Sprayers inspection in Venetian Region: experiences, issues and future perspectives

Cristiano Baldoin

Dept. TeSAF, University of Padua, Agripolis, viale dell'Universita', 35020 Legnaro Italy

Abstract

Italy fully adopted the 2009 Directive on Sustainable Use of Pesticides (SUD) only in 2014 with the publication of the National Action Plan (NAP), but some regions had started to put the service on immediately after the enter into force of the Directive as well. Venetian Regional administration issued a deliberation early in 2011 in order to re-organise the existing voluntary-based service according to the new legislation, train inspectors and authorize appointed workshops. Between 2011 and 2014, four training coursed were set up and 132 inspectors were licensed; in the following years, 41 testing centres were acknowledged in the Region, in addition to 11 extra-regional centres by mutual acknowledgement.

On the deadline of 26th November 2016, over 25.000 inspection were performed. The present work reports the results of the activity of the inspection service, the Issues and criticalities that emerged about the application of the protocols established by the NAP.

Keywords

Pesticides application equipment, sustainable use of pesticides

Introduction

In 2009, European Commission issued the European Directive 2009/128 on the sustainable use of pesticides, aiming to fill the existing regulatory gap on the use on field of equipment for the distribution of plant protection products, an operation known to be affected by serious shortcomings in efficiency. In fact, pesticide losses during spray application on vineyards and orchards are often higher than 50% of spray mixture. To improve spray technology, thus achieving a better efficiency of the process, Italy started some local and national actions since the end of 1990s; in this framework, Regional administrations established a voluntary-based service of inspection and calibration of sprayer, using the EN13790 as guideline for the workshops appointed for the service. During the following years, while the Thematic Strategy for the sustainable use of pesticides was developed and the SPISE Group started its activity, in Italy the ENAMA Working Group, co-ordinated by Prof. Paolo Balsari (Crop Protection Technology Research Group – dept. DISAFA, University of Turin) operated to set up an operational framework for the application of the upcoming SU Directive 2009/128. The full adoption of the SUD in Italian legislation occurred only in 2014 with the publication of the National Action Plan, but in the meanwhile, some Regions had already taken on some local initiatives anticipating the contents of the Directive.

In 1996, the Ministry of Agriculture and Forestry launched an interregional program named "Agriculture and Quality", with the aim of increasing the competitiveness of the agricultural sector by improving the quality of production. In that context, one of the actions had the aim to improve the efficiency of pesticide distribution, also through the promotion of initiative like the training of inspectors and the institution of a service of functional verification and calibration of sprayers on a voluntary basis. The service operated in the following years, mainly due to the possibility for farmers to get financial benefits by agro-environmental measures (eg: European Regulation 2078/92). In that context, a number of inspectors were trained and 12 testing centres were authorized to carry out the inspection and calibration service. The centres went on with their activity until 2011, although operating with a certain continuity only until the end of the aforementioned agro-environmental measures. In fact, the service was requested only by a few farmers, mostly those who sell their products to the great retailers,

which require the inspection and calibration of the equipment for the distribution of crop protection products.

Experiences and issues

In 2011, the Phytosanitary Office of Venetian Region, in co-operation with Department of Land, Environment, Agriculture and Forestry (TeSAF) of University of Padua, started the full rearrangement of the existing service of functional inspection of the sprayers; the previously released authorizations to the testing centres expired on 14 December 2011. The first initiative was a training course, carried out in November 2011, for new inspectors and a refreshing course for those ones who were already authorised to operate inside the previous service. The program of the course, held by Dept. TeSAF and consisting into a theoretical and a practical section, was prepared according to the guidelines developed by the abovementioned ENAMA Working Group (Document n. 1). The course was afterwards repeated in April 2012 and in February and April 2014, leading to the qualification of 132 inspectors; 33 of them came from out of Veneto, due to the delay of most of Italian regions to start the service.

From 14 December 2011 to date, the Regional administration released 41 authorisations to new testing centres; out of them, 21 are workshops or retailers, 10 are manufacturers and 10 other structures (wine cooperatives, unions of producers, etc.), while 11 further ones from other Regions are approved to operate in Veneto by mutual recognition (fig. 1).

During this first phase of the adoption of the SU Directive, some local initiatives have helped to speed up the start of the process, such as the issue of a specific local police regulation by the municipalities of the Prosecco vines cultivation area, that anticipated the contents of the Directive.

The correct operation of the testing centres, authorized and recognized in the regional area, has been continuously tested, both through the analysis of quarterly reports, and through targeted inspections that, in almost all cases, have highlighted the full compliance with the provisions of the law. Only in very few cases, the controls made it possible to avoid the occurrence of irregular situations.

As resulting from the processing of the data transmitted quarterly to the regional authority, 25.004 inspections were carried out as at 30 September 2017, with a sharp increase in activity, as expected, as the deadline set by the NAP approached. This was also due to the Region's decision to restrict the grant of the subsidized diesel fuel for spraying operations to the presentation of the certificate of control.

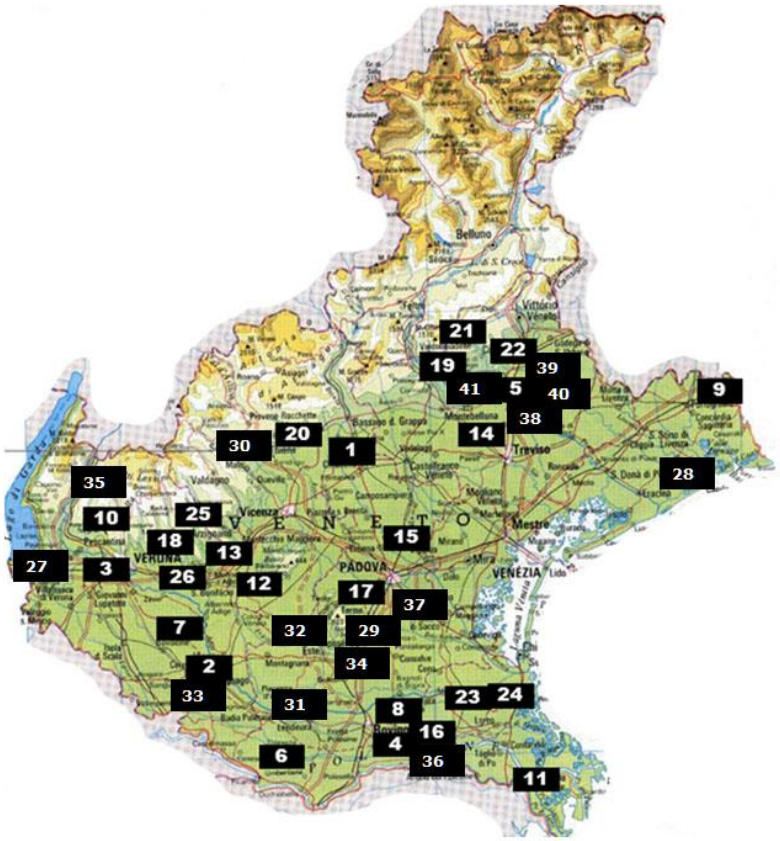

Fig. 1 – distribution of the testing centres in Veneto Region

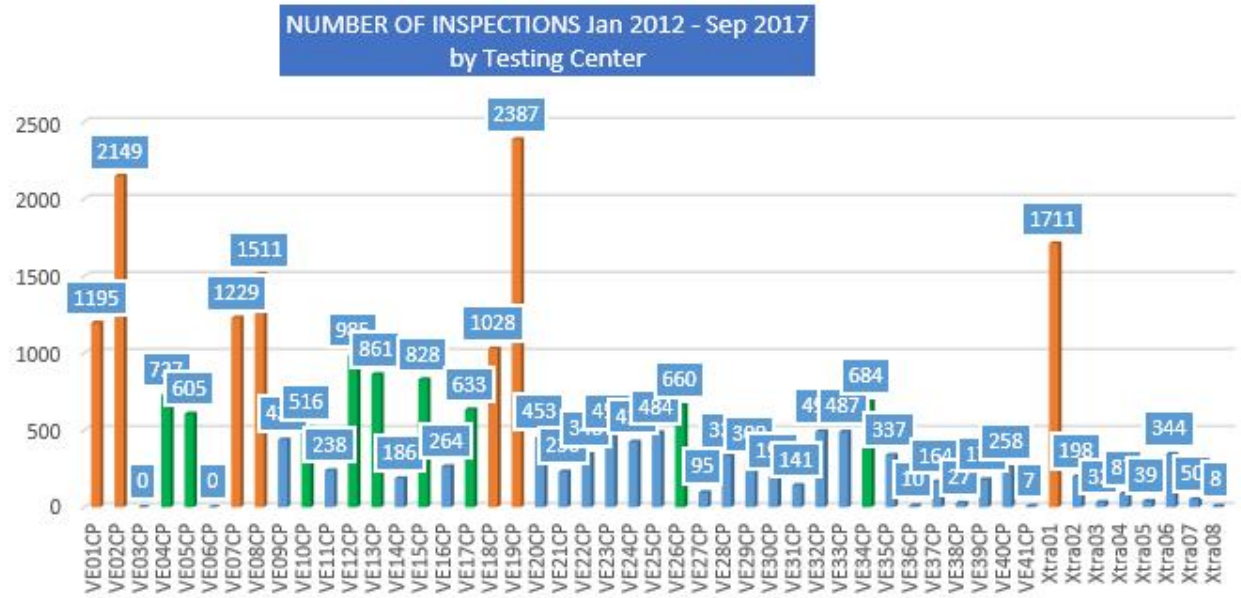

Fig. 2 - total number of inspections carried out in Veneto from 2012 to September 2017

The elaboration includes the controls carried out by the 41 test centres based in Veneto, and the 11 of other Regions authorized by mutual recognition. An estimate of the percentage of inspections carried out on the total number of sprayers in use on the territory is impossible, as their number is not known; however, considering that many equipment used in small farms have been likely to be abandoned, the result obtained in terms of the number of checks is to be considered more than satisfactory. Figures 2

and 3 show a synthesis of the number of inspections carried out from 2012 to 2017, grouped by testing centre, by province and by type of sprayer.

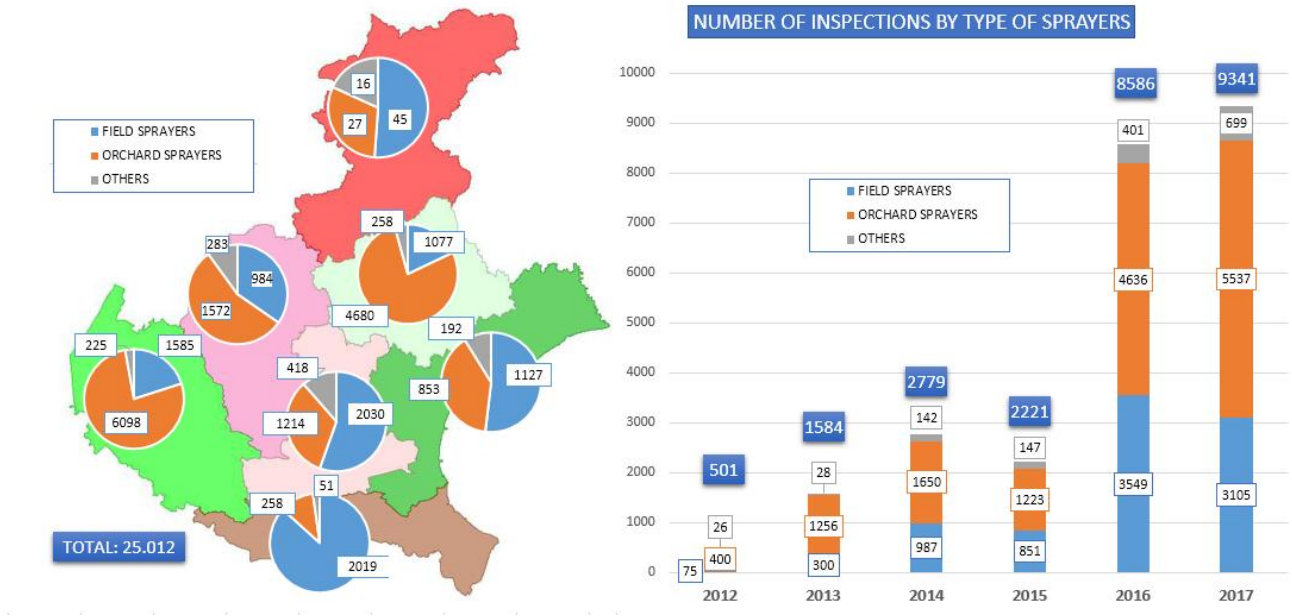

Fig. 3 – number of inspections by province and type of sprayers

As shown in the graph, only 16 out of 49 active test centres have carried out more than 500 inspections, thus contributing over 70% of the total; only seven centres (highlighted in orange in graph), one of which is extra-regional, carried out more than 1.000 inspections. Taking a precautionary view of the availability of 100 working days and a theoretical operating capacity that can be assessed in six checks per day, it can be observed that the three most productive centres performed, in almost six years, on average less than three inspections a day, thus largely below their potential. It is therefore clear that the coverage of the regional control service can be considered adequate to the amount of work required in the territory, when fully operational. Considering the above parameters, the current regional service would theoretically allow to carry out at least 20,000 checks a year, i.e. exactly the number of machines to be inspected every three years according to regulations. For this reason, no new qualification courses were planned during this period.

Since 2012, personnel appointed by Regional administration performed periodical inspections to evaluate the correctness of the testing centres performance.

Issues and technical concerns

During their activity, testing centres have highlighted some technical and administrative problems, which were analysed by experts of University and Phytosanitary Office, also in co-operation with Crop Protection Technology research group of University of Turin. In fact, on several instances, the instructions given in the NAP, if interpreted literally, can make it hard, if not impossible, to pass the functional check, also in case of sprayers not particularly old or even new.

The first issue concerns the functionality of the measuring, control and regulation systems. The first point of attention is the respect of the points 1.5d and 2.6d ("*Pressure stability at the closure of the boom sections*"), a parameter that must not increase more than 10% of the working pressure when the sections supply are closed one by one. This requirement, if intended as mandatory in all cases, is a problem for sprayers, especially those for tree crop, equipped with control units without compensative returns, since in the absence of such devices, compliance with the requirement is impossible. In this regard, the Enama documents no. 6 and 7, which form the basis for the Annex II of the NAP, report at the end of the aforementioned period the sentence "*The outcome of this test is not binding for the*

overcoming of control, but the extent of the pressure drop must be reported in the test report.". Furthermore, the ISO 16122 standard, which was not yet issued at that time, stated: "*This requirement is only applicable for sprayer equipped with specific devices for compensative returns in the tank*". Therefore, considering the need to complete the controls on the territory, Test Centres were given instruction, in the case of sprayers not equipped with compensative returns and pressure variation exceeding 10%, to pass the sprayer while recording the measured values in the test report. Obviously, the Test Centre can suggest, if necessary, interventions to improve the sprayer, evaluating costs and benefits with the owner, also in relation to the use of the machine, the magnitude of the pressure variation, etc.

The third issue pointed out by some technicians refers to the method to measure of the pressure drop at the end of the last spraying section; it should be noted that, unlike the old standard, ISO 16122 makes the result of the test mandatory to pass the inspection. However, the test methodology is not specified accurately, merely prescribing the placement of a calibrated manometer "*at the same position as a nozzle at the outermost end of each boom section*" (ISO 16122, part 2 – 3). In this regard, it should be noted that there are two ways to perform this measurement: in fact, the reference manometer can be placed "near" the terminal nozzle or "in place" of the latter, using two different versions of the calibrated gauge, regularly on the market, as shown in fig. 4 (source: AAMS Salvarani catalog).

In the first case, the pressure gauge is placed "near" the terminal holder of the bar section, with the nozzle mounted at the drain of the pressure gauge, while in the second it is placed "in place" of the nozzle, thus occluding the discharge. In general, the pressure gauge placed in line with the terminal nozzle is used more frequently during the functional check of the boom sprayers, but nothing prevents the same method from being used on the orchard sprayers, for example to simultaneously measure the flow rate and pressure drop through a special adapter.

The two measurement techniques obviously provide different results: given the same pressure at the inlet of the boom section, the occlusion of the terminal nozzle by the blind pressure gauge causes a reduction in the overall flow rate of the section proportional to the capacity of the closed nozzle. Consequently, the pressure drop is lower than the measurement carried out with the nozzle mounted. The variation in the value of the pressure drop is not high, but since this test, according to ISO 16122, is required to pass the inspection, it was considered interesting to evaluate if, and possibly, under what conditions, the carrying out the test in one way rather than the other can affect the result.

Fig 4 – manometers for measurement of pressure drop

The experimental verification was made on a new air-carrier sprayer with six nozzles per side, using five sets of nozzles at increasing pressures, as shown in table 1.

In absolute terms, the decrease in flow rate resulting from closing the terminal nozzle during the measurement of the pressure drop is not so high to cause a particularly huge increase in the measured parameter. However, as shown in the table, under some conditions (highlighted in the table) this variation is enough to exceed the value of 10%, thus causing the machine to fail the inspection. It must also be said that the sprayer used for the test was new and of rather simple construction, but it is not unlikely that, on a machine with a more complex hydraulic system, the probability that the threshold value will be exceeded increases.

			TERMINAL NOZZLE			
			CLOSED		OPEN	
TYPE	FLOW RATE	INLET PRESSURE	OUTLET PRESSURE	PRESSURE DROP %	OUTLET PRESSURE	PRESSURE DROP %
DISC/CORE 1.0/-	LOW	5	4,9	2,0	4,8	4,0
		10	9,9	1,0	9,5	5,0
		15	14,8	1,3	14,5	3,3
		20	19,6	2,0	19,3	3,5
		30	28,0	6,7	27,0	10,0
ISO 80 015 GREEN		5	4,8	4,0	4,6	8,0
		10	9,8	2,5	9,2	8,0
		15	14,6	2,7	14,2	5,3
DISC/CORE 1.2/-	MEDIUM	20	19,6	2,0	18,8	6,0
		30	28,0	6,7	27,0	10,0
		5	5,0	1,0	4,8	4,0
		10	9,9	1,0	9,7	3,0
		15	14,9	0,7	14,7	2,0
ISO 80 03 BLUE	HIGH	5	4,7	6,0	4,5	10,0
		10	9,6	4,0	9,1	9,0
		15	14,4	4,0	13,9	7,3
ISO 80 04 RED		5	4,6	8,0	4,2	16,0
		10	9,3	7,0	8,6	14,0
		15	14,0	6,7	12,9	14,0

Table 1 – results of the test on the measurement of pressure drop

Finally, by placing another pressure gauge immediately after of the pressure regulator, it was observed that the pressure indicated was almost identical to that measured by the manometer at the end, confirming that the primary source of the pressure drop is the regulator itself. This also confirms the widespread perplexities about the decision to make such proof binding for the passing of the functional control. In fact, it is not possible in almost all cases to implement any corrective action in case of overrun of the 10% threshold; moreover, two identical machines can obtain different results only for the different location of the main pressure gauge.

Inspection of greenhouse spraying equipment

A further in-depth analysis focused on fixed and semi-mobile equipment for spraying protected crops (horticultural and mushrooms), for which no specific guidelines have been published so far; therefore, these inspections are carried out by adapting the protocols provided for the open field equipment. However, given some specific features present on these plants, some inspectors pointed out some operational criticalities, therefore some investigation was made to elaborate some practical suggestions.

For the distribution of plant protection products on greenhouse crops, generally on the ground or on benches, the most common system is based on booms installed on suspended rails that allow the movement along the greenhouse. From a functional point of view, this type of spraying system is completely similar to a generic traditional sprayer for field crops, since the operating principle is identical. The main difference, in addition to the dislocation of the construction parts, concerns the dosing of the pesticide, which does not take place by preparing a diluted mixture contained in the main tank, but is carried out by injecting a concentrated suspension of commercial formulation at the inlet of the boom by a proportional volumetric dosing device (*dosatron*, see fig. 5).

Fig. 5 – spraying equipment in greenhouse and proportional dosing device

The general layout of the plant generally vary depending on the arrangement of the greenhouse and its dimensions, but in principle it includes a series of "spraying units", each consisting of a group of booms connected to a *dosatron* unit for the distribution of the concentrated phytosanitary mixture. There is not a dedicated tank, as the water comes from the central plant; this one may eventually be equipped with tanks, but they are aimed at preparing the fertilizing solution distributed with irrigation and do not fall, therefore, among the constructive elements to be included in the functional check. It is also noted that often, since the same plant is used both for fertigation and for the distribution of plant protection products, the boom has a double line of diversified nozzles, intended for the two different uses; therefore, in this case the functional check concerns only the dedicated line. With regard to the individual points of the functional check, reference was made to the Enama document no. 6 related to field sprayers, making the appropriate modifications. The first operation concerns the identification of the power supply units and the related spraying elements (modules), generally consisting of one or more bars, each stably located on a lane of the greenhouse; these lanes are, in general, uniquely numbered within the farm, so that this number can be referred to for the identification in the testing report. To facilitate operations, an ad-hoc test report has been prepared, based on the official regional forms for field crop sprayers, taking into account the observed specificities. The report consists of two parts, the first one dedicated to the identification and verification of the main mixing unit, the second one for the collection of data relating to the bars belonging to the main unit; this second form is filled in as a number of copies corresponding to the bars in question. Each test report therefore refers to an autonomous unit, supplied by a mixing group, which will be identified, and eventually stamped by the Test Centre. The stamping can be placed on the frame or on the platform where the dispenser is firmly fixed.

The first page of the test report collects the data relating to the mixing unit (typically the *dosatron*), with the description of the type, the identification number and the description of the distribution system; the number of distribution bars / modules supplied by the group and the relative working width

must also be indicated. The elements common to traditional sprayers, such as the manometer, filters and pipes are inspected in the same way; the functionality of the *dosatron* is assessed by measuring the time taken by the device to draw a known volume of water and relating it to the flow rate of the boom in which the product is injected. The attached sheet is compiled for each bar supplied by the mixing unit to which it relates and reports, as in the case of traditional sprayers, the results of checks of horizontality, symmetry, absence of contamination, and data on the nozzle flow rate and anti-drip functionality. The requirements for passing control are the same as sprayers for field crops.

Inspection of mushroom greenhouse equipment

Mushroom plants are not very common, but they also represent important productive situations. The cultivation is carried out in air-conditioned buildings on multi-storey pallets, spaced about 50 cm from each other, on which the cultivation substrate is placed. Each production cycle, lasting six weeks, involves a fungicidal treatment, distributed using the same equipment used for the irrigation of the substrate. A commonly used system is based on mobile carriages as shown in fig. 6. The carriages are hooked to the upper edge of the highest pallet, connected to a tube that carries water at very low pressure (0.5 bar) which feeds - for each pallet - a pair of manifolds that branch off from a central vertical tube. Each of them has four cone nozzles, arranged so as to discharge their jet horizontally, plus a fifth nozzle, of the mirror type, arranged on the upper part of the manifold and also oriented so as to wet the pallet horizontally for its full width (fig. 6).

The movement of the nozzle holder takes place manually; the operator walks backwards, taking care to adjust the speed to distribute the right dose; also, the supply pressure can be adjusted to obtain the correct range of the nozzles to wet the pallet without passing over it.

In the case of the distribution of plant protection products, also in this case a proportional metering device is used.

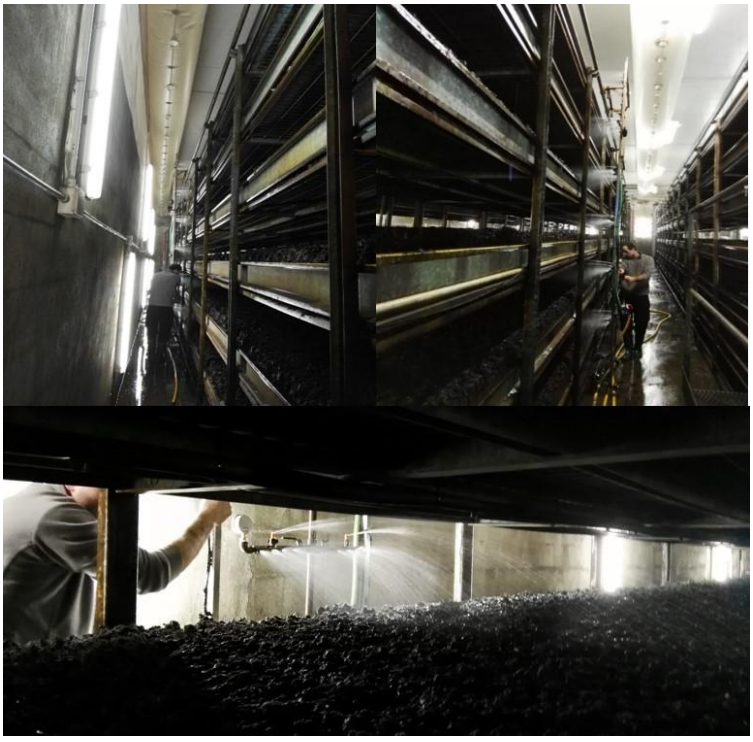

Fig. 6 – carriages for spraying mushroom benches

Compared to the equipment for greenhouse spraying, there are some constructive and functional peculiarities. First, the nozzle carriage is not fixed in the shed, but is moved from a rack of benches to another and between the sheds. No particular problems arise to measure of the nozzle flow, since it is possible to collect it with a specially designed manifold. A complication concerns the very low water

supply pressure, which makes it impossible to fit a traditional anti-drip device, as these operate at pressures above 1-1.5 bar; the problem arises for the first two collectors from below, which drip for about 8 seconds from the moment the tap is closed. The proposed solution is the unloading of the entire column into a container, so that it is possible to re-use the mixture for subsequent treatments, or possibly dispose it of according to regulations.

For the functional check, it is therefore possible to use the same test report prepared for the equipment for the greenhouses, taking care to note the construction and functional features in the appropriate spaces. Also in this case, reference will be made to the functional unit constituted by the metering unit, to which all the nozzle carts will be combined, which must be uniquely identified and possibly stamped.

Conclusions and future perspectives

The results of the activity carried out in the Veneto Region allow drawing some considerations.

First, the quality of the services provided by the Centres in this first step of the service was more than satisfactory, as confirmed by the inspections carried out by the Regional authority: all of the accredited facilities resulted in compliance with the requirements of the regional legislation to continue their activity.

Unfortunately, the delayed approval of the National Action Plan, expected by the end of 2011 and approved only at the beginning of 2014, has led to a delay in the start of demands for inspections by agricultural operators. This was due to the missing of a scheduling of the expiration dates for the inspection, together with the false expectation of an extension of the deadline among the operators.

For the above, the progress of the activity of the centres has undergone a certain inertia in the first year, and then accelerated in the following years. A further acceleration of activities, as the expiry date set by the NAP approached, occurred due to the decision of the Region to restrict the concession of the subsidized diesel fuel to the presentation of the certificate of control.

This decision led to a predictable overload for the Test Centres; anyway, they were able to face without excessive problems, considering that no penalties were imposed on companies that did not comply with the obligation of control by the expiration date, provided that the machines were not used before they had been checked, thus granting a *de facto* extension for the duration of winter.

The percentage of completion of inspections at the deadline of 25 November 2016 is almost impossible to assess with precision, given the unavailability of the total number of sprayers involved in the control. However, the initial assessment that assumed this number in about 50,000 units, today appears decidedly overestimated, considering that probably a high number of equipment used in marginal farms, or obsolete and / or requiring heavy interventions to make them suitable for overcoming control, are been scrapped or abandoned. There was also a clear increase in sales of new equipment in 2016 and 2017, as confirmed by Test Centres operating at dealers.

Considering the extension of the full activity of the Centres throughout the spring of 2017, it can be estimated that most of the "professional" companies have fulfilled the obligation; this means that in the Italian situation, Veneto is among the regions that have better implemented the provisions of the SU Directive.

With regard to the activity of the Centres in detail, it has suffered from a strong inertia in the start-up due to the lack of scheduling of the controls, thus resulting overall well below potential capacity. However, considering the large number of recognized Centres, it is likely to expect that, after the first round of inspections, there will be a progressive normalization of the activity, also in consideration of the awareness of the operators that functional control is not to be considered as a further tax, but as an opportunity to improve the efficiency, and indirectly the low cost, of their machinery.

It is also appropriate to point out that the updating activities of the operational protocols by the SPISE and Enama Working Groups are still ongoing, in view of the improvement of the control services implemented by the Regions. Furthermore, it is to be considered that the drift mitigation measures

elaborated by the specific Ministry of Health Commission are now entering the scheme, when authorizing or revising the phytosanitary product labels. These measures will have an impact on the classification of sprayers based on the components installed on them, and consequently on the calibration; the Test Centres will be called to provide indications to users, therefore it will be necessary to plan initiatives for further training and updating of already qualified operators.

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