Regulating pasture composition with herbicides

C.W. Thorn
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Regulating pasture composition with herbicides

By C. W. Thorn, Pasture Research Officer; M. W. Perry, Crop Research Officer

Regulating the balance between such pasture species as subterranean clover, annual grasses and capeweed has attracted an extensive research effort ever since sub. clover was introduced into Western Australia in the 1940s.

Traditionally pasture composition has been regulated by stock and fertiliser management. We know that clover dominance can be achieved under high stocking rates, while understocking and deferred grazing in early winter favours grass build up. Annual pasture species respond differentially to phosphate fertiliser, for example clover and erodium are dominant at low levels of soil phosphate and grass, particularly Bromus diandrus and capeweed (Arctotheca calendula) being dominant at high levels of soil phosphate (Rossiter 1964). Davies and Greenwood (1973) observed that low soil nitrogen levels resulted in clover dominance, while high levels resulted in grass dominance.

In a ley farming system it is not always possible to control pasture composition by stock management because of limited stock numbers and the rapid growth of pastures in spring. But in recent years the development of quick-acting grass-selective herbicides has offered farmers an alternative to grazing pressure to regulate pasture composition.

Why regulate pasture composition?

By suppressing grasses in a pasture, clover dominance can be re-established with the potential benefits of:

• improving the quality of summer pasture
• increasing sub. clover seed set
• controlling grass-related animal disorders, such as annual ryegrass toxicity
• increasing wool income through reducing vegetable fault.

Also, most pastures are in rotation with cereal crops, so grass suppression in the pasture the year before the crop offers the prospects of:

• a grass weed-free crop
• earlier seeding with in-crop broadleaved weed control
• “straight in” tillage systems
• a greater build up of soil nitrogen
• control of grass-associated cereal crop root diseases.

Against these advantages must be weighed the costs of a probable loss in total pasture production, the possibility of an increase in clover disease such as clover scorch on clover dominant paddocks and a potential for soil erosion should the clover not be dense enough to compensate for the lost grass component. Of these, the most important is the effect of
changed pasture quantity and composition on animal production from sub. clover-based pastures.

Other areas where grass-selective herbicides may be useful are:

- establishing a grass-free area for sowing new clover varieties
- commercial clover seed production
- in legume seed crops to control grasses, for example lucerne, lupins.

**Herbicide effectiveness on annual grasses**

*Herbicides available*

Seed set control techniques and direct removal of grasses with herbicides present the two major ways of controlling grasses.

Seed set control with ‘spraytop’ involves the use of dessicant type herbicides such as Sprayseed® and Roundup® on heavily grazed pastures in spring before grass seeds have matured. Grazing before spraying results in an even emergence of grass heads which enhances the herbicides’ effectiveness. Later rains may encourage re-tillering and seed set thereby reducing the effectiveness of the spraytopping.

The most promising techniques are those which selectively removed grasses from clover pastures.

Kerb®, Surflan®, Yield®, Gramoxone®, Spray Seed® and PP009 have been evaluated over the last three years in Western Australia.

Kerb® is very effective against all annual grasses normally present in our pastures. It can be used both as a pre-emergent and post-emergent herbicide. Experimental rates used have ranged from 0.375 to 1.5 kilograms per hectare. It is registered for small seeded legume crops such as lucerne, medic and sub. clover in South Australia. An early application within three weeks of the break of season appears the most successful. Late applications in July have met with varied success, with failures being recorded in drought years where little rain falls after application. At present its price is a major drawback to its broad-scale use.

Surflan® will kill or suppress all grasses when applied up to the early tillering growth stage. It requires some moisture to be effective. Yield® is used because of its Surflan® content.

Gramoxone® is the cheapest treatment available for grass control in pastures. Rates tested have ranged from 450 to 500 ml/ha. Results have varied from little effect to 85 per cent effective. This variation may be caused by plant size and growing conditions. Some clover damage has been observed, however this is usually transient. To achieve good results Gramoxone® should be applied to short, rapidly growing pasture, with the clover being at least at the six-leaf stage.

Spray Seed® has been used for the control of grasses and broadleaved weeds...mainly capeweed. It is not recommended for use on medic pastures as they are more sensitive than clovers. The rate most commonly used is 880 ml/ha. One of the major drawbacks to the use of Spray Seed® is its effect on the medicos and to a lesser extent the clovers.

PP009 is not commercially available at present in Western Australia. It gives excellent control of rye, barley and brome grasses but not silver grass. The rates used have varied from 0.25 to 2.0 L/ha. Its selectivity gives it the potential for broad-scale use, however, this will depend on its price on release.

A number of other broad-spectrum grass-suppressing herbicides have been developed and will be available for testing in the near future.

**The effect of grass-suppressing herbicides on pasture production**

Little experimental evidence exists to support a claim that 25 per cent clover in a pasture is better than 75 per cent or even 100 per cent in
terms of animal productivity. Current research is aimed at evaluating the need for annual grasses in our sub. clover based pastures.

The results from two trials in 1981 show that early and late winter applications of propyzamide (Kerb®) can almost totally suppress annual grasses. A mid-winter application of paraquat at 500 ml/ha reduced the grass levels by 60 per cent, whereas Spray.Seed® at 880ml/ha sprayed on the same day reduced the grass levels by 40 to 50 per cent.

Haggar and Bastian (1980) recorded that paraquat increased the white clover content of a perennial pasture from 14 to 22 per cent; carbetamide increased it to 32 per cent while propyzamide increased it to 88 per cent. Barrett et al. (1973) found that paraquat applied in mid-winter could increase the clover content of an annual pasture to 95 per cent. Mid-winter applications were more effective than spring applications at increasing the clover content. Some pasture died after spraying, but by spring there was little difference in production. Results from Williams and Avondale show that the removal of annual grasses from a pasture may result in lost production in spring amounting to 10 to 60 per cent. The “knockdown” herbicides, paraquat and Spray.Seed® had a greater effect on the amount of pasture production lost than either the early or late application of propyzamide, which is selective.

Research workers believe the pasture losses from spraying in the first year do not carry over into the next season. Results of a large scale grazing trial support this, with Spray.Seed® reducing pasture production by 36 per cent in the spraying year and having only little effect in the following year (Table 2).

Trials in 1981-82 indicate that the potential loss of pasture production from sprayed pastures depends on:

- the relative grass and clover content of the pasture
- the herbicide’s effectiveness. This depends on timing, rate and plant growth stage
- the type of herbicide, whether selective or knockdown, for example, propyzamide and sprayseed.

The effect of the loss on overall farm production will depend on:

- feed availability on the farm
- the proportion of the farm sprayed
- the proportion of the farm in crop
- the need for high quality summer feed.

Grass suppression does not necessarily result in an increase in the proportion of clover in a pasture. Barrett et al. (1973) noted an increase in the proportion of capeweed in the sprayed plots in the second year. Results from Moora...
Table 2. The effect of herbicides on pasture production in the spraying year and following year at Esperance.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Winter pasture production (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spraying year</td>
</tr>
<tr>
<td>Control</td>
<td>1371</td>
</tr>
<tr>
<td>Kerb®/Sprayzr</td>
<td>1276</td>
</tr>
<tr>
<td>SS/Sprayzr</td>
<td>541</td>
</tr>
<tr>
<td>Spray Seed®</td>
<td>881</td>
</tr>
</tbody>
</table>

This coincided with the pasture drying off and possibly, with a change in pasture digestibility and nitrogen content. The maximum weight changes of the animals on the clover/capeweed pasture was higher than that of the animals on a grass/clover/capeweed pasture.

Davies et al. (1973) and Smith (1970) found that grass swards did not have to produce as much feed in winter for sheep to maintain their weights as did clover swards. Davies also found that sheep on grass swards reached 90 per cent of their maximum weight gain in only 69 days from the date the grass germinated. Those on clover took 108 days. However, the Moora results do not support this. One of the possible reasons could be the high capeweed component of the sprayed pasture. (Table 3). Capeweed is easily accessible to sheep and produces rapidly in winter. Also it has high digestibility and a nitrogen content equivalent to that of clover in winter. McIvor and Smith (1973) found that in May, Woogenellup sub. clover had a nitrogen content of 5.0 per cent while capeweed’s was 4.75 per cent. Moora results show that capeweed, in early July, had a digestibility of 74 per cent while Dugalup sub. clover had a digestibility of 64 per cent and barley grass (Hordeum leporinum), 68 per cent. These results are in accord with those of McIvor and Smith (1973), who found that in early July capeweed, Woogenellup sub. clover, and barley grass had digestibilities of 69 per cent, 56 per cent and 62 per cent respectively.

The type of pasture had no significant effect on wool production in 1981 when lightly stocked. At the high stocking rate, the sheep on the unsprayed pastures produced 0.4 kg more of clean wool than those on the clover pasture.

Table 3. Composition of pasture at Moora in the spraying year and following year 1982.

<table>
<thead>
<tr>
<th></th>
<th>Spring clover composition % 1981</th>
<th>Winter clover composition % 1982</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unsprayed</td>
<td>Sprayed</td>
</tr>
<tr>
<td>Clover</td>
<td>43</td>
<td>65</td>
</tr>
<tr>
<td>Capeweed</td>
<td>35</td>
<td>33</td>
</tr>
<tr>
<td>Grass</td>
<td>31</td>
<td>5</td>
</tr>
</tbody>
</table>

also suggest that removing grasses may make way for capeweed (Table 3).

The value of annual grasses to animal production

Animals grazing annual pastures normally gain weight for a period in late winter and spring, maintain weight in early summer and then lose it from middle to late summer and into the autumn after the break of season.

Annual grasses are acknowledged as valuable sources of feed in the first five to eight weeks following the break of season, because of their winter production and accessibility to grazing animals.

In a trial at Moora in 1981 a pasture was sprayed with 1.5 kg/ha of propyzamide to remove annual grasses, and its productivity compared with that of a normal pasture grazed at two stocking rates.

The two stocking rates were four and eight weaner wethers, 18 months old when the trial started, per hectare. Four to the hectare was equivalent to the district average stocking rate. The spraying was effective in reducing the grass content to a low level and the resulting pasture was a mixture of clover and capeweed.

The results showed that at the low stocking rate, removing the grasses had only slight effects on pasture and animal production. At the high stocking rate, removing the grasses resulted in a liveweight depression in autumn in both 1981 and 1982. However in 1982 the sheep on the sprayed pasture grew faster in late winter, spring and early summer. Those on the clover gained more weight than those on the unsprayed pastures in late October-early November in both years at both stocking rates.

Clover dominant pastures and crop production

Clover dominant, grass free pastures should benefit crop production through their potential to fix more nitrogen, freedom from constraints imposed by difficult-to-kill brome, barley and silver grasses and a suppression of cereal diseases harboured by the grasses in the pasture phase of the rotation.

Reduced grass weed competition in the crop

Studies of the effect of grass weed competition on wheat crops have shown that ryegrass, brome grass and barley grass have major effects on crop yields. In 1981 at Badgingarra ryegrass and brome densities of 100 plants per square metre caused wheat yield losses of 6 and 7 per cent respectively, while at 300 plants/m² it was 18 and 23 per cent (Poole, personal communication). At Moora in 1981 a barley grass density of 100 plants/m² caused a yield loss of 21 per cent.
Although effective pre- and post-emergent herbicides are available for ryegrass control, no in-crop herbicides are available yet for controlling brome and barley grass. If in a direct drilling programme, the spray and single cultivation at seeding fails to control brome and barley grass then they cannot be removed from the crop. Although traditional cultivation techniques and pre-seeding incorporation of Trifluralin®-based herbicides can control barley and brome grasses they cause excessive delays at seeding, and erosion problems.

**Early seeding**

There is evidence that late planting results in reduced crop yields of about 20 to 30 kg/ha/day after the break, due to fewer heads per square metre and smaller grains.

Delays caused by extra cultivations or waiting till weeds are ready for spraying may be costing producers more than the visible costs of extra fuel and labour.

**Soil nitrogen build up**

Barrett *et al.* (1973) and Haggar and Bastian (1980) recorded an increase in the nitrogen content of the mature herbage on clover dominant plots. Watson (1973) showed that the amount of soil nitrogen was related to the amount of clover tops. Results from a number of trials have indicated that there is little more value, in terms of mineral nitrogen, in one year of pure clover compared with a mixed grass/clover pasture.

This may have resulted from the high background soil nitrogen levels of old pastures—most of the pastures which have been manipulated to remove grasses had not been cropped for at least three years. However, long term trials have proved that legume pasture can contribute 40 to 60 kg/ha of nitrogen to the soil a year.

**'Straight in' tillage systems**

Spraying with herbicides to reduce the grass content of a pasture paves the way for more energy-efficient tillage systems—such as the "straight in on the break" system. No previous cultivation is necessary to control barley, brome or silver grass, hence a cost saving, a reduced erosion risk and better prospects of improving soil structure. However, 98 to 100 per cent of the grass must be eliminated from a pasture for satisfactory weed control in the following crop as even small amounts of grass can set large amounts of seed. Capeweed and other broadleaved weeds may be controlled in the crop with a post-emergent broadleaved herbicide.

The yield from the Spray.Seed® direct drilling crop treatment equalled that from the crop following the pasture manipulation "straight-in". However, the straight-in system could have been sown two weeks earlier than the Spray.Seed direct drilled crop and so given a potential for a higher yield.

**Reduced take-all levels**

Take-all is the most serious root disease of wheat and barley in Western Australia. It is most common in the medium and high rainfall areas where the fungus *Gaumannomyces graminis* var. tritici over-summers on the residues of crops and volunteer grasses. The incidence and severity of take-all has been linked with the previous pasture years' grass levels. The removal of the grass host early in the pasture phase effectively makes the pasture a cleaning crop as little or no undecomposed grass root material is available to carry the fungus over. A similar principle exists where cereal cyst nematode is a problem. CCN is not a major root disease of crops in Western Australia.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>SR</th>
<th>Wool production/head (kg clean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsprayed</td>
<td>low</td>
<td>2.93</td>
</tr>
<tr>
<td></td>
<td>high</td>
<td>2.57</td>
</tr>
<tr>
<td>Sprayed</td>
<td>low</td>
<td>3.09</td>
</tr>
<tr>
<td></td>
<td>high</td>
<td>2.17</td>
</tr>
</tbody>
</table>

*Checking sheep weights in the Department of Agriculture pasture trials.*
Control of crop pests
Webworm is known to cause major damage to direct-drilled crops. Webworm moths rest and lay their eggs amongst grass tufts in the pasture. Management practices such as grass control the year before cropping, heavy grazing or continuous cropping may go a long way towards reducing the webworm problem in direct drilled crops. Generally, old grassy pastures are most likely to support pest populations.

Other uses of pasture manipulation
The use of grass-selective herbicides in legume seed crops may benefit commercial clover seed producers. Results from a Moora grazing trial (Table 6) indicate that grass control increased clover seed production by 26 per cent at the low stocking rate of four sheep/ha. At the high stocking rate the lack of grass in the sprayed plots increased grazing pressure enough to halve sub. clover seed set.

Benefits accruing from grass suppression could be lost if other species such as capeweed replace the grass.

The use of herbicides to remove grasses in newly established clover pastures will enhance the clover’s survival, subsequent production and seed set in the first year. Resowing costs are high, a good reason for ensuring that a newly sown pasture is established successfully.

The future of pasture manipulation studies
Further research is needed to compare the value of ‘knockdown’ herbicides and ‘selective’ herbicides for both grass and capeweed suppression in pastures. Optimum spraying times and herbicide efficiency need evaluation.

Also, further research is needed into the effects of pasture composition on animal production, and the long term stability of the grass-free system. Research is needed to define the tolerance of grasses, sub. clovers and medics to the herbicides, and also to determine whether the herbicides have any effect on legume nodulation and nitrogen fixation. Herbicides now offer the potential of generating clover dominant pastures from mixed pastures.

However, whether such a pasture would be more productive than a mixed pasture over a run of seasons and years has yet to be evaluated.

Conclusions
With the development and extension of herbicide technology, farmers are now able to regulate pasture composition on a paddock basis to suit a cropping or grazing programme. A grass-free farming system has the potential to increase crop productivity and contain costs, while maintaining or even increasing livestock production above its present level. Long term and further extensive research is required before costs and benefits can be put to the system.

References

Acknowledgements
This work is wholly supported by the Commonwealth Wheat Industry Research Council.

<table>
<thead>
<tr>
<th>Herbicide costs</th>
<th>$/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spraytop at 500 ml to 1.0 L/ha</td>
<td>4.70 to 7.60</td>
</tr>
<tr>
<td>Gramoxone at 450/1 to 1.3 L/ha</td>
<td>3.60 to 10.40</td>
</tr>
<tr>
<td>Yield and Surflan</td>
<td>14.00 to 20.00</td>
</tr>
<tr>
<td>*Kerb WP50 at 750 g</td>
<td>26.00 to 56.00</td>
</tr>
<tr>
<td>*FF009 (Fusilade) at 500 ml to 1.0 L/ha</td>
<td>10.00 to 20.00</td>
</tr>
<tr>
<td>*Not registered for use in Western Australia. Prices only approximate.</td>
<td></td>
</tr>
</tbody>
</table>

Table 5: The effect of a 'straight-in' tillage system on crop yield, Moora 1981
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Grass level prior to cropping plants m²</th>
<th>Grass level in the crop plants m²</th>
<th>Grain yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1570</td>
<td>178</td>
<td>1709</td>
</tr>
<tr>
<td>Kerb®</td>
<td>120</td>
<td>8</td>
<td>2679</td>
</tr>
<tr>
<td>Gramoxone®</td>
<td>1520</td>
<td>115</td>
<td>1847</td>
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<tr>
<td>Spraytop®</td>
<td>1105</td>
<td>107</td>
<td>1957</td>
</tr>
<tr>
<td>'straight-in' sprayseed</td>
<td>10</td>
<td>7</td>
<td>2518</td>
</tr>
<tr>
<td>'straight-in' sprayseed</td>
<td>9</td>
<td>3</td>
<td>2435</td>
</tr>
</tbody>
</table>
Medics return to favour

Background
Annual medics orginated in the Mediterranean region (Heyn 1963). The spiny burrs of many species of annual medic have helped disperse them widely from their centres of origin. Western Australia is one of the many parts of the world where a number of accidentally introduced medic species have become naturalised. It is likely that these arrived early in the agricultural development of the State. They most likely came here from western Europe and the western Mediterranean. The most common naturalised species in Western Australia are burr medic (Medicago polymorpha), Goldfields medic (M. minima) and cut leaf medic (M. laciniata). Other species that have been recorded but are not widespread are M. praecox, M. arabica, M. intertexta and M. orbicularis.

In their natural Mediterranean environment annual medics grow over a wide range of soils, temperature regimes and growing season. They are found most commonly on alkaline soils but some species are found on mildly acid soils. In Western Australia our soils of light surface texture are generally acid and our heavy soils neutral to alkaline. In the Mediterranean region this is not a general link. Light alkaline soils are common, and medics are spread widely on these soils. Some medic species such as M. truncatula occur more commonly on the more

Subterranean clovers led the way in Western Australia’s improved pasture boom of the 1950s and 1960s. But farmers and scientists soon realised that some soil types and situations did not suit the sub. clovers at all. The forest soils of the wheatbelt were typical of these. They were the well favoured clay loams which usually carried such timbers as gilmit, salmon gum and morrel. Also, they were alkaline. But volunteer medics seemed to thrive there, particularly burr medic and Goldfields medic. Unfortunately, these plants had very spiny burrs which contaminated wool.

Then in the late 1950s, some commercial barrel medic (Medicago truncatula) was introduced from South Australia. It had a prolific growth habit and its burrs were not as spiny as the volunteer species, but it matured too late for most of the short growing season wheatbelt districts.

It was not long before better suited earlier maturing lines were being sought to take advantage of the situation.

Like the sub. clovers, pasture medics have suffered a considerable decline, resulting largely from the poorer returns from sheep and wool relative to wheat in the wheatbelt, a series of droughts, and the continuous cropping system now developing. Nevertheless some farmers are looking again to legume based pastures as part of a longer term rotation.

By M. A. Ewing, Pasture Research Officer

![A member of the Western Australian team collecting medics in a Libyan dust storm.](image)

Medics survive in harsh situations in the Middle East.