Plant disease - cereal smut diseases and their control

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CEREAL SMUT DISEASES AND THEIR CONTROL


The well-known smut diseases of wheat, oats and barley are caused by fungal parasites which produce masses of soot-like fungal seeds or spores in the plants they attack, and it is from this dark coloured spore material that the name "smut" is derived.

Until about the early 1920's, the cereal smuts were responsible for heavy economic losses, but today the damage that they cause is relatively insignificant. There are two main reasons for this beneficial change; firstly, improved scientific knowledge has led to the development of more effective control measures; and secondly, the necessity for routine application of these measures yearly is now widely appreciated by farmers.

It must be emphasised however that the cereal smuts have not been eradicated, and where control measures are neglected these diseases may soon multiply and again become very damaging.

With one exception, the smut diseases which attack wheat, oats and barley are head smuts, i.e., they give rise to smut masses which appear more or less conspicuously in the heads or ears. Covered smut or bunt of wheat, loose smut of wheat, and the smuts of oats and barley are examples. In the case of flag smut of wheat however, the smut masses develop in the leaves and stems where they are less obvious.

The head smuts of cereals are of two types, known respectively as "covered" and "loose."

Covered smut is so named because the smut masses which replace the normal grain remain enclosed by a skin or membrane until the crop is harvested, when they are broken up into a spore dust which contaminates the healthy grain.

Loose smut, on the other hand, replaces both the grain and chaff with powdery spore masses which are only loosely held and thus are gradually blown away by wind, until at harvest time the rachis or stalk of the ear is more or less bare.

Each of the cereal smuts is caused by a distinct species of fungus which has its own characteristics and life-history; and the smuts which attack wheat, cannot attack oats, or barley.

LOOSE SMUT OF WHEAT

Loose or flying smut of wheat caused by the fungus Ustilago tritici is common in our wheat areas but is seldom present in serious amounts. Affected plants become conspicuous in the early heading stage when both the grain and chaff of diseased ears is replaced by the loose, dark, powdery spore material (see Fig. 1).
The loose smut fungus can only infect other wheat plants at the flowering stage. The spores in affected ears are readily dispersed by wind, and if they lodge on the open flowers of other wheat plants they germinate and penetrate the embryo grain. Cool humid weather when wheat crops are flowering favours infection, whereas hot dry conditions reduce the spread of the disease.

At harvest time, infected grain appears healthy and normal in size, but as it contains the threads of the loose smut fungus, it will give rise to smutted plants in the following crop if used for seed purposes.

**Control:**
As the fungus is carried **internally** in infected seed, dusting the seed **externally** with copper or mercury containing dusts is ineffective. A hot water disinfection treatment has been devised but this operation is a complicated one. If loose smut becomes prevalent, healthy seed should be obtained either from one of the Department’s Research Stations or from other clean crops in the district.

**COVERED SMUT OR BUNT OF WHEAT**
This disease is also known as ball smut or stinking smut and it is caused by the parasitic fungi *Tilletia caries* (*T. tritici*) and *Tilletia foetida* (*T. levis*).

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Fig. 1.—Loose smut of wheat. Note that the powdery spore masses are gradually dispersed until at harvest time the stalk of the ear is more or less bare.
The disease is characterised by the formation in the ears, of smut or bunt balls, instead of normal grain (Fig. 2). These have an objectionable odour like putrid fish.

When an affected crop is harvested many of the bunt balls are crushed, and the powdery spore dust which is thus released contaminates the healthy grain.

As one bunt ball may contain several million fungal spores, extensive contamination of the grain can occur even when the disease is apparently not very prevalent in the crop.

As is well known smutty wheat is unsuitable for milling and is subject to price dockage.

Unlike loose smut of wheat, infection of wheat with covered smut occurs at the seedling stage, from grain contaminated with spores during harvesting operations.

When contaminated seed is planted, both seed and spores germinate together and the young seedling is infected. Fortunately, under our conditions, little if any infection occurs from contaminated soil and therefore the disease is readily controlled by seed disinfection with suitable fungicides.

Control:
Dry-pickling with standard copper dusts, e.g., copper carbonate or copper oxychloride at dosages of 1½-2 oz. per bushel has been standard practice locally for
many years and has proved so effective that today bunt of wheat is comparatively rare, except where treatment has been neglected or improperly applied. Organic mercury dusts at the same dosage are just as effective but they have not been recommended by this Department in the past for the control of this disease because until recently they cost more than the copper compounds.

Recently a material known as hexachlorobenzene (H.C.B.) has been developed specifically for the control of bunt or ball smut of wheat.

Tests conducted here during the last two years have shown that H.C.B. dusts are just as effective for bunt control as the copper or organic mercury compounds.

However, the copper and mercury dusts will also kill flag smut spores that may be transmitted by the seed, but H.C.B. is unsatisfactory for this purpose.

For this and other reasons the general use of H.C.B. in preference to the well tried copper or organic mercury dusts, as the standard dry-pickle for wheat cannot be recommended.

Whatever dust is used for dry-pickling seed wheat, an adequate dosage as recommended by the manufacturer, and thoroughness of application are essential.

To ensure that this is achieved, contract grading and dry-pickling operations should always be supervised by the grower.

It is sometimes claimed that 2 oz. of copper or mercury dust will not adhere properly to a bushel of wheat as this dosage is excessive. However, if this difficulty is experienced, the fault lies either with the dry-pickling machinery or the manner in which it is operated.

**FLAG SMUT OF WHEAT**

This disease of wheat caused by the fungus *Urocystis tritici* is potentially a very serious one as older farmers know only too well. In the 1920’s, flag smut was spreading rapidly not only in W.A., but in other wheat-producing States of the Commonwealth and jeopardised Australian wheat...
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production. Losses in yield of 10 to 15 per cent. were common and in some cases almost total crop failure resulted.

Fortunately it was discovered in this State that the locally-bred variety Nabawa was resistant to flag smut and, largely because of this quality, Nabawa which was grown on a small acreage only in 1925, became by 1932 the most popular Australian wheat variety.

Symptoms and Life-history:

As the name of the disease indicates, the flag smut fungus causes smut masses to develop in the leaves and leaf sheaths, but the stems and even the lower spikelets in the ears may also be affected.

Long, narrow, leaden-coloured stripes appear in the leaves running parallel with the veins (Fig. 3). These stripes are often raised above the general leaf surface and as the plants mature, they may burst and expose a black sooty mass of fungus spores.

Flag smut affected plants are often badly stunted, twisted and malformed (Fig. 4).

During harvesting operations, diseased plants are broken up and some of the fine spore dust which is released falls to the ground and some adheres to the grain.

From the control aspect, the life history of flag smut is similar, in all but one important respect, to covered smut or bunt of wheat. Both diseases may be caused by the planting of contaminated seed harvested from affected crops, but, in addition, flag smut spores which fall to the ground may remain alive for several years and contaminate the soil.

Thus, while seed treatment with an effective fungicide is very useful in guarding against the spread of the disease to new areas, it may not prevent infection from spores present in contaminated soil.

Control:

During the last 20 or 25 years the incidence of flag smut has decreased very considerably. Although the disease is still observed in the field each year, it is generally seen now in trace amounts only. Factors largely responsible for this decrease include, first and foremost, the wide use of flag smut resistant varieties, and secondly, the general practice of dry-pickling of seed wheat with copper dusts, which are effective against flag smut
spores carried on the seed. Unfortunately however, approximately 20 per cent. of our wheat acreage is still planted to susceptible varieties (chiefly Gabo and Gluclub) and in some instances seed treatment has been either neglected or inadequately carried out. As a result crops are still sometimes noticed in which flag smut is taking serious toll.

In some countries, the flag smut fungus has evolved new races each of which can attack different varieties. As far as is known, the fungus has remained stable in Australia and thus old resistant varieties such as Nabawa still maintain resistance to the disease. However, we should not become too complacent on this account, for it is uncertain whether this position will continue or whether it will change due to the production here of new and more virulent races.

It seems logical to believe that the latter will be less likely to occur if the fungus is kept under subjection, than if it is allowed to multiply, and for this reason measures for the control of flag smut should be constantly applied.

The main measures for the control of the flag smut disease include:—

1. Plant resistant varieties. For many years now resistance to flag smut has been one of the qualities required in wheats bred by the W.A. Department of Agriculture. The disease reaction of the more important varieties as shown by experiments conducted by officers of the Wheat Branch is as follows:—

   **Highly Resistant:**
   - Nabawa, Eureka II, Festival, Koorda, Warigo.

   **Resistant:**
   - Bencubbin, Bencubbin 48, Bungulla, Dowerin, Javelin 48, Kondut, Panther, Wongoondy.

   **Susceptible:**
   - Gabo, Gluclub, Insignia, Ranee, Regalia, Bluclub, Noongaar, Merredin, Gluyas Early.
2. Dry-pickle seed wheat and especially flag smut susceptible varieties with a fungicidal dust which will kill both flag smut and bunt spores that may be carried on the seed. Copper and mercury dusts meet this specification but Hexachlorbenzene (H.C.B.) does not (see Table 1).

3. As flag smut only attacks wheat a rotation with other crops for at least four years will help to reduce flag smut inoculum in the soil.

Also if both flag smut resistant and susceptible varieties are being grown, plant the susceptible varieties on land formerly cropped to resistant kinds.

OAT SMUTS

Two head smuts of oats occur in Western Australia namely loose smut caused by the fungus *Ustilago avenae* and covered smut caused by *Ustilago kollerl* (Fig. 5).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Percentage Flag Smutted Plants Wongan Hills</th>
<th>Merredin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Clean seed untreated</td>
<td>0.17</td>
<td>0.2</td>
</tr>
<tr>
<td>2. Seed smutted 1:150</td>
<td>23.58</td>
<td>23.46</td>
</tr>
<tr>
<td>3. Seed smutted and dusted with copper carbonate 2 oz. per bush</td>
<td>0.88</td>
<td>0.2</td>
</tr>
<tr>
<td>4. Seed smutted and dusted with organic mercury compound, 2 oz. per bush</td>
<td>0.53</td>
<td>0.36</td>
</tr>
<tr>
<td>5. Seed smutted and dusted with 20 per cent. H.C.B. compound 2 oz. per bush</td>
<td>24.18</td>
<td>18.85</td>
</tr>
</tbody>
</table>

Difference for significance at 99:1 level | 7.65 | 3.05 |
Fortunately, both cause infection at the seedling stage due to the planting of smut-contaminated grain, and are therefore controlled by the same method of seed treatment.

Formerly these diseases were held in check by disinfecting the seed with formalin solution, but although this method was very effective, it was laborious and prone to damage the grain.

Good control of oat smuts may be obtained by thoroughly dusting the seed with organic mercury dusts at the rate of 2-3 oz. per bushel and this is now the standard method of treatment in W.A.

It should be noted that copper carbonate is not recommended for controlling the oat smuts.

**BARLEY SMUTS**

Covered smut of barley caused by the fungus *Ustilago hordei* is the most prevalent smut disease of this cereal in Western Australia. The smut masses which replace the grain and glumes in affected ears remain enclosed within a membrane, until harvesting takes place, when they are broken up and the spore dust thus released contaminates the healthy grain (Fig. 6).

Covered smut of barley may be controlled by thoroughly dusting the seed with organic mercury compounds in a similar manner to the oat smuts. A formalin method of disinfection is also available but this is seldom used.

**Loose smut** of barley caused by the fungus *Ustilago nuda* occurs here in trace amounts, but there are some indications that it is increasing.

The powdery spore masses which appear in affected ears are gradually blown away by wind, until at harvest time the stalk of the ear is more or less bare (Fig. 6). Infection occurs at the flowering stage in a manner resembling loose smut of wheat, and for this reason dusting the seed with fungicides is not satisfactory.

Farmers who see much smut in barley crops grown from seed thoroughly pickled with organic mercury dusts, are asked to submit specimens for identification, for if loose smut becomes prevalent healthy seed must be obtained from research stations or clean crops in the district.