Testing device for a complex measurement of the performances nozzles

Józef Sawa[1)]; Bruno Huyghebaert[2]; Stanisław Parafiniuk[1)]

[1] University of Life Sciences, Lublin, Poland, Department of Machinery Exploitation and Management in Agricultural Engineering, e-mail: jozef.sawa@up.lublin.pl

[2] Walloon Agricultural Research Centre – Gembloux, Belgium, e-mail: huyghebaert@cra.wallonie.be

DOI 10.5073/jka.2012.439.027

Summary

The testing device for complex automatic measurements of agricultural nozzles (Fig.1), and some tests methods are presented. The developed methods provide information on the individual parameters of spraying quality of each studied nozzle. Results of those studies has been recorded in the electronic database, and then analyzed by means of a computer program which will also make it possible to eliminate faulty nozzles. Besides, results of the estimation for the nozzles considered to satisfy the requirements of the standards but examined on a 50 mm grooved table (according to the ISO standard 5681-1:1996) has been subjected to conversion to the requirements of the grooved table (100 mm). Differences results CV for virtual paternator and laboratory paternator tests were obtained: 0,4 to 3,1 percentage point.

Conversion of the results will be performed by of the prepared computer program and adopted to practically use sprayer booms of agricultural nozzles (virtual paternator). This program will also determine the sequence of placing the nozzles on the spray boom. Program environment "R" is used on conversion of results.

Key words: spraying quality, mandatory inspection, device to complex testing of agricultural nozzles.

Introduction

Agricultural nozzles are one of the working elements of the sprayer which (in some situation) can lead to wrong application of Plant Protection Products. Causes of wrong spraying quality of nozzles could be different: the wrong nozzle type, its wear-out as a result of a wrong or too long use, or a mechanical deformation of the spraying opening. A visual estimation of the spraying quality of the nozzle is limited and in fact possible only in case of extremely faulty operation. Therefore, different procedures and measuring device have been developed to estimate the spraying quality of the nozzle. But as the spraying quality could be characterized by different parameter, those procedures and devices allow only to determine on of these parameters.

One of the factors actually very important following our opinion is the good choice of the used nozzles, and also the parameters measured to evaluate the performances of this nozzles. The spraying quality of nozzles is characterized by such parameters as (Fig. 1): flow rate, individual pattern (spraying angle, coefficient of asymmetry) and transverse distribution under the boom (Coefficient of Variation - CV).

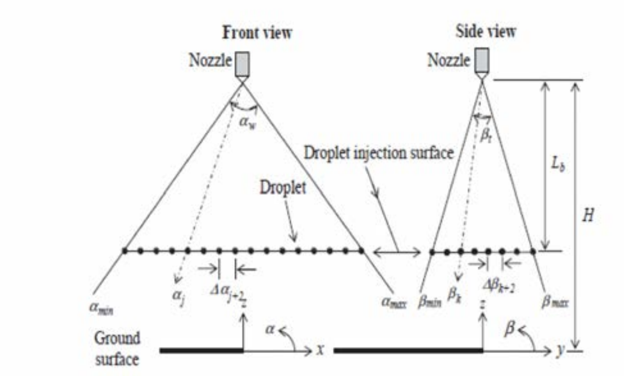

Fig. 1. Schematic showing the virtual nozzle with spray cloud boundaries, droplet injection surface, and droplet injection positions: x,y and z, coordinates; α and β angular coordinates defining the spray boundary and droplet positions; H, nozzle height above the ground, Lb liquid sheet break-up length. [Sidahmed and al., 2005].

Using nozzles presenting a poor spraying quality for the application of Plant Protection Products in agriculture increases the potential risks of the environment contamination and decreases the efficacy of the plant protection. At present, very complex, multi-sided activities are undertaken on the organizational and technological levels, which aim at applying pesticides in a precise way (tab. 1).

Tab.1. Main activity area in the mandatory periodic inspection of sprayers

Nr	Specification
1.	Keep standards for organizational factors principally connected with theoretical preparation (training) of the operator on the performance of pesticide treatments.
2.	Keep standards for technical factors, related to the improvement of the construction the technical state of the equipment for plant protection
3.	Keep standards for technological factors, related to the improvement and preservation the mandatory periodic inspection
4.	Keep standards about Integrated Quality Management Systems for technical sprayers control and process in plant protection on individual farm.

Studies on nozzles are conducted considering the requirements of ISO standard 5681-1:1996. However, it should be stressed that separate measuring devices are necessary to determine the different parameters of the nozzle spraying quality parameters [Sawa and al. 2001]. Moreover serious problem can make up of standards about Integrated Quality Management Systems for sprayers control process in Sprayers Control Station (SKO) and use sprayer to pesticides on farm. Therefore it was put some questions about control methods used sprayers (and nozzles) runes in closed rooms SKO and results of nozzles test useful in respect of time, see tab. 2.

Tab. 2. Characterization of the tests conditions of sprayers in SKO - questions

Specification questions	Measurement methods			
	Patternator (measurement unit CV)		Flow rate methods	
	Electronic	manual	spray booms	**Electronic device**
1. To measurement indispensable room is *(yes, no)*	yes	yes	no	no
2. Evaluate concerns measurement : ***(****spray or flow rate)*	spray	spray	Flow rate	Flow rate
3. Water to test is taken from reservoir of testing sprayer *(yes , no)*	yes	yes	no	no
4. Which individual pattern each single nozzles are measured	no	no	Flow rate	Flow rate
5. In time of measurement observed drift of sprayed liquid is • *(yes, no)*	yes	yes	~ no	~ no
6. Work of sprayers induce circulation of air about -speeds in range ***($m•s^{-1}$)***	1 - 2 m/s	1 - 2 m/s	0	0
7. Work of sprayers induce out height of % moisture of air, in room from e.g. 67%	99,9%	99,9%	70%	68%
8. Work of sprayers in room with temperature e.g. 18 ⁰C induce fall down of temperature abort ⁰C	2 – 3 ⁰C	2 –3 ⁰C	~ no	~ no
9. Employee of service do they have direct contact with solution of sprayed liquid *(yes, no)*	yes	yes	no	no

Question from table 2 and some results of CRA-W Gembloux studies ([Debouche and al. 2000]) determine the base for project device and complex measurement performances of nozzles. The developed methods will provide information on the individual parameters of spraying quality of each studied nozzle. Results of those studies will be recorded in the electronic database, and then analyzed by means of a computer program which will also make it possible to eliminate faulty nozzles. Testing device (Fig. 2 and Fig. 3) and researches was done in UP Lublin, Poland. Validation of the developed methods of studies and the spraying process was performed in the Walloon Agricultural Research Centre – Gembloux, Belgium (CRA-W), which has an accredited laboratory (ISO 17 025, Certificate BELAC 266-T) for the nozzle spray pattern measurement.

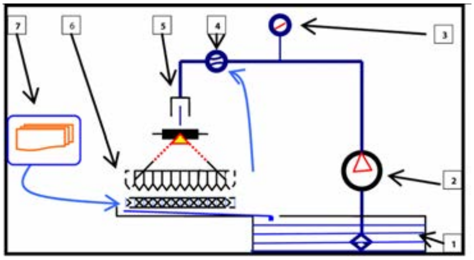

Fig. 2. Device to complex measurements of agricultural nozzles (schema)

1. Reservoir waters and filter of pump,
2. Pump in hydraulic arrangement,
3. Manometer,
4. Flow-meter
5. Nozzles container and telescopic liquid feeder system,
6. Groove table,
7. Measure (electronic) device with computer.

Fig. 3. Device to complex measurements of agricultural nozzles

- Grooved table with dimensions 2500 mm x 1000 mm with spacing grooves every 50 mm of wall height of 100 mm.
- Pump with single-phase 230 V power supply with a capacity exceeding 10 l / min and a maximum operating pressure of 12 bar.
- Industrial computer supports automatic nozzle testing equipment.

Aims and sphere of investigation

Realization of the project is aimed at developing a measuring device and methods that in laboratory conditions will ensure complex evaluation of the nozzles, and the obtained results and their characteristics will make it possible to determine the spraying quality of the spray boom of the sprayer with a great degree of probability for field conditions - ***virtual patternator.***

The methodology followed during the study is to determined and measured the performances of each single nozzles, registered these parameters in a database and finally enlarge by a computed processing the results and the conclusion under the whole boom. The basically measured parameters of each single nozzles are the flow rate and the individual spray pattern measured on a 50 mm grooved table (according 5681-1:1996).

The computed processing allows determining the transverse distribution of the whole spray boom under a virtual 100 mm grooved table. The process mace possible to determining the best sequence of placing the nozzle on the boom.

Programme environment "R" is used on conversion of results. The idea of conversion is presented in Fig. 4.

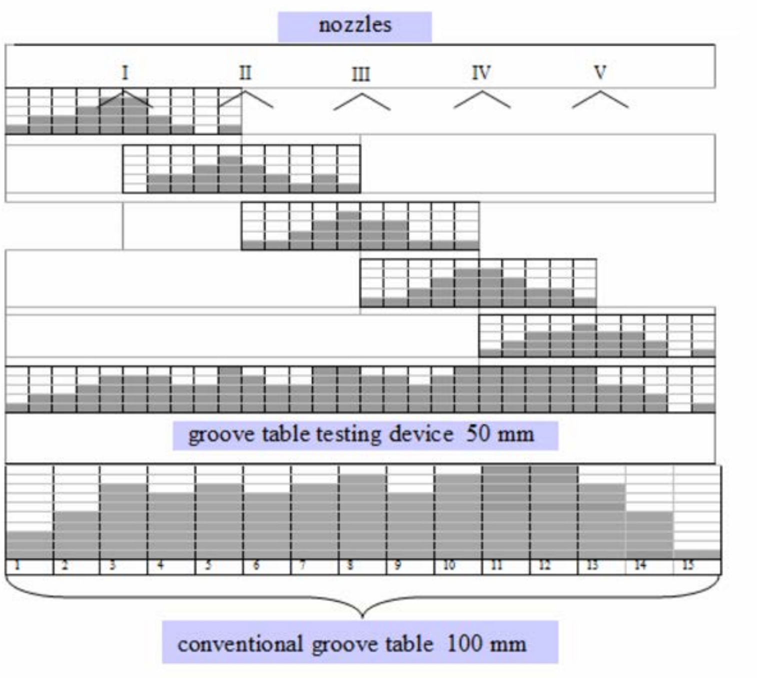

Fig. 4. Method of converting volumes of liquid table testing device (grooves 50 mm) for the table conventional patternator (grooves 100 mm)- virtual boom sprayer.Results of first tests and conclusion

The developed methods provide information on the individual parameters of spraying quality of each studied nozzle: flow rate, individual pattern (spraying angle, coefficient of asymmetry). Results of those studies are reliable and recorded in the electronic database, and then analyzed by means of a computer program. The converting studies results of transverse distribution under the boom (CV) for virtual spray boom and conventional patternator are inconclusive. Some conversion obtained results CV on virtual spray boom to the requirements of the conventional grooved table (100 mm) are presented in Tab. 3.

Tab. 3. Results of studied CV for some types of tested nozzles

A – CV virtual spray boom UP Lublin

B – CV conventional patternator CRA-W Gembloux

New nozzles **Nozzle type, spray at height 500 mm** **Pressure: 3 bars**				**Used nozzles** **Nozzle type, spray at height 500 mm** **Pressure: 3 bars**			
CV% - RS MM 110 04		CV% - HYPRO VP 110 03		CV% - Albuz ADI 110 04		CV% - TTD JET 110 04	
A	B	A	B	A	B	A	B
4,98	4,60	4,45	3.59	10,07	10,49	19,48	16,36
A-B = 0,38		A-B = 0,86		A-B = -0,42		A-B = 3,12	

The obtained results are not unequivocal for measured and simulated CV. More investigation are in realization.

References

DEBOUCHE, C., HUYGHEBAERT, B., MOSTADE, O., 2000: Simulated and Measured Coefcients of Variation for the Spray Distribution under a Static Spray Boom. *J. agric. Engng Res*. 76, 381-388

SAWA, J,: KUBACKI, K., HUYGHEBAERT, B., 2001: Equivalence of the criteria of assessing results of tests in legalizing crop sprayers. .„Electronic Journal of Polish Agricultural Universities, V. 4. nr 1. Agricultural Engineering. http// www. ejpau. Media. pl

SIDAHMED, M.M., TAHER, M.D., BROWNAND, R.B., 2005: A Virtual Nozzle for Simulation of Spray Generation and Droplet Transport. Biosystems Engineering) 92 (3), 295–307