Pesticide application horticultural and floricultural farms of Liguria Region: Current situation and results of one year of sprayer inspections

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Summary

DEIAFA – University of Turin is the co-ordinator of a Project, financed by Liguria Regional Administration, aimed at realising a permanent service of inspections for hand held sprayers that are mainly used in horticultural and floricultural farms.

A preliminary survey was conducted in 160 horticultural and flowers farms to acquire up to date information about the characteristics of knapsack sprayers in use and, more in general, about the management of pesticides. A specific equipment (test benches) to make the inspections was studied and realised and an ad hoc test protocols were prepared on the basis of the indications provided by the national working group leaded by ENAMA (National Board for Agricultural Mechanisation). During the first year of activity, the technicians of four local cooperatives involved in the Project and trained by DEIAFA carried out more than 250 sprayers inspections.

Results pointed out that most of knapsack sprayers used in Liguria region are obsolete, featured by a poor technological level, unsafe for the operator, and generally not conveniently adjusted, as in many cases there is a lack of knowledge about the correct use and calibration of such machines. 25% of the sprayers inspected however presented inconvenient which impede their correct functioning. This result is related to the very simple technology available on these machines and also to the less severe requirements to pass the inspection, in comparison with field crop and air-assisted sprayers.

Introduction

Several studies (Balsari & Oggero, 2001; Balsari et al., 2008; Cerruto et al., 2008) carried out on spraying equipment used on protected crops in Italy pointed out that the negative results in terms of environmental pollution, pest and disease control and operator contamination are often related to the use of obsolete or not adequate sprayers and to the adoption of not correct operating parameters, especially pressure and volume rate. More in details, it is estimated that in Italian protected crops farms, corresponding to a surface of about 40000 ha (ISTAT report, 2006), 24000 sprayers are employed. More than 70% are hand held spraying equipment, like lances or knapsack sprayers. In order to improve this situation, the Liguria Regional Administration funded DEIAFA – University of Torino for making a research project aimed at realising a sprayer inspection and calibration service on the territory, focussed on sprayers used in horticulture and floriculture. It is the first experience in this sense in Italy, while in Northern Europe some experimental activities about the inspection of knapsack sprayers in use have already been promoted (Kole J. C., 2007; Koch et al., 2007). This initiative complies with the indications of the European Directive on the Sustainable Use of Pesticides, that foresees the mandatory inspection for all the sprayers that are employed for professional use, and it also complies with the requirements from large-scale retail trade, as Global GAP certification for the suppliers.

Thanks to the inspection service, the operator will operate a sprayer properly working and conveniently adjusted, and he'll be able to adequate spray volumes according to the specific needs. A properly adjusted sprayer allows to prevent unwanted environmental pollution, guarantees a better operator safety and enables to save time and considerable amounts of pesticides.

Definition of the methodology for hand held sprayer inspection

The adopted test methodology is divided in two parts: one deals with spray lances, the second part deals with knapsack sprayers. Test methodology related to spray lances takes into account inspections on pump, tank, tank contents indicator, pressure gauge, hoses, strainers, pressure drop and nozzles; the methodology addressed to knapsack sprayers considers inspections on pressure gauge (only for sprayers equipped with a circuit under pressure), hoses, strainers and nozzles.

Requirements and performance limits (Table 1 and Table 2) have been taken out, when possible, from existing documents as EN 13790, ISO 19932, FAO guidelines (Balsari et al, 2007)

Tab. 1 Spray guns and lances: main parameters to be inspected and related requirements

Components to be inspected	Requirements	Type of control
Main pump		
Flow rate	The pump shall have sufficient flow rate capacity in order to be able to spray at maximum working pressure as recommended by the sprayer manufacturer while maintaining a visible agitation	visual
Pulsations	There shall be no visible pulsations caused by the pump.	visual
Losses	There shall be no leakages (e.g. dripping) from the pump.	visual
Pressure safety valve	When there is a pressure safety valve on the pressure side of the pump, this valve shall work reliably.	visual
Spray liquid tank		
Losses	There shall be no leakages from the tank	visual
Emptied spray liquid	It shall be possible to collect the emptied spray liquid simply, without tools, reliably and without spillage (not mandatory)	visual
Non –return device	If there is a non-return device on the water filling device of the tank, this device shall work reliably.	visual
Agitation	A clearly visible recirculation shall be achieved when spraying at the nominal pump flow rate and in the part of tank farer from the pump, with the tank filled to the half of its nominal capacity.	visual
Liquid lever indicator	There shall be a clearly readable liquid level indicator on the tank which is visible from where the tank is filled.	visual
Measuring and regulation systems	All devices for measuring, switching on and off and adjusting pressure and/or flow rate shall work reliably and there shall be no leakages. All devices for adjusting pressure shall keep a constant pressure with a tolerance of ±10 % at constant flow rate and shall be able to achieve the same original operating pressure after the equipment has been stopped and then reactivated.	visual
Pressure gauge		
Presence	Near the pump it shall be present at least one pressure gauge. If possible, one other pressure gauge shall be present also near the lance or spray gun.	visual
Functionality	The pointer on the pressure gauge shall remain stable in order to permit reading-off of the working pressure. The pressure gauge shall measure with an accuracy of 10 % of the real value.	measurement
Scale	The scale of the pressure gauge shall be clearly readable during all spraying and suitable for the working pressure range used. The scale shall be marked: - at least every 0,2 bar for working pressures less than 5 bar; - at least every 1,0 bar for working pressures between 5 bar and 20 bar; - at least every 2,0 bar for working pressures more than 20 bar.	visual
Pipes and hoses	They shall be integral with no visible alterations. Their structural features shall comply with the operating pressure. There shall be no leakages from pipes or hoses when tested up to the maximum pressure recommended by the sprayer manufacturer. In case of pipes and hoses breaking, it shall be possible to stop the spray supply at the beginning of these ones (e.g with one or more valves on the delivery line)	visual
Filtering system		
Strainers	If the filling hole of the tank is present, it shall be equipped with a strainer . There shall be at least one strainer on the pressure or on the suction side of the pump . The strainer(s) shall be in good condition and the mesh size shall correspond to the nozzles fitted according to the instructions of nozzle manufacturers.	visual

Components to be inspected	Requirements	Type of control
Isolating device	If an isolating device is provided, it shall be possible, with the tank filled to its nominal volume, to clean filters without any spray liquid leaking out except for that which may be present in the filter casing and the suction lines.	visual
Pressure losses	If present, they shall be registered	measurement
Nozzle flow rate	The deviation of the flow rate of each nozzle type shall not exceed ±10 % of the nominal flow rate indicated by the manufacturer. If there are more nozzles (spaced at least 10 cm) the deviation of the flow rate of each nozzle shall not exceed ± 5 % of the average value. If it is not possible to know the nominal flow rate, it shall be indicated in the test report and, if possible, it shall be compared its flow rate with the flow rate of a new nozzle.	measurement

Tab. 2 Mist blowers and knapsack sprayers: main parameters to be inspected and related requirements.

Components to be inspected	Requirements	Type of control
General	There shall be no leakages from the sprayer. The tank shall be fitted with a lid in order to avoid liquid losses. There shall be a liquid level indicator on the tank. There shall be present a straps in good condition with length ≥ 30 mm	visual measurement
Measuring and regulation systems	All devices for measuring, switching on and off and adjusting pressure and/or flow rate shall work reliably and there shall be no leakages.	visual
Pressure gauge		
Presence	It shall be present on the hydraulic sprayers (not mandatory)	visual
Functionality	The pointer on the pressure gauge shall remain stable in order to permit reading-off of the working pressure. The pressure gauge shall measure with an accuracy of 0,2 bar.	Visual measurement
Scale	The scale shall be marked- at least every 0,2 bar	visual
Pipes and hoses	There shall be no leakages from pipes or hoses when tested up to the maximum pressure recommended by the sprayer manufacturer.	visual
Filtering system	There shall be present a strainer in a good condition in the filling hole of the tank. There shall be at least one strainer on the pressure side . The strainer(s) shall be in good condition and the mesh size shall correspond to the nozzles fitted according to the instructions of nozzle manufacturers	visual
Nozzle flow rate	The deviation of the flow rate shall not exceed ±10 % of the nominal flow rate indicated by the manufacturer. If it is not possible to know the nominal flow rate, it shall be indicated in the test report If more nozzles (spaced at least 10 cm) are present, the deviation of the flow rate of each nozzle of the same type shall not exceed ± 5 % of the average value.	measurement

Devices to use for the inspection

To avoid that during the nozzle flow rate test liquid losses occur (especially when operating high flow rates), a specific test bench (total weight = 28 kg) has been studied by DEIAFA and developed by AAMS and Salvarani companies. It is composed by an aluminium frame equipped with an aluminium hopper, in which – thanks to a suitable housing - it is possible to place the spray lance to be tested. The flow rate value can be read on a graduated cylinder (capacity = 2 litres) positioned under the hopper and connected to it by a pipe fitting (Figure 1).

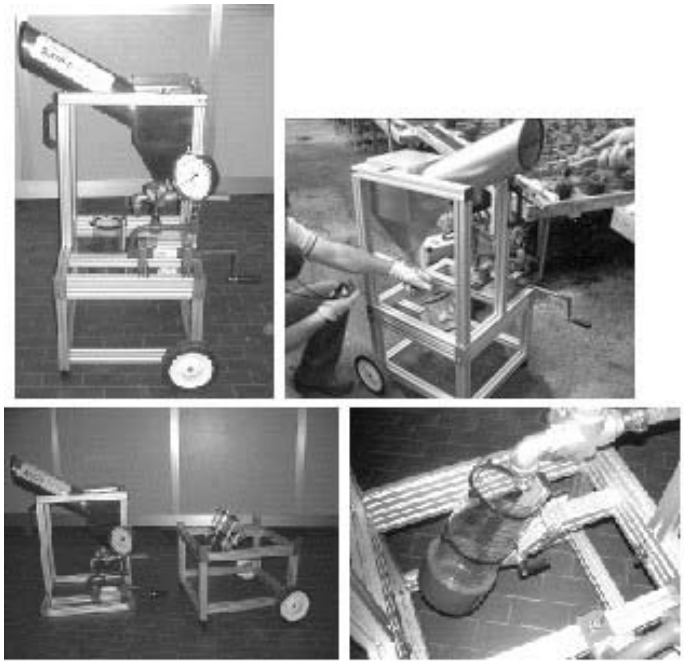

Fig. 1 Test bench for measurement of spray guns and spray lances flow rate

To evaluate pressure drop a very simply test bench has been designed (Figure 2). This device enables to measure the operating pressure close to the lance and to the gun and to compare this value with the pressure registered close to the pump.

Fig. 2 Test bench to assess pressure drop for spray lances

To inspect the functionality and the accuracy of pressure gauge a specific tester has been realized (Figure 3). Concerning the characteristics of the precision manometer to be used for this type of test, it shall fulfil the requirements reported in the EN 13790 standard.

Fig. 3 Pressure gauge tester

Results of inspections carried out in 2008

In the first 12 months of the Project, 279 sprayers (270 hand held spray lances, 7 hand lever knapsack sprayers and 2 motorised knapsack sprayers) were inspected. The farms involved in this sprayers inspection activity were mostly floricultural farms (73 %), the remaining 27 % were horticultural farms. The total surface of the farms inspected was 260 hectares (on average 1.5 ha per farm); 62 hectares were covered by tunnels or glasshouses (on average 0.40 ha per farm). In details, floricultural farms had usually a surface between 0.8 and 1.2 ha, while the horticultural farms were generally featured by a surface of more than 2 hectares Figure 4). About three quarters (77 %) of the spray lances inspected were composed by a tank and a pump installed in a fix position and by a set of hoses, reaching the different parts of the farm, to which the spray lance could be connected when necessary. In the remaining cases, spray lances were linked to a group made of a tank and a motor pump mounted on wheeled frames or on trailers (15 % of cases) or they were connected to a pump directly operated by the tractor PTO (8 % of cases).

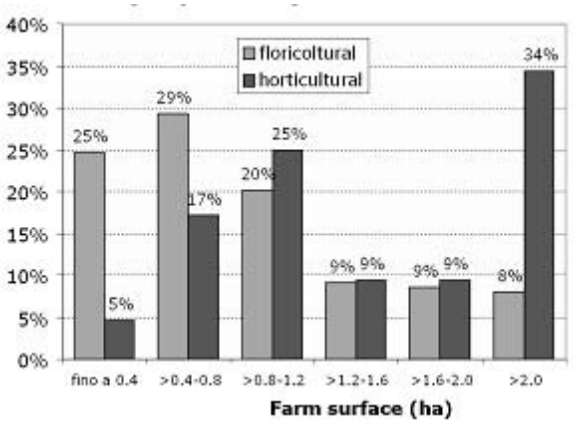

Fig. 4 Average farm surface.

Almost all the knapsack sprayers and 9 % of spray lances resulted not equipped with a pressure gauge mounted close to the pump. The pressure gauge close to the spray lance/gun was never present. Most frequently pressure gauge scale (73 % of cases) resulted the one featured by 2 bar intervals, but in 14 % of sprayers inspected the scale interval was even higher and therefore not complying at all with the requirements of the test protocol. Analysing the inspection sheets where also the end scale value of the pressure gauge was reported, it was found that the most frequent situation was a pressure gauge scale

interval of 2 bar and an end scale value of 80 bar. Over 20 % of the manometers inspected were featured by an end scale value of 100 bar, not adequate for the spray application purposes.

No correlation was observed between the most used operating pressure (18 bar on average) and the pressure gauge scale interval. A new manometer had to be mounted on 20 % of sprayers inspected. This percentage may appear low, but it must be considered that many farmers, despite of the indications from the advisers aimed at reducing the pressures used for spray application, still prefer to adopt high pressures (at least 20 bar). This operating condition therefore allowed a lot of farmers to keep their original pressure gauges that, if used at lower pressures, should be changed. In 3 % of cases the farmer refused to change the manometer, even if it was recommended by the result of the inspection.

Spray lances flow rate resulted between 1.2 and 13.2 l/min, with an average value of 5 l/min. Operator forward speed was on average about 3 km/h. In only 3% of tanks there was not any content indicator, nevertheless in the big tanks (e.g. made of concrete) the systems to indicate the tank content were not adequate to provide an affordable estimation of the amount of liquid present. Due to the small capacity of tanks and to their simple geometrical shape, the agitation of the liquid in the tank resulted always sufficient, even if generally obtained only by the backflow from the pump. No problems were found on pumps functioning (only in one case it was necessary to replace the pump) while some minor defects, as dripping from tanks and hoses, were fixed during the inspections. In 9 % of cases the nozzles of the sprayer were changed. A summary of the defects registered during the inspection activity is reported in Figure 5.

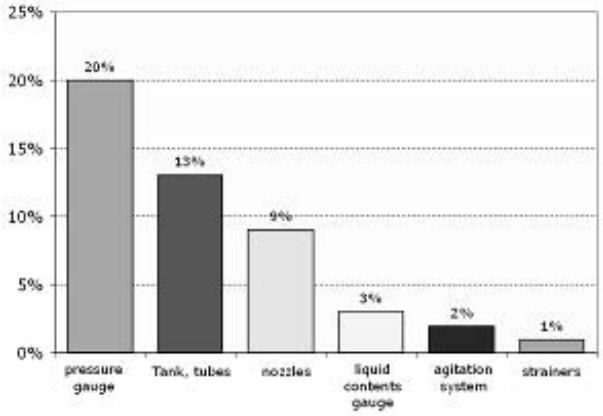

Fig. 5 Defects impeding the correct functioning of sprayers registered during the inspection activity

In general terms about 25 % of the sprayers inspected presented main functional defects that impede their correct functioning. It is a relatively low value, if compared with other inspections survey carried out on field crop sprayers or on air-assisted sprayers, but it's not surprising if we consider the very simple technology of these spraying equipment used in protected crops and if we take into account that the inspection requirements for them are less strict with respect to those adopted for field crop sprayers.

Training and dissemination

In order to awaken farmers about the adoption of more adequate nozzles and operating parameters, to train them to adjust their sprayers at the end of the inspection and to verify the quality of spray distribution using water sensitive papers, ad hoc training courses in the field were organised (Figure 6). The use of ISO nozzles mounted on articulated nozzle holders (single or double) was especially promoted, as these nozzles enable to spray at lower pressure (10-15 bar) obtaining a good target coverage and avoiding spray mixture runoff. At the same time a wider dissemination action towards the farmers of Liguria Region was carried out realising a brochure and a multimedia DVD which describe the scope and the procedure of sprayers inspections and provide information about the correct adjustment of spraying equipment used in protected crops.

Fig. 6 Training of Ligurian farmers (technical meeting, brochure, multimedia DVD)

Conclusions

The results of the activity carried out showed that most of sprayers used on protected crops, even if they passed the inspection, could be operated in a more appropriate way, reducing volume application rates and operating pressures, if correctly adjusted. To do that it is necessary to implement farmers training on this subject.

A general improvement of sprayers technology is however necessary, with special regard to nozzles and presence of a pressure gauge close to the spray lance. Test methods and inspection equipment realised allowed to carry out the inspections and the sprayer adjustment in an appropriate way and within reasonable time (on average 1 hour per sprayer). To further improve the inspection service on this kind of sprayers it would however be useful to issue a specific international standard that, taking into account the situations in the various countries, defines in a more complete and eventually more strict way the test protocols and the requirements to pass the inspection.

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