ea engenharia agrícola
Journal of the Brazilian Association of Agricultural Engineering
ISSN: 1809-4430 (on-line)

PESTICIDES DEPOSITION IN VINEYARDS ON DIFFERENT CONDITIONS OF LEAF WETNESS

Doi:http://dx.doi.org/10.1590/1809-4430-Eng.Agric.v37n2p286-291/2017

OTAVIO J. G. ABI SAAB[1*], FABIANO GRIESANG[2], KARINA A. ALVES[3], LEANDRO R. HIGASHIBARA[4], WERNER GENTA[5]

[1*]Corresponding author. Universidade Estadual de Londrina/ Londrina - PR, Brasil. E-mail: abisaab@uel.br

ABSTRACT: The high susceptibility to diseases of fine table grapes cultivars demand intensive use of pesticides, and the presence of water on the leaf surface can worsen the deposition of these products. The objective of this study was to evaluate the spray deposition in vine leaves in different conditions of leaf wetness, and test the effectiveness of an artificial ventilation method to remove water on the leaf surface. We evaluated the spray deposition in vine applied over: wet canopy (presence of high leaf wetness); canopy dried artificially (dried with air jet from air-assisted sprayer, wind speed of 25 km h^{-1}) and canopy dried naturally (naturally dried leaves and free of water on its surface). Saline marker was used in the spray and the deposition on the canopy was determined by conductimetry. A pesticide application in vine, with the presence of water in the leaf surface, causes losses by run-off and reduces the deposit of spraying. The use of air jet formed by air-assisted sprayer fan is efficient for the removal of water on the vine leaf surface and its use can increase the favorable period for the application of pesticides without causing dilution and losses by run-off of the applied product.

KEYWORDS: air assistance, air-assisted sprayer, application technology, dew, electrical conductivity, *Vitis vinifera.*

INTRODUCTION

The application technology of pesticides has substantial importance in the search for increase the effectiveness and efficiency of the application. The aim is to reduce the losses of products by drift, reducing contaminations of the environment and the applicator (MION et al., 2011); to optimize the action of available pesticides and to protect crops from losses caused by pathogens (van ZYL, et al., 2010); to determine the best time for the intervention, observing favorable environmental conditions for the application (OTTO et al., 2013) and susceptibility of the pathogen to the pesticide used; to adapt the operational efficiency of the equipment (GUEDES et al., 2012), so as to allow the operation in a short time, taking advantage of ideal moments for the application.

Among the forms of phytopathogen control currently available, the use of pesticides is the most used, mainly due to their practicality, effectiveness and availability. The majority of these products used to control the major diseases of the vine are protective or contact products. In this way, theoretically, the coverage provided by pesticides should reach the totality (impossible in actual fact) of the susceptible tissues and the quantity/concentration of the product deposited is sufficient to preclude the pathogen.

Greater coverage is achieved through the increasing of application rates or by decreasing the size of the spray drops (ABI SAAB et al., 2002; SCHNEIDER et al., 2013). In the search for better operational yields and decrease of the amount of water used in spraying, the strategy of reducing drops size is the most adopted. The inconvenience of this choice is the vulnerability of this drop spectrum to adverse environmental conditions, being subject to rapid evaporation and drift (GANDOLFO et al., 2013).

[2] Universidade Estadual Paulista "Júlio de Mesquita Filho"/ Jaboticabal - SP, Brasil.
[3] Universidade Norte do Paraná, Bandeirantes/ Jacarezinho - PR , Brasil.
[4] Universidade Estadual de Londrina/ Londrina - PR, Brasil.
[5] Associação Norte Paranaense de Estudos em Fruticultura/ Marialva - PR, Brasil.
Received in: 4-28-2016
Accepted in: 10-5-2016

In view of this, the air assistance coupled to the sprayers has gained space in the application technology, bringing advantages in increasing the coverage and deposition of pesticides, achieving bigger and less variable number of drops per area in portions of the canopy located in all the plant strata, especially in the least accessible (PRADO et al., 2010). This is mainly due to the fact that it allows the lower spectrum of drops to reach the target.

The use of air assisted sprayer in the application of pesticides in the vine has gained great importance for its practicality and operational efficiency, allowing a significant decrease in the application rates, maintaining good rates of coverage and deposition of spray on the targets (FURNESS & VAL PINCZEWSKIA, 1985).

The presence of water on the organs of the plant, caused by rain or dew, makes it difficult to apply pesticides, mainly due to the dilution to which these products are subjected at the time of application and the possibility of subsequent run-off (TAYLOR, 2011). In a study conducted by ROMAN et al. (2004), evaluating the glyphosate herbicide efficiency in the desiccation of *Brachiaria plantaginea*, a significant reduction in the death of plants under leaf wetness conditions at various concentrations of the product tested was found. PIGATI et al. (2010) observed lower control of *Sclerotinia homoeocarpa* with the application of fungicide in the presence of dew, in an experiment carried out during three years, comparing applications in the presence and absence of dew.

To enable the application in adverse conditions of leaf moisture, it is common to wait for the evaporation of leaf wetness. This wait for adequate conditions increases the plant's exposure to the propitious condition to infection by plant pathogens (DU et al., 2015).

The aim of this study was to evaluate the deposition of spray on vine leaves under different leaf wetness conditions, as well as to test the efficiency of a forced ventilation method to eliminate the water present on the leaves.

The hypothesis is that the mechanical intervention eliminates excessive wetness and allows the anticipation in the application, maintaining satisfactory quality.

MATERIAL AND METHODS

The study was carried out in a commercial orchard located in Marialva, Paraná, Brazil(23°26’10”S and 51°48’29”W), with an altitude of 600 m. The Rubi variety was used, with almost five years old, with a spacing of 3 meters between rows and 6 meters between alternating plants, height of 1.90 meters, conducted in a permanent lattice type structure.

The experimental design was completely randomized, with ten replications. The treatments consisted in the application of saline marker spray in the vine crop in three conditions of leaf wetness at the time of application, with wet canopy (WC), artificially dried canopy (ADC) and naturally dried canopy (NDC).

As accumulation of water on the surface of the leaves in the form of dew is variable and dependent on environmental conditions, and this accumulation is difficult to quantify, the experiment was conducted at a time without the presence of dew. To simulate leaf wetness, water was applied from a transported jet trawl sprayer in the amount of 840 L ha^{-1}, in a way to form a thin layer of water on the leaves surface.

For the ADC treatment, the air jet of a air-assisted (spraying system deactivated) with a wind speed of 25 km h^{-1} was used, sufficient to remove water from the plant tissues by shaking the leaves (ZHANG et al. 2012). For the NDC treatment, the canopy was naturally dry and free of the water on its surface from the total evaporation of the water.

The spray consisted of potable water plus two markers: potassium chloride (0.25 g L^{-1}) and magnesium sulphate (0.25 g L^{-1}). Each plot consisted of an application range with 12 x 3 m, with 6 m of border. The spraying was carried out by a Valmet tractor adapted and remodeled to pass under the orchard and air-assisted sprayer fan (CIAMAG brand, MAFU 300L model), composed by section bar of ten nozzles, three in each side section (right and left) and four in the central section (facing up). The spray nozzle used was the TX80067VK (Teejet®: empty conical jet), at a pressure of 900 kPa (flow rate of 0.434 L min^{-1} per nozzle), moving at a speed of 3.14 km h^{-1}, resulting in application rate of 280 L ha^{-1}. The spraying started at 7:45 a.m. and finished at 11 a.m. During the application, the temperature varied between 24.5 and 28°C, the relative humidity between 75 and 83% and the wind speed between 1.5 and 4 m s^{-1}.

Fifteen minutes after the applications, ten leaves per plot were collected and packaged in identified plastic packages (groups of ten leaves). Subsequently, they were washed for 30 s in 300 mL of distilled and deionized water, by shaking, altering between horizontal and vertical movements. The saline solution of wash was submitted to electrical conductivity measurement. The leaf area of each leaf of the sample was measured and then the marker concentration per leaf area was calculated. For the measurement of the leaf area, the leaf area of each leaf was calculated, using [eq. (1)] (ABI SAAB, 2002), specific for this grape variety:

$$La = 0.920897.L1.Lw \quad (r^2 = 0.97) \tag{1}$$

That,

La - estimated leaf area (cm^2);

Ll - leaf length (cm); measured from the insertion of the petiole to the end of the leaf,

Lw - maximum leaf width measured between the lateral extremities of the leaf (cm).

The values of leaf area and electrical conductivity obtained were inserted in [eq. (2)], in order to obtain values of deposits, in electrical conductivity per unit area (μS cm^{-1} cm^{-2}).

$$D = \frac{Ec}{La} \tag{2}$$

That,

D – deposit (μS cm^{-1} cm^{-2});

Ec - electrical conductivity of the leaf wash solution (μS cm^{-1}), and

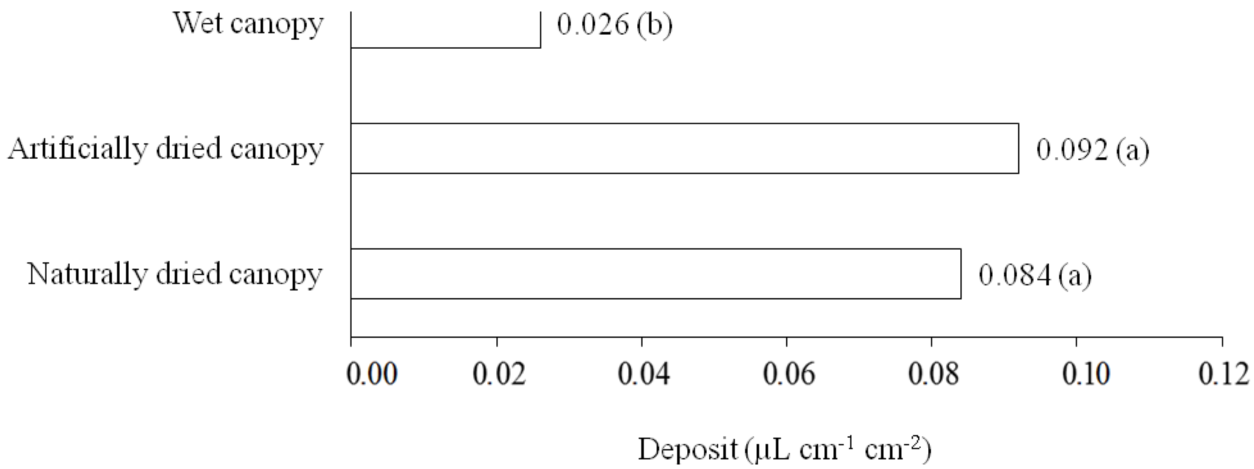
La – leaf area (cm^2).

Before the spraying, ten leaves of each plot were collected to verify the magnitude of the electrical conductivity present in the leaves (standard), and submitted to the steps described above to obtain the value prior to the applications. From each value of electrical conductivity of the treatments, the average value obtained from the standard samples was subtracted. The data were submitted to analysis of variance by the F test and the averages of the treatments compared by the Tukey test ($p<0.05$).

RESULTS AND DISCUSSION

The electrical conductivity of the samples obtained before the applications was uniform in the entire experimental area (0.018 μL cm^{-1} cm^{-2}). Knowing the quantity and uniformity of the solutes present on the leaf surface before application is essential for the satisfactory reliability on the variation caused by the treatments.

The deposition on the leaves of the vine was reduced by 3.5 times when the application was carried out with the presence of wetness in the leaf, when compared to the application on the culture with dry leaves (Figure 1). In the presence of dew, the spray drops that can coalesce with the water drops on the leaves and cause dilution of the applied pesticide until the run-off, due to the excess of water on the leaf (JULIATTI et al., 2013). The run-off may be aggravated by the use of spreader adjuvants added to the spray or present in the product formulation, as the reduction in the surface tension of the spray predisposes to the lower liquid retention capacity of the leaves (JULIATTI et al., 2013).



[1]Dried canopy with air-assisted sprayer (off spraying) under 25 km h^{-1} wind speed in the vine leaves position (Zhang et al, 2012.); CV: 15.44%.

FIGURE 1. Spray deposit in the grape crop (Rubi variety) due to the presence of water in the leaf.

The deposit of sprayed pesticides is a key aspect of the biological activity of the product, both for herbicides and fungicides (PIGATI et al., 2010). Therefore, the dilution of pesticides in dew present on the leaf surface, followed by run-off, can significantly decrease its efficiency (SANTOS et al., 2013).The application of glyphosate on *B. plantaginea* in the absence of dew caused the death of 75.8% of the plants, while in the presence of wetness the average control was only 50.4%, representing a 25.4% decrease in the control efficiency in the presence of dew (ROMAN et al., 2004).The higher the application rate, the greater will be the negative effects of the presence of dew due to the increased dilution of the product and the retention difficulty of the spray by the leaf (PIGATI, 2010). As in vine cultivation it is common to use high rates of application, 700 to 1000 L ha^{-1} (PEREIRA et al., 2012), 312 to 569 L ha^{-1} (ABI SAAB et al., 2002), 358 to 1675 L ha^{-1} (BALAN et al., 2006), the presence of dew may negatively influence the efficacy of the application.

The vine leaves, which had the excess of water from the leaves removed with air jet provided by air-assisted sprayer fan, presented the same deposit that the plants that had their leaves dried naturally by the environment. In the north region of the state of Paraná, pesticides in the vine requires about 50 applications in a single cycle (BALAN et al., 2006) and not always the conditions of temperature, relative humidity and wind speed throughout the day allow a sufficient period of time to carry out these applications in order to minimize losses and environmental contamination. It is recommended that spraying of pesticides should be carried out in the morning or late afternoon in order to avoid high temperatures and low relative humidity, and consequently rapid evaporation of the applied spray and drift losses (BALAN et al., 2008). However, the presence of dew in the morning is also a limitation to spraying, because of the losses by dilution and runoff, causing concern among farmers and researchers (SANTOS et al., 2013), since it delays the beginning of spraying until the foliage is dry. Therefore, the use of artificial ventilation is beneficial, since it increases the period of time to the application of pesticides without causing losses by run-off and dilution of the applied product.

CONCLUSIONS

To carry out pesticides applications in vine with the presence of water in the leaf will cause losses by run-off and reduction in the deposit of the spraying.

The use of air jet formed by the air-assisted sprayer fan is effective in the removal of water on the vine leaf and its use allows increasing the period of time to the application of pesticides without causing losses by run-off and dilution of the applied product.

REFERENCES

ABI SAAB, O. J. G.; ANTUNIASSI, U. R.; FONSECA, I. C. B.; GENTA, W.; BATISTELA, M. Efeito do tamanho de gota e volume de aplicação na deposição de agrotóxicos em folhas de videiras. **Semina: Ciências Agrárias**, Londrina, v.23, n.2, p.221, 2002. Disponível em: <http://dx.doi.org/10.5433/1679-0359.2002v23n2p221>.

BALAN, M. G.; ABI-SAAB, O. J. G.; DA SILVA, C. G.; DO RIO, A. Deposição da calda pulverizada por três pontas de pulverização sob diferentes condições meteorológicas. **Semina: Ciências Agrárias**, Londrina, v.29, n.2, p.293-298, 2008. Disponível em: <http://dx.doi.org/10.5433/1679-0359.2008v29n2p293>.

BALAN, M. G.; ABI SAAB, O. J. G.; SILVA, C. G. Depósito e perdas de calda em sistema de pulverização com turboatomizador em videira. **Engenharia Agrícola**, Jaboticabal, v.26, n.2, p.470-477, 2006.

DU, F.; DENG, W.; YANG, M.; WANG, H.; MAO, R.; SHAO, J.; FAN, J.; CHEN, Y.; FU, Y.; LI, C.; HE, X.; ZHU, Y.; ZHU, S. Protecting grapevines from rainfall in rainy conditions reduces disease severity and enhances profitability. **Crop Protection**, Amsterdam, v.67, p.261-268, jan. 2015. Disponível em: <http://dx.doi.org/10.1016/j.cropro.2014.10.024>.

FURNESS, G. O.; VAL PINCZEWSKIA, W. Comparison of the spray distribution obtained from sprayers with converging and diverging airjets with low volume air assisted spraying on citrus and grapevines. **Journal of Agricultural Engineering Research**, West Park, v.32, n.4, p.291-310, dez. 1985. Disponível em: <http://dx.doi.org/10.1016/0021-8634(85)90095-2>.

GANDOLFO, M. A.; CHECHETTO, R. G.; CARVALHO, F. K.; GANDOLFO, U. D.; DE MORAES, E. D. Influência de pontas de pulverização e adjuvantes na deriva em caldas com glyphosate. **Revista Ciência Agronômica**, Fortaleza, v.44, n.3, jul.-set. 2013. Disponível em: <http://dx.doi.org/10.1590/S1806-66902013000300008>.

GUEDES, J. V. C.; FIORIN, R. A.; STURMER, G. R.; DAL PRA, E.; PERINI, C. R.; BIGOLIN, M. Sistemas de aplicação e inseticidas no controle de *Anticarsia gemmatalis* na soja. **Revista Brasileira de Engenharia Agrícola e Ambiental**, Campina Grande, v.16, n.8, p.910-915. 2012.

JULIATTI, F. C.; JULIATTI, B. C. M.; JACCOUD-FILHO, D. S. **Technology of pesticide application in corn–nozzles, sprays volume, economic analysis and diseases control**. In: Fungicides–Showcases of Integrated Plant Disease Management from Around the World, p.99-114. mai. 2013. Disponível em: <http://dx.doi.org/10.5772/51103>.

MION, R. L.; SOMBRA, W. A.; DUARTE, J. M. de L.; NASCIMENTO, E. M. S.; VILIOTTI, C. A.; LUCAS, F. C. B.; MONTE, C. A. Uso de mesa vertical como parâmetro para regulagens de turboatomizadores. **Engenharia Agrícola**, Jaboticabal, v.31, n.2, p.352-358. 2011. Disponível em: <http://dx.doi.org/10.1590/S0100-69162011000200015>.

OTTO, S.; MORI, N.; FORNASIERO, D.; VERES, A.; TIRELLO, P.; POZZEBON, A.; DUSO, C.; ZANIN, G. Insecticide drift and its effect on *Kampimodromus aberrans* in an Italian vineyard-hedgerow system. **Biosystems Engineering**, v.116, n.4, p.447-456. dez. 2013. Disponível em: <http://dx.doi.org/10.1016/j.biosystemseng.2013.10.007>.

PEREIRA, V. F.; DE RESENDE, M. L. V.; JÚNIOR, P. M. R.; DE ALBUQUERQUE REGINA, M.; DA MOTA, R. V.; VITORINO, L. R. R. Fosfito de potássio no controle do míldio da videira e características físico-químicas de uvas Merlot. **Pesquisa agropecuária brasileira.** v.47, n.11, p.1581-1588, nov. 2012. Disponível em: <http://dx.doi.org/10.1590/S0100-204X2012001100004>.

PIGATI, R. L.; DERNOEDEN, P. H.; GRYBAUSKAS, A. P. Early curative dollar spot control in creeping bent grass as influenced by fungicide spray volume and application timing. **Applied Turfgrass Science**, St Paul, v.7, n.1. mar. 2010. Disponível em: <http://dx.doi.org/10.1094/ATS-2010-0312-03-RS>.

PRADO, E. P.; RAETANO, C. G.; AGUIAR JÚNIOR, H. O.; DAL POGETTO, M. H. F. A.; CHRISTOVAM, F. S.; GIMENES, M. J.; DE ARAÚJO, D. Velocidade do ar em barra de pulverização na deposição da calda fungicida, severidade da ferrugem asiática e produtividade da soja. **Summa phytopathologica,** v.36, n.1, jan.-mar. 2010. Disponível em: <http://dx.doi.org/10.1590/S0100-54052010000100008>.

ROMAN, E. S.; VARGAS, L.; RIBEIRO, M. C. F.; LUIZ, A. R. M. Influência do orvalho e volume de calda de aplicação na eficácia do glyphosate na dessecação de *Brachiaria plantaginea*. **Planta Daninha**, v.22, n.3, p.479-482. jul.-set. 2004. Disponível em: <http://dx.doi.org/10.1590/S0100-83582004000300019>.

SANTOS, R. B.; DE SOUZA, A. P.; SILVA, A. C.;ALMEIDA, F. T.; ARANTES, K. R.; DE SIQUEIRA, J. L. Planejamento da pulverização de fungicidas em função das variáveis meteorológicas na região de Sinop-MT. **Global Science and Technology**, Rio Verde, v.6, n.1, p.72-87, jan.-abr. 2013. Disponível em: <http://dx.doi.org/10.14688/1984-3801.v06n01a07>.

SCHNEIDER, J. L.; OLIVEIRA, G. M.; BALAN, R. E.; CANTERI, M. G.; ABI SAAB, O. J. G. Cobertura de gotas de pulverização obtida com diferentes pontas e taxas de aplicação na parte aérea da cana-de-açúcar. **Ciência Rural**, Santa Maria, v.43, n.5, p.797-802. 2013. Disponível em: <http://dx.doi.org/10.1590/S0103-84782013000500007>.

TAYLOR, P. The wetting of leaf surfaces. **Current Opinion in Colloid & Interface Science,** New York, v.16, n.4, p.326-334. ago. 2011. Disponível em: <http://dx.doi.org/10.1016/j.cocis.2010.12.003>.

VAN ZYL, S. A.; BRINK, J. C.; CALITZ, F. J.; COERTZE, S.; FOURIE, P. H. The use of adjuvants to improve spray deposition and *Botrytis cinerea* control on Chardonnay grapevine leaves. **Crop Protection**, Amsterdam, v.29, p.58-67. 2010. Disponível em: <http://dx.doi.org/10.1016/j.cropro.2009.08.012>.

ZHANG, J. J.; WANG, J. F.; MAO, W. L.; GU, F.; HUO, Y. P. Numerical simulation of the air-assisted boom spraying and droplets transporting process. **Advanced Materials Research,** v.516-517, p.769-772. mai. 2012. Disponível em: <http://dx.doi.org/10.4028/www.scientific.net/AMR.516-517.769>.