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Control take-all and gain other benefits of eliminating grass from ley pastures by chemical manipulation

By Bill MacLeod, Research Officer, Plant Pathology Branch, South Perth and Gordon MacNish, Plant Pathologist, Esperance

Take-all is the most serious root disease of wheat and barley in Western Australia.

The fungus which causes take-all (Gaeumannomyces graminis var tritici) is widespread throughout the wheatbelt but is most common in the high and medium rainfall regions (400 mm to 750 mm average annual rainfall, see map).

Along the south coast take-all may be so serious that cropping to wheat or barley is not always economically feasible.

Elsewhere in the wheatbelt the presence of take-all affected cereal plants and the loss of crop yield may go unnoticed unless the roots of cereal plants are examined in detail.

How much grass does a pasture contain? Within these 0.5 sq. m quadrats there is (from top) 580 kg/ha of grass, 620 kg/ha or 1100 kg/ha of grass.

Symptoms

Paddock appearance

Take-all affected plants are stunted and usually appear in the crop as indistinct patches which range in size from a few plants up to several metres across. Near the centre of patches most plants are affected, but the proportion decreases towards the edges. In a severe outbreak of take-all large areas of a paddock may be covered by overlapping patches so that the paddock will appear to be a mosaic of varying densities of affected plants.

Take-all affected plants may hay-off early, causing pinched grain. A crop with large areas affected by take-all may not be worth harvesting.

Take-all should not be confused with rhizoctonia bare patch which causes patches of a similar size. However, rhizoctonia patches have sharply defined edges and become apparent early in the season, at the three- to six-leaf stage of cereal plants (Zadoks 13-16).

Plant appearance

The most common symptom of take-all is the presence of dark brown roots due to invasion by the fungus. The roots of mature plants are brittle, black and break off short, whereas healthy plants have roots which are long and white. Severely affected plants may have a black crust around the stem base. Removing the leaf sheath at the base of the plant may reveal this crust or just brown to black streaks or spots.

Symptoms of take-all in roots of wheat plants: healthy roots (left) and diseased roots.
Life cycle of the fungus

Gaeumannomyces graminis infects wheat and barley and to a lesser extent, oats. It also infects most volunteer and pasture grasses. Barley grass (Hordeum leporinum) is the most susceptible common grass, followed closely by annual ryegrass (Lolium rigidum) and silver grass (Vulpia sp.), while brome grass (Bromus diandrus) is least susceptible. The susceptibility of other pasture grasses falls within the range of these common pasture grasses.

The fungus does not infect non-grass pasture plants such as clover, medic or capeweed, or non-cereal crops such as lupins, peas or rapeseed.

Carry-over

The take-all fungus survives over summer in the roots and crowns of plants infected during the previous growing season. Survival is affected by soil conditions and tends to be longer where soil fertility has been improved by the establishment of pasture legumes. Its survival is also affected by soil moisture and temperature. In the absence of live host plants, the fungus persists longer in dry soils than moist, and longer in cool temperatures than hot.

At the break of the next growing season, the surviving fungus infects susceptible host plants whose roots grow near stubble or grass fragments that harbour the fungus. If no susceptible host root grows near by, the fungus will remain in the fragments until they are broken down by the normal processes of decay.

Some pieces of debris may be large enough to remain relatively intact for one or two growing seasons, while most smaller pieces will break down in the first growing season. The amount of viable fungus available to infect a wheat or barley crop will therefore be greatly reduced by one season in which no host plants are available for the fungus to infect and carry-over.

Eliminating hosts plants in legume pastures

Results of two long term rotation experiments at Esperance Downs Research Station show that there is a close relationship between the incidence of take-all in a crop, and the amount of grass in the previous pasture.

In these experiments the pasture composition was manipulated with herbicides. Measurements taken over six years showed that the incidence of take-all over the whole crop increased by about 5 per cent for each 100 kg/ha of grass dry matter in the previous year's pasture, measured in spring (Figure 1).
## STRATEGIES FOR CONTROL OF TAKE-ALL

### PASTURE YEAR 1

<table>
<thead>
<tr>
<th>Spring</th>
<th>Autumn</th>
<th>Winter</th>
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</thead>
<tbody>
<tr>
<td>Untreated grassy pasture</td>
<td>Large numbers of grasses emerge</td>
<td>Grasses shade out clover plants</td>
</tr>
</tbody>
</table>

### PASTURE YEAR 2

<table>
<thead>
<tr>
<th>Seed set control two years before cropping</th>
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<tr>
<td>Spraying stops grass setting seed</td>
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<tr>
<td>Few grasses germinate</td>
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<tr>
<td>Grazing removes most grass</td>
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<table>
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<tr>
<th>Selective grass control one year before cropping</th>
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<tr>
<td>Legume based grassy pasture</td>
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<td>Emerging grasses sprayed out</td>
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<th>Combined strategy for very grassy pastures</th>
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<tr>
<td>Spraying limits grass seed-set</td>
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</table>

Legume based grassy pasture
Emerging grasses sprayed out
Grasses shade out clover plants
Grazing removes most grass
Grazing keeps down grass content
By pasture manipulation

Spring

Take-all fungus thrives in grass roots

Winter

Grass weed control needed

Spring

Crop yield reduced by take-all

Little carry-over of take-all

Key

Very low take-all infection of crops

Few grass weeds in crops

Little carry-over of take-all

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Pasture manipulation

There are two options for manipulation of pasture (grass-legume mixtures) with herbicides to control take-all.

• Seed set control two years before cropping; and
• Selective grass control by spraying (six-leaf stage of clover) in the year before cropping.

Both techniques aim to produce a pasture free of grass for most of the year before sowing a wheat or barley crop. Both options have advantages and disadvantages.

Seed set control

Herbicides can be applied in the late stages of grass development to prevent seed set. Either a broad spectrum or a grass selective herbicide can be used during the early stages of flowering of the predominant grass in the pasture. This ensures a minimum amount of viable seed is set for germination in the following year. (Department of Agriculture advisers should be contacted for practical recommendations of herbicides to be used and timing of applications.)

Farmers can only use this technique if they know two years in advance where cereal crops will be sown. All pasture grasses must be flowering at about the same time so that a single herbicide application will minimize the amount of grass seed set. Herbicide needs to be applied early enough to prevent viable seeds being set, but late enough to prevent the production of new tillers which would set more seeds. Also the legume component of the pasture must set enough seed to be competitive with grasses that germinate, and to provide enough grazing in the following year, that is, the year of pasture before cropping.

Selective grass control

This method allows manipulation of pasture composition the year before a cereal crop is sown. A broad-spectrum or selective herbicide can be applied at about the six-leaf stage of the clover or medic plants. After grass control some pasture production is lost in late autumn and early winter when grazing is already in short supply. However, to complete the control of grass, grazing pressure must be maintained on the pasture to prevent tillers developing on sprayed plants and the establishment of late germinating grasses. (Department of Agriculture advisers should be contacted for recommendations of herbicides to be used.)

Before using this method of pasture manipulation first ensure there is enough clover or medic in the pasture, that is 1,000 to 2,000 plants per sq. m. This number of clover or medic plants is required to compensate for the loss of grass in the pasture and to smother grass plants that survive or emerge after spraying.

Herbicide must be applied as early as possible in the growing season to allow maximum time for grass root fragments harbouring the fungus to break down. Delaying herbicide application by as little as three weeks can considerably increase the amount of take-all fungus that survives to the end of the growing season (Figure 2).

Strategy for very grassy pastures

In a predominantly grassy pasture where the numbers of clover or medic plants are too low to use selective grass control successfully, there are two choices.

• A combination of the two options for pasture manipulation. Seed set control with a grass selective herbicide two years before cropping will allow the legume to set more seed and reduce the grass seed-bank. It should be followed by a selective spray to further decrease grass in the year before a cereal crop.
• Use a rotation with a non-host crop before sowing to wheat or barley. However, grasses must still be completely controlled within this crop to provide a ‘break’ in the disease cycle.

Other advantages of eliminating grasses from pastures

As well as controlling take-all, there will be:

• Fewer grass weeds in crops.
• The opportunity to sow earlier than usual.
• Increased nitrogen fixation by pastures.
• Better quality grazing for stock.
• Minimal grass seed contamination of wool.
• Control of annual ryegrass toxicity.

Fewer grass weeds in crops

Control of broadleaf weeds in cereal crops is relatively easy and cheap with the range of herbicides now available. However, control of grass weeds is more difficult, and no chemicals are available to control silver, barley or brome grasses in cereal crops. Grass weeds must still be controlled before sowing, either with herbicides or by cultivation. Whichever of these methods is used sowing will be delayed, but if grasses are controlled in the pasture phase a wider range of herbicides can be used. Seeding will be more timely the following year.
Early sowing

Sowing wheat earlier than usual can increase yield substantially, particularly in the higher rainfall regions. The Department of Agriculture has estimated that delayed seeding reduces wheat yield by 25 to 35 kilograms per hectare per day in regions with more than 450 mm average annual rainfall. Thus delays caused by pre-seeding operations to control grass weeds are costing farmers more than the direct costs of fuel and labour.

Nitrogen fixation by pasture legumes

Legume based pastures were developed initially as an important source of nitrogen for cereal crops. A legume dominant pasture can add an average of 64 kg of nitrogen per hectare per year to the top 7.5 cm of soil (Perry et al. 1980) providing the pasture remains legume dominant.

Also the pattern of nitrogen supply from organic (legume) nitrogen differs from that of fertilizer nitrogen. There is a slow release of nitrogen from organic (legume) sources, whereas generally, fertilizer nitrogen is immediately available. In soils where leaching is a problem, the slow release nature of organic nitrogen may be important for maximum uptake of the available nitrogen by crops.

Grazing of manipulated pastures

In grazing trials on pastures manipulated to eliminate grasses, sheep grazing grass-free pastures had lower liveweights during winter in the year that the pastures were manipulated, but made compensatory gains in weight during late spring and early summer due to the higher quality of the grass-free pastures (Thorn and Perry 1987). In the year following manipulation, grazing grass-free pastures had little effect on sheep liveweight. Total wool production did not change in this trial. In other trials where the legume component increased without loss of total pasture production, wool production over summer was increased.

Grass seed contamination of wool, and production losses caused by grass seed damage to sheep, would be almost eliminated on grass-free pastures.

Eliminating grasses from pastures also avoids annual ryegrass toxicity. The present practices for control of annual ryegrass toxicity concentrate on removing ryegrass in cereal crops, seed set control and grazing of pastures to reduce the formation of galls colonised by the toxic bacterium. However these techniques are not as effective as using herbicides for selective grass control.

Further reading
