Improvements of pesticide handling in greenhouse situations

By K LÖFKVIST[1] and S A SVENSSON[2]

[1] *HIR - The Rural Economy and Agricultural Societies, Borgeby, Sweden*
[2] *Department of Agrosystems, Swedish Univ. of Agricultural Sciences, Alnarp, Sweden*

Summary

The use of pesticides in greenhouses has often been regarded, formally at least, as if the greenhouse was a closed system, isolated from surrounding soil, air, and water. Recently, several pesticide residues studies in watercourses have been conducted, showing pollution that could be related to greenhouse production. In a previous project, several potential point sources were identified. The objective of this project was to transform identified shortcomings within the field of point sources, into improvements; to reduce the risk of accidents and minimize the consequences. A filling/mixing/cleaning station was developed as a 'mock-up' and tested by growers and advisers, and after that, further improved. An important part of the design was to facilitate the handling work and, in this way, reduce the temptation to handle pesticides at inexpedient places. A promising idea from users themselves is also described; an attachment to standard sprayer tanks, to minimize spilling.

Key words: Pesticide, pollution, greenhouse, pot plant, point source, safe handling

Introduction

The use of pesticides in greenhouses has often, formally at least, been regarded as if the greenhouse was a closed system; isolated from surrounding soil, air, and water. Recently, several studies of pesticide residues in watercourses downstream greenhouses have been conducted, revealing pesticide residues that relate to greenhouse use (Kreuger *et al*., 2009; Pirzadeh. 2011; Roseth *et al*., 2007; Roseth & Haarstad, 2010). Point sources are mentioned as a possible cause for pollution. Paths and models for greenhouse pollution have been studied, covering spraying, irrigation, ventilation etc (Stangellini, 2009; van der Linden, 2009; Vermeulen *et al*., 2010; EFSA, 2010). In these cases, no account was taken to point sources. Greenhouses, including other glasshouse industry premises, are characterized by an artificial environment, without the biologically active soil as base, which in field production would reduce pollution through its buffering and degrading ability. Greenhouse floor conditions are often more like farmyards, thus inducing special attention (Wenneker *et al*., 2010).

The exact pathways of pesticides from greenhouses are not clear and it is not known whether the dominant reason is point or diffuse sources. Most likely, the pollution will derive from a combination of several pollution sources. Accidents in handling situations have to be regarded with other aspects than the continuous activity of spraying. In a project regarding chemical plant protection in Swedish greenhouse production, possible risk situations were described (Löfkvist *et al*., 2009).

Several campaigns and measures have been carried out in Sweden to reduce the contamination risk connected to point sources. Furthermore, during the last years, the TOPPS-program made much more information available. However, it seems as many greenhouse growers had difficulty implementing the information because it referred to tractor sprayers and field agriculture. The available advice and methods were not easy to apply directly in greenhouse production. Biobeds could be mentioned as an example, as they use expensive greenhouse area and outdoor biobeds are difficult to keep active during Swedish winter conditions. Indoor biobeds are regarded as a potential propagation bed for pests.

This project concentrates on point sources, related to handling of pesticides (including all operations, except spraying). In a previous project, the handling of pesticides was investigated through case studies, during real life situations, in order to survey high risk situations, in need for improvements, as well as good examples.

The result of the project could be summarised as follows (Löfkvist & Svensson, 2010). Storing of chemicals was mostly satisfactory, but the location of the storage room implied long internal transportation distances between storage and filling. Sometimes the spray operator carried open containers with partly mixed, concentrated pesticides, while opening doors, passing farmyards and pulling the sprayer simultaneously (Fig. 1). Measuring pesticides, rinsing of measure cups and filling of sprayer were made at places, where a possible spill would cause pollution of soil and water (Fig. 2). Inappropriate, temporary pesticide storages were found in greenhouses, as a result of having the ordinary storage far away (Fig. 3). Cleaning of the sprayer was a rare operation and if carried out, it could be done at the greenhouse floor (Fig. 4) (Löfkvist *et al.*, 2009; Löfkvist & Svensson, 2010). The result also showed good examples and solutions.

Fig. 1. Risky transports with open buckets and concentrated pesticide mixtures.

Fig. 2. Measuring and filling pesticides in the greenhouse, with high risk for spill (photo: Torbjörn Hansson).

Thus, greenhouse growers need other types of solutions and information to limit the risks connected with pesticide handling, filling, mixing, cleaning, etc. based on their own existing practical conditions. Still, it is reasonable that many of the components and methods of pollution control could be transferred from field agriculture, e.g. biobeds, separate concrete slabs, filling facilities, etc.

Fig. 3. Temporary “pesticide storage” in the greenhouse (photo: Torbjörn Hansson).

Fig. 4. Cleaning of the sprayer in the greenhouse (photo: Torbjörn Hansson).

The objective of this project was to transform identified shortcomings into practical improvements; to reduce the risk of accidents and minimise the consequences, when applied in growers’ situations. Problems, pointed out in previous projects should be transferred into improvements, where growers’ ideas and opinions should be utilized as much as possible, to increase possible implementation.

Material and Methods

Earlier projects resulted in an extensive photo material. This was analyzed, in particular to find ways to generalize situations. Input data was also complemented, focusing on growers' best practices. This phase also included discussions with producers and suppliers of sprayers and equipment. After analyzing the situations, the work continued according to three lines.

The first was to design a safe working place, localized in an optimal position of the greenhouse premises, to avoid long and awkward transports. Pesticide storage, locker rooms, shower and laundry facilities should also be concentrated to this area. Further on, the place should be equipped with most tools needed for suitable operations. The place should be the natural parking and cleaning place for the sprayer. Finally, any pesticide spill and waste should easily be taken care of.

A number of drafts for safe workplaces were designed together with an architect, ensuring that measures were appropriate for work operations. Inspiration was derived from literature, agriculture, and growers' suggestions (Veenhuizen & Ozkan, 1993; TOPPS, 2011; Debaer & Jaeken, 2006). A first design is shown in Fig. 5. To avoid communication problems and a greater commitment during tests, a mock-up of the safe place was built in a greenhouse on SLU Campus, Alnarp, Sweden.

Growers were invited to test the space in a mixing and filling operation. Suggestions and notes were collected. Advisers and local authorities visited and were asked to comment. Finally, students used the facilities in laboratory work. The mock-up was changed and rebuilt according to recorded advice.

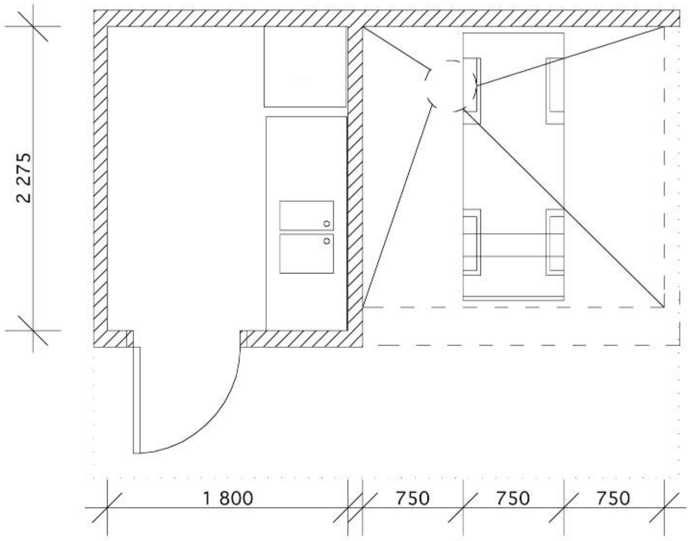

Fig. 5. A first draft of a safe working place for measuring/mixing/filling the sprayer in a greenhouse (drawing: Ateljé Alfa Arkitekter).

The second line was to collect and present ideas and solutions, developed by growers. In most cases, the solutions covered specific problems, but some of them had a more general approach. Growers were visited and their suggestions were documented.

The third line was to support larger growers, where several sprayer tanks were sprayed during one operation. In this case, we could hardly expect the spray operator to return with the sprayer to a safe place every time the sprayer was filled. Growers presented ideas of a tool or platform to put on the sprayer tank, firstly to get a horizontal safe working surface, secondly to provide a “forgiving” place to mix and rinse measuring jars etc, even if done in the greenhouse. The concept was discussed and compared to commercial products, suitable for field agriculture conditions.

Results and Discussion

The safe place, as it was realized after modifications, is shown as a mock-up in Fig. 6. It should be localized in a central place of the greenhouse premises. It has a pesticide storage (in greenhouse context a smaller cabinet is sufficient). Directly adjacent is locker rooms, shower and washing machine. The place has a concrete slab, with a floor drain, connected to a biobed or separate tank, preferable placed outside the greenhouse. Measuring cylinders and jugs could be rinsed on an easy-to-clean workbench, connected to the same point as the concrete floor drain. The sink could be equipped with drying rack, measure cups, balance and water tap. To improve the working environment, an exhaust fan will collect dust. Hoses with suitable nozzles to fill and clean the sprayer, including a flow meter device, are placed nearby. For cleaning, the place could be surrounded by plastic curtains, to reduce splashing off the concrete floor.

The design in Fig. 6 is based on the given proposals for changes and has been appreciated by growers and advisers. This means that a number of the noted risks for point pollution could be minimized, in the same time as the working situation was improved. We believe that the existence of a well functioning working place could reduce the temptation of the high risk spontaneous filling of the sprayer in the greenhouses.

Some of the interesting grower ideas are illustrated. There are examples where storage is placed close to the filling place. The sprayer is placed on a floor grating, with a concrete sump pump pit below (Fig. 7). The pump could be connected to an outdoor biobed or separate tank (Fig. 8). Another photo shows a grower, bringing an extra piece of water hose with couplings, to avoid contamination of ordinary hoses in the greenhouse (Fig. 9). The sprayer is also equipped with a small, tight box for pesticide containers (Fig. 10). One grower has arranged a place in the greenhouse, where he can clean off the sprayer, with excess waste water collected and transported to an outdoor biobed (Fig. 11). Fig. 12 shows another modern working place, with nice hard surfaces, exhaust fan, tap water, etc.

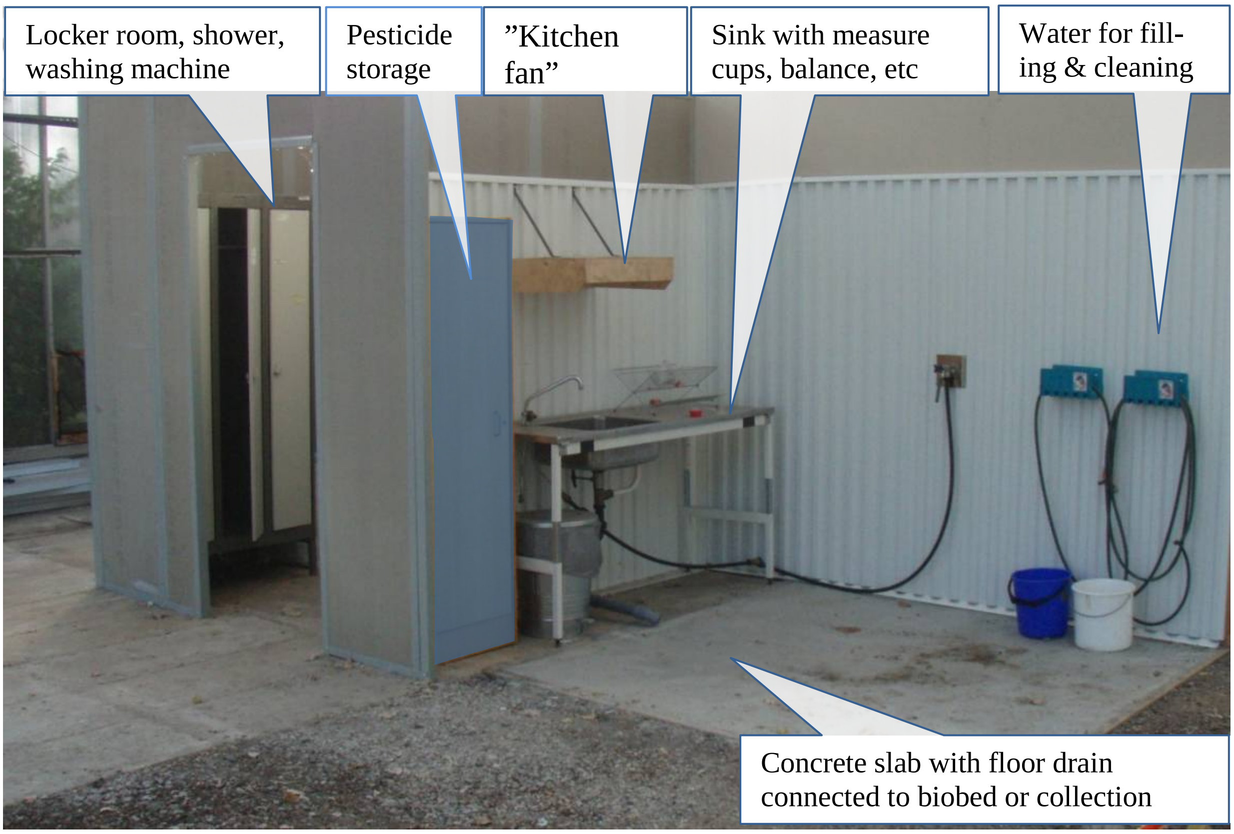

Fig. 6. The mock-up of the working place, after tests and modifications.

Fig. 7. Sprayer parking place on a permeable floor, above a sump pump pit, close to the pesticide storage

Fig. 8. Working place with a sump pump pit, connected to a separate waste tank.

The final part was a suggested new attachment to put on the sprayer, to get better and safer working conditions. Based on discussions with growers and advisers, we present an idea in Fig. 13. A platform, sloping down in the tank and with protecting edges, is attached in the original filling hole. It is equipped with a horizontal working surface, also with space for a balance. In one end is a permeable box for a safe placement of pesticide containers and boxes. There are also holders for measure glasses to dry after rinsing. The water intake has an electronic flow meter and backflow prevention.

Fig. 9. Sprayer with an extra piece of hose for filling, just to avoid contamination of the normal water hoses

Fig. 10. A tight box to keep pesticide containers on the sprayer.

Fig. 11. Grower cleaning the sprayer on a concrete slab, with floor drain, connected to the outdoor biobed (seen in the background).

Fig.12. Modern working bench for measure/ /mixing, nicely arranged

Conclusions

With rather simple and low-cost means, we have been able to suggest improvements that can greatly reduce the risk of point sources in greenhouse situations. To arrange a safe place in the greenhouse facility may also force the grower to think of other logistical issues. A greenhouse plant often illustrates an gradually growing facility, with boiler room, packing shed and other technical areas (e.g. pesticide storage, nutrient mixing, changing rooms and parking space for the sprayer) at one end of the plant, while the high-producing, modern greenhouses are far away. Equipment for improving greenhouse working situations is required, for work safety and environmental protection, as well as for efficient work. The proposals will be presented to growers in various seminars. We are so far confident on the positive influence on the industry.

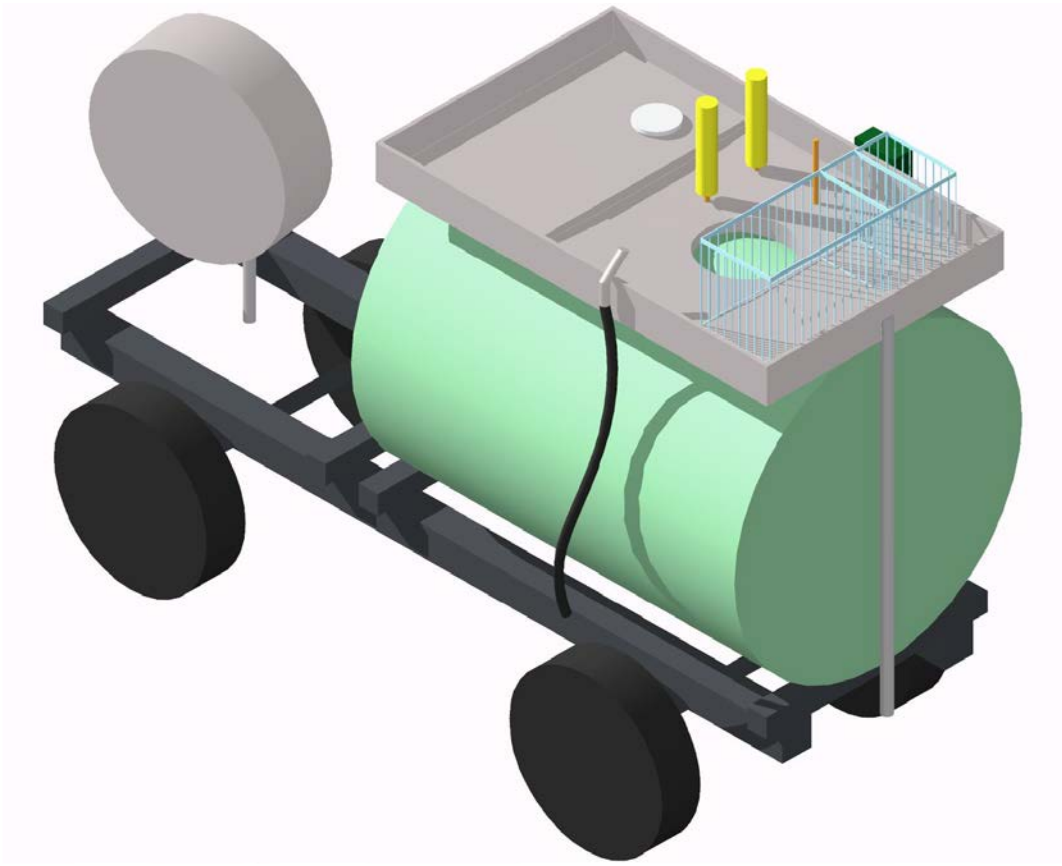

Fig. 13. A suggested attachment to the sprayer filling hole, to constitute a working bench, with a safer situation for measuring/mixing/filling (model: Ateljé Alfa Arkitekter).

Acknowledgements

First of all we want to thank all involved growers, who let us follow them during spray operations. We are also very thankful to those growers, advisers, authorities and students, who gave us important feedback on our mock-up activities. We also want to thank pot plant grower Bengt Jönsson, Löddeköpinge, Sweden, who had most of the ideas of the attachment to put on top of the sprayer tank. Finally, we want to thank the Swedish Farmers' Foundation for Agricultural Research, who financed the project.

References

Debaer C, Jaeken P. 2006. Modified bio filters to clean up leftovers from spray loading and cleaning; experience from pilot installations. Aspects of Applied Biology **77**, International Advances in Pesticide Application, pp 247 - 252.

EFSA (European Food Safety Authority). 2010. Report on the PPR stakeholder workshop PROTEA on pesticide emissions from protected crop systems. EFSA Journal 2010; 8 (2):1509. [31 pp.].

Kreuger J, Graaf S, Patring J & Adielsson S. 2009. Bekämpningsmedel i vattendrag från områden med odling av trädgårdsgrödor under 2008 (Pesticides in waterways from areas with horticultural crop production during 2008). Ekohydrologi 110. Swedish University of Agricultural Sciences, Division of Water Quality Management. Uppsala, Sweden

van der Linden AMA. 2009. Emissions by "other routes than air" from protected crop systems (greenhouses and crops grown under cover) - Position paper. RIVM report letter 607050004. Laboratory for Ecological Risk Assessment. Bilthoven, the Netherlands

Löfkvist K & Svensson S A. 2010. Safer handling of pesticides in greenhouses. Aspects of Applied Biology 99, 2010, International Advances in Pesticide Application, pp 431 - 434.

Löfkvist K, Hansson T & Svensson S A. 2009. Förluster av växtskyddsmedel till omgivande mark och vatten vid användning i svenska växthus - en genomgång av möjliga riskmoment (Losses of pesticides to soil and water from greenhouse uses – an overview of possible risk factors). Rapport 2009:6. Swedish University of Agricultural Sciences, Alnarp, Sweden.

Pirzadeh P. 2011. Bekämpningsmedel i skånska vattendrag – Resultat från den regionala miljöövervakningen 2010 (Pesticides in Scanian waterways – Result from the regional environmental survey). Länsstyrelsen i Skåne län, Report 2011-15, Malmö, Sweden

Roseth R, Ludvigsen G H & Aasen R. 2007. Forprosjekt – plantevernmidler i avrenning fra veksthus. Rapport, 2: 162. Bioforsk, Ås, Norway

Roseth R & Haarstad K. 2010. Pesticide runoff from greenhouse production. Water Science & Technology 61(6): p1373 – 81.

Stanghellini C. 2009. Emissions by aerial routes from protected crop systems (greenhouses and crops grown under cover) - A position paper. Report 224. Wageningen UR Greenhouse Horticulture, Wageningen, the Netherlands

TOPPS (Training the Operators to Prevent Pollution from Point Sources). 2011. Website with numerous information from several countries and organizations. [available online: http://www.topps-life.org/web/page.asp]

Veenhuizen M A, Ozkan H E. 1993. On-Farm Agrichemical Mixing/Loading Pad, Ohio State University Extension Factsheet AEX-522, Columbus, OH, USA

Vermeulen T, van der Linden A M A & van Os E A. 2010. Emissions of plant protection products from glasshouses to surface water in The Netherlands. Rapport GTB-1002; RIVM Rapport: 607407001. Wageningen UR. Wageningen, the Netherlands

Wenneker M, Beltman W H J, de Werd H A E, van Zeeland M G, van der Lans A & van der Weide R Y. 2010. Quantifying point source entries of pesticides in surface waters. Aspects of Applied Biology 99, 2010, International Advances in Pesticide Application, pp 69 – 74.