Proposed Protocol
Requirements & Specifications for 2017/18 Drift Trials

Version: 3.4
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Please Note:

Protocol is specific to the 2017/18 SETAC drift trials. Clearly some aspects will be optional later (*e.g.*, choice of nozzle, crop, *etc*.)

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Proposed protocol for drift trials

1. Introduction

1.1 Purpose

The ‘Protocol - Requirements & Specifications for Drift Trials‘ describes a proposed framework of conditions under which the SETAC DRAW research drift trials should be conducted.

The protocol describes the requirements and specifications for measurements and parameters.

1.2 Background

The trials and their data are important to generate reliable and comparable results to establish a uniform conclusion, statement and meaning on drift values – at a global scale. Therefore it is of great importance to conduct trials following exactly the same design. The proposed protocol sets up the framework for these trials – from a scientific and statistical point of view.

It is recognised that there is an International Standard (ISO 22866: Equipment for Crop Protection – Methods for field measurement of spray drift: ISO 2005) that defines some of the methodology for the field measurement of drift covering both ground deposition and airborne drift concentrations. This protocol builds on the requirements in this standard but relates only to ground drift deposits.

The trial area will have an area of bare ground to be sprayed next to the cropped area (Figure 1), giving a referenced field trial. This is in effect, two trials, one next to the other.

1.3 Terminology

A trial is a number of drift collection events, with an event covering a single application condition (*e.g.,* wind speed) as close to similar across the replicate events as possible (*c.f.*, ISO 22866). Each event is single pass along a set of drift collectors (*i.e.*, a replicate within a trial). Three replicates (events) are needed for each treatment (*c.f.*, ISO 22866). The treatment list makes up the trial.

A drift line is a single row of collectors stretching downwind from the edge the sprayed area. A drift line will generate a single drift curve.

1.4 Mandatory Requirements: EFSA

The full list of EFSA mandatory inclusion / exclusion criteria is given in Section 3. Fulfilment is required in order for the data to be considered acceptable for inclusion in any EFSA data set or compilation. In general, following the protocol will fulfil EFSA’s criteria (see Section 3, but also note protocol entries marked **EFSA**) .

1.5 Archiving

Archiving of especially met. data is necessary, as is any video documentation of the trial (see Section 2.10.1).

2. Proposed protocol

Item	Value/Requirement	Type	Remarks
2.1 Factors & Repetitions			
2.1.1 Repetitions – measuring points	A minimum of 6 (preferably 10) drift lines plus doubling of samplers on one li e (minimum) for reference purposes **if** petri-dishes are not used [1]	Mandatory	= Row (drift line) of the different distances = each distance is placed six (up to 10) times in the field (Figure 3)
2.1.2 Number of distances	Minimum 6 to cover 1 m to 20 m downwind	Mandatory	see also: Section 2.6 in this table
2.1.3 Number of sampler types	1, but must include petri-dishes (see 2.6.1) if another sampler type is used.		See also Section 2.6 in this table
2.1.4 Replicated trials over different the growth stages	Suggested minimum of 3 growth stages	Mandatory	*e.g.* BBCH 12-21, 31/32 & 37-49 (see Figure 5, Appendices)
2.1.5 Number of replicates in any trial	Suggested minimum of 3 (for statistical purposes: CI of 5%)	Mandatory	As suggested in ISO 22866 – p. 5, Section 3.6
2.2 Testing area **The area on which the trial is performed** **+ the area on which the measurements are performed (see also Appendix 5.1 and 5.2)**			
2.2.1 Treatment area – length	180 m (2 x 90 m) The length has to cover the scenario that the potential drift will be driven by the wind with the maximum allowed deviation (30°) – see Figure 1 and Figure 2	Minimum	• Length over measuring points ≈ 10 m (11 lines at 1 m spacing) • Additional length in case of wind with maximum deviation (30°) ≈ 80 m (2 x 40.4 m)
2.2.2 Treatment area – width	Boom width plus 20 m of equivalent cropped area upwind	Minimum	Minimum 18 m boom to be used, with <u>one</u> pass (see also Section 5.6) with a sprayer working width of 18 m or greater <u>plus</u> an upwind area of crop for weather tower (see 2.5.8) In the case where a farmer has already set up the field such that only a smaller sprayer can be used, this can go down to 18 m. [2]

[1] Allows for an assessment of the variability of drift at the very small scale of the area in which the various sampler types are placed.

[2] There will be situations where a farmer's field is already set up with tramlines for a smaller sprayer. Then, either the existing sprayer boom width is used (*e.g.*, 18 m) or if a very small sprayer has been used (*e.g.*, 12 m boom), then a 36 m boom could be used to cover the 18 m wide swath of the (1.5 x) 12 m boom travel and tramlines. This is a matter of judgment for the trialist. In general, the trials will be set up on bare ground prior to drilling, so this issue can be resolved earlier.

Item	Value/Requirement	Type	Remarks
2.2.3 Treatment area – surface	Crop and bare ground (see Figure 1)	Mandatory	Good farming practice; cultivated following local conditions (PPPs, fertilizer, *etc.*)
2.2.4 Conditions area	Standard soil preparation	Mandatory	No unevenness or bumps
2.2.5 Conditions field crop	Minimized overlaps and/or gaps in the field	Mandatory	Large empty areas in the crop have to be avoided (no placement of measuring points aligned in this direction)
2.2.6 Measurement area – dimensions	Length same as treatment area Width at least = furthest measuring point plus at least 10 m to the nearest obstacle (*e.g.*, 20 m downwind + 10 m)	Minimum	
2.2.7 Measurement area – surface	Seed bed quality area downwind for sampler locations	Mandatory	To be a standard across all trials
2.2.8 Slope of the treat-ment & the measurement area	<2% (2 m rise in every 100)	Request	Test area should be as level as possible. Slope to be recorded **(EFSA)**
2.2.9 Surrounding area	No hills, trees or forests, hedges or buildings on both sides within 10 widths of the sprayer to be used.	Request	As far as possible Both sides (upwind and downwind) are important. To be recorded **(EFSA)**.
2.2.10 Trial location	Latitude and longitude	Mandatory	So as to be able to locate field *e.g.*, in Google Earth. To be recorded **(EFSA)**.
2.3 Machinery – Sprayer **The sprayer should be a standard sprayer available on the market with a current state of the art design and a conventional design of boom. It should have a good well maintained boom suspension system.** It shall be a mounted or trailed sprayer with no air assistance. An official sprayer inspection has to be done, or its equivalent.			
For every trial and every test run throughout the different growth stages, the same sprayer has to be used		Mandatory	
2.3.1 Sprayer type	Trailed, mounted, or self-propelled		Until studies show substantial differences between sprayer types due to wake effects, this point is left open. Choice of sprayer is upt to the trialist.
2.3.2 Sprayer description		Mandatory	Manufacturer, size, make, age.
2.3.3 Working width	18 to 36 m	Minimum / Maximum	One pass only (See Appendices, Section 5.6)
2.3.4 Working speed	8 kph	Requested	Within the standard range of appl. speed in Europe; same over all test runs. (Note: 8 kph means *ca.* 4.5 second pass along sampling area.)
2.3.5 Agitation	On	Mandatory	
2.4 Machinery – Nozzle & Boom			

Item	Value/Requirement	Type	Remarks
2.4.1 Nozzle spacing	50 cm	Mandatory	The standard spacing in Europe and around the world
2.4.2 Pressure at the nozzle	In the range of 2.0 to 3.0 bar	Mandatory	Nominal set pressure must be as close to 3.0 as possible and the actual value must be recorded
2.4.3 Nozzle type	TeeJet XR 110 04	Mandatory	(see Appendix 5.3)
2.4.4 Nozzle size	04 at 3.0 bar	Mandatory	All trials done with *exactly* the same nozzle
2.4.5 Boom height	Nominally 50 cm above target	Mandatory	
2.4.6 Sprayer position and timing	GPS position of sprayer at time of application. Be sure that all time recording devices are synchronised.	Mandatory	Allows wind speed to be linked to sprayer and spray drift lines at high resolution
2.5 Weather & Weather recording			
2.5.1 Wind direction	Nominally 90 degree angle to the working direction; Maximum deviation of 30 degrees (must be considered, see also: Section 2.2 in this table)	Mandatory	Height: 2 m above the ground,
2.5.2 Average wind speed over the trial	Range 2.0 m/s to 5.0 m/s	Mandatory	Relates to mean values during spraying
2.5.3 Wind speed measurement method	Either: a) Ultrasonic anemometers [3] measuring 3 components of wind speed at 2 heights and recorded at 5 Hz or greater; or b) Cup anemometers at 3 heights (or more) and recording every 5 s.	Minimum Maximum	Recording: minimum 5 Hz if sonic anemometer used Height: First 2.0 m above the ground; second at least 4.0 m above ground.
2.5.4 Temperature	Range 5° C to 25° C	Minimum / Maximum Both as a Request	Recording: Once per test run If using 3D sonic anemometers, Measured to accuracy of 0.5°C Height: At same heights as anemometers (*e.g.*, 2.0 m and 4.0 m). If using cup anemometers or 2D sonic anemometers - T°C accurate enough to resolve a temperature difference of 0.01 °C between the two heights

[3] Sonic anemometers are to be preferred as their sampling frequency can be set to match sample lines to wind speed.

Item	Value/Requirement	Type	Remarks
2.5.5 Multiple wind towers	As above.	Optional	If available, the second wind tower should be placed at centre of downwind edge of sampling area.
2.5.6 Humidity	40% 90%	Minimum Maximum	Recording: Once per test run Height: at 2.0 m
2.5.7 Weather station – type	To suit instrumentation	Request	
2.5.8 Weather station – placement	See Figure 3	Mandatory	Within the crop canopy, upwind of sprayed area, on the centreline of the sampling area. If second weather tower available, at centre of downwind edge of sampling area.
2.5.9 No. measurement heights		Mandatory	2 m and 4 m above ground – c(minimum: second measurement height should be higher if possible). Allows for the wind profile to be determined.
2.5.10 Archiving of raw wind speed data	Wind speed raw data needs to be archived – not just the averages recorded		Allows wind speed to be assessed later, *e.g.*, for gustiness.
2.6 Drift measurement (Overview: see Appendix 5.1)			
2.6.1 Sampler types	Sampler of choice, but if not a petri dish then one line of the six (preferably ten) must have petri dishes paired to each sampler. If petri dishes used, then the reference sampler is: 140 mm petri dish, with a 20 mm lip [as per JKI, at the moment until data shows otherwise]	Mandatory	ALL samplers to be uniquely labelled (x,y coordinates in sampling area: *e.g.*, "Line 1; 3 m"). Data recorded as x,y co-ordinates from EoF (x) and first line of collectors (y) (*e.g.*, 3,7 would be 3 m from EoF and 7 m from first line of collectors)
2.6.2 Measuring points – distances	1 – 3 – 5 – 10 – 15 – 20 m	Mandatory	Edge of Field (EoF) is last drilled line. For cereal crops - last nozzle is located 0.25 m in from EoF.
2.6.3 Measuring points – repetitions	Suggested: 10 lines 1 m apart (See Section 2.12.1. in this table)	Mandatory	Distance between drift lines 1 m
2.6.4 Sampler positioning	6 (preferably 10) lines with principal sampler types, of which one line doubles up - principal sampler plus reference sampler	Mandatory	
2.6.5 Sampling area	Seed bed quality area downwind for sampler locations	Mandatory	Common to all drift trials and crops

Item	Value/Requirement	Type	Remarks
2.6.6 Sampling time	Time taken from spraying to collection of last sampler	Mandatory **(EFSA)**	
2.7 Spray liquid			
2.7.1 Tracer	Tracer most reliably used at institute doing analysis for the trial	Request	Must be water-soluble, non-volatile.
2.7.2 Tracer concentration	Sufficiently high to reach 10 x LOQ at maximum distance for the experiment	Mandatory	Resolution required at furthest distance to be able to separate out the variables in the trial. Depends on collector efficiency. This is a matter of expert judgement based on the trialists understanding and experience.
2.7.3 Tracer stability	UV photostability must be demonstrated in advance of the trial. A check on photolysis must also be made in the field at the time of the trial.	Mandatory	See Appendix.5.4. Note: this is a regulatory requirement in other fields.
2.7.4 Surfactant	No surfactant.	Mandatory	(Except that which may be part of the formulation of the tracer.)
2.7.5 Water	Function of nozzle, pressure, and forward speed as outlined above.		Recording mandatory
2.7.6 Plant Protection Products	None	Mandatory	
2.8 Calibration			
2.8.1 Calibration with suitable measuring techniques	• Spray rate • Driving speed • Exact time of start of spraying	Mandatory	To be recorded. Start time important to link to weather data
2.8.2 Field calibration	Check of actual application rate of sprayer	Mandatory	A minimum 0.5 m by 0.5 m filter paper square, replicated three times, in the bare ground area and at the top of the crop. Position under the centre of the sprayer and at the mid-point on each side of the boom.
2.9 Analytical work			
2.9.1 Analytical system 2.9.2 Photo-stability check	Preferred method at institute. Checked in the field at the time of the trial	Mandatory Mandatory	See Section 5.7. See Section 5.4
2.10 Other			
2.10.1 Video recoding	Generally available digital standard (*e.g.*, MPEG 4)	Request	Useful for assessing drift trial differences later

Item	Value/Requirement	Type	Remarks
		Types: Mandatory = no variation are allowed Request = minor variations are allowed – if unavoidable Minimum = the value has to reach at least the given level Maximum = the value must not exceed the given level	

3. EFSA Criteria - essential

1. A clear description of the methodology is given and justified
2. Drift must be directly linked to a plant protection substance application event via a realistic experimental study.
3. The aims, objectives and context are clearly stated and appropriate to the study
4. The sampling approach is clearly described and is justifiable, representative and appropriate, and allows for a consistent sample to be collected. As a minimum this must include sampling time, sampling interval, distance from application to sampling point, sampler type/collector, sampler height.
5. Sampling surfaces/collectors should be adequately sized and spatially distributed. There should be at least 3 sampling points per site.
6. The test site should be clearly defined. This should include the location where the experiment was conducted, positioning of sampling points and time of year. It should also include information on site topography e.g. slope and any obstructions to air flow.
7. Key experimental data must be reported. As a minimum this should be identification of the PPP, formulation, composition, application rate and crop. If a named commercial product is used the concentration in the product should also be reported.
8. Key equipment information must be provided. As a minimum this must include sprayer type, nozzle type, pressure, and if any drift reduction technologies have been used.
9. The meteorological conditions must be fully reported. As a minimum this must include temperature, humidity & wind speed.
10. Rainfall, sunshine/cloud, wind direction would be desirable.
11. Measurements should be replicated under conditions as similar as can be reasonably expected. A minimum of 2 replicates are required.
12. Statistical analysis is appropriate and must address the variability of the study results.
13. Laboratory / analytical work should be done using a validated technique. LOQ / LOD should be reported or identifiable from elsewhere.
14. If a surrogate is used instead of a pesticide the compound must be clearly identifiable. A clear description of the methodology is given and justified

4. Sourcing for reference samplers

For 2016, the reference sampler is the JKI petri dish.

Polystyrene, diameter 140mm, height of lip= 20mm

Supplier:
Greiner bio-one
Ref.Nr. : 639102
https://shop.gbo.com/en/row/articles/catalogue/article/0110_0100_0010_0010/12948/

5. Appendices

5.1 Overview of drift trial

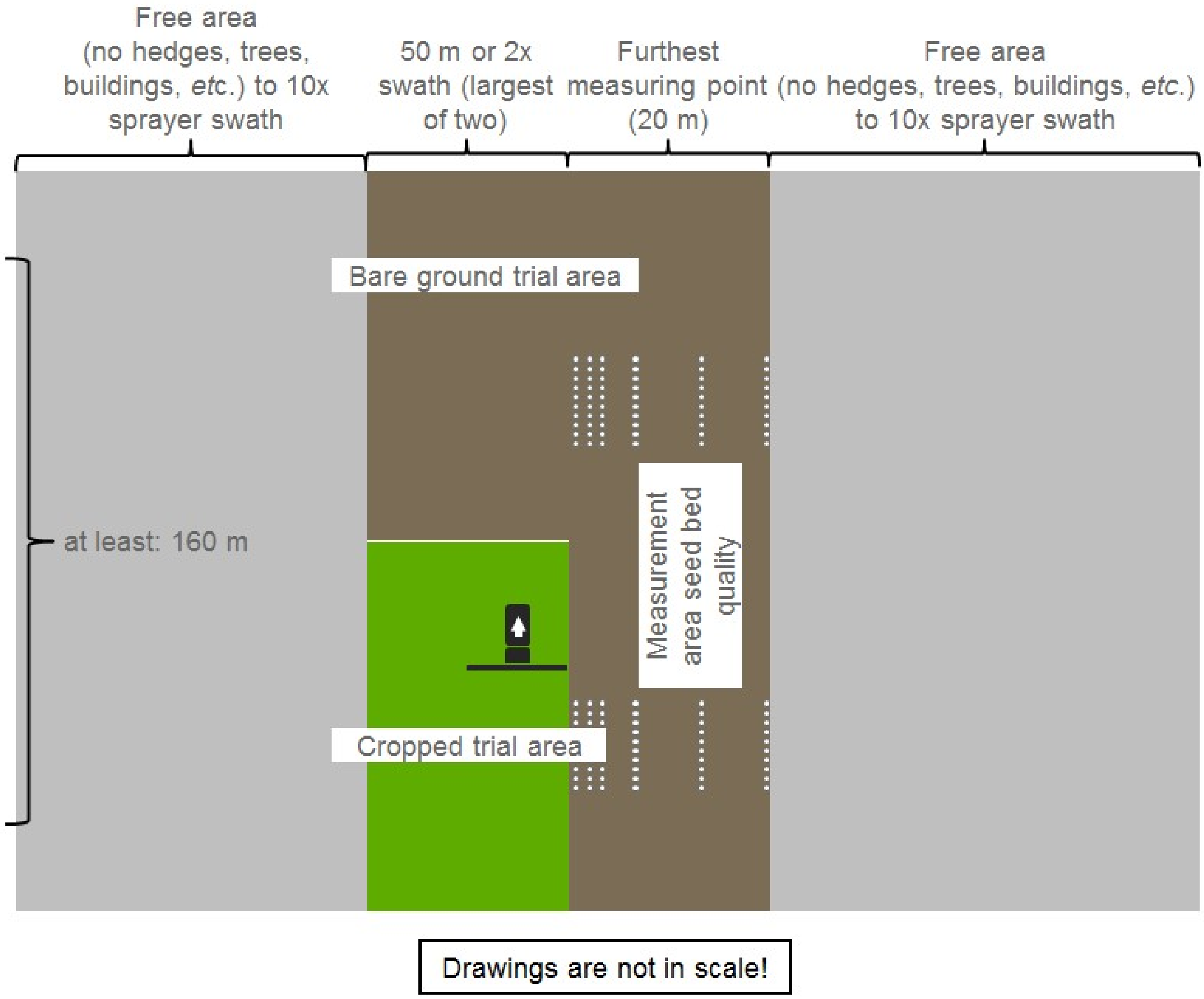

Figure 1. Overall layout of cropped and bare ground components.

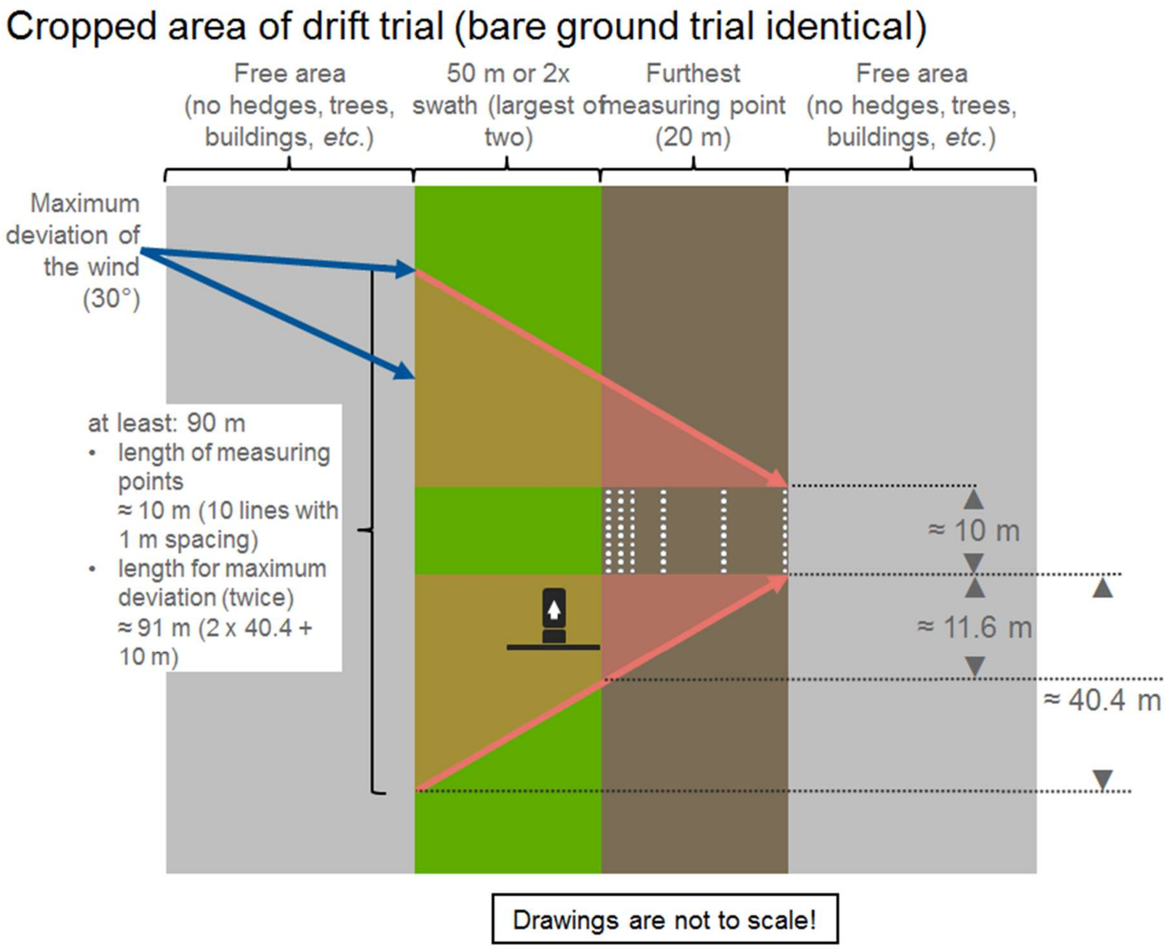

Figure 2. Dimensions of cropped area accounting for wind divergence of 30°.

5.2 Measuring points

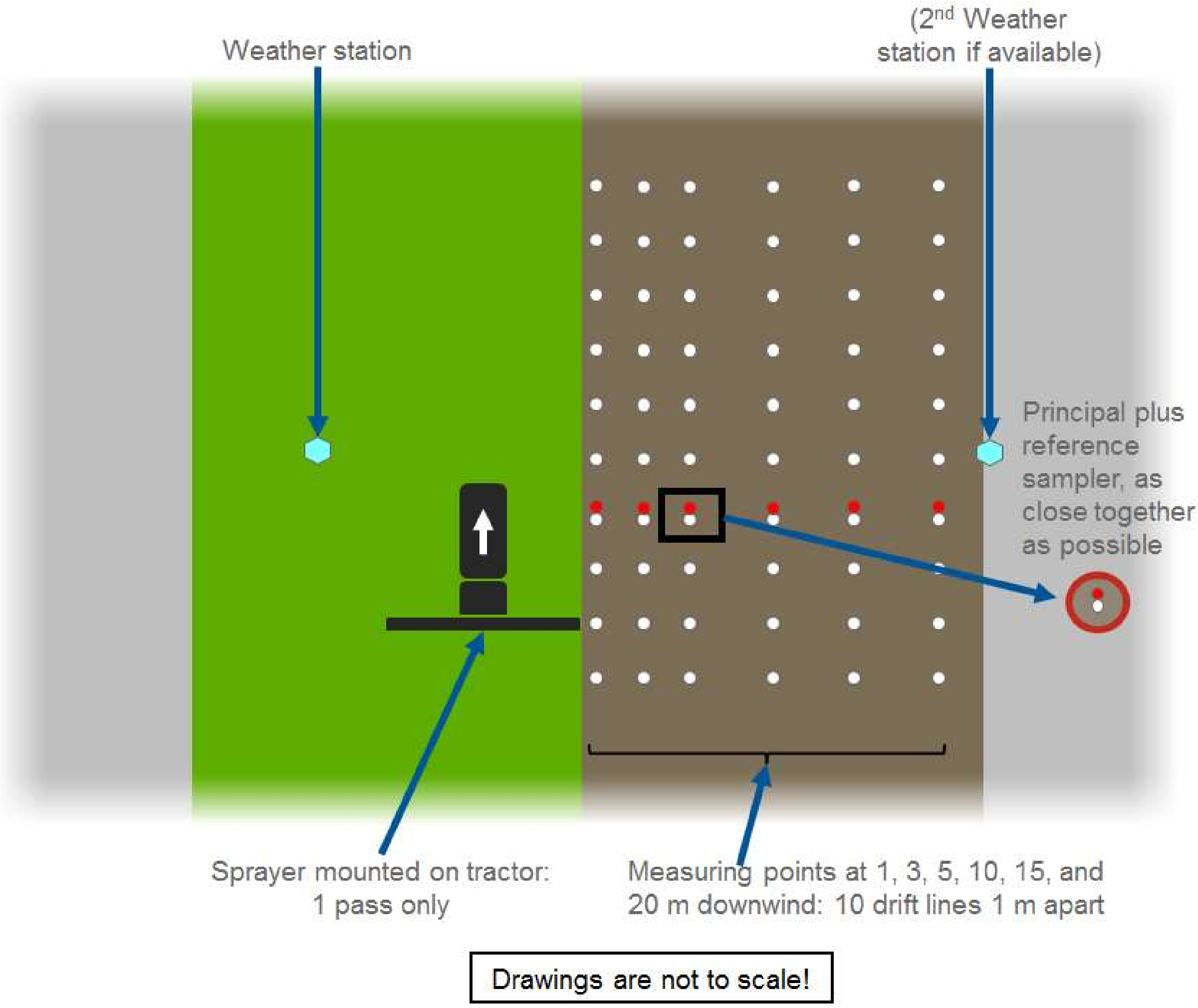

Figure 3. Overall layout of drift lines and measuring points (principal sampler white, reference sampler red), including location of weather towers.

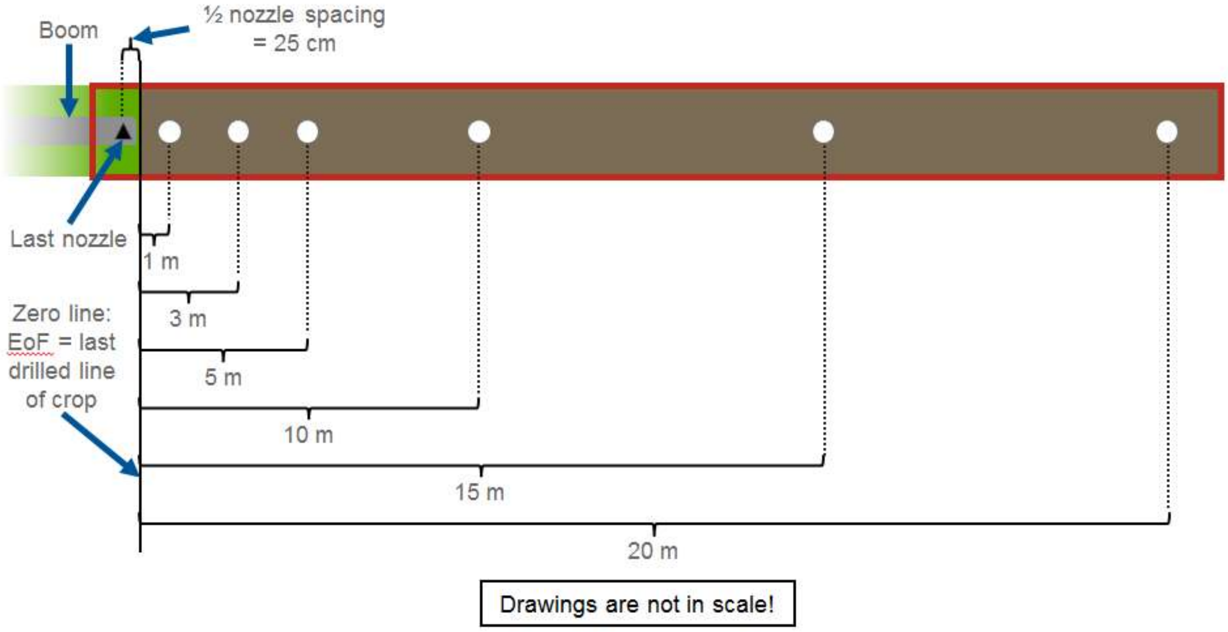

Figure 4. Detailed layout of drift lines and measuring points (various samplers).

5.3 Nozzle Choice

At Workshop 1, the choice of a "standard nozzle" was made as a stainless steel TeeJet 11004 flat fan. There is currently no general agreement in Europe as to what constitutes a standard nozzle for drift trials. There are various arguments that can be made for either standard flat fans or their extended range equivalents.

For the purposes of the trial protocol assessment, the following points were considered, partly at the workshop and then later in "offline" discussions.

1. XR nozzles generate more drift than standard flat fans (Std FFans), even at the same mid-range pressures.
2. The droplet data curves for drift classes are driven by standard flat fans, not XR type.
3. The arable drift data obtained so far by Jane Bonds is split roughly 50:50 on data points from XR or FFan – thus, no particularly compelling case for preference for XR nozzles.
4. Std FFans used by BE & NL; XR by DE & NL; Std FFans+DG type used by DE, NL, & BE.

For the purposes of the trials in 2017/18, it has been decided that the reference nozzle will be a TeeJet XR 100 04, at 3 bar.

5.4 Photostability check

Initial checks must be made to verify the performance of the tracer dye with the collectors to be used so that batches that may have limitations regarding photo-stability are identified. This can use any accepted method established at the laboratory.

Photo-stability must also be checked at the time of the trial. This will involve putting out collectors with a known applied dose that are then exposed for the period when the application is made and the samples collected. This can be done using any documented and validated approach used at the laboratory.

As a minimum, three pairs of collectors can be placed under the sprayer (aligned for and aft) such that they are sprayed with the first pass of the sprayer. When sprayed, both collectors in each pair are removed from the swath – one is then covered and stored in a cool dark place whereas the other is exposed as for the collectors used in the trial. The collectors are then analysed as pairs with the results for the exposed and covered collectors compared to give an estimate of photodegradation.

5.5 Drift trial checklist

To be inserted

5.6 Single versus multiple passes: current rationale

The current thinking is as follows:

One of the aims of the SETAC DRAW Workshops is to build upon, or refine, rather than replace, ISO 22866 (and related drift protocols). The proposed protocol supports two assessments that cannot be investigated with clarity and certainty from legacy drift trials:

1. Providing a better understanding of whether or not the different collectors used by the various research institutes contribute significantly to the difference in results obtained by those research institutes.
2. The protocol is a first step towards supporting higher tier approaches to drift risk assessment (RA) by:
   a. generating drift curves for crops at different growth stages (e.g., the effects of boom height due to different crops)
   b. enable a better understanding of variability in drift at the edge of the field to support enhanced representation of this more directly in more subtle, landscape orientated risk assessments– more directly allowing representation of variability.

From Workshop 1, it was noted that this landscape-orientated assessment requires an accurate direct understanding of the actual variability of drift occurring downwind of the sprayed area. Hence, the size and layout of the samplers bears these requirements very much in mind (*e.g.*, 1 m distance between the spray lines, as agreed by Breakout Group 4). Also important is the requirement that the variability seen in the matrix of samplers accurately represents spray drift variability. This matrix of results will then be used in a landscape RA, as demonstrated in the workshop by Thomas Preuss, using Monte Carlo simulations to obtain a full picture of possible drift exposure in a given landscape.

If a second pass is included in the trial - as is common practice in many trial designs but not explicitly required by ISO 22866 - then the variability is averaged or masked. To take an extreme example, if the sprayer was driven up and down the edge of the field 1000 times, the samplers would all collect the same amount of drift, with extremely small variation. Adding in a second pass takes the measured variability for a single pass towards an average result. Also, the second pass will have different wind conditions: the samplers are exposed to *ca.* 4 seconds of spray, or 4 seconds of the wind conditions at time of spraying. The tractor continues onwards up the field to spray the second drift (reference) area, turns and comes back. This will take some minutes. Wind conditions will change in this time interval: this was made clear by the invited speaker, Richard Perkins, that turbulence effects will always lead to variability in wind conditions over time, even at very short time scales. Thus the samplers will obtain a picture of the variability that contains two overlapping sets of spray drift, leading to wind speed variability being masked in the data.

Especially for trials done with small booms, it is possible that a landscape risk assessment will be judged not to have taken into account the drift from further up the field. The second pass will contribute more drift, but not more than 5%-10% (according to Paul Miller's and Tom Wolf's experience). The existing data values could then be increased by adding in the extrapolated drift from, say, a second pass with a 12 m boom if that was what was used. This would give higher individual drift values for the RA, but the drift variability would remain the same, which is the important input for the RA. This is one reason why the protocol requires a minimum 24 m boom, as the wider the first pass swath, the less important is the contribution from subsequent passes.

The drift trial protocol therefore tries to achieve a compromise between linking to legacy data (*e.g.*, basing the protocol on ISO 22866 as a starting point) to linking through to the current RA approach (drift curves at various tiers) to future requirements (Monte Carlo analysis of actual drift variability extrapolated out to the landscape scale) - and the current drift trial protocol reflects those compromises.

5.7 Example analytical methodology

Overall requirements of any analytical technique.

To be based on SSAU SOP (as this is cleared by UK-CRD as being approx. GLP)

Must include tank calibration curves for loading in order to recover reliable values above LOD.

Tank sample taken from nozzle(s).

5.8 Example cereal crop heights

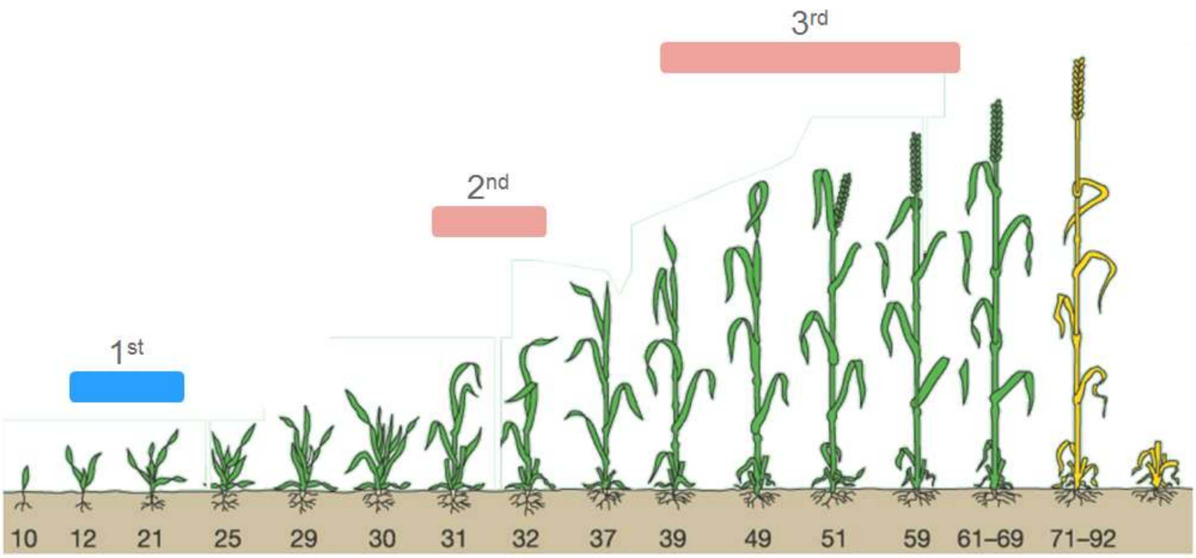

Figure 5. Example ranges of BBCH codes for the cereals.