



# 第二届植保机械与施药技术 国际学术研讨会论文集

**Proceedings of 2nd International  
Workshop of Plant Protection  
Machinery and Application Techniques**

(2010 年 9 月 15-17 日, 中国北京)

(Sep. 15<sup>th</sup>-17<sup>th</sup> 2010 Beijing, China)

主 编

何雄奎 邵振润 张钟宁

H. Ganzelmeier



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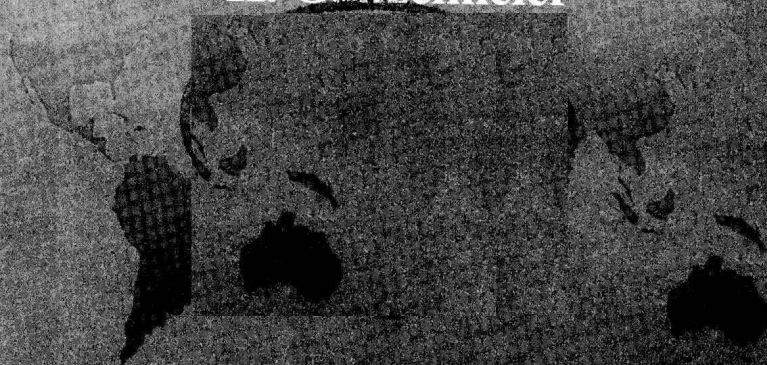
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# 目 录

## Part One 第一部分

A Study of Dosage Adjustment for Pesticide Application in Vineyards	Jizhong Zhou, Andrew J Landers( 3 )
Dosage Adjustment for Pesticide Application in Orchards and Vineyards	Jizhong Zhou, Andrew J Landers(13)
Canopy Related Dosing and Spray Application in Top Fruit-Influence on Target Coverage	Triloff P. , Bäcker G. , Kleisinger S. (23)
Field Measurements of Spray Drift Potential in Strawberry	N. Bjugstad, P. Hermansen(34)
Potential Operator Exposure when Spraying in a Strawberry and Raspberry Tunnel System versus a Conventional Open Field	N. Bjugstad, P. Hermansen(46)
On-line Mixing Pesticide Technology on Variable Rate Spray	Liu Zhizhuang, Hong Tiansheng, Song Shuran, et al. (61)
Simulation of Spraying Bar with Oblique Rope	Wu Weibin, Hong Tiansheng, Chen Kaicheng, et al. (67)
TeeJet Nozzle Design and Atomizing Techniques	Eric Petersen(76)
Drift mitigation in fruit crops — airflow adjustment is the answer!	Dr Andrew Landers(77)
Seeing is believing — enhancing the Pygmalion effect	Dr Andrew Landers(78)
Computer Simulation of Spray Droplet and Canopy Interactions to Minimise Environmental and Public Health Risk of Pesticides	Dr Gary Dorr(79)
A global survey on the performance of side lever knapsack sprayers when judged by ISO 19932	A HERBST, W TAYLOR, C KELLY(80)
The Discovery and Application of Spinosad, a Green Insecticide	Hang Chio(82)
Current situation and development trends of chemical application techniques for arable crops in Europe	A HERBST, H Ganzelmeier(84)
Decision support for plant protection with use of mobile devices	Zb. Czaczyk, A. Piotrowski, T. Kluza, Xiongkui HE(86)
Research Present State of Orchard Air-assisted Spray Technology in China	Lv Xiaolan, Fu Ximin, Wu Ping, et al. (89)
Develop On Automatic Testing And Controlling System of the Fan Performance	Zhou Haiyan, Li Shujun, Yang Xuejun, et al. (89)

- Spray pesticide constant pressure controlled system design in mountainous orchard  
..... Song Shuran, Ruan Yaocan, Hong Tiansheng, et al. (90)
- WEB-based Intelligent Diagnosis System for Cotton Diseases Control  
..... Li Hui, Zhang Jinyue, Ji Ronghua, et al. (91)
- Research on the sprayer chassis systems used in the high-density orchard  
..... Qiu Wei, Ding Weimin, Gong Yan, et al. (92)
- Visual servoing system used in agriculture ..... Liu Tao, Zhang Bin, Zhang Dongbo(92)
- Structural analysis of droplets from anti-drift nozzle  
..... Ma Ning, He Xiongkui, Song Jianli(93)
- The progress on applied techniques of boomsprayer in Heilongjiang Province  
..... Wang Xianfeng(93)
- Study of deposition efficiency under different collection devices  
..... Dai Meiling, Song Jianli, Yang Xiwa, et al. (94)
- The Application of Electrolyzed Water on plant protection  
..... Liu Haijie, Hao Jianxiong, Zhou Yanxin, et al. (94)
- The numerical simulation of pesticide recycling system with rotary air curtain  
..... Wang Shuangshuang, Song Jianli, He Xiongkui(95)
- Measurement method of spray droplet size and velocity  
..... Deng Wei, Zhao Chunjiang, Chen Liping, et al. (95)
- Experimental Study of Droplets Deposition and Distribution of Air-assisted  
Spraying of Disk Fan ..... Yan Huijuan, Ding Weimin, Fu Ximin, et al. (96)
- Development of Automatically Infrared Detection Sprayer based on Color  
Recognition ..... Li Heng, He Xiongkui(97)
- Research on target Agrochemical Spray Robot in Greenhouse  
..... Geng Changxing, Zhang Junxiong, Cao Zhengyong, et al. (97)
- A walking self-propelled high space boom sprayer ..... Tao Lei, Yang Bakang(98)
- Research on Spout Atomizing Performance of Air-blast Sprayer for Grasshopper  
Control ..... Zhao Wencheng, Zeng Aijun(98)
- Studied on the atomization characteristics of the gas-liquid two-phase inducing  
electrostatic sprayer ..... Gong Shuai, He Xiongkui(99)
- Research Progresses on Spraying Nozzles in Plant Protection Machinery  
..... Li Guibin, Li Hongjun, Liu Yajia, et al. (99)
- Study on Effects on Two Different Flow Deflector Structures of Duct Flow Field  
..... Liu Xuemei, Zhang Xiaohui(100)
- Study on air-flowing distribution character of greenhouse air-assisted sprayer  
based on CFD ..... Yuan Xue, Zhang Jinyue, Zhao Yaqing, et al. (101)
- Research on Influence of Crop Canopy Structure on Droplets Deposit Distribution  
..... Zhang Jing, Song Jianli, He Xiongkui(102)
- Study on the Relationship Between Three Kinds of Pesticides Concentration and BSF  
..... Yang Xiwa, Song Jianli, Dai Meiling, et al. (102)

Study on Synergism of N-F100 to azoxystrobin SC(250 g/L) Prevention red pepper downy mildew .....	Yu Chunxin, Liu Fen, Guo Zheng, et al. (103)
Study on Synergism of Silwet408 to azoxystrobin SC(250 g/L) Prevention red pepper downy mildew .....	Yu Chunxin, Liu Fen, Guo Zheng, et al. (103)
Silwet408 Application in Rice .....	Yu Chunxin, Guo Zheng, Du Fengpei(104)
The influence of target plants and liquor properties on the utilization of pesticides .....	Yu Chunxin, Zhang Xiaoxi, Yan Pengfei, et al. (104)
Preliminary test the Silicone surfactant used in detergent .....	Li Deng, Liu Yajia, He Xiongkui (105)

## Part Two 第二部分

### I 植保机械

植保机械喷头磨损研究进展 .....	李桂彬, 李红军, 刘亚佳, 等(110)
我国果园风送式喷雾技术研究现状 .....	吕晓兰, 傅锡敏, 吴 萍, 等(115)
气液两相感应式静电喷头雾化特征研究 .....	官 帅, 何雄奎(120)
草原灭蝗风送式喷雾机喷筒雾化性能研究 .....	赵文成, 曾爱军(126)
风机性能自动测控系统开发 .....	周海燕, 李树君, 杨学军, 等(132)
山地果园喷药恒压控制系统设计 .....	宋淑然, 阮耀灿, 洪添胜, 等(138)
不同收集装置对雾滴沉积影响的研究 .....	代美灵, 宋坚利, 杨希娃, 等(143)
一种手扶自走式高地隙喷杆喷雾机的设计开发 .....	陶 雷, 杨八康(147)
密植型果园喷雾机底盘系统的研究 .....	邱 威, 丁为民, 龚 艳, 等(150)
旋转风幕式药液回收循环系统的数值模拟 .....	王双双, 宋坚利, 何雄奎(156)
防飘喷头的雾滴结构分析 .....	马 宁, 何雄奎, 宋坚利(164)
黑龙江垦区喷杆喷雾机使用技术进展 .....	王险峰, 关成宏(170)
两种不同结构的导流板对风筒流场的影响 .....	刘雪美, 张晓辉(179)
TeeJet 喷头设计及喷雾技术 .....	Eric Petersen(183)
减少果树中的飘失——气流调整是答案 .....	Dr Andrew Landers(185)
提高皮格马利效应方法研究 .....	Dr Andrew Landers(186)
草莓地田间喷雾飘移性能测试 .....	N. Bjugstad, P. Hermansen(187)
草莓地不同喷雾作业对操作者污染程度的对比研究 .....	N. Bjugstad, P. Hermansen(198)
喷雾液滴尺寸和速度测量方法 .....	邓 巍, 赵春江, 陈立平, 等(190)
圆盘风扇风送喷雾雾滴沉积分布试验研究 .....	闫惠娟, 丁为民, 傅锡敏, 等(197)

### II 精准施药技术

基于颜色传感的喷雾靶标红外探测系统研制 .....	李 恒, 何雄奎(202)
温室黄瓜对靶施药机器人系统 .....	耿长兴, 张俊雄, 曹峥勇, 等(208)
基于 AT89S52 单片机的风送式喷雾机风扇的无级调速控制器设计 ...	任丽春, 汪小昆(213)
基于 CFD 的温室无人自助风送式喷雾机风流场分布特性研究 .....	袁 雪, 张金月, 赵亚青, 等(217)

计算机模拟雾滴与冠层的交互作用以降低农药对环境及公众健康的危害

..... Dr Gary Dorr(218)

基于变量喷雾系统的在线混药技术

..... 刘志壮,洪添胜,宋淑然,等.(220)

带斜拉索喷杆的仿真模拟 ..... 吴伟斌,洪添胜,陈凯诚,等(220)

视觉伺服技术在农业中的应用 ..... 刘 涛,张 宾,张东波(221)

基于 WEB 的棉花病害智能诊断系统 ..... 李 慧,张金月,冀荣华,等(230)

几种新型喷头及其不同组合的喷雾穿透性对比研究 ..... 王雪娟,曾爱军,宋坚利(237)

### III 农药制剂、传递与功效

三种农药浓度与 BSF 荧光强度关系初探 ..... 杨希娃,宋坚利,代美灵,等(246)

N-F100 对 250 g/L 啞菌酯 SC 防治辣椒霜霉病的增效研究

..... 于春欣,刘 芬,郭 正,等(252)

Silwet408 对 250 g/L 啞菌酯 SC 防治辣椒霜霉病的增效研究

..... 于春欣,刘 芬,郭 正,等(256)

Silwet408 在水稻上的应用 ..... 于春欣,郭 正,杜凤沛(260)

靶标植物和药液理化性质对农药利用率的影响 ..... 于春欣,张晓曦,闫鹏飞,等(263)

有机硅表面活性剂在洗涤剂中的应用初探 ..... 邓 丽,刘亚佳,何雄奎(270)

电生功能水在植物保护上的应用研究 ..... 刘海杰,郝建雄,周艳鑫,等(277)

与冠层相关的剂量和喷雾装置对果树树冠农药覆盖率的影响

..... Triloff P., Bäcker G., Kleisinger S. (281)

小麦冠层结构对雾滴沉积分布影响的试验研究 ..... 张 京,宋坚利,何雄奎(282)

### Other 其 他

AquaCrop 作物生长模型的校正和应用 ..... 杜文勇,Shamaila Zia,胡振方,等(289)

不同灌溉方式下冬小麦根系分布与产量的关系研究 ..... 胡振方,曾爱军,杜文勇(292)

A SCADA SOFTWARE FOR MANAGEMENT OF AN AUTOMATIC AGROCLIMATIC STATION BASED IN A cRIO ..... José Miguel Molina Martínez,

Pedro Javier Navarro Lorente,Manuel Jiménez Buendía,et al. (296)

DEPLOYMENT OF A WIRELESS SENSOR NET AS A HELP FOR IRRIGATION

MANAGEMENT ..... José Miguel Molina Martínez,

Fulgencio Soto Valles,Manuel Jimenez Buendía,et al. (306)

TELENATURA: AN UNIVERSITY SPIN OFF ENTERPRISE IN THE AGRONOMY AND ENVIRONMENTAL SECTORS

..... Ruiz-Canales A, Puerto-Molina H, Melián-Navarro A, et al. (312)



# Part One

# 第一部分



# A Study of Dosage Adjustment for Pesticide Application in Vineyards

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**Abstract:** Traditional pesticide application in grapevines causes large losses to the air and the ground, particularly in early to mid-season application. Traditional application rates do not differ very much according to the season. Pesticide labels for vineyard sprays are based upon ground area, but growers choose different row widths, varieties and trellis designs, so canopy volume varies. Dosage adjustment, according to the fruit canopy characteristic, has been developed. In the trial described in this paper, three of them, Unit Canopy Row (UCR) (Australia), DOSAVIÑA (Spain and USA) and Fruit-Wall Area (FWA) (Germany and Belgium) are compared with the traditional application rates and their pros and cons are discussed. This paper presents the methodology and experimental results of the study.

Sampling methods affect the results of pesticides distribution through the grape canopy significantly, due to leaf size variation within the canopy and individuals not selecting leaves from the same area of the canopy. A new tool was designed, in favor of sampling more precisely. Evaluation of the tool was carried out in the field.

Two trials have done until now. Results demonstrated that at early growth stage, deposition of DOSAVIÑA and LWA was not different significantly from that of traditional method; deposition was not different significantly from each other among DOSAVIÑA, LWA and UCR, (application rate was 327, 281, 234 and 187 L/ha for traditional, LWA, DOSAVIÑA and UCR, respectively). At middle growth stage, LWA and traditional methods still achieved similar results, while deposition of DOSAVIÑA and UCR was not different significantly, when application rate for traditional model increased to 700 L/ha, for LWA, DOSAVIÑA and UCR, 560, 327 and 374 L/ha, respectively. The results shown high potential of reducing application rates using alternative models compared with traditional way, also emphasizes the importance of changing air from sprayer in terms of reducing the volume and speed by a louver system or changing the nozzle orientation.

**Key words:** Sampling method, UCR, DOSAVIÑA, Fruit-Wall-Area, Vineyard spraying

## 1 Introduction

It's well known that application techniques on field crops and orchards or grapevines are different. As for field crops (sometimes, cotton, tomato, and band plants are exclusive),

the effects of plant height and leaves on flow rates are neglectable; the ground under the crops can be considered as the targeted area, while for vertical high crops (orchards and vineyards), the ground area is not the proper parameter to which the dose rates are adjusted, even the pesticide labels still persist the ground area dominant tradition and are registered to be applied on all the crops irrespective of the canopy structure.

Most pesticides used in USA are expressed in oz (ounce) per acre. It's difficult for a vineyard grower to make it clear how to choose the right dose rate. Three kinds of row distance exist in American vineyard training systems, i. e. 2.7 m (traditional), 2.1 m (modern) and 1.2 m (the others). The pesticide label registration procedures are usually based on traditional row distance of 2.7 m, so 29% and 125% less of pesticides should be applied on modern vineyard and vineyard of 1.2 m row distance, respectively, if other operational parameters are kept constant, such as variety, growth stages, training system, and so on. Even for the same vineyard, no doubt that canopy characteristics like canopy height, width and density change tremendously along the growing season. Leaf area can change from nothing during the dormant time to over 23 000 m<sup>2</sup> per hectare at the later growth stages (Siegfried et al, 2007). The fixed rate application method may cause over dosing at early growth stage, when big gaps exist in the canopies, and under dosing at later growth stage, which results in less active ingredients being applied, which in turn may result in pest resistance (Furness and Magarey, 2000). The pruning system also affects the deposition significantly (Balsari, 2004).

The vineyard growers are prone to shut off top nozzles to reduce the dosage rate at early stage, sometimes, are encouraged by the pesticide manufacturers. What they always do depends on their experiences, while the scientists have trying to develop some models to match the changeable canopy structures. The short summaries of chosen models listed below are also what we used in the trial:

**DOSAVIÑA** is Excel based software developed by Gil (Gil and Escola, 2009). It's originated in Spain, and further modified to use in New York and Pennsylvania (Landers and Gil, 2009). The software is convinced as its data are from several years of results in real conditions using different types of sprayers. It involves three main screens, data input, results and information. Parameters such as crop characteristics (growth stages, dimensions, structure and parcel layout), sprayer and nozzle type are taken into account. The real volume rate is corrected by a factor of efficiency from the theoretical volume at the last step. The theory behind the software is Tree Row Volume (TRV), i. e. cubic m of canopy per hectare. The TRV value is calculated by canopy width multiplies canopy height multiplies row length per hectare.

DOSAVIÑA is proved by a continual trial lasted four years from 2006-2009 in New York (Landers and Gil, 2009). The traditional method is performed as control. The results demonstrated the minimal 30% saving on pesticide costs without any loss of biological efficacies.

**Unit Canopy Row (UCR)**: this method is initiated by Furness et al. (1998) in Australia

to reduce the variability and increase the biological efficiencies caused by the fixed rate method (Furness, et al. , 2006). UCR is considered as the modified version from TRV, and has an advantage of being simpler to use in the field. Two concepts are defined in the UCR method, appropriate spraying volume (ASV, the volume needed to wet the targeted foliage per UCR), and maximum spraying volume (MSV, the volume sprayed until runoff for both outer and inner foliage surfaces).

The UCR method has a potential of reducing pesticides in excess of 50% (Furness, et al. , 1998). Barani et al. (2008) tested the model and indicated satisfactory results and similar level of pest control as standard spraying practice using only one fifth of both spray volume and active ingredients, where the fruit zone was the target.

**Leaf wall area (LWA)**: the vineyard canopy displays a wall of leaves, especially at trellis training system and after pruning. The LWA method was launched in Germany by Koch (2007). In this method, the priority of the appropriate dose expression is the sprayer function. The formula for boom sprayers still works for vineyard sprayers, if the treated area is defined as a virtual plane between nozzles and canopy.

The linear relation between pesticides delivered per 10,000 m<sup>2</sup> leaf wall area and deposits expressed in ng cm<sup>-2</sup>, was derived from experiments on apple orchards, which was thought to be the rationale behind the LWA method (Weisser and Koch, 2005). Trials investigating the LWA method shown that it reduced the variability of deposits in the canopy, and saved an average of 29% of dose rate, when the traditional method was compared (Pergher and Petris, 2008).

The objectives of this program are to study the potential of reducing the application rates in vineyards located in New York using LWA, UCR and DOSAVIÑA methods in terms of deposits and distribution of pesticides in the canopy. The sprayer was calibrated by orientating the nozzles to match the canopy and reducing the air flow emitted through a louver system to improve the spray quality.

## 2 Methods and materials

### 2.1 Experimental date

Two trials have finished until now and the third one is planned to be done in early August, corresponded to the early, middle and late growth stage, respectively. The first trial was done on 20 May 2010, while the second one was on 8 June 2010.

### 2.2 Treatments

Four treatments were carried out for each trial: (i) traditional method, (ii) Leaf Wall Area (LWA) method, (iii) DOSAVIÑA method, and (iv) Unit Canopy Row (UCR) method. The only variable among the treatments was the different application rates according to the certain growth stages using a normal air-blast sprayer. Canopy size was measured one



day before the trial. Ten points were selected randomly the blocks and the mean values (Table 1) were used to calculate the canopy volume, on which the application rates were based (Table 2). The widths and heights were measured at the same points. The issue to be emphasized was to ignore the sparse cane protruding from the canopy.

**Table 1 The mean values of canopy size and standard deviation values in parenthesis measured at individual growth stage**

Canopy size	May 20	June 8
Width (m) <sup>a</sup>	0.6 (0.12)	0.7 (0.08)
Height (m)	0.6 (0.15)	1.1 (0.05)

<sup>a</sup> Mean values calculated based on 10 measurements.

**Table 2 Flow rates (L/ha) for each treatment calculated based on individual formula at two grow stages**

Treatments	Traditional	LWA <sup>a</sup>	DOSAVIÑA	UCR <sup>b</sup>
May 20	327	280	234	187
June 8	700	560	327	374

<sup>a</sup> LWA= Leaf Wall Area, <sup>b</sup> UCR= Unit Canopy Row

## 2.3 Vineyard

The trials were conducted in a vineyard of 130 rows at Ovid, NY. The vineyard comprised var. GR7 on a vertical shoot position (VSP) trellis system. The distance was 2.7 m between the rows and 2.1 m in the row. Grapevines were planted in 1992.

## 2.4 Sprayer settings

All treatments were applied using a conventional air-blast sprayer (Berthoud, Simoun 600). The operational parameters of the sprayer were kept constant for the whole experiment, except for the flow rates. Different flow rates were generated by Lechler hollow cone nozzles (Lechler Inc. 445 Kautz Road, USA) at different pressures (Table 3). Four nozzles

**Table 3 Operating parameters of the air-blast sprayer for each treatment**

Treatments	Traditional		LWA <sup>a</sup>		DOSAVIÑA		UCR <sup>b</sup>	
	1 <sup>c</sup>	2 <sup>d</sup>	1	2	1	2	1	2
Nozzle type <sup>e</sup>	Green	Blue	Green	Blue	Green	Blue	Orange	Green
No. nozzles	8	10	8	10	8	10	8	10
Pressure (Bar)	8.27	5.52	5.52	3.45	3.65	4.69	5.72	5.86
Flow rate (l min <sup>-1</sup> )	7.32	15.48	6.21	12.38	5.15	7.23	4.13	8.25
Speed (km h <sup>-1</sup> )	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
PTO speed (rpm) <sup>f</sup>	2 850	2 850	2 850	2 850	2 850	2 850	2 850	2 850

<sup>a</sup> LWA= Leaf Wall Area, <sup>b</sup> UCR= Unite Canopy Row, <sup>c</sup> 1= May 20, <sup>d</sup> 2= June 8

<sup>e</sup> Nozzle type= Lechler TR & hollow cone nozzles, <sup>f</sup> PTO speed from manufactures information

per side were fitted for the first trial while five nozzles per side for the second trial. The nozzle orientation was adjustable to match the canopy structure, especial at the early growth stage. The air volume from the sprayer was controlled by a louver system developed by Cornell with the aim to reduce the drift from the targeted row. The nozzle orientation and air volume was tested just before the trials commenced on similar rows far from the blocks.

## 2.5 Experimental design

Experimental design was randomized block involved five plots for each treatment. The plot consisted of a panel of three vines. At least three panels were buffered between each plot or from the end of row, and two rows between each block to prevent contamination from each other. The rows were sprayed from both sides of the sprayer.

The middle vines of each plot were used for sampling. The leaves were picked from each sampling zone as soon as one treatment was done. All trial was finished within two hours to limit the errors caused by the light-sensitive tracer dye. To make the sampling procedure prompt and accurate, a tool was designed to have 2.1 long and 0.5 m wide. The horizontal bars were to mark different sampling heights. The leaves between two bars were picked randomly, then were stored in an ice box and transported to the laboratory where they were kept in refrigerator at low temperature until the extraction.

## 2.6 Tracer and sampling

A yellow dye, Tartrazine, was used for deposition at a concentration of 2 g/L. Samples of tank solution were put into tubes before and after the trials to check the concentration.

For the first trial, the canopy was divided into four zones, two vertical heights and two horizontal depths. The middle and central parts were exclusive due to the narrow canopy width and limited height. Five leaves were sampled from each zone. For the second trial, the leaves were picked from seven zones, three vertical heights on both sides of canopy and one central part. Three leaves were sampled for each bag.

When in laboratory, the dye was washed off by 50 ml of deionized water. The bags were locked and shaken for 30 s, and then the concentrations in the bags were determined using Plate CHAMELEON TM multilabel counter (Hidex, Turku, Finland) equipped with MikroWin 2000 Hidex driver software. The leaves were taken from the bags and dried, then were scanned. The areas of leaves were measured by image analysis software (APS Assess, The American Phytopathological Society, St. Paul, Minnesota). A 40-fold dilution of the tank solution was used as a calibration standard for the spectrophotometer. All the data were normalized to the concentration of 2 g/L. Final deposits were expressed in  $\mu\text{g}/\text{cm}^2$ .

## 2.7 Meteorological measurements

The meteorological conditions (Table 4) included temperature, relative humidity and windy speed at the time of application were monitored by WatchDog Model 2700 Weather

Station (Spectrum Technologies, Inc. Illinois, USA). The measurements were conducted at a height of 1.5 m above the ground and 10 m from the vineyard. Data were recorded until all the treatments were finished.

**Table 4 Meteorological conditions for the two trials**

Canopy size	May 20	June 8
Wind speed ( $\text{m s}^{-1}$ )	2.07	2.57
Relative humidity (%)	45	55
Temperature ( $^{\circ}\text{C}$ )	21.7	17.2

## 2.8 Statistical analysis

All data were examined for equality of variance using Levene's test across the four treatments and five replicates prior to analysis. Data were log or X2 transformed if necessary. Tukey's HSD test (SPSS, SPSS Inc.) was used for multiple comparisons and the significance level was. Furthermore, coefficients of variation were calculated for the array of values affected by different sampling zones, locations and flow rates.

## 3 Results

### 3.1 Deposits on leaves for the first trial

Analysis of variance indicated that the average deposits were significantly affected by treatment ( $P=0.035$ ) and height ( $P=0.001$ ), not by side (Table 5). More application rate achieved more deposits on the leaves (Table 6), though there were not statistical significant differences among the UCR, DOSAVIÑA and LWA; neither were among the DOSAVIÑA, LWA and Traditional methods. From table 6, it shown that no significant differences were observed among the four treatments on different locations, except for the left top, where the deposits of UCR were less significantly than that of Traditional, but not than that of DOSAVIÑA and LWA. The application rate of Traditional, even after adjustment by the growers themselves, is still higher than what is needed on the leaves in the view of deposits. Consider the vulnerable to pests and disease at early growth stage; it's safer to apply the rate of DOSAVIÑA, however, under lighter pests and disease pressure condition, it's acceptable to use the rate of UCR.

Deposits on the bottom of the canopy tended to be larger than top parts. Gil et al. (2007) also found the same trend. During the trial, the top nozzle was shut off in order to control drift beyond the canopy, however, there should be some balance between the enhancement of deposits on the top of canopy and the reduction of drift in the air. The long distance between the nozzles to the top zone and the filter effect by the leaves also contributed to the final results.

**Table 5 Analysis of Variance for normalized deposits ( $\mu\text{g}/\text{cm}^2$ ) at early stage**

Source of Variance	df	Mean Square	F	P
Treatment	3	2.343	3.046	0.035
Side	1	0.145	0.188	0.666
Height	1	9.221	11.984	0.001
Treatment * Side	3	1.491	1.938	0.132
Treatment * Height	3	0.477	0.62	0.605
Side * Height	1	0.032	0.042	0.839
Treatment * Side * Height	3	0.566	0.735	0.535
Error	64	0.769		

**Table 6 Normalized deposits ( $\mu\text{g}/\text{cm}^2$ ) on different parts of the vines at early growth stage**

Treatments	Locations				Average
	Right-top	Right-bottom	Left-top	Left-bottom	
UCR2	2.10 a <sup>1</sup>	2.10 a	1.22 a	1.70 a	1.78 a
DOSAVIÑA	1.74 a	2.83 a	1.98 a b	2.76 a	2.33 a b
LWA 3	1.72 a	2.26 a	2.19 a b	3.17 a	2.34 a b
Traditional	1.87 a	3.12 a	2.54 b	2.86 a	2.60 b

<sup>1</sup> Values followed by the same letter in columns do not differ statistically (Tukey HSD test,  $p < 0.05$ )

<sup>2</sup> UCR= Unit Canopy Row; <sup>3</sup> LWA= Leaf Wall Area

### 3.2 Deposits on leaves for the second trial

Table 7 demonstrated that different treatments and heights affected the deposits significantly; the same trend had been shown in the first trial. Carefully adjustment of orientation of nozzles for both sides of sprayer achieved positive results ( $P = 0.733$ ).

**Table 7 Analysis of Variance for normalized deposits ( $\mu\text{g}/\text{cm}^2$ ) at middle stage**

Source of Variance	df	Mean Square	F	P
Treatment	3	0.31	28.960	0.000
Side	2	0.003	0.311	0.733
Height	2	0.871	81.443	0.000
Treatment * Side	6	0.010	0.896	0.500
Treatment * Height	6	0.020	1.894	0.088
Side * Height	2	0.001	0.054	0.948
Treatment * Side * Height	6	0.002	0.148	0.989
Error	111	0.011		

For the second trial, the application rates ranged from 327 L/ha (DOSAVIÑA) to 700 L/ha (Traditional), two times for the largest rate more than the lowest rate. The results shown in Table 8 that, deposits of UCR were significantly less than that of DOSAVIÑA, which in turn less significantly than that of LWA and Traditional. Higher rate still dominated the