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First attempts to obtain a reference drift curve for traditional olive grove's plantations following ISO 22866

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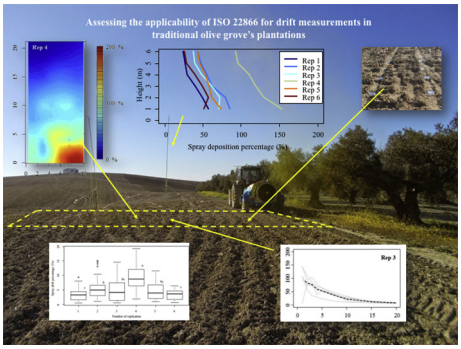
HIGHLIGHTS

- A series of tests following ISO 22866 were carried out in olive trees.
- A complete fulfil of standard's requirements is very difficult to achieve.
- Minor deviations from the established thresholds leads to reject entire tests.
- Special characteristics of olive trees plantations add difficulties to accomplish the international standard.
- A review of the current standard for drift measurements in field should be arranged.

GRAPHICAL ABSTRACT



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ABSTRACT

The current standard for the field measurements of spray drift (ISO 22866) is the only official standard for drift measurements in field conditions for all type of crops, including bushes and trees. A series of field trials following all the requirements established in the standard were arranged in a traditional olive grove in Córdoba (south of Spain). The aims of the study were to evaluate the applicability of the current standard procedure to the particular conditions of traditional olive trees plantations, to evaluate the critical requirements for performing the tests and to obtain a specific drift curve for such as important and specific crop as olive trees in traditional plantations, considering the enormous area covered by this type of crop all around the world. Results showed that the field trials incur a very complex process due to the particular conditions of the crop and the very precise environmental requirements. Furthermore, the trials offered a very low level of repeatability as the drift values varied significantly from one spray application to the next, with the obtained results being closely related to the wind speed, even when considering the standard minimum value of 1 $m \cdot s^{-1}$. The collector's placement with respect to the position of the isolated trees was determined as being critical since this substantially modifies the ground deposit in the first 5 m. Even though, a new drift curve for olive trees in traditional plantation has been defined, giving an interesting tool for regulatory aspects. Conclusions indicated that a deep review of the official standard is needed to allow its application to the most relevant orchard/fruit crops.

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1. Introduction

The legal framework concerning the use of pesticides in Europe changed dramatically after the official publication of the Sustainable Use of Pesticides (Parliament, 2009a). However, in addition, the publication of European Directive 2009/127/EC (Parliament, 2009b), amending Directive 2006/42/EC with regard to the machinery used for pesticide application, which regulates the environmental aspects of pesticide application equipment newly manufactured in Europe, and the Plant Protection Products Regulation 1107/2009 (Parliament, 2009c) has recently generated substantial changes in crop protection activities and has forced all the stakeholders to undertake considerable efforts to implement these mandatory rules.

One of the aspects that has undergone changes is related to the required spray application conditions necessary for a particular active substance, including its safe use, thus avoiding both environmental risks and pollution. This issue is directly related to the establishment of so-called buffer zones, whereby a pesticide non-use zone shall be implemented in those situations where the use of plant protection products could incur a risk for the environment (Burn, 2003; de Snoo and de Wit, 1998). This fact has led to the derivation of a wide range of solutions among EU members, where the relative importance afforded has depended on aspects such as the degree of hazard of the active ingredient or the technological level of the equipment used and its ability to reduce drift.

The technological level of the equipment for crop protection, together with the conditions of use therefore and the criteria for the selection of operating parameters have a direct influence on the risk of contamination. Several improvements to quantify these effects have been carried out in the past (Doruchowski et al., 2014; Doruchowski et al., 2013; Wang and Rautmann, 2008), and some research efforts have been applied to establish classification schemes based on drift values that have been measured using different techniques or procedures (De Schampheleire et al., 2008; Herbst, 2001; van De Zande et al., 2008; van de Zande et al., 2015). Nevertheless, there are still important aspects concerning drift measurement that require further improvement, especially regarding the application of pesticide in the likes of orchards, vineyards, and citrus or olive groves).

Currently, three official procedures are recognised for drift measurements: ISO 22856: 2008, the standard protocol for evaluating the drift from nozzles in a wind tunnel under controlled conditions in the laboratory (ISO 22856, 2008); ISO 22866:2005 for drift measurements under field conditions, for both field crop and orchard sprayers (ISO 22866, 2005); and the latest developed ISO 22401:2015 for the measurement of the drift potential of boom sprayers (ISO 22401, 2015). A close look to these standards reveals that different aspects, parameters, and procedures must be considered for each procedure, leading in some cases to difficulties with comparing the obtained results (Balsari et al., 2007; van de Zande et al., 2000). It is also important to note that only ISO 22866 is fully dedicated to field trials, being the only standard capable of evaluating the pesticide application equipment under real-world conditions. This fact is especially important in the case of field trials to determine drift measurements when using orchard sprayers for bush and tree crops. Even if this standard and the results obtained after its application (Ganzelmeier et al., 1995) are used as a reference for the official pesticide registration process (FOCUS, 2001, 2014; Rautmann et al., 2001) it is clear that external factors such as weather conditions, the canopy structure, and dimensions and distribution of the trees in the field have a great effect on the measured values. Additionally, it is worth noting that the complete application of this standard would lead to some great difficulties and would incur a considerable use of time and labour (De Schampheleire et al., 2008; Ravier et al., 2005; Rimmer et al., 2009). Furthermore, the difficulty with obtaining good repeatability of the results has also been demonstrated (Balsari et al., 2005; Ozkan, 1998; van de Zande et al., 2000). Great variability due to the influence of environmental conditions is observed, resulting in an extremely time consuming, complex, and difficult process. Other researchers (Arvidsson et al., 2011) concluded that a sequence of experiments could require several hours, even if the line of the measurements did not have to be changed as long as the average wind deviation was in the range of ±30° from the original line. Furthermore, it is necessary to consider the specific requirements regarding the deposition values at different measurement points both in the horizontal and vertical collectors, which gives rise to major difficulties when attempting to completely attain the requirements.

Considering the fact that ISO 22866: 2005 is the only official procedure for measuring the drift generated by orchard sprayers in a field, and considering the great difficulties associated with its application, as determined by previous research efforts, this study set out to evaluate the adaptability of the standard for drift measurement to traditional olive groves and to propose a specific drift curve for this kind of crop to be used for regulatory aspects, given that olives are one of the most popular and widespread crops in the southern part of Europe. A series of field trials that precisely follow the standard requirements were arranged in traditional olive groves in the south of Spain. The specific objectives of this research were: 1) to evaluate the effect of each requirement on the final results, 2) to quantify the difficulties related to satisfying all the very restrictive requirements and 3) to propose and olive-drift curve and compare it with the actual most close available (drift curve in late growth stage fruit crops and hops).

2. Materials and methods

2.1. Specifications of ISO 22866:2005

2.1.1. Main changes related to hedgerow crops

As mentioned above, ISO 22866:2005 was mainly devised for to be applied for field crop drift measurements (Tavares et al., 2017), even if several attempts for drift measurements in orchard/vineyard sprayers have been developed in the last years (García-Ramos et al., 2015; Grella et al., 2017) however, its application to the case of large, isolated and irregular trees, such as traditional olive trees plantations, represents additional difficulties and considerable requirements for its adaptation. In this research, a specific protocol was developed such that all of the requirements set out in the standard were satisfied while including the specific characteristics of the crop. The main change was related to the number of samples: The total number of samples at each distance should be, according to the standard's requirements, such that a confidence interval of 95% can be achieved for the mean deposit at a point 5 m from the edge of the directly sprayed area. Nevertheless, irregularities in the shapes of the olive tree crowns made necessary to increase the number of replications of the whole test. Furthermore, it was necessary to adapt the sampling area according to the distance between the trees (Fig. 1).

2.1.2. Experimental design

The tests were carried out by placing horizontal collectors (Petri dishes) on the ground, and vertical collectors (drift masts using nylon line). Six replications of the test were performed.

2.1.2.1. Horizontal collectors. Petri dishes were used as horizontal collectors to collect the drift being deposited on the ground. The sampling area was placed starting on the bare ground at 3 m distance of the outer tree row and the dishes were set at points between 1 m and 20 m from the beginning of the sampling area, following the standard requirements. Thus, from 1 to 5 m, there was 1 m distance between the collectors, but this was increased to 2.5 m between 5 and 10 m from the trees, and to 5 m between 10 and 20 m. A total of six lines were established, starting from the centre of the first tree's trunk (Figs. 1 and 2a). Petri dishes were 150 mm in diameter, so a total of 1060.3 cm^2 of sampling surface was established over all the sampling distances (the standard establishes a minimum of 1000 cm^2).