OCCC
TRIAL METHODS
AND PROCEDURES

February 2013
Version 1.0

Also refer to 'Guide to the Operation of the Ontario Cereal Crops Committee and Genotype Testing Procedures',
available on www.gocereals.ca

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1.0 GENERAL INFORMATION

1.1 Purpose This document sets out the approved procedures to be used for growing trials/tests and conducting character assessments as defined by the OCCC.

These procedures apply to all varieties/cultivars of spring and winter cereals in performance and registration trials grown under the auspices of the OCCC.

2.0 AGRONOMY AND DISEASE TRIAL PROCEDURES

2.1 Site Suitability

The Trial/Disease site Operator will be responsible for providing a suitable location, which meets the following criteria:

- Previous cropping must be appropriate for the cereal crop to be grown.
- Soil type should be typical of those on which cereals are grown locally. Soil fertility and texture should be uniform across the site. The soil should be sufficiently uniform to avoid variation in the growth of the trial.
- The trial should be sited away from trees, hedges, headlands and other features, which are likely to cause uneven growth or encourage grazing damage from wildlife.
- The trial area should be cultivated in the direction of ploughing and drilled across the direction of ploughing and cultivation such that each plot receives similar wheel compaction. Cultivations should follow best local practice.

2.2 Sowing the Trial

Trial design/layout: The Performance Trial and Disease Site Operators will be supplied their final sowing list by the Performance Data Coordinator and also the trial design. For Registration trials, design should be RCBD, Lattice, Alpha Lattice or other recognized experimental design. All trials grown for Performance or Registration purposes must be a minimum of 4 replicates

Plot Size: For growing trials, the harvested plot area per variety must be no less than $3m^2$ per replicate for trials with four replications. The plot width for calculating the harvested area is measured from outer row to outer row, plus half the inter-plot gap on either side. The allowance for the inter-plot gap must be no greater than 0.46 m.

Plant population: The following tables give the required number of viable seeds per square metre to achieve the desired target populations for each crop, after any losses due to poor germination or establishment. Trial operators are responsible for achieving the correct target populations.

Crop	Viable Seeds /m^2
Winter & Spring Wheat and Winter Barley	400
Spring Barley	400
Oats	300

The following formula will be used to calculate the seed rate for a given thousand seed weight:

Seed rate (g/plot) = (Viable seeds/m^2 X Plot Area m^2 X TKW/1000)/actual % germ

Planting: Plot seeders are to be set up, calibrated and used only when conditions are fit for planting. Care must be taken with drill settings and drilling speed to ensure satisfactory and uniform establishment and plant population from plot to plot. It is also important to ensure that there is no carry over of seed between plots. Precautions must be taken to avoid any missing rows. Any missing rows and/or parts of rows must be noted.

2.3 HUSBANDRY

The crop production methods for the test should generally follow those for the crop as recommended in 'OMAFRA Pub 296, Field Crop Recommendations'.

Agronomy: Where not specified in these procedures agronomy should follow practices as outlined within the Agronomy Guide for Field Crops (Publication 811).

Fertilizer application: Application of fertilizers and sprays should be uniform. It is normally best to apply these across the direction of the plots. It should take into account inherent fertility, previous crop, winter rainfall, the best local practice and advisory guideline Publication 811. In winter cereals, supplemental spring nitrogen should be applied at the rate for soft wheat and as early as conditions allow safe application and least chance of damage to the developing crop/plots.

Herbicides: Chemicals should be used as potential yield reduction may occur if not applied. Application should be across the direction of the plots. Rate and timing should be as directed by the manufacturers.

Pest Control: Chemicals may be applied in the event of a severe pest infestation [such as army worm] that threatens the viability of the trial.

2.4 HARVESTING

Timing of harvesting: Date of harvesting will be determined by the respective Trial and Disease Site Operator and will be based on crop maturity and local weather conditions.

The plot dimensions should be measured prior to harvesting. If it is necessary to reduce the size of any plot to below that of current OCCC protocol at harvest, clear details should be record.

Harvesting method: Plots should be harvested by direct combining and combine settings must be optimal for the crop and harvest conditions. For oats in particular, settings should ensure excessive de-hulling does not take place. This must be done by taking samples from the discard plots of varieties that are susceptible to de-hulling and counting the number of de-hulled grains, aiming at no more than 5 de-hulled grains per 100.

Samples: Samples should be retained until January 1 following the crop season to allow for further analysis if required/desired.

It is essential that all samples:

- Are representative of the variety/plot from which they are taken with minimal contamination. When sampling on-combine, it is essential to minimise the risk of contamination of grain from the previous plot.
- Are taken from the same source.
- Contain the weight of grain required to perform any additional testing.

All bagged samples must be kept in good condition at a moisture content and temperature appropriate for long term storage. They should be clearly marked with variety name/breeders reference, Test/Entry ID#, replicate number and Trial/Disease Site location.

2.5 RECORDS

Site Information report: Site details including site location, detailed plot map, outline of agrochemical applications (fertilizer, herbicide; etc.) prior/post seeding should be recorded. If the trial is in good condition, with no problems, this should also be recorded.

Site Character report: All characteristics observationed and their respective means shall be included within the final characteristic report. All yield rep data should be made available for review if requested.

3.0 TRIAL CHARACTERISTICS FOR ASSESSMENT

Procedures for recording Characteristics: The test procedures as outlined in Table 1 below must be followed for measuring characteristics used in assessment. For Performance Trials, characteristics are listed as either mandatory (required, if present) or additional (present at a high enough level to be recorded and/or requested of the site operator by the Trial Coordinator). Additional characteristics may be "added" to the site characteristic report within the "additional characteristics section". Site Operators are to enter the appropriate characteristic under the appropriate column within the input template.

* Mandatory for all winter cereals if discernable differences are present
** Mandatory for all cereals
*** Mandatory for all cereals if discernable differences are present and/or requested by OCCC Inspection team
Italics = Additional only if requested by the test co-ordinator

The following must also be measured or recorded for all trials:

- Sowing Date
- Harvest Date
- Plot Size
- Plant Population (where there are plots in trial with poor establishment)
- Bird Damage (where present at levels that will affect results)
- Stalk Breakage (where present at a level which will affect results)
- Winter survival notes for winter types only

Table 1.

Assessment	**Characteristic**	**Wheat** (spring & winter)	**Barley** (spring & winter)	**Oats**
Yield	Grain Yield **	✔	✔	✔
Quality	Hectolitre weight**	✔	✔	✔
	Thousand Grain Weight**	✔	✔	✔
	Protein Content	✔		
	Hagberg Falling Number	✔		
	Sprouting	✔		
Resistance to Disease***	Refer to Section ?: Disease Test Procedures for Crop Specific assessments	✔	✔	✔
Reaction to Environment	Winter hardiness/survival*	✔	✔	
	Plant Height**	✔	✔	✔
	Lodging***	✔	✔	✔
	Days to Heading***	✔	✔	✔
	Days to Maturity***	✔	✔	✔

4.0 YIELD TEST PROCEDURES

For the Performance trials, yield shall be listed in T/ha (tonnes/hectare) at two decimal points, at 13.5% moisture when reported to the Data Coordinator. Yields on the individual plot data sheet may be listed in kg/ha (kilograms/hectare) based upon 13.5% moisture.

In some cases, as a result of the inspection and/or the trial site operator's opinion, yield may be supplied but not incorporated into the final report. Yield CV's greater than 16% will come under review, and, after evaluation, may be re-analyzed and missing plots used to offset peculiarities within the data set.

Moisture at harvest may vary according to environmental conditions. All material should be adjusted to 13.5%. Actual wt (13.5%) = [13.5%/%harvest moisture] x weight of harvested material.

Measurements of plots should be taken to ensure that plot yields are relative to all other plots in the trial. If plot yield is based on 3m plots, for a plot 3.5 m yield would be 12% higher than the normal plot. 3m plot yield= ([wt at 3.5m]*3m plot)/3.5 m plot.

5.0 QUALITY TEST PROCEDURES

5.1 Hectoliter/Test Weight (kg/hl)

Determining test weight: Source: Official Grain Grading Guide 1-1 August 1, 2006

Test weight is the weight of a measured volume of grain expressed in kilograms per hectolitre.

Equipment needed to determine test weight:

- **Ohaus 0.5 litre measure** A cylindrical shaped cup with an inside diameter of approximately 90 mm and a height of approximately 77.5 mm. The measure is calibrated to contain 500 ml of water, ± 1 mL, at 20°C.
- **Cox funnel** A funnel with a 3.81 cm opening and a drop of 4.41 cm, from the opening in the funnel to the top of the measure used to uniformly direct the flow of grain into the 0.5 litre cup..
- **Striker** A piece of round hardwood, 2.2 cm in diameter and approximately 23 cm in length.
- **Scale** Any CGC approved electronic metric scale.
- **Computer interface** For CGC inspection purposes, the electronic scale is connected to a computer which converts the grams in the 0.5 L Ohaus measure to grams per hectolitre. If the computer interface is not available, the test weight conversion can be done by utilizing charts provided by the CGC Statistical unit.
- **Test weight conversion charts** Used to convert the weight in grams from the Ohaus 0.5 L measure to kg/hL.

Procedure: Fill the Ohaus measure to overflowing with the grain to be tested. Ensure the slide is inserted into the Cox funnel. Pour the contents of the 0.5 litre measure, plus an extra handful, into the Cox funnel. Place the 0.5 litre measure on a solid base. Position the Cox funnel on top of the 0.5 litre measure so that the notched legs of theCox funnel fit securely onto the measure's rim. Remove the slide on the Cox funnel quickly so that the grain drops evenly into the 0.5 litre measure. Carefully remove the Cox funnel from the top of the 0.5 litre measure so as not to disturb the grain. ▲ **Important:** Any jarring of the cup at this point will result in compaction of the grain in the 0.5 litre measure and could produce inaccurate results. Place the hardwood striker on the rim of the 0.5 litre measure and, using three zigzag, equal motions, scalp off the excess the grain in the measure. Pour the grain remaining in the 0.5 litre measure into the scale pan. Determine the weight in grams of the grain in the scale pan. Convert the grams in the 0.5 litre measure to kg/hl.

5.2 TKW Thousand kernel weight (gm)

The weight of a representative 1000 grains at 85% dry matter from a cleaned grain sample is recorded.

Procedure: Select a representative sample of clean grain—250g minimum. Count a pre-determined number of whole kernels (100-200). Weigh the counted kernels (g). Multiply the weight x 5 (200) or 10 (100) to represent weight of 1000 kernels. A minimum of 2-replicates per test is recommended.

5.3 Protein Content Determination (%)

An approved NIR methodology can be used, provided that the instrument uses reference samples from ECORC and/or the Canadian Grain Commission for the appropriate crops.

5.4 Hagberg Falling Number (sec)

A methodology recognised by the National Authorities must be used.

5.5 Sprouting (%)

This must be recorded where present at a level which will affect results. Sprouting in the ear of the mature plant is an important field character and has a detrimental effect on grain quality.

Determining Sprouting: Source: Official Grain Grading Guide 1-1 August 1, 2006
Kernels are classified as spouted if one of the following conditions exists:

- Kernels show clear evidence of growth in the germ area. The bran is noticeably split over the germ from apparent growth. The germ is missing and there is apparent greyish discolouration normally attributable to sprouting. The germ, though intact, appears distinctly swollen as a result of sprouting activity.

Sprouting Procedure (% SPTD): Obtain a representative clean sample from the plot for analysis—250g minimum. Using a Boerner-type divider, divide a representative portion from the 250g plot sample (Minimum—10 g Optimum—100 g). Separate all kernels showing any evidence of sprouting. ▲ **Important:** For CEWW, unless there is clear evidence of growth, do not count the kernel as sprouted. You may use a 10-power magnifying lens to confirm sprouting activity. For Performance purposes, take the weight of spouted kernel as a % of the total sample used. A minimum of two replicates may be required to get an true indication of sprouting within that trial and entries.

Formula: wt sprouted(g)/wt sample (g) x 100= % sprouted (SPTD)

5.6 Kernel//Groat Content Of (hulled) Oats (% GRT)

Each grain sample tested should be in good condition, having been stored at 15% moisture content and cleaned according to approved CGC methods (Source: Official Grain Grading Guide 1-1 August 1, 2006).

Simplified hand method: The bulk sample (minimum 250g) of each entry must be thoroughly mixed and divided by quartering until two 10 gram samples are obtained. Any material other than grain and husk should be removed and discarded. Any free grains found in each sample should be extracted, weighed and discarded. If the free grain content of the sample is more than 1% of the total, by weight, a note should be taken. 5g of good oats should be retained from each sample for manual de-hulling. The remainder of the sample should be set aside. Each sub-sample should be de-hulled by applying pressure to the base of each grain with the thumb/finger or tweezers. The good kernels and husks should be placed in separate containers and then weighed. The mean kernel and husk weights should then be calculated. If the weight of kernel and husk obtained from the two sub-samples differs by more than 1%, then a further sub-sample should be drawn from the original bulk and dehulled. If this is necessary, the final percentage of kernel should be the mean of the three results.

The mean percentage of kernel in the samples should be calculated thus:
((Mean weight of kernel (g) / Total mean weight of kernel and husk (g)) x 100)

The data should be recorded as % GRT (% Groat Content)

Mechanical method: Two sub samples per entry are de-hulled. The 'fresh' (air-dry) sample is thoroughly mixed and divided by halving until two 25 gram samples are obtained (one for de-hulling and a spare if needed for checking). Any material other than grain and husk is removed and discarded. The sample is de-hulled for 2 minutes in the Streckel & Schrader impact de-huller Model Bt 459e at 6 bar and aperture 50% open (for further details see White, McGarel and Ardies (2000) Plant Varieties and Seeds 13, 45-59). After de-hulling separate the de-hulled sample and remove any hulls and un-hulled grain. Check the remaining kernel fraction for broken kernels and include in the kernel fraction. Weigh the kernel fraction. Kernel yield is the weight of the kernel fraction expressed as a percentage of the initial 25 g sample minus weight of un-hulled grain.

The data should be recorded as % GRT (% Groat Yield)

5.7 Moisture Content Determination For Yield

Yield data must be corrected to 13.5% moisture content. In order to do this, the moisture content of the harvested plot grain is required. One of three methods of determining dry matter must be used – electronic moisture analysers, NIR determination or the oven method.

1. Electronic Moisture Assessment (Moisture Analysers)

Principles: Moisture analysers, either separate instruments or probes on combines, may be used for determining the dry matter of harvested grain. There are no restrictions on the make or model of moisture analyser that may be used, provided the conditions described below are met. The manufacturer's recommendations for use must be followed. On-combine analysis must only be carried out on equipment specifically manufactured for this purpose. 'Desk-top' analysers should not be used on the combine because it has been shown that heat and vibration can cause inaccuracy.

The analysing equipment must:

- be calibrated at least once annually for each crop according to the manufacturer's instructions using check samples (see reference below) and have a moisture content accuracy of plus/minus 0.5%. The calibration data should be retained for a minimum of 1 year.
- be serviced regularly, especially just prior to harvest, according to manufacturer recommendations. The action taken should be documented and the information held for a minimum of 1 year.
- be fit for use in accordance with manufacturer instructions. It should have an adequate power supply throughout operation. Instructions should be held with the machine and all operators adequately trained in its operation.

In the field:

- the determination of dry matter must be the same for all plots in a trial replicate. For this reason, there should be minimal risk of rainfall during the harvest of a replicate. If there is a significant risk then backup samples should be taken from all plots to allow comparison through the oven method.
- the grain samples to be analysed must be between 83 and 88% dry matter (12 to 17% moisture content). If it is possible that samples in a replicate may fall outside this range, samples must be taken from all plots so that the oven method may be used should it be necessary. Polythene bags and plot identity labels must be carried at all times to allow this to be carried out.
- The grain to be analysed must be fully ripe with no green ears/grains in any sample. In these cases the samples for the oven method should be used.

2. Oven Method

Samples are dried until constant mass is achieved. For expediency it is permissible to dry samples for a fixed time provided it can be demonstrated that this is sufficient to reliably achieve constant mass for samples even when the chosen apparatus is fully loaded with samples.

Apparatus and Equipment:

- Oven: Electrically heated and controlled in such a way that, during normal working, the mean temperature of the air and of the shelves carrying the test samples is 100°C and operates within the range 96 - 104°C. The oven should be regularly maintained and regularly checked for correct operation.
- Sample drying trays: Durable under test conditions and being of a size which enables the test sample to be distributed evenly within the tray and at depth which does not protract the drying time.
- Balance: Accuracy 0.1g ± 0.05g. The balance should be regularly serviced and calibrated. Frequent checks on its correct operation should be made during the period when the balance is in use.

Method: The test samples are received direct from the combine in hermetically sealed bags or containers. Weigh a fully representative 100g sub-sample or an accurately recorded catch-weight

between 100-200g and place into the drying tray with an identifying label. Place the drying trays containing the test samples into the pre-heated oven. Dry the test samples for the pre-determined period or until constant mass is achieved (see below). Remove the test samples from the oven and allow to cool to ambient temperature. Record the dry weight of the test sample to 0.1g. If achievement of constant mass is to be directly measured, five check samples should be removed from a range of positions within the oven after a period of about16hrs. The dry weight of these samples should be recorded as above. The check samples should be returned to the oven and dried for a further 2 hours and the dry weight again recorded. A dry matter content of less than 0.3% between the two determinations will be accepted as representing constant mass. If constant mass has not been achieved, the check samples should be returned to the oven for further periods of two hours until constant mass is observed.

Results: The dry matter content of the test sample is calculated as follows;

$$\text{Dry Matter (\%)} = \frac{\text{Dry test sample weight}}{\text{Original test sample weight}} \times 100$$

When the dry weights are reported as a percentage, the fresh weight should be reported as 100.

References:

BS 4317-24:1990, ISO 7700/1-1984 Methods of test for cereals and pulses. Method of checking the calibration of moisture meters for cereals.

6.0 DISEASE TEST PROCEDURES - NATURALLY OCCURING

The Performance Trial/Site Operator is responsible for carrying out these procedures.

6.1 Diseases recorded

There shall be no addition of any fungicide treatment to reduce or inhibit natural infestation, unless directed to do so by the Trial Coordinator. Separate fungicide trials grown in proximity to Performance plots shall be a minimum of 2m from the closest Performance trial plot. Care should be taken to ensure that carryover from spraying plots does not come into contact with their Performance neighbours.

The following diseases must be recorded if differences occur within Performance trials:

	Abbr.	Winter Wheat	Spring Wheat	Winter Barley	Spring Barley	Oats
Mildew (E. graminis)	PMIL	√	√	√	√	
Leaf rust (P. recondita)	LRUW	√	√			
Leaf rust (P. hordei)	LRUB			√	√	
Stripe rust (P. striiformis)	STRS	√	√	√	√	√
Stem rust (P. graminis)	STRG	√	√	√	√	√
Crown Rust (P. coronata)	CRRC					√
Septoria leaf blotch (S. tritici)	SEPT	√	√			
Septoria avenae blotch (S. avenae)	SEPA					√
Septoria glume blotch (S.nodurum)	SEPG	√	√			
Scald (R. Secalis)	RHYN			√	√	
Spot Blotch (C. Sativus)*	SPBL			√	√	
Net Blotch (P. teres)*	NTBL			√	√	
Barley Yellow Dwarf	BYDV	√	√	√	√	√
Wheat Spindle Streak Mosaic Virus	WSSM	√				

*****Although every effort should be made to differentiate between Net and Spot Blotch in field trials, operators may occasionally find it impossible. In this case only, symptoms may be recorded as Blotch (list under SPBL*).*

6.2 Timing of assessments

- At or slightly before GS31: Record foliar disease if moderate infections (around 5% or score 3) occur in any plot.
- GS31-60: An assessment of foliar disease is required if moderate infections (around 5% or score 3) develop in any plot.
- .GS 60-80: Assess all foliar diseases that reach (5% or score 3) infection in any one plot during this period.

The precise time to rate is best judged by the Trial/Site Operator with regard to the stage and development of disease. It may be appropriate to assess different diseases at different stages within this period (e.g. mildew might be better assessed relatively early and leaf rust late).

6.3 General Assessment Procedures

Disease may be recorded on a percentage scale or 0-9 score **but the data must be submitted as a 0-9 score.** Only assess diseases which reach a minimum of 5% (score 3) infection in any one plot. Assess disease in all replicates of the trial. Assess foliar diseases on a 'whole-plot' basis, i.e. make an overall assessment of the average percentage infection on all tillers in a small area of the plot and repeat at a minimum of 4 points in each plot. Do not restrict examination to individual tillers or individual leaves. Where primary foci of high infection occur, these should be averaged over the plot as a whole. For foliar diseases, examine the top 4 leaves. As the lower leaves senescence naturally at later growth stages it will become necessary to examine only the top 3 or 2 leaves or, in the case of very late assessments, the flag leaves alone.

Diseases of Field Crops in Canada is an excellent resource for discerning differences amongst the various diseases. The publication is published by 'The Canadian Phytopathological Society.

7.0 DISEASE TEST PROCEDURES - INOCULATED TESTS FOR FUSARIUM HEAD BLIGHT

The Disease Site Operators are responsible for conducting the tests according to these procedures.

Disease values entered on Characteristic Sheet as:

Fusarium head blight (F. graminearum)	FHBI
Deoxynivalenol	DON

7.1 Winter and Spring Wheat

Fusarium ear blight (FHBI):
One of the following two inoculation techniques must be used:

a) Seed varieties/cultivars will be sown in small plots/rows and spray inoculated with a spore suspension of mixture of Fusarium graminearum isolates at 50,000 spores/ml. The plots will be inoculated at -2, 0, +2 days prior to/at/post 100% anthesis and misted. Each variety will be assessed for visual symptoms when the early dough stage was reached (ZGS 83). Whole plots will be visually rated for FHB incidence and severity.

b) Seed varieties/cultivars will be sown in small plots/rows and inoculated with two applications of infested barley and corn kernels (Fusarium infested grain spawn) about 3 and 2 weeks before anthesis (Zadoks scale 15-30). The grain spawn should be separately inoculated with three isolates of Fusarium graminearum and equal volumes of the three isolates should be mixed and used for field inoculation. At each inoculation, approximately 50 g of the infested grain spawn should be scattered evenly by hand between the two rows of each plot. Supplementary watering (sprinkler irrigation) should be applied twice daily for about 0.5 hour each in the morning and afternoon (excluding rain days), starting at the first inoculation with the infested grain spawn and continuing until about 3 weeks after anthesis, when plants were at the soft dough stage."

Don accumulation in grain (DON ppm): Deoxynivalenol (DON) content will be estimated from the four replicates of each variety or from the three replicates with the highest mean FHB index.

Fusarium inoculum used in evaluating Ontario winter wheat cultivars needs to be a mixture of at least 3 aggressive isolates of F. graminearum representative in pathogenicity occurring in Ontario as shown by reaction on inoculated check(s) or as per Disease Co-ordinator. Suggested F. graminearum isolates: DAOM178148, DAOM234041, DAOM234042 and DAOM234043 are available from the Canadian collection of fungal cultures in Ottawa.

7.2 Barley – the same as wheat

7.3 Oats - hard to correctly estimate FHB visual symptoms and FDK; after inoculation (with *Fusarium graminearum* or a different species, if required) use DON accumulation in grain (DON ppm) and percent of *Fusarium* spp. infected seeds

8.0 ASSESSMENT PROCEDURES OF TRIAL CHARACTERISTICS IN THE FIELD:

SITE FACTORS
Any reactions to the physical environment by the entries in the crop specific Performance Trial that affect the yield must be evaluated.

WINTER HARDINESS (WHAR) – Winter Crops, 0-100%
To be taken for autumn sown trials. Records should be taken from all plots. At least one record should be taken before the onset of spring growth, even if no damage is observed. Varieties should be scored on a 0-100% scale, where 100% = no damage.

PLANT HEIGHT (PLHT) - all crops, cm rating
Distance in cm from the soil surface to tip of inflorescense, excluding awns. The general height of the plot must be measured from at least one point in the plot chosen at random.

LODGING (LODG) - all crops, 0-9 rating
The Trial Site Operator should assess lodging at a stage that provides good discrimination between varieties and be prepared to repeat the assessment if further lodging develops. If there is lodging it should be recorded as follows: 0 = no lodging, 9 = whole plot flat on the ground. If lodging does not occur, it must be recorded as 0.

HEADING DATE (HDAY) - all crops, Julian Days or Days from Planting
Days to heading is defined as when 50% of plants are at Zadok's 51 - in barley 50% of heads have awns visible, oats and wheat inflorescence just coming out of boot. The date should be indicated in Julian days for winter cereals (JAN 1=1), and days from planting in springs. The rate at which the crop develops may vary and is dependent on weather conditions, so it may be necessary to make daily assessments to determine the full range of heading.

MATURITY DATE (MDAY) - all crops, Julian Days or Days from Planting
Ripening date is defined as when the grain is first hard, and difficult to divide by thumbnail (Growth stage 91), or when 50% of plants have no green left in glumes. Records for this character should be taken from all yield plots of requested variety and controls. It may be necessary to use straw colour as the criterion for ripeness. The date should be indicated as Julian days for winter crops (Jan 1=1) and days from planting for spring crops. The rate at which the crop ripens is dependent on weather conditions but daily assessments may be necessary during hot, dry conditions.

BIRD DAMAGE (BDAM) – all crops, 0-9 rating
This must be recorded where present at a level which will affect results.
0 = no bird damage, 9 = total decimation of plot. All plots should be assessed.

EMERGENCE PROBLEMS (EMER) – all crops, 0-100%
This must be recorded where there is evidence of poor initial emergence or low establishment (0-100%). 100%=no loss. All plots should be assessed.

STALK BREAK (SBRK) – all crops, 0-9 rating
This term refers to buckling of the straw at a point well above ground level. It occurs particularly when the crop has become over-ripe but varietal differences may occur at an earlier stage. 0 = no stalk break

9.0 GROWTH STAGES OF CEREALS

SEEDLING GROWTH
10 first leaf through coleoptile
11 first leaf unfolded
12 2 leaves unfolded
13 3 leaves unfolded
14 4 leaves unfolded
15 5 leaves unfolded
16 6 leaves unfolded
17 6 leaves unfolded
18 8 leaves unfolded
19 9 or more leaves unfolded

TILLERING
20 main shoot only
21 main shoot and 1 tiller
22 main shoot and 2 tillers
23 main shoot and 3 tillers
24 main shoot and 4 tillers
25 main shoot and 5 tillers
26 main shoot and 6 tillers
27 main shoot and 7 tillers
28 main shoot and 8 tillers
29 main shoot and 9 or more tillers

STEM ELONGATION
30 Ear at 1 cm
31 1st node detectable
32 2nd node detectable
33 3rd node detectable
34 4th node detectable
35 5th node detectable
36 6th node detectable
37 flag leaf just visible
39 flag leaf ligule/collar just visible

BOOTING
41 flag leaf sheath extending
43 boots just visibly swollen
45 boots swollen
47 lag leaf sheath opening
49 first awns visible

INFLORESCENCE (EAR EMERGENCE)
51 First spikelet of inflorescence just visible
52 ¼ of inflorescence emerged
55 ½ of inflorescence emerged

57 ¾ of inflorescence emerged
59 inflorescence completed

ANTHESIS
60 beginning of anthesis
61
64 anthesis half-way
65
68 anthesis completed
69

MILK DEVELOPMENT
71 caryopsis watery ripe
73 early milk
75 medium milk
77 late milk

DOUGH DEVELOPMENT
83 early dough
85 soft dough
87 hard dough

RIPENING
91 caryopsis hard (difficult to divide by thumb-nail)
92 caryopsis hard (can no longer be dented by thumb-nail)
93 caryopsis loosening in daytime

Reference: Tottman D R, Broad H (1987) Decimal Code for the Growth Stages of Cereals Annals ofApplied Biology 100, 683-687.

10.0 ASSESSMENT KEYS FOR CEREAL DISEASES – Under Development!