

Survey on Vineyards Treatment and Pesticide Remnant Management in Sicilian Vine-Growing Farms

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Abstract

Some aspects of plant protection treatments can affect strongly the environmental pollution, mainly of soils and subsurface waters. The internal-external washing water and the residues of mixture after treatments represent a source of diffuse and localized pollution.

A survey of 21 wine-growing farms was carried out in order to assess the main aspects related to phytosanitary treatments. The most widespread sprayers are conventional atomizers, with hydraulic pulverization, and about 57% of them are equipped with washing tank and with an easy system to empty the main tank. But only in 33% of cases it is possible to recover the final mixture. The average number of treatments per year is about 14: 62% of farms with 12–18 and the remaining with 4–10.

With regards to the residual mixture, 60% of farms produce from 5 to 50 litres and this mixture is sprayed in the same or in other vineyards, or spilled on the ground.

The internal cleaning of the sprayer is carried out with the washing system (only 3 farms out of 21), with the washing system and external water (only 3 farms out of 21), or using external water (15 farms out of 21). About the frequency of cleaning, the answers are not very reassuring, as well as those regarding the place where the mixture is drained.

The external cleaning is carried out in the same place of the farm in the majority of cases (86%) and only one farm is equipped with a lined *biobed*, designed to treat pesticide solutions.

Keywords: safety, pesticide application, environment

Introduction

Several studies demonstrate that environmental pollution and operator exposure coming from pesticide distribution are mostly attributable to the use of obsolete and not very functional sprayers, and to the choice of wrong operating parameters as high working pressures and high sprayed volume rates (Balsari and Oggero, 2001; Balsari *et al.*, 2008; Balsari and Oggero, 2009; Cerruto *et al.*, 2008). Beside this, it must be added that chemical product applications is not always done correctly and prudently during all phases concerning their use.

How sprayers are internally and externally cleaned and the places where washing is carried out are crucial aspects of phytosanitary treatments, as they can affect strongly and negatively the environmental pollution, mainly of soils and subsurface waters. The residues of mixture after treatments, when not safely disposed, constitute a source of pollution from point sources too, much more serious than the washing waters. Unfortunately, in the agricultural world it is considered negligible the polluting capabilities of these remnants and the necessity to provide for their safe disposal is considered of minor importance (D'Antonio *et al.*, 2005).

A recent survey at national level carried out on a representative sample of about 100 wine-growing farms, pointed out that the residual mixture after treatment is on average 270 litres a year and that the amount of water used to clean the sprayer (internally and externally) is about 1300 litres a year. This implies an amount of active substance of at least 1.6 kg a year, dispersed on the soil and absorbed, in time, by the subsoil (Balsari *et al.*, 2006). Moreover, the disposal of the washing waters is generally carried out in the same place, which is very often near to the supply source, so producing a form of pollution from point source, very noxious for the environment and human beings.

Since 2000, when the European Water Framework Directive was adopted, which fixes the maximum allowable threshold of plant protection product concentration in drinkable water at 0.1 µg/L, prevention of water contamination from pesticides has come into particular focus. Exceeding the admitted threshold, in fact, could mean a ban for some pesticides from the market, hence reducing the range of available crop protection solutions for farmers (Balsari *et al.*, 2008). Moreover, the European directives 127 and 128 of 21 October 2009 must be considered: the former amends the Directive 2006/42/EC with regard to machinery for pesticide application and the latter establishes a framework for Community action to achieve the sustainable use of pesticides. In detail, the Directive 127 recognises the use of pesticides as posing threats both to human health and the environment and quotes (Article 1, Section 2.4.6.1, concerning the sprayer washing) “The machinery must be designed and constructed to allow its easy and thorough cleaning without contamination of the environment”. The Directive 128 pays special attention to the protection of the aquatic environment, defining (Article 11) some “Specific measures to protect the aquatic environment and drinking water”. Among these, it should be promoted the “use of mitigation measures which minimise the risk of off-site pollution caused by spray drift, drain-flow and run-off”.

So, as it can be observed, during the last years there has been, both from the scientific community and the law-maker, a growing and pressing attention towards the bad effects on the environment and the human health coming from an improper use of pesticides in the agricultural world.

In this context, it was carried out a survey on a sample of 21 wine-growing farms, mainly located in the provinces of Catania and Ragusa, aimed at assessing the main aspects related to phytosanitary treatments: number of applications per year, application modalities, type of sprayer, management and disposal of residual mixture and washing waters.

Materials and Methods

A questionnaire was prepared and submitted to 21 wine-growers in the South-East of Sicily. It covered several aspects related to pesticide applications in vineyards, among which:

- Farm statistics: cultivated areas, land morphology (flat or hilly land), type of crop (wine- or table-grape), plant layout;
- Machinery used: type of sprayer, distribution system, presence of cleaning system, emptying tank system and possibility for remnant recovery;
- Operating parameters: type of pesticides, number of treatments per year, volume rates with respect to the phenological stages;
- Post-treatment activities: presence of residual mixture and its management, frequency of sprayer cleaning (internal and external), place of cleaning and its typology, distance from the nearest surface watercourse.

The replies were statistically analysed and the distributions of the main quantities were computed. All statistical analyses and graphical representations were carried out by means of the open source software R.

Results and Discussions

Farm statistics

The 21 surveyed farms are in the provinces of Ragusa (7), Catania (11), and Caltanissetta (1); two farms extend over both provinces of Catania and Ragusa. Their total surface ranges from 4 up to 150 ha (mean about 32 ha), whereas that with vineyards ranges from 2.5 up to 70 ha. The average surface is about 18 ha and the majority of farms (60%) extend over a surface smaller than 8 ha (Figure 1). Approximately one out of three farms is on flat ground, one out of three on hilly ground, and one out of three on both; when the land is hilly, vineyard rows are always arranged along the lines of maximum slope.

Out of the entire sample, one farm produces only wine-grapes, 18 farms only table-grapes, and two farms both. The typical plant growth system for table-grapes is the "Tendone", present in almost all the surveyed farms (20). Wine-grapes are produced in two espalier vineyards and in one *tendone* vineyard. In five farms, the vineyards (*tendone*) are in greenhouses.

The plant layout distribution in *tendone* vineyards is reported in Figure 2. It shows that the most widespread layout in open field is 2.8 m × 2.8 m, which implies a plant density of 1276 ha⁻¹. The second most widespread layout in open field is the 3.0 m × 3.0 m (plant density of 1111 ha⁻¹), whereas narrower layouts are preferred in greenhouse (2.5 m × 2.5 m, 2.5 m × 1.9 m, 3.0 m × 2.0 m), which imply higher plant densities (1600, 2105, 1667 ha⁻¹, respectively).

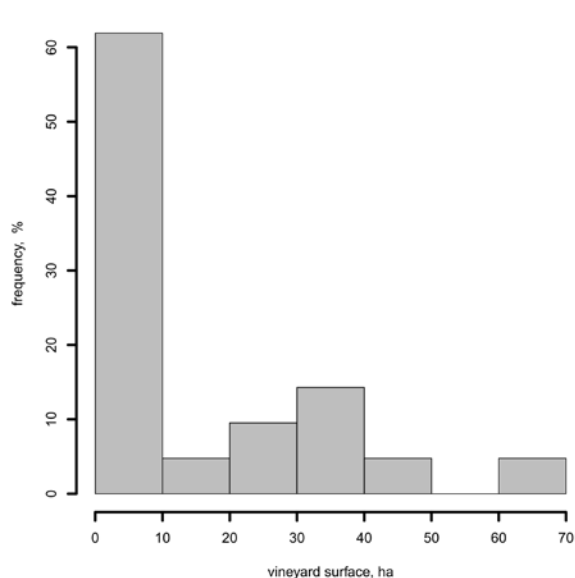


Figure 1. Vineyard surface distribution.

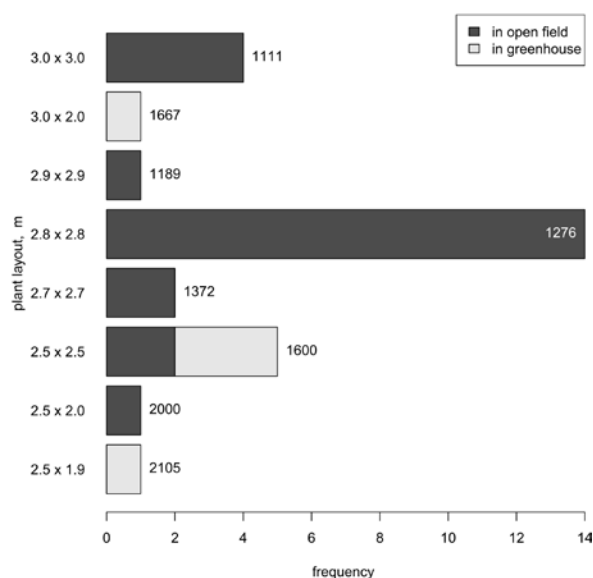


Figure 2. Plant layout and plant density (ha⁻¹, on the bars) in *tendone* vineyards.

Sprayers

The most widespread sprayer type is the conventional atomiser, with hydraulic pulverisation, air assisted spray, towed by a tractor. In detail, 20 out of 21 sprayers are towed and only 1 is carried, 19 out of 21 present a hydraulic system for drop pulverisation and only 2 a pneumatic one. The distribution system is the conventional one when the pulverisation is hydraulic and made of adjustable diffusers when the pulverisation is pneumatic.

About 57 percent (12 out of 21) of sprayers are equipped with washing tank and all offer the facility of emptying the main tank (33% by means of washer and 67% by means of

plug), but only in 33% of cases it is possible to recover the mixture due to the inadequacy of the emptying device positioning.

Phytosanitary treatments

The number of phytosanitary treatments per year ranges from 4 up to 18 (Figure 3), with an average value of about 14. In the majority of farms (62%), the number is between 12 and 18, while in the remaining 38% it is between 4 and 10. Moreover, in 62% of farms, treatments are shared half-and-half between insecticidal and fungicidal, in 29% of farms fungicidal treatments are prevalent (60% vs. 40%), and in the remaining 9% of farms insecticidal treatments prevail over the fungicidal ones (60% vs. 40%). Active substances in most cases (41%) act by contact (from 20 up to 70%), in 39 percent of cases are systemic (from 10 up to 50%), and in 20% of cases are cytotoxic (from 10 up to 40%).

The volume of mixture sprayed per hectare changes according to the phenological development (Figure 4): in early stages, volumes vary from 400 up to 1000 L/ha (average value of about 640 L/ha), whereas in late stages vary from 300 up to 600 L/ha (mean of about 440 L/ha). This reduction in volumes rates is due to the necessity to preserve the aesthetic integrity of the bunches of table-grapes (greater volumes may stain the berries, so depreciating the crop).

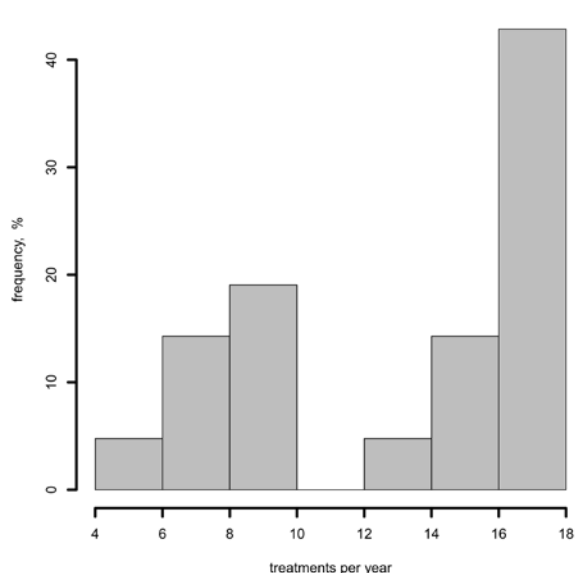


Figure 3. Number of treatments per year in the surveyed farms.

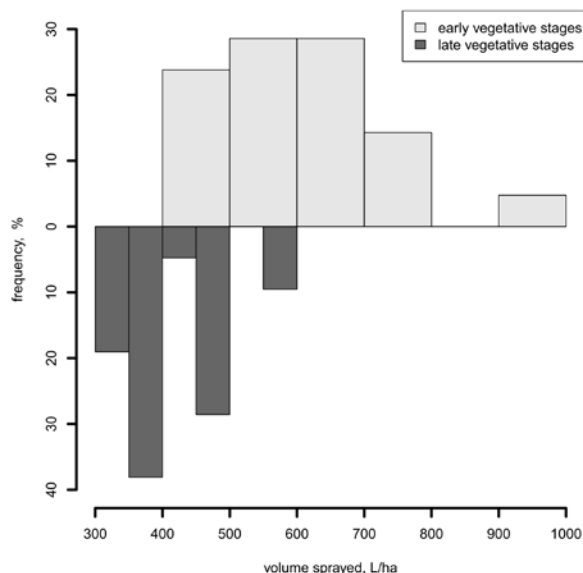


Figure 4. Volume per hectare sprayed in the surveyed farms.

After treatment activities

As regards the post-treatment activities, which can make strongly worse the environmental effects of phytosanitary treatments due to the pollution from point sources, the questionnaire covered several aspects.

About the residual mixture after each treatment, 60% of interviewed replied that it ranged from few litres (about 5) up to 50 litres (mean of 8 litres), while 40% replied that no mixture was present in tank after treatment. The residual mixture, when present, was sprayed in the same (77%) or other vineyard (8%), or, simply and incorrectly, spilled on the ground (15%). Nobody stores it for further applications. A summary of the replies is reported in Figure 5.

All the operators perform the internal cleaning of the sprayer: 95% (20 out of 21), correctly, of both tank and hydraulic plant, 5% (1 out of 21) of the tank only, so exposing the nozzles at risk of blockage. Only a quarter of operators (3 out of 12) use the washing system when present on the sprayer, another quarter use both the washing system and external water, and 50% use external water. When the washing system isn't present (43% of the cases), external water is used. The results are graphically reported in Figure 6.

The frequency of internal washing is quite varied: only 57% of interviewed operate correctly, cleaning the sprayer after the treatments. Moreover, 10% of operators clean the sprayer when the active substance is changed, 23% randomly, and 10% at the end of the season's yield, so neglecting any problem of possible phyto-toxicity resulting from the mixing of more chemicals or the risks of corrosion of tank and pump. Only 24% (5 out of 21) of interviewed provide an estimate of the water used to wash internally the sprayer: according to their replies, it ranges from 10 to 20 litres (mean of 17 litres). Taking into account the 14 treatments per year, it results about 240 litres of mixture per farm to be drained. To this end, operators act differently: the majority of them (57%) drain it on the ground in vineyard or at the farm centre, 29%, beside this, spray it in vineyard, 10% drain it on the ground in vineyard, and the remaining part (4%), drain it on the ground at the farm centre or spray it in vineyard. No information is provided about the draining place. The replies regarding the internal washing of the sprayer are represented graphically in Figure 7.

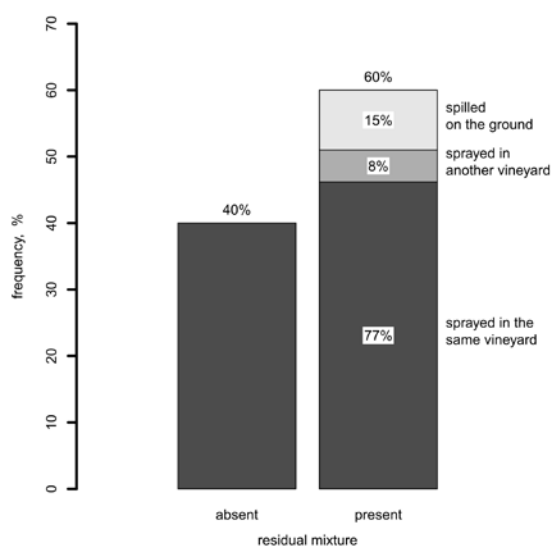


Figure 5. Management of the residual mixture after treatments.

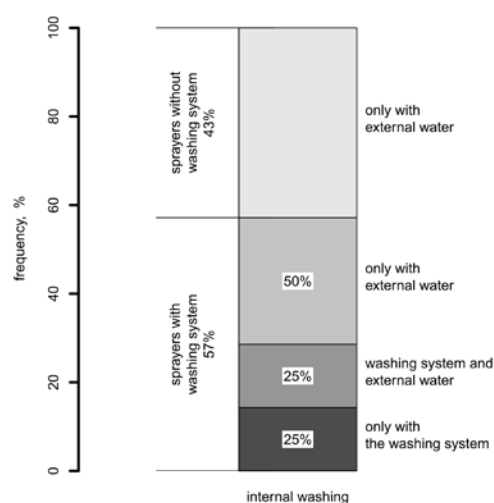


Figure 6. Sprayer's internal washing modality.

The external washing of the sprayer is mainly related to the operator's safety. Very often it is carried out jointly to the internal one. The majority of operators (48%) do it at the end of the treatment, 14% at the end of the season's yield, 5% when change the active substance, and 1 out of 3 (33%) randomly. To ignore the external washing of the sprayer can expose the operator at high risk of contamination during the preparation of the mixture, as some studies have demonstrated that up to 2 percent of the sprayed product can settle on the external surface of the sprayer.

The place where external washing is performed is always the same in the majority of cases (86%) and varied in the other cases (14%). To choice the same place for the sprayer

washing activities is a common practice that leads to pollution from point sources. Some researches carried out in Great Britain and published by Crop Protection Association have pointed out that almost 50% of the surface water contamination is due to an improper disposal of the sprayer washing water. Considering a dose of 2.5 kg/ha of active substance, on average 7 g reach water-bearing layers and about 30 percent of them come from sprayer's cleaning.

To these results contributes also the typology of the place and its permeability: the present research pointed out that it is terrain (covered—33%—or not—48%—with grass) or a small floor of about 6–8 m² (14%). Only one farm is equipped with a lined *biobed* designed to treat pesticide solutions. The land is not very permeable in the majority of cases (62%), very permeable in 24% of cases, and varied in the remaining cases (14%). The water-bearing layer depth range from 5 up to 80 m (mean of about 25 m), while the distance from the nearest surface watercourse is less than 50 m in 10% of cases, less than 100 m in 14% of cases, and greater than 500 m in the remaining cases (76%). The replies to the questionnaire are summarised in Figure 8.

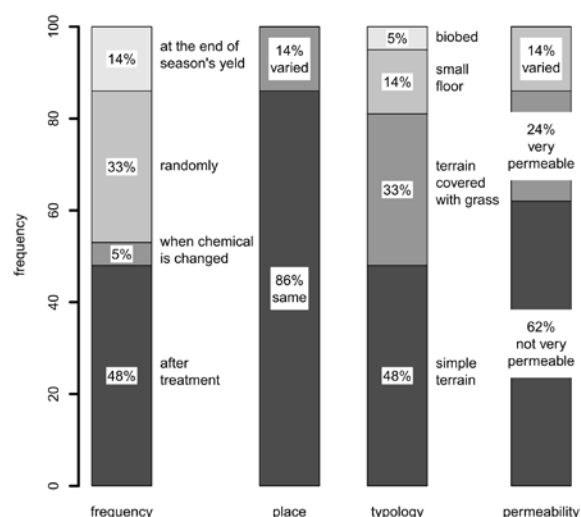
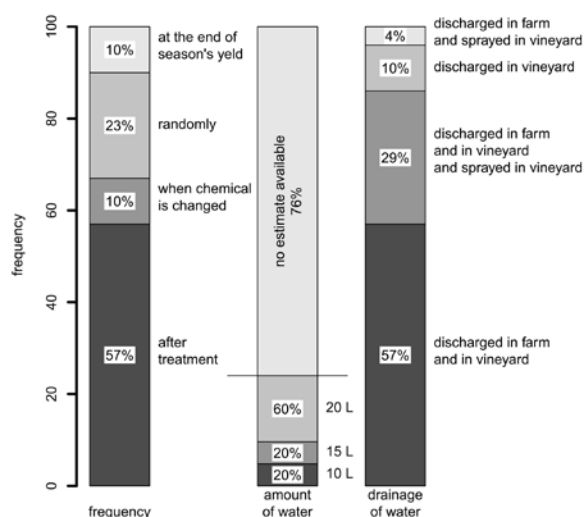


Figure 7. Internal washing of the sprayer.

Figure 8. External washing of the sprayer.

Conclusions

The study shows the surveyed wine-growing farms consider of minor importance the post-treatments activities and underestimate the risks of environmental pollution, mainly of soils and subsurface waters.

A main aspect concerns the used machines: only 57% of sprayers are equipped with washing tank and with an easy system to empty the main tank, but only in 33% of cases it is possible to recover the final mixture due to the inadequacy of the emptying device positioning. Other important aspects involve the management of the residual mixture and also the internal-external cleaning of the sprayer. The results show the need to inform the farmers of the right modalities of the post-treatments activities. In fact, only one farm is equipped with a lined *biobed*, designed to treat pesticide solutions.

Actually, the residual mixture is sprayed in the same or in other vineyards, or incorrectly spilled on the ground; nobody stores it for further treatments.

Especially the frequency of the internal cleaning is not very reassuring, as well as the place of mixture draining, because only 57% of farmers clean the sprayer after the treatments and all

of them drain the washing water on arbitrary places.

The external cleaning of the sprayer, mainly related to the operator's safety during the preparation of the mixture, is regularly done only by 48% of the operators and it is carried out in the same place in the majority of cases. In terms of environmental pollution, to choose the same place is a practice very dangerous, leading to pollution from point sources.

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