ISSN 2364-7574

SPISE ADVICE

Standardized **P**rocedure for the **I**nspection of **S**prayers in **E**urope

05/2015

compiled by :
SPISE Technical Working Group 6

Advice for field crop sprayer adjustments

Advice for field crop sprayer adjustments

This document has been compiled by the SPISE Technical Working Group 6.

Chairmen: Paolo Balsari (University of Turin, Italy)
Andreas Herbst (Julius Kühn Institute, Germany)
Jan Langenakens (A.A.M.S. NV, Belgium)

CONTENTS

1 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 by 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 , it is necessary to use ad hoc test benches .

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

2 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 are the following:

1. Optimal boom height selected according to the nozzle type used, the target crop height and the environmental conditions;
2. 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.

3 Optimal boom height

3.1 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 consider boom heights that is not hitting the ground.

Nozzles spacing (m)	Boom height (m)				
	Hollow cone nozzles		Flat fan nozzles		
	α = 60°	α = 80°	α = 80°	α = 90°	α = 110°
0,33	0,50	0,50	-	-	-
0,50	0,55	0,50	0,60	0,50	0,50
0,65	-	-	0,75	0,65	0,50
0,75	-	-	0,90	0,75	0,55

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

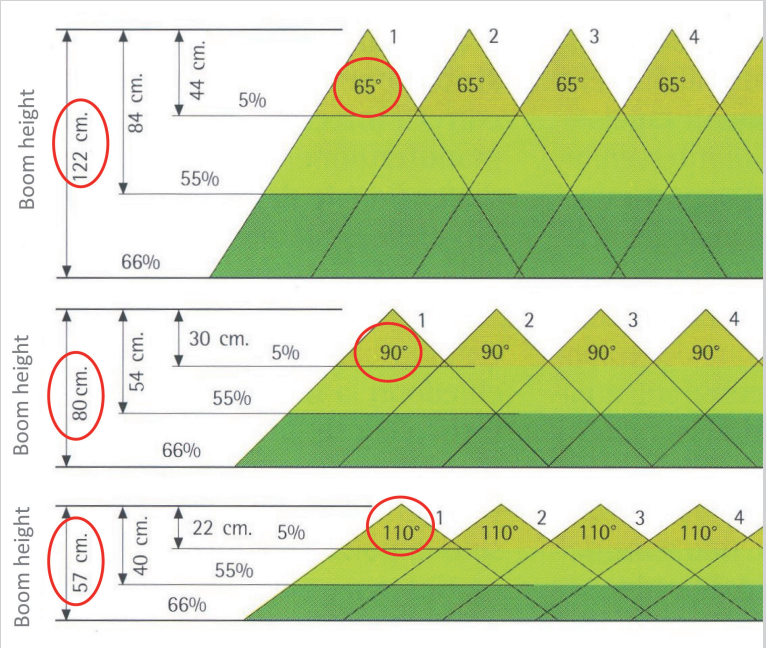

Fig. 1 .Nozzle with wide angle allowed to maintain the boom closer to the target using the same spray overlapping and minimizing spray drift losses.

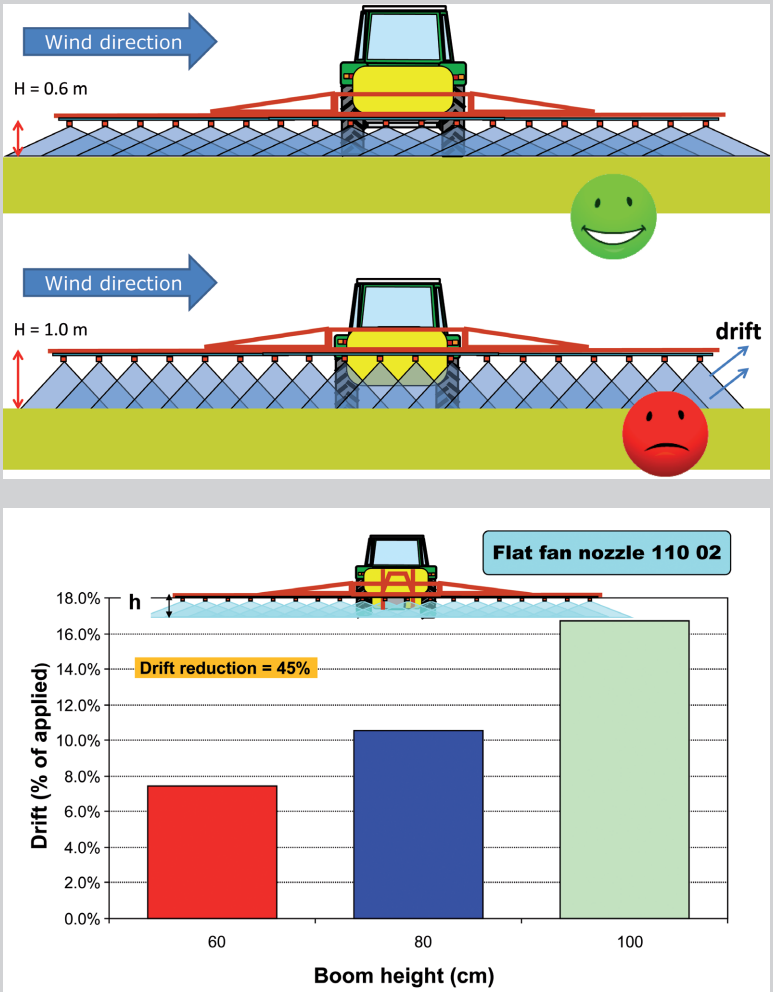

Fig. 2 –Example of Influence of boom height on spray drift (Marucco & Tamagnone, 2002).

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.

3.2 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 (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.

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

3.3 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.
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

	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.

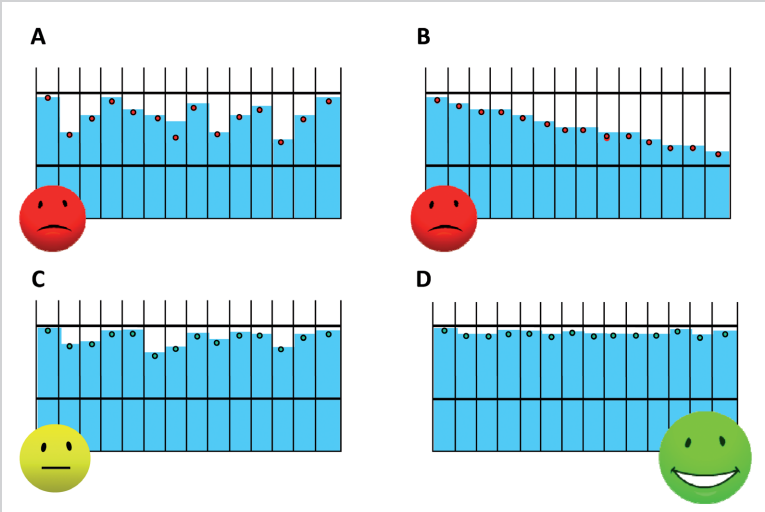

Fig. 4 –Example of evaluation of transverse spray distribution diagrams to individuate the optimal boom height. A and B) necessity to act on nozzles, C) necessity to modify the boom height, D) optimal boom height.

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.

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.

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.

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

4 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:

0. Ceck manual indication/informations
1. Disconnect fan or select air flow to minimum when applying on bare soil (ensure that the air sleeve not interfere with the spray);
2. When spraying low crops reduce the air velocity in order to prevent dust generation and orient the air stream backwards (if possible) to avoid bouncing of the sprayed droplets;
3. When it is necessary to achieve a better spray droplets penetration into dense canopies, increase the air velocity and (if possible) orient the air stream conveniently to open the canopy and to support droplets penetration;
4. 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;
5. In presence of back wind orient the air stream backward;
6. In presence of front wind orient the air stream forward (Fig. 6);

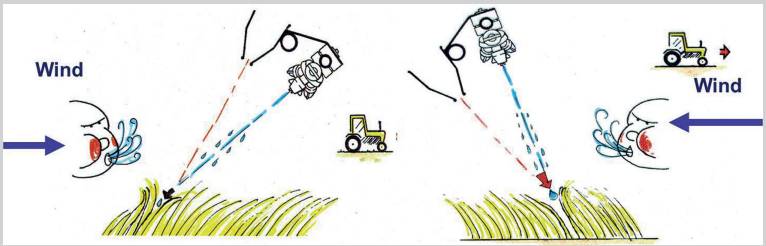

Fig. 6 – Air sleeve adjustment to contrast the action of wind and to prevent spray drift.

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

5 References

Andersen P. G., Jorgensen M.K. (2010). *Calibration of sprayers*. Julius-Kühn-Archiv 426. Third European Workshop on Standardised Procedure for the Inspection of Sprayers - SPISE 3, p. 143-152.

Balsari P., Oggero G., Marucco P. (2007). *Proposal of a guide for sprayers calibration*. Mitteilungen aus der Biologischen Bundesanstalt 412. Second European Workshop on Standardised Procedure for the Inspection of Sprayers in Europe - SPISE 2, p. 60-72.

Balsari P., Marucco P., Doruchowski G., Opho 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 (Drift reduction evaluation of antidrift nozzles and air assisted boom sprayer)*. Proceedings of convention: "La deriva del prodotto fi toiatrico: l'importanza del fenomeno e le soluzioni tecniche per contenerlo" (Eima in campo 2002), p. 12-16.

ANNEX 1

REPORT OF FIELD CROP SPRAYER ADJUSTMENT

SECTION 1

Adviser: _____

Owner's identity: _____

Owner's address: _____

Sprayer

Manufacturer: _____

Type: _____

Boom width (m): _____

Mounted [ ] Trailed [ ] Self propelled [ ]

ANNEX 2

SECTION 2[1]

CROP _____

Treatment

Pre emergence weed control [ ] Post emergence weed control [ ]

Insecticide [ ] Fungicide [ ]

Nozzle Type

Flat fan [ ] Twin [ ] Hollow cone [ ] Mirror [ ]

Opening angle 80 [ ] 110 [ ] other _____

Air induction or similar [yes] [no]

Working pressure (bar): _____

Nozzle spacing (m): _____

Optimum boom height established(m): _____

CV (%) at the boom height _____

Air assistance system

Presence [yes] [no]

If yes, main goal of air assistance system

Anti drift [ ] Increase penetration into dense canopies [ ]

Optimum air stream velocity

PTO revolution (rpm) _____

Air velocity (m/s) _____

(mean values along the spray boom)

Air assistance system inclination respect to forward direction

Backward [ ] Forward [ ] Vertical [ ]

_____

(date)

_____ _____

(adviser signature) (Station stamp)

[1] Fill out a new section for each crop and treatment for which sprayer adjustment has been carried out

SPISE – Standardized Procedure for the Inspection of Sprayers in Europe
Established in 2004 by founding members from Belgium, France, Germany, Italy and the Netherlands, the SPISE Working Group aims to further the harmonisation and mutual acceptance of equipment inspections. In regular meetings, several Technical Working Groups (TWG) prepare advice about the items taken into account by the EU Directive 128/2009/EC but still not considered in the actual ISO/CEN Standards. The present document is intended to provide technical instructions and describes a procedure which is not mandatory but can be voluntary adopted in the course of inspection or calibration.

Further information can be found at **http://spise.jki.bund.de**

An electronic version of this document is freely available at **http://pub.jki.bund.de**

Editor-in-Chief

Prof. Paolo Balsari
University of Turin
Department of Agriculture, Forestry and Food Sciences (DISAFA)
Largo P. Braccini 2
10095 Grugliasco (TO) (Italy)

Publisher

Julius Kühn Institute - Federal Research Centre for Cultivated Plants
Erwin-Baur-Str. 27
D-06484 Quedlinburg (Germany)

ISSN: 2364-7574
DOI: 10.5073/spise.en.2015.01
May 2015

This work is published open access under the terms of the Creative Commons Attribution 4.0 license (https://creativecommons.org/licenses/by/4.0/). It may be freely distributed and build upon provided the original work is properly cited.