Pasture deterioration: causes and cures

D J. Gillespie

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Pasture deterioration - causes and cures

The term 'pasture deterioration' is commonly used to describe a wide range of pasture malaise from a reduction in legume content to almost total failure of most species.

Deterioration must not be confused with the normal changes that occur as a pasture ages, nor with normal between-year fluctuations in density and composition. After a paddock has been cleared of native vegetation and subterranean clover* established, a number of major changes occur as the pasture gets older. Plant nutrient levels in the soil increase steadily, especially those of phosphorus and nitrogen, enabling non-legume species to compete much better. Marked changes occur in the number of insects and fungi, along with steady increases in the soil organic matter content.

These changes are accompanied by a steady change from sub. clover dominance to a mixed-species pasture, often containing less than 50 per cent sub. clover. The proportion of sub. clover ultimately present in a healthy permanent pasture will depend largely on the inherent soil fertility, the amount of phosphorus applied and the grazing management.

Year to year fluctuations in the sub. clover percentage and density are common. There are a number of causes of such changes, the most important of which relate to the nature and timing of the 'break of the season.' (See Fig. 1).

Sometimes it is not easy to distinguish between these normal trends and fluctuations, and genuine pasture deterioration. Observations or information must be recorded for several years before it is possible to say with confidence that a pasture has deteriorated.

In this article a deteriorated pasture is defined as 'one in which the subterranean clover component has declined to a level at which the total productivity of the pasture is permanently reduced'.

In this context 'productivity' refers to the production of digestible nutrients for the grazing animal, production of seed for subsequent regeneration, and/or production of nitrogen for subsequent crops. The definition distinguishes between the normal changes in sub. clover content associated with seasonal conditions and pasture ageing, and permanent decline which will not improve without input from outside the system, such as re-seeding or a change in management.

By D. J. Gillespie,
Pasture Research Officer

*Although this article concerns deterioration in sub. clover pastures, many of the principles apply also to medic-based pastures. However, because medic-based pastures differ greatly in some respects, such as hard seed level and grazing reaction, their responses also may be quite different. Please refer to the article "Medics return to favour" in this review.

Figure 1: Year to year fluctuations in clover percentage at Koornup.

- Weedy and "run down"
- Balanced and productive.
- Good pasture is the basis of our animal industries.
Background
Pasture deterioration has been evident for many years in Western Australia. For example, Meadly reported on pasture 'stalling' in 1946. However, during the 1970s, pasture deterioration problems were reported with increasing frequency from many parts of the State's agricultural areas. As a result, the Department of Agriculture intensified its investigations of the reasons for the increasing incidence of the problem.

It is now possible to explain much of the pasture deterioration problem in Western Australia. More importantly, an understanding of the causes is allowing researchers to work towards overcoming the problems.

The trend of the 1970s is being reversed already in some areas.

Causes of pasture deterioration
In almost all situations, no one factor is responsible for pasture deterioration but rather several factors, usually interacting together in a complex manner, result in a decline in sub. clover proportions. The main factors identified as contributing to widespread pasture deterioration during the 1970s were: seasonal conditions, increased cropping, diseases and insects, and management.

Seasonal conditions
Farmers will recall that throughout the 1960s seasonal conditions in most parts of the State were regarded as 'above average' for both pastures and crops. Pastures were often sub. clover dominant, stocking rates increased, and few problems were experienced in maintaining highly productive pastures.

The end of this series of good years was heralded by the drought of 1969. Many of the 13 years since then have been characterised by either poor 'starts' to the season, dry 'finishes' or in some areas, true drought conditions throughout the year.

A comparison of rainfall data for the period shows a slight drop in growing season rainfall for many centres and a big increase in the number of 'false breaks' and dry springs.

At Wongan Hills Research Station the April to October rainfall for the 10 years 1959 to 1968 averaged 304mm while for 1969 to 1978 it was 239mm ... 21 per cent lower. False breaks occurred in three years of the first period, and dry springs in three. In the 1969 to 1978 period, six false breaks and five dry springs occurred.

Analysis of the break of season dates shows that it was eight days later on average during the 1970s than in the 1960s. At Kojoonup the growing season rainfall was only slightly lower in the 1970s, but the number of false breaks increased. More significantly, the break of the season was 11 days later, on average, than in the 1960s.

To appreciate the effects of these seasonal conditions on the persistence of annual legumes, we need an understanding of the interaction between rainfall quantity and distribution, and legume plant and seed survival. Firstly, sub. clover tends to dominate pasture swards in years when the season opens early and continues without drought periods. Late starts to the season, and early starts followed by long 'dry spells' favour grass and broad-leaved weed dominance in the sward.

An example of the year-to-year fluctuations in sub. clover percentage is shown in Figure 1, taken from data recorded by Rossiter (1966) for a grazed pasture at Kojoonup.

The good sub. clover years of 1957 and 1960 were associated respectively with good April and March breaks. In 1955 and 1956, heavy early rains were followed by long dry spells, and severe sub. clover mortality occurred, whereas deeper-rooted species such as capeweed and erodium fared much better. (See Figure 2) (Rossiter 1966). In spite of these losses, 1955 was still a good sub. clover year (Fig. 1), probably because of significant further seed softening after the February rains.

A series of late starts or false breaks to the season, such as occurred in many parts of the State during the 1970s, obviously has a major effect on reducing sub. clover density in subsequent pastures.

Poor spring rains affect sub. clover density in subsequent years by reducing seed set. Although it is rare for a sub. clover-based pasture to set no seed, poor finishes can often reduce the seed set to a level below that need for satisfactory regeneration in the following year. Figure 3, taken from Collins' data (1981), shows major reductions in seed yield when the growing season finishes before flowering is complete.

A high proportion of sub. clover seed is classified as 'hard seeded' when it first matures in late spring. Fluctuating day and night temperatures in summer cause a gradual softening of this seed so that it becomes permeable to water if rains fall. The rate of softening varies widely between sub. clover cultivars. Nungarin is the hardest seeded of the available commercial sub. clovers but most of the medics are considerably harder.

As the summer proceeds more seeds soften, so that false breaks late in summer will cause a higher proportion of the total seed bank to germinate. Seeds soften faster on bare paddocks because the temperature fluctuations at the soil surface are greater.

Increased cropping
During the past ten years, the area sown to crops in Western Australia has increased steadily. This trend has been occurring in most
parts of the State, including the traditional grazing regions such as the Great Southern. Table 1 shows that the proportion of land in crop increased by an average of 48 per cent for a randomly selected number of Shires from 1970 to 1980.

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Table 1.—Proportion of cleared land in crop (%)

Cropping prevents the sub. clover from producing seed in that year so that the pasture must rely on hard seed reserves for its regeneration the following year. Therefore increases in cropping frequency make survival more difficult for sub. clover based pastures.

Recently released varieties of sub. clover such as Nungarin and Northam have a considerably higher proportion of hard seeds than the varieties they replaced, such as Geraldton and Dwalganup respectively. Therefore they are likely to regenerate more successfully after a crop. Soft seeded varieties such as Woogenellup can be disadvantaged seriously by cropping and may be eliminated from a paddock by several crops in succession. Figure 4 shows the effect of one year’s crop on summer seed reserves at Bannister. (Data from D. A. Nicholas).

To regenerate successfully as a dense pasture after a cropping year, a sub. clover variety must produce plenty of viable seed, a high proportion of which must be hard seed. During the 1970s many legume-based pastures did not set adequate seed in some years because of poor seasonal conditions. When increased cropping frequency was imposed on a series of poor seed-setting years, the effect on sub. clover persistence was disastrous. For example at Wongan Hills Research Station the spring of 1977 was very dry and sub. clover seed set was reduced. Paddocks cropped in 1978 therefore carried low sub. clover seed reserves for regeneration in 1979. Also, 1979 was characterised by both a false break and another dry spring, so little sub. clover seed would have been set. The plant density would have been very low in 1980, and if cropped again, for example on a year-in-year-out rotation, virtually all sub. clover would have been eliminated.

During the 1960s chemical weed control was a relatively rare practice, and sub. clover soon under a crop frequently survived and set some seed. But the trend towards early cereal sowing through minimum cultivation techniques followed by in-crop sprays for weed control, has resulted in minimal sub. clover survival and seed set in the cropping year. The once-common practice of putting "a jam tin of sub. clover seed in the super box" with each refill, although it seldom resulted in much sub. clover seed set, is of even less value today when in-crop herbicides are used.

Dense cereal stubbles can cause serious failures in newly germinating pastures. There is evidence that stubble residues often contain substances that inhibit pasture seed germination. Also there is an increase in fungal diseases under a dense mat of stubble, and diseases such as 'damping off' can kill many newly-emerged seedlings. Increases in cropping intensity, especially in higher rainfall areas where dense stubbles are common, will result in increased pasture seedling deaths unless steps are taken to reduce the effect of stubble residues. Burning, raking and heavy grazing all help reduce this problem.

![Figure 4: Summer clover seed yield at Bannister after continuous pasture and after one crop.](image)

DISEASES AND INSECTS

Until the later 1960s, it was generally accepted that diseases and insect problems in sub. clover-based pastures were rare, apart from red-legged earth mite and lucerne flea damage. Then in the early 1970s sub. clover scorch disease affected a big proportion of the higher rainfall areas of southern Australia. Soon after, root rots were recognised as a cause of major reductions in sub. clover survival in high rainfall south coastal regions of Western Australia. Later, in 1979, blue-green aphid (BGA) arrived in Western Australia and began causing serious damage to sub. clover and medic pastures.

**Clover scorch (Kabatiella cauliflora)**

The first reports of widespread serious clover scorch infection were received in 1970 from the Albany and Bunbury regions. They were followed in 1971 by a severe epidemic affecting areas from Bunbury to Esperance. Since then,
although clover scorch has not been as serious as in 1971, it has continued to have major effects on pasture production and persistence.

Clover scorch can kill susceptible varieties completely in bad years, and the resulting lack of seed set will affect pasture composition and productivity for several years.

Sub. clover cultivars vary in their reaction to clover scorch infection. Unfortunately the varieties Woogenellup and Yarloop which were distributed widely throughout southern Australia in the early 1970s are both highly susceptible. Mt Barker, on the other hand has a reasonable degree of tolerance and pastures based on this variety have fared much better in years of serious clover scorch.

The devastating effect of scorch infection on seed production is shown in Figure 5 for an experiment at Denmark.

In this experiment Woogenellup set only 56 kg/ha . . . 8 per cent of that from sprayed control plots . . . when attacked by clover scorch.

In another long-term grazing experiment at Mt Barker where the highly scorch susceptible Yarloop variety was compared with the scorch tolerant Trikkala, the Yarloop infected with scorch suffered a 90 per cent yield reduction and set little seed.

The plant density of the scorch-affected Yarloop in the following year was only one third that of the sprayed pasture. Trikkala was virtually unaffected by scorch.

Fortunately clover scorch does not occur throughout the State. Districts as far north as Perth are affected sometimes, but generally the disease is confined to areas with more than 650 mm annual rainfall, south of Bunbury.

**Root rot**

South coast root rot is an insidious disease affecting pastures in the high rainfall areas from Busselton to east of Albany. It is caused by several fungal pathogens the most important of which are Pythium irregularare, Fusarium avenaceum and Fusarium oxysporum. Woogenellup, Mt Barker and Yarloop are the most susceptible commercial varieties and Diminup and Daliak the most tolerant. (For more detail on root rot see the article on pasture diseases in this issue of the Journal).

**Bluegreen aphid**

Bluegreen aphids have been causing damage to sub. clover based pastures in Western Australia since their arrival in this State in 1979. They have not caused widespread damage, but in particular areas they have been responsible for the spectacular collapse of spring pastures. BGA can not be considered as contributing to pasture deterioration at this stage, but they undoubtedly have the potential to seriously reduce pasture productivity and seed set where climatic conditions are favourable. Experimental evidence from NSW has shown that the seed yield of susceptible varieties was reduced by more than 50 per cent by BGA attacks In Western Australia some paddocks attacked early in spring have set no seed at all.

**Red-legged earth mite**

Red-legged earth mite have have presented problems in Western Australian pastures, particularly in autumn, for many years. When pastures are dense and sub. clover dominant, the seedling damage and deaths resulting from RLEM attack are relatively unimportant. But if seedlings are sparse as a result of poor germination, for example, the damage the pests inflict is proportionately greater.

The amount of RLEM damage also is related to the date of break of season. The eggs of these pests require moisture, and temperatures below about 15deg C for hatching.

When the rainfall season starts late, the RLEM hatch . . . if they have not hatched already . . . as the sub. clover emerges. Under such conditions seedling deaths can be severe and many plants never fully emerge before they are killed. If the paddock is not inspected until several weeks later . . . perhaps after cereal seeding has finished . . . there may be no sign of the dead plants, and the lack of sub. clover may be wrongly attributed to a germination failure.

During the 1970s, and also in 1981 and 1982, later starts to the season were common. The effect of RLEM on sub. clover then was undoubtedly greater than during the 1960s, when the break was generally earlier and sub. clover density was higher. In late-break years, when a bigger percentage of seedlings is likely to be lost, farmers should consider using an appropriate insecticide.
MANAGEMENT

Most legume-based dry-land pastures in Western Australia are inefficiently managed. As a result, the production potential of these pastures is seldom realised. Farmers generally have become highly efficient in their cropping and animal management, but too often, pastures have been left to fend for themselves.

When seasonal conditions are good and there is less pressure on pastures, the effects of poor management are not so obvious as when pastures are already struggling to survive because of one or more of the factors discussed above.

An understanding of the effect of various management decisions on pasture productivity and persistence is required if management is to be improved. Each situation will vary but the general principles outlined below will usually apply.

Grazing

Sub. clover is well-adapted to withstand hard grazing. Its growing points are situated close to the ground at the base of the plant, flowers are borne low in the canopy, and a high proportion of the seed is buried during maturation. Many introductions of sub. clover from the Mediterranean region were collected in extremely hard-grazed situations. Under such conditions, sub. clover is often the dominant species.

Experiments throughout Australia usually show an increase in sub. clover percentage with increasing stocking rate (e.g. Fig. 6) (Bowden et al. 1978).

Light grazing allows more-upright species such as the grasses, or more-spreading species such as capeweed, to overtop the sub. clover resulting in shading and moisture stress.

Competition from other species can result in sub. clover deaths throughout the season, or in reduced seed set, due to competition for light and moisture. Moderate to heavy grazing allows the sub. clover to compete far more successfully, especially with upright grass species. Even in pure sub. clover stands, grazing, until flowering starts, increases seed yield. Figure 3, taken from a cutting experiment (Collins 1981) shows a big increase in seed yield from cutting, even when the growing season finishes early.

Extremely heavy stocking during flowering can reduce sub. clover seed set by removing flowers, but usually the pastures are so bulky at that time of the year that overstocking is not a serious problem. If stock are removing too many flowers in closely grazed sub. clover dominant paddocks, it is wise to move them to less sub. clover dominant areas where closer grazing will disadvantage the grasses and weeds rather than the sub. clover.

Leaving a bulky pasture ungrazed throughout the summer is not good management. Hard seed breakdown is reduced under a layer of dry pasture residue, thus a smaller proportion of seeds will germinate at the start of the season.

Sub. clover is at more of a disadvantage than grasses when germinating under a mat of pasture residue as it has more difficulty forcing its cotyledons through the mat, and is vulnerable to attack by disease such as damping off.

Clover varieties

In the past 10 years six new sub. clover varieties have been released for use in Western Australia. All have better characteristics than the varieties they are intended to replace.

The Department recommends that, in cropping areas, farmers should sow varieties with higher proportions of hard seed and better seed yielding ability than the varieties they used when cropping less frequently. In higher rainfall disease prone areas, only those varieties with improved disease resistance should be sown. Also it is important for varieties with the correct maturity for the area to be used. Varieties maturing too late will set little seed, especially during a dry spring. Varieties maturing too early produce less seed and can suffer severe seed losses in a late, wet spring. (Collins and Quinlivan 1980). Details about the characteristics of the new varieties, and recommendations for each area of the State are available from Farmnotes.

Changing management

As discussed above, false breaks, dry springs and cropping all reduce sub. clover seed reserves and subsequent plant density. When several of these events occur in succession, seed reserves may be reduced to a point of imminent failure of the legume component of the pasture. At this point, very careful management is required to restore the sub. clover density. Management then should be aimed at maximising seed set in the following year by:

- Encouraging maximum sub. clover establishment, by grazing pasture residues, burning stubbles, and spraying for RLEM if present.

- Giving the sub. clover the best possible competitive advantage during the growing season with moderate to heavy grazing at least until early flowering, then easing the grazing somewhat if other species are not overshadowing the sub. clover.

If seed reserves are already too low for satisfactory regeneration, if a further crop is planned, or if a severe false break occurs, then re-seeding is essential. It is a waste of time waiting a further 12 months to see if the pasture will improve by itself in these circumstances.
As a general rule, if little or no sub. clover seed has set in two successive seasons, then the farmer should consider re-sowing the paddock. Whether this will be necessary depends almost entirely on the sub. clover seed reserves before these two years, and on the proportion of hard seeded in the sub. clover variety. For example, if the pasture were previously dense and sub. clover dominant with a hard seeded variety such as Nungarin, Geraldton, Northam or Dinninup it will probably regenerate satisfactorily after two failed years. If on the other hand the pasture contained less than 20 to 30 per cent of sub. clover or if the varieties were soft seeded, as are Woogenellup, Mt Barker or Trikala, then reseeding would be essential.

Fertilisers

Figure 5 shows the long term effect of super rates on the sub. clover percentage in grazed pasture. High soil phosphate levels encourage more growth of grasses and broad-leaved plants than sub. clover. In these conditions moderate to high stocking rates are essential if adequate clover levels are to be maintained. High phosphate fertiliser applications should be avoided when stocking rates are low.

Mild potassium deficiency in pastures first results in a reduction in sub. clover seed set while more severe deficiency affects its growth as well as seed set. Grasses and herbs usually are not affected as much as sub. clovers, but may run rapidly into nitrogen deficiency because of the lack of sub. clover. Probably sub. clover seed set is reduced by marginal potassium deficiencies over a large part of the medium rainfall, sandy surface soil regions that have never received potash. The Esperance sandplain is an example. The best way to check a soil's potassium status is by soil testing.

Trace element deficiency can seriously affect sub. clover survival, plant production and seed set. Soils that are known to be trace element deficient can be avoided by not cropping when seed reserves are known to be low, or by being prepared to re-seed to restore seed reserves.

Conclusions

Farmers can avoid pasture deterioration through an understanding of the effects of environmental factors and management strategies on sub. clover persistence and production, and by acting to avoid or overcome potentially damaging situations.

The following points are particularly important:

• Cropping and poor seasons reduce sub. clover seed reserves and subsequent pasture density. Several poor seasons and/or crops in succession may reduce seed reserves to unacceptably low levels. This can be avoided by not cropping when seed reserves are known to be low, or by being prepared to re-seed to restore seed reserves.

• Diseases such as clover scorch and root rot will reduce the productivity and persistence of susceptible sub. clover varieties. Short term methods to control clover scorch include close grazing to avoid rank growth, and the use of fungicides when closing up for hay production. Re-sowing pastures with resistant or tolerant varieties is the only long term solution.

• Pasture reseeding is a necessary component of good management. It enables a farmer not only to improve the sub. clover density in a paddock but also to incorporate new, improved varieties which in themselves go a long way towards preventing further deterioration.

References


