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Agricultural and forestry machinery — Unmanned aerial spraying systems —

Part 2: Test methods to assess the horizontal transverse spray distribution

Matériel agricole et forestier — Systèmes de pulvérisation aériens sans pilote —
Partie 2: Méthodes d'essai pour évaluer la distribution transversale horizontale de la pulvérisation

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Foreword

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This document was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 6, *Equipment for crop protection*.

A list of all parts in the ISO 23117 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The efficacy of plant protection products (PPPs) and their safety to the crop and environment are heavily influenced by spraying efficiency. The dose of the active ingredient(s) that is retained on target surfaces needs to be measured in a manner that is both accurate and precise, together with any assessment of variability in spray deposition.

The location, number and sampling structures used to monitor spray deposition needs to be defined in a standard manner to enable results from different tests to be compared.

A test can be set up to quantify or describe the in-field situation or for machine comparison. A spray system can be compared with a reference system.

ISO 5682-2 and ISO 24253-1 specify the standard test methods to assess the transverse spray distribution on a horizontal plane surface for ground vehicle mounted horizontal boom sprayers, but do not cover aerial spraying systems, including unmanned agricultural aerial sprayers (UAASs). UAAS is the combination of an unmanned aerial spraying system (UASS) fitted to an unmanned aircraft system (UAS).

UAAS operations from the aviation perspective are standardized in ISO 21384-3.

This document provides standard test methods to assess spray distribution in the transverse direction in a horizontal plane representing a flat soil surface or for example, a paddy field surface where the crop is very dense and of uniform height, using UAAS.

The popularity of UASs or drones and the continued advances in flight control, flight duration and payload potential has increased the suitability of UAS for agricultural purposes. However, use of specific UAAS can impact on the surrounding environment through spray drift or incorrect application of PPPs. Unmanned aerial spraying performance is dependent on a number of factors including nozzle/atomizer parameters, UAS rotor downwash, flying speed and height, the crop being sprayed and weather conditions.

The spray distribution of UASS is known to be significantly affected by the downwash effect of UAS so the performance of the spray depends on performance of UAS. Nozzle/atomizer arrangement in UAAS and application methods of UAAS are different from that of the ground vehicle mounted horizontal boom sprayers for field crops (deposition of which in a horizontal plane is covered in ISO 24253-1).

This document does not deal with the deposition of spray outside the treatment zone, that is lost as airborne spray drift, nor in canopy spray deposition in field and bush and tree crops from UASS. Standards regarding these measures of UASS performance are expected to be developed in future. Refer to ISO 22522 for tree and bush crops, ISO 24253-2 for the determination of canopy spray deposition and ISO 22866 for spray drift.

Agricultural and forestry machinery — Unmanned aerial spraying systems —

Part 2:
Test methods to assess the horizontal transverse spray distribution

1 Scope

This document specifies field measurements of spray deposition to determine the quantity and distribution of spray in a plane surface area in the transverse direction to the flight direction, treated by specific Unmanned Agricultural Aerial Sprayer (UAAS) with downward directed application.

These field measurements can be used to determine the effective swath width of UAAS.

This document is not appropriate for evaluating spray deposition within a crop canopy (three-dimensional deposition). It is not appropriate for those spraying systems which rely on the presence of a crop canopy for efficient spray deposition (for example directed spraying, electrostatic charged spraying, very fine sprays).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5681, *Equipment for crop protection — Vocabulary*

ISO 5682-1:2017, *Equipment for crop protection — Spraying equipment — Part 1: Test methods for sprayer nozzles*

ISO 21384-4, *Unmanned aircraft systems — Part 4: Vocabulary*

ISO 23117-1:2023, *Agricultural and forestry machinery — Unmanned aerial spraying systems — Part 1: Environmental requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5681, ISO 21384-4 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
unmanned agricultural aerial sprayer
UAAS
assembly of an unmanned aircraft system (UAS) fitted with all of the spraying equipment necessary for testing an unmanned aerial spraying system (UASS) filled with the required volume of the test liquid and if used, any additional devices/sensors for collecting test data

3.2
spray pattern
transverse distribution of spray deposits applied by the UAAS

3.3
tracer
traceable material representing a plant protection product (PPP) to assess test spray deposition

3.4
tracer dose rate
quantity of tracer applied per unit area

Note 1 to entry: Expressed in kg/10 000 m^2 (kg/ha) for solids and l/10 000 m^2 (l/ha) for spray liquids

3.5
test liquid
mixture of water, tracer and/or plant production products (PPP) and/or additives which is sprayed during the test

3.6
test spray deposition
amount of spray liquid that is deposited on the collector(s) in the test

3.7
collector
artificial target to collect the sprayed liquid

3.8
flight route
pre-determined path taken by the UAAS

3.9
unidirectional application
spraying successive adjacent swaths with the same heading using the same nozzles/atomizers

Note 1 to entry: See Figure 1.

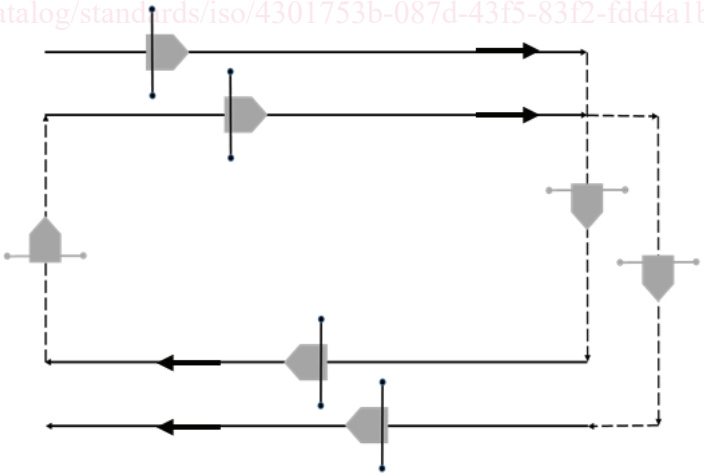


Figure 1 — Unidirectional application

3.10
progressive application with alternating heading and same nozzle/atomizer
spraying successive adjacent swaths with alternating heading using the same nozzles/atomizers

Note 1 to entry: See Figure 2.

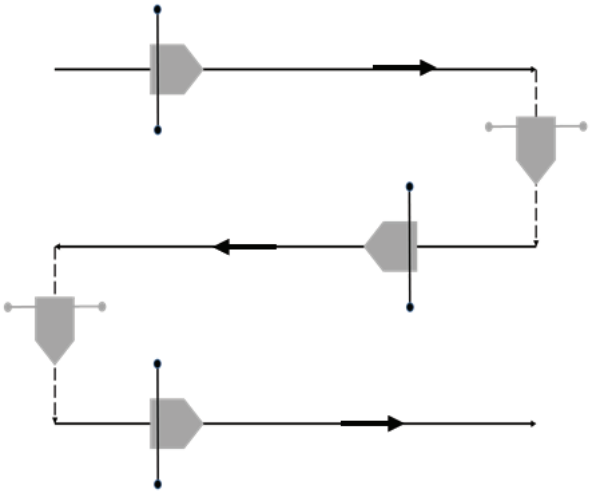


Figure 2 — Progressive application with alternating heading and same nozzles/atomizers

Note 2 to entry: The majority of small UAAS currently use progressive application (3.10, 3.11, and 3.12) for broadcast application.

3.11
progressive application with fixed heading and same nozzle/atomizer
spraying successive adjacent swaths with fixed heading using the same nozzles/atomizers

Note 1 to entry: See Figure 3.

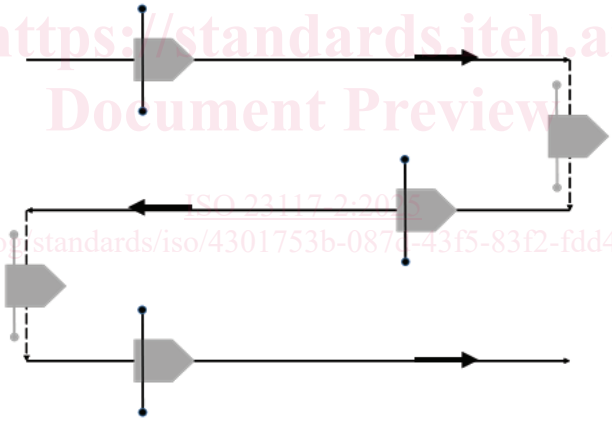


Figure 3 — Progressive application with fixed heading and same nozzles/atomizers

3.12
progressive application with fixed heading and alternating nozzles/atomizers
spraying successive adjacent swaths with fixed heading and spray system adjusting so that only rear nozzles/atomizers (relative to flight direction) are used for application in each pass

Note 1 to entry: See Figure 4.

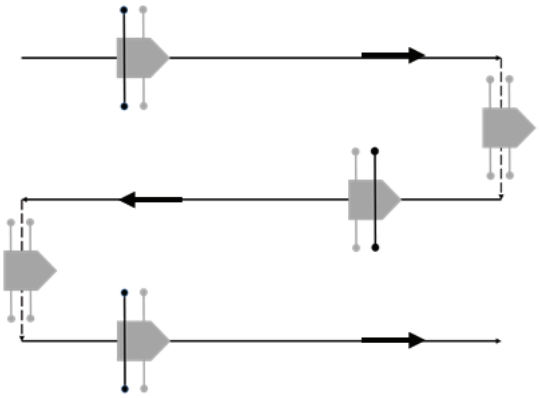


Figure 4 — Progressive application with fixed heading and alternating nozzles/atomizers

3.13
centre of distribution
CoD
parameter defining the centre position of the spray swath from the deposition distribution

4 Test materials and requirements

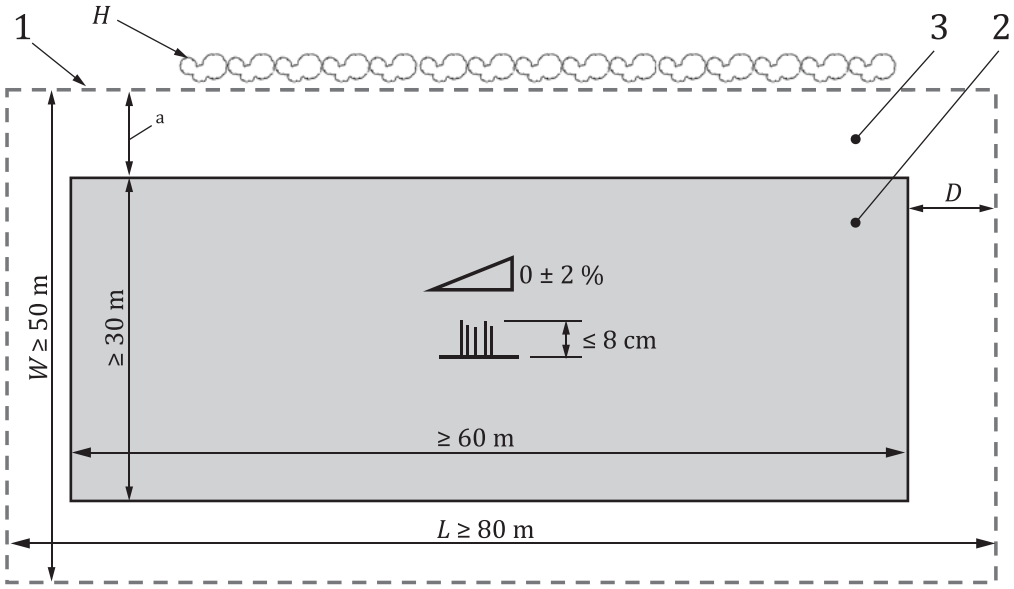
4.1 Principle of test

Spray distribution depends on the operational parameters of the UAAS as well as the environmental and weather conditions, therefore the requirements provided in 4.2 to 4.6 shall be followed.

Spray distribution can be expressed as an absolute amount of spray liquid per unit area and/or in relative terms as a percentage of the intended spray volume or tracer dose rate.

4.2 Test site

The test site, which surrounds and includes the test area, shall have free areas to reduce the effect of surrounding obstacles affecting wind conditions in the test area. The test area shall be level ground with a gradient of 0 ± 2 %, with a bare soil surface or short mowed grass of maximum 8 cm height. The distance (D) in Figure 5 between the border of test area and surrounding vegetation or building may vary but shall be a minimum of 10 m or 10 times the height of surrounding vegetation or building height (H) whichever is greater.



Key

1 border of test site
2 test area
3 free area
D distance between the border of test site and test area
H height of vegetation or building
L length of test site
W width of test site
[a] *D*≥10 m or 10×*H*.

Figure 5 — Layout and size of test site

The length of test area in Figure 5 which is parallel to the flight route shall be greater or equal to 60 m. The width of test area shall be at least 30 m.

The flight route, the collector line and the take-off/landing position of the UASS shall be marked visibly in the test area. The minimum distance between the end of the collector line and the edge of the test area shall be 1,5 m. The test area shall have sufficient, equal, track length before and after the sampling area to ensure the intended liquid output from the UAAS is achieved over the sampling area. This length will depend on the size, and flight speed of the UAAS. To ensure consistency of liquid output, concentration within the sampling area and flight speed whilst spraying, the minimum flight distance whilst spraying shall include 20 m before and after the line of collectors (see Figure 6). Layout and size of the test site and the test area (as shown in Figure 5 and Figure 6) shall be fully reported with the test results. The size of test site is dependent on the size of the UAAS and application parameters and shall therefore be adjusted accordingly.

When spraying over a bare ground surface the ground surface conditions, such as ploughed surface or prepared seedbed, shall be recorded and reported.