FEDER UNACOMA
Italian Agricultural Machinery Manufacturers Federation

CLUB OF BOLOGNA
*strategies for the development of agricultural mechanisation*

Accademia dei Georgofili

# *Giuseppe Pellizzi Prize 2018*

## [F] PhD Extended Abstract Form

**AIR BLAST SPRAYERS SPRAY DRIFT PERFORMANCE EVALUATION.**
**Application of direct (ISO22866:2005) and new alternative indirect test methods for spray drift assessment.**

by Marco Grella
University of Turin (UNITO), Department of Agricultural, Forest and Food Sciences (DiSAFA) – ITALY; marco.grella@unito.it, Largo Paolo Braccini, 2, 10095 Grugliasco (TO)

**Extended Abstract**

### 1. Introduction

The Sustainable Use Directive 128/2009/EC represents bedrock EU legislation for all improvements pertaining to drift reduction and efficiency of pesticide application, including an overall definition and requirement for dedicated buffer zones. Each EU Member State specifies the characteristics of these zones in its National Action Plan; minimum buffer zone widths and the relationship of their width with different spray application techniques must also be delineated (in terms of drift reduction or avoidance capacity). These requirements clearly indicate that harmonized drift measurement methodologies and classification schemes of each sprayer/technology, based on potential contamination risk, are essential tools. Actually the unique recognized method to assess spray drift is the standardized ISO22866:2005 method. This method requires complicated field trials that are time consuming and the results are deeply dependent on environmental conditions, making it unsuitable for establishing any rank or classification of spray equipment tested.

In parallel EU Regulation 1107/2009 specifies that the adoption of mitigation measures as buffer zones and their characteristics should be related to the risk of exposure to toxic level of pesticide. So, for individual chemicals where the Predicted Environmental Concentration (PEC) is known, it is possible to determine the required buffer distance from a sensitive target. At present, the PEC values calculation is generally based on German models available for field crop, grapevine, fruit crop and hops; these crop type are widespread in north Europe and are proved not appropriate for south Europe. Furthermore, the prediction of spray drift fallout pattern does not consider others growing systems (e.g. citrus, olive tree, arboreal crops for wood production, etc). Given the absence of reference drift curves for the above mentioned crops and many others, the German models are anyway used during PPP regulatory registration procedure, even if they are not always suitable.

In this context three aspects emerge:

a) the need to develop an easier, faster and cheaper alternative method of drift measurements able to quantify the drift generated by the sprayers used for PPP application in bush/tree crops.

b) the need to assess the spray drift generated during spray applications at regional level, to improve the accuracy of the regulatory risk assessment through a desirable future revision of German models.

c) the need to build reference curves for the crops and growing systems not contemplate by the German models, to provide a useful tool for the authorities involved in the PPP registration procedure.

In order to partially cover these requirements a specific research activity has been established.

The general objectives of this research were to easier assess the amount of spray drift in vineyard, orchard and high tree plantations, to obtain a first set of data about spray drift for bush/tree plantations and to investigate the influence of spray application technology and operational sprayer settings on the amount of spray drift. Therefore, indirect and direct drift assessment means were used, namely the new test bench methodology to assess spray drift potential of air blast sprayers and ISO22866 standardized method for field drift measurements.

The specific objectives and results are described in the following sections corresponding to the three research articles elaborated during PhD research years.

**2. PAPER A:** Grella, M., Gil, E., Balsari, P., Marucco, P., Gallart, M., 2017. Advances in developing a new test method to assess spray drift potential from air blast sprayers. *Spanish Journal of Agricultural Engineering*, 15(3), e0207.

This study proposes and tests an alternative methodology for quantifying the drift of air blast sprayers, trying to avoid the difficulties faced in conducting field trials according to the standard protocol (ISO 22866:2005), determining the drift potential (DP) instead of the drift. DP was determined collecting the fraction of spray liquid remaining in the air after the spray process and potentially susceptible to drift out of the treated area. For this purpose, an ad hoc test bench designed for DP comparative measurements was used. The proposed methodology was evaluated in terms of robustness, repetitiveness and coherence by arranging a series of trials. Representative orchard and vineyard air blast sprayers in eight different configurations (combination of two forward speeds, two air fan flow rates, and two nozzle types) were tested. The test bench was placed perpendicular to the spray track to collect the fraction of spray liquid remaining in the air after the spray process and potentially susceptible to drift out of the treated area. Deposition curves were obtained and a new approach was proposed to calculate an index value of the DP estimation that could allow the differences among the tested configurations to be described. Results indicated that forward speed of 1.67 m $s^{-1}$ allows better discrimination among configurations tested. Highest DP reduction, over 87.5%, was achieved using air induction hollow cone nozzles in combination with low air fan flow rate; conversely, the highest DP value was obtained using conventional hollow cone nozzles in combination with high air fan flow rate.

**3. PAPER B:** Grella, M., Gallart, M., Marucco, P., Balsari, P., Gil E., 2017. Ground deposition and airborne spray drift assessment in vineyard and orchard: the influence of environmental variables and sprayer settings. *Sustainability*, 9(5), 728.

This study evaluates the effects of different parameters on comparative measurements of ground and airborne spray drift employing the ISO22866:2005 test protocol. Both in orchard and in vineyard, four configurations of one air blast sprayer, derived from two fan airflow rates and two nozzle types (conventional and air-injection), were tested. Ground and airborne spray drift profiles were obtained, from which corresponding Drift Values (DVs) were calculated. Both sprayer settings and environmental variables statistically affect spray drift total amounts and results variability. Moreover, the shape of curves suggested that canopy structure influenced DVs. PCA analysis to identify and quantify the effect of the most relevant spray drift process variables showed that nozzle type and wind speed characteristics explained 51% and 24% of the variance, respectively. Ground and airborne DVs reflecting the influence of canopy structure explained an additional 14% of the variance. The effect of a reduced fan airflow rate went undetected, as it was concealed by environmental variables.

**4. PAPER C:** Grella, M., Marucco, P., Manzone, M., Gallart, M., Balsari, P., 2017. Effect of sprayer settings on spray drift during pesticide application in poplar plantations (*Populus* spp.). *Science of Total Environment*, 578, 427-439.

This study assessed spray drift generated by sprayer settings commonly used for pesticide application in poplar plantations (*Populus* spp.). Tests were conducted applying the ISO22866 methodology using a mounted air-assisted sprayer (Tifone VRP600) equipped with a swivel-cannon air conveyor (model Cannone 50S). Trials evaluated sprayer settings, combinations of nozzle types, airflow rates, and air direction in both adult and young poplar plantations. Overall, spray drift amounts registered downwind of poplar plantations resulted lower than those related to late-growth-stage fruit crops (reference German models) that are at present used for the registration process of pesticide products applied in such type of crop. In the adult poplar plantation, Venturi nozzles (TVI 8004 red) yielded the highest drift reductions compared to reference sprayer setting, especially at distances farthest from the sprayed area (86% between 40 and 47 m). Highest total drift reductions were achieved when conventional nozzles (1.81 mm ceramic disc-core) were combined with their spray direction modified for an inclined cannon spray unit. Alternatively, the young poplar plantation showed no drift reduction for distances farthest from the sprayed area, regardless of sprayer settings, which likely resulted from lower foliage density and widely-spaced rows. Yet, both Venturi nozzles combined with high fan flow rates and conventional nozzles combined with reduced fan flow rate showed total spray drift reductions of over 70% within the downwind sampling area.

**5. General conclusions**

Thanks to the drift study carried out applying the ISO22866 methodology, a database with airborne and ground drift results of different spray application techniques used in vineyard and orchard that are representative for south Europe

regions is now available. Furthermore, the results achieved underline the fundamental role of wind speed and direction in the final result of spray drift evaluation, even though the stringent requirement of standard protocol are accomplished. Substantially ISO22866 allows the determination of "real" drift values; however, the effect of uncontrollable environmental conditions makes objective and comparative tests very difficult. Conversely for spray drift comparative assessments a "relative" drift values are more suitable. In this sense, the use of innovative test bench methodology developed shows a promising potentiality giving for the first time the concrete opportunity to measure spray drift deriving from different air blast sprayers settings in an easy and fast way. This will allow sprayers manufacturers to determine objectively, in easy and cheap way, the drift potential for their manufactured spray equipment.

Furthermore, the results of field drift trials conducted in poplar plantations allowed to achieve a first set of data on sedimenting spray drift amounts in high tree plantations (over 20 m), which is a key element for defining the reference curves at regulatory level and enabled to get indications about best practices to reduce spray drift.

**Final remarks concerning the competition benchmarks and strength points**

- For the first time an engineering approach to measure potential spray drift from airblast sprayers is proposed; for this purpose an *ad hoc* test bench device and trials methodology were specifically developed.
- In light of EN ISO11619-3:E (2013) the proposed indirect method give for the first time the concrete opportunity for manufacturers to measure spray drift performance of the whole airblast sprayer "apparatus", not only performance ascribable to the single spray component (nozzle type).