

PHILIPPINE NATIONAL STANDARD

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ICS 65.060.40

Agricultural Power Sprayer — Methods of Test



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Foreword

In 2022, the Philippine Council for Agricultural and Fisheries (PCAF)-National Sectoral Committee on Agricultural and Fisheries Mechanization (CAFMech) issued Resolution No. 34, series of 2022 (Recommending to the Bureau of Agriculture and Fisheries Standards [BAFS] the Prioritization of the Amendment of the Philippine National Standards [PNS] for Specifications and Methods of Test of the Power Sprayer for Mango), endorsing the revision of PNS/Philippine Agricultural Engineering Standards (PAES) on Power Sprayer for Mango — Specifications (PNS/PAES 157:2011) and Methods of Test (PNS/PAES 158:2011). The purpose of the proposed amendment aims to expand the coverage of the PNS for power sprayer for mango to include other crops and agricultural uses, as well as the revision of its several manufacturing and performance requirements to address procurement challenges.

In response, the BAFS-Department of Agriculture (DA) officially created a Technical Working Group (TWG) to develop the PNS under the following Special Orders (SO):

1. SO No. 146, series of 2023 (Creation of TWG for the Development of PNS for Agricultural and Fishery Products, Machinery, and Infrastructures);
2. SO No. 532, series of 2023 (Addendum to SO No. 146, series of 2023 entitled, “Creation of TWG for the Development of PNS for Agricultural and Fishery Products, Machinery, and Infrastructures”); and
3. SO No. 954, series of 2023 (Addendum to SO No. 532, series of 2023 entitled, “Creation of TWG for the Development of PNS for Agricultural and Fishery Products, Machinery, and Infrastructures”).

The TWG was composed of relevant stakeholders from the government sector, academe/research institutions, private sector organizations, and Civil Society Organizations (CSO). The draft PNS underwent an extensive series of TWG meetings and stakeholder consultations from January to October 2023 prior to its endorsement to the DA Secretary for approval.

This standard includes the following significant changes compared to the PNS/PAES 158:2011:

1. Modification on the scope to include evaluation on the ease of handling and safety features;
2. Inclusion of definitions for overall dimensions (height, length, and width);
3. Inclusion of provisions for pre-test activities to cover the running-in and preliminary adjustments, verification of specifications, and preparation of the APS for testing; and
4. Modification on the performance test to include methods of testing for speed of components, system efficiency, horizontal and vertical spray ranges, and spray quality.

This Standard cancel and replaces PNS/PAES 158:2011 (Power sprayer for mango — Methods of test). This document was written in accordance with the formatting and editorial rules of the Standardization Guide No. 1 (Writing the PNS) developed by the Standards Development Division (SDD) of the BAFS.

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1 Scope

This Standard specifies the methods of test and inspection for agricultural power sprayer (APS). Specifically, it shall be used to:

- a) Verify the mechanism, main dimensions, materials, accessories of APS, and the list of specifications submitted by the test applicant;
- b) Determine the laboratory and/or performances of the machine;
- c) Evaluate the ease of handling and safety features; and
- d) Prepare the test report.

2 Normative References

The following documents are referred to in the text in such a way that some or all their contents constitute the requirements of this document. The latest edition of the referenced document (including any amendments) applies.

Agricultural Machinery Testing and Evaluation Center (AMTEC)-University of the Philippines (UPLB). (2000). Agricultural machinery — Method of sampling (PAES 103:2000). <https://amtec.ceat.uplb.edu.ph/wp-content/uploads/2019/07/PAES-103-2000-Agricultural-Machinery-Method-of-Sampling.pdf>

Bureau of Agriculture and Fisheries Standards (BAFS)-Department of Agriculture (DA). (2023). Agricultural power sprayer — Specifications (PNS/BAFS 375:2023).

3 Terms and Definitions

For the purpose of this Standard, the definitions given in PNS/BAFS 375:2023 (Agricultural power sprayer — Specifications) and the following shall apply:

3.1

overall height

distance between the horizontal supporting plane surface and the horizontal plane touching the uppermost part of the machine (AMTEC-UPLB, 2021)

3.2

overall length

distance between the vertical planes perpendicular to the median plane of the machine, each plane touching the front and rear extremities of the machine (AMTEC-UPLB, 2021)

3.3

overall width

distance between the vertical planes parallel to the median plane of the machine, each plane touching the outermost point of the machine on its left and right sides (AMTEC-UPLB, 2021)

3.4

spray range

distance from the nozzle at which spraying could be carried out (AMTEC-UPLB, 2023)

3.5

spray quality

refers to the classification of droplet size spectrum against a reference (International Organization for Standardization [ISO], 2020)

3.6

system efficiency

ratio between an output of performance and an input of energy (ISO, 2018, *modified*)

4 Principles of Test

The test shall be carried out to verify the actual specification of the APS. Its specifications shall be validated with PNS/BAFS 375:2023 (Agricultural power sprayer — Specifications).

5 Test Equipment and Materials

The suggested minimum list of laboratory test equipment and materials needed to carry out the test is shown in Annex A (Minimum list of test equipment and materials).

5.1 Test equipment and instruments

The test equipment and instruments to be used shall be calibrated regularly, physically checked for operation, and shall be cleaned before and after each test.

5.2 Test materials

The APS shall be tested using a clean and solid-free tap water.

6 General Considerations

6.1 Test site conditions

The APS shall be tested under normal operations in a controlled environment with ample space. The site should be suitable to normal working conditions. Adequate ventilation and lighting shall be provided in the area.

6.2 Suspension/termination of test

During the test run, if the APS stops (due to breakdown or malfunction) affecting its performance, the test shall be suspended. If the machine is unable to continue operation, the test shall be terminated.

6.3 Pre-test activities

6.3.1 Running-in and preliminary adjustments

The APS shall have undergone a running-in period before starting the test. During the running-in period, various adjustments of the APS shall be made according to the recommendation of the manufacturer.

6.3.2 Verification of specifications

The specifications claimed by the manufacturer and other physical details given in Annex B (Specifications of APS) shall be verified. A stable and even surface shall be used as reference plane for verification of dimensional machine specifications when fully assembled and ready for testing.

6.3.3 Preparation of the APS for testing

The APS shall be checked to ensure that the machine has been assembled and installed in conformance with the instruction of the manufacturer.

7 Performance Test and Procedures

7.1 Operation of the APS

The APS shall be operated with load by using the recommended setting of the manufacturer. The spray hose to be used for testing shall have a length of 10 m. The items to be inspected or measured shall be recorded in the corresponding performance test data sheets. It shall be tested according to the manufacturer's specifications (e.g., rated operating pressure).

7.2 Data collection

7.2.1 Discharge test

The APS shall be tested at the rated maximum and minimum pressures stated by the manufacturer and two other intermediate pressures for a duration of one minute with the cut-off valve fully opened. In case the manufacturer does not indicate the rated maximum and minimum pressures to be used, rated operating pressure of the sprayer shall be used. The following shall be measured for minimum of two trials for each pressure setting.

7.2.1.1 Discharge rate

The discharge rate of the APS shall be obtained either by directly using a graduated cylinder or water collecting equipment and recording the time or by measuring the volume of water required to refill the APS after spraying and getting the total time to discharge the water. The discharge rate shall be computed using the formula specified in Annex C (Formulas for calculations of test parameters).

7.2.1.2 Noise level

The sound emitted by the sprayer with load, shall be measured using a sound level meter at the location of the operator/s. The noise level, expressed in dB (A), shall be measured at two points or distance from the machine, (a) 50 mm away from the ear level of the operator's nearest position (b) 5 m away. For each data to be taken, there shall be a minimum of five observations.

7.2.1.3 Speed of components

The speed of the rotating shafts of the major components (e.g., prime mover shaft and pump shaft) of the APS expressed in rpm shall be measured using a tachometer. For each data to be taken, there shall be a minimum of five observations.

7.2.1.4 Fuel consumption

The fuel consumption may be obtained using any of the following methods:

a) Refilling the fuel tank

The fuel consumption of the engine of the APS shall be obtained by measuring the volume of fuel refilled after the test. The tank shall be filled to full capacity before and after each trial. The total operating time of the engine shall be recorded. The fuel consumption shall be computed using the formula specified in Annex C (Formulas for calculations of test parameters).

b) Using fuel consumption meter

The fuel consumption shall be obtained by connecting the APS fuel tank to a fuel consumption meter. The total time to consume a given volume of fuel (i.e., 10 mL) shall be recorded. The fuel consumption shall be computed using the formula specified in Annex C (Formulas for calculations of test parameters).

7.2.1.5 System efficiency

The input power, water power, and system efficiency shall be computed using the formula specified in Annex C (Formulas for calculations of test parameters).

7.2.2 Spray range

The APS shall be set at the rated maximum pressure stated by the manufacturer with the cut-off valve fully opened. Wind speed relative to the direction of the spray in the test site shall be measured and recorded. It shall be measured 1 m from the ground, 1 m away from the nozzle, and 1 m away from the line of spray as shown in Figure 1. The horizontal and vertical spray ranges shall be measured for three trials.

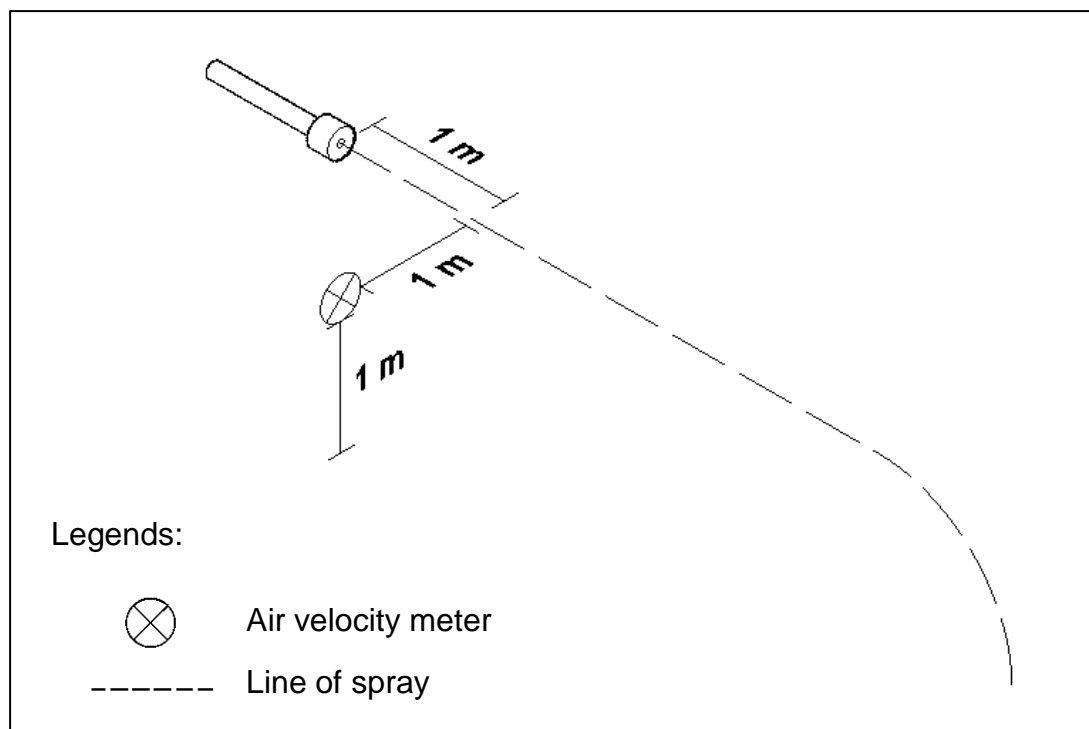


Figure 1. Position of air velocity meter during wind speed measurement (AMTEC-UPLB, 2023)

7.2.2.1 Horizontal spray range

The horizontal spray range shall be obtained by directing the nozzle horizontally at a height of 1 m and by measuring the spray from the tip of the nozzle up to its point of declination from the line of spray as shown in Figure 2.

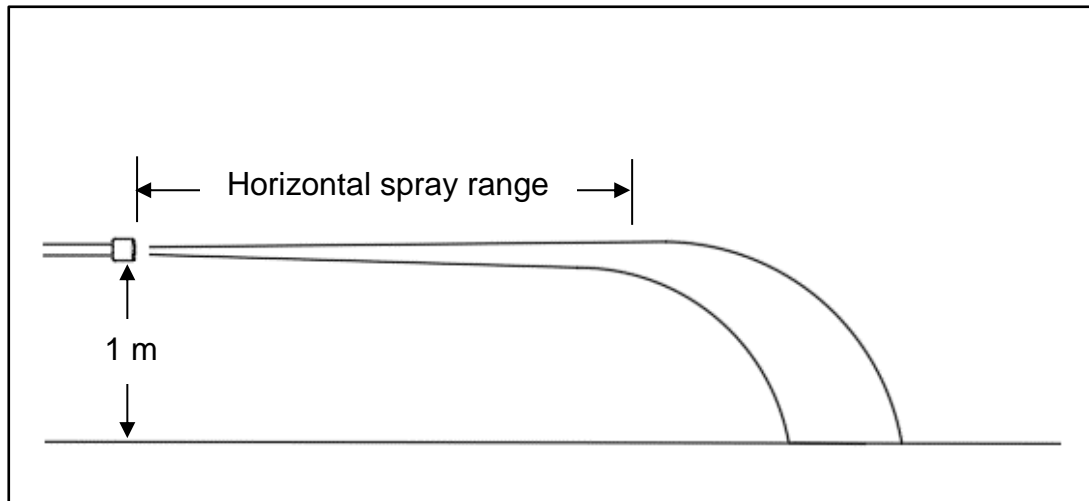


Figure 2. Direction of spray for horizontal spray range (AMTEC-UPLB, 2023)

7.2.2.2 Vertical spray range

The vertical spray range shall be obtained by directing the nozzle upward vertically and by measuring the longest reach of the spray from the tip of the nozzle as shown in Figure 3.

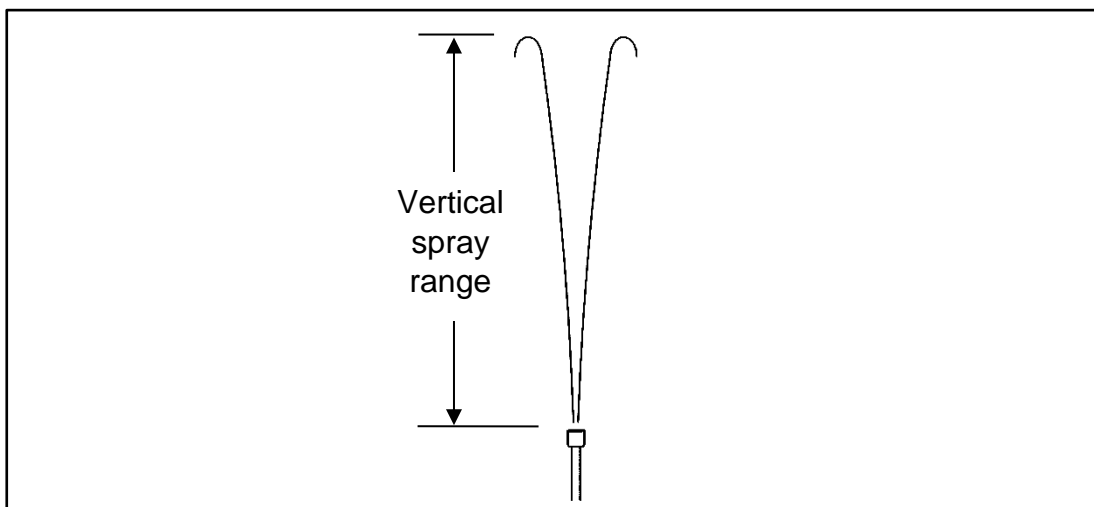
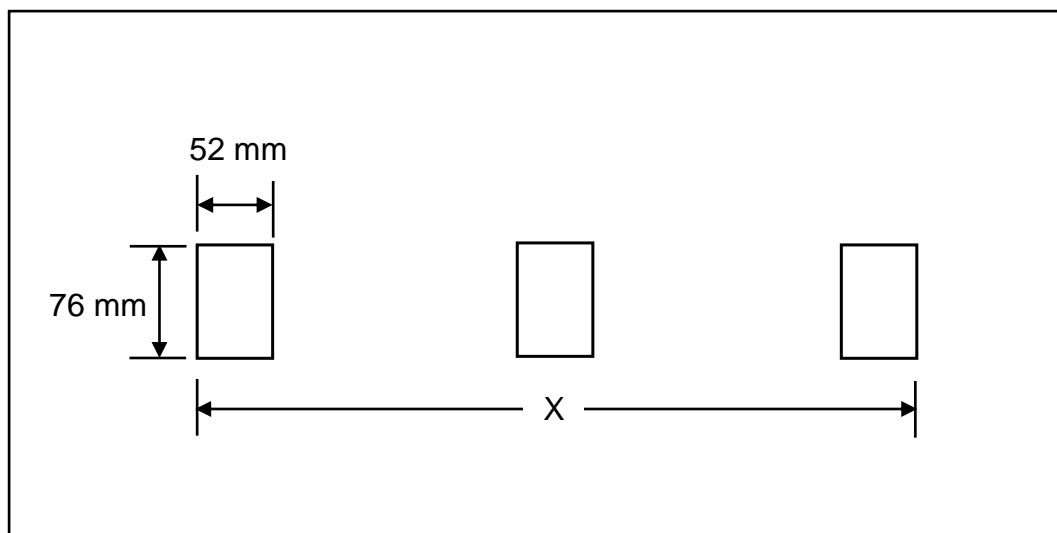


Figure 3. Direction of spray for vertical spray range (AMTEC-UPLB, 2023)

7.2.3 Spray quality

The following are the step-by-step method to measure the spray droplets size of the nozzle:

- a) The test shall be conducted in a space without interferences due to wind. In case of limited indoor spaces, the wind speed shall also be measured following the procedures in 7.2.2 (Spray range). Record the ambient relative humidity and temperature during the test;
- b) The spray target shall include three Water Sensitive Papers (WSP) with size of 76 mm x 52 mm placed in a rigid surface positioned vertically resembling like a wall as in Figure 4;
- c) Use the maximum rated operating pressure and nozzle type recommended by the manufacturer before the test. For adjustable nozzle, set the nozzle adjustment at two extreme points. Fill the spray tank with clean tap water;
- d) The nozzle/s shall be positioned horizontally at a height of 1 m and at the horizontal spray range;
- e) Start the sprayer by pointing the nozzle/s away from the spray target for 10 s. After which, move the nozzle vertically on the spray target for a short spraying time (about 1 s);
- f) Shortly after spraying, wait for the WSP to dry (1-5 min), then collect the dried spray targets and place inside a sealable plastic bag;
- g) Scan each of WSP card and analyze it using an image analysis system or any methods of determining spray droplet size; and
- h) Determine the Volume Median Diameter (VMD) and number and volume of spray droplets per area.



NOTE The distance (X) of WSP depends on the width of spray of the sprayer. In case of using three WSP, one is placed on the middle and two on either side.

Figure 4. Lay-out of WSP cards (AMTEC-UPLB, 2023)

7.2.4 Data recording and observations

Record sheet for all data and information during the test is given in Annex D (Performance test data sheet). Necessary observations and other parameters to be taken during the field performance test should be recorded in this sheet.

8 Formula

The formulas to be used during calculations and testing are given in Annex C (Formulas for calculations of test parameters).

9 Test Report

The test report shall include the following information in the order given:

- a) Name of testing agency;
- b) Test report number;
- c) Title;
- d) Summary of results;
- e) Purpose and scope of test;
- f) Methods of test;
- g) Description of the machine;
- h) Specifications;
- i) Results;
- j) Observations (include pictures); and
- k) Names, signatures, and designation of test engineers.

Annex A
(Informative)

Minimum list of test equipment and materials

	Test equipment and materials	Quantity
A.1	Test equipment and instruments	
A.1.1	Sound level meter Range: 30 dB(A) to 130 dB(A)	1
A.1.2	Stopwatch Maximum resolution: 0.1 sec	1
A.1.3	Measuring tape Minimum length: 10 m	1
A.1.4	Camera	1
A.1.5	Vernier caliper Maximum resolution: 0.1 mm	1
A.1.6	Weighing scale	1
A.1.7	Graduated cylinder (1000-ml capacity)	1
A.1.8	Tachometer (pulse and laser)	1
A.1.9	Pressure gauge Maximum resolution: 137.90 kPa (20 psi)	1
A.1.10	Computer	1
A.1.11	Fuel consumption meter	1
A.1.12	Water collecting equipment	1
A.1.13	Air velocity meter	1
A.2	Test materials	
A.2.1	Clean tap water	
A.2.2	Water Sensitive Paper (WSP) cards	

Annex B
(Normative)

Specifications of APS

Name of Applicant : _____
Address : _____
Tel. No. : _____

Name of Manufacturer : _____
Address : _____
Tel. No. : _____

GENERAL INFORMATION

Make : _____ Type : _____
Serial No. : _____ Brand/Model : _____
Date of Manufacture : _____
Testing Agency : _____ Test Engineer : _____
Location of Test : _____ Date of Test : _____

No.	Item ¹	Manufacturer's specification	Verification by the testing agency
1	Overall dimensions and weight		
1.1	Length, mm		
1.2	Width, mm		
1.3	Height, mm		
1.4	Weight, kg		
2	Spray tank		
2.1	Material		
2.2	Thickness, mm		
2.3	Capacity, L		
3	Spray tank cover		
3.1	Material		
4	Gasket		
4.1	Material		
5	Spray hose		
5.1	Material		
5.2	Thickness, mm		
5.3	Length, mm		
5.4	Inside diameter, mm		
5.5	No. of plies		
6	Lance		

No.	Item ¹	Manufacturer's specification	Verification by the testing agency
6.1	Material		
6.2	Length, mm		
7	Nozzle		
7.1	No. of orifice		
7.2	Orifice hole diameter, mm		
7.3	Material		
8	Strainer		
8.1	Type		
8.2	Mesh size		
9	Pressure gauge		
9.1	Resolution, kPa		
10	Prime mover		
10.1	Type		
10.2	Power rating, kW		
10.3	Type of starting		
10.4	Speed, rpm		
11	Pump		
11.1	Type		
11.2	Rated maximum pressure, kPa		
12	Valve		
12.1	Type		
13	Power transmission system		
14	Type of mounting		
15	Safety features		

¹ The parameter will be checked upon availability

Annex C
(Normative)

Formulas for calculations of test parameters

C.1 Discharge rate

$$Q = \frac{V}{t}$$

where:

Q is the discharge rate of the APS, L/min
 V is the total volume of water required to refill the APS, L
 t is the total time required to consume the water, min

C.2 Fuel consumption

$$F_C = \frac{V}{t_e}$$

where:

F_C is the fuel consumption rate, L/h
 V is the total volume of fuel consumed, L
 t_e is the total operating time of the engine, h

C.3 System efficiency

$$SE = \frac{P_o}{P_i} \times 100$$

$$P_o = \frac{Q \times p}{60000}$$

For APS powered by engine:

$$P_i = HV_f \times \rho_f \times F_C$$

For APS powered by electric motor (single-phase):

$$P_i = \frac{V \times I \times PF}{1000}$$

For APS powered by electric motor (three-phased):

$$P_i = \frac{V \times I \times \sqrt{3} \times PF}{1000}$$

where:

- SE is the system efficiency, %
- P_o is the output water power, kW
- P_i is the input power, kW
- Q is the discharge rate, L/min
- p is the pressure, kPa
- HV_f is the heating value of fuel, MJ/kg
- ρ_f is the density of fuel, kg/m³
- F_c is the fuel consumption rate, L/h
- V is the voltage, V
- I is the current, A
- PF is the power factor

Annex D
(Normative)

Performance test data sheet

Test Trial No. : _____ Date : _____
 Test Engineer/s : _____ Location : _____
 Assistants : _____ Machine : _____
 Test Applicant : _____ Manufacturer: _____

D.1 Discharge test

Setting	Trials	Pressure, kPa	Ambient temperature, °C	Relative humidity, %	Prime mover shaft, rpm	Pump shaft, rpm	Fuel consumed, mL	Total operating time of engine, min	Fuel consumption, L/h	Discharge, L	Total discharge time, min	Discharge rate, L/min	Noise level (a), dB(A)	Noise level (b), dB(A)	Input power, kW	Water power, kW	System efficiency, %
1	I																
	II																
	III																
2	I																
	II																
	III																
3	I																
	II																
	III																
4	I																
	II																
	III																

D.2 Spray range

Item	Data
Rated maximum pressure, kPa	
Wind speed, m/s	

Item	Trials			Average
	I	II	III	
Horizontal spray range, m				
Vertical spray range, m				

D.3 Droplets size analysis

Item	Data
Wind speed, m/s	
Ambient temperature, °C	
Ambient relative humidity, %	

WSP position	VMD, μm	Droplet distribution, spray droplets/cm ²	Deposition, $\mu\text{L}/\text{cm}^2$	Spray quality ¹
1				
2				
3				

¹ American Society of Agricultural and Biological Engineers (ASABE). (2020). Droplet size classification (ASABE S-572.1).

D.4 Observations

D.4.1 Special features

D.4.2 Other observations

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