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Management of cereals for control of take-all

By G.C. MacNish*

An intensive research programme by the Department of Agriculture since 1975 has led to some management recommendations.

Take-all is the most serious root disease of wheat and barley in Western Australia. Although widespread throughout the wheatbelt, it is most serious in southern regions (Fig. 1). Losses to the State due to take-all have been estimated at about $20 million a year.

The fungus which causes take-all (Gaeumannomyces graminis var. tritici Walker) survives on residues of wheat and barley or on the roots of grasses. Losses can be reduced by cultural methods which reduce the amount of infected crop or grass root residue in the soil, and by encouraging vigorous growth of the crop.

Symptoms

Take-all affected plants usually appear in the crop in patches of up to several metres in diameter, but it may also affect individual plants or all plants over large areas. The root infection may cause death of seedlings, but more often causes stunting or early ripening.

Because of the tendency to ripen early, the heads of some affected plants are seen as ‘whiteheads’ in the green crop. ‘Whiteheads’ are usually empty hence the term take-all, or they contain only small, shrivelled grain.

However ‘whiteheads’ do not prove that take-all is present, as they may also result from other causes. With a severe outbreak of take-all the whole crop may hay-off early causing large reduction in yield and sometimes the crop may not be worth harvesting.

The most characteristic take-all symptom on the plant is a black crust around the stem base. Removal of the leaf sheath at the base of the plant may reveal this black crust or sometimes just dark brown to black streaks or spots.

Roots of affected plants are dark brown due to fungal invasion. As the plant matures, the roots become rotten and brittle and the plants can be easily pulled from the soil.

Carry-over

The fungus causing take-all survives over the summer on wheat or barley stubble and grass root and crown residues. Survival is affected by soil conditions and tends to be longer in areas where soil fertility has been improved by the establishment of clovers and medics.

During the non-cropping phase of the paddock rotation, the fungus exists on the roots of susceptible grasses. The density of fungus in the soil increases as the grass content in the pasture increases.

Hosts

The take-all fungus infects both wheat and barley; however, the effect of the disease on the yield of barley appears to be less than on wheat. Oats were considered to be resistant but recent research has shown that they can be infected. The level of infection on this crop is usually slight and probably has little or no effect on yield.

Many grasses are susceptible. Barley grass and spear grass are considered to be important hosts in Western Australia. All non-grasses including subterranean clover, medics, lupins, rapeseed and linseed are not infected by take-all.

Distribution

Surveys in south-west Western Australia have shown that the general occurrence of take-all is strongly related to location (see Figure 1). Take-all tends to be worse in the high rainfall areas.

Soil moisture

Within any season, high rainfall tends to increase take-all. However, without moisture stress the plant is better able to cope despite the increase in root damage. A dry finish to the season is likely to restrict take-all but may also make it difficult for the plant to obtain enough moisture through its damaged root system. As a result, yield may be drastically reduced.

Crop rotation

The take-all fungus can survive for one and possibly two years in old crowns.
and roots of host plants. Any practice that encourages the breakdown of this trash will help to eliminate the fungus, provided new hosts such as grasses or cereals are not present for re-infection.

Resistant plants can be used as 'cleaning' crops to reduce take-all in the following wheat or barley crop. Oats once popular as a cleaning crop, can still be used to reduce take-all. However, oats can also be infected and are not as effective as lupins and linseed for cleaning.

**Paddock history**

Survey results and general experience indicate that take-all is worse on recently developed areas and generally less important on those paddocks which have been established for many years. This is thought to be due to a slow build-up in the soil of a 'generalised antagonism' to the take-all fungus.

**Cultural practices**

Research on control of take-all by cultural practices has found that:

- All recommend wheat varieties are equally susceptible to take-all.
- Drill-row spacing has no effect on take-all.
- Plant density has little or no effect on take-all.
- Delayed sowing following the breaking up of the soil after the opening rains can reduce take-all. A short delay allows a breakdown of infected trash in the moist soil.

- Burning the stubble may help reduce the level of infected trash above ground, but the heat does not penetrate the soil and cannot reduce the amount of infected material below ground.
- Short rotations reduce take-all. It is thought that this is due to a reduction of grass content in the pasture and possibly a build-up of micro-organisms that are antagonistic to take-all fungus.
- Any practice encouraging crop growth will help overcome the effects of take-all. These practices include good weed control and the application of adequate fertiliser.

**Nitrogenous fertilisers**

Experiments over the last four years have shown that the ammonium form of nitrogenous fertiliser reduces take-all. In general, the higher the rate of ammonium nitrogen the more likely take-all will be reduced. However, where take-all is at very high levels, ammonium nitrogen is ineffective.

Results indicate that the control of take-all by various nitrogenous fertilisers is in the following descending order of effectiveness: ammonium sulphate (drilled), Agras No.1 and No.2, ammonium sulphate (top dressed), DAP, Agran 34, and urea. Sodium nitrate does not reduce take-all.

The rates of nitrogen used in these experiments were higher than those generally recommended for Western Australian cereal crops. Higher rates may be economic in take-all areas where ammonium-type fertilisers would be used to reduce take-all as well as provide a source of nitrogen.

**Control**

The following control measures can therefore be recommended:

- Reduce grass content in pastures in the year before cropping by stock management or chemicals.
- If the level of take-all is expected to be very high, use a cleaning crop such as lupins, linseed, rapeseed or oats in the year before cropping.
- If wheat or barley must be grown on a take-all prone area, sow barley rather than wheat.
- If nitrogen is to be applied, use Agras No.1 or No.2 at 25 to 45 kg of nitrogen per hectare (see Table 1). As a second choice use DAP at the same rate.
- Avoid sowing wheat or barley immediately after breaking up a grassy pasture. Allow a short period for breakdown of trash.
- Encourage crop growth by reducing weed competition and by supplying adequate fertilisers.
- Consider using short crop-pasture rotation.
Wheat affected by take-all while the surrounding oats are unaffected.

Effect of a cleaning crop. The healthier crop on the left was grown on land sown to lupins the previous year, and the crop on the right is the second successive wheat crop.

Table 1. Rates of fertilisers to give equivalent rates of nitrogen (kg/ha)

<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>Agras No.1</th>
<th>Agras No.2</th>
<th>DAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>139</td>
<td>208</td>
<td>139</td>
</tr>
<tr>
<td>35</td>
<td>194</td>
<td>292</td>
<td>194</td>
</tr>
<tr>
<td>45</td>
<td>250</td>
<td>275</td>
<td>250</td>
</tr>
</tbody>
</table>

Table 2. Soil type and risk of take-all.

<table>
<thead>
<tr>
<th>High risk</th>
<th>Low risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand plain</td>
<td>Heavy loam</td>
</tr>
<tr>
<td>Mallee</td>
<td>Heavy clay soil</td>
</tr>
<tr>
<td>Sandy loam</td>
<td>Loamy gravel (wet south-western edge of cereal-belt only)</td>
</tr>
<tr>
<td>Loamy gravel</td>
<td>Black wattle sand</td>
</tr>
</tbody>
</table>

Effect of nitrogen source on take-all. The plot on the left received sodium nitrate, centre plot ammonium sulphate (drilled) and the plot on the right ammonium sulphate (topdressed). All plots received the same rate of nitrogen.
Take-all prediction

Many factors affect the level of take-all. Any prediction of the level of take-all will vary according to local conditions. Despite this limitation, Figure 2 is an attempt to help determine the likely risk of take-all.

The chart in Figure 2 should be used with Figure 1 which shows the effects of location, and Tables 2 and 3 which refer to the effect of soil type and paddock history on take-all risk.

Note that this is a preliminary attempt to provide a method of predicting the take-all risk. Farmers should use it with caution, and should also consider their own experience and advice from local Department of Agriculture advisers.

Acknowledgements

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