Session 6: Minimum workshop facilities necessary to make an appropriate sprayer adjustment of orchard sprayer at the workshop during the inspection (TWG 6)

SPISE guidelines on how to make sprayer adjustment at the workshop as an addition to the functional inspection of field crop sprayers

A. Herbst

Julius Kühn-Institut, Federal Research Centre for Cultivated Plants, Messeweg 11/12, 38104 Braunschweig, Germany
DOI 10.5073/jka.2015.449.0020

In the ambit of SPISE working Group several Technical Working Groups (TWG) have been recently created with the aim to prepare guidelines about the items taken into account by the EU Directive 128/2009/EC but still not considered in the actual ISO/CEN standards.

SPISE TWG 6 in particular has defined guidelines on what are the minimum workshop facilities necessary and how to make an appropriate sprayer adjustment of field crop sprayers at the workshop during the inspection/calibration activities.

Sprayer adjustment is focused to the adaptation of the sprayer output (both liquid and air) to the specific crop and eventually environmental situations present on the farm. To guide and verify the correct sprayer adjustment at the workshop, it is necessary to use ad hoc test benches that the workshops should have in their set of instruments.

It is an operation that shall be made at the end of the functional inspection but before the eventual calibration of the sprayer. It has to be carried out for each crop type and situation present on the farm or at least for the most representative ones, because only a correct adjusted sprayer guarantees that the spray mixture is addressed to the target, the use of PPP is optimized and the risks for the environment (e.g. spray drift) and for the consumers are minimized.

For these reasons an advice with the following content will be published:

Foreword

The SPISE Working Group was established in 2004 during the first SPISE workshop. There the participants welcomed the thought of Dr. Ganzelmeier (JKI) that a working group should work on further steps for the harmonization and mutual acceptance of equipment inspections. In the following years, thanks to SPISE engagement, a constant exchange of information has been made possible within the working group and consultations went on between the EC and MS on improving the sustainability of plant protection.

The 5 members of the SPISE working group came from Belgium, France, Germany, Italy and the Netherlands. They represented the member states with most experience in the fields of inspection of sprayers at that time.

In the ambit of SPISE working Group several Technical Working Groups (TWG) have been recently created with the aim to prepare guidelines about the items taken into account by the EU Directive 128/2009/EC but still not considered in the actual ISO/CEN standards.

SPISE TWG 6 (°), in particular, has defined guidelines on how and what are the minimal workshop facilities necessary to make an appropriate sprayer adjustment of field crop sprayer at the workshop during the inspection/calibration activity.

(°)SPISE TWG 6 members

Chairmen:

Balsari Paolo, DISAFA, Italy

Herbst Andreas, JKI, Germany

Langenakens Jan, A.A.M.S. NV, Belgium

Introduction

In the Article 8 of the EU Directive 128/2009/EC it is foreseen that professional users have to be properly trained about the procedures for calibration/adjustment of sprayers, in order to be able to apply them with their own equipment in an appropriate and environmental safe way. Sprayer calibration made at farm is however limited due to the lack of appropriate instruments/devices available, except for those that have been provided together with the machine, and that are described in the user manual. A more accurate and appropriate sprayer adjustment can be therefore made from time to time in the authorized workshops as a complement to the sprayer inspection/calibration.

In practice it is important to distinguish the difference between the sprayer calibration and the sprayer adjustment.

Sprayer **calibration** aims at achieving a determined spray volume application rate through the selection of the appropriate forward speed, operating pressure, nozzle types and sizes (nozzle flow rate). The basic data to make sprayer calibration are derived from the functional inspection. Calibration can also be made directly by the professional user, when he's adequately trained.

Sprayer **adjustment**, on the other hand, is focused to the adaptation of the sprayer output (both liquid and air) to the specific crop and eventually environmental situations present in the farm (Balsari et *al*., 2007). To guide and verify the correct sprayer adjustment at the workshop, it is necessary to use ad hoc test benches that the workshops should have in their set of instruments.

This document provides some guidelines on how to operate field crop sprayer **adjustment** at the workshop and about the type of instruments needed, with their minimum technical requirements.

1. Sprayer adjustment

It is an operation that shall be made at the end of the functional inspection, but before the eventual calibration of the sprayer. It has to be carried out for each crop type and situation present in the farm or at least for the most representative ones, because only a correct adjusted sprayer guarantees that the spray mixture is addressed to the target, the use of PPP is optimized and the risks for the environment (e.g. spray drift) and for the consumers are minimized (Andersen & Jørgensen, 2009).

The operative parameters of the sprayer that is recommended to take into account for the sprayer adjustment made at the workshop are the following:

Optimal boom height selected according to the nozzle type used, the target crop height and the environmental conditions;

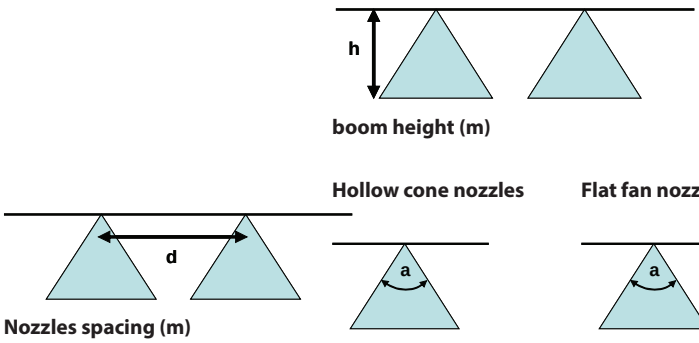
Air velocity and direction (only if the spray boom is equipped with an air sleeve) selected according to the target crop type and the environmental conditions.

2. Optimal boom height

Indications on optimal boom height

In order to achieve a sufficient evenness of transversal spray distribution, it is necessary to operate with an appropriate spray boom working height. As boom height it is intended the distance between the nozzle tip and the target (crop or soil). For boom height selection it is important to consider the spray angle of the nozzles mounted along the boom and their spacing (Tab. 1). In general terms nozzles featured by wide spray angles are preferable because they allow reducing the boom height and therefore mitigating spray drift (Fig. 1 and Fig. 2). Especially when wide boom sprayers are employed, it is recommended to keep a boom not lower than 0.50 m in order to prevent the ends of the boom from hitting the ground.

Tab. 1. Boom heights enabling to achieve the correct spray jets overlapping in function of the nozzle type and of the nozzle spray angle



	α = 80° /90°	α = 80° /90°	α = 110° /120°
0,25	-	-	*0,30*
0,33	*0,50*	*0,50*	*0,40*
0,50	*0,75*	*0,75*	*0,50*

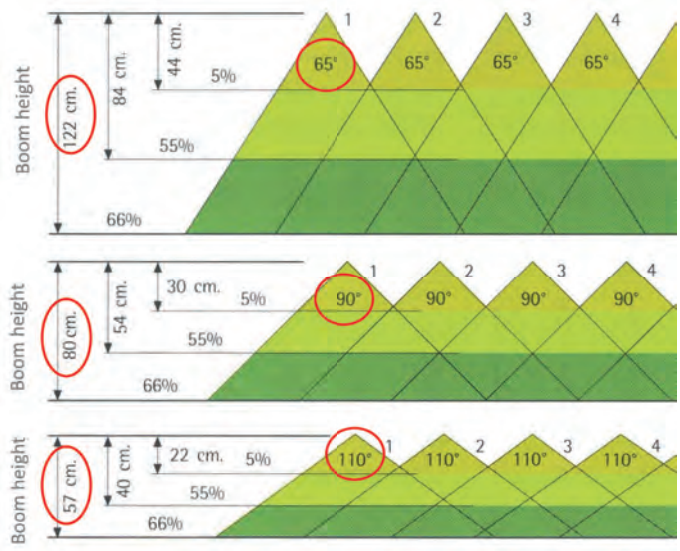


Fig. 1. Nozzle with wide angle allowed to maintain the boom closer to the target using the same spray overlapping and minimizing spray drift losses.

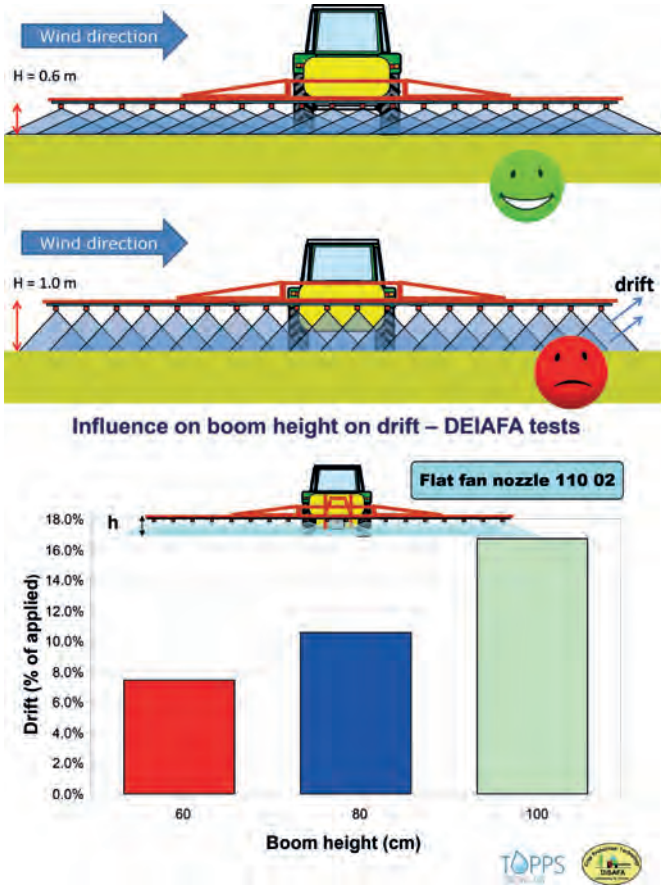


Fig. 2. Influence of boom height on spray drift (Marucco & Tamagnone, 2002).

When specific nozzles for band spray application are used the boom height adjustment is dependent on the spray angle, nozzle twist and nozzle spacing. Boom height shall be set to achieve a correct spray distribution on the applied band and to prevent spray drift.

Note: Consider the real spray angle, at lower pressures angles become smaller than the indicated spray angle. Some manufacturers are not precise in mentioning the spray angle for commercial reasons.

Optimal boom height evaluation

The optimal boom height is the one which allows obtaining the most even transverse spray distribution diagram according to the intended spray application (open field or band treatment).

The assessment of the optimal boom height shall be carried out in the area of the overlapping spray jets, excluding the outer parts of the boom while the nozzles are operated at the pressure indicated by the professional user and using a horizontal patternator, according to chapter 5.6.1 of EN ISO 16122-2.

Minimum technical features of this patternator are:

- grooves 100 ± 2,5 mm wide and at least 80 mm deep, measured as a distance between the top and the bottom of the groove
- Length of the groove: at least 1,5 m.

The groove width of a patternator working in steps with electronic data sampling (e.g. scanners) shall be 100 mm ± 1 mm.

The error of measurement shall not be more than 10 ml or ± 2 % of the measured value whichever is greater.

When passing the measuring track, positioning in single steps shall be completed with an accuracy of ± 20 mm. The measuring error of the volume of the single grooves at a flow volume of 300 ml/min shall be less than ± 4 %. The adjustment and calibration of the patternator shall be in accordance with the patternator manufacturer's instruction handbook.

Influences by external conditions on the reproducibility on the results shall be minimized.

Optimal boom height determination

Manual Test bench

After checking that the field crop sprayer is positioned on a horizontal surface and is set according to the parameters (operating pressure and boom height) normally used in the farm, activate the nozzles and position the test bench (Fig. 3) under the boom section to examine.

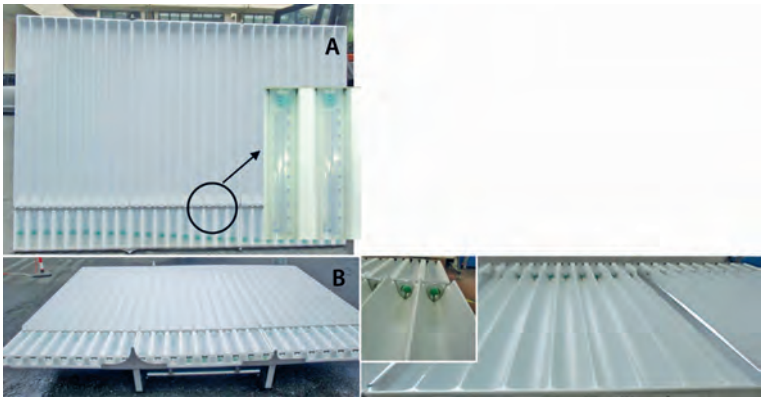


Fig. 3. Examples of manual horizontal patternator.

If the sprayer is equipped with an air sleeve, the test is carried out with the fan disabled or if it cannot be disabled, at the lowest possible pressure

The test shall be repeated for all the nozzle series present on the boom sprayer and used in the farm.

Duration of the test depends on the technical features of the test bench and on the nozzles flow rate (Tab. 2).

At the end of the trial the uniformity of transverse spray distribution under the boom is assessed visually on the test bench, looking at the profile of the water in the filled grooves. The presence of floats inside the collecting tubes of the test bench allows making a simpler and quicker evaluation (Fig. 6).

For the interpretation of the result it is important to consider the nozzle type used: for instance, using hollow cone nozzles it will never be possible to achieve the uniformity level reached using flat fan nozzles, while the specific nozzles for band spraying shall show spray distribution peaks in correspondence of each nozzle position.

	Spaziatura ugelli sulla barra (m)		
	0,33	0,50	1,00
Portata ugelli (l/min)	Tempo (s)		
0,2	257	390	780
0,3	172	260	520
0,4	129	195	390
0,5	103	156	312
0,6	86	130	260
0,7	74	111	223
0,8	64	98	195
0,9	57	87	173
1,0	51	78	156
1,2	43	65	130
1,4	37	56	111
1,6	32	49	98
1,8	29	43	87
2,0	26	39	78
2,2	23	35	71
2,4	21	33	65
2,6	20	30	60
2,8	18	28	56
3,0	17	26	52
3,5	15	22	45
4,0	13	20	39

	Spaziatura ugelli (m)		
	0,33	0,5	1
Portata ugelli (l/min)	Tempo (s)		
0,2	297	450	900
0,3	198	300	600
0,4	149	225	450
0,5	119	180	360
0,6	99	150	300
0,7	85	129	257
0,8	74	113	225
0,9	66	100	200
1,0	59	90	180
1,2	50	75	150
1,4	42	64	129
1,6	37	56	113
1,8	33	50	100
2,0	30	45	90
2,2	27	41	82
2,4	25	38	75
2,6	23	35	69
2,8	21	32	64
3,0	20	30	60
3,5	17	26	51
4,0	15	23	45

Tab. 2. Examples of tables reporting the time of spraying, depending on nozzles flow rate, for tests made using manual test benches (grooves width 100 mm, groove depth 96 mm) having different collecting surfaces: A): height of collecting surface 0.90 m, tube height: 0.27 m - B): height of collecting surface: 1.50 m, tube height: 0.40 m Diese Tabelle ist eine Abbildung!!!

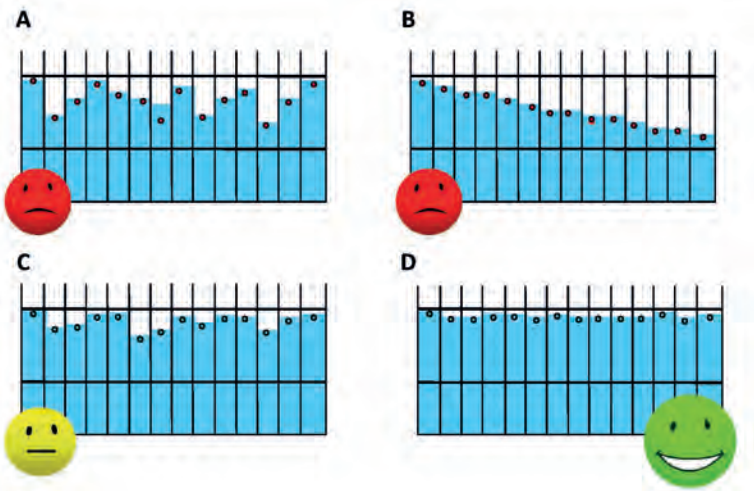


Fig. 4. Evaluation of transverse spray distribution diagrams to individuate the optimal boom height. A and B) necessity to act on nozzles, C) necessity to modify the boom height, D) optimal boom height.

Electronic test bench (e.g. "scanner")

After checking that the field crop sprayer is positioned on a horizontal surface and is set according to the parameters (operating pressure and boom height) normally used in the farm, activate the nozzles and the data acquisition from the test bench (Fig. 5) that shall be already positioned under the boom sprayer to evaluate.

If the sprayer is equipped with an air sleeve, the test is carried out with the fan disabled or if it cannot be disabled, at the lowest possible pressure. The test shall be repeated for all the nozzle series present on the boom sprayer and used in the farm.

Fig. 5. Examples of electronic horizontal test benches (e.g. "scanner" type).

The test bench works autonomously under the boom. Generally the test bench displacement from one position to the next under the boom is related to the filling of the tubes in the collecting grooves.

At the end of the test, the system generally provides on the PC the graph of the liquid profile of the collected liquid with the corresponding coefficient of variation. According to the amount of this obtained value it is possible to make further tests at different boom heights and or pressures

3. Air velocity

When air-assisted boom sprayers are operated, it is necessary to adjust the air stream velocity and the inclination of the nozzles (or of the air sleeve itself, when possible) with respect to the air flux according to the spray application conditions (Balsari et *al*. 2013).

In detail:

4. Disconnect the fan when applying on bare soil (ensure that the air sleeve not interfere with the spray);

5. When spraying low crops reduce the air velocity in order to prevent dust generation and orient the air stream backwards to avoid bouncing of the sprayed droplets;

6. When it is necessary to achieve a better spray droplets penetration into dense canopies, increase the air velocity and orient the air stream conveniently to open the canopy and to support droplets penetration;

7. In presence of side wind or in absence of wind, keep the air stream direction vertical and only orient it forwards if the forward speed exceeds 8 km/h;

8. In presence of back wind orient the air stream backward;

9. In presence of front wind orient the air stream forward (Fig. 6);

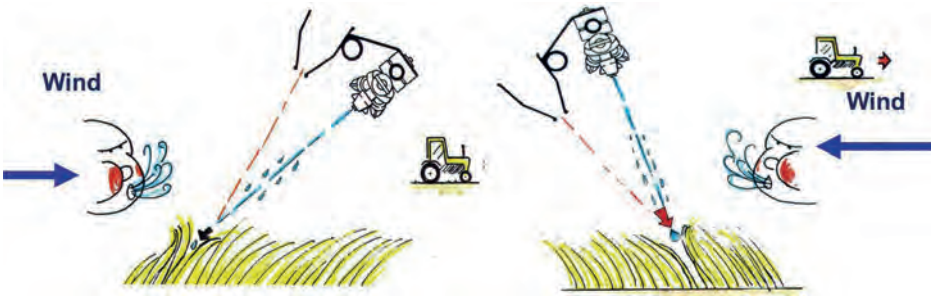


Fig. 6. Air sleeve adjustment to contrast the action of wind and to prevent spray drift.

Always carefully control the meteorological conditions in which the spray application is carried out. If wind speed and direction change it is recommended to modify the orientation of the air stream conveniently.

To assess the air velocity it is necessary to use a specific test bench provided with an anemometer (Fig. 7) having **at least** the following **technical features**:

Numbers of anemometers: 1

Anemometer measuring range: 0÷25 m/s

Error: max. 0.25 m/s

Longitudinal distance between measurement positions: max. 100 mm

Transversal distance between measurement positions: max. 500 mm

Number of measurements per position: 1

Fig. 7. Example of test bench equipped with sonic anemometer.

References

Andersen P. G., Jorgensen M.K. (2010). *Calibration of sprayers*. Proceedings of European Workshop "Spise 3" in: Julius Kühn Archiv n° 426, pag. 143-152.

Balsari P., Oggero G., Marucco P. (2007). *Proposal of a guide for sprayers calibration*. Proceedings of European Workshop "Spise 2" in: Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft Berlin-Dahlem, 412; pag. 60-72, ISSN: 0067-5849.

Balsari P., Marucco P., Doruchowski G., Ophoff H., Roettle M. (2013). *Best Management Practice to reduce spray drift* – Topps Prowadis Project.

Marucco P., Tamagnone M. (2002). *La validità degli ugelli antideriva e della manica d'aria*.(Drif reduction evaluation of antidrift nozzles and air assisted boom sprayer) Proceedings of convention: "La deriva del prodotto fitoiatrico: l'importanza del fenomeno e le soluzioni tecniche per contenerlo" (Eima in campo 2002), pag. 12-16.

SPISE Technical Working Group 6, Advice for field crop sprayer adjustments, 05/2015, ISSN 2364-7574, DOI:10.5073/spise.en.2015.01