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Continuous cleaning – time efficient sprayer cleaning with minimum water usage

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Summary

Testing residual concentrations with fluorescent dye indicates that the continuous cleaning method is very efficient leaving only small concentrations of residue in the sprayers after cleaning. Further advantages of the method are: low water consumption and that it takes only about 5 mins to do a complete internal sprayer cleaning.

The tests presented here add to earlier testing by indicating that large sprayers with big tanks and wide booms can also be cleaned efficiently and very fast using the continuous cleaning method. Booms with recirculation systems may need special attention unless the return-to-tank-hoses are short (1,5 m).

Key words: Continuous cleaning. residue concentration, rinsing time, point source pollution, pesticides, sprayer rinsing, lift mounted sprayer, trailed sprayer, self-propelled sprayer, boom recirculation

Introduction

In a paper describing results and lessons learned from the work in the EU and ECPA funded project TOPPS (Training the Operators to prevent Pollution from Point Sources), it is stressed that both technology and farmer practice [behaviour] are important factors in the future work for less point source contamination (Roettele, 2008). Thus the success of the initiatives to minimise point source pollution seems to build on a combination of modern technology and quick and easy to use design.

A new method for cleaning - continuous cleaning – has been developed to satisfy both effectiveness and to be very manageable in farming practise. All testing carried out so far supports that it is a very efficient method for cleaning sprayers leaving very low concentration in the residues after cleaning, and at the same time the cleaning procedure is simple and very easy to carry out and very little time consuming. Tests have shown that small lift mounted sprayers of 800–1000 L and 12 m booms can be cleaned in less than 5 mins using only 55 L of rinsing water (Klausen *et al*., 2009). This paper presents further testing of continuous cleaning on sprayers with larger tanks and booms as well as boom circulation.

Materials and Methods

Continuous cleaning was tested on a mounted sprayer (1200 L, 21 m boom), a trailed sprayer (3200 L, 36 m boom with circulation) and a self-propelled sprayer (4000 L and 40 m boom with

circulation). Continuous cleaning requires an extra pump - in this case a pump with 25 L min^{-1} capacity was chosen for working with the large liquid systems of the sprayers to be tested. The cleaning pump capacity must be 20–50% less than the total nominal nozzle output (at a pressure of 1–2 bar above opening pressure for check valves – which is the working pressure for the sprayer during the continuous cleaning procedure). When there is less liquid fed into the liquid system than the total nominal flow of the nozzles at the working pressure, the contaminated liquid is "pushed out" by clean rinsing water and a minimum or no contaminated liquid returns to the main tank during rinsing. This is how the water consumption is minimised and rinsing becomes time efficient.

For continuous cleaning the cleaning water is fed directly from the cleaning tank into the spray tank via a separate cleaning pump and tank rinsing nozzles applying the rinsing water over the field just treated. At the same time the main pump continues to emit the ever diluting spray through the nozzles. All valves are operated during the cleaning procedure to ensure all hoses are flushed.

The sprayers were tested using the following method for evaluating the cleaning efficacy as described by Andersen *et al*. (2010):

With the liquid system full of water and 100 L of water in the main tank fluorescent dye (pre dissolved natrium fluoresceine, concentration 0,00005%) is added to the main tank. The tracer dye is added via the main tank filling hole. All functions offered by the liquid system are activated. After circulating the dye to all parts of the sprayer a reference-sample is taken from the main tank (100%).

The sprayer is then emptied as much as possible by spraying as in normal practise. The pump has been kept running till only air and no more liquid is coming out of the nozzles, in order to minimise the residue in the sprayer.

Now the cleaning procedure starts – In order to be able to evaluate how much rinsing water is necessary to rinse to the level set by France/Denmark (1% / 2%) (Ministere de l'agriculture (2006) and Miljøstyrelsen (2009)), samples are taken from the boom tip nozzle at intervals of 30 s, and time is noted, all through the cleaning procedure.

In an initial test, cleaning water was fed to the main tank with a calibrated water hose (25 L min^{-1}) and nozzle samples were taken for a time corresponding to up to three times the volume of a normal cleaning procedure. For the two sprayers with recirculation on the boom, the nozzles were shut off at short intervals two times during the process to flush the hose returning liquid from the entire boom system boom to the main tank – this in order to evaluate if there were fluctuations in the residue concentration due to boom circulation. After measuring the residual concentration it is possible, based on the time factor (seconds) to recalculate how much rinsing water was necessary to get below the 1 or 2% (dilution of original tank mix concentration) as French and Danish legislation expects.

Results

In Figs 1, 2 and 3 the results from continuous cleaning are presented for each sprayer where residue concentration (%) is plotted against the duration of the cleaning procedure (seconds).

The initial testing of the recirculation booms (not presented in the paper) showed that for the trailed sprayer the residue concentration increased after returning all boom liquid to tank – however this was not the case for the self-propelled sprayer where the return hose from boom to tank was very short (1,5 m). This is the reason why the cleaning procedure in the final test, shown in Fig. 2, was run for a longer time only for the trailer sprayer and showing "return to tank" on the x-axis.

For the self-propelled sprayer the continuous cleaning gave a residue concentration of 1,1% within 3 mins and 0,6% in 3,5 mins. Only 110 L were used for the cleaning, which is well below the 10% of nominal main tank volume for the 4000 L tank. Only 110 L were used for the cleaning, which is well below the 10% of nominal main tank volume for the 4000 L tank.

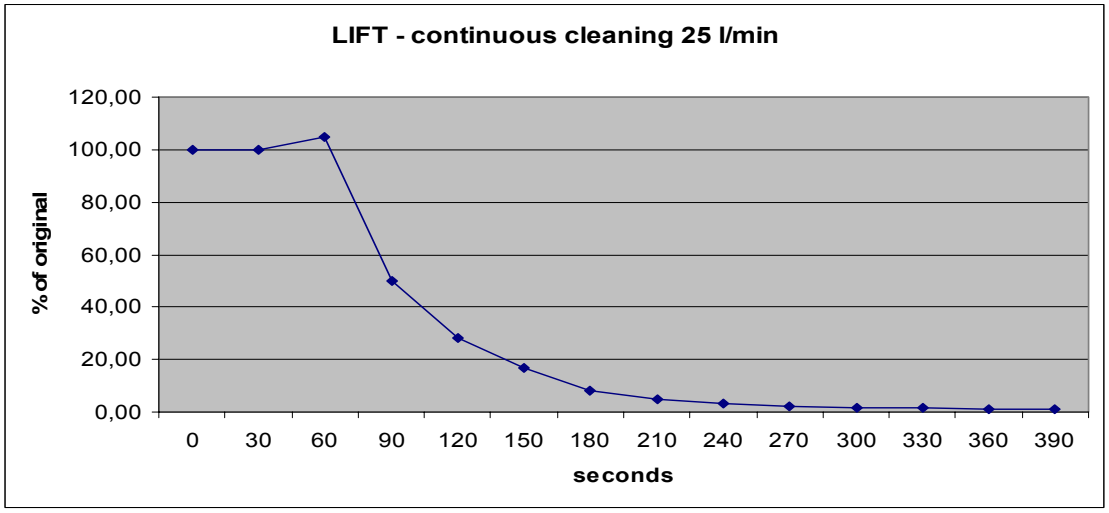

Fig. 1. Continuous cleaning of a lift mounted sprayer 1200 L and 21 m boom. Cleaning pump capacity 25 L min^{-1}.

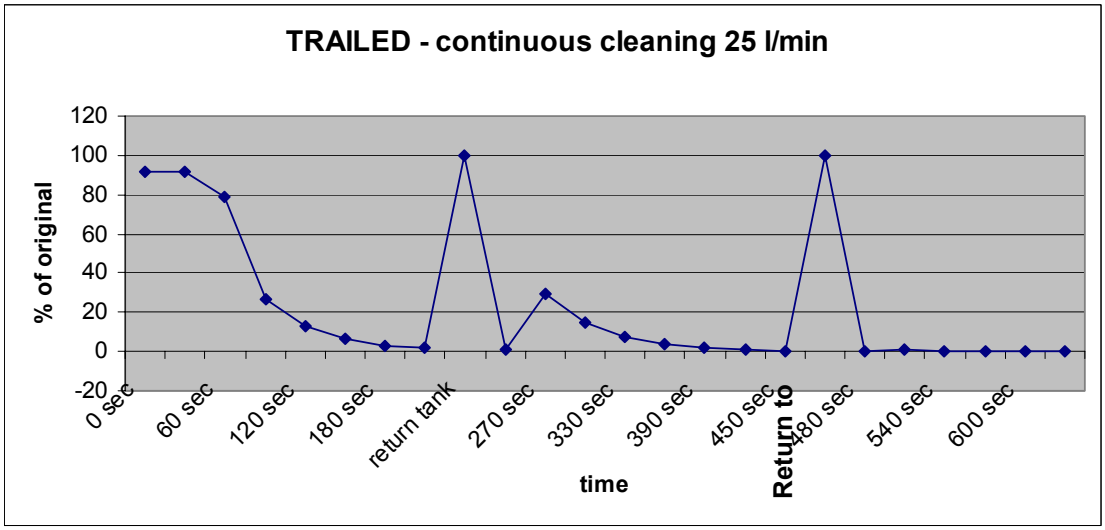

Fig. 2. Continuous cleaning of a trailed sprayer 3200 L and 36 m boom with boom circulation. Cleaning pump capacity 25 L min^{-1}.

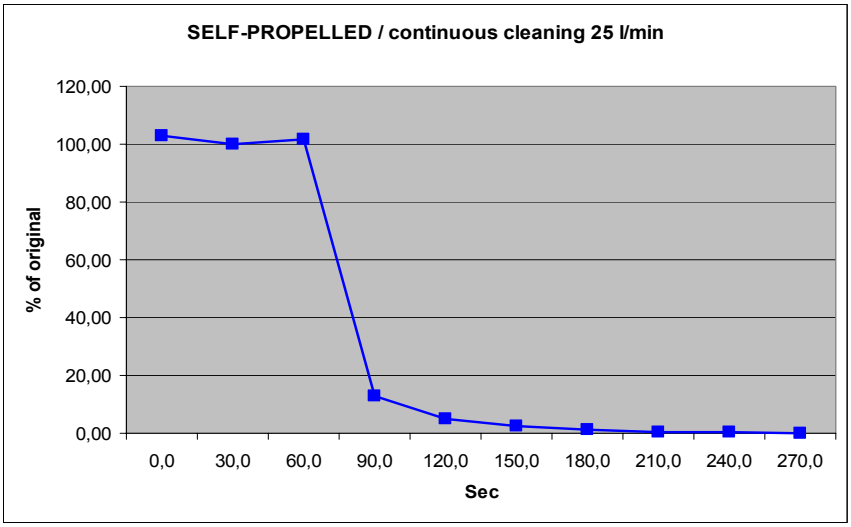

Fig. 3. Continuous cleaning of a self propelled sprayer 4000 L and 40 m boom with circulation. Initiating test showed no increase in concentration % if nozzles were turned off at 240 s. Cleaning pump capacity 25 L min^{-1}.

For the mounted sprayer the residue concentration was reduced to1,95% in 4,5 mins.

For the trailed sprayer with boom recirculation (and a long Return-to tank-hose) the figure shows that every time the sprayer cleaning was interrupted by turning off the nozzles and returning liquid from the boom circulation system to main tank- the residue concentration went up to 100% (Fig. 2). However after re-opening the nozzles after the second interruption the low residue concentration is re established at 0,21% within 30 s.

Conclusion

According to the test results for the self-propelled sprayer with boom-recirculation, continuous cleaning reduced the residue concentration enough to satisfy the levels accepted in France and Denmark.

For the mounted sprayer to get below 1% residue concentration, 150 L of rinsing water was necessary – which is more than the 120 L the clean water tank is supposed to contain on a 1200 L sprayer.

For the trailed sprayer with boom recirculation the results showed that continuous cleaning as described in this report did not clean the sprayer to the levels dictated by French and Danish authorities.

The tests showed that for booms with circulation the return hoses are not necessarily clean even if the residue concentration is acceptable at the nozzles. On the other hand if the self-propelled sprayer with a return hose of 1,5 m caused no problems for efficient cleaning it is an indication that boom circulation is not always a problem when using continuous cleaning.

The tests indicate that also high capacity tanks and big boom can be cleaned efficiently by using the continuous cleaning method.

With rinsing times in the area of 5 mins the continuous cleaning method may offer a major step forward towards making sprayer cleaning a fully integrated part of every spray job – as a farmer practice.

Perspective

The continuous cleaning method has shown potential for limiting the water consumption with no compromise on efficient cleaning also for sprayers with big tanks and wide booms – thus leaving water for external sprayer cleaning in the field too. A sprayer with a 4000 L main tank like the self-propelled must be equipped with minimum 400 L rinsing tank according to EN 12761 (2002, 2004). When using only about 100 L, for internal cleaning *c*. 300 L are left for external cleaning in the field.

The tests showed that boom circulation with long return hoses call for special attention for farmers as well as researchers when evaluating cleaning method efficacy. Had the nozzles not been shut off during the initial cleaning the high concentration hiding in the return hose from boom to tank would not have shown up.

Had there not been recirculation on the trailed sprayer boom, there is a clear indication that the results would have been some what similar to the results for the self propelled sprayer, as the cleaning was time and water efficient until returning the residuals from the hose returning spray liquid from boom to main tank. This scenario is showed in Fig. 4 as “Trailer*”.

The reason why the lift mounted sprayer with smaller tank and smaller boom uses the highest amount of water to be cleaned (see Fig. 4) is a mismatch of cleaning pump size and size of liquid system/boom size on the sprayer. If the amount of rinsing water fed to the sprayer exceeds the nominal total nozzle capacity there will be a relatively high volume of contaminated residual liquid returning to the spray tank and thereby re-contaminating the clean rinsing water that is

continuously added to the main tank – and the whole idea of continuous cleaning is lost. The 25 l/min pump was too big for the boom size on the lift sprayer.

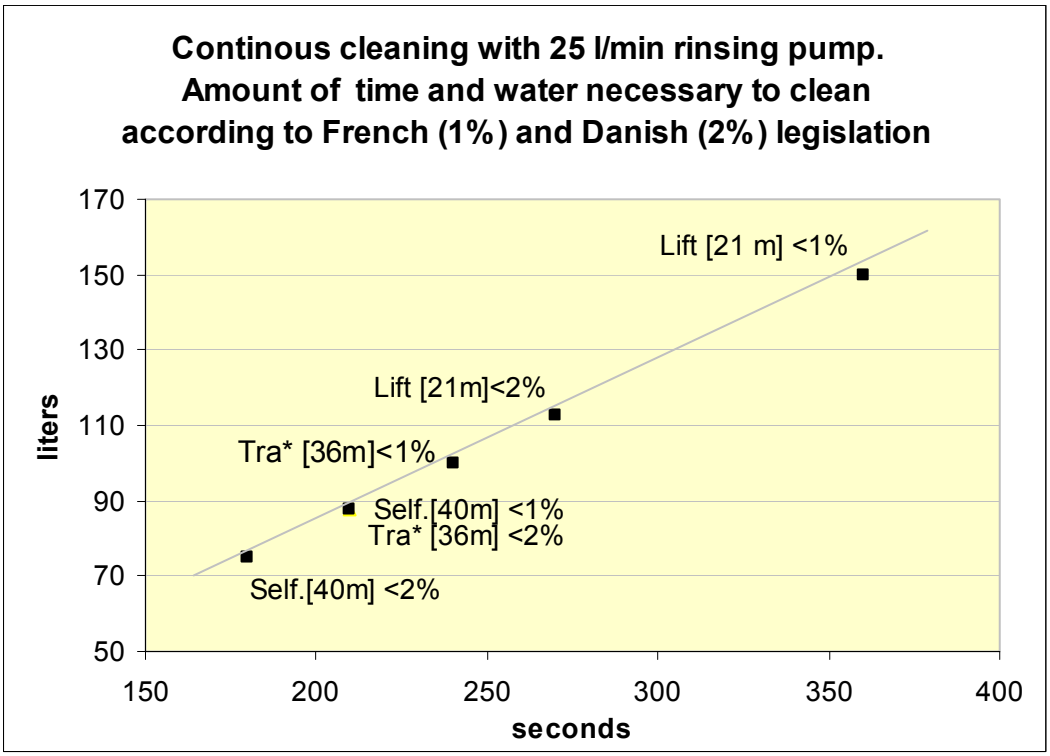

Fig. 4. The relation between cleaning time (s) and water consumption (L) for the three sprayers("Tra." is the trailer sprayer and "Self". is the self-propelled sprayer) when cleaning to satisfy French and Danish requirements (<1% and <2%) for dilution of chemical residues in sprayers comparing to original tankmix. (100%). Boom sizes are added on diagram labels. *The figures for the trailer sprayer are estimates as if there was no boom recirculation and deducted from the test presented in Fig. 2.and sprayer boom size.

The cleaning tests presented in this paper are solely based on measuring residues at the nozzles – it can be argued that to be sure the total liquid system is clean, samples need to be taken representing the whole liquid system (Andersen *et al*., 2010). Such further testing, could answer the question if the cleaning pump dimension can be decided alone based on the boom and nozzle sizes or if the total volume of the dilutable fraction of the liquid system residue needs to be accounted for too.

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