Session 6: Miscellaneous

An overview of the defects on tested orchard sprayers in Belgium

Declercq, J.[1]; Huyghebaert, B.[2]; Nuyttens, D.[1]

[1] Institute for Agricultural and Fisheries Research (ILVO), Technology & Food Science Unit - Agricultural Engineering – Burg. Van Gansberghelaan 115, bus 1, 9820 Merelbeke, Belgium

[2] Agricultural Research Centre (CRA-W) – Agricultural Engineering Department, Chée de Namur 146, 5030 Gembloux, Belgium

DOI 10.5073/jka.2012.439.036

In Belgium, the inspection of sprayers is performed by official and mobile teams ruled by two regional inspection authorities, ILVO and CRA-W. The management of the inspection is done by the Federal Ministry for Consumer Protection, Public Health and the Environment (FAVV). Inspection authorities need to have an ISO 17020 certification, consequently the Belgian inspection is completely independent and objective. FAVV delegates the inspection to one inspection service per region (one for the Walloon part and one for the Flemish part). In this way inspection results are centralized and easily consultable. The inspection results are a very useful tool to have an overview of the general condition of the Belgian sprayers. Those results can be helpful when advising on changes in legislation. They can also be used as an instrument to advise fruit growers and farmers how to improve their spraying machines, or what points they have to pay attention to when buying a new or second-hand machine. Therefore, a detailed overview is made of the inspection results on orchard sprayers for the 5th inspection cyclus (3 years: 2008-2009-2010).

Fig. 1. Measuring nozzle flow rate and spray pressures.

Key words: sprayers, inspection, results, defects

1. Introduction

Since 1995 sprayer inspection is mandatory in Belgium which makes it one of the forerunners in this field in Europe. At that time, the bad technical condition of the sprayers, the excessive supplementary costs for the farmer arising from an inefficient pesticide use,, the negative impact on the environment and the necessary restructuring of the European Agriculture to keep it competitive after the CAP reform and GATT negotiations, were the main reasons for the implementation of the sprayer inspection. Now, the Framework Directive for a sustainable use of pesticides introduces the inspection for all pesticide application equipment in Europe.

In many ways, the mandatory inspection of sprayers in Belgium differs from inspections in other European countries. The inspection is carried out by two official bodies : ILVO (Flemish region) and CRA-W (Walloon region). Those two official bodies are also accredited according to ISO 17020 (BELAC) which guarantees a maximum quality of the performed inspections. The inspection teams (3 in the Flemish region and 2 in the Walloon part) are equipped with a test van that contains all necessary equipment to perform the inspection according to Belgian federal legislation. The inspections are carried out at a

neutral location where farmers/contractors are invited at an exact date and time, to present their sprayer for testing at this place. All over the country test locations are hired in a way that farmers/contractors don't need to travel distances > 15 km with their sprayers. At this moment about 20.800 machines are tested every 3 year, mainly boom sprayers (87%) but also orchard sprayers (9%) and greenhouse/horticulture/floriculture sprayers (4%). The inspection procedure is based on the analytical principle which means that all parts of the machine are tested separately. On average, one inspection team carries out about 12 inspections a day. After the inspection the farmer/contractor receives a certificate confirming the approval of the sprayer for the next three years or specifying all the items that need to be repaired in case of a rejection. No repairs are made to the sprayer during the inspection, so the farmer/contractor needs to repair the defects himself or leave the repairs up to a workshop. Consequently, the repaired sprayer has to be represented for a second passage. The inspections can be performed at a very competitive price from 76€ for all orchard sprayers.

Fig. 2. Inspection van with test equipment.

2. The diagnosis principle and rejection procedure for orchard sprayers

The protocol of inspection developed in Belgium fits the EN 13790-2 for 90% in terms of inspected criteria. The inspection methodology is based on the analytical principle which consists in measuring separately and independently the performance of the different parts of the sprayer. In this way, the defect(s) can be determined and a precise diagnosis can be made. No spray distribution measurements using a patternator are performed.

This analytical principle can be illustrated for the check of the pressure stability. The pressure stability is described for an orchard sprayer in EN 13790-2 (paragraph 4.2.2.) as follows: "There shall be no visible pulsations caused by the pump". If one follows a simple inspection protocol, the inspection can be stopped after observing pressure pulsations on, for example, the working manometer.

Following the analytical principle, further measurements, observations and analysis are carried out to determine the exact cause of the pressure pulsations. Indeed, pressure stability depends on several factors such as the pressure in the air-bell, the state of the diaphragm of the air-bell, the state of the induction and exhaust valves and the membranes of the pump, the air-tightness at the induction side of the pump, etc. With the analytical principle all these factors are measured or observed to determine the precise cause of the pressure pulsations and to advise the user on how to solve the problem.

Up to 53 criteria are checked on the sprayer, some are checked visually (agitation, blower, etc...), others are measured (pressure, nozzle flow rate, nozzle spacing, volume/hectare, etc...). All checks and measurements are encoded and stored in a computer with tailor-written software. The analysis is done automatically and the inspection report is printed on site.

The dysfunctions are listed in this report and classified according to their seriousness to disturb sprayer performance, together with advice on how to repair the defect. The combined analysis of the dysfunction and its cause allows to determine the weight of this dysfunction in the inspection results. The dysfunction leads to a rejection of the sprayer if it significantly disturbs spray results or safety and if its origin is imputable to the user (lack of maintenance). Moreover, for objectivity reasons, the dysfunction leading to a rejection of the sprayer always has to be determined in an indisputable and objective

way (measurements). Thus, not all checked criteria lead to a rejection of the sprayer.. Moreover, the same defect criterion could lead to different consequences (rejection or not). From the 53 checked criteria, only 16 can potentially lead to a rejection of the sprayer.

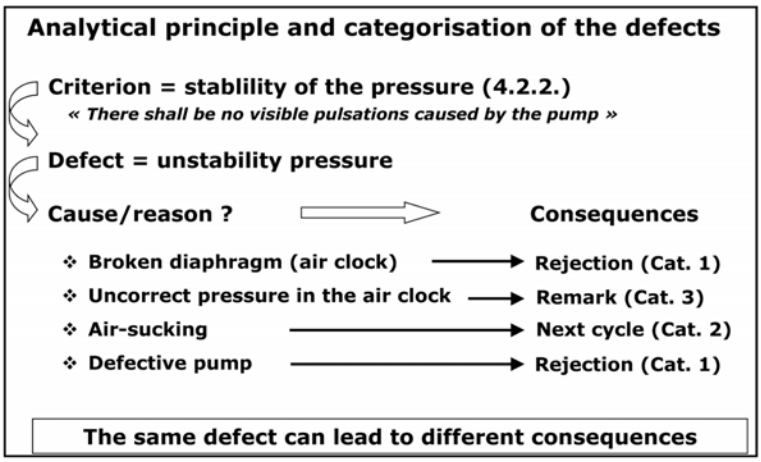

Fig. 3. Analytical principle and categorisation of the defects.

The defects observed during the diagnosis are divided into three different categories:
Category I are defects that automatically result in a rejection. Faults within this category must be repaired within four months and the sprayer must be submitted for retesting.
Category II defects do not result in rejection, but should be repaired before the next inspection. This means that the user has three years time (= one inspection cycle) to repair these defects.
Defects of **category III** are only added for information reasons and are aimed at improving the general operation of the sprayer. The user is completely free to follow these comments.

3. Overview of the defects of orchard sprayers

This overview is based on the inspection results obtained in the 5th inspection cyclus (2008-2009-2010) in the Flemish region. 1.557 orchard sprayers were inspected and 152 (9.7%) of them were rejected during the first passage. A sprayer can have several defects from different categories, or from one category (e.g. 2 defects cat. I). Also sprayers that were inspected successfully can have defects from category II or category III.

3.1 Defects of category I

Defects of category I lead to rejection of the sprayer. The defect must be repaired and the spray must be re-inspected within 4 months. Between the first and the second inspection it is allowed to use the sprayer.

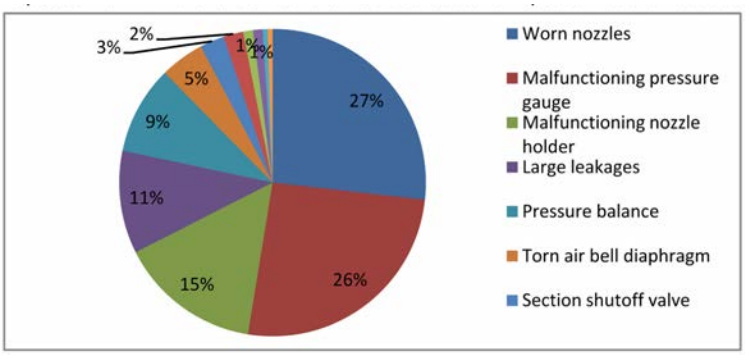

Fig. 4. An overview of category I defects during 2008-2009-2010 (Orchards sprayers).

Within category I defects, the largest number of rejections was caused by worn nozzles (27%). The nozzles are first tested on the sprayer and when the flow results measured on the sprayer are not satisfying (average flow rate deviates too much from nominal flow rate) they are removed from the boom and placed on a specific nozzle test bench to measure their individual flow rates. When the deviation between the average flow rate of the inspected nozzles and the nominal flow rate also exceeds the threshold value on the test bench, the complete nozzle set and sprayer are rejected.
When the measured flow rate on the test bench meets the threshold then the problem is situated at the nozzle holder. Bad nozzle holders are responsible for 15% of the rejections.
Malfunctioning pressure gauges cause the second highest number of rejections (26%). The sprayer pressure gauge is checked by comparison with a reference manometer placed on a nozzle holder. The whole measuring range is tested, generally from 2 to 15 bar depending on the type of orchard sprayer. When the deviation exceeds 10% the pressure gauge is dismantled from the sprayer and tested on a pressure test bench. When the deviation is also higher than 10% on the test bench, the pressure gauge and the sprayer are rejected.

Fig. 5. Testing the sprayer manometer.

Although the user is asked to pay attention to leakages, this criterion often poses problems. Leakages are still responsible for 11% of the rejections. Possible leakages are observed for spraying pressures from 5 to 15 bar and are measured using a measuring cylinder and a chronometer. Leakages higher than 30 ml/min are considered as major leakages (Cat. I), leaks below 30 ml/min are classified as minor (Cat. II). Major leakages (pump, tank, pipes, etc.) are considered as critical and automatically lead to a rejection of the sprayer.
The pressure balance between the left and right section is a major parameter to ensure equal feeding of all nozzles. The pressure deviation between the sprayer manometer and the pressure at the boom, but also between the left and the right section(s) should be as small as possible. A manometer is placed on the left and the right section(s) to check the pressures. The mean pressure is calculated from the results of all section manometers, and if the pressure deviation of one or more sections exceeds 10% the sprayer is rejected. There can be different reasons for pressure heterogeneity: sections and/or feeding pipes of different length, clogged filters in the sections, blocked or strangled feeding pipes, and a defective distribution block. According to the weighted analysis, only the last two defects lead to a rejection of the sprayer. About 9% of the sprayers are rejected as a result of an unequal pressure between the left/right sections.
A torn air bell diaphragm is responsible for 5 % of the rejections. A torn diaphragm is one of the main causes of pressure instability. The pressure pulsations are detected on the working manometer as a rapid oscillation of the needle. Additionally, the inflating pressure of the air-bell is checked (1/3 to 1/2 of the spraying pressure). A broken diaphragm is detected when water squirts from the inflating valve. Another cause can be a defective pump. But this defect occurs much less frequently (1 %).
A number of Cat I problems also appear less frequently. Heterogeneity of the nozzle sets (type, size, angle) (0.5 % of the rejections) is nowadays less of a problem. User awareness on the importance of this parameter is higher than in the past. Also defects involving sprayer regulation system are less frequent. Only a few of the rejected sprayers are affected by a defective pressure valve (2.1%), a defective distribution block (2.6%) and malfunctioning sensors, flow meter or computer (0,5%).

3.2 Defects of category II

Category II defects do not lead to a rejection of the sprayer but the user is encouraged to repair these effects as soon as possible. Anyway, these defects have to be repaired by the next inspection (3 years later). If not repaired, these defects will result in a rejection.

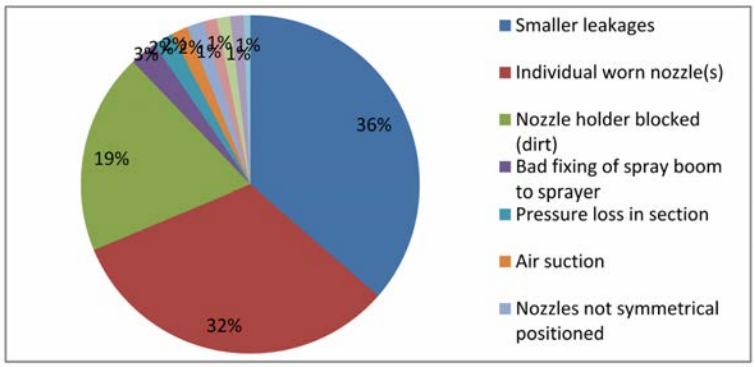

Fig. 6. An overview of category II defects during 2008-2009-2010 (Orchards sprayers).

Three major items are responsible for 87% of the Category II defects i.e. small leakages (36%), worn or blocked nozzles (32%) and partly blocked nozzle holders (19%). Small leakages mainly occur at hoses and nozzle holders but also a number of other sprayer components can show smaller leakages such as the pump, the filter housing and the shut off valves.
Second item are individual worn or blocked nozzles. It happens that only some individual nozzles of the set are worn or dirty (32% of the Category II defects). Those nozzles are clearly marked in the inspection certificate but don't need to be replaced in case the average nozzle flow doesn't exceed the limits. In most cases, it concerns nozzles that are partly blocked due to dirt because fruit growers have the habit to replace their nozzles by new ones every time they are called for an inspection.
Third important item is pressure loss caused by dirty or partly blocked nozzle holders (19%). Partly blocked nozzle holders can cause a significant pressure drop with lower flow rate as a consequence. These nozzle holders are also clearly marked in the inspection certificate so the owner can solve the problem by replacing or deblokking the nozzle holder(s).
Furthermore there are also some smaller category II defects that are rarely noted.
A rejected sprayer can also display defects from this second category.

3.3 Defects of category III

Defects of category III never lead to a rejection. The user is simply encouraged to repair the determined defects of this category. Those defects are less important, but their reparation will improve pray quality or user comfort and safety.

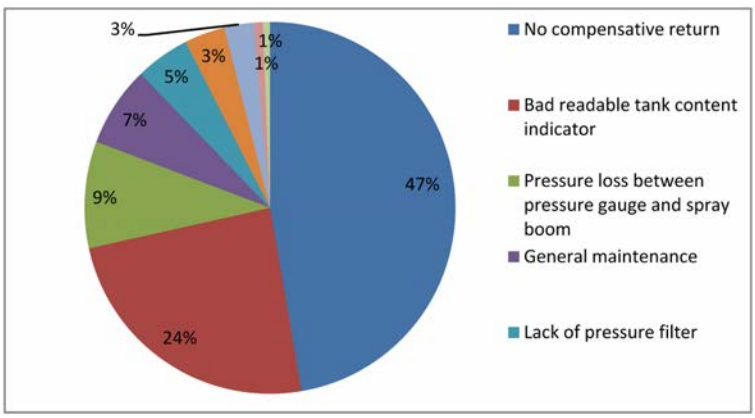

Fig. 7. An overview of category III defects during 2008-2009-2010 (Orchards sprayers).

Many old sprayers don't have the pressure compensation (47%). The user has to adjust the working pressure when he closes a section in order to obtain the same rate. Also a large number of problems concern the readability of the tank content indicator (unreadable or defect: 24%). Further on, 9% of the sprayers show a pressure drop between the working pressure gauge and the spray boom (9 %). The pressure drop value is registered on the inspection certificate. This gives the owner the possibility to adjust the pressure at the working gauge to obtain the desired pressure at the spray boom. Furthermore some smaller items are noted, such as bad general maintenance (7%), lack of a pressure filter (3%) and wrong air bell pressure (3%).
There are also a large number of smaller remarks that do not often occur .

4. Conclusions

The fruit growers are as much as possible involved in the actual inspection and they are given advice during the inspection. All test results are registered in an official test report.
Since the start of the inspection in Belgium, **fruit growers became far more aware** of the negative effects of a badly maintained sprayer resulting in a significant decrease in the number of rejections. However continuous information and training is still necessary to maintain or even improve the current maintenance level of the sprayers.

References

Braekman, P., Huyghebaert, B., Sonck, B., 2004: The Belgian way of organising a compulsory inspection of sprayers. I European Workshop, Standardized Procedure for Inspection of Sprayers in Europe/SPISE, Braunschweig– Germany 5 pp.

Huyghebaert, B., Mostade, O., Braekman, P., 2004: Overview of the Sprayer Inspection in Belgium. I European Workshop, Standardized Procedure for Inspection of Sprayers in Europe/SPISE, Braunschweig– Germany 5 pp.

Declercq, J., Huyghebaert, B., Nuyttens, D., 2009: An overview of the compulsory inspection of sprayers in Belgium. III European Workshop, Standardized Procedure for Inspection of Sprayers in Europe/SPISE, Brno, 1pp.

Declercq, J., Huyghebaert, B., Nuyttens, D., 2009: An overview of the defects on tested field sprayers in Belgium. III European Workshop, Standardized Procedure for Inspection of Sprayers in Europe/SPISE, Brno 7 pp.