
Session 5: Additional Workshops activities including PAE adjustment

What to be considered when you buy a sprayer: the SPISE advice

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Abstract

Since the publication of European Directive (2009/127/EC), environmental requirements for new orchard sprayers are mandatory. Only equipment which has successfully accomplish the specifications can be placed into the EU market. For this purpose, the new harmonized ISO 16119 series represents an interesting tool to fulfil the requirements. However, not all the sprayers placed in the market after the publication of the Directive are in line with it. SPISE community has developed a practical guideline in order to guarantee a clear and universal dissemination among farmers and other stakeholders about the main requirements to be accomplished by the sprayers.

Introduction

Mandatory inspection of sprayers in use became mandatory in Europe since the official publication of the European Directive for a Sustainable Use of Pesticides (EC, 2009). From the technical point of view, the official procedure for the inspection is very well defined after the publication of the harmonized standard EN ISO 16122 (ISO, 2015). At the same time, the European Directive 2009/127/EC amending 2006/42/EC with regard to the spraying equipment was also published, establishing the essential environmental and safety requirements to be accomplished for new sprayers. European sprayer's manufacturers shall take all appropriate measures to be sure that their machinery may be placed on the market and put into service accomplishing the relevant provisions established in the legislation. In a similar way, the harmonized standard EN ISO 16119 (2014) was also published as a technical reference document.

However, there is still an important lack of information among the involved stakeholders (manufacturers, farmers, advisors...) concerning the mandatory requirements to be accomplished by new sprayers. It is still possible to find in the market new sprayers with defaults in some important aspects (cleaning, agitation, measuring devices...) that should be avoided. In most cases these defaults have been produced as a consequence of a lack of information by small and medium manufacturers. This fact, linked with the difficulty to arrive to farmers with clear information about the official requirements, derive in the selection of new sprayers with technical default with great influence on quality of applications, generating also difficulties during the mandatory inspection process.

For those reasons, SPISE community decided to develop a practical guideline with the main objective to inform on an easy and clear way, which are the main requirements that farmers should check before to acquire a new sprayer. This guideline cannot be considered as a law. It is just a practical document where main requirements are clearly explained in order to help farmers, and also other stakeholders, during the selection process of the most accurate sprayer for their interests.

Structure of the SPISE guideline for new sprayers

The guideline has been developed in a practical way, avoiding too many texts and providing farmers with clear descriptions, schemes and figures. Along the guideline, the main aspects addressed are included in table 1.

Table 1. Main aspects considered in the SPISE advice about new sprayers

Aspect	Requirements according ISO 16119-1
Inspection of sprayers	Sprayers shall be provided by adequate devices in order to facilitate the connection of special devices for the mandatory inspection of sprayers in use (ISO 16122 series)
Adjustment of sprayer	It shall be possible to adjust the sprayers for the intended volume application rate. The sprayer shall be delivered with adequate and reliable measuring systems.
Spray distribution	Characteristics of the sprayer shall allow to obtain a uniform distribution of the sprayed liquid according the intended target, while minimizing losses and drift and avoid contamination of non-target areas.
Information	The sprayer shall contain a specific placement where operator will write the name and specifications of PPP in use
Filling, emptying and cleaning	All the sprayers shall be provided with reliable and safe systems for filling and emptying the tank without environmental risk. Sprayers shall incorporate devices for cleaning the whole machine (inside and outside) after the application process.
Marking	Specific spare parts as nozzles and filters shall be clearly identified (manufacturer, size, type...)
Instruction handbook	It is mandatory to provide a clear, precise and useful instruction book with all the sprayers. Information about calibration, cleaning and maintenance shall be provided.

All the aspects described in table 1 are in accordance with the official requirements established in the European Directive 2009/127.

Contents of the SPISE guideline

It is obvious that not all the technical requirements included in ISO 16119 can be explained briefly and easily on a practical guideline as it is. For that reason, this SPISE guideline includes the most relevant a practical aspect to be considered. The included items are:

- Required characteristics of the spray tank
- Technical requirements of the pump
- Spray boom (for field sprayers)
- Filters and nozzles
- Devices for avoiding drift
- Measuring systems
- Provisions for connecting test equipment
- Air and liquid adjustments
- Cleaning devices
- Induction hopper

All the included aspects have been selected due its possibility to be easily checked over a sprayer, without any kind of measurement or instrument. The SPISE guideline includes also a special chapter dedicated to band sprayers and its special requirements.

Figures and schemes

As a practical guideline, most of the items included on it have been accompanied with explanatory figures or schemes. The main objective of this guideline is to be used as a practical document to help farmers during the process of sprayer selection. Figures 1 and 2 are some examples of graphical information included on the guideline.



Figure 1. The sprayer shall be provided with a device for an easily connection of instruments used during the mandatory inspection of sprayers in use according ISO 16122. Left: easy adaptor for pump tester; right, easy plugging adaptor for testing manometer.

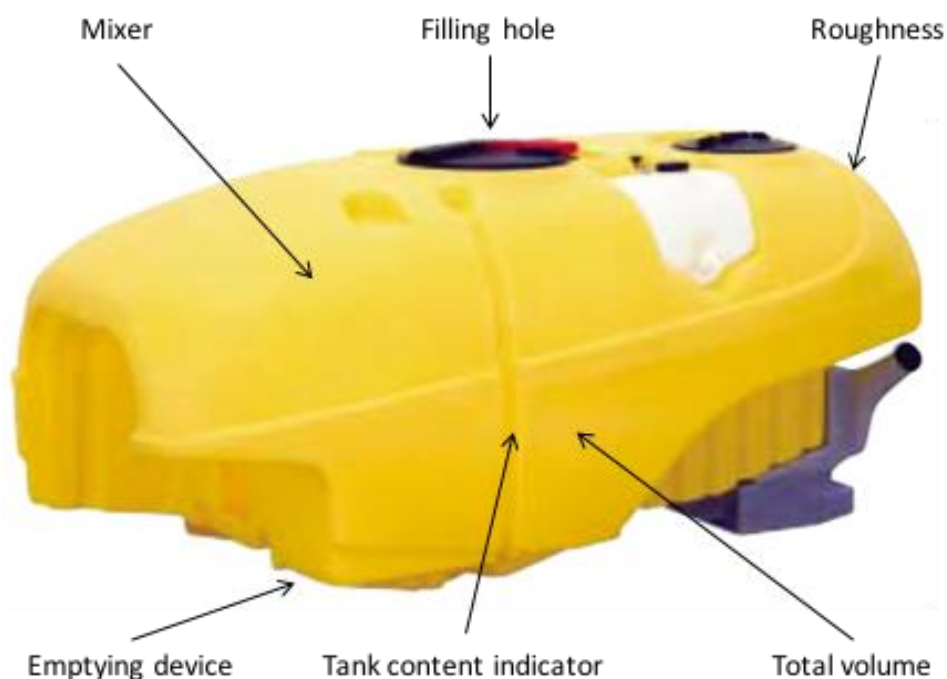


Figure 1. Main aspects to be considered on a sprayer tank

Instruction handbook

As a mandatory requirement established in EU Directive 2009/127, all the sprayers must be provided with a instruction handbook. This document shall incorporate diverse aspects in order to help the users for a proper use of the sprayer. For this reason, a specific chapter concerning instruction handbook has been included in the SPISE guideline. Table 2 shows the mandatory information to be included.

Conclusions

Following the aim of SPISE community, the development of the advises' guidelines collection follows to increase the knowledge and dissemination of all aspects related with inspection of sprayers in use, knowing the importance of the topic directly related with a good a safe use of pesticides. The entire collection of the guidelines can be downloaded at <https://spise.julius-kuehn.de/index.php?menuid=34&getlang=en>

Table 4. Main aspects to be included in the instruction handbook

Subject	Information to be included in the instruction handbook
Adjustment and calibration process	Detailed explanation about how to adjust the working pressure Complete calibration procedure information Folding/unfolding method of boom sprayer How to proceed in case of blocked nozzle, or other problems during the spraying process in the field.
Maintenance	Maintenance and updating process of the sprayer after the Winter break Practical information about how to prepare the sprayer for the winter break Precautions to be considered during the cleaning process, especially those concerning to environmental contamination Detailed information about maintenance procedure and safety measurements before dismounting pieces. Practical information concerning pump substitution
Safety	Practical recommendations to avoid direct contact with plant protection products, or inhalation dangerous vapours. Practical information about safe use of front spray boom (if applicable) Information about risk of a complete entry on the sprayer's tank Check the presence of other persons close to the sprayer before starting; special concerns must be indicated about blower Information about potential accident with high electrical lines. Information about maximal working pressure of the circuit

References

EC/127. Directive 2009/127/EC of the European Parliament and of the Council of 21 October 2009 amending Directive 2006/42/EC with regard to machinery for pesticide application; 2009 [Of. J. EU, 25.11.2009, L 310/29].

EC/128. Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides; 2009 [Of. J. EU, 24.11.2009, L 309/71].

Effect of sprayer boom curvature on spray distribution: test on spray distribution bench

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Introduction

Since the establishment (1995) of the control of pesticide application equipment in Belgium, the boom curvatures are appreciated only qualitatively. Where there is a doubt, a string is stretched on the extension of the imaginary line of the boom. Until now, limits have been set arbitrarily. So far, a large curvature is the cause of a refusal of the sprayer to control. In front of this lack of accuracy in measurement, pertinence was needed for justification of the sanctions. A study that specifically targeted the effects of boom curvatures on spray quality was missing. Scientific results should help to objectively determinate legal tolerances.

Materials and methods

A boom of 6 meters is used: The structure is suspended above a splitter bench. The nozzles mounted on the ramp are 110 ° slotted nozzles. The "curvature" tested in this test actually is a straight slope of the boom. The 6 m boom is considered a half boom, one end of which corresponds to the center of the spray. The angles of inclination are made into the vertical and horizontal planes. In addition, combinations of the two planes are also tested. The boom is inclined at the angles of 0 °, 1 °, 3 °, 5 ° and 6 °. The working height is fixed at 60 cm. It corresponds to a commonly used height and also to a test height recommended in standard 5682-2. The 0° angle defines the ideal position of the ramp.

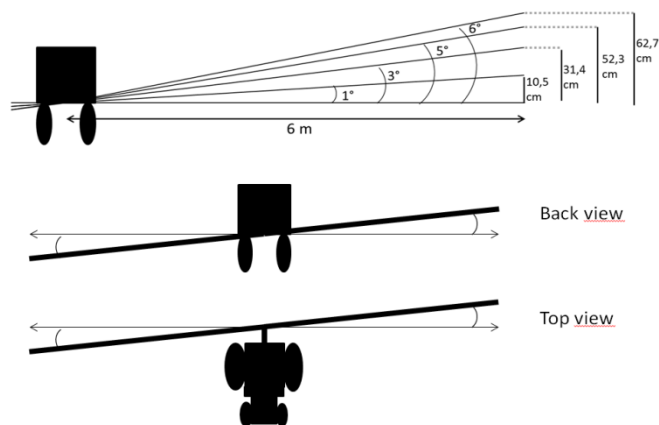


Figure 15 : boom positions into two planes tilts

Spraying is carried out on a static boom, inside a closed room, guaranteeing the absence of wind and a stable ambient temperature and hygrometry. The spray pressure is set at 2 bar. Three theoretical working heights are fixed: The most used height = 60 cm; a lower value = 50 cm; a higher value = 75 cm. The spraying time is 120 seconds. Three repetitions are performed for each measurement.

The total spray width on the bench is 7.5 m for a boom at 60 cm working height on horizontal position. At the ends of the boom there are edge effects of about 1.5 m because the jets of the last nozzles do not benefit from overlays as those of their neighbors. Delimitations were set so that within the range of 4.5 m wide, no edge effects are observed.

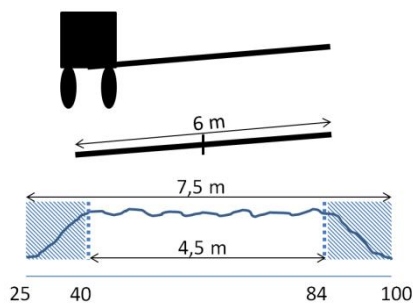


Figure 16 : spray pattern in the 75 collecting tubes. Hatched = edge effect. Numbers under repartition = collecting tube numbers

The 6 m boom is used to simulate a half ramp of a 12 m hypothetical sprayer. At the extremity that represents the theoretical center of the 12 m ramp, the edge effect is not taken into account. Indeed, it is non-existent in the center of a ramp. On the other hand, the edge effect on the extremity that represents the boom end is maintained in the results because it corresponds to a field reality (Figure 16). From all water volumes of collecting tubes, charts are made representing distribution of each measurement. To simplify the reading of these graphs, three points are defined on the ramp: A = nozzle of the left end; B = nozzle of the right end; C = center of ramp (Figure 17). Point C is always fixed at working height. In the case of vertical angles, point A is always pointing downwards and the point B always upwards. These points A, B and C are shown on the distribution charts.

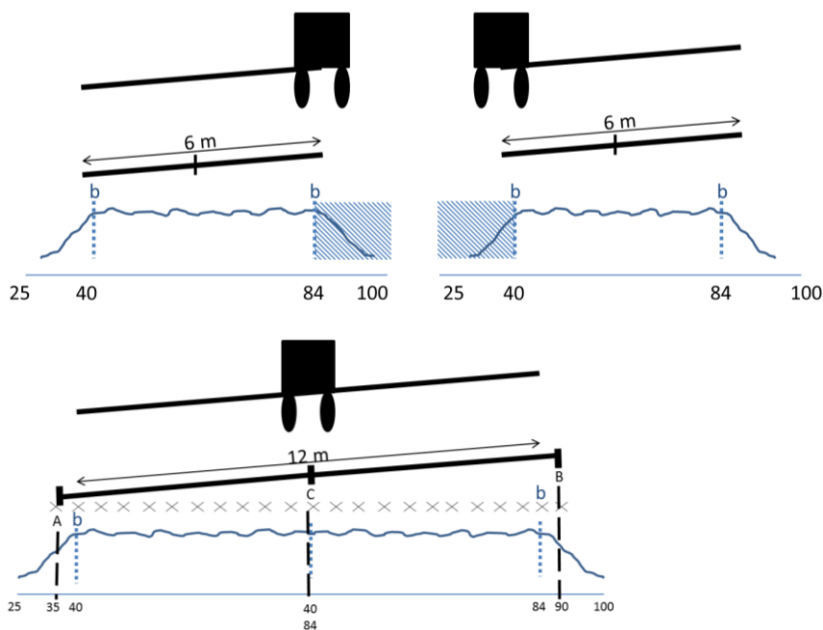


Figure 17 : Simulation of the distribution for a 12 m boom by combination of two half-boom of 6 m. The unwanted edge effects of the center of the boom are removed beyond the tube 84 and before the tube 40. "b" = boundary of the edge effect. Hatched = edge effect deleted from the data. Cross = location of a nozzle

Results and discussion

Coefficients of variation (C.V.)

The coefficient of variation (C.V.) is calculated as the ratio of the standard deviation to the mean and it is expressed as a percentage. In the analysis of C.V., edge effects were deduced.

In theory, for slit nozzles of 110 ° and spaced 50 cm apart, the overlap is double from 35 cm working height and triple from 50 cm working height. The coverage of the jets on the ground increases with the

height of the nozzles. As a result, C.V. decreases with height. Unsurprisingly, C.V. from this work also increases with the amplitude of the vertical angle facing down because the working height decreases. On the other hand, C.V. obtained with vertical angles upward are all similar to each other beyond 60 cm in height. That could be explained by the fact that the recovery reaches its maximum beyond 60 cm. However, the quality of repartition (in term of C.V.) is not affected by any horizontal deviation (until 6°).

Distribution

At a working height of 50 cm, the distribution difference between the horizontal position and 1° of inclination is barely visible. On the other hand, from 3° inclination, the disturbance of the distribution is well marked. It is located at the lower end of the ramp (left on the Figure 18). No effect is observable on the upper part (right), except for a slight increase in the width sprayed at the end. At an average working height of 60 cm, the effect of the inclination 3° is reduced compared to the working height of 50 cm. This is because the nozzles are higher and the overlap is better. On the other hand, spectacular effects are visible as soon as the inclination of the boom is stronger. On chart, the disturbances due to the angles 5° and 6° are visible as of the 5th nozzle starting from the end left.

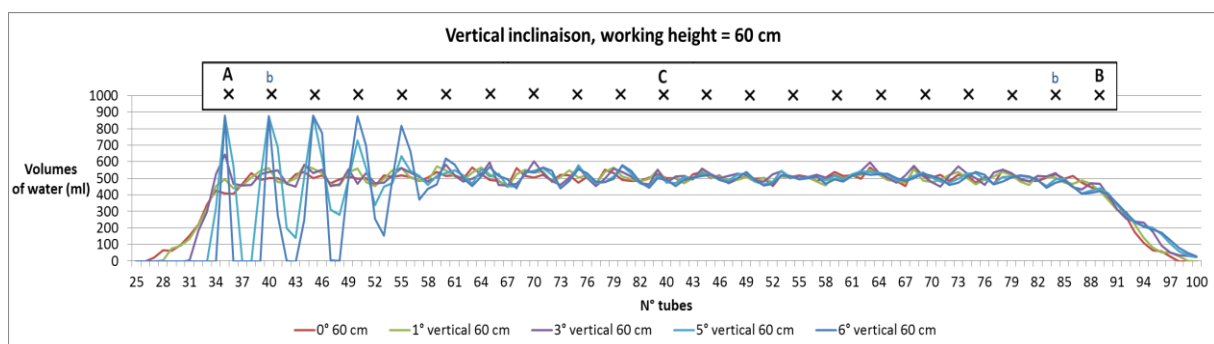


Figure 18 : spray pattern for a ramp inclined vertically. The simulation is carried out from 2 half-ramps of 6 m which meet at point "C" as on Figure 3. "A" = nozzle at the low end. "B" = nozzle at the high end. "b" blue = limits of edge effects. Cross = nozzle location. Working height = 60 cm fixed at point "C"

Similar observations to those of the height 60 cm can be made on the graph of the working height of 75 cm. Again, distribution disturbances are generally reduced by the higher spraying.

By observing these graphs, interesting information emerges about the width of work. This latter increases slightly with the working height. When boom is perfectly horizontal, liquid is projected beyond the end nozzles ("B" points). The additional widths are 70 cm, 80 cm and 100 cm for the respective working heights of 50 cm, 60 cm and 75 cm (Figure 18). If the boom is tilted downwards, working widths are lost. In this test these lost are similar regardless of the working height, but variations are observable according to the angles.

Effects of back and forth on field

The following charts simulate sum of two boom-end sprays crossings on field, for side-by-side or for back and forth. The example is given for a working height fixed at 60 cm on the half-boom of 6 m. Between 1 and 3 degrees of angular amplitude, only one occasional accident appears in the distribution for side-by-side passage (Figure 19): a slight underdosing and a slight overdose.

From 5° angle amplitude, the effects are clearly observable. Since a vertical angle is directed downwards, the over- and under-dosages are spectacular despite the summation of the two passes. Already when passing side by side a boom that is deformed upwards and another deformed downwards, the distribution quality is reduced by about 2.5 m wide (Figure 19). During the passage of two deformed booms downwards side by side, some areas are not treated at all and the occasional overdose peaks are doubled over a total width of nearly 4.5 m (Figure 20). On the contrary, when two upward booms pass side by side, the distribution quality is almost undisturbed (Figure 21).

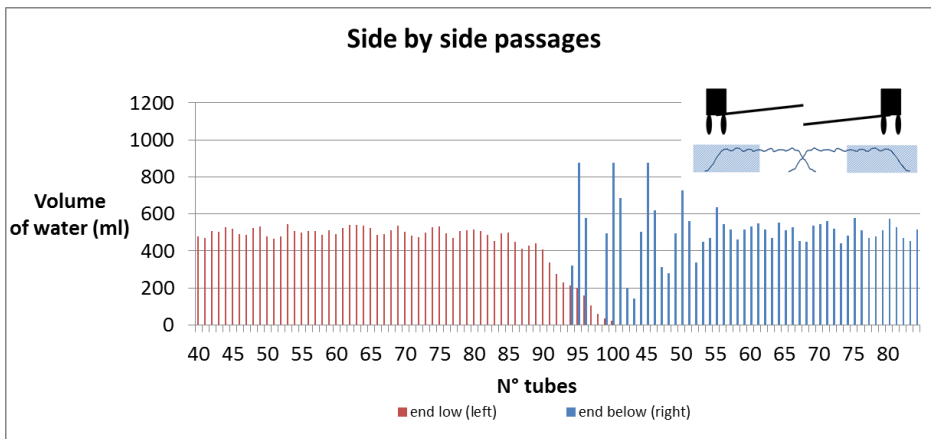


Figure 19 : sprays at the boom ends during two side-by-side passages: chart shows the decomposition of the liquid sprayed by each of the two passages. Half booms are inclined 5 ° upwards and downwards respectively. Working height = 60 cm

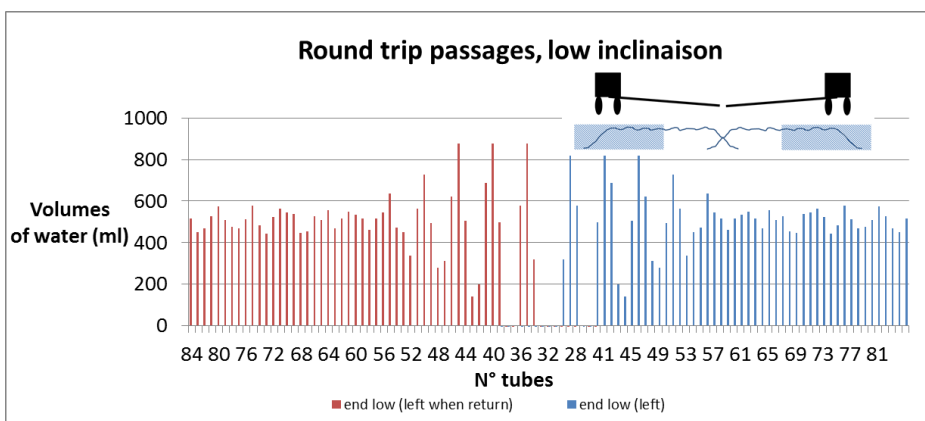


Figure 20 : sprays at the boom ends during two round trip passages: chart shows the decomposition of the liquid sprayed by each of the two passages. Half booms are inclined 5 ° downwards. Working height = 60 cm

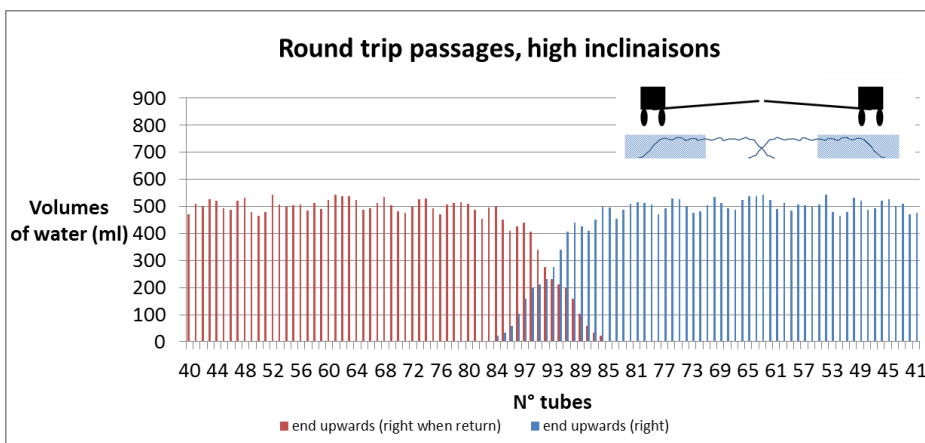


Figure 21 : sprays at the boom ends during two round trip passages: chart shows the decomposition of the liquid sprayed by each of the two passages. Half booms are inclined 5 ° upwards. Working height = 60 cm

Conclusion

Results of this study provide quantitative information on the effects of boom inclination. The main conclusions are the following:

- Inclinations of the boom in horizontal plane from the angle of 1° to 6° have no effect on spray distribution. This criterion considered in the context of mandatory control could therefore be re-evaluated.

- Inclinations of the boom in vertical plane induce different effects following it is directed upwards or downwards.

Upwards, even the strong inclination (63 cm of deflection for a 6 m of boom length), does not affect the distribution out of edge effects. At the boom end, only a very slight increase in the distribution area is observable. This causes a negligible effect on the crop by the round trip of the tractor in the field.

Oriented downwards, the inclination of the half ramp of 6 m induces significant disturbances from an angle of 3° . The importance of these disturbances does not only depend on the deviation that is measured at the control, but depends on the initial working height, the angle and the length of the boom. This work shows that the disturbances of the distribution are in reality strongly dependent on the height of the nozzles at the end of the boom. A too low height induces a lack of covering sprays and a decrease of surface sprayed by each nozzle. The return of the tractor in the field on the neighboring pulverized strip reduces the distribution fault for parallel passages but increases it for round-trip passages. In addition, it should be noticed that the study was performed in a laboratory in a static situation. In the field, distribution is inevitably strongly variable: the boom moves continuously by effect of ground irregularities and the wind modifies sprays of droplets. So, it can be retained from all results that downward inclination is an important point in the control of the sprayers. However, the way of measuring it and the way of setting the acceptable limits could be reconsidered.