

Safety Aspects Regarding Spraying Pesticides in Protected Environments

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Abstract

This work deals with the procedure and equipment for the distribution of pesticides. The research was carried out in a greenhouse nursery. The aim of the work was to identify the critical points underlying the risk to the health and safety of the operators and to the environment. The investigation was not limited to the spraying stage but was extended to the operators' entire working day. The investigation focussed on the operators and included the preliminary and conclusive stages of their day, starting with their arrival at the nursery and ending with their departure through the gate. The multiple observations carried out at the same time required the presence of the research group. The observations were based on the break down of the work into component phases and the timing of each of these. Also the input as resources used and output as chemical waste were considered. The breakdown was carried out following the CIOSTA – AIIA and Methodology of Organisational Congruence (MOC) indications. The identification of the critical points was made on the basis of the *Testo Unico sulla Sicurezza* (D.Lgs. 81/08) (Single Safety test, law 81/08), the Global Gap protocol in effect (version 3.0-2_sep07 and version 3.0-3_feb09) specific to market gardens, the ENAMA protocol for the functional testing of the spraying machines and the European regulation in effect since 12 December 2009, and, more in general, by consulting the current regulations. The stages of the work were identified; the resources, tasks, responsibilities, actions and equipment were identified and assessed; and finally, together with the risk factors, also the critical points for correct management of the materials, machines and chemical waste were found. The results represent the basis for a plan of action aiming at risk reduction and prevention in greenhouse nursery.

Keywords: greenhouse, health, safety, work organisation, Global Gap protocol, ENAMA protocol

1. Introduction

The market garden and nursery plants section in protected environments in the south-east of the Sicilian Region, comprising the provinces of Ragusa and Syracuse, covers about 7500 hectares per 13200 ULA. It is thought that at least 15.20 % of the total work involves spraying pesticides.

Workers are at risk of intoxication when spraying pesticides in greenhouses; therefore, a monitoring system has been set up by the institutions concerned with preventive medicine (S.Pre.S.A.L.).

Despite the lack of statistics about this, experience has led us to believe that there is a risk of intoxication in other phases of the operation besides spraying. For this reason, the treatment methods and the equipment used for the pesticide spraying have been monitored, and the entire working day of the operators has been examined. The objective of the investigation is to identify all the phases of risk, besides the actual spraying phase, and to lay down the foundations for a method to assess the risk of intoxication of the workers.

2. Materials and Methods

The research took place in a company growing nursery plants and vegetables with a SAU of about 5 hectares with crops in a protected environment. The greenhouses are made of steel with a semi-circular domed covering, a span of 9 m, highest point 5.45 m and height at the eaves of 3.75 m. The structural characteristics comply with the EN European regulations (UNI EN 13031-1:2004). The greenhouses have a PE plastic film roofing that lasts two years and is 0.15 mm thick, and a further anti-aphid net to protect the crops from disease vectors.

The 3 greenhouses examined here, (A, B e C), 4.500 m², 3.500 m² and 2.200 m², form a layout of a central longitudinal corridor and 4 transversal corridors that mark out the areas with beds that support the polystyrene trays.

The work of the pesticide spraying operators was surveyed and broken down into component phases that were described and timed using the methodology CIOSTA – AIGR (today AIIA), and following the methodological procedure suggested by the Method of Organisational Congruencies MOC. All the important points were reported, with the standardized surface of 1000 m² considered as reference module.

The assessment of the critical points for the safety aspects of the workers was carried out using the contents of the single text on safety (D.Lgs. 81/08), of the GlobalGap protocol currently in force (version 3.0-2_Sept07 and version 3.0-3_Feb09) specifically for fruit and vegetables.

The equipment for the pesticide spraying which the workers use when carrying out monitoring work was tested following the indications of the protocol ENAMA for the functional testing of spraying machines (reference procedure for the activation of the service for the functional control of spraying machines and the periodical testing of this activity, headed by the Technical Work Group for the national planning of control activities of spraying machines Rev. December 2009) and referring to recently approved European regulations (Directive 2009/128/CE of the European Parliament and Council of 21 October 2009 that sets down a framework for community action regarding the sustainable use of pesticides – Directive 2006/42/CE of the European Council and Parliament of 17 May 2006 concerning machines, in force since 29.12.2009), and more in general referring to current regulations.

3 Results and discussions

3.1. The work phases

The protection of the crops is entrusted to 3 teams, each with two workers. The spraying work usually takes place 3 times a week, rotating all the preparations. A monitoring system of the environmental conditions, the most sensitive plants and the vectors present in the cultivation area may suggest extra interventions. The work was broken down into 8 phases. (Table 1).

Table 1 – Pesticide spraying in greenhouses – 8 phases [greenhouse 1000 m²]

	Phase	Place	Average duration Min	Description of operation
1	Dressing	Changing room	15	The workers collect the protective clothing and put it on
2	Preparation of the mixture	Pesticide warehouse	15	One or more workers prepare the mixture to distribute among all the teams in charge of the treatments
3	Transfer from warehouse to greenhouse	Paths in the company	5	The workers go to the greenhouse on foot, carrying the mixture in containers
4	Preparation of spraying machine	Greenhouse	10-15	The machine is programmed for the treatment, the appropriate regulations are made, the mixture is poured into the tank and the water tank is filled.
5	Pesticide spraying	Greenhouse	5 (1000 m ²)	One worker traverses the nozzle while the other sees to the necessary operations of assistance, like handling the tube, keeping a distance of about 8 metres from his colleague
6	Washing the equipment	Tap next to the greenhouse	7	The workers rinse out the spray pistol and the containers
7	Transfer from the greenhouse to the warehouse	Paths in the company	4	The workers return on foot to the warehouse and put the equipment in its place (spray gun and containers)
8	Undressing	Dressing room and tap in front of the warehouse	15	The workers take off the protective clothing, clean it and keep it or dispose of it. The workers get washed

The entire duration of the work cycle, referring to a greenhouse surface area of 1000 m², is 76 minutes, with a higher incidence of the sub-phases of dressing of the workers (19%), preparation of the mixture (19%), setting up the sprayer (13,1%) and undressing (19%). The spraying phase comprises 6.5% of the entire work cycle. Also, the relatively important duration of the transfers should be highlighted, especially the one from the warehouse to the greenhouse with the containers full of the mixture, and finally the duration of the operation of managing the equipment after carrying out the treatments.

3.2 The critical points

We identified the following critical points (CCP) for all 8 phases of pesticide spraying:

Table. 2 – Critical points of “dressing”

Critical points noted	GlobalGap	Regulation of reference
‘Danger’ signs on the entry doors to the warehouse.	AF 3.3.2 - mm	Legislative decree 81/08 Title V – Attachments from XXIV a XXXII
Procedures in case of accidents	AF 3.3.1 - mm	Legislative decree 81/08 Title I – Section VI D.M. n. 388 del 15 July 2003 Legislative decree 81/08 Title IX Legislative decree 81/08 attachment IV
Ventilation of changing room	-	Legislative decree 81/08 attachment IV – paragraph 2 – point 2.1.8.1
Access to changing room Tap inside.	-	Legislative decree 81/08 attachment IV – paragraph 1 – point 1.13.2.2 – 1.13.3.1
Devices for individual protection.	AF 3.4.1 - MM AF 3.4.2 – MM	Legislative decree 81/08 attachment IV – paragraph 1 – points 1.12.4 and 1.12.5 ISPESL – Operative lines for clearing and maintenance of DPI (March 2008)
Procedures for putting on and taking off DPI	-	Procedures and advice given by producers of pesticides
Footwear used in course of treatments	AF 3.4.1 - MM AF 3.4.2 – MM	Legislative decree 81/08 Title III – Chap II Legislative decree 81/08 Title IX Legislative decree 475/92 EN 344 - EN 345 – EN 347

The analysis of the CCP in the “dressing” and “undressing” phases indicates the need for a different management of the protective clothing, and also the need to restructure the changing room, providing it with a separate access from the warehouse and posters describing what to do in case of accidents.

Table. 3 – Critical points in “storage, preparation and transport of mixture” phases

Critical points noted	GlobalGap	Regulation of reference
Various pesticides in the warehouse	CB 8.7.8 - mm	Regulations for carrying out D.P.R. 290/01;
Arrangement of pesticides on the shelves	CB 8.7.17 – mm	Regulations for carrying out the D.P.R. 290/01;
Inert materials (sand) in the warehouse	CB 8.7.12 - mm	Legislative decree 81/08 attachment IV – paragraph 2 – point 2.1.12
Registration of files documentation of treatments.	CB 8.2.5 – mm CB 8.2.6 – mm CB 8.2.7 - mm CB 8.2.9 - mm:	D.P.R. 23 April 2001, n. 290; Memorandum 30 October 2002; Legislative decree n. 65 of 14/3/2004
Annual balance setting	CB 8.7.11 – mm	UNI CEI EN ISO/IEC 17025 (requirements of chemical laboratories)
Tools for the preparation of the mixtures	CB 8.7.11 – mm CB 8.9.6 - MM	Legislative decree 81/08 attachment IV – paragraph 2 – point 2.1.3
Disposal of mixture and water	CB 8.9.7 – mm	Legislative decree 5 February 1997 n. 22 and s.m.i. “carrying out of directives 91/156/cee on waste, 91/689/cee on dangerous waste and 94/62/ce on packaging and waste produced by packaging”. Legislative decree 22 May 1999, n. 209 “carrying out of directive 96/59/ce Concerning discharge of polychlorinated biphenyl and polychlorinated triphenyl”
Bench for preparing the mixtures		Legislative decree 81/08 attachment IV – paragraph 2– points 2.1.5 e 2.1.8.1; UNI EN 14175 (chemical hoods and extractors required)
Containers for transport.		Legislative decree 81/08 attachment IV – paragraph 3 – Point 3.10

The analysis of the CCP in the phases of “storing, preparation and transport of the mixture” shows that the operations of preparing the mixture need to be revised, avoiding the use of unprofessional equipment and studying different solutions for transporting the mixture.

Table 4 – Critical points of the phases of “preparation of sprayer” and “spraying”

Critical points noted	GlobalGap	Regulations of reference
Periodical control of sprayers	CB 8.4.1 – mm CB 8.4.2 – R	EN 13790-2: 2003
EC branding, identification plate, instruction manual, safety pictogram		Directive 2006/42/CE Legislative decree 17/2010
Protection sheath for pressure tubes. Leaks from the tank Manometer always visible. Tank hermetic cover Control system of the level of mixture. Tank for washing hands	CB 8.4.1 – mm	UNI EN ISO 4254-1:2006; UNI EN 982: 2009; UNI EN 907:1998; ISO 11684:1995; ISO 5681:1992 point 3.9.5; ISO 5681:1992 point 3.9.5; attachment A of law EN 12761-1:2003;
Washing after each treatment.	CB 8.4.1 – mm CB 8.5.2 - R	Dir. 1600/2002/CE Dir. 2000/60/CE Dir. 2006/42/CE
Posters warning of danger at the entry to the greenhouse being treated.	AF 3.3.2 - mm	Legislative decree 81/08 Title V –Attachments from XXIV to XXXII
Return times	CB 8.8.2 – MM CB 8.8.3 – mm	Directive CEE 91/414 received in the GU 76 on 3/10/91

The analysis shows that the question raised by the up-dating of equipment in the light of current regulations needs to be radically tackled. The analysis also shows that some features of the sprayers need to conform to the current regulations, especially to avoid problems of pollution from punctiform sources. As regards the return times, the company itself fixes a suitable interval (the research has shown that there are no satisfying indications regarding this). A thorough revision of the necessary precautions and actions for the spraying is advisable.

Table. 5 – Critical points of the “washing and handling of equipment”

Critical points highlighted	GlobalGap	Reference to regulations
Residual mixture in tank	CB 8.5.1 – mm	Dir 1600/2002/CE Dir 2000/60/CE Dir 2006/42/CE
Water container for washing	CB 8.5.2 – R	
Devices for washing the containers or alternative procedures	CB 8.9.6 – MM	
Disposal of liquid for rinsing the containers and water after washing. Partial disposal of containers	CB 8.9.1 – mm CB 8.9.7 – mm	Legislative decree 5 February 1997 n. 22 and s.m.i. “carrying out directive 91/156/cee on waste, 91/689/cee on dangerous waste and 94/62/ce on packaging and waste from packaging”. Legislative decree 22 May 1999, n. 209 “carrying out directive 96/59/ce Concerning disposal of polychlorinated biphenyl and polychlorinated triphenyl
Opening devices of drums for stored material, accessibility, sign indicating area of stock pile	CB 8.9.2 – CB 8.9.5 - CB 8.9.8 – mm	Regulation EN 840:2004 UNI 10571:1995 DIN 30740

The analysis shows that the residuals must be reduced to a minimum through precise calculations of the quantity of the pesticide used; the equipment used must be in good condition and subject to periodical control. Also the procedures for the disposal of residuals should be revised.

A revision of the procedures of the necessary movements to be made during dressing and undressing is advisable.

Conclusions and recommendations

The studies on the organization of the work show the areas of risk and the times of exposure; the epidemiological ones could provide information about the number of accidents that happen in each phase. With the results of the research carried out on the quantity of pesticides that contaminate the workers, one could reach a valid algorithm for determining the risks of acute and/or chronic intoxication of those who carry out pesticide spraying and concentrate precautions in the critical areas.

The breakdown of the work into phases through the MOC - CIOSTA methodology has enabled us to highlight the risks of each sub-phase and not only that of the spraying, seen by workers as risky. The CCP test of the 8 sub phases and the research of regulation references indicate the following recommendations:

1. handle the protective clothing in a appropriate way;
2. structure adequately the changing room;
3. revise the operations for preparing the mixture;
4. study adequate solutions for transporting the mixture.

Although the procedures used for the spraying are carried out with the required precautions, they should be examined, as should the dressing and undressing operations. The question posed by the up-dating of equipment in the light of current regulations needs to be tackled radically. Inspections, meetings of work groups, meetings with the operators and with

company managers are necessary to discuss the work and plan the change of some procedures and up-dating of some equipment.

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Sitography

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