain at various times and spasmodic attempts have been made to establish the plant as a pasture in various parts of the agricultural areas. As a result, although it is not a commercial clover, it is commonly found as an admixture in other strains in many districts. (Fig. 15.)

Pink-Flowered.—This strain was found growing at Muresk in 1929. It is not common and is readily distinguished by its characteristic pink petals.

Mulwala.—An Eastern States strain which at one time was produced commercially to a limited extent in New South Wales. Its maturity is approximately one week later than Dwalganup. It was tried by a number of farmers in this State about 1935 but was not a sufficient improvement on Dwalganup to warrant extensive planting. It is still found growing occasionally as an admixture in pastures, particularly at Boyup Brook. It can be distinguished from Dwalganup by its deeply indented leaflets (Fig. 16.)

Gingin.—This strain has been found growing along the roadsides near Gingin. It matures 7-10 days later than Dwalganup. It has a vigorous growth habit, and is distinguishable from other early maturing strains by its abnormally large stipules and runners and distinctly marked upper leaf surface. (Fig. 17.)

Four Leaf.—This strain is characterised by frequently having four or five leaflets on each petiole. The number of leaflets is not constant. A single plant may have three, four or five leaflets on separate petioles. This strain was found growing as an admixture in Yarloop and Mt. Barker pastures in the Harvey district a
few years ago. It is similar to Yarloop in its maturity and other characteristics. (Fig. 18.)

Wenijup.—As mentioned earlier, this clover was accidentally introduced into the Bridgetown district about 1890, and is a late maturing type. Attempts to establish it on a larger scale have been made spasmodically, it is however not as popular as the Mt. Barker and Tallarook strains. It is also known as the “Late Brunswick” strain and is found in small patches in a number of localities in the lower South-West. (Fig. 19.)

THE IDENTIFICATION OF STRAINS

Table I is adapted from a similar type of table published by Aitken and Drake in the Journal of the Victorian Royal Society (2). All the known named strains growing under field conditions in this State have been included. Naturally enough the ones which will be encountered most frequently are the commercial strains, which have been listed in heavy type. The other minor strains are shown in lighter type. The list is set out in order of maturity.

Black and white photographs of most of the strains mentioned are shown in Figs. 2-19. Naturally enough such photographs are of limited value by themselves as a means of identification, but should be useful as an aid to identification in association with the illustrative method given in Fig. 20 and Table I.

Subterranean clover shows a considerable variation in its morphological characteristics under different climatic and soil conditions. Those which may invariably be present when the plants are grown spaced apart in test rows need not necessarily show up under field conditions. Bacchus Marsh for example, always has a distinctive heavily flecked upper leaf surface when grown in test rows but under field conditions this may or may not be present.

The characteristics which are used in Table I for the identification of the strains as far as is known, do not change no matter under what conditions the plants are growing.

The meaning of the botanical terms used in Table I, i.e., calyx, stipule, etc., may be obtained by consulting Fig. 1.

A brief description of the characteristics used in the table is as follows:

1. **Leaf.**

   (a) **Pattern of Pale Central Mark.**—Most strains have some type of marking on the upper leaf surface other than the variable brown anthocyanin flecking. In the centre of the leaf the area is a pale green colour, towards the extremities it is a whitish colour. This white marking varies in form or may be entirely absent. A diagramatic description of these markings is given in Fig. 20. Some strains, i.e. Daliak, have no leaf markings, others have either a pale central mark or a mark on the outer edge of the leaf. A few such as Dwalganup have a combination of both.

   (b) **Leaf and Petiole Hairiness.**—The hairiness of the leaf and petiole varies from none at all in the case of Clare to very hairy with Dwalganup. The degree of hairiness is divided into four categories as follows:

   (i) No hairs.
   (ii) Few hairs.
   (iii) Hairy.
   (iv) Very hairy.

   The division between the latter three groups is purely arbitrary, and for this reason the differential degree of hairiness is not used as a definite means of distinguishing between strains. When a strain is hairless this characteristic has been used as a differential.

   (c) **Stipule Colour.**—The colour of the stipule is very variable between strains but remarkably constant within the strain. It varies from a greenish white colour with green veins to a predominantly purple red colour with red veins. For purposes of differentiation the varying stipules have been divided into four types as illustrated in Fig. 20.
2. **Runner Hairiness.**

The degree of hairiness on the runners has been categorised in the same manner as the petiole and leaf.

3. **Flower.**

   (a) **Corolla Colour.**—The colour of the corolla or petals can be divided into three types—pure white, white with pink stripes and pink. Only one definitely pink flowered type is known, i.e., the “Pink flowered” strain and this is of minor importance. All the other strains can be placed in one of the first two groups. The Dwalganup strain frequently has a decided pink tinge in the petals, particularly when the plants are grown in rows. Under natural field conditions the colour is normally white with pink stripes.

   (b) **Calyx Colour.**—The type of colouration on the calyx is one of the most important means of distinguishing between the various strains. The colour variation ranges from deep red over the whole calyx, e.g., Daliak to a greenish white with no red pigmentation, e.g., Bacchus Marsh. For the purposes of differentiation in the key, this characteristic has been divided into four groups, as illustrated in Fig. 20.

   (c) **Time of Flowering.**—Subterranean clover strains can be broadly divided into “Early,” “Midseason” and “Late” maturing types. Naturally enough, these groups overlap one another at times. The early group has normally commenced full flowering by the end of August. A gap of about a week follows before the first of the Midseason types, i.e., Bacchus Marsh commences to flower about mid September. The late maturing types, e.g., Tallarook, normally commence flowering about mid October.

   Although the time of flowering is not a defined characteristic, it can be very useful in differentiating between strains and has therefore been included.

4. **Seed Colour.**

The seed colour is a distinctive characteristic only in the case of the White Seeded Dwalganup and Yarloop strains. The Mt. Barker strain has a purplish coloured seed when compared to others but this is not sufficiently distinct to be used for differentiation.

**GENERAL**

Naturally enough the identification of strains within a species is normally a more difficult undertaking than the identification of species within a genus. There are, however, sufficient distinctive features between the strains of subterranean clover to enable a quick determination of any flowering specimen from Table I.

To identify a specimen its characteristics as set out in Fig 20 should be tabulated and then compared with those given for each strain in Table I. In most cases the specimen will be one of the commercial strains which are listed in heavy type. Specimens of the minor strains will rarely be encountered and have been included in the table mainly for record purposes.
Fig. 20—Identification chart to be used in conjunction with Table 1.
<table>
<thead>
<tr>
<th></th>
<th>Leaf.</th>
<th>Runner.</th>
<th>Flower.</th>
<th>Seed.</th>
<th>Other Distinctive Characteristics</th>
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<tr>
<td></td>
<td>(a)</td>
<td>(b)</td>
<td>(c)</td>
<td>(d)</td>
<td>Other Distinctive Characteristics</td>
</tr>
<tr>
<td>Dwalganup</td>
<td>L3L5</td>
<td>+++</td>
<td>+</td>
<td>S3</td>
<td>+++</td>
</tr>
<tr>
<td>Dwalganup (White seeded)</td>
<td>L3L5</td>
<td>+++</td>
<td>+</td>
<td>S4</td>
<td>+++</td>
</tr>
<tr>
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<td>+</td>
<td>+</td>
<td>S3</td>
<td>+++</td>
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<tr>
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<td>+</td>
<td>S3</td>
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<td>+</td>
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<td>+</td>
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<td>S3</td>
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<td>+</td>
<td>S3</td>
<td>+++</td>
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<tr>
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<td>+</td>
<td>-</td>
<td>S2</td>
<td>-</td>
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<tr>
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<td>+++</td>
<td>+</td>
<td>S3</td>
<td>+++</td>
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<tr>
<td>Gingin</td>
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<td>+</td>
<td>+</td>
<td>S3</td>
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<td>+</td>
<td>+</td>
<td>S4</td>
<td>+++</td>
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<td>L2L4</td>
<td>-</td>
<td>-</td>
<td>S2-3</td>
<td>-</td>
</tr>
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<td>+</td>
<td>+</td>
<td>S2-3</td>
<td>-</td>
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<tr>
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<td>-</td>
<td>S2-3</td>
<td>-</td>
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<tr>
<td>Mt. Barker</td>
<td>L2</td>
<td>+</td>
<td>+</td>
<td>S2-3</td>
<td>-</td>
</tr>
<tr>
<td>Tallarook</td>
<td>L3</td>
<td>+</td>
<td>+</td>
<td>S4</td>
<td>+++</td>
</tr>
<tr>
<td>Wenvlup</td>
<td>Unmarked</td>
<td>+</td>
<td>+</td>
<td>S4</td>
<td>-</td>
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</tbody>
</table>

Leaflet not indented, corolla sometimes distinctly pinkish.
No purple anthocyanin on any part of plant.
Sometimes anthocyanin around base of leaf.
Leaflet distinctly indented.
Sometimes a thin faint pale central mark on the leaf.
Similar to Dwalganup, distinguished by mature leaf having few or no hairs below pale central mark.
Anthocyanin frequently distinctive on leaf around midrib below crescent.
Anthocyanin frequently distinctive on leaf around midrib below crescent.
Leaf small and similar to Dwalganup in general shape.
Anthocyanin frequently along lower midrib.
Leaflet distinctly heart-shaped. Comparatively deep indentation in outer leaf margin.
Stipules and runners abnormally large.
Uppe leaf surface frequently spotted with anthocyanin.
Anthocyanin frequently present below pale central mark on leaf.
Stipules larger than normal.
Distinct from other strains in having 3, 4 or 5 leaflets on each petiole. Stipules larger than normal.
Abnormally thick runners and large stipules.
ACKNOWLEDGMENTS

Acknowledgment is made to Mr. J. W. Green, Botanist, State Herbarium, for the drawing of Fig. 20 and to Dr. A. J. Millington of the Institute of Agriculture and Dr. R. C. Rossiter of the C.S.I.R.O. for providing a number of specimens.

REFERENCES


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