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Herbicides should be applied at the correct crop growth stage for best results.

Using the Zadoks growth scale

By M. W. Perry, Senior Research Officer and D. G. Bowran, Research Officer, Division of Plant Research and G. Brown, Adviser, Moora District Office

The Zadoks growth scale, which is already used overseas as an aid to better crop management, is gradually being adopted in crop production in Western Australia.

By using the scale grain growers are able to identify the various stages of crop development, particularly those growth stages that are closely related to practices such as crop spraying where treatment too early or too late may be ineffective or damaging.

Crop growth stages

The growth stages of cereal crops include germination, emergence, leaf production, tillering, ear initiation, stem elongation, flowering and grain filling.

There are two important reasons why the ability to assess and accurately record a cereal crop’s growth stage can contribute to improving crop management and grain yields.

• Timing of management practices.

A crop’s reaction to management decisions often depends on its growth stage. The most economically important example of this is the application of ‘hormone-like’ herbicides such as 2, 4-D and MCPA, where the effects of the herbicide on the crop depend on its growth stage at the time of application. (See ‘Tolerance of cereal crops to herbicides’ on page 14.)

• Communication.

Other examples are the application of the growth regulator chlormequat to shorten the stems of tall-growing varieties, and in the use of fungicides for disease control.

Zadoks decimal growth scale

Several cereal crop growth scales have been used in Western Australia. However, the Zadoks decimal growth scale is now recognised internationally for research, advisory work and farming practice.
In Europe, the Zadoks decimal codes are used in farming publications and in the labelling of agricultural chemicals. Its use in Australia is being examined by the Australian Weeds Committee.

The Zadoks scale is based on 10 principal growth stages labelled from zero to nine. These units sub-divide the cereal plant’s life cycle into 10 major or primary stages:

- 0 Germination
- 1 Seedling growth
- 2 Tillering
- 3 Stem elongation
- 4 Booting
- 5 Ear emergence
- 6 Flowering
- 7 Milk development
- 8 Dough development
- 9 Ripening

Each primary growth stage is sub-divided into 10 secondary growth stages, extending the scale from 00 to 99. See Farmnote No. 78/84 ‘The Decimal (Zadoks) growth scale for cereals’.

The Zadoks scale has several advantages over its earlier competitors.

- The early growth stages of seedling growth (1), tillering (2) and stem elongation (3)—which are the most important commercially—are described exactly and in a logical manner by counting the number of organs on the plant. For example, a ‘one-leaf plant is scored 1-1 or Z11 and a ‘three-leaf plant as Z13. Similarly a plant with one tiller is scored Z21 and with four tillers, Z24.

- Growth scores for the plant are concurrent, that is, the scores acknowledge that more than one growth process is occurring on the plant at the same time, for example, leaves emerging and tillers appearing. The Zadoks growth score for such a plant may be Z14/22—an accurate shorthand description of a plant with four fully emerged leaves and two tillers.

Using the Zadoks scale

Like all growth scales, the Zadoks scale includes certain conventions with which the user must be familiar, and requires some practice before people become proficient with the scale.

By following this guide, we hope that users will become conversant with the main features of the Zadoks scale and be able to use it confidently.

Step 1

Choose plants that are representative of the crop. The Zadoks scale is based on observation of individual plants, not the general appearance of the crop. Soil type changes within a paddock or different sowing dates may affect crop growth stage.

Step 2

Identify the main stem or culm of the plant. Plants should be uprooted and the main stem, which is the oldest and largest stem, identified. An easy way of finding the main stem is to hold the plant with the leaves hanging downward and grasp the longest leaf. This will be the last fully emerged leaf on the main stem.

Step 3

Use a ‘Z’ to indicate scoring with the Zadoks scale.

Step 4

Count the number of leaves formed on the main stem (see diagram). Leaves are counted from the base upward, with the first leaf counted as ‘1’. This is easy whilst the plant has up to three leaves. Once tillering starts greater care must be taken to identify only those leaves which originate from the main stem.

An important decision is when to count the topmost, youngest leaf as a full leaf. In the Zadoks scale a leaf is counted as ‘emerged’ when either its ligule (the membranous outgrowth at the junction of the leaf blade and leaf sheath) has emerged from the sheath of the preceding leaf, or when the tip of the next leaf is visible.

These definitions can be confusing and we have adopted the alternative system of sub-dividing the scale by always scoring the youngest leaf in tenths by judging its size against that of the preceeding leaf. A score of Z12.5 therefore corresponds to two-and-a-half leaves and Z13.9 is very close to the stage of four fully emerged leaves.

Step 5

Tillers originate from small buds where each leaf joins the stem. They grow and emerge from between the leaf sheath and the stem. In wheat the first tiller usually appears at Z13-14, that is at the stage where three to four leaves are fully emerged.

Tillers are scored by:

- Counting tillers as soon as they emerge from the leaf sheath.
- Counting only tillers, not the main stem.

The Zadoks score is thus built up by adding the code that identifies tillering (a ‘2’) plus a second digit to give the number of tillers. A plant with three fully emerged leaves—Z13—grows to become a plant with say four fully emerged leaves and one tiller, and is scored Z14/21.

Step 6

Stem elongation or ‘jointing’ is the process by which the ear is pushed to the top of the crop canopy. The ear was originally formed
between the four and six-leaf stages (scores Z14 and Z16) and positioned in the crown one to two centimetres below the ground surface.

As the stem grows, the nodes or joints separate and swell and are more easily seen at the base of the stem. A detectable node is defined arbitrarily as one where the internode below it is more than two centimetres long.

The Zadoks score for stem elongation has a basic code of '3' and the number of detectable nodes is added as the second digit. The score Z31 indicates a plant with one detectable node on the main stem, and Z33 three detectable nodes.

As with leaf production and tillering, a more detailed score may be built up. A plant may have six fully emerged leaves, three tillers and one detectable node and would be scored Z16/23/31. Often, however, the first two to three leaves will have decayed and disappeared by this stage and the plant can be scored Z23/31.

The three Zadoks stages of seedling growth, tillering and stem elongation are those most relevant to the practical application of the scale in the field. They are usually the growth stages where problems appear and where herbicides and other management practices are being applied.

The remaining parts of the scale cover booting, ear emergence, flowering, milk development, dough development and ripening. Unlike the three early stages where counting of the particular organs gives an unequivocal growth score, the later stages are subject to wider individual interpretation. At these stages, the scale is still acceptable for general use provided the user recognises that extreme precision is not intended or possible.

Why have a scale?

Some people may regard the introduction of the Zadoks growth scale as an unnecessary and unwelcome complication to the already complex business of crop management. Yet it is the increase in knowledge of crop production, and the realisation that the effects of management may critically depend on crop growth stage, that has led to the introduction of the Zadoks scale.

The Zadoks scale can be used to time the effective application of herbicide sprays. Its use is expected to become more important as further research explores the use of fungicides and growth regulators on cereal crops.

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