BS ISO 24253-1:2015

BSI Standards Publication

Crop protection equipment — Spray deposition test for field crop

Part 1: Measurement in a horizontal plane

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National foreword

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Crop protection equipment — Spray deposition test for field crop —

Part 1: Measurement in a horizontal plane

Matériel de protection des cultures — Essais de dépôt de la pulvérisation sur les grandes cultures —

Partie 1: Mesurage dans un plan horizontal

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 6, *Equipment for crop protection*.

ISO 24253 consists of the following parts, under the general title *Crop protection equipment — Spray deposition test for field crop*:

— *Part 1: Measurement in a horizontal plane*

— *Part 2: Measurement in a crop*

Introduction

Efficacy of plant protection products (PPP), their safety to the crop and the environment may be much influenced by spraying efficiency. The dose of the active ingredient and its variation that is retained on target surfaces in a downward directed (boom) spray application such as ground surface need to be measured in a manner that is both accurate and precise.

The location, numbers, and sampling structures used to monitor sprayed depositions need to be defined in a standard manner to enable results from different experiments to be compared.

A test can be set up to quantify or to describe the in-field situation or for machine comparison.

A spray system can be compared with a reference system.

This International Standard does not deal with the deposition of spray outside the treatment zone, in crop canopy nor that lost as airborne spray drift. However, the combination of this part of ISO 24253 with the protocol for field measurements of spray drift as given in ISO 22866[5] when measured at the same time may result in a possible evaluation of spray mass balance. On the other hand, its combination with the measuring of sprayer boom movements in the field (see ISO 14131[2]) can also be used to evaluate the spray deposition and its variation in the field as a result of the boom movement.

Spray deposition from horizontal boom sprayers with downward directed application is affected by nozzle parameters, boom height, boom steadiness, sprayer speed, meteorological conditions, and other sprayer additional devices such as air assistance. These dynamic factors can all be elements of a test to determine the quantity and the variation in spray deposition.

INTERNATIONAL STANDARD ISO 24253-1:2015(E)

Crop protection equipment — Spray deposition test for field crop —

Part 1: Measurement in a horizontal plane

1 Scope

This part of ISO 24253 specifies field measurements of spray deposition to determine the quantity and distribution of spray in a plane surface area, treated by horizontal boom sprayers with downward directed application.

This part of ISO 24253 allows flexibility in the arrangement of field tests, but specifies standardized measurement procedures that are useful to be able to compare the results from different field experiments or to compare with laboratory tests, such as that described in ISO 5682-2.[1]

This part of ISO 24253 may not be appropriate for those spraying systems which rely on the presence of a crop canopy for efficient deposition (for example directed spraying, electrostatic charged spraying, very fine spraying, variable rate spraying).

This International Standard is not intended for use in or for a regulatory framework.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
spray dose
quantity of active ingredient (PPP or tracer) applied

Note 1 to entry: It is expressed in kg/ha (solids) or l/ha (liquids).

2.2
spray volume
quantity of sprayed liquid applied

Note 1 to entry: It is expressed in l/ha.

2.3
spray deposition
quantity of spray liquid that is deposited on the collector(s)

Note 1 to entry: It can be expressed as absolute amount of spray per unit of area (µl/cm2, l/ha) as well as in relative terms as a % of theoretically applied spray volume or spray dose.

2.4
collector
artificial target to collect the sprayed liquid

Note 1 to entry: Examples of collectors for spray deposition measurements are listed in Annex A.

2.5
tracer
traceable material representing a plant protection product to quantify spray deposition

[SOURCE: Adapted from ISO 22522.]

2.6
target area
area where it is intended to apply spray liquid

2.7
spray liquid
mixture of water, tracer and/or pesticide and/or additives which is sprayed

3 Test method

3.1 Principle

A spray deposition test comprises the measurement of spray deposition immediately available to the target area being the ground surface, represented by the collectors. This spray deposition measurement may utilize a dye, or other readily measurable tracer to simulate a plant protection product.

Spray depositions are assessed quantitatively. The variation in spray deposition is quantified.

Spray deposition values used to quantify mean deposition and deposition variation of the spray liquid applied by the tested sprayer is assessed using spray deposition collectors placed on a ground surface.

3.2 Test area

The test shall be performed on the ground surface (bare soil surface or short mowed grass of max. 8 cm height). Since there are influences from boom movement (boom ends) and other disturbances such as air turbulences around the tractor and the sprayer (centre of the machine), measurements shall be taken on both sides of the sprayer and at different distances along the spray boom (see 4.3).

The length of the test area shall ensure the output of the intended spray volume over the sampling area. The test area shall therefore have a track length before and after the sampling area assuring that the sprayer has reached even intended output flow considering sprayer size and forward speed.

NOTE With rate control in manual mode, a minimum track length of 10 m is suggested for travelling speeds of up to 2 m/s and 20 m for travelling speeds up to 4 m/s. With the rate control in automatic mode, the track length has to be adapted also considering the system reaction time.

Details of the spraying and sampling layout shall be fully reported with the test results, in accordance with Annex B (see also 4.3).

In identifying the place of the test area take notice of surrounding vegetation on the wind profile. The test area should be at least 10 times the height of the vegetation away from the surrounding vegetation or constructions.

Details of the test area and surroundings shall be specified in the test report.

3.3 Monitoring of meteorological conditions

Monitoring of the meteorological conditions shall be made at the time and the place of the test. The maximum error of measurements shall be

— for wind speed: 0,1 m/s for wind speed up to and including 1 m/s and 0,2 m/s for wind speed over 1 m/s,

— for temperature: 0,5 °C, recorded in the shade, and

— for humidity: 5 % of the relative humidity.

Measurements shall be made at (2 ± 0,1) m height above the ground surface. Measurements of wind (direction and velocity) shall be made at a frequency of at least 1 Hz (every 1 s) sampling rate. The instruments should be calibrated prior to their use according to instrument instructions.

3.4 Acceptable meteorological conditions for field measurement of spray deposition

Average wind speed during spraying shall not be higher than local recommendation or practice and preferably below 2 m/s at the measuring height specified in 3.3. The wind speed shall be stable during the test (the standard deviation shall not exceed ±1 m/s).

For wind speeds above 2 m/s, the wind direction should be within ±30 ° of the mean wind direction.

Temperature shall be between 5 °C to 35 °C.

Temperature inversions affect deposition measurements and need to be reported (preferably by using of 3D anemometer alternatively by cloud cover or measurements of temperature at two heights).

3.5 Tracers

Tracers shall be safe for their intended use. See the environmental and operator safety data sheets for the suitability for this purpose.

NOTE Local Pesticide Regulatory Bodies ought to be able to comment on the use of suitable candidate products and their restrictions for this purpose.

The tracers shall be stable in field conditions and with a good recovery (at least >90 %; preferably >95 %) from all kind of collectors (see 3.6) used in the test. See e.g. Herbst, 2006[4] and Stallinga et al., 2012.[5]

Examples of usable tracers are the following:

— metal ions (recommended for several applications on the same target);

— food dyes:

  — tartrazine (E102);

— fluorescent dyes:

  — brilliant Sulfo Flavine;

  — sodium fluorescein.

3.6 Collectors

Collectors are used to sample spray deposition on the ground surface. The recovery of the sprayed tracer from the collectors shall be determined prior to the experiment.

The collectors used shall provide a good recovery (at least >90 %; preferably >95 %). Examples of collectors which can be used are given in Annex A. How to quantify tracer recovery from the collector is described in Annex C.

Background emission from the collectors is to be determined (see Annex C). The average reading of the blank collectors should not be higher than 0,1 % of the average reading of the sprayed collectors. Accuracy of the measuring device, artificial collector types, and background emission from artificial collectors shall be recorded and chosen to obtain a coefficient of variation of the background emission lower than 10 % (of at least 10 collectors; see Annex C).

Care shall be taken to ensure that the sampling collectors used to verify the applied dose and volume rate do not saturate. This shall be checked before the tests.

3.7 Spray liquid

The spray liquid shall be representative of liquids typically used in the application of plant protection products. Tap water or standard tank mix is often used in spray drift measurements (see ISO 22866[5]). A standard tank mix can be achieved by the addition of a water-soluble non-ionic surfactant at rates typically from 0,005 % to 0,5 % v/v, following manufacturers recommendation.

The type and concentration of additives shall be specified in the test report.

3.8 Soil surface roughness

When spraying a bare ground surface area, the ground surface roughness e.g. ploughed surface, seedbed prepared land, or roughness index from soil tillage studies shall be documented in the test report.

4 Test procedure

4.1 General

A test can be set up to quantify or to describe the in-field situation, or it can be a defined situation (specific track) for machine comparison. In a comparison test if mounted or trailed sprayers are used, preferably the same tractor configuration shall be used. Tractor type should be reported in the test report.

Each measurement shall involve sampling spray depositions on the ground surface (see Figure B.1). Make at least three measurements at the same collector positions or at different places after each other.

Place the collectors in a plane surface. A number of collectors shall be placed in a continuous line, both in the driving direction and in the cross direction (along the boom). The size of the collector shall be adapted to the resolution of interest; field level (m^2), plant level (dm^2), (disease/weed) spot level (cm^2). This defines also the needed collector area to take a representative sample.

The sum of the total collector areas shall be at least: for the field level 1 m^2, for the plant level 0,5 m^2, and for the spot level 0,1 m^2.

Collector type, location, and size shall be specified in the test report.

Spray deposition result-presentation can be done in different ways. Either it is expressed on a relative basis, e.g. in percentage of spray volume, or on an absolute basis, e.g. $\mu l/cm^2$.

After the spraying, gather (as soon as possible following the tracer requirements and within 30 min after spraying) and code the artificial collectors and store them in a dark and dry and depending on substance, cool place. Extract the tracer from the collectors and determine the spray deposition, e.g. by fluorimetry as described in Annex C.

The test shall be performed with the rate controller in manual mode unless the rate control in itself is being tested. Sprayer speed and nozzle output (l/min) over the test area shall be directly measured and recorded in the test report. Information from the rate controller (such as volume, speed, pressure) shall also be visually checked or recorded, and specified in the test report.

Preferably a laboratory spray distribution measurement of the sprayer should be done as described in ISO 5682-2[1] and presented in the report.

The results of all deposition measurements shall be statistically evaluated in accordance with the analysis of variance, ANOVA, 10 %.

Procedures for handling collectors prior to and post exposure to spray that minimize the risk of cross-contamination shall be established. The potential for cross-contamination and tracer degradation shall be monitored during a trial using clean collectors and those loaded with a measured volume of the tracer solution.

4.2 Comparison with a reference sprayer setup

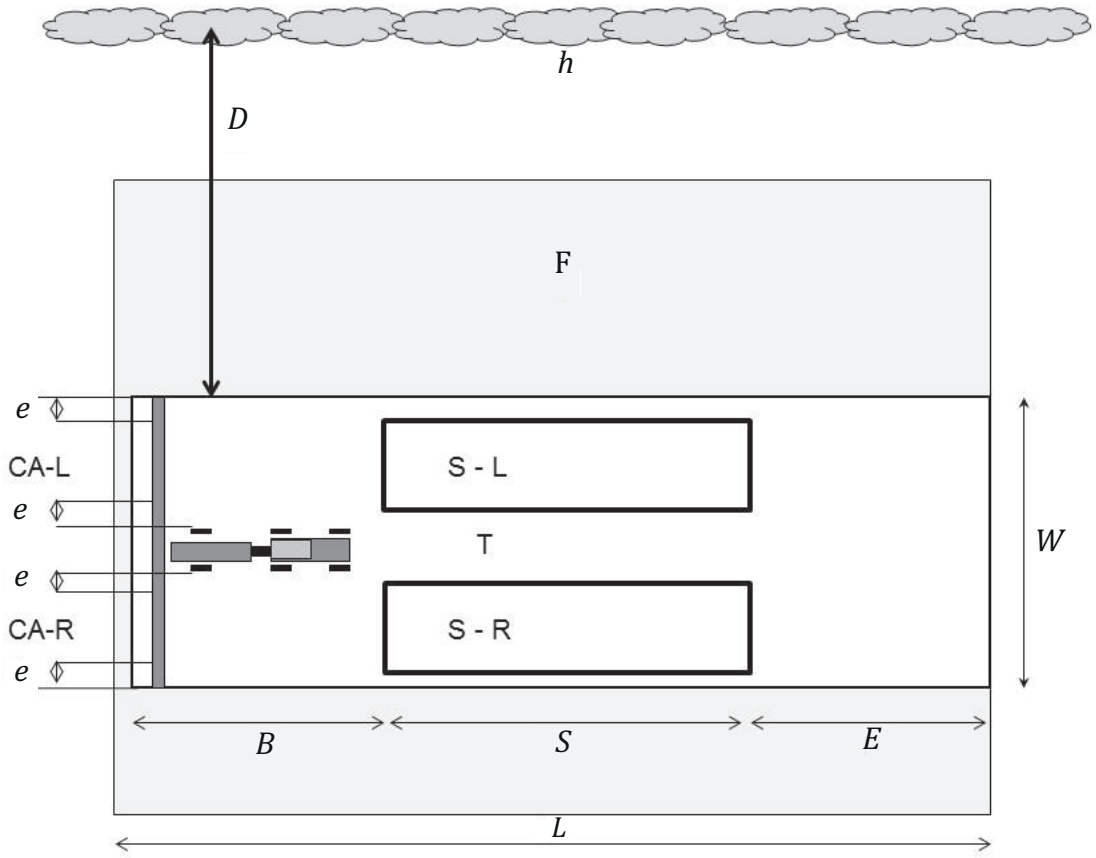
For inter study comparisons of results, a reference sprayer setup should be included in the field measurement programme. The reference sprayer setup should be that typically used for the application of plant protection products in a certain region and crop, with defined application parameters. Good agricultural practice shall relate to the local conditions where the test is conducted.

Preferably collectors of same size and type should be used.

NOTE Reference sprayer setup can be according to ISO 22369-2.[4]

4.3 Sampling spray deposition on the ground surface

The test area for the deposition measurement is to be marked in the field. Spray deposition is to be measured on a bare ground surface in the field to quantify the amount and the variation of total spray deposition coming onto ground surface. The collectors are placed generally in the centre area at each side of the spray boom between 1,5 m from the end of the boom and the sprayer/tractor wheel (see Figure 1). Sampling spray deposition is done at least at three places according to Figure B.1. For special purposes like sprayer boom movement effect place collectors underneath the tip of the boom (see Figure B.2), for the sprayer/tractor wake effect place collectors e.g. close to the sprayer. When placing collectors across the boom, the place of the collectors shall represent both the area “under” the nozzle positions and “between” the nozzle positions.



Key

W	working width
h	height of the surrounding vegetation
e	edge distance from end of boom or sprayer
CA-L	central area under left half boom
CA-R	central area under right half boom
F	field
D	distance between vegetation and test area, $D > 10 \times h$
T	test area
S – L	left sampling area
S – R	right sampling area
L	track length
B	start length
S	sampling area length
E	stop length

Figure 1 — Schematic presentation of field layout, test area and sampling areas under the (left and right) centre of the spray boom

Flat artificial collectors fixed on bars or plates (max. height 20 mm) shall be located so that the collecting surface is placed horizontally max 8 cm above ground surface. Maximum collector length is 1 m and maximum width of the collectors is 0,2 m.

Collecting area can be a strip of e.g. 10 m length in the driving direction, subdivided in smaller parts for analysis (general practice is 100 cm × 10 cm collectors or 50 cm × 10 cm or 10 cm × 10 cm), a line of distinct collectors, individual angled collectors to the driving direction or a square meter of collectors subdivided in e.g. 10 cm square parts. The length of the collector line in the driving direction shall at least be 2 m and adapted to sprayer speed. The length of the sampling area shall increase with speed by doubling the length for the speed in m/s. [collector length = 2 × sprayer speed (m/s)].

NOTE Collector size influences coefficient of variation. When measuring the same area, the average spray deposition is the same independent of collector sizes.

Details on the accuracy of the measuring system, collector efficiencies, and recoveries shall be recorded.

4.4 Drop distribution/spray coverage

When more information is wanted on drop distribution and area covered with drops, this can be obtained by placing water sensitive papers (or similar papers) on the artificial collector places specified above. Quantification of drop numbers and coverage from these papers can be done with image analysis systems. Proper calibration of the image analysis system is required (e.g. on pixel-size relation and background threshold/removal). Percentage of coverage or number of drops per unit of area (spot median diameter) on the different sample places is presented (see also Annex F).

Collectors such as water sensitive papers are only to be used on a comparative basis. Tracers and additives have an effect on the spread factor of the sprayed liquid on water sensitive papers. Also the angle, with which the droplets touch the paper, influences the spot at the paper. Very small drops will not show up and high spray volumes lead to total colouring of the water sensitive papers.

Storage and handling of collectors such as water sensitive papers should minimize changes in stain distribution on the collectors after the treatment.

The results of the drop distribution measurements can be statistically evaluated in accordance with the analysis of variance, ANOVA, 10 %.

5 Test report

5.1 Data relating to the spraying system

5.1.1 Sprayer working condition

At least, the following items shall be described:

— manufacturer;

— sprayer type and model;

— tractor type, model and configuration (if applicable);

— travel speed (km/h); time over 100 m length;

— electronic devices/spray computer;

— mounted/trailed/self-propelled;

— tires, pressure (sprayer + tractor);

— wheel suspension (yes/no).

5.1.2 Sprayer boom

At least, the following items shall be described:

— working width;

— height above target;

— number of sections;

— hydraulic/mechanic section operation;

— stabilization system;

— boom movement (see ISO 14131[2] for quantification else visual recording in a qualitative way, e.g. stable, swaying, oscillating).

5.1.3 Nozzles and liquid distribution

At least, the following items shall be described:

— nozzle type, size and brand name;

— nozzle spray quality (e.g. fine/medium/coarse or D_{v10}, D_{v50} (VMD), D_{v90});

— working pressure (sprayer pressure gauge reading MPa);

— nozzles spacing and orientation and positions;

— number of nozzle sections on spray boom;

— spray volume (l/ha);

— liquid flow rate from the nozzles over the sampling areas (l/min).

5.1.4 Air flow distribution (for air assisted sprayers)

At least, the following items shall be described:

— fan type;

— gear position;

— PTO speed ($r.min^{-1}$);

— non-contact measurement fan speed ($r.min^{-1}$);

— rotation direction: clockwise, counter-clockwise;

— characteristics of the air setting (air – direction) description;

— air speed at the outlet and airflow rate of the sprayer (e.g. according to Annex E).

5.2 Data relating to the field

At least, the following items shall be described:

— surface roughness (e.g. ploughed surface, seedbed prepared land, or Roughness Index from ground tillage studies);

— slope of the field (e.g. m elevation over 100 m field length);

— soil type (sand/clay/peat, etc.);

— ground humidity conditions (e.g. wet / dry, dust from wheels)

— vegetation or bare ground.

5.3 Data relating to the spray liquid

All tank mix ingredients shall be reported:

— tracers (ID e.g. Colour index number; batch), additives, chemical used (see Annex C);

— sprayed dose (liquid, tracer, additive) including specific rheological parameters e.g. viscosity and surface tension, at (20 ± 2) °C and preferably temperature during the test;

— tracer or plant protection product (PPP) concentration based on representative samples of the spray liquid taken (preferably at the nozzle outlet) for analysing immediately before and after spraying and before and after each replication.

If different tracers are used in the same test, they shall be allocated at random to each application

6 Expression of results

The spray deposition can be expressed in amount of spray liquid (or tracer or substance) per unit of area (µl/cm^2, ng/cm^2) or % of spray volume applied or percentage of coverage or number of drops per unit of area (spot median diameter) on the different sample places (see also Annex D). The variation in deposition is expressed as coefficient of variation (*CV*).

Where line-sampling methods are used, the deposition can also be presented as a function of driving distance or distance along the sprayer boom or nozzle sections on the spray boom. Then mean or median deposition, and min and max deposition values and deviations are also relevant.

Annex A
(informative)

Examples of collectors for spray deposition measurements

A.1 Ground surface

The following are collectors for spray deposition measurements:

— acetate sheets;

— aluminium foil;

— filter paper;

— chromatography paper;

— filter material;

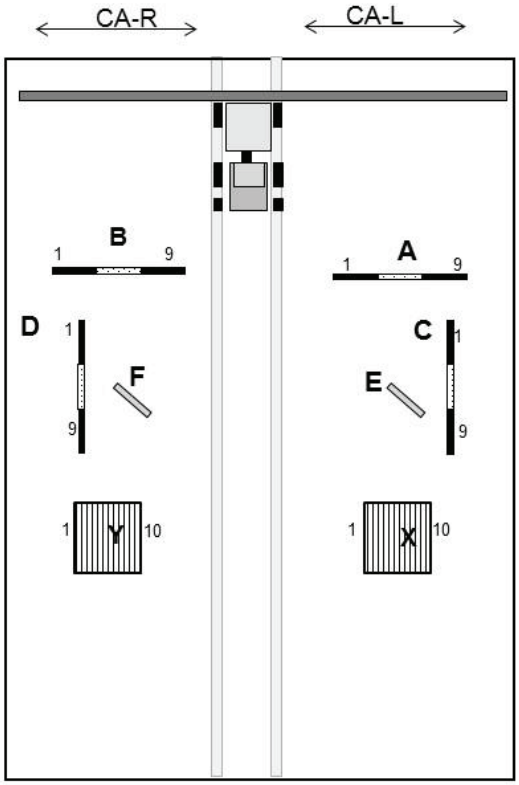
— water sensitive papers;

— petri dishes.

NOTE Mixing collectors could give misleading results.

Annex B
(informative)

Example of a layout of the collectors and schematic presentation of collector places in the field



Key

A, B 4,5 m cross section deposition collectors, 9 collectors of (0,5 × 0,1) m

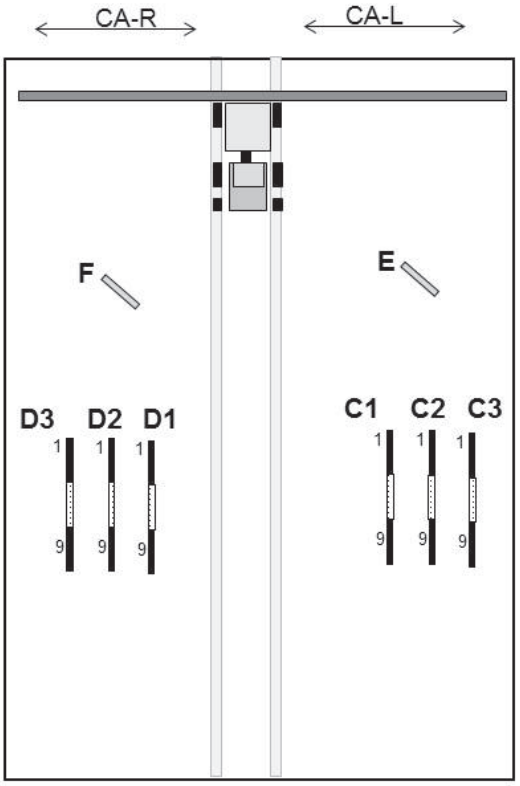
C, D 4,5 m length section deposition collectors, 9 collectors of (0,5 × 0,1) m

E, F individual deposition collectors 45° in driving direction of (1,0 × 0,1) m

X, Y 1 m^2 deposition collectors, 10 collectors (0,1 m width) sampling 1 m width under middle boom (1 m length)

NOTE This is an example of collector places in the centre area of the left (CA-L) and right (CA-R) side of the spray boom, between 1,5 m from the end of the boom and the sprayer (vehicle wheel).

Figure B.1 — Example of a schematic presentation of collector places in the field on ground surface for a sprayer with a 24 m boom



Key

C, D 4,5 m length section deposition collectors, 9 collectors of (0,5 × 0,1) m

E, F individual deposition collectors 45° in driving direction of (1,0 × 0,1) m

Figure B.2 — Example of a schematic presentation of collector places when the spray deposition of spray boom movement is of special interest

In Figure B.2, additional length collectors (C1-C3, D1-D3) are placed near the sprayer, in the centre of the spray boom half and at the end of the spray boom. Average spray deposition is controlled with the E and F collectors. Example for a sprayer with a 24 m boom

Annex C
(informative)

Fluorimetry and deposition calculation

C.1 General

In case of using a fluorescent dye as a tracer, it is important to optimize the excitation and emission wavelength of the fluorimeter to the tracer to maximize discrimination of tracer and background fluorescence. Noise or background fluorescence can come from the collector, the dilution liquid (e.g. fluorescence of tap or demineralised water can change in time) and the pollution of the capillary (measuring) cell in the fluorimeter. When collectors are placed on ground surface care has to be taken about the background fluorescence from the contamination by dust from ground surface.

Soak collectors with dilution liquid to get the tracer into solution. Minimize the volume of the dilution liquid to maximize fluorescent recovery, but it is dependent on the collection area and the spray content caught. The dilution volume and the amount of tracer on the collector also determine the recovery from the collector surface. Investigate in advance the optimal dilution volume and time necessary for the tracer to get in solution.

The reading of the fluorimeter is related to the amount of tracer in solution through a calibration curve. This curve, within limits of the scale is a straight line (e.g. $10 < x < 950$ of 0 - 1 000), and determined through sampling known concentrations of the tracer.

Calculate from the reading of the fluorimeter, the calibration line, the collector surface area, the tracer concentration in the spray liquid, the background fluorescence (collector and dilution liquid), and the volume of dilution liquid, the amount of spray deposition per unit area can be calculated, e.g. in μl/cm^2, in accordance with Formula C.1. From this spray deposition, the percentage of spray deposition on a collector can be calculated by relating the spray deposition to the amount applied in the field on the same unit of area, in accordance with Formula C.2.

$$\beta_{\mathrm{dep}} = \frac{\left(\rho_{\mathrm{smpl}} - \rho_{\mathrm{blk}}\right) \times F_{\mathrm{cal}} \times \mathrm{V}_{\mathrm{dil}}}{\rho_{\mathrm{spray}} \times \mathrm{A}_{\mathrm{col}}} \qquad \text{(C.1)}$$

$$\beta_{dep\%} = \frac{\beta_{dep}}{((\beta_V)/100)} \times 100 \quad \text{(C.2)}$$

where

β_{dep} is the spray deposition, expressed in microlitres per square centimetre (µl/cm^2);

$\beta_{dep\%}$ is the spray deposition percentage (%);

β_V is the spray volume, expressed in litres per hectare (l/ha);

ρ_{smpl} is the fluorimeter reading of the sample;

ρ_{blk} is the fluorimeter reading of the blanks (collector + dilution water);

F_{cal} is the relationship between fluorimeter reading and tracer concentration ((µg/l)/ fluorimeter scale unit);

V_{dil} is the volume or dilution liquid (e.g. tap or demineralised water) used to solute tracer from collector, expressed in litres (l);

ρ_{spray} is the amount of tracer solute in the spray liquid, sampled at the nozzle, expressed in grams per litres (g/l);

A_{col} is the (projected) area of the collector to catch spray, expressed in square centimetres (cm^2).

C.2 Background collectors

The determination of the background reading from collectors can be obtained by taking at least 10 collectors; soak the collectors with the agreed dilution volume for the collector type; and determine the fluorescence value according to the protocol. The mean background value is determined from the individual fluorimeter readings.

It is advised to take up in the standard analysis procedure of the collectors from the test area to put a blank water sample and a blank collector for background determination at the beginning and at the end of the series of samples.

C.3 Recovery of tracer from collector

The determination of the recovery of the used tracer from the used collectors can be obtained by taking at least 10 collectors, put a specified amount of tracer evenly distributed on the collector (e.g. with a pipet), soak the collector with the agreed dilution volume for the collector type, and determine the fluorescence value according to the protocol. The ratio of the recovered tracer and the applied tracer on the collector indicates the recovery level of the tracer from the collector.

The concentration of the applied tracer solution is preferably similar to the spray liquid concentration to be used in the field for the spray deposition experiment.

Annex D
(informative)

Calculations and expression of the spray deposition results

D.1 Measured spray deposition on collectors on the ground

Values of measured spray deposition shall be indicated as the amount of spray per unit of area. Collector area can be determined, if necessary. Normalization to a given application rate is required to compare between different application conditions. Therefore, the tracer concentration in the sprayed liquid shall be measured by taking samples at the nozzle outlet before and after the treatment.

Average spray deposition ($\overline{x}$) shall be given in amount of spray per unit of area (µl/cm^2) or in percent of spray volume from sprayer output.

The uniformity of the spray deposition on the sampling places shall be reported as the coefficient of variation (CV) of the measured spray deposition values or the maximum deviation ($d_{\max}$).

D.2 Calculation

Average spray deposition ($\overline{x}$):

$$\overline{x} = \frac{\sum_{i=1}^{n}(x_i)}{n} \tag{D.1}$$

where

n is the number of collectors;

x_i is the spray collected on collector *i.*

Maximum deviation ($d_{\max}$):

$$d_{\max} = \max\left(\frac{|x_i - \overline{x}|}{\overline{x}} \times 100\right) \tag{D.2}$$

Coefficient of variation (CV):

$$CV = \frac{d_s}{\overline{x}} \times 100 \tag{D.3}$$

where

d_s is the standard deviation.

$$d_s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \overline{x})^2}$$

Annex E
(informative)

Specifying air assistance on horizontal boom sprayers

E.1 General

When air assistance is used on a horizontal boom sprayer, the amount of air at the outlet is measured and the air outlet dimensions are specified. From these parameters, an indication of the total amount of air delivery is calculated.

E.2 Air outlet area

The air assistance system is described in size of the air outlet (slot, holes or spouts), and number of slots, holes, or spouts over the working width. The air outlet area is calculated for each slot, hole, or spout and added for all the slots, holes, or spouts to give the total air outlet area.

E.3 Measuring air speed

The air speed is measured at the air outlet holes or spouts of the air assistance system. An air speed measuring device (e.g. small cup anemometer, ultrasonic anemometer) is kept in the air stream in the outlet and moved around a little to determine the maximum air speed (variation in air speed occurs along the edges of the outlet). Air speed is determined along the spray boom at different points at least for every boom section one time. Results are recorded and averaged to give a mean air speed. Air outlet velocity is generally presented as m/s.

An indication of total air outlet capacity can be calculated as:

Air outlet capacity (m^3/h) = average air outlet speed (m/s) × air outlet slot area (m^2) × 3 600

Annex F
(informative)

Calculations and expression of the spray distribution results

F.1 Examples of collectors used for spray distribution measurements

— Water Sensitive Paper (WSP), commercially available in sizes of 50 mm × 25 mm and 500 mm × 25 mm;

— Kromekote Cards (KC), commercially available one sided and two sided and in different sheets sizes.

F.2 Measured spray distribution on collectors on the ground

Spray distribution can be measured by placing Water Sensitive Papers (WSP) or Kromekote Cards (KC) on the collector places. After spraying of the spray liquid, spray depositions on the WSP or KC will be visible as a pattern of spots. Drop patterns on a WSP turn the yellow card into a yellow card with blue spots where the drops hit the paper. This pattern of spots can be analysed with image analysis systems and produce spray distribution parameters as percentage of area covered with spots and the number of spots per unit area.

Values of measured spray distribution shall be indicated as the percentage of area covered by spots (% coverage), and the spot number as number of spots per unit area (spots/cm^2).

Average spray coverage ($\overline{x}$) shall be given in percentage of the ground area.

Average spot number ($\overline{x}$) shall be given in spots/cm^2.

The uniformity of the spray distribution on the sampling places shall be reported as the coefficient of variation (CV) of the measured spray distribution (% coverage or spot number) values or the maximum deviation (d_{max}).

F.3 Calculation

Average spray distribution (coverage or spot number) ($\overline{x}$):

$$\overline{x} = \frac{\sum_{i=1}^{n}(x_i)}{n} \tag{F.1}$$

where

n is the number of collectors;

x_i is the spray spots (coverage or spot number) collected on collector *i.*

Maximum deviation ($d_{\max}$):

$$d_{\max} = \max\left(\frac{\left|x_i - \bar{x}\right|}{\bar{x}} \times 100\right) \tag{F.2}$$

Coefficient of variation (CV):

$$CV = \frac{d_s}{\bar{x}} \times 100 \tag{F.3}$$

where

d_s is the standard deviation.

$$d_s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}$$

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