

# CEREALS - Frost Identification: THE BACK POCKET GUIDE

Bulletin 4375

Replaces Bulletin 4373

ISSN 1326-415X

June 2000

Reprinted October 2003



# Frost

**Frost damage reduces crop yield and grain quality. Early identification of symptoms allows timely crop salvage decisions to be made.**

Inspect cereal crops between ear emergence and late grain filling if night air temperature (recorded 1.2m above ground) falls below 2°C and there was a frost. Check low lying, light coloured soil types and known frost prone areas first. Then check other areas.

Symptoms may not be obvious until 5 to 7 days after the frost.

## To identify frost damage:

- you MUST OPEN FLORETS and peel back leaves on plants so that you can clearly see the plant parts that are affected,
- a magnifying glass and fine tweezers or a needle can be useful.

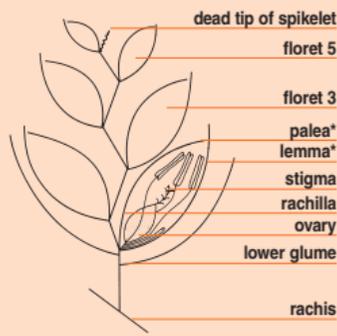
## How to use this guide

This field guide will help you identify the common symptoms of frost damage in cereal crops. It also contains pictures of other plant symptoms often confused with frost damage.

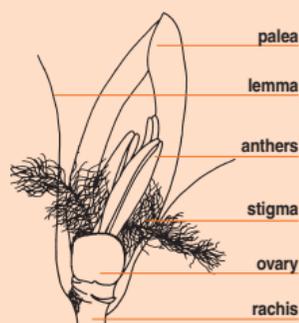
## Plant parts referred to in this guide



Head



Spikelet of wheat  
\* floret 1



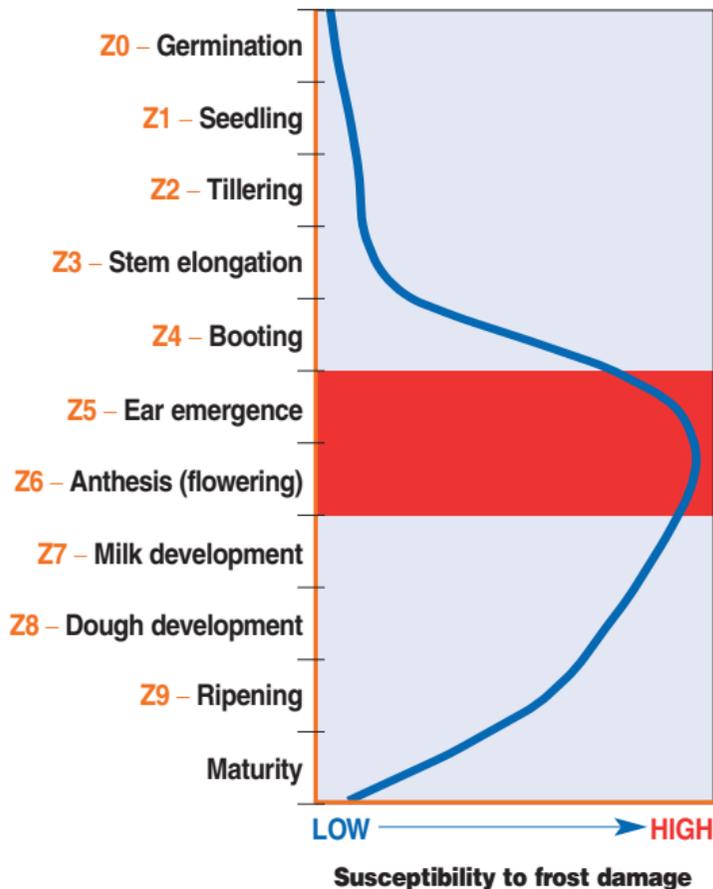
Floret of wheat

## Common terms used in this guide:

Denoted throughout in *colour*

<i>Awn</i>	Whisker
<i>Anther</i>	Reproductive organ that produces pollen
<i>Ear/head</i>	A collection of florets (spikelet)
<i>Floret</i>	Flower of a cereal plant
<i>Lemma</i>	Outer shells (husk) that contain the reproductive organs
<i>Ovary</i>	Reproductive organ that develops into the grain
<i>Peduncle</i>	Stem attached directly to the wheat head
<i>Stigma</i>	Small feathery organ below the anthers that receives and transmits pollen to the ovary

# CEREAL SUSCEPTIBILITY TO FROST DAMAGE



Note: Diagram not to scale

## Factors affecting frost damage

Frost damage in crops tends to be patchy, with great variability occurring within paddocks and on the same plant. This is caused by many factors including: temperature, soil type, soil moisture, cloud cover, wind speed, position in landscape, crop species, crop nutrition and crop density.

## Period of risk

Cereals are susceptible to frost damage after the growing tip has grown away from the protection of the soil, when the stem begins to elongate, through until late grain filling. Wheat is most susceptible to frost damage at flowering (see diagram left).

Frost damage management to date has focused on avoiding susceptible crop stages coinciding with the period of greatest frost risk in the area.

## Which parts are susceptible?

Leaves, stems, *florets* and grain can all be affected by frost. In some circumstances a plant may show stem and head symptoms.

## Will the plant recover or compensate?

Sometimes a “process of elimination” is required to decide whether crop damage has occurred. For example, if the *anthers* are healthy, then check for stem damage. If the stem is damaged, then it is unlikely that grain will form properly. If the stem is only moderately damaged – monitor grain growth and development by tagging some plants and checking them a few days later.

# BLEACHED, SHRIVELLED AND DWARFED FLORETS



Emerging wheat head partially sterilised.

## Why does it occur?

When the head is emerging from the boot, cold air or water is caught next to the flag leaf, or travels down the **awns** into the boot, freezing the sensitive tissues.

## Symptoms

**Florets** are bleached, shrivelled or dwarfed, making them sterile, and grain will not form. The surviving **florets** will form normally, provided they are not affected by later frosts.



Healthy

Whole wheat heads killed by frost.

# STEM FROST



Stem frost in wheat (unaffected on left).

## Why does it occur?

Stem frost occurs when a small amount of water settles inside the boot after a light shower of rain has fallen on dusk, followed by a frost which freezes the water around the *peduncle*.

## Diagnosis and symptoms

Pull the head and the *peduncle* (stem attached to the head) from the plant and check for the following:

- pale green to white ring on the *peduncle*,
- crimped, cracked and/or blistered *peduncle* base,
- a rough texture between your fingers,
- the area of *peduncle* damaged will turn brown/black due to microbes.

The ease at which the head and stem pulls away from the plant is not an indication of frost damage.

In many cases, stem frost will reduce or cut off water and nutrient supply to the *ear*.

## External damage

Leaf sheaths surrounding the stem and nodes are often blistered and/or cracked by frost. Water and nutrient supply is not usually cut off by this external damage, however subsequent growth of affected tillers may be distorted (e.g. stem bends over).



Crimping & cracking of base of the *peduncle*.

# FLOWER FROST



Frost affected 'banana shaped' anthers.



Healthy anthers and pollinated ovary.

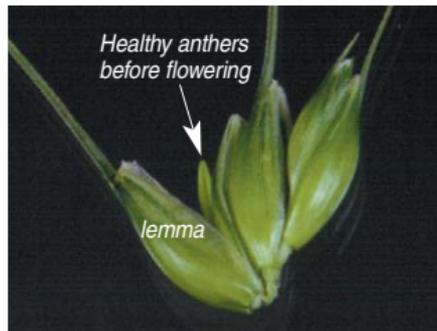
## Period of risk

Pollen cells and reproductive organs do not tolerate low temperatures. These are exposed when the crop is near or at flowering.

Wheat begins flowering in the centre of the head and extends to the top and bottom over a 5 day period.

## Diagnosis and symptoms

Frost at flowering sterilizes reproductive organs – grain will not form.



Healthy Anthers.

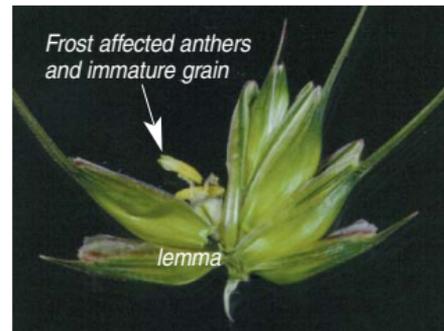
Peel back the *lemma* (husk) carefully and check the condition of the reproductive organs:

## Healthy Anthers

- *before flowering*: Green to yellow in colour,
- *after flowering* (blooming): Yellow, gradually turning white with age.

## Frost affected Anthers

- white turning dull in colour (brownish) due to microbial invasion,
- often 'banana' shaped.



Frost affected Anthers.

# ANTHERS, STIGMA AND OVARY

**Frost affected**



Ovary is "spongy" when squeezed, and turns dark in colour (due to microbes). Anthers are white and dull coloured.

**Healthy**



Ovary is bright white and "crisp" when squeezed. As grain develops it turns green in colour. Anthers are green to yellow in colour.

# DEVELOPING GRAIN



Healthy developing wheat grain.

## Diagnosis

To assess whether grain will form or not:

- peel open *florets* carefully and note the stage of grain fill,
- loosely tag the *peduncle* and check the head again every 2 days,
- note whether the grain size has increased or not, and check the condition of the grain.

## Healthy grain (developing)

- light to dark green colour,
- green and plump appearance,
- exudes liquid (white milk/dough) when squeezed.

## Affected grain

- white, eventually turning brown (due to microbes),
- dimpled and crimped appearance,
- usually “spongy” when squeezed,
- does not exude milk/dough (sometimes a small amount of straw coloured liquid exudes).

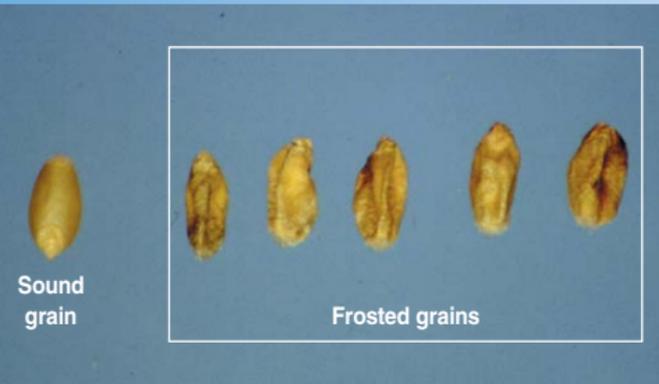


Healthy endosperm (dough).



Frosted endosperm (dough).

## MATURE GRAIN



Many environmental factors, including water deficit during a dry finish, and nutrient deficiency, will cause small grain and screenings in a grain sample.

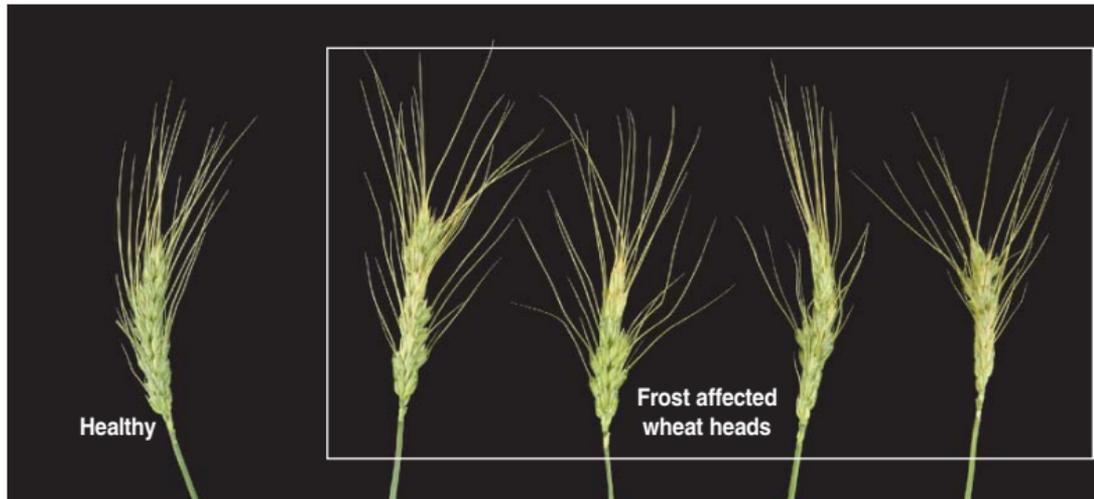
### Diagnosis

- frosted grain is creased along the long axis, rather like a pair of long nose pliers has crimped the grain,

- creases are regular, not random as is usually the case, with moisture stressed and nutrient deficient grain,
- in some cases the grain will have a blue/grey appearance,
- frosted grain can have a detrimental effect on sample acceptance.



Frosted grain sample.



Frosted wheat heads (unaffected on left).

# FROST SYMPTOMS IN BARLEY AND OATS



Frosted barley heads (unaffected on left).

Barley and oat crops can tolerate lower temperatures than wheat. This is due to the structure of plant parts and the way that the plant develops.

## Barley

- flowering occurs close to the boot, offering protection to *anthers* against frost exposure,
- sterility of *florets* leads to absence of grains,
- stem frost is very rare.

## Oats

- the *florets* hang downwards allowing warm air to be trapped inside, protecting them from frost,
- sterility of *florets* sometimes occurs as the pannicle is emerging.



Frosted oat panicle.

## OTHER PROBLEMS WITH SIMILAR SYMPTOMS



**Moisture stress** (drought tipping) – tips of ears are shrivelled and bleached. All heads will be affected.



**Diseases** (Crown rot and take-all) cause white heads. Whole plants are affected, containing grain that has formed but not filled properly. Affected plants will follow seeder rows. Inset: *Fusarium* on wheat crown.



**Nutrient deficiencies** such as copper create 'rat-tail' and droopy head symptoms, and all plants will be affected in patches.



**Herbicide damage** (Phenoxy damage) causes distortion of heads and onion leaf type rolling of the flag leaf.



## FURTHER INFORMATION

### Further information is available from:

Department of Agriculture Western Australia  
Dryland Research Institute  
Merredin  
Western Australia 6415

Website: <http://www.agric.wa.gov.au>  
(Search for “Frost”)

### Written by:

Craig White  
Agriculture Western Australia

### Photography:

Craig White & Peter Maloney

### Disclaimer:

This material has been written for Western Australian conditions. Any recommendations contained in this publication do not necessarily represent Department of Agriculture Western Australia or GRDC policy. Its availability does not imply suitability to other areas, and any interpretation or use is the responsibility of the user. No person should act on the basis of the contents of this publication, whether as to matters of fact, opinion or other content, without first obtaining specific, independent professional advice which confirms the information contained within this publication. Mention of product or trade names does not imply recommendation, and any omissions are unintentional. Recommendations were current at the time of preparation of the original publication.

© Copyright Chief Executive Officer, Department of Agriculture Western Australia and the Grains Research and Development Corporation, 2000. No unauthorised duplication allowed without the copyright owner's permission.

