Operator and Environmental Safety During Pesticide Application in Liguria Region Greenhouses

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Abstract
A survey has been carried out in 160 Liguria Region (north west Italy) greenhouse farms examining several aspects related to pesticide application and operator safety. About a half of the floricultural farmers interviewed make more than 40 treatments per year, and 45% of horticultural farmers make between 21 and 30 treatments per year. The most frequent (68%) volume rates are in the range between 1000 and 2000 L/ha and lances and spray guns, with both forward and backward movement, are the only type of spray equipment used. During pesticide application only 60% of workers use impermeable gloves, 92% respiratory masks, 60% wear impermeable overalls (17% wear textile overalls).
Almost all operators (92%) clean the empty pesticide containers and add the cleaning water to the pesticide mixture to be distributed. Empty containers are sent to specialised collecting centres (34%), thrown in dumping grounds (48%), burned (9%), or stored in the farm (9%). Most farmers (94%) use to clean the spray equipment after each pesticide application and with water only (98%). Average amount of water used for the equipment cleaning is 42 L. Rinsing water is drained on the ground (53%), sprayed on the crop (33%), thrown in the sewers (14%).

Keywords: greenhouse, pesticide application, operator and environmental safety

Introduction

Cultivation in glasshouses and greenhouses is featured by peculiar climatic (high temperatures an relative humidity) and agricultural conditions (frequent irrigation and fertilisation, high density crops, enclosed area), that may favour the development and spreading of plant pests and weeds more rapidly than in field cropping. This implies that in such conditions the use of PPP considerably arises. Within the 22000 ha of covered crops in Italy, a consume of about 300 tons is estimated just for the insecticides, referred to one single crop cycle. Considering the frequency of crop rotations during the whole year, values of pesticide consume referred to one year are expected to be much higher.

Taking into account that PPP are often featured by high toxicity levels, sprayers must comply with constructive and functional requisites able to minimise the risks for operators, enabling the preparation and distribution of the spray mixture in conditions of safety. The operator, however, has to be informed about the precautions to be adopted when making the spray applications, with special regard to the use of (Personal Protection Equipment (PPE). These information are especially needed when the application is made using hand-held or knapsack sprayers, widely spread in horticultural farms, as in these cases there is a higher risk of accidental operator contamination with pesticides (Bjugstad and Torgrimsen, 1996; Sutherland et al., 1990). A survey carried out in Southern Europe (Italy, Greece, Portugal and Spain) in horticultural glasshouses pointed out a worrying situation in terms of potential operator exposure to pesticides, with level of potential dermal exposure ranging from 70 up to over 900 ml/h. It is important to underline that these values of potential exposure to pesticides

are considerably higher with respect to those assessed in similar studies made in Northern Europe, where the figures resulted not more than 20 ml/h. This difference is mainly related to the higher consideration for the operator safety and to the use of more efficient spraying equipment in the Northern European countries (Glass et *al*., 1999).

In Italy a survey on the application of PPPs (Cerruto et *al*., 2008), carried out in Piemonte, Veneto, Toscana Puglia and Sicilia Regions, has enlightened greenhouse crops to be characterised by high numbers of pesticide application (even more than 20 per cultural cycle, that in a year can double in consequence of rapid crop rotations), and by high volume rates (even more than 4000 l/ha). Beside this, the survey has also pointed out poor attention towards the equipment maintenance (pressure regulators absent, pressure gauges broken or not visible during applications), as well as towards the operator safety (improper use of PPE, especially during mixture preparation, when concentrated pesticides are manipulated) and the environmental safeguard (improper disposal of mixture remnants and machineries' washing waters).

The effects of pesticide exposure on operators health were investigated also in several medical studies, like the one made in Spain, in the Almeria region, (Martin Rubi et *al*., 1996), where there are 40000 ha of protected crops. Between 1981 and 1992, 506 cases of poisoning due to dermal absorption, inhalation or ingestion of PPP were recorded. Also in Italy, some studies carried out in the Imperia province (Lotti, 2001) pointed out an increasing number of persons affected by cancer in the areas where intensive agriculture (glasshouses) is practised.

Main objectives of this study were to know how pesticide application is managed in Liguria Region greenhouses (about 5000 ha), and to evaluate its potential impact on the operator and environmental safety. To discover the extent to which PPE are used and how the remnants of the spray applications are managed, a specific questionnaire was prepared and presented to a significant number of horticultural and floricultural farms.

Materials and methods

The survey was carried out in 160 horticultural and floricultural farms located in Liguria region, submitting to the farmers a specific questionnaire. The survey considered several aspects related to pesticide application and operator safety:

- farm statistics (farm surface, main cultivation)
- equipment used, its maintenance and operating parameters;
- number of treatments per year and volume rates applied;
- use PPE: during the preparation and the distribution of the pesticide mixture and during the cleaning of the equipment;
- environment protection: cleaning and management of the empty pesticide containers, management of the waste water.

Results

The cultivated surface involved in the survey amounted to about 200 ha, where 60 hectares were in glasshouses; the average farms surface resulted 1.22 ha, with 0.35 ha in glasshouses. 62% of the farms examined were mainly addressed to flowers production, while the remaining 38% were more focussed on horticultural production. The number of pesticide distribution carried out per year is very high, especially in the floricultural farms where in 46% of cases more than 40 applications are made in one year; on the other hand, in the horticultural farms, only 13% of the farmers interviewed declared to make more than 30 treatments per year (Fig 1).

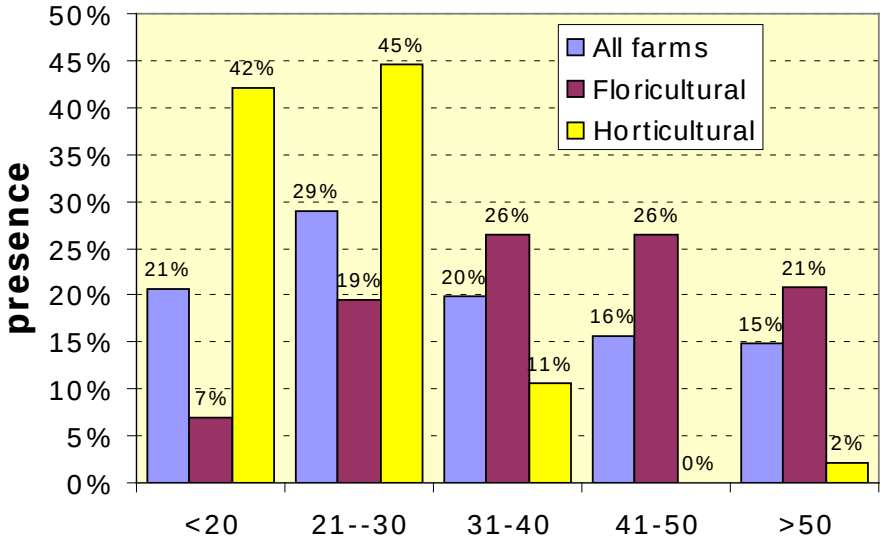

Figure 1 – Numbers of pesticide application per years in the surveyed farms.

Spraying equipment more used resulted short spray lances fitted with a large spout (n°1 in Fig. 2, 35% of cases) and long spray lances, (n° 2 in Fig. 2 - 31% of cases); especially in the floricultural farms located in the province of Imperia, spray lances fitted with three nozzles resulted very much spread (58% of cases) (n°3 in Fig. 2). The lance age ranges from 1 to 25 years, with a mean of 6 years.

Figure 2 – Main type of lances and spray guns for pesticides application used in the surveyed farms.

Average spray volume (145 l/1000 m^2 of glasshouse) as well as average operating pressure (21 bar) resulted very high. It is important to underline that in 20% of the farms examined average spray application rates higher than 200 l/1000 m^2 were employed and that in 18% of the farms surveyed operating pressure even over 25 bar were used (Fig. 3 and Fig. 4). In the flowers farms spray application rates were usually higher (175 l/1000 m^2) than those adopted in the horticultural farms; in this latter case, operating pressures were generally higher.

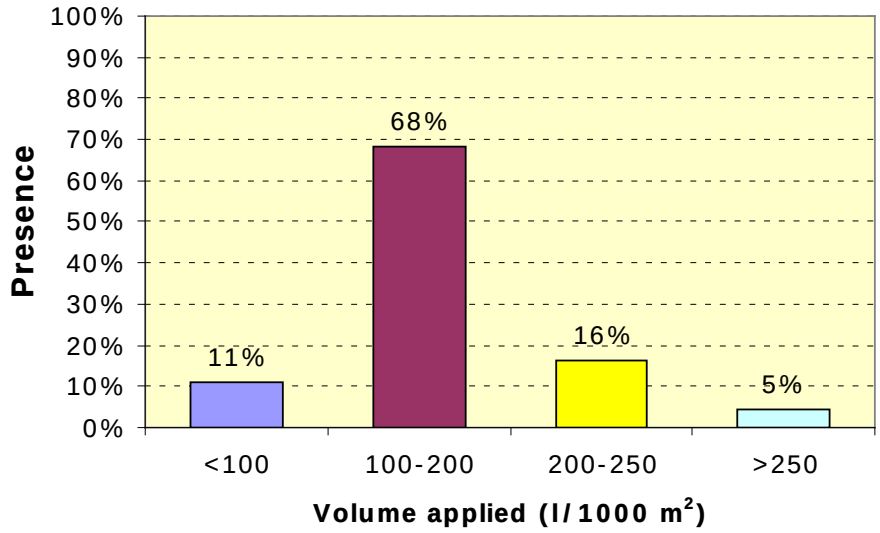

Figure 3 - Volume rate used in the surveyed farms.

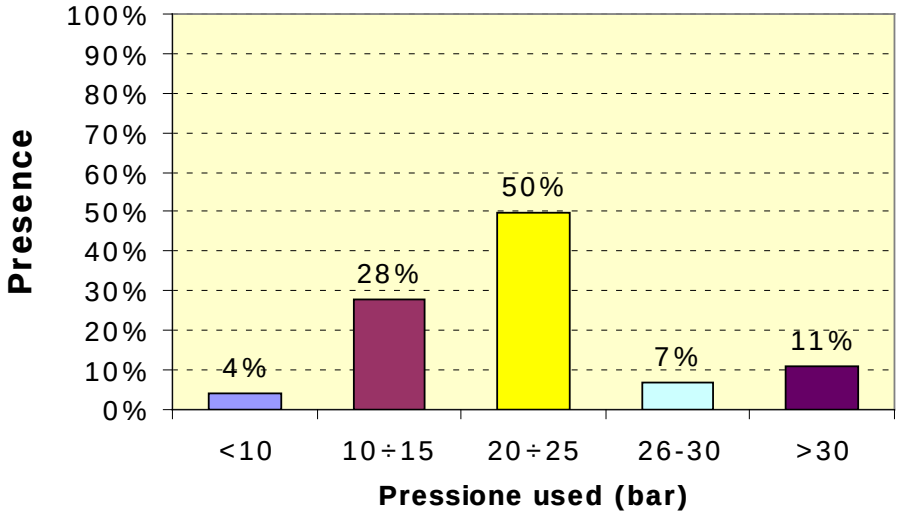

Figure 4 – Pressure used in the surveyed farms.

94% of farmers interviewed declared to clean regularly their spraying equipment at the end of each application (87% of cases) or when the type of pesticide is changed (7% of cases). Cleaning is mostly carried out employing just clear water (98% of cases), seldom adding cleaning agents or soda. The amount of water used for cleaning the sprayer is very variable depending on the accuracy of the cleaning and on the size of hoses. On average it amounted to 42 litres. Washings are often disposed directly in the ground (53% of cases) or on the crop (33% of cases), but sometimes they are also directly poured in the sewers (Fig. 5). 64% of farmers declared to have not any pesticide mixture residue at the end of the treatment, while 30% declared to apply it directly on the crop, 3% declared to pour it on the ground and 3% to leave it in the sprayer tank for reuse in the next application. When making the cleaning of PPP cans, 92% of farmers declared to add the washings to spray mixture. Emptied PPP cans were delivered to specialised disposal companies in 34% of cases, or put in the urban wastes

containers (48% of cases), or they were stored in the farm (9% of cases) or even burned (9% of cases, Fig. 6).

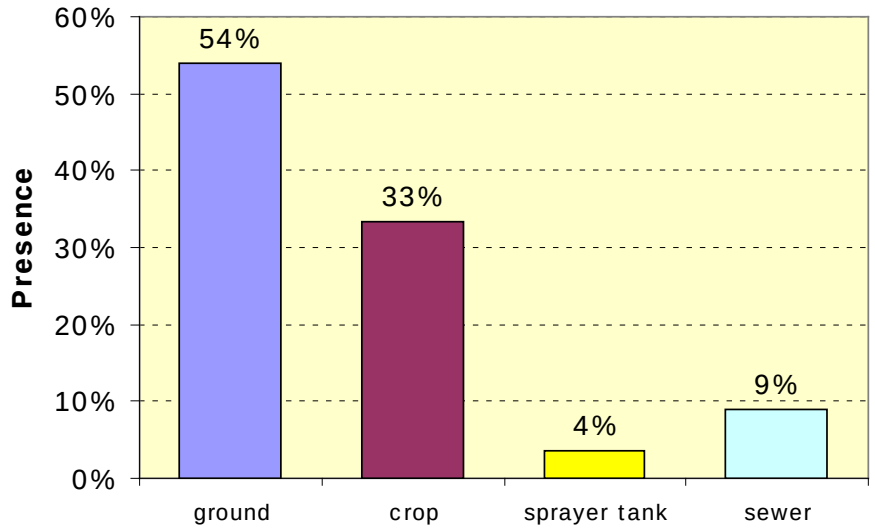

Figure 5 – Rinsing water destiny.

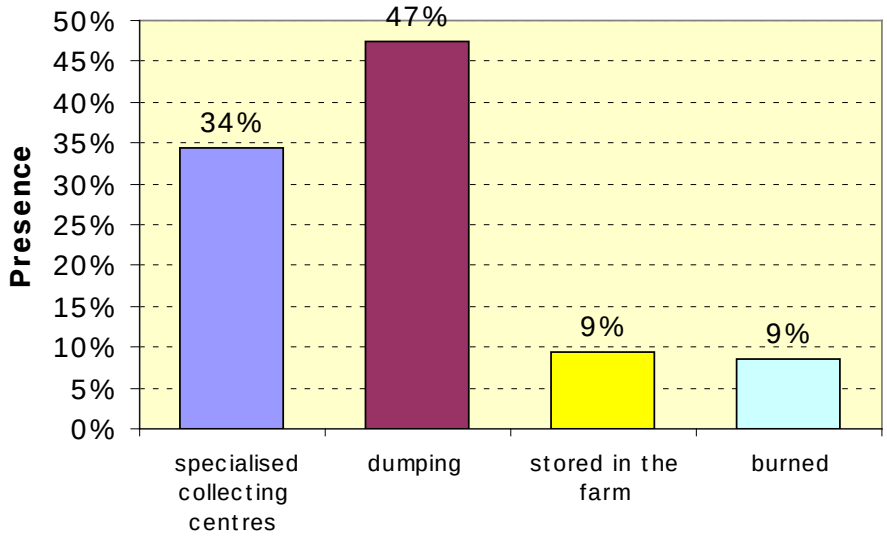

Figure 6 – Empty cans destiny.

94% of farmers interviewed declared that while making the PPP spray application they wear protective gloves: in 60% of cases gloves were impermeable but it was not possible to establish if they were impermeable to chemicals or only water proof. It is important to notice that the use of cotton or latex gloves, as registered in 40% of the farms surveyed, does not protect the hands against chemical agents. Protection from PPP inhalation was adopted in 97% of cases: 92% of farmers declared to wear a mask, fitted with active carbons filters (85% of cases) or an integral helmet (7%). In the remaining cases, temporary solutions are adopted (e.g. anti-dust masks, handkerchiefs, textile masks, etc.) that are not effective in terms of operator safety. For the protection of the body (88% of the farmers interviewed declared to consider it) the most spread solution (52% of cases) is to wear impermeable overalls, even if,

as already mentioned about the gloves, it was not possible to state their effectiveness in preventing from PPP contact. Also the disposable overalls, used in 23% of farms, do not represent a guarantee in terms of operator safety, as their effectiveness depends on the material they are made of (Fig 7 and Fig. 8). In any case it is recommended to avoid the use of textile overalls (that was still registered in 25% of farms) which can absorb the chemicals and therefore increase the PPP dermal exposure for the operator.

Figure 7 – Correct use of PPE during pesticide application.

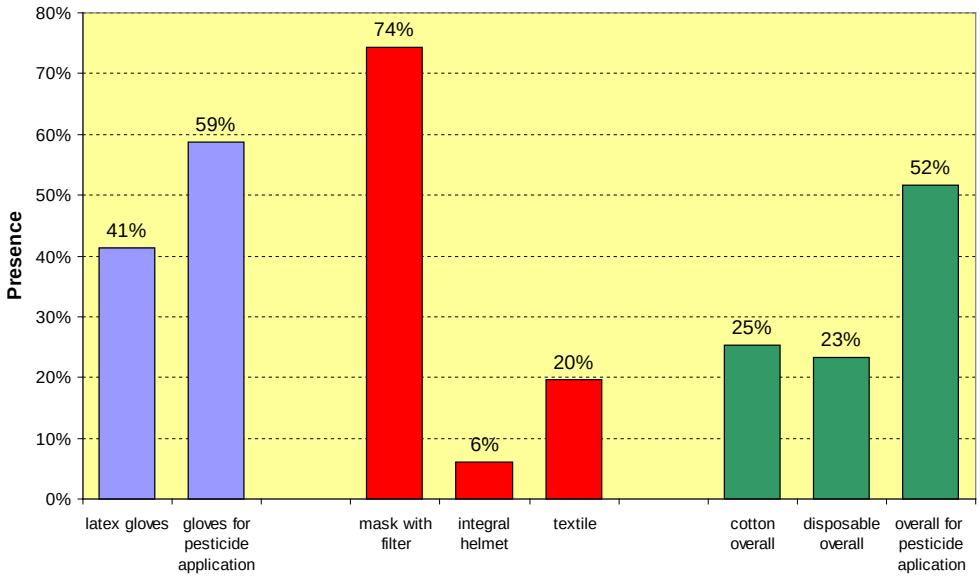

Figure 8 - Summary of the PPE use during pesticide application.

The operator, when applying the spray mixture, walks backward in 41% of cases, walks forward in 27% of cases and modifies the way of moving according to the crop type, to the features of the field/glasshouse or to the environmental conditions (38%). It is important to

remind that the choice to walk in the forward direction is not recommended because it increases the risks for the operators of direct (from liquid sprayed) and indirect (from already treated leaves) PPP contamination. Especially in the most extreme conditions (very high spray volume rates and very developed vegetation), to pass from backward walking to forward walking while spraying may lead to an increment by 8 times of the operator PPP contamination (Cerruto et *al*., 2008, Fig. 13).

Conclusions

The survey carried out, that involved a significant number of farms, and therefore can be considered representative for the situation in Liguria region, pointed out that pesticide application in horticultural and floricultural farms is made in a not optimal way. More in details, spraying equipment used are very poor in terms of technology, they are often old, not safe and they are used not properly.

Operators generally have a lack of basic knowledge about the correct use of the sprayers and especially about their correct adjustment. Also the management of PPP wastes is often carried out not properly. If we consider that an average of 42 litres of clear water are employed for cleaning the equipment and that 40 treatments are made each year, then the farmers has to manage 2 m^3 of washings containing PPP, that, as pointed out by the survey, are usually poured on the ground, typically always in the same place of the farm, therefore generating PPP point sources.

Also the measures adopted to guarantee the operator safety while making pesticide application resulted in most cases not sufficient and therefore it was confirmed the need for a more appropriate training of the operators.

Acknowledgements

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References

Bjugstad N., Torgrimsen T. 1996. Operator safety and plant deposit when using pesticide in greenhouse. Agricultural Engineering Research, 65, pag 205-212.

Cerruto E. Emma G., Manetto G. 2008 Operator contamination during pesticide application in tomato green house. Acta Horticulturae (801), 1515-1522.

Cerruto E., Balsari P., Oggero G., Friso D, Guarella P., Raffaelli M. 2008. Operator safety during pesticide application in greenhouse: a survey on italian situation. Acta Horticolture (801), 1507-1514.

Martin Rubi J.C., Yelamos Rodriguez F., Laynez Bretones F., Cordoba Escamez J., Diez Garcia F., Lardelli Claret A., Blanco Coronado J.L. Vicente Ruiz J,R. (1996). Intoxicaciones por insecticidas organofosforados : estudio de 506 casos. Revista clinica espanola n° 126, pag. 3-8.

Glass C. R., Mathers J.J., Martinez Vidal J.L., Egea Gonzalez F.J., Moreira J.F., Machera K., Kapetanakis E., Capri E. (1999). Potential operator exposure in southern european

greenhouses and orchards. In: Human and environmental exposure to xenobiotics (AA. VV) La Goliardica Pavese, pag. 633-638.

Lotti G.(2001) Le malattie professionali del floricoltore. Oral comunication in Workshop "La corretta modalità di distribuzione dei fitofarmaci alle colture floricole" Sanremo, Sala Congressi UCFLOR, 1 dicembre 2001.