Animal & Plant Health Agency

United Kingdom National List Trials: Trial Procedures for Official Examination of Value for Cultivation and Use (VCU) Harvest 2019

Cereals – Wheat, Barley, Oats, Triticale, Rye, Spelt Wheat

March 2019

Changes from Harvest 2018 VCU procedures

1. p4, A.4.4.1 – Untreated, Plot yield, moisture content, Lodging and Leaning measurements for winter wheat only.

2. p4, A.4.4.1 – ”(where there are plots in trial with poor establishment)” deleted.

3. p6, A.4.4.3 – Plot yield (fungicide – PGR is measured for Spring Oats only, Lodging and Leaning in untreated trials correct from + PGR to – PGR and measurement of specific weight becomes obligatory.

4. p6 to 9, A.4.4.3 to A.4.4.6 – ”(where there are plots in trial with poor establishment)” deleted.

5. p13, C.3.4.1 – Trials Organiser must be informed if drilling is to be delayed beyond ‘normal local practice’.

6. p14, C.5.1.2 – shortening of plots clarified.

7. p17, C.6.3.3 – “(IF LOSSES ARE PRESENT)” and “where there is evidence of plant loss during the winter or imperfect establishment” deleted.

8. p21 and 22, D.2.3.1 and D.2.6 – Ramularia added.

9. p26, E.2.2.1 – specific weight obligatory in oats.

10. p32, Appendix 2 – seed treatments amended

11. p34 and 35, Appendix 4 – Trial sites,
    - spring barley: Scottish Agronomy, Kelso replaced by Stockbridge Technology Centre, Cawood, N Yorks,
    - winter oats: IBERS, Lydbury replaced by NIAB, Callow, Hereford,
    - spring oats: IBERS, Morfa Mawr replaced by: Saaten Union trial, Cowlinge.

12. p36, Appendix 5 – Controls:
    - winter wheat: Elation replaces JB Diego, KWS Barrel replaces Zulu and Gleam additional control in NL1 only,
    - winter barley: Croft replaces Talisman, KWS Orwell replaces KWS Glacier and KWS Astaire additional control in NL1 only,
    - winter oats: RGT Southwark replaces RGT lineout,
    - spring wheat: Cochise replaces KWS Willow.

13. p42, Appendix 6 – Plant Growth Regulator Protocol: updated.

14. p46, Appendix 7 – Fungicide Protocol: updated.

15. p52, Appendix 11 – Assessment Keys for diseases: ramularia added.

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Section A - General Information

A.1. Purpose

A.1.1 This document sets out the approved procedures to be used for growing trials, tests and assessments as required by the current Protocol for Official Examination of Value for Cultivation and Use for Cereals (wheat, barley, oats, triticale, rye and spelt wheat).

A.2. Scope

A.2.1 These procedures apply to all varieties of cereals (wheat, barley, oats, triticale, rye and spelt wheat).

A.3. Responsibilities

A.3.1 **Procedures Development Group**
The Procedures Development Group is responsible for reviewing these procedures annually and making amendments for which it has responsibility, in accordance with the provisions of the VCU Protocol.

A.3.2 Organisers and Operators

A.3.2.1 Trials Organiser

British Society of Plant Breeders Ltd (BSPB)
BSPB House
114 Lancaster Way Business Park
Ely Tel No: 01353 653846
Cambs. Fax No: 01353 661156
CB6 3NX Email: jeremy.widdowson@bspb.co.uk

A.3.2.2 The Trials Organiser is responsible for ensuring that all **VCU Protocol** and **Procedures** requirements are followed and for liaising with all Operators carrying out trials for National List purposes, including supply of seed and data handling.

A.3.2.3. Pathology Trials Operator

The Pathology Trials Operator appointed by APHA is responsible for co-ordinating the assessment of disease using Disease Observation Tussocks in accordance with the VCU Protocol and these Procedures.

A.3.2.4 Data Handling Operator

The Data Handling Operator identified by the Trials Organiser is responsible for trial design and data validation in accordance with the **VCU Protocol** and associated **Procedures.**

A.3.2.5 Growing Trial Operators, Seed Handling Operators and Quality Testing Operators.

The Trials Organiser is responsible for potential Growing Trial Operators and Quality Testing Operators to carry out trials and tests as determined by the Procedures Development annual review in accordance with the **VCU Protocol**, and these **Procedures**. The Trials Organiser is also responsible for finding Seed Handling Operators who are able to carry out seed handling. Seed Handling Operators prepare trial seed for sowing on behalf of any Growing Trials Operator in accordance with the **VCU Protocol** and these **Procedures**.

A.3.2.6 A list of all approved Organisers and Operators is shown in Appendix 1.

A.3.3 **VCU Protocol and Procedures non-compliance**

A.3.3.1 Where these procedures use the words "must or will" for any action then failure to carry out this action will result in non-compliance. Where the word "should" is used for any action then this is the method to be followed unless there are clear reasons not to, which can be justified by the operator as technically sound.

A.3.3.2 The Trials Organiser will forward any reports on VCU Protocol or Procedures non-compliance to APHA within 1 week of receipt. The Trials Organiser will obtain authorisation from APHA for any actions, including those necessary to remedy non-compliances, which are not within the requirements of the VCU Protocol. Such actions must be recorded as non-compliance. Where emergency action is required and APHA staff are not available (e.g. evenings/ weekends) the Trials Organiser should act but report this to APHA at the earliest opportunity. Where GMOs are concerned the arrangements are as detailed in section 3.4.

A.3.4 **Procedures for GM varieties**

A.3.4.1 The National Authorities and Trials Organiser will develop procedures for GM varieties if an application for a GM candidate variety is received.

A.3.5 **Processing of Seed**

A.3.5.1 The Trials Organiser is responsible for organising the processing of seed of candidate varieties submitted by the applicant, and seed of control, or other reference varieties, in accordance with the requirements set out in these **Procedures** and the current **VCU Protocol**. The Trials Organiser will ensure that any seed treatments or additives are approved for the purpose. Approved products are listed in Appendix 2.

A.3.6 **Dispatch of Seed**

A.3.6.1 The Trials Organiser will arrange for seed to arrive at the Seed Handling Operator by the relevant deadline – see Appendix 3. The Seed Handling Operator is responsible for processing and dispatch of seed to Growing Trials Operators. APHA are responsible for arranging submission of DUS seed and seed for authentication.

A.3.7 **Monitoring of Growing Trial Operators and Seed Handling Operators Documentation**

A.3.7.1 The Trials Organiser will take any necessary action to enforce deadline dates and quality standards for required documentation.

A.3.7.2 The Trials Organiser will ensure Growing Trial Operators and Seed Handling Operators have access to all current protocols and procedures relevant to them and that they are notified of any amendments.

A.3.8 **Seed Quantities**

A.3.8.1 The Trials Organiser will determine the quantity of seed required for all VCU tests and trials in each annual series, including authentication, and will notify the applicant of quantities and delivery addresses.

A.3 9 **Labelling of seed**

A.3.9.1 The Trials Organiser is responsible for ensuring all seed is clearly labelled with variety name/breeders reference and AFP number.

A.3.10 **Seed Quality**

A.3.10.1 Seed submitted for VCU testing should meet the standards for the final generation of seed given in the appropriate seed regulations, in respect of germination, analytical purity and content of other seeds and any other impurities.

A.4. Summary of Growing Trials, Tests and Assessments Procedures

A.4.1 The number of trials and site locations are as detailed in Appendix 4.

A.4.2 Control varieties are listed in Appendix 5. A commercially available naked oat variety is grown if there are naked oat candidates in trial. The naked comparator is not a yield control.

A.4.3 The Trials Organiser is responsible for informing the Growing Trial Operators of the additional characters, which must be recorded as and when requested by applicants, and any samples that may be required for analysis.

A.4.4 VCU trial assessments required

A.4.4.1 **Wheat**

Bold = Obligatory *Italics = Additional only if requested by the applicant*

Type of Character	Reference	Description of assessment
Yield	Section C	**Plot yield (treated)** **Plot yield (untreated) (WW only)** **Moisture content (treated)** **Moisture content (untreated) (WW only)**
Behaviour with respect to factors in the physical environment.	Section C	**Lodging (treated)** **Lodging (untreated) (WW only)** **Leaning (treated)** **Leaning (untreated) (WW only)** *Ripening date* *Straw length*
Resistance to harmful organisms	Section D	**Mildew** **Yellow rust** **Brown Rust** ***Septoria tritici*** ***Septoria Nodorum (WW ONLY)*** **Eyespot (inoculated test only)** *Sharp eyespot (inoculated test only)* **Fusarium ear blight** *Fusarium (inoculated test only)* *Soil Borne Wheat Mosaic Virus*
Quality characteristics (Laboratory Tests)	Section E	**Specific Weight** *Protein Content* *Hagberg Falling Number* *Endosperm texture* *Bread making quality* *Biscuit making quality* *Thousand Grain Weight*

*Growing Trial Operators may find it difficult to differentiate between Septoria species in field trials and may record as *Septoria species.*

NB Not all trials have untreated plots

FURTHER MEASUREMENTS

The following must be measured or recorded in all trials, following procedures in Section C.

Sowing Date
Harvest date
Pre-harvest shedding
Plot size
Plant population
Combine losses
Sprouting
Bird Damage
Winter hardiness (autumn sown trials)

A.4.4.2 **Barley**

Bold = Obligatory *Italics = Additional only if requested by the applicant*

Type of Character	Reference	Description of assessment
Yield	Section C	**Plot yield (treated)** **Plot yield (untreated)** **Moisture content (treated)** **Moisture content (untreated)**
Behaviour with respect to factors in the physical environment.	Section C	**Lodging (treated)** **Lodging (untreated)** **Leaning (treated)** **Leaning (untreated)** **Ear loss** *Ripening date* *Straw length*
Resistance to harmful organisms	Section D	**Mildew** **Yellow rust** **Brown rust** **Rhynchosporium** **Net blotch (WB only)** *Ramularia*
Quality characteristics (Laboratory Tests)	Section E	**Specific weight** *Hot Water Extract (HWE)* *Thousand Grain Weight* *Nitrogen Content*

NB Not all trials have untreated plots

FURTHER MEASUREMENTS
The following must be measured or recorded in all trials, following procedures in Section C.

Sowing Date
Harvest date
Pre-harvest shedding
Plot size
Plant population
Combine losses
Sprouting
Bird Damage
Brackling
Winter hardiness (autumn sown trials)
BMMV/BYMV (WB only)
BYDV (SB only)

A.4.4.3 **Oats**

Bold = Obligatory *Italics = Additional only if requested by the applicant*

Type of Character	Reference	Description of assessment
Yield	Section C	**Plot yield (fungicide + plant growth regulator)** **Plot yield (fungicide - plant growth regulator) (SO only)** **Moisture content (fungicide + plant growth regulator)** **Moisture content (fungicide - plant growth regulator)**
Behaviour with respect to factors in the physical environment.	Section C	**Lodging (treated) + PGR** **Lodging (untreated) - PGR** **Leaning (treated) + PGR** **Leaning (untreated) - PGR** ***Ripening date*** *Straw length*
Resistance to harmful organisms	Section D	**Mildew** **Crown rust** *Septoria avenae*
Quality characteristics (Laboratory Tests)	Section E	**Kernel content** **Specific Weight** *Protein Content* *Thousand Grain Weight* *Sieving Fraction*

FURTHER MEASUREMENTS
The following must be measured or recorded in all trials, following procedures in Section C.

Sowing Date
Harvest date
Yield
Plot size
Plant population
Combine losses
Sprouting
Bird damage
Pre-harvest shedding
Brackling

A.4.4.4 **Triticale**

Bold = Obligatory *Italics = Additional only if requested by the applicant*

Type of Character	Reference	Description of assessment
Yield	Section C	**Plot yield (treated)** **Moisture content (treated)**
Behaviour with respect to factors in the physical environment.	Section C	**Lodging (treated)** **Leaning (treated)** *Ripening date* *Straw length*
Resistance to harmful organisms	Section D	**Mildew** **Yellow rust** **Brown rust** ***Septoria tritici**
Quality characteristics (Laboratory Tests)	Section E	**Specific Weight** *Protein Content* *Thousand Grain Weight*

*Growing Trial Operators may find it difficult to differentiate between Septoria species in field trials and may record as *Septoria species.*

FURTHER MEASUREMENTS
The following must be measured or recorded in all trials, following procedures in Section C.

Sowing Date
Harvest date
Pre-harvest shedding
Plot size
Plant population
Combine losses
Sprouting
Bird damage
Winter hardiness (autumn sown trials)

A.4.4.5 **Rye**

Bold = Obligatory *Italics = Additional only if requested by the applicant*

Type of Character	Reference	Description of assessment
Yield	Section C	**Plot yield (treated)** **Moisture content (treated)**
Behaviour with respect to factors in the physical environment.	Section C	**Lodging (treated)** **Leaning (treated)** *Ripening date* *Straw length*
Resistance to harmful organisms	Section D	**Mildew** **Yellow rust** **Brown rust** ***Septoria tritici**
Quality characteristics (Laboratory Tests)	Section E	**Specific Weight** *Protein Content* *Hagberg Falling Number* *Endosperm texture* *Bread making quality* *Biscuit making quality* *Thousand Grain Weight*

*Growing Trial Operators may find it difficult to differentiate between Septoria species in field trials and may record as *Septoria species.*

FURTHER MEASUREMENTS
The following must be measured or recorded in all trials, following procedures in Section C.

Sowing Date
Harvest date
Pre-harvest shedding
Plot size
Plant population
Combine losses
Sprouting
Bird damage
Winter hardiness (autumn sown trials)

A.4.4.6 **Spelt Wheat**

Bold = Obligatory *Italics = Additional only if requested by the applicant*

Type of Character	Reference	Description of assessment
Yield	Section C	**Plot yield (managed)** **Moisture content (managed)**
Behaviour with respect to factors in the physical environment.	Section C	**Lodging (managed)** **Leaning (managed)** *Ripening date* *Straw length*
Resistance to harmful organisms	Section D	**Mildew** **Yellow rust** **Brown rust** ***Septoria tritici**
Quality characteristics (Laboratory Tests)	Section E	**Specific Weight** *Protein Content* *Hagberg Falling Number* *Endosperm texture* *Bread making quality* *Biscuit making quality* *Thousand Grain Weight*

*Growing Trial Operators may find it difficult to differentiate between Septoria species in field trials and may record as *Septoria species.*

FURTHER MEASUREMENTS
The following must be measured or recorded in all trials, following procedures in Section C.

Sowing Date
Harvest date
Plot size
Plant population
Combine losses
Sprouting
Bird damage
Pre-harvest shedding
Winter hardiness (autumn sown trials)

Section B – Seed Handling Procedures

B.1. Responsibilities

B.1.1 Seed Handling Operators or Growing Trial Operators are responsible for carrying out the following seed handling procedures.

B.2. Seed Handling Procedures

B.2.1 Seed Handling Operators/Growing Trial Operators will receive a sowing list from the Trials Organiser, along with instructions as to which seed treatments or additives may be used. A list of chemicals approved by the Procedures Development Group is at Appendix 2.

B.2.2 Seed Handling Operators/Growing Trial Operators must record receipt of seed from applicants by checking it off against the sowing list as it arrives. The Trials Organiser and Applicant should be notified of any damage to the packaging, loss of seed or identification problems within one working day of receipt.

B.2.3 Each Seed Handling Operator (or Growing Trial Operator if handling the seed) must retain 200 grams untreated sample of the seed submitted of every variety in the trial, for authentication by the DUS test centre.

B.2.4 Seed Handling Operators/Growing Trial Operators must record use of treatment chemicals in accordance with best practice and in full observance of all manufacturers' recommendations and relevant statutory obligations.

B.2.5 Any seed treatment equipment used must be fit for the purpose, properly calibrated, set up and operated in accordance with the manufacturer's recommendation.

B.2.6 Cross contamination must be avoided by ensuring equipment is clean between weighing and treatments.

B.2.7 A record must be kept of chemicals used and date of treatment.

B.2.8 Seed treatment should take place as near to the drilling date as possible.

B.2.9 Once seed has been treated, it must be kept safely until required for drilling and quality control. Each Seed Handling Operator must retain a 100 gram sample of treated seed until one month after harvest.

B.3. Authentication of VCU Seed

B.3.1 The Trials Organiser will notify the minimum quantity required for authentication to Growing Trial Operators/Seed Handling Operators annually. Authentication samples are not required from Growing Trial Operators who receive seed from another Seed Handling Operator. All samples for authentication must be retained until one month after harvest.

B.3.2 All samples must be kept under suitable conditions for the authentication procedures required and must be clearly labelled and sealed.

B.3.3 APHA will select samples from Growing Trial Operators/Seed Handling Operators for authentication at DUS test centre.

B.3.4 Growing Trial Operators/Seed Handling Operators must send requested samples to the DUS test centre by the date specified by APHA.

B.3.5 Where there is more than one Seed Handling Operator, APHA will select samples for authentication from at least two Seed Handling Operators.

B.3.6 If the level of offtypes recorded in DUS tests or VCU authentication of a candidate exceeds 10%, the VCU tests will be considered invalid.

Section C – Growing Trial Procedures

C.1. Responsibilities

C.1.1 The Growing Trial Operators are responsible for conducting the trials according to these procedures.

C.2. Site Suitability

C.2.1 The Growing Trial Operator will be responsible for providing a suitable site, which meets the following criteria:

C.2.2 Previous cropping must be appropriate for a cereal crop to be grown.

C.2.3 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.

C.2.4 The trial should be sited away from trees, hedges, headlands and other features, which are likely to cause uneven growth or encourage damage from fauna.

C.2.5 The trial area should be cultivated in the direction of primary cultivation and drilled across the direction of ploughing and cultivation such that each plot receives similar wheeling compaction. Cultivations should follow best local practice.

C.3 Sowing the Trial

C.3.1 **Plot Size**

C.3.1.1 For treated trials, the harvested plot area per variety must be not less than 19 m^2 per replicate for trials with two replications and 15 m^2 per replicate for trials with 3 or 4 replications. For untreated trials the harvest plot must be not less than 15 m^2 for 2 or 3 replicates (minimum plot length for DOPS is 4 m). For treated spring wheat, winter and spring oats, winter and spring triticale, rye, durum wheat and spelt wheat a minimum of 3 replicates must be sown. For untreated spring wheat a minimum of 2 replicates must be sown. Plots must be drilled to a greater length than required and cut back to the required length prior to harvest. 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 0.45 m.

C.3.2 **Plant population**

C.3.2.1 The following tables give the target populations for each crop, ie the final plant population per m^2 after any losses due to poor germination or establishment. The target population for hybrid varieties will be 70% of that for non-hybrid varieties.

	Population plants/m^2	
Crop	England and Wales	Scotland and N. Ireland
Winter wheat	200 to 300 depending on conditions at the time using the following as a guide: 200 for Sept sowings (140 for hybrids) 250 for Oct sowings (175 for hybrids) 300 for Nov sowings (210 for hybrids)	
Winter barley	275 (hybrids 193)	320 (hybrids 225)
Winter oats	275	320 – 350
Spring wheat (autumn sown)	300	-
Spring wheat (spring sown)	320	-
Spring barley	300 - 325*	300 - 350
Spring oats	300 - 325	300 - 350
Triticale	300 - 325	300 - 350
Rye	300 - 325 (hybrids 210-230)	300 - 350 (including hybrids)
Spelt Wheat	300 - 325	300 - 350

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

$$\text{Seed rate (kg/ha)} = \frac{(\text{Target population} \times \text{Thousand seed weight}) \times 100}{(\text{Establishment\%} \times \text{Germination \%})}$$

The likely establishment should be judged carefully depending on soil conditions and seedbeds. Growing Trial Operators are responsible for achieving the correct target populations.

***** Contact Trials Organiser if there is a need to increase the plant population.

C.3.3 **Trial layout**

C.3.3.1 The Trials Organiser following consultation with APHA produces provisional sowing lists. The Trials Organiser will make final sowing lists available to Growing Trial Operators along with the trial plans produced by the Data Handling Operator.

C.3.3.2 The trial should be sown according to the plan produced by the Data Handling Operator and may be an incomplete block design. In an incomplete block design each replicate is split into a number of sub-blocks. Any splitting of replicates must be between sub-blocks and not through sub-blocks. Varieties can be moved within a sub-block but must not be moved from their sub-block. Varieties must not be moved around within the plan e.g. if drilling errors occur. If plots are moved out of their original sub-block they will have to be treated as missing plots. If there are any queries please contact the Trials Organiser.

C.3.3.3 Buffer plots may be required in some instances; e.g. where there is a significant height difference between a variety or varieties. The Trials Organiser will advise if this is the case.

C.3.3.4 If there is a need to replace a planned variety e.g. if varieties are withdrawn, affected plots must be sown with any of the standard control varieties. Any such replacements must be agreed with the Trials Organiser. The control varieties are listed in Appendix 5.

C.3.4 Drilling

C.3.4.1 Drills to be set up, calibrated and used only when conditions are right. The Trials Organiser must be notified if drilling is to be delayed beyond normal local practice.

C.3.4.2 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.

C.3.4.3 At least ***one*** discard plot must be drilled on either side of the trial with the same drill and at the same time that the trial is drilled. In the case of oats, the discard plots must be a hulling susceptible variety.

C.3.4.4 Precautions must be taken to avoid any missing rows. Any missing rows or parts of rows must be noted in the trial diary and reported to the Trials Organiser within one month of emergence.

C.3.5 **Confirmation of trial layout**

C.3.5.1 After full establishment and within two months of sowing (autumn sown trials) or one month of sowing (spring sown trials) the Growing Trial Operator must confirm that the trial has been sown to plan or give details of any changes to plan. This should be done by clearly highlighting the changes in the electronic plan and returning it to the Data Handling Operator.

- Return a completed site data 1 sheet including the following information:
- Site location details including how to get to the field.
- Sketch showing the layout of the trial in the field, in relation to other trials and showing access roads, gates, etc.
- Trial sketch showing plot numbers and variety codes and/or names.
- A short post-establishment report of the condition of the trial.

C.4. Husbandry

C.4.1 **Agronomy**

Where not specified in these procedures agronomy should follow best local practice, advisory and regulatory guidelines. Application of fertilisers and sprays should be uniform. It is normally best to apply these across the direction of the plots. Application wheelings should not run through the harvested plot area.

C.4.2 Fertiliser application

It should take into account inherent fertility, previous cropping, winter rainfall and the best local practice. All fertiliser applications should take account of the AHDB Nutrient Management Guide (RB209), the corresponding advisory publications in England, Wales, Scotland and Northern Ireland and past trialling experience.

C.4.3 **Herbicides**

The Trials Organiser must be consulted. Any sensitivity to herbicides must be reported to the Trials Organiser.

C.4.4 **Growth Regulators**

The schedule is shown in Appendix 6. Growth regulators must only be used on treated and managed trials and should be used to keep lodging to a minimum.

Note that there are restrictions on the use of plant growth regulators. The manufacturer's instructions must be followed.

C.4.5 **Pest and Disease Control**

C.4.5.1 **Pest control**

Appropriate seed dressings must be applied as approved by the Trials Organiser (Appendix 2). Precautions should be taken against attacks by birds, molluscs, mammals and insects such as wireworm, leatherjackets and wheat bulb fly.

C.4.5.2 **Disease control**

All treatments applied should be according to the schedule in Appendix 7. In exceptional circumstances it may be necessary to deviate from the programme; eg additional sprays may be required during periods of extremely high disease pressure, or reduced rates may be required for drought stressed trials under low disease pressure. The Trials Organiser must be consulted before taking such a decision.

Treated plots will receive a fungicide programme designed to keep controllable disease levels below 5%.

Untreated trials will receive no fungicide.

Managed trials are normally non-fungicide treated but fungicide may be applied if severe disease (such as yellow rust) is establishing. The Trials Organiser must be consulted if disease is building up above 5% in any of the control varieties.

C.4.5.3 **Lodging control**

Treated and managed trials will receive a plant growth regulator (PGR) according to Appendix 6.

C.4.6 **Irrigation**

Irrigation will not be permitted without the specific agreement of the Trials Organiser.

C.4.7 **Pathways**

There should be a minimum of 2m between treated and untreated replicates.

C.5 Harvesting

C.5.1 Timing of harvesting

C.5.1.1 Date of harvesting will be determined by the Growing Trial Operator based on crop maturity and local weather conditions.

C.5.1.2 Plots should be trimmed to their final length prior to harvesting. The plot dimensions must be measured prior to harvesting. Any one plot of 1 variety may be shortened by up to half its length. If it is necessary to reduce the size of any plot at harvest give clear details on the yield file. Individual harvested plot lengths should be recorded.

C.5.2 **Harvesting method: Direct combining**

Combine settings must be optimal for the crop. 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.

The Trials Organiser will alert you if he is aware of susceptible varieties in the trial.

C.5.2.1 **Pre-harvest desiccation**

Pre-harvest desiccation should not be used. In exceptional circumstances and on a case-by-case basis, desiccation of the whole trial may be allowed but this must be discussed and agreed in advance with the Trials Organiser.

C.5.3 **Samples**

C.5.3.1 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 requested.

C.5.3.2 Moisture content samples must be assessed from every yield plot in the trial by the Growing Trial Operator. If moisture content cannot be assessed electronically (see Appendix 8) a sample of at least 200 g from each plot must be taken at the time of plot weighing and sealed in a moisture proof container for Dry Matter determination by the oven method using the method in Appendix 8.

C.5.3.3 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 both inside and outside the container/bag.

C.5.3.4 Samples may not be required from every variety - the Trials Organiser will provide details of which varieties require samples, the quantities required and the tests to be carried out.

C.5.3.5 Sample drying should be undertaken, on site, using a cold/warm air drier. Except for malting barley the aim is to reduce moisture content to 15% or below. Malting barley (micro malting groups) should be dried to 12% moisture content or below. The temperature of the drying air should not exceed 45°C for barley and 60ºC for other crops

C.5.3.6 All plot samples must be labelled with trial identification number, variety name/breeders reference, AFP number, plot number and Growing Trial Operator identification number. Where it is necessary to store samples, it is very important that they are stored in good conditions, dry and vermin free. Discuss any drying or storage problems with the Trials Organiser.

C.5.3.7 A 1kg Quality/Reference sample for each variety should be taken at harvest. This will be used for determining quality characters according to crop. The samples should be sent to the appropriate Quality Testing Operator as soon as practicable after harvest, or after the completion of any drying where this is necessary. Notification of dispatch should be faxed or emailed to the Trials Organiser at the same time. The sample remaining after testing will be kept as a reference sample. There are three levels of priority for dispatch of samples:

1. Samples to be sent immediately after harvest.
2. Those to be sent as soon as possible after harvest, once the moisture content of the samples has been dried down to 12% (barley) or 15 % (other crops). Samples should be in transit within 48 hours of harvest, if drying takes longer than this, contact the Trials Organiser.
3. Those to be held on site at 12% or 15% moisture content awaiting further instructions (micro malting groups). Once notification is received that samples are required, it is very important that they are dispatched quickly (within 48 hours of notification).

C.5.3.8 Where additional quality tests are requested by applicants, the Trials Organiser will provide appropriate instruction and labels. The samples should be dispatched to the appropriate Quality Testing Operator as soon as practical after harvest, or after completion of drying where necessary.

C.5.4 **Submission of data and samples**

C.5.4.1 Appendix 9 lists the records, with deadlines, to be sent to the Trials Organiser. Diary sheets and other field records should be returned to the Trials Organiser within 5 working days

C.5.4.2 All plot records should be transmitted to the Data Handling Operator following the deadlines set out in Appendix 9. The Growing Trial Operator should ensure that data are free from errors before transmission. After scrutiny, copies of results will be returned to the Growing Trial Operator for action as agreed by the Trials Organiser.

C.5.4.3 All samples should be sent to the appropriate Quality Testing Operator following the deadlines set out in Appendix 9.

C.6. Records

C.6.1 There are four components:

1	**Diary**	Field notes of trial status.
*2.	**Site data part 1**	Including full location details: 1) map of site location showing nearby settlements and roads, 2) a sketch showing the layout of trials in the field with access points and 3) trial layout, showing plot numbers and variety codes/names.
*3.	**Site data part 2**	Details of agrochemical applications and irrigation.
4.	**Plot records**	Plot data.

* Template available from Trials Organiser

C.6.1.1 An entry in the Diary sheet should be made on every trials visit and any observations relevant to variety performance should be recorded. If the trial is in good condition, with no problems, this should be recorded.

C.6.2 Plot records

C.6.2.1 Plot data may be recorded direct onto a data logger using a system approved by the Trials Organiser or recorded on paper then entered and validated onto a computer using an approved system. A system of ensuring that data are recoverable, in the event of loss of original data, must be implemented, e.g. copy and safe storage. Whichever method is used, individual plot data will only be accepted by the appropriate Data Handling Operator in an approved format using the variety names and units as listed in Sections C and D.

C.6.2.2 All observations should be checked at the time of recording to ensure that they lie within acceptable limits for the character recorded. Observations that have been designated as exceptional by the recorder should be identified with a note on the approved data file or hard copy medium describing the possible causes together with a recommendation for their exclusion or inclusion in the trial analysis.

C.6.2.3 Plot numbers on record sheets must correspond with the numbering on the field plan.

C.6.2.4 If a character is not recorded or is missing the Growing Trial Operator should indicate in the diary or on the recording sheet the reason why it has been excluded.

C.6.2.5 Where a plot record is missing the Growing Trial Operator should enter "*" in the approved data file or hard copy medium and, unless the non-recording of the plot has already been agreed with the Trials Organiser, append a note to the file explaining why a missing value has been entered for that plot. The Growing Trial Operator should not enter "0" for missing plots.

C.6.2.6 Specific plot records should be made as counts or on the scales shown for each character. Only the character names as listed may be used. All records should be returned to the Data Handling Operator as soon as possible after they are completed.

C.6.2.7 All records should be returned as soon as reasonably possible and when complete for the whole trial. Indicative deadlines are given in Appendix 9. All records must be returned by the final deadlines.

C.6.3 **Procedures for recording Characters**

C.6.3.1 The following procedures must be followed for measuring all characters to be used in NL decision-making.

C.6.3.2 **SOWING DATE of each trial (OBLIGATORY) (Day/month/year)**

This is recorded in Part 1 of the Site Information Form.

C.6.3.3 **PLANT POPULATION from all plots (OBLIGATORY) (1-9)**

This must be recorded (1-9). 9=no loss. The number of plants/m^2 for the highest and lowest value should be recorded.

C.6.3.4 **WINTER HARDINESS (OBLIGATORY) (1-9)**

To be taken from autumn sown trials. Records should be taken from all plots. At the discretion of the Growing Trial Operator the character should be recorded after any period of freezing conditions. 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 1-9 scale, where 9 = no damage.

C.6.3.5 **PLOT YIELD AND MOISTURE CONTENT (OBLIGATORY) (kg)**

The following information must accompany the yield data:

The moisture content % of the harvested grain, determined either by oven or an approved electronic method. See Appendix 8.

Plot length: the plot length harvested in metres.
Plot width: the width of the harvested plot in metres from outer row to outer row plus half of the inter-plot gap on either side. The allowance for the inter-plot gap should be no greater than 0.45m.

If these are not the same for every plot, a separate record must be submitted

Growth stage: usually 92 at harvest. The Growth Stage Chart for cereals is at Appendix 10.

Yield (in kilograms). Note clearly any tare weight to be subtracted.
Yield, Moisture content, Plot length, Plot width and harvest date data should be sent to appropriate data handling centre within 5 days of harvesting the trial.

C.6.3.6 **LODGING from all plots (OBLIGATORY) (%)**

Lodging is defined as areas of the plot where plants have gone down, the stem buckling at the base of the plant to an angle greater than 45° to the vertical. The Growing Trial 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 lodging does not occur, it must be recorded as 0.

C.6.3.7 **LEANING from all plots (OBLIGATORY) (%)**

Normally recorded at the same time as lodging. Leaning % is defined as areas of the plot leaning to not more than 45° to the vertical.

C.6.3.8 *RIPENING DATE (ADDITIONAL) (Day/Month/Year)*

Measured from treated plots where available - otherwise from untreated trials. Ripening date is defined as when the grain is first hard, and difficult to divide by thumbnail (Growth stage 91). The crop may not necessarily be ready to cut at this stage. 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 given numerically as day, month, and year and written in full for each plot.

Example 02/07/13

The rate at which the crop ripens is dependent on weather conditions but daily assessments may be necessary during hot, dry conditions.

An alternative method of assessing ripening date where daily visits are not practicable is described below.

The assessment should take place where the earliest variety is at growth stage 91. Use a 1-9 scale to record maturity e.g.

9	8	7	6	5	4	3	2	1
Ripe	2 days later	4 days later	6 days later	8 days later	10 days later	12 days later	14 days later	16 days later

Record each plot for varieties and controls if this character is requested in the trial on the 1 to 9 scale. A second visit to confirm the earlier observation would be advisable. Convert the 1 to 9 scale to dates. PLEASE SEND IN THE RIPENING DATES **NOT** THE 1-9 ASSESSMENTS. eg

Plot	Score (2/8/13)	Estimated ripening date
1	9	02.08.13
2	8	04.08.13
3	5	10.08.13
4	4	12.08.13
5	2	16.08.13
6	7	06.08.13

C.6.3.9 **SHEDDING from all plots (OBLIGATORY) (1-9)**

9 = no shedding. Shedding occurs in the mature plant. Indicate the estimated number of grains lost per m^2 for the lowest score given on the 1 to 9 scale.

C.6.3.10 *STRAW LENGTH (ADDITIONAL)* (cm)

Records should be taken from untreated plots only, but if these are not available then from treated plots.

Using a graduated rod the general height of the plot must be measured from at least one point in the plot chosen at random. The measurement must be from ground level to the top of the ear/panicles, ignoring awns.

C.6.3.11**HARVEST DATE (OBLIGATORY) (Day/month/year)**

C.6.3.12**COMBINE LOSSES from all plots (OBLIGATORY) (1-9)**

9 = no combine losses. Combine losses should be assessed if the losses are thought sufficient to exclude the yield data from results. Indicate the estimated number of grains lost per m^2 for the lowest score given on the 1 to 9 scale.

C.6.3.13 **SPROUTING from all plots (OBLIGATORY) (%)**

Sprouting in the ear of the mature plant is an important field character and has a detrimental effect on grain quality. Harvested samples from all plots in the trial should be taken if conditions have been conducive for sprouting and evidence of visible sprouting is seen in the plots at a level which will affect results. The assessment of sprouting should be based on observations on these grain samples.

C.6.3.14 **EAR LOSS from all plots (OBLIGATORY - barley) (1-9)**

9 = no ear loss. Usually occurs in barley as a result of necking. This is an important field character and should be assessed whenever it occurs. Estimate the number of ears lost per m^2 for a specified rating on the 1 to 9 scale.

C.6.3.15 **BIRD DAMAGE from all plots (OBLIGATORY) (1-9)**

9 = no bird damage. This must be recorded where there is evidence of bird damage present at a level which will affect results.

C.6.3.16 **BRACKLING from all plots (OBLIGATORY - barley and oats) (%)**

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.

C.6.4 **SITE FACTORS**

Any factors which may have affected the yield of the trial or individual plots must be noted and accompany the yield data.

Where varietal differences are seen in pest or disease attack, records should be made in accordance with the procedure in Section D for disease.

Records for other scores should be taken as plants affected on a 1 to 9 scale. Include definitions for each rating on the 1 to 9 scales.

C.6.5 **TRIAL INSPECTION**

All trials will be inspected by the Trial Inspection and Technical Validation Operator and, in some cases, it may be necessary to visit on more than one occasion.

The requirements for Growing Trial Operators in respect of inspections are as follows:

1 To give reasonable access to trials to inspectors.
2 To supply the inspector with information (for example sprays applied etc) within seven days of a request.
3 To co-operate with the inspector in making any non-routine assessments required to establish the validity of the trial (for example population counts).
4. To carry out any action agreed in consultation with the inspector. In particular it is important that any requirement to shorten plots is undertaken. The data on plots that the trials operator and inspector agree to exclude should not be submitted.

Section D – Disease Testing Procedures

D.1. Assessment of Natural Infection

D.1.1 **Disease Observation Tussocks**

D.1.2 The Pathology Trials Operator appointed by APHA is responsible for co-ordinating these procedures.

D.1.3 Disease observation tussocks (DOTs) are small plots specifically sited in disease prone areas, where they are at high risk from natural infection. Sites may be in farm crops or adjacent to trials, but in either situation must be kept free of fungicides. All NL1 and NL2 candidate varieties and VCU controls, together with standard varieties of known resistance, are sown in DOTs. The set of plots is usually unreplicated but sometimes comprises 2 replications.

The precise location of sites may vary from year to year. The number of DOT sites (including Scotland and N. Ireland) is reviewed annually.

D.2 Naturally Occurring Disease in VCU Growing Trials

D.2.1 The Growing Trial Operator is responsible for carrying out these procedures.

D.2.2 Untreated trials and/or Disease Observation Plots (DOPs) will be grown with no fungicide treatment. A barrier of at least 2m of untreated crop should be left between the treated and untreated plots and it is the responsibility of the Growing Trial Operator to ensure that fungicide does not drift onto untreated areas. Disease Observation Plots do not need to be taken to yield and can be used for the recording of straw characters and natural disease infection.

D.2.3 **Diseases recorded**

D.2.3.1 The following diseases must be recorded if they reach the infection levels specified

	Abb.	*Winter wheat*	*Spring wheat*	*Winter barley*	*Spring barley*	*Winter oats*	*Spring oats*	*Triticale*	*Rye*	*Spelt wheat*
Mildew	MIL	√	√	√	√	√	√	√	√	√
Yellow Rust	YR	√	√	√	√			√	√	√
Brown Rust	BR	√	√	√	√			√	√	
*Septoria nodorum**	SEPN	√								
*Septoria tritici**	SEPT	√	√					√	√	√
Rhynchosporium	RHYN			√	√					
Net Blotch	NB			√						
Crown Rust	CR					√	√			
Fusarium ear blight	FEB	√								
Septoria avenae	SEPA					√	√			
*Ramularia **	RAM			√	√					

*Although every effort should be made to differentiate between *Septoria* species in field trials, growing trial operators may occasionally find it impossible. In this case symptoms may be recorded as *Septoria species.*

Scores should be taken from the middle of plots, never the edge. There are only about 5-7 days when you can get an accurate Ramularia assessment, so trials should be visited regularly **from flowering onwards to monitor the progression of the disease.

√ Obligatory score

D.2.4 **Timing of assessments**

At or slightly before GS 31	Record foliar disease if moderate infections (around 5% or score 4) occur in any plot. If an early optional spray is to be applied a score should be made before application.
GS 31-60	An assessment of foliar disease is required if moderate infections (around 5% or score 4) develop in any plot.
GS 60-80	Assess all foliar diseases that reach 5% (score 4) infection in any one plot during this period. The precise timing is best judged by the Growing Trial Operator in relation to disease development. It may be appropriate to assess different diseases at different stages within this period (e.g. mildew might be better assessed relatively early and brown rust late).

D.2.5 **Assessment keys**

D.2.5.1 The keys to be used for routine assessments are included in Appendix 11.

Disease may be recorded on a percentage scale or 1-9 score **but the data must be submitted as a 1-9 score**. Both scales are given in the assessment keys. For diseases or disorders for which no standard key exists, a scale which increases with severity should be used.

D.2.6 **General Assessment Procedures**

	Only assess diseases which reach a minimum of 5% (score 4) infection in any one untreated plot. Where disease is present in fungicide treated trials, please see (vii)
	Each time a trial is assessed for disease, please enter a comment on the status of diseases which have not been assessed e.g. that they are absent or less than 5% (score 4).
	Assess disease in all replicates of the trial, except for treated replicates when they are disease free.
	Assess foliar diseases on a 'whole-plot' basis, ie 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.
	Fungicide treated trials must be inspected for failure to control disease. A full record must be taken if the infection level for any disease reaches 5% (score 4) or greater. A comment on the disease levels in treated trials should accompany all disease records from the corresponding untreated trials.

Disease names:

Only the accepted disease names and units may be used, exactly as specified below:

MILDEW 1-9	SEPTORIA NODORUM 1-9	RHYNCHOSPORIUM 1-9
YELLOW RUST 1-9	SEPTORIA TRITICI 1-9	NET BLOTCH 1-9
BROWN RUST 1-9	SEPTORIA AVENAE 1-9	FUSARIUM EAR 1-9
CROWN RUST 1-9	SEPTORIA SPP 1-9	SHARP EYESPOT DI
	RAMULARIA 1-9	BYMV (0-5)
		BYDV 1-9

D.2.7 **Recording methods**

Appropriate assessment keys are given in Appendix 11. All disease records to be sent to the Data Handling Operator as soon as they are made.

All disease data should be received by the Data Handling Operator by;

Winter barley and winter oats	***11 July***
Winter wheat, Triticale, Rye and Spelt wheat	***2 August***
Spring cereals	***16 August***

Data arriving after these dates, may not be included in the calculation of resistance ratings, will be stored in the database for future use.

If no disease assessments have been made on untreated trials during the period GS 60 (beginning of anthesis) to GS 80 (late milk/early dough), this fact should be recorded and a fax /email message giving this information sent to the Trials Organiser before the deadline for data receipt.

Where disease levels are very low and the decision is taken to postpone an assessment until a later date please enter this information in the trial diary

D.3 Inoculated Disease Tests

The Pathology Trials Operator is responsible for conducting the tests according to these procedures.

D.3.1 WHEAT

D.3.1.1 Yellow Rust of wheat

Inoculated Adult Plant Tests

NL varieties of winter and spring wheat, both sown in the autumn, together with control varieties of known resistance, are tested using mixed inoculum. Up to 4 isolates may be used in the nursery. Isolates are selected annually on UKCPVS advice to represent all important virulences / virulence combinations in the UK pathogen population.

WW NL1 and NL2 nurseries are combined, SW NL1 and NL2 should be combined in a separate trial. Control varieties which will indicate the presence of virulences in the isolates used should be included in each nursery, and these will be advised each year through UKCPVS. Each trial should contain spreader rows next to the candidate variety rows. Candidate rows should be approximately between 1m and 2m in length.

The spreader must be a known, universally susceptible variety, or mixture of varieties designed to maximise the duration of infectivity of the spreader.

Spreader rows within the trials are inoculated at about GS 30/31 with a spore mixture (in talc or other inert carrier) or infected transplants. Isolates must be increased separately, and applied to the spreader rows as a mixture. In the case of spore/carrier mixtures, equal amounts of each isolate must be used in the mixture, and this should then be applied directly to the spreader rows. In the case of infected transplants, equal numbers of transplants for each isolate must be placed in the spreader rows at a sufficient density to ensure infection. Percent leaf area infection is assessed using the NIAB whole plot assessment key (Key No. 11, Anon 1985, Appendix 9) at 7-14 day intervals, starting when 10% of the varieties reach the 5% level of infection (usually 3 assessments).

D.3.1.2 Brown Rust of wheat

Inoculated adult plant test

As for yellow rust (D3.1.1). Repeat inoculations may be employed as needed. Less than 3 assessments can be acceptable due to the late season nature of brown rust epidemics

D.3.1.3 Eyespot of wheat

Inoculated adult plant tests

NL2 varieties of winter wheat, together with susceptible and resistant control varieties, are tested in field trials, at two sites. There is no inoculated test at the NL1 stage.

A plot size of approximately 2 m x 1 m is used with 6 replications. Plots are inoculated at the 1st leaf stage by spreading infected oat grains over the plot. Samples of 20 tillers are assessed for eyespot symptoms once at around GS 75, depending on disease development, using an eyespot index key (Key No 12, Anon 1985, Appendix 11). Test plots are treated with fungicide to control non-target diseases

D.3.1.4 Wheat - additional VCU Character tests

1) Soil-borne Cereal Mosaic Virus

This is an additional VCU character and the test is only performed for those varieties for which breeders claim resistance and make a request for the test. A resistance statement is provided after two years in tests (resistant/tolerant or susceptible). Winter wheat NL1 and NL2 varieties are sown in small plots (c. 0.5 m x 0.5 m; replicated twice) on a site/s known to be infected with Soil-borne Cereal Mosaic Virus. Plots are then assessed when symptoms are most pronounced, usually from early March onwards, as percentage of tillers infected.

Visual assessments on test varieties may be confirmed by ELISA tests if necessary.

2) Sharp eyespot

This is an additional VCU character and the test is only performed for those varieties for which breeders claim resistance and make a request for the test. Seed of NL2 and NL1 varieties is mixed with oat grain inoculum of the pathogen and sown in 2 m^2 plots. Disease is assessed at both the seedling and adult plant stages, according to the degree of infection of the stem-base, using standard keys.

3) Fusarium Ear Blight

This is an additional VCU character and the test is only performed for those varieties for which breeders claim resistance and make a request for the test. Seed of NL2 and NL1 varieties is sown in small plots (2 m^2) and inoculated with a spore suspension of *F culmorum* (or a different species, if required) at anthesis. Infection is enhanced through the use of mist irrigation. Ear blight infection is assessed, using a pictorial key from GS80 onwards.

D.3.2 BARLEY

D3.2.1 No inoculated disease tests are carried out routinely.

D.3.2.2 Barley – additional character VCU tests

Barley mosaic viruses

This is an additional VCU character and the test is only performed for those varieties for which breeders claim resistance, and/or make a request for the test. A firm resistance statement is provided after two years in tests (resistant or susceptible). Winter barley NL1 and NL2 varieties are sown in small plots on sites known to be infected with either barley mild mosaic virus (BaMMV), barley yellow mosaic virus (BaYMV1), or the resistance-breaking strain of barley yellow mosaic virus (BaYMV2). Plots are then assessed when symptoms are most pronounced, in February/March, on a 1-5 scale, as detailed below:

no infection
few tillers with symptoms
up to 25% tillers with symptoms
up to 50% tillers with symptoms
between 50 and 100% tillers with symptoms
100% tillers with symptoms

Barley Yellow Dwarf Virus (BYDV)

This is an additional VCU character and the test is only performed at the breeder's specific request. Spring barley NL1 and NL2 varieties are drilled late (c. mid May), in two locations: NIAB HQ and NIAB Harper Adams. The aim is for the plants to be at the vulnerable seedling stage at the peak of aphid numbers. Plots are assessed for percentage leaf area affected by yellowing, caused by BYDV, at 7-14 day intervals, on a whole plot basis.

D.3.3 OATS

No inoculated disease tests are carried out on winter or spring oats.

D.3.4 TRITICALE

No inoculated disease tests are carried out on triticale.

D.3.5 RYE

No inoculated disease tests are carried out on rye.

D.3.6 SPELT WHEAT

No inoculated disease tests are carried out on spelt wheat.

Section E - Quality Testing Procedures

E.1. Responsibilities

E.1.1 The Quality Testing Operators appointed by the Trials Organiser are responsible for conducting approved quality tests according to these procedures.

E.2 Quality Assessment Methodology for Obligatory and Additional Tests

E.2.1 Preparation of samples prior to quality analysis

Samples should be:

- relatively weed free
- free from excessive numbers of broken grains
- bright and of good colour
- well filled and free from visual sprouting.

E.2.1.2 Sample cleaning

The samples should be cleaned to remove combining debris such as straw, chaff, unthreshed ears and weed seeds. The cleaning may be by hand or with hand-held or mechanical sieves. If sieves are used, the following bottom screen sizes should be used: Wheat, triticale and rye: 2.0 mm bottom. Barley: 2.2 mm bottom. Oats: 1.5 mm bottom. The top screen size should be of a suitable size to remove unthreshed ears and large debris.

E.2.2 **Quality tests**

E.2.2.1 **SPECIFIC WEIGHT**

(OBLIGATORY – wheat/barley)
(OBLIGATORY – triticale)
(OBLIGATORY – rye)
(OBLIGATORY – spelt wheat)
(OBLIGATORY – oats)

This can be determined using a chondrometer, Dickey-John analyser or by approved NIR methodology.

E.2.2.1.1 **Chondrometer**

The chondrometer has two compartments divided by a slide. The lower compartment is of a known fixed volume (usually 1 litre) and is removable. The upper compartment has greater capacity.

The slide is put in place while the upper chamber is filled with grain. The slide is then removed quickly, allowing the lower compartment to fill after which the slide is re-inserted. The weight of grain trapped in the lower compartment is measured and converted into kg/hl using conversion tables.

E.2.2.1.2 **Dickey-John analyser**

The Dickey-John analyser must be used according to the manufacturer's instructions. The instrument must be calibrated annually and possess a current 'Certificate of Calibration'.

E.2.2.1.3 **NIR method**

The NIR method is permitted for the measurement of specific weight provided that the instrument uses current UK NIR Network calibrations for the appropriate crops. The operator must also participate in the monthly ring checks for the various calibrations being used to demonstrate that the instrument and operating practices are performing within specification. Records of the results of the monthly ring checks should be available for inspection if required.

E.2.2.1.4 **Correction of specific weight data for moisture content**

In the case of wheat, adjustment has to be made to the kg/hl value to take account of moisture content. The calculation procedure for this is as follows:

Add 0.35 kg/hl for each 1% moisture above 15%.

Subtract 0.35 kg/hl for each 1% below 15%.

In the case of barley and oats, no adjustment should be made to the kg/hl value to take account of moisture content.

E.2.2.2 **KERNEL CONTENT OF (CONVENTIONAL) OATS (OBLIGATORY) (%) (KER)**

E.2.2.2.1 Each grain sample tested should be in good condition, having been stored at 15% moisture content and cleaned as in E.2.1.

E.2.2.2.2 Simplified hand method.

E.2.2.2.3 The bulk sample must be thoroughly mixed and divided by quartering until two 10 g 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 de-hulled. 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:

$$\frac{\text{Mean weight of kernel (g)}}{\text{Total mean weight of kernel and husk (g)}} \times 100$$

The data should be recorded as KERNEL CONTENT%

E.2.2.2.4 Mechanical method

E.2.2.2.5 Two sub samples per variety are de-hulled. The 'fresh' (air-dry) sample is thoroughly mixed and divided by halving until two 25 g 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 KERNEL YIELD%.

E.2.2.3 *PROTEIN CONTENT DETERMINATION (ADDITIONAL) (%)*

E.2.2.3.1 Hammer milling of grain prior to analysis

The mill must be a hammer mill fitted with a 1 mm screen. 300 g of sample is milled and the material must be totally removed from the receptacle. The sample must be spread thinly, either with a printer's roller or with a wide blade spatula. The sample must be re-formed into a pile and the process repeated four times. After mixing, a representative sub-sample must be taken in the following manner:-

A sample jar of 250 ml capacity should be filled in small stages re-mixing the bulk between stages and blending each stage within the jar.
The sample jar must be filled and then sealed with a close fitting lid.

E.2.2.3.2 Determination of Crude Protein or Total Nitrogen Content

Determination of Crude Protein or Total Nitrogen Content must be by a chemical method, recognised by competent authorities (IBD, AOAC, ISO, etc) and which makes direct measurement of nitrogen content. Alternately an approved NIR methodology can be used.

Methods acceptable to the National Authorities are currently, total nitrogen determined by the Kjeldahl method and total nitrogen using the Dumas method. These methods are only acceptable where instrumentation used is capable of analysing sample sizes greater than 0.5 g. Alternately an approved NIR methodology can be used, **for wheat only**, provided that the instrument uses current UK NIR Network calibration. The operator must also participate in the monthly ring checks for the various calibrations being used to demonstrate that the instrument and operating practices are performing within specification. Records of the results of the monthly ring checks should be available for inspection if required.

Quality assurance of the analytical procedures must include regular analysis of a suitable test material - for example, a sample of flour maintained for that purpose.

Systematic errors in Kjeldahl nitrogen analysis must be controlled by the inclusion of blank analyses and by the analysis of a suitable analytical standard (Ammonium Sulphate, Methionine in a suitable bulking agent) for which the nitrogen content is known.

Instrument drift in Dumas nitrogen must be controlled by standardisation against a suitable analytical standard (EDTA, Glycine), for which the nitrogen content is known.

E.2.2.4 *HAGBERG FALLING NUMBER (ADDITIONAL - Wheat, Rye and Spelt)*

A methodology recognised by the National Authorities must be used.

E.2.2.5 *ENDOSPERM TEXTURE (ADDITIONAL - Wheat, Rye and Spelt)*

A methodology recognised by the National Authorities must be used.

E.2.2.6 *BREAD MAKING QUALITY (ADDITIONAL - Wheat, Rye and Spelt)*

A methodology recognised by the National Authorities must be used.

E.2.2.7 *BISCUIT MAKING POTENTIAL (ADDITIONAL - Wheat, Rye and Spelt)*

A methodology recognised by the National Authorities must be used.

E.2.2.8 *HOT WATER EXTRACT (ADDITIONAL - Barley)*

Hot Water Extract must be determined as described in the Recommended Methods of Analysis published by the Institute of Brewing, 1986 revision 2,2.4., 15-18.

The method describes 2 settings for the Buhler-Miag mill. Only the coarse grind setting at 0.7mm is to be used.

E.2.2.9 *SIEVING FRACTION (ADDITIONAL - Oats)*

Previously cleaned grain, with large debris and weed seed removed, is passed over a sieve 1.8 mm for naked oats, 2 mm for oats/wheat and 2.5 mm for barley. The % of grain remaining on the sieve is recorded.

E.2.2.10 *THOUSAND GRAIN WEIGHT (ADDITIONAL)*

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

Section F - Trial Design and Data Handling

F.1. Plan Validation and Storage

F.1.2 After the trial has been drilled, the Growing Trial Operator must:

a) Confirm that the trial has been drilled according to plan and provide the sowing date, by returning site data 1 and associated trial sketch to the Trials Organiser who will send to appropriate Data Handling Operator.

b) If any amendments to the plan have been made, return a hard copy of the plan with any amendments clearly indicated to the Trials Organiser who will send to appropriate Data Handling Operator. Alternatively, amendments may be notified electronically with the agreement of the Data Handling Operator.

F.1.3 The Data Handling Operator will check these for statistical validity and, once this has been done, will load the plan on the database.

F.2 Data Recording

F.2.1 Data are recorded using the methods and characters given in Sections C, D and E.

F.2.2. Site information is recorded for each trial including, for example, data on previous cropping, seed rates, soil details and fertiliser applications.

F.2.3 Details of any agrochemical applications are also recorded and retained by the Growing Trial Operator.

F.3 Other Tests and Trials

F.3.1 Any additional or alternative designs required for the assessment of additional VCU characters not detailed in Appendix 3 of the **VCU TRIAL PROTOCOL** for cereals (wheat, barley, oats, triticale, rye and spelt wheat), will be added to these **Procedures** as and when approved by the NLSC.

Appendix 1 Approved Trial Organisers/ Operators For Wheat, Barley, Oats, Triticale, Rye and Spelt Wheat.

Activity	Organisers/Operators Responsible
Data Handling Operators	BioSS* AHDB Cereals and Oilseeds** NIAB***
Trials Organiser	BSPB
Pathology Trials Operator	NIAB
Trial Inspection and Technical Validation Operator	AHDB Cereals and Oilseeds
Quality Testing Operators	NIAB and Campden BRI
Data Review and Standards Setting Operator	NIAB

*Wheat, Barley, Oats

**Triticale, Rye

*** Spelt wheat

Appendix 2 Seed Treatment Products for Use on NL Trials

Where there are alternative treatments, all varieties in the trial must be treated with the same product

Crop	Treatment
Winter Wheat	Prothioconazole + Clothianidin (eg Redigo Deter) if not available use Redigo Pro
Winter Barley	Prothioconazole + Clothianidin (eg Redigo Deter) if not available use Redigo Pro. Raxil Star (Prothioconazole, Tebuconazole + fluopyram) may be used
Winter Oats	Prothioconazole + Clothianidin (eg Redigo Deter) if not available use Redigo Pro
Autumn and Spring sown Wheat	Prothioconazole + Tebuconazole (eg Redigo Pro) or fludioxonil + tefluthrin (eg Austral Plus)
Spring Barley	Prothioconazole + Tebuconazole (eg Redigo Pro)
Spring Oats	Prothioconazole + Tebuconazole (eg Redigo Pro)
Triticale	Prothioconazole + Tebuconazole (eg Redigo Pro)
Rye	Prothioconazole + Tebuconazole (eg Redigo Pro)
Spelt Wheat	No Treatment

Appendix 3 Seed Dispatch Deadline Dates

VCU seed must be delivered to each Growing Trials Operator/ Seed Handling Operator by:

Winter wheat	15th September
Triticale	1st September
Rye	1st September
Spelt wheat	1st September
Winter barley	8th September
Winter oats	15th September
Spring wheat	23rd October
Spring barley	15th January
Spring oats	15th January

Appendix 4 Growing Trial Operators and Trial Locations

1. Growing Trial Operators/Seed Handling Operators

A. WINTER WHEAT

Growing Trial Operator	Seed Handling Operator (if not Trial Operator)	Location of Trial	Trial Description
Saaten Union UK Ltd		Ulceby, Lincolnshire	T and UnT
NIAB		Norfolk	T only
NIAB		Callow, Hereford.	T and UnT
Elsoms Wheat Ltd		Spalding, Lincs	T, UnT and L
KWS UK Ltd		Framlingham, Suffolk	T and UnT
KWS UK Ltd		Melton Mowbray, Leics	T and L
RAGT Seeds Ltd		Ickleton, Cambs.	T only
Agrii		Great Dunmow, Essex	T only
Limagrain UK Ltd		Elmswell, Bury St Edmunds	T only
Syngenta Ltd		Great Sturton, Lincs.	T only
Syngenta Ltd		Watlington, Oxon	T only
NIAB		Broughton, Hants	T only
NIAB		Petham, Kent	T only
Frontier Agriculture Ltd	Saaten Union	Driffield, Yorks	T only
SRUC	Agrii	Humbie, East Lothian	T, UnT and L
DSV UK Ltd		Wardington, Banbury, Oxon	T only
SRUC	Agrii	Laurencekirk, Aberdeenshire	T and UnT

B. ALTERNATIVE WHEAT

Growing Trial Operator	Seed Handling Operator (if not Trial Operator)	Location of Trial	Trial Description
Agrii		Great Dunmow, Essex	T and DOP
KWS UK Ltd		Framlingham, Suffolk	T and DOP
Elsoms Wheat Ltd		Spalding, Lincs	T and DOP

C. SPRING WHEAT

Growing Trial Operator	Seed Handling Operator (if not Trial Operator)	Location of Trial	Trial Description
Saaten Union UK Ltd		Cowlinge, Suffolk	T and DOP
Agrii		Revesby, Horncastle Lincs	T and DOP
KWS UK Ltd		Melbourne, Cambs	T and DOP

D. WINTER BARLEY

Growing Trial Operator	Seed Handling Operator (if not Trial Operator)	Location of Trial	Trial Description
Agrii		Great Dunmow, Essex	T only
Saaten Union UK Ltd		Cowlinge, Suffolk	T only
KWS UK Ltd		Fulbourne, Cambs	T only
Syngenta Ltd		Great Sturton, Lincs	T and UnT
Scottish Agronomy	Agrii	Balgonie, Fife	T and UnT
NIAB		Broughton, Hants	T and UnT
NIAB		Callow, Hereford	T and UnT
Frontier Agriculture	Saaten Union	Driffield, Yorks	T only
Scottish Agronomy	Agrii	Maxton nr St Boswells	T and UnT
Scottish Agronomy	Agrii	Ellon, Aberdeenshire	T and UnT

E. SPRING BARLEY

Growing Trial Operator	Seed Handling Operator (if not Trial Operator)	Location Of Trial	Trial Description
KWS UK LTD		**Fulbourn, Cambridge**	**T only**
Envirofield		Drinkstone, Suffolk	T only
Scottish Agronomy	Agrii	Milnathort, Perth	T and UnT
Syngenta Ltd		Great Sturton, Lincs	T and UnT
Stockbridge Technology Centre	tbc	Cawood, n Yorks	T only
Scottish Agronomy	Agrii	Alness, Ross-shire	T only
Trials Force	Agrii	Laurencekirk, Aberdeenshire	T and UnT
NIAB		Andover, Hants	T and UnT
Trials Force	Agrii	Cullen, Banffshire	T only
SRUC	Agrii	Humbie, East Lothian	T only
SRUC	Agrii	Humbie, East Lothian	UnT only
AFBI	Agrii	Crossnacreevy	T and UnT

F. WINTER OATS

Growing Trial Operator	Seed Handling Operator (if not Trial Operator)	Location of Trial	Trial Description
Agrii		Great Dunmow, Essex	T only
Scottish Agronomy	Agrii	Balgonie, Fife	T and L
NIAB		Callow, Hereford	T and L

G. SPRING OATS

Growing Trial Operator	Seed Handling Operator (if not Trial Operator)	Location of Trial	Trial Description
Scottish Agronomy	Agrii	Makerstoun, Kelso	T and UnT
Saaten Union		Cowlinge, Suffolk	T and UnT
NIAB		Callow Hereford	T only
Scottish Agronomy	Agrii	Balgonie, Fife	T and UnT
AFBI	Agrii	Crossnacreevy	T and UnT

H. WINTER RYE

Growing Trial Operator	Seed Handling Operator (if not Trial Operator)	Location of Trial	Trial Description
Saaten Union UK Ltd		Cowlinge, Suffolk	T and UnT

I. WINTER TRITICALE

Growing Trial Operator	Seed Handling Operator (if not Trial Operator)	Location of Trial	Trial Description
Saaten Union UK Ltd		Cowlinge, Suffolk	T only

J. SPRING TRITICALE

Growing Trial Operator	Seed Handling Operator (if not Trial Operator)	Location of Trial	Trial Description
Saaten Union UK Ltd		Cowlinge, Suffolk	T only

2. Pathology Trials Operator

Pathology Trials Operator	Location of Trial
NIAB	UK

Appendix 5 Control Varieties for VCU Assessments

The Control Varieties are:

Winter Wheat	Elation (Feed)
	KWS Santiago (Feed)
	Skyfall (Bread Making)
	KWS Barrel (Biscuit Making)
	KWS Siskin
	KWS Siskin (Disease check (UT only))
	Gleam (Additional control NL 1 only)
Winter Barley	Craft (Malting)
	Funky (6 row Feed)
	Bazooka (6 row Feed)
	SY Venture (Malting)
	KWS Orwell (Feed)
	KWS Astaire (additional control NL1 only)
Winter Oats	RGT Southwark
	Mascani
	Dalguise
	Grafton (Comparator) - naked oat
Winter Triticale	Fido
	Agostino
Spelt Wheat	Zollernspelz
Spring Barley	KWS Irina
	Propino
	RGT Planet
	Concerto
	Laureate
Spring Triticale	Doublet
	Trimour
Spring Wheat	Mulika
	KWS Cochise
	KWS Alderon
Spring Oats	Canyon
	WPB Elyann
	Aspen
Rye	SU Mephisto

Appendix 6 Plant Growth Regulator Protocol for Cereal Variety Trials - 2019

Last updated December 2018

Recommendations by Peter Riley BASIS registration number R/0/163/M and Sean Burns BASIS registration number: R/E/5408/ICM.

RL Trials Co-ordinator: Mark Bollebakker 01480 482989: NL Co-ordinator: Jeremy Widdowson (BSPB) 01353 653846 mobile 07747 567351

The following notes are given for guidance in the use of plant growth regulators (PGRs) on National List trials. The full manufacturer instructions should be consulted prior to the storage, handling or use of any agrochemical product. The instructions and advice given on product labels should be followed at all times. There should be no conflicting advice between that given in this protocol and on the product label; if there appears to be any conflict, inform the Trials Co-ordinators before the application is made.

Table 1: Summary of applications for NL trials:

Crop	Fungicide treated plots	Plots or DOPs without fungicide treatment	'Lodging' trials
Winter wheat	Yes	No	No
Spring wheat (late autumn or spring sown)	Yes	No	N/A
Winter barley	Yes, unless the crop is stressed and the risk of lodging is negligible.	Yes, unless the crop is stressed and the risk of lodging is negligible.	No
Spring barley	**Only if there is a high risk of lodging.**	No	No
Winter oats	Yes. To +F/+PGR plots only	N/A	No
Spring oats	Yes. To +F/+PGR plots only	No	N/A
Winter rye	Yes	Yes	N/A
Winter triticale	Yes	Yes	N/A

Plant growth regulators should **not** be applied to trials grown specifically for the assessment of lodging.
There are important restrictions relating to the use of plant growth regulators. Crop damage can occur if the manufacturer's guidelines are not followed.

Common restrictions are those relating to crops that:

are sited on soils of low fertility
are suffering from herbicide damage
are under stress from drought, waterlogging or any other cause
were sown in the very late spring

Trial managers should consult the manufacturer's instructions to see if any of these restrictions apply.

IN ALL CASES, PLANT GROWTH REGULATOR SHOULD BE APPLIED TO DESIGNATED PLOTS ONLY AS SPECIFIED IN THE AHDB RECOMMENDED LIST CEREAL TRIALS PROTOCOL.

General guidance and notes specific to the use of PGRs on variety trials

Products should be used according to current manufacturer's instructions. It is the responsibility of the trial manager to ensure that the growth stages of all of the varieties in the trial are within the manufacturer's guidelines for use. The following notes are intended to highlight matters of particular relevance to the use of PGR products on variety trials and timings are relevant to earliest varieties.

The **Terpal** doses in this protocol are below full rate (**2.0 l/ha**).

Consult the Trials Co-ordinator if you feel that a higher dose is needed eg, if there is a risk of severe lodging. However be aware that late applications of **Terpal** (eg at around the flag leaf emergence stage) at higher doses can lead to crop damage or stimulate the production of secondary tillers.

Winter wheat and late autumn sown spring wheat

Product	Crop	Rate & timing
SPLIT DOSE 3C Chlormequat 750 + Moddus OR SINGLE DOSE (Winter wheat and late autumn sown Spring wheat) **3C Chlormequat 750 + Moddus**	**Winter Wheat only**	**3C Chlormequat 750** at 1.0 l/ha at GS25-30 PLUS †**Moddus** at 0.1 l/ha if applied at the GS30 timing. followed at GS31-32 by **3C Chlormequat 750** at 1.0 l/ha PLUS †**Moddus** at 0.1-0.2 l/ha. **Do not apply if any variety is beyond the GS32 timing**
	Winter Wheat	**3C Chlormequat 750** @ 1.5-2.0 l/ha at GS30-31 (in the North and North-west regions this can be delayed to GS32) PLUS †**Moddus** at 0.1-0.2 l/ha **Do not apply if any variety is beyond the GS32 timing.**
	Spring Wheat	**3C Chlormequat 750** @ 1.25 l/ha at GS30-31 (in the North and North-west regions this can be delayed to GS32) PLUS †**Moddus** at 0.1-0.2 l/ha. **Do not apply if any variety is beyond the GS32 timing**
Terpal		Either **single-dose** of 0.75-1.5 l/ha (depending on lodging risk and *condition of the crop) at GS32-37 **OR (particularly for the early sown crops)** a **split dose** of 1.0 l/ha at GS33 plus 0.75 l/ha at GS37 **Maximum individual dose is 2.0 l/ha, maximum total dose is 2.0 l/ha and maximum number of treatments is 2 per crop.**

*__Terpal__ should not be applied if, on any variety in the trial, if the leaf sheaths have split and the ears are visible. Do **NOT** apply **Terpal** if the crop is suffering from herbicide damage or physical stress caused by e.g. waterlogging, drought, take-all. Do **NOT** apply in temperatures above 21°C. If, in Winter wheat/Spring wheat trials there are large differences in growth stages; contact the RL Trials Co-ordinator/ NL Coordinator.

† Moddus. Apply unless the crop is stressed or the lodging risk is negligible.

Spring sown spring wheat trials

Product	Rate & timing
3C Chlormequat 750	Single dose of 0.6-1.0 l/ha at GS30-31. Consult the Trials Co-ordinator if the crop is late sown and/or under stress. **Do not apply if any variety is beyond the GS32 timing.**

Terpal and Moddus should not be applied to spring sown spring wheat trials.

Winter barley trials

Product	Rate & timing
3C Chlormequat 750 + Moddus	3C Chlormequat 750 at 1.5-2.0 l/ha at GS25-30 PLUS †Moddus at 0.1-0.2 l/ha if applied at the GS30 timing.
Moddus	*Optional: GS 31-32 in high fertility situations (0.1-0.2 l/ha)*
Terpal	0.75-1.0 l/ha at *GS32-39

* The preferred option for **Terpal** is for the product to be applied separately from the T2 application. Terpal should not be applied if, on any variety in the trial, the leaf sheaths have split and the ears are visible. Do NOT apply Terpal if the crop is suffering from herbicide damage or physical stress caused by eg waterlogging, drought, take-all. Do NOT apply in temperatures above 21°C.

† **Moddus**. Apply unless the crop is stressed or the lodging risk is negligible.

Spring barley trials

Product	Rate & timing
Moddus	*Optional: Moddus may be applied at 0.1-0.2 l/ha at GS30 for increased rooting and tiller survival and where lodging may be expected.*
Terpal	*Optional: Terpal 0.5 l/ha at GS32-37. Apply only if the risk of lodging is high and the crop shows no signs of stress.*

Winter & spring oat trials

Product	Rate & timing
Moddus	*Optional: Moddus at 0.1-0.2 l/ha, in high lodging risk situations and if applied at GS30,*
3C Chlormequat 750 NOT FOR LODGING TRIALS	Single dose: 3C Chlormequat 750 1.5-2.0 l/ha at GS31- 32. A non-ionic wetting agent should be used: see product label.

Apply routinely as a single application to all appropriate trials unless it is felt that the application is inadvisable, in which case the Trials Co-ordinators should be consulted. Do not apply to 'lodging' trials.

Terpal should not be used on oat trials.

Winter rye trials

Product	Rate & timing
3C Chlormequat 750	*Either single dose: 3C Chlormequat 750 at 1.0 l/ha PLUS †Moddus at 0.1-0.2 l/ha at GS30*
	OR
	(optional for rye) split dose: 3C Chlormequat 750 1.0 l/ha at GS 31-32 PLUS †Moddus at 0.1-0.2 l/ha
Terpal	Terpal 1.5-2.0 l/ha at GS37 (use lower rate if crop is stressed).

Winter triticale trials

Product	Rate & timing
3C Chlormequat 750	**Single dose: 3C Chlormequat 750 at 1.5-2.0 l/ha PLUS †Moddus at 0.1-0.2 l/ha at GS30.**
Terpal	Terpal 1.0-1.5 l/ha

† Moddus. Apply unless the crop is stressed or the lodging risk is negligible.

Spring triticale (NL trial)

Product	Rate & timing
3C Chlormequat 750	**Single dose: 3C Chlormequat 750 at 2.0 l/ha**

Appendix 7 Fungicide Protocol for Cereal Variety Trials – 2017

Last updated December 2017

Recommendations by Peter Riley, BASIS registration number R/0/163/M and Sean Burns, BASIS registration number: R/E/5408/ICM

RL Trials Co-ordinator:	Mark Bollebakker	01480 482989
NL Co-ordinator:	Jeremy Widdowson	01353 653846

This programme is for use on AHDB Recommended List and National List cereal trials in 2019:

- For spring and summer applications to 2018/19 trials
- for autumn applications to 2019/20 trials

It is an experimental protocol and is designed to meet the protocol aim of keeping disease levels in treated plots below 5% infection in all varieties and in all trials. It is not intended to follow commercial practice.

Please note that most treatments are compulsory and the rates and timings specified should be adhered to as closely as possible. The protocol is robust and, if applied correctly, should be effective. **If, however, disease levels rise above 5% (e.g. if weather conditions do not allow optimal application), please contact Mark Bollebakker (RL) or Jeremy Widdowson (NL) to discuss an appropriate course of action.**

Fungicides should be applied at the stated dose rates unless agreed otherwise with the RL Trials Co-ordinator or NL Coordinator. Changes to dose rates will only be sanctioned in exceptional circumstances, such as drought-stressed trials under low disease pressure.

Please contact the RL Trials Co-ordinator or NL Co-ordinator if you have any difficulty in sourcing a particular product.

In some cases, two or more products may be available from a company with the same active substances and formulation; if you wish to use such a product and it is not listed in this protocol, contact the RL Trials Co-ordinator or NL Co-ordinator. Generic products should be avoided as they may contain the same active substances but in a different formulation.

Important: Every care has been taken to ensure that all mixtures, rates and timings are approved, meeting COSSH regulations and manufacturer's guidelines. However, it is the responsibility of the Trial Manager to ensure that they meet all current regulations at the time of application. The RL Trials Co-ordinator or NL Co-ordinator should be notified of any conflict between the protocol and current regulations.

In accordance with FRAC guidelines, only two applications of strobilurin fungicides and two SDHI fungicides are to be applied to any crop.

When you are applying optional treatments make sure you adhere to Product Labels regarding maximum total dose and maximum number of treatments.

Products, active substances and manufacturers

Product	Active substance	Amount of active substance	Manufacturer
Adexar	fluxapyroxad epoxiconazole	62.5 g/l 62.5 g/l	BASF
Ascra Xpro	Bixafen fluuopram proticonazole	65 g/l 65 g/l 130 g/l	Bayer CropScience
Amistar Opti	azoxystrobin chlorothalonil	100 g/l 500 g/l	Syngenta
Aviator 235 Xpro	bixafen prothioconazole	75 g/l 160 g/l	Bayer CropScience
Bravo 500	chlorothalonil	500 g/l	Syngenta
Comet 200	pyraclostrobin	200 g/l	BASF
Corbel	fenpropimorph	750 g/l	BASF
Crafter	Chlorothalonil tebuconazole	250 g/l 90 g/l	Nufarm
Cyflamid	cyflufenamid	50 g/l	Certis
Elatus ERA	benzovindiflupyr prothioconazole	75 g/l 150 g/l	Syngenta
Fandango	fluoxastrobin prothioconazole	100 g/l 100 g/l	Bayer CropScience
Priaxor	fluxapyroxad pyraclostrobin	75 g/l 150 g/l	BASF
Proline 275	prothioconazole	275 g/l	Bayer
Prosaro	prothioconazole tebuconazole	125 g/l 125 g/l	Bayer
Rubric/Cortez	epoxiconazole	125 g/l	Headland/Adama
Scotia/Manitoba	Epiconazole folpet	50 g/l 375 g/l	Adama
Siltra Xpro	bixafen prothioconazole	60 g/l 200 g/l	Bayer
Talius/Justice	proquinazid	200 g/l	DuPont

Note: in the following tables, compulsory applications are highlighted as **bold** text, optional applications are highlighted in *italics*.

Winter wheat (including the very early sown winter wheat series)

Treatment Timing	Growth Stage	Application
Before T0	*Optional if rusts present in the autumn or early spring*	*Rubric or Cortez (0.5 l/ha)*
	Optional if mildew present in the autumn	*Corbel (0.5 l/ha)*
T0	**GS 30 (no later than when 50% of varieties at GS30.)**	**Cyflamid (0.25-0.35 l/ha) + Crafter (2.0 l/ha) [or Cherokee (1.33 l/ha) if available to use up]**
	Plus optional if septoria present AND the autumn option was not applied.	*Rubric or Cortez (0.5 l/ha)*
T1	**GS 32 (most varieties at GS32) but no later than 4 weeks after application T0. <u>Target: leaf 3.</u>**	
	EITHER: where eyespot is the main concern:	**Adexar (0.75 l/ha) +Tracker (1.0 l/ha) + Bravo 500 (1.0 l/ha) + Talius/Justice (0.15 l/ha)**
	Optional if rust developing	*Comet 200 (0.4-0.6 l/ha)*
	OR: where septoria is the main concern:	**Elatus ERA (1.0 l/ha) + Bravo 500 (1.0 l/ha) + Talius/Justice (0.15 l/ha)**
	Optional if rust developing	*Comet 200 (0.4-0.6 l/ha)*
T 1.5	*GS 33 (targeting leaf 2 emerg) – should be used if septoria risk is high*	*Scotia/Manitoba (1.5 l/ha)*
When using optional products, note maximum number of epoxiconazole and chlorothalonil applications. **No more than 2 applications of SDHI fungicides should be applied to any cereal crop** **Depending if "knock down" or protectant activity is required, applications of Cyflamid (eradicant) and Talius/Justice (protectant) can be swapped at T0 or T1.** **Note for Cyflamid, the maximum number of treatments is 2 per crop on all recommended cereals. Apply only in the Spring.**		
Treatment Timing	**Growth Stage**	**Application**
T2	**GS 30-45 and no later than 4 weeks after application T1. <u>Target leaf 1</u>**	**Ascra Xpro (1.2-1.5 l/ha) + Bravo 500 (1.0 l/ha)**
	Optional, if mildew established	*+ Cyflamid (0.25-0.5 l/ha)*
T3	**GS 55-61 Timing for Fusarium control (very early anthesis preferred)**	**Proline 275 (0.5-0.72 l/ha) + Amistar Opti (1.0 l/ha)**
	In high risk brown rust situations, replace Amistar Opti with Comet 200 at the higher rate	*Comet 200 (0.4-0.6 l/ha)*
T4	**For extreme septoria conditions please contact the trials co-ordinators.**	

Spring wheat (autumn sown)

Treatment Timing	Growth Stage	Application
	If there is disease infection prior to GS 29, consult the Trials Co-ordinator/NL Coordinator.	
T0	*Optional if mildew is developing*	*Corbel (0.5 l/ha)*
T1	**GS 29-31** **Cyflamid (eradicant) can be swapped with Talius/Justice (protectant) in a mildew situation.**	**Cyflamid (0.25-0.35 l/ha)** **+ Amistar Opti (1.0 l/ha)** **+ Rubic/Cortez (0.3-0.5 l/ha)**
T2	**GS 37 and no later than 3 weeks after T1 application.**	**Ascra Xpro (1.0-1.2 l/ha)** **+ Bravo 500 (1.0 l/ha)** **+ Talius/Justice (0.15 l/ha)**
T3	*Optional, if rust established but note risk of crop stress.*	*+ * Comet 200 (0.4-0.6 l/ha)*

*Apply the higher rate in high risk brown rust situations

Spring wheat (spring sown)

Treatment Timing	Growth Stage	Application
	If there is disease infection prior to GS 29, consult the RL Trials Co-ordinator/NL Co-ordinator.	
T1	**GS 29-31** **Cyflamid (eradicant) can be swapped with Talius/Justice (protectant) in a mildew situation.**	**Cyflamid (0.25-0.35 l/ha)** **+ Amistar Opti (1.0 l/ha)** **+ Rubic/Cortez (0.3-0.5 l/ha)**
T2	**GS 37 and no later than 3 weeks after T1 application.** *Optional, if rust established but note risk of crop stress.*	**Ascra Xpro (1.0-1.2 l/ha)** **+ Bravo 500 (1.0 l/ha)** **+ Talius/Justice (0.15 l/ha)** *+ * Comet 200 (0.4-0.6 l/ha)*
T3	**GS 51-61**	**Proline 275 (0.5-0.72 l/ha)** **+ * Comet 200 (0.4-0.6 l/ha)**

*Apply the higher rate in high risk brown rust situations

Winter Barley

Treatment Timing	Growth Stage	Application
	Optional if net blotch is present in the autumn or early spring.	*Proline 275 (0.5 l/ha)*
T0	*Optional if mildew present in the autumn or early spring.*	*Corbel (0.5 l/ha)*
T1	**GS 26-30 at the start of spring growth.**	**Proline 275 (0.3-0.5 l/ha) + Corbel (0.35-0.5 l/ha)**
T2	**GS 39-45 (earliest varieties should not exceed GS45).**	**Priaxor (1.0-1.5 l/ha) + Bravo 500 (1.0-2.0 l/ha)**
	Optional: if net blotch or rhynchosporium developing	*Proline 275 (0.3-0.5 l/ha)*
T3	*GS 59-61 Compulsory if brown rust is a risk*	*Fandango 0.75 l/ha*

BYDV management tool

Barley/cereal yellow dwarf viruses (BYDV) are mainly transmitted by the bird cherry–oat aphid and the grain aphid.

Initially, aphids colonise relatively few crop plants. When the second generation offspring are produced, these tend to move away from the plant originally colonised. Controlling this generation is a key component of a BYDV management strategy.

The timing of the second generation can be approximated by accumulating daily average air temperatures above a baseline temperature of 3°C. It takes around 170 'day degrees' (DD) for the second generation to be produced.

The BYDV management tool (https://ahdb.org.uk/bydv) can be used to calculate when the 170DD threshold has been reached at sites in our weather station network.

Spring barley

Treatment Timing	Growth Stage	Application
T0	*GS 13-15 Optional if disease present*	*Corbel (0.35 l/ha)* *Proline (0.2-0.4 l/ha)*
T1	**GS 25-31 Applications at the earlier end of this range may be necessary if rhynchosporium or mildew is developing.**	**Siltra Xpro (0.4-0.6 l/ha) + Bravo 500 (1.0 l/ha)**
	Optional if mildew present	*Cyflamid (0.25-0.35 l/ha)*
T2	**GS 39-59 (earliest varieties should not exceed GS 59) but no later than 3 weeks after T1 application** **If any variety has passed the GS59 timing, contact the Trials Co-ordinator.**	**Priaxor (1.0-1 5 l/ha) + Bravo 500 (1.0-2.0 l/ha)**
T3	*GS 59-61 Compulsory if brown rust is a risk*	*Fandango (0.75 l/ha)*

Winter oats

Treatment Timing	Growth Stage	Application
T0	**Mid to late tillering**	**Cyflamid (0.25-0.35 l/ha) + Rubric or Cortez (0.5 l/ha)**
	Optional if mildew present	*Corbel (0.5 l/ha)*
T1	**GS 31 (Please note: Maximum application of Siltra to a crop is 1.0 l/ha)**	**Siltra Xpro (0.4-0.6 l/ha) + Talius/Justice (0.15 l/ha)**
	Additional compulsory if crown rust pressure is high.	*+ Comet 200 (0.5 l/ha)*
T2	**GS 39-45 (Please note: Maximum application of Siltra to a crop is 1.0 l/ha)**	**Siltra Xpro (0.4-0.6 l/ha) + Cyflamid (0.25-0.35 l/ha)**
	Optional if crown rust pressure is high	*+ Comet 200 (0.5 l/ha)*
T3	*Optional if crown rust remains a problem before GS59-61*	*Rubric or Cortez (0.5 l/ha)*

Spring Oats

Treatment Timing	Growth Stage	Application
T0	*GS 13-15 Optional if disease present*	*Corbel (0.35 l/ha)*
T1	**Mid to late tillering (Please note; Maximum application of Siltra to a crop is 1.0 l/ha)**	**Siltra Xpro (0.4 l/ha) + Cyflamid (0.25-0.35 l/ha)**
	Optional if crown rust is a problem	*+ Comet 200 (0.5 l/ha)*
T2	**GS 39-45 (Please note; Maximum application of Siltra to a crop is 1.0 l/ha)**	**Siltra Xpro (0.4 l/ha) + Talius/Justice (0.15 l/ha)**
	Optional if crown rust is a problem	*+ Comet 200 (0.5 l/ha)*

Winter rye and winter triticale

Treatment Timing	Growth Stage	Application
T0	**GS 30 (may be applied earlier if rust is present)**	**Rubric or Cortez (0.5 l/ha) + Corbel (0.35-0.5 l/ha)**
T1	**GS 31-32**	**Elatus ERA 1.0 l/ha + Corbel (0.35-0.5 l/ha)**
	Optional if rust developing	*+ Amistar (0.5-1.0 l/ha)*
T2	**GS 39-45**	**Adexar (1.5 l/ha)**
	Optional if rust developing	*+ Fandango (0.75-1.0 l/ha)*
T3	*Optional (rye only) if rust remains a problem before GS61*	*Prosaro (0.8 l/ha)*
	Optional (rye only) if mildew remains a problem before GS61	*Corbel (0.35-0.5 l/ha) OR Clayton Spigot (0.35-0.5 l/ha)*

Spring triticale (NL trial only)

Treatment Timing	Growth Stage	Application
T1	**GS 31-32**	**Elatus ERA 1.0l/ha + Talius/Justice (0.15 l/ha)**
T2	**GS 39**	**Adexar (1.5 l/ha)**

Appendix 8 Moisture Content Determination for Yield

Yield data must be corrected to 15% 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 – the oven method, electronic moisture analysers method or NIR determination.

1. 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. (Temperature to be reviewed by the Procedures Development Group).

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 0.1 g ± 0.05 g. 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 100 g sub-sample or an accurately recorded catch-weight between 100-200 g 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 0.1 g.

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 about 16hrs. 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 all samples from a given trial have been recorded, the fresh and dry weights are immediately reported to the Data Handling Operator electronically. When the dry weights are reported as a percentage, the fresh weight should be reported as 100.

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.

Equipment

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.
- The data sent to the Data Handling Operator must be in the form DRYMATTER%.

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.

2 NIR Determination

The NIR method is permitted for the measurement of moisture content provided that the instrument uses current UK NIR Network calibrations for the appropriate crops. The operator must also participate in the monthly ring checks for the various calibrations being used to demonstrate that the instrument and operating practices are performing within specification. Records of the results of the monthly ring checks should be available for inspection if required.

Appendix 9 Dates by which Records should be Submitted

1 Dates by which Records Should be Sent to Trials Organiser

Record	Latest date of receipt by Trials Organiser
Site data part 1 (including site sketch)	Within 2 months of drilling trial (autumn sown trials) Within 1 month of drilling trial (spring sown trials)
Site data part 2	By the time trials harvested
Plot records (in approved electronic format)	Growing Trial Operator should notify Trials Organiser that trial has been harvested within 2 days of harvest

2 Dates for Submission of Plot Records to Data Handling Operator

Record	Date
Plot records SHOULD be sent to Data Handling Operator	Yield and moisture data within 3 days of harvest Other data within 10 days of record being taken

3 Dates of Submission of Plot Samples to Quality Testing Operator

Samples	Date
Plot samples for quality testing SHOULD be sent to Quality Testing Operator	Within 2 days of harvest

Appendix 10 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	flag 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 of Applied Biology 100, 683-687.

Appendix 11 Assessment Keys for Cereal Diseases

1) Examine top 4 leaves. If top leaf has been fully expanded for less than 14 days, refer to 2nd leaf as 'top leaf'.

2) Ignore all naturally senescent leaf tissue.

3) Include all chlorosis and necrosis attributable to disease.

4) Record % infection; use interpolated values (e.g. 3%) if necessary.

If foci present, record average over the plot as a whole.

Report infection as a score (1-9).

% Infection	Infection by score (1-9)	Crown rust	Yellow rust	Brown rust
0	1	No infection observed		
0.1	2	1 small cluster of pustules per tiller	1 stripes per tiller	25 pustules per tiller
1	3	1 cluster per leaf	2 stripes per leaf	100 pustules per leaf
5	4	Most tillers infected but some top leaves uninfected	Most tillers infected but some top leaves uninfected	Top leaf – numerous pustules but leaves appear green overall
10	5	All leaves infected but leaves appear green overall	All leaves infected but leaves appear green overall	Top leaf – pustules sufficiently dense to give brown appearance in patches
25	6	Leaves appear ½ infected ½ green		
50	7	Leaves appear more infected than green		
75	8	Very little green leaf tissue left		
100	9	Leaves dead - no green tissue left		

% Infection	Infection by score (1-9)	Septoria	Rhynchosporium	Net blotch
0	1	No infection observed		
0.1	2	1 lesion per 10 tiller	1 lesion per 10 tillers	1 small lesion per 10 tillers
1	3	2 small lesions per tiller	1 lesion per tiller	1 small lesion per tiller
5	4	Small lesions beginning to form areas of dead tissue across width of leaf	Discrete lesions on most tillers, about 2 per leaf	2 lower leaves appear ¼ infected. Other leaves - few lesions
10	5	2 lower leaves – large areas of diseased tissue some covering 1/3 of leaf	Lesions coalescing but leaves appear green overall	2 lower leaves appear ½ infected. Other leaves - numerous lesions
25	6	Leaves appear ½ infected ½ green		
50	7	Leaves appear more infected than green		
75	8	Very little green leaf tissue left		
100	9	Leaves dead - no green tissue left		

% Infection	Infection by score (1-9)	Mildew
0	1	
0.1	2	3 pustules per tiller
1	3	5 pustules per leaf
5	4	2 lower leaves appear ¼ infected
10	5	2 lower leaves appear ½ infected
25	6	Leaves appear ½ infected ½ green
50	7	Leaves appear more infected than green
75	8	Very little green leaf tissue left
100	9	Leaves dead - no green tissue left

% Infection	Infection by score (1-9)	Ramularia
0	1	
1 – 5	2	Sparse lesions on upper leaves
6 – 10	3	More lesions on upper leaves
11 – 20	4	Numerous lesions on middle and upper leaves with some necrosis
21 – 30	5	Many lesions and severe necrosis on upper leaves and lesions on middle leaves
31 – 40	6	Extensive lesions on upper leaves many lesions on middle leaves and necrosis
41 – 50	7	Severe damage to upper leaves more lesions and necrosis on middle and lower leaves
51 – 75	8	100% lesions on upper leaves severe necrosis on middle leaves
75 – 100	9	Almost all leaves necrotic with lesions on all leaves

Ear Blight of Wheat (*Fusarium* Spp.)

Percentage area infected
(O = Healthy)

Notes on assessment
1) Carry out the assessment between GS 80-90.
2) Conduct a 'whole-plot' assessment using the diagram above as a guide to infection

levels.
3) Estimate the infection level at several points in the plot, giving a single score per plot that is representative of the whole plot.

For further details see Parry D W, Bayles R A & Priestley R H (1984). Resistance of winter wheat varieties to Ear Blight *(Fusarium culmorum).* Journal the National Institute of Agricultural Botany 16, 465-468.

Wheat Glume Blotch (*Septoria nodorum* Berk.)

Percentage of ear affected

Notes on assessment
1) Carry out the assessment between GS 80-90.
2) Conduct a 'whole-plot' assessment using the diagram above as a guide to infection levels.
3) Estimate the infection level at several points in the plot, giving a single score per plot that is representative of the whole plot.

For further details see Parry D W, Bayles R A & Priestley R H (1984).
Resistance of winter wheat varieties to Ear Blight *(Fusarium culmorum).*
Journal the National Institute of Agricultural Botany 16, 465-4

For further information and photos see the HGCA cereals encyclopaedia at http://cereals.ahdb.org.uk/.

This publication is available at www.gov.uk/government/publications

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