ONTARIO CEREAL CROPS COMMITTEE

VARIETY TRIAL METHODS

AND

TESTING PROCEDURES

(revised March 2017)

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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.

Trial cooperators who wish to deviate from the following procedures or who are uncertain as to the appropriate course of action must consult with the trial coordinator before making changes.

2.0 AGRONOMY AND DISEASE TRIAL PROCEDURES

2.1 Site Suitability

The Trial/Disease site cooperator 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, texture and drainage 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. If a trial is grown close to a tree line, it is recommended that the distance from the tree line should be at least 1.5 times the height of the trees.
- 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.
- The goal should be to select a site with a phosphorus soil test level of 20 ppm P (Olsen test) or higher and a potassium soil test level of 120 ppm K or higher.

2.2 Sowing the Trial

Trial design/layout: The Performance Trial Coordinator will supply the performance trial and disease site cooperators with the final sowing list and 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: 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 and for making sure equal number of viable seed is planted in each experimental unit. The following seeding rates are based on OMAFRA recommendations.

Crop	Viable Seeds /m^2
Winter Wheat	350-450
Winter Barley	350-400
Spring Wheat	300-400
Spring Barley	250-350
Oats	200-300
Rye and Triticale	200-300

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.

Planting date. Cooperators should plant the winter trials as close as possible to recommended planting date recommendation in the OMAFRA Agronomy Guide for Field Crops (OMAFRA Publication 811). For spring cereals, planting as early as possible is recommended.

2.3 SEED

Seed Quality:

The seed **must meet** the quality criteria (germination, purity, etc.) for Canada Certified #1 under the Canada Seeds Act as a minimum.

Labelling of Seed:

Seed must be labeled appropriately when shipped to cooperators. Seed must be clearly marked with "Entry name", and "Performance Trial" and "Seed treatment used".

1000 kernel weight and **germination** must be provided for each entry **at the time of shipment**

The following cultivar information must be provided at the time of entry:
Winter Wheat: hrw = hard red winter; sww=soft white winter; srw=soft red winter
a = awned;
Spring Cereals:
Wheat classes: hrs = hard red spring; efs = eastern feed spring; sd = spring durum; a = awned
Barley classes: 6R =six row; 2R = two row; H = hulless
Oat classes: Y = yellow; W = white; H = hulless

Seed Treatment:

Winter Wheat: Seed must be treated with a registered fungicide that includes difenoconazole for control of soil borne dwarf bunt.

Treatment with a registered insecticide to control European chafer is also recommended, due to presence of the insect at some sites.

Spring Cereals: **All seed must be treated**. Only registered fungicidal seed treatments applied at the rate recommended by the manufacturer are allowed. Samples must be labeled as "*Performance Trial Seed Treated with [chemical name]"* so that the appropriate safety precautions for handling treated seed can be followed.

2.4 HUSBANDRY

Agronomy: The crop production methods for OCCC trials should generally follow those for the crop as recommended in 'OMAFRA Agronomy Guide for Field Crops (Publication 811) and must be reflective of farm practices employed by growers in Ontario.

Fertilizer application: Application of fertilizers should be uniform. It is normally best to apply these perpendicular to the direction of the plots. Application rates should take into account inherent fertility, soil test, previous crop, rainfall, the best local practices, and advisory guidelines found in OMAFRA Publication 811. In winter cereals, supplemental spring nitrogen should be applied at the higher end of the rate for soft wheat and as early as conditions allow safe application with the least chance of damage to the developing crop/plots. Phosphorus and potassium applications should be based on a soil test and OMAFRA recommendation (Pub 811). Cooperators should target to build and/or maintain a phosphorus soil test level of 20 ppm P (Olsen test) or higher and a potassium soil test level of 120 ppm K or higher.

Weed Control: Weeds should be controlled an appropriate, registered herbicide based on the weed population in the field applied according to label recommendations. Application should be perpendicular to the direction of the plots. Rate and timing should be as based on label recommendations.

Insect Control: Registered pesticides should be applied in the event of a severe pest infestation [such as army worm] that threatens the viability of the trial. Application timing, rates and methods should be based on label recommendations.

Foliar Disease Control: Fungicides should **not** be applied on Regular Performance Trials or Inoculated Fusarium trials for control of foliar diseases. Fungicides should be applied on Intensive Management Trials in accordance with the protocols established for those trials and label recommendations.

2.5 HARVESTING

Timing of harvesting: The date of harvesting is to be determined by the respective Trial and Disease Site Operator based on crop maturity and local weather conditions.

Harvest Area: The plot dimensions should be measured prior to harvesting. If it is necessary to reduce the size of any plot at harvest to less than below current OCCC standards, details of the changes should be clearly recorded.

Harvesting method: Plots should be harvested by direct combining and combine settings must be optimal for the crop and harvest conditions.

Samples: A composite sample for each cultivar (minimum of 5 kg) 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 and have 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.

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

2.6 RECORDS

Site Information record: 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 recorded 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.

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: Characteristics to be Recorded:

Assessment	Characteristic	Wheat	Barley	Oats	Rye & Triticale
		winter & spring	winter & spring		
Yield	**Grain Yield**	**	**	**	**
Quality	**Hectolitre weight (Test Wt)**	**	**	**	**
	Thousand Grain Weight	**	**	**	**
	Protein Content	*			
	Hagberg Falling Number	**			
	Sprouting	*			
Resistance to Disease* **	**Refer to Section 6.0: Disease** Test Procedures for Crop Specific assessments	***	***	***	***
Reaction to Environment	**Winter hardiness/survival**	*	*		*
	Plant Height	**	**	**	**
	Lodging	***	***	***	***
	Days to Heading	***	***	***	***
	Days to physiological Maturity	***	***	***	***

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

4.0 YIELD TESTING PROCEDURES

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

Standard Moisture Contents:

Wheat (all types), Rye, Triticale, Spelt: 14.0%

Oats and Barley: 13.5%

Buckwheat: 16%

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 the standard moisture content for the crop being reported.

Adjusted Weight @ Std moisture %
= Harvest Weight X (100 - % harvest moisture) / (100 - std moisture %)

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 TESTING PROCEDURES

5.1 Hectoliter/Test Weight (kg/hl)

Determining test weight: Source: Official Grain Grading Guide 1-1 August 1, 2016
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 litre 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 litre 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 the Cox 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 (grams)

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—250 g 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 ORDC and/or the Canadian Grain Commission for the appropriate crops.

5.4 Hagberg Falling Number (sec)

A methodology recognized by the Canadian Grain Commission must be used.

5.5 Sprouting (%)

This must be recorded where present at a level which will affect grain quality.

Determining Sprouting: Source: Official Grain Grading Guide 1-1 August 1, 2016

Grains other than Oats:

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 (250 g minimum). Using a Boerner-type divider, divide a representative portion from the 250 g 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 percentage of the total sample used. A minimum of two replicates may be required to get a true indication of sprouting within that trial and entries.

% sprouted (SPTD) = weight sprouted (g) / weight sample (g) x 100

Oats

For oats, groats must be used for the sprouting determination.

1. Divide representative sample using Boerner or other type divider.
2. Using split of 50 grams, dehull sample using Codema de-huller or other.
   - Codema settings: 100 psi, 2 min. run time.
3. Pick groat sample for Sprout Damage (germ missing).

% Sprout Damage = [weight of sprout damaged groats (g.)] / [weight of hulled groats (g.)] x 100

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

Each grain sample tested should be in good condition having been stored at 13.5 % moisture content or less and cleaned according to approved CGC methods (Source: Official Grain Grading Guide 1-1 August 1, 2016).

Simplified hand method: Use this method only if a mechanical huller is not available. The bulk sample (minimum 250 g) of each entry must be thoroughly mixed and divided by quartering, using a Boerner divider, 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. Five g 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 individually. 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; otherwise, the final percentage should be the mean of the two sub-sample results.

The mean percentage of kernels (groats) 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. Dehull sample using Codema de-huller or other.

• Codema settings: 100 psi, 2 minute run time.

After de-hulling separate the de-hulled sample and remove any hulls and un-hulled grain. Check the remaining de-hulled kernel fraction for broken kernels and include in the kernel fraction. Weigh the de-hulled kernel fraction. Kernel content/yield is the weight of the de-hulled kernel fraction expressed as a percentage of: the initial 25 g sample weight minus weight of un-hulled grain.

The mean percentage of kernels (groats) 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)

5.7 Moisture Content Determination for Yield

Yield data must be corrected to the standard moisture content for the grain being tested. (See Section 4.0) The moisture content of the harvested plot grain may be measured using one of the three following methods: electronic moisture analyzers, NIR determination, or the oven method. Measuring equipment must be properly maintained and calibrated on a regular basis and used according to manufacturers' recommendations.

Combine-mounted moisture meters must be specifically manufactured for this purpose. The determination of moisture content must be the same for all plots in a replication. If there is a significant risk of rainfall during the harvesting of a replication, then backup samples should be taken from all plots in a replication to allow comparison through the oven method. Similarly, backup samples should be collected if there is reason to question the accuracy of the electronic measurement.

6.0 DISEASE TEST PROCEDURES - NATURALLY OCCURING

The 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 trials.

	Winter Wheat	Spring Wheat	Winter Barley	Spring Barley	Oats	Rye/ Triticale
Mildew (*E. graminis*)	√	√	√	√		
Leaf rust (*P. triticina*)	√	√				
Leaf rust (*P. hordei*)			√	√		
Stripe rust (*P. striiformis*)	√	√	√	√		√
Stem rust (*P. graminis*)	√	√	√	√	√	
Crown Rust (*P. coronata*)					√	
Septoria leaf blotch (*S. tritici*)	√	√				√
Septoria avenae blotch (*S. avenae*)					√	
Glume blotch (*S.nodurum*)	√	√				√
Scald (*R. Secalis*)			√	√		
Spot Blotch (*C. Sativus*)*			√	√		
Net Blotch (*P. teres*)*			√	√		
Barley Yellow Dwarf	√	√	√	√	√	
Wheat Mosaic Virus	√					
Ergot (*C. purpurea*)						√

*****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*).*

Any other pathogenic or physiological disorder should be recorded

6.2 Timing of assessments

At or slightly before GS 31:	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 should be scored according to the rating system described in the OCCC Wheat Disease Guide: (http://www.gocereals.ca/Wheat_Disease_Guide.pdf). 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 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 are to be entered on Characteristic Sheet as:

Fusarium head blight ratings Index (F. graminearum)	FHB
Deoxynivalenol	DON

7.1 Winter and Spring Wheat

Fusarium ear blight (FHB):

Each variety will be assessed for visual symptoms when the early dough stage is reached (ZGS 83). Whole plots will be visually rated for FHB incidence and severity. Incidence is defined as the percentage of spikes that show FHB symptoms (i.e. % infected spikes). Severity is defined as the percentage of infected spikelets in the affected spikes. A Visual Ratings Index (VRI or FHB Index) will be calculated as the % Incidence X & Severity/100 should be calculated for each plot and averaged across the reps.

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.

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 may be estimated from the samples from each plot or by using a composite sample from all replicates of each variety or from the three replicates with the highest mean FHB index. Either a suitable ELISA test or gas chromatography mass spectrometry may be used.

Fusarium inoculum used in evaluating Ontario winter wheat cultivars must a mixture of at least 3 aggressive isolates of *F. graminearum* representative of the pathogenicity occurring in Ontario as shown by reaction on inoculated check(s). A mixture of two isolates of 15-ADON and one or two isolates of 3-ADON is recommended.

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 trial that affect the yield must be evaluated, as an example physiological fleck.

WINTER SURVIVAL: 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: all crops, cm rating

Distance in cm from the soil surface to tip of inflorescence, excluding awns. The general height of the plot must be measured from at least one point in the plot chosen at random.

LODGING: 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 in the trial site, do not report data.

HEADING DATE: all crops
Winter Crops: Julian Days; Spring Crops: Days from Planting
For wheat, rye, triticale and oats, days to heading is defined as when 75% of the plants are at Zadok's 59 - in barley, heading date is recorded as the day when 75% of heads have awns visible. The date should be indicated in Julian days for winter cereals (JAN 1=1), and days from planting for spring cereals. Because the rate at which the crop develops may vary and is dependent on weather conditions, it may be necessary to make daily assessments to determine the full range of heading.

PHYSIOLOGICAL MATURITY all crops,
Winter Crops: Julian Days; Spring Crops: Days from Planting
The date of physiological maturity as when the peduncle color has turned yellow in 75% of the plot. Records for this character should be taken from all yield plots varieties including checks. The date should be indicated as Julian days for winter crops (Jan 1=1) and days from planting for spring crops. Because the rate at which the crop ripens is dependent on weather conditions, daily assessments may be necessary during hot, dry conditions.

BIRD DAMAGE 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 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 1/4 of inflorescence emerged
55 1/2 of inflorescence emerged
57 3/4 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 of Applied Biology 100, 683-