Equipment and Installations for the Distribution of Pesticides in Greenhouses: Aspects Connected with Testing and Bringing Into Compliance with Standing Regulations

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Abstract

Fixed or semi-fixed installations for the distribution of pesticides are becoming more and more common in Sicilian greenhouses. As in the case of spraying machinery, these installations have to be periodically tested in order to detect any malfunctioning that could lead to inefficacious treatment, risk to human health and environmental damage. The aim of this work is to investigate the real possibility of carrying out the checks required by current regulations and also to provide information for the drawing up of guide lines for operators intending to provide their greenhouses with fixed or semi-fixed installations for the distribution of pesticides. This paper presents the results of research carried out in greenhouses provided with various types of installations in the southeast of Sicily. For each distribution system the possibility of checking the working order of the components in accordance with the protocol drawn up by an ENAMA project National Work Group was examined. The results obtained show the current situation as regards installations for the treatment of protected crops on the southeast coast of Sicily. Moreover suggestions are given for the construction of installations complying with the current regulations and which can be periodically tested as required by those regulations and GDO recommendations.

Keywords: mechanisation, safety, health, treatment, ENAMA protocol

Introduction

Pesticide defence in Mediterranean greenhouses is either carried out with backpack or towed equipment or with installed plants (complete with distributors positioned around the greenhouse or made up of a tank, hoses and guns equipped with one or more nozzles handled by operators. In environments with a wide central corridor, treatments are sometimes carried out with sprayers towed by tractors (Bellissima *et al.* 1998, Cerruto *et al.* 1997, Balsari *et al*. 2008, Schillaci *et al.* 2009) Recently, a small self-propelled tracked vehicle has begun to be used and semi-automatic and automatic versions are being developed (Balloni *et al.* 2008 Balloni *et al.* 2009). Working towards more efficient distribution of the pesticides numerous trials have been carried out to perfect the boom (Schillaci *et al*. 2009, Cerruto et al. 2009, Nuyttens S. *et al.* 2005,) For periodic control of the spraying machines commonly in use, the EN 13790 regulation (currently being revised) applies. Moreover, recently directive 2009/128/EC was issued and this was accepted also in Italy. Functional control of spraying equipment is urgently required by the GDO also for equipment not included in the current regulations, with the aim of eliminating the problem of residue accumulating on the products currently on the market. Moreover, only by subjecting processes to control can a firm hope to obtain quality certification ISO 9001 *Vision* and following modifications. The heterogeneity of the equipment present in Sicilian greenhouses and the pressures applied by the regulations

and market forces led to the idea of carrying out a survey in south-east Sicily as regards installations for the distribution of pesticides and their ability to conform to the periodic tests required by the current regulations.

Materials and Methods

The study was carried out in greenhouses on the south-east coast of Sicily, where greenhouse cultivation is very widespread. The greenhouses investigated were of a common and, at the same time, modern type with metal supporting structures, plastic film covers and lateral closable openings. During the inspections the spraying equipment was examined and the presence and condition of components necessary for a positive outcome of a hypothetical functional test (ENAMA 2007) was checked. Finally, the critical points of the installations and the standing procedures for pesticide distribution and the disposal of waste were noted, with reference to the TOPPS project guidelines, the GlobalGap protocol recommendations and the regulations contained in the Safety Consolidating Act (Legislative Decree 81/08).

Results

The research made it possible to identify certain recurrent types of equipment for distribution. There is always an operator that directs the nozzle and a helper that moves the hose.

Tractor-sprayer complex at fixed place outside the greenhouse. When there is not sufficient space inside the greenhouse a stationary external tractor-sprayer complex is used. Spraying takes place by means of a flexible hose with a gun at the end of it. This is probably a widespread combination.

Semi-fixed centralised plant Here there is a conventional fibreglass, PE or brickwork tank inside a centrally positioned greenhouse. Pipes starting from a medium – high pressure pump arrive at the other greenhouses: these pipes maybe underground or aerial. In each greenhouse the pipes end with a connection to other tubes around ten metres long and ending with a common gun.

Semi-fixed installations. When there is enough room in the greenhouse corridors, sprayers assembled on a trolley and manufactured by local craftsman are used. There is a motor-pump, a tank and a hose reel. Spraying takes place from a gun at the end of a long hose.

There are also, although these are not common, fixed installations with aerial pipes and fixed sprayers installed on them at regular intervals. Moreover, as already said, there are rare cases in which the sprayer, pulled by a tractor, can operate inside the greenhouse.



For each component of the three main types of installation, the ability to meet the requirements of the functional ENAMA test was examined (Tab. 1).

Tab. 1 – Components of defence equipment, requirements and findings

Components checked	**Requirememts**	**Sem-fixed installations**	**Spraying machine**	**Fixed installations**
Main pump				
Capacity	Must be able to guarantee adequate pulverisation at the furthest spraying point, working at the maximum pressure indicated by the constructor of the spraying device and at the same time guaranteeing visible mixing, or else must be ≥90% of nominal capacity	YES	YES	YES
Pulsations and leaks	There must not be visible pulsations caused by the pump	YES	YES	YES
Over pressure valve	If present must function correctly	N.P.	YES	YES

N.P not present

Components checked	Requirements	Semi-fixed installations	Spraying machines	Fixed installations
Main tank				
Leaks	There must not be leaks from the tank	NO	YES	NO
Emptying	It must be possible to easily and reliably collect the liquid from the tank, without any leaks	NO	YES	NO
Non-return device	If present it must operate correctly	N.P.	N.P.	N.P.
Mixing	A clearly visible recircling must be obtained when spraying is carried out according to the nominal regime of the ptd, with the tank filled to half of its nominal capacity	NO	YES	NO
Liquid level indicator	There must be at least one tank liquid level indicator. This must be visible and legible during filling	NO	YES	NO
Measuring and regulation system	All the devices for measuring, switching on and switching off and pressure and/or capacity regulation must function correctly and there must be no leaks. All devices for pressure regulation must maintain a constant pressure with a ±10% tolerance and constant capacity and reach the same work pressure after the equipment has been stopped and restarted.	YES	YES	YES

Components checked	Requisiti	Semi-fixed installations	Spraying machines	Fixed installations
Manometer				
Presence	There must be at least one manometer near the pump and preferably one near the gun	Y/N	Y/N	Y/N
Functioning	The hand of the manometer(s) must be stable and permit the work pressure to be read. The manometer(s) must measure with a precision of ±10% with respect to the actual value	NO	YES	YES
Reading scale	The manometer's (s') reading scale must be clearly visible and legible by the operator for the entire duration of the spraying and it should be suitable for the work pressure interval used. The manometer's (s') reading scale must have a reading interval ≤0,2 bar for work pressures of ≤5 bar; ≤1,0 bar for work pressures between 5 and 20 bar; ≤2,0 bar for work pressures ≥20 bar	NO	NO	NO
Conduits and hoses	These must be in a good state of repair and show no signs of damage. Their construction characteristics must be compatible with the working pressure. There must not be leaks from the conduits or hoses when tried with the maximum working pressure indicated by the constructor of the spraying machine. In the case of breakage of the pipes/hoses it must be possible to possible to interrupt spraying immediately (for example with one or more taps situated on the delivery pipe).	YES	YES	NO

Components checked	Requirements	Semi-fixed installations	Spraying machines	Fixed installations
Filtration system, conduits and hoses				
Filters	There must be a filter in the filling opening of the tank and at least one filter on the delivery pipe or pump aspiration. The filters must be in good condition and with link sizes suitable for the assembled nozzles	NO	YES	YES
Insulating device	There must be an insulating filter device which, even when there is liquid in the tank, permits cleaning of the filter with no loss of liquid except for that which could be inside the filter itself or in the aspiration pipe.	NO	YES	YES
Load/charge loss	The working pressure indicated by the manometer mounted near the lance must be compared with the pressure shown by the manometer near the pump. The two values must be shown in the trial report.	NO	NO	NO

Components checked	Requirements	Semi-fixed installations	Spraying machines	Fixed installations
Nozzles				
Nozzle capacity	The capacity of each nozzle mounted on the lance must not differ by more than ±10% from the nominal value. If it is not possible to find the nominal capacity of the nozzle, this should be indicated on the trial report, and, if possible, its capacity should be compared with that obtained using a brand new lance or nozzle. Determine the capacity of each nozzle to the working pressure normally used by the operator, checking, in the case of several nozzles of the same type that the capacities do not differ by more than ±5% from the mean value calculated	YES	YES	YES
Loss through dripping	After switching off, the nozzles should not drip. Once five seconds have passed after switch off there should be no dripping.	YES	YES	YES

It should be pointed out that often for treatments at fixed sites outside the greenhouse, an obsolete spraying machine is used, with a tank and other components that do not meet current regulations. As regards fixed or semi-fixed installations, with a single tank or tanks in each greenhouse, as these are the result of artisan type assembly, they often lack the requirements of DPR 459/96: EU marking, identification plate (only the pump has one); the pipes connecting the pump to the tank are not covered with a sheath, the tank does not have devices inside to mix the contents; moreover, the tank lid is not hermetic or may even be absent. Often the installations and equipment lack devices for washing the circuits and neither are there auxiliary tanks (15L) for hand washing, even if this might not be necessary in greenhouses with running water.

Besides the components, particular attention was paid to the procedures, or better preparation and transport of the pesticide mixture, washing of the spraying equipment (tanks, conduits and guns) and to the disposal of waste matter. In the light of Global Gap protocol and the current regulations various critical points emerged (Tab. 2).

Tab. 2 – Critical points relative to preparation and transport of misture, washing of the equipment and disposal of waste.

Critical points found	Global Gap	Regulation
Bench for preparation of mixture		D.Lgs. 81/08 attachment IV – paragraph 2– points 2.1.5 and 2.1.8.1; UNI EN 14175 (requirements for chemical and aspiration hood)
Tools for misture preparation	**CB 8.7.11 – mm** **CB 8.9.6 - MM**	D.Lgs. 81/08 attachment IV – paragraph 2 – point 2.1.3
Inert materials in store	**CB 8.7.12 - mm**	D.Lgs. 81/08 attachment IV – paragraph 2 – point 2.1.12
Transport containers		D.Lgs. 81/08 attachment IV – paragraph 3 – Point 3.10
Washing after each treatment.	**CB 8.4.1 – mm** **CB 8.5.2 - R**	Dir. 1600/2002/EU Dir. 2000/60/EU Dir. 2006/42/EU
Washing water container	**CB 8.5.2 – R**	
Devices for container washing or alternative procedure	**CB 8.9.6 – MM**	
Mixture left in tank	**CB 8.5.1 – mm**	Dir 1600/2002/CE Dir 2000/60/CE Dir 2006/42/CE
Disposal of rinsing liquid for the containers and washing water. Partial disposal of the containers.	**CB 8.9.1 – mm** **CB 8.9.7 – mm**	D.lgs. 5 February 1997 n. 22 e s.m.i. "actuation of directives 91/156/eec regarding waste, 91/689/eec regarding dangerous waste and 94/62/eec on packaging and packaging waste". D.lgs. 22 May 1999, n. 209 "actuation of directive 96/59/ec regarding disposal of polychlorodiphenyls and dipolychlorotriphenyls"

From an analysis of the critical points, it emerges that the mixture preparation phase should be radically re-organised, avoiding the use of artisan-type equipment and instead using the specific equipment available on the market, such as a pre-mixer.
The transport of the mixture from its place of preparation to the tank seems to be an underestimated phase, as is the cleaning of the equipment used for the treatments.
A very weak point is represented by the management of the residual pesticide mixture (i.e. the quantity left at the end of the treatment). It is necessary to calculate more accurately the volume of liquid to be sprayed, to use tanks that comply with current regulations and inspect

and regulate the equipment appropriately. Any remaining mixture could be diluted and disposed of in the field. Where this is not possible, firms should acquire commercially available systems for the biodegradation of pesticide waste.

Conclusions

Given this research is based on samples, it is certainly not complete, but it provides some indications that might be useful for farmers, companies and technicians involved in pesticide defence and/or the construction of relative installations.
With reference to the area of the research, the great heterogeneity of equipment installed in the greenhouses is confirmed. There is clearly a great trend towards 'do it yourself', with the contribution of the farmer himself or small artisan firms involved in the construction of the whole pesticide distribution plant or as suppliers of a part of it.
Critical points of these plants are represented by the tank, the pipes (whether aerial or embedded) used to channel the mixture from the tank to the spraying point (particularly as regards fixed plants), and by the guns manually used for spraying, at present not subjected to any periodical control.
Possible solutions are the elimination of self-made mixing tanks and the use of tanks complying with standing regulations (parts of modern spraying systems on the market), the elimination of delivery pipes (or plants with a centralised tank serving several greenhouses), the subjection of entire plants, however they are organised, as well as the guns to periodical tests.
To sum up, the distribution of pesticides in the greenhouse should take place with the use of equipment complying with current regulations – either equipment on the market or self-made equipment using parts complying with these regulations. In the case of mobile equipment, this can easily be periodically tested. As regards fixed or semi- fixed installations, these should be built and assembled on trolleys with wheels (tank, pump, filters, conduits, lance), so that they can be transported to the control centres.
As regards procedures, the dangerousness of the preparation phase should be lessened with pre-mixer devices. Moreover, transport should involve hermetic containers. A more accurate calculation of the volumes to be distributed would make it possible to drastically reduce the amount of waste to be disposed of. If the quantity to be disposed of is still too great for disposal in the field, firms should buy and install adequate plants for this purpose.

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