EXAMINATION OF CONCENTRATED ENVIRONMENTAL ENDURANCES DURING THE CLEANING OF PLANT PROTECTION SPRAYERS

Tamás Sándor*, Béla Pályi, Kornél Németh

University of Pannonia, Georgikon Faculty, Hungary, Keszthely
Department of Agricultural Mechanization
H-8360, Keszthely, Festetics Str. 7.,
muszaki@georgikon.hu

Abstract

Unsatisfactory technical condition or insufficient adjusting of plant protection machines may cause considerable environmental pollution. During their maintenance and cleaning (mechanical errors) more or less concentrated plant protecting chemicals may get into living water and from these even into drink water. Naturally, during spraying the wind may drift the chemicals into natural waters. In 1999 the International Standardization Organization has established a working group to elaborate rules to decrease environment pollution by efficient cleaning of sprayers. As a result of their work, in March 2004 the ISO/DIS 22368 standard plan came into force, which describes in three chapters the inner cleaning of sprayers as well as the investigation of effectiveness of cleaning devices for outer and inner side of pesticide tank of sprayers. Our aim was to investigate the effectiveness of the cleaning devices and to make proposals to improve directions of the standard.

Key words: plant protection, maintenance and cleaning, international standards, measuring methods, effectiveness.

KONCENTRÁLT KÖRNYEZETI TERHELÉSEK ÉS ELJÁRÁSTECHNIKAI ÖSSZEFÜGGÉSEK VIZSGÁLATA NÖVÉNYVÉDŐGÉPEK TISZTÍTÁSA SORÁN

Sándor Tamás, Pályi Béla, Németh Kornél

Összefoglaló

A növényvédelmi gépek rossz műszaki állapota vagy helytelen beállítása jelentős környezeti terhelés forrása lehet. Karbantartás és tisztítás során (mechanikai hibák) a vegyszerek nagy koncentrációban, közvetlenül juthatnak az élővizekbe és így az ivóvízkészletekbe egyaránt. Természetesen permetezéskor a szél hatására (elsodródás) szintén eljuthat a permetszer az élővizekbe. Ezen károk csökkentése érdekében a Nemzetközi Szabványügyi Szervezet (ISO) 1999-ben egy munkacsoportot állított fel. Munkájuk eredményeképp 2004 márciusában megjelent a három fejezetből álló ISO/DIS 22368 szabvány tervezet, mely leírja a permetezőgép teljes belső tisztítását, a permetlétartály belső és a külső tisztítóberendezések hatékonyságának vizsgálatát. Kutatásunk e normák alapján vizsgálja, hogy mennyire hatékonyak e tisztítóberendezések, illetve ajánlásokat tesz ezen iránymutatások javítására.

Kulcsszavak: növényvédelem, karbantartás és tisztítás, nemzetközi szabvány, mérési módszerek, hatékonyság.

Introduction

The plant protection is an indispensable part of the agricultural production, since it influences the profitability (high prices of pesticides, damages by insects, fungi, microorganisms, weeds, etc.). Beside this we can often hear in the media news about vegetable- and fruit lots having chemical residues above the sanitary regulation levels. Higher residue levels may be due to unsatisfactory technical state or lack of maintenance and of thorough cleaning of the sprayers. Different types of pesticides are used in plant protection, like insecticides, fungicides and herbicides, which can be applied at different plant types and in many cases could not be mixed, consequently cleaning machines between sprayings is always necessary. Also the subsidies by the European Union are subjects to conditions of environmentally-friendly farming and proper practice, which means that farmers have to take care of cleaning (Sándor, 2007).

Everywhere in Europe efforts have been made to decrease pesticide residue problems. As a result of this the regulation DIN/EN 12761 (2001) came into force, which oblige sprayer producers to provide the new sprayers with inner cleaning devices, rinsing tank and to create possibilities of attaching outer cleaning unit, by which quick and water saving cleaning can be made (Csizmazia, 2006). Beside this the European Plant Protection Association created the TOPPS-program (2005) to which the „Life" program of the European Committee joined. They organize demonstrations, create and distribute brochures for further training of farmers to avoid point source pollutions (EU Commission, 2008). To achieve these goals, the International Organization for Standardization (ISO) has established a working group in 1999 with the leading of Institute Julius Kühn, Application-technics in Plant Protection, to elaborate measuring methods for the evaluation of efficiency of cleaning devices.

Experts of Belgium, Denmark, England, France, Italy and Sweden are members of its working group. Their work resulted in the Standard ISO/DIS 22368, with has three chapters. The first part deals with the full inside cleaning of machines, the second with the outer cleaning, and the third with the inner rinsing of the liquid tank. Nowadays the group deals with the determination of output criteria (Herbst and Ganzelmeier, 2002; Wehmann, 2008).

Our department joined these research works in 2005, helping the measurements of the inner cleanings. Nowadays our research is focused on the third chapter of the theme, we investigate the efficiency of tank rinsing nozzles, and we make proposals to increase the efficiency of measuring methods, as well as to decrease cost and time demand of the cleaning.

Materials and Methods

The measuring of effectiveness of cleaning nozzles has been made according to the mentioned ISO/DIS 22368 regulation of the third chapter. There can only be used sprayers, which do not have direct liquid injection systems.

We investigated in Hungary available cleaning nozzles (Table 1, Photo 1) with the described pressures.

Table 1. The investigated cleaning nozzles

Reseller	Manufac-turer	Part number / Type	Mounting connection	Capacity (litre/min)	
				2 bar	3 bar
Farmcenter Kft.	Teejet	(B)27500E-8TEF	½	26.00	32.00
AXIÁL Kft.	Lechler	500.191	½	20.00	24.00
Farmgép Kft.	Polmac	63408399	½	20.10	24.00
	ARAG	510.120	½	47.00	57.00

Photo 1
The nozzles used for the measuring (Teejet, Lechler, Polmac, ARAG)

For test liquid is a 1 % solution diluted copper-oxy-chloride product (Funguran, OB21, Cupravit) in use, containing 45 % copper. Since in Hungary no product of this concentration is available, we made an appropriate dilution from a product (ASTRA) containing 50 % copper. (We measured its sedimentation and its concentration to be the same quality as for the testing described product). This is a rather instable suspension, sediments quickly; therefore care had to be taken during the stirring and sampling. The measuring started, when the sprayer tank was filled with the comparison liquid up to its maximum capacity. During this the mixer was in action (Photo 2).

Photo 2 Testing liquid in the tank

Photo 3 Simulation of spraying

Then, as a simulation of spraying the tank was depleted including the technical rests in the sprayer (Photo 3). Following this, all part of the sprayer was washed out except for the tank and the mixer device.

Photo 4 Sedimented pesticide

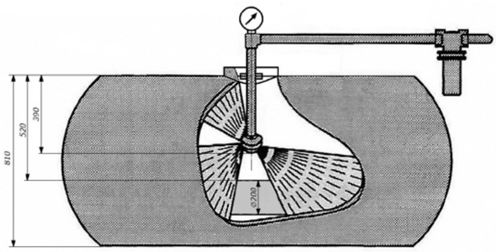

Fig. 1 Location of the nozzle in the tank

This was followed by a 24 h waiting. During this the pesticide sedimented, dried out, it became easier to measure the effectiveness of the different cleaning devices and nozzles (Photo 4). After drying the cleaning process was performed according to the manual of the machine and nozzles. It has to be stressed out, that nozzles were located in the same height in the tank (Fig.1). The rinsing water was collected and samplings were taken (Photo 5). At the end a high pressure washer was used to remove the sediment rests, its water amount was also measured and samplings were taken also from this.

Photo 5 Collection of rinsing water

Photo 6 The VARIAN SpectrAA 300

The copper concentration of the two rinsing water were measured by a VARIAN SpectrAA 300 atomic spectrophotometer (Photo 6), for which the samples were treated with Titriplex III (Selecton B2) reagent, which made the copper content measurable.

The efficiency of cleaning nozzles was counted by the equation given in the standard plan as follows:

$$M = \frac{C_{AM} \times V_A}{C_{AM} \times V_A + C_{BM} \times V_B} \times 100 \qquad \textbf{(1)}$$

where

M – amount of copper washed out by the cleaning device in percentage of the full amount of copper remained in the tank, in %.

C_{AM} – average copper concentration of rinsing water washed out by the cleaning device, in mg/litre.

V_A – water amount used by the cleaning device in litre.

C_{BM} – average copper concentration of cleaning water used by the high pressure washer in mg/litre.

V_B – water amount used by the washer in litre.

(ISO/DIS 22368-3:2004)

Results

The results are summarized in Figure 2. It can be seen, that in case of three nozzle types the higher pressure caused 15 – 18 % decrease in the cleaning efficiency.

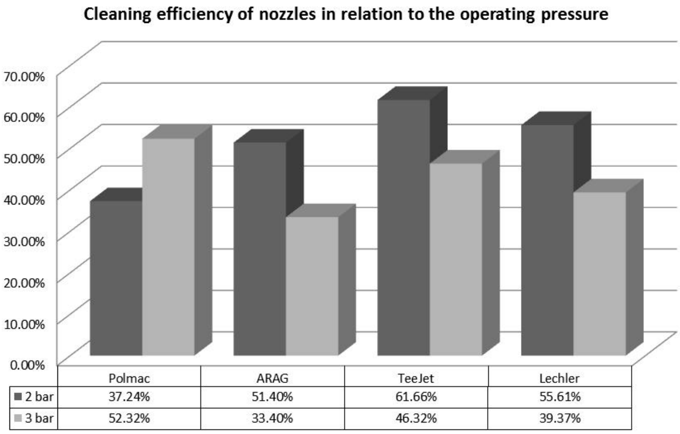

Fig. 2

Cleaning efficiency of nozzles in relation to the operating pressure

This can be explained by the fact, that the higher pressure changed the angle of the water jet (Photo 7), therefore the water was directed more to the sides of the tank, instead of its bottom, where the copper easier sediments.

Photo 7 ARAG nozzle during operation

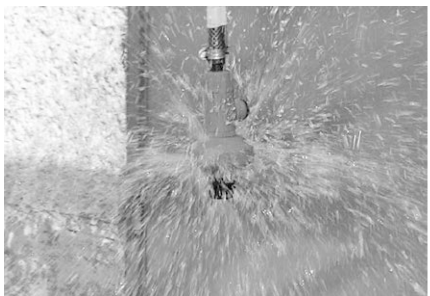

Photo 8 Polmac nozzle during operation

One of the nozzles however showed 15 % increase at the higher pressure. This is because at the higher pressure the bore-holes and the rotating part of the nozzle break the water jet better (Photo 8), therefore the water arrives in the same angle to the tank sides and to the bottom.

We have also investigated the improvement possibility of the standard plan, and possibility of its cost reduction. The cost reduction has two ways: reduction of water amount and of pesticide amount during the investigation. We could achieve cost reduction by the way, that we reused the testing liquid with repeated adjusting its pesticide concentration to be the same as it was in the first measuring. By this we could reduce water amount during the 8 measuring by 77 %, and of pesticide amount by 37 % (Table 2).

Table 2

Summarizing table of water and pesticide usage and their costs

Denomination	Water usage (litre)	Pesticide usage (kg)
Without reuse of testing liquid	9 137.5	72
With reuse	2 137.5	45
Spared	7000	27
Saved in %	**76.61**	**37.50**
Prices (in HUF/m^3; HUF/kg)	948	2 000
Costs without reuse (HUF)	8 662	144 000
Costs with reuse (HUF)	2 026	90 000
Summary saved (HUF)	**6 636**	**54 000**

Considerable sum of money could be spared with reusing of testing liquid, especially on the pesticide side, which takes 54 000 HUF. This way of measuring is better also regarding the environmental pollution, since much less liquid remains after testing, which later on has to be destroyed. This liquid may not be sprayed onto plant cultures or taken onto the fields, it is considered as dangerous waste, and has to be transported to special destruction.

Conclusion

The ISO/DIS standard plan gives good directions to the farmers and sprayer producers in all respect of sprayer maintenance and cleaning to achieve a cleaner environment and to get residue-free, healthier foods.

The examination of nozzle efficacy showed, that in the case of three different nozzles the increased water pressure caused 15 – 18 % efficiency decrease. Our aim was the comparsion by the same settings (operating pressure, nozzle height determination in the tank), so these reductions can be improved with appropriate height adjustment.

Our methodological changes in the investigations (reusing of the test liquid) contribute to a better, quicker and cheaper measurements, which are also friendlier to the environment.

Our investigations will be continued to improve the standard plan and new investigations are planned in the field of the second chapter of the standard to determine outer pollution of the sprayer with pesticides and of its cleaning.

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