Efficacy of Unit Canopy Row Spraying System for Control of European Vine Moth (Lobesia botrana) in Vineyards

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ABSTRACT

A one year study on the efficacy of Unit Canopy Row (UCR) spraying method for controlling European vine moth, *Lobesia botrana,* was carried out in a hedgerow vineyard (cv. Lambrusco Salamino) of the Emilia-Romagna region wine-growing area. The trial aimed to compare two different spraying techniques on 2nd and the 3rd generation of the phytofagous. The Standard technique, in which the whole canopy was sprayed with a volume obtained according to the farmer's spraying practices, was compared with UCR technique. In this latter spraying technique, volume was calculated according to the UCR formula and measuring only the height and width of the bunch zone. The same plant protection products and the same timing were adopted, therefore, the two plots differed regarding both the spraying volumes and the dosages per hectare of the plant protection products applied.

The results were quite promising, but much more research is still necessary.

Keywords: UCR method, *Lobesia botrana*, vineyard, spraying volumes, Italy.

1. INTRODUCTION

During the last decades, studies have provided very promising spraying methods to control pest and reduce contamination of the operators and also off-target losses into the environment.

Among different spray calibration approaches for determining both spray volume and plant protection product rates and improving the efficiency of pesticide application, a method called Unit Canopy Row (UCR) (Furness *et al.*, 1998) has been proposed. The method is based on a formula, which adjusts the spray volume to canopy size. The UCR formula is defined as canopy height (m) x canopy width (m) x appropriate spray volume. The latter is a coefficient described as the minimum spray volume required for achieving canopy wetness of 100 m^3 of foliage with dilute spraying (Furness *et al.*, 1998). The spray volume calculated with UCR formula is expressed in l/100 m of row length, means that area and row spacing are not required as parameters in the formulae.

Thanks to a three-year research (2002-2004) which was supported by Emilia-Romagna region (L.R 28/98), Syngenta Crop Protection and Arag Spraying and Irrigation and coordinated by

CRPV (Research centre of Emilia-Romagna region), it was estimated positively the potential use of the UCR spraying method on hedgerow vineyards in the Reggio Emilia wine growing areas.

With reference to the promising field trail results (Franchi et al., 2006) had obtained during the past years to control the most damaging grape diseases downy mildew (*Plasmopara viticola)* and powdery mildew (*Uncinula necator*), follow-up studies were carried out in 2006 in order to continue the assessment of the UCR approach against the most harmful diseases (downy, powdery mildew and grey rot) and pest (European vine moth) which affect grapevine in Emilia-Romagna region (Franchi *et al.*, 2008). Such field trials were carried out in prospects of a subsequent three-year project in order to evaluate the UCR system in the different wine growing areas of the Emilia-Romagna region.

The aim of this study was to assess the effectiveness of the UCR spraying method in chemical control of European vine moth (*Lobesia botrana*). Two pesticide distribution techniques were compared:

-UCR technique, in which spraying was done only towards the bunch zone. The UCR spraying volume was calculated according to the UCR formula and measuring only the height and width of the bunch zone; and

-Standard technique, in which the spraying volume was obtained according to the farmer's spraying practices treating the whole vine canopy.

The same plant protection products and same spray timing were adopted.

The two plots differed regarding both the spraying volumes and the dosages per hectare of the plant protection products applied.

2. MATERIAL AND METHODS

2.1 Experiment Site and Arrangements

The field experiment was done against the 2nd and the 3rd generation of the *L. botrana* on a commercial hedgerow-trained vineyard (Sylvoz) in the Emilia-Romagna wine-growing area (other field conditions are summarised in table1).

Table 1. Vineyard characteristic

Planted year	Vine spacing (m)	Cordon height (m)	Variety
2000	3.2 x 1.5	1.4	Lambrusco Salamino

The vineyard was divided into three large plots, corresponding to the following treatments tested: (a) Standard, (b) UCR and (c) Untreated. These untreated plots were made of 6 rows, which were long 60 m (plot size 960 m^2); on the contrary the untreated plot consisted of 6 rows long 10 (plot

size192 m^2). These large plots were arranged in order to reduce to a minimum any possible interference among the plots. The middle rows of each plot were used as many replicates.

2.2. Canopy Volume Measurements

On the contrary of the UCR principles, the calculations of the vine canopy size were done measuring only the width and the height related to the bunch zone. This shift was determined by the characteristics of the life cycle of the *Lobesia botrana,* whose larvae of the 2nd and 3rd generation feed on berries, causing yield loss and the occurrence of diseases, above all, grey rot. The height and width of the canopy related to the bunch zone was recorded, using a measuring metal rod. The height was measured in twenty five representative points which were selected randomly in the vineyard. The width calculations were done on the same canopy sites where the heights were measured (figure 1). The total number of measurements was twenty five heights and twenty five widths. Once the average height and width of the canopy were calculated, these values were used to determine the canopy volume.

Figure 1. The canopy measurements

2.3 Spraying Volumes

According to the experimental protocol, the theoretical volumes compared were: (a) 1000 l/ha applied on Standard plot; (b) 176 l/ha applied on UCR plot. After the calibration of the sprayer the volumes applied were higher: (a) 1152; (b) 224 l/ha (table 3).

The UCR volume was calculated according to the UCR formula and the canopy size of the bunch area (table 2). The value of the ASV coefficient adopted was 22 l/100 m^3. This value was chosen according to the outcomes of a previous research regarding the potential use of the UCR method,

for applications performed from the post fruit-setting growth stage on (Franchi *et al*., 2003; Franchi *et al*., 2006).

Table 2. Canopy parameters (bunch area) and spray volume calculated with UCR formula

H average (m)	W average (m)	*Canopy volume related to bunch area	ASV coefficient (l/100 m^3 of canopy)	Volume expressed as (l/100m)	Volume expressed as (l/ha)
0.6368	0.3894	24.80	22	5.63	175.93

* The overall canopy volume recorded in standard vineyards of the wine growing area is equivalent to 120-140 m^3/100 m of row length.

2.4 The Sprayer

All treatments were applied with a tower commercial airblast, equipped with an axial back-mounted fan, a bilateral conveyor (TGZ650 P10 model, Unigreen crop protection, figure 2.) and seven hydraulic nozzles per side, which were arranged inside the air outlet section. To obtain the spray volume rates Lechler red (TR 80-04) and blue (TR 80-03) hollow-cone nozzles were fitted to double-jet holders, and used as alternatives. To adjust the sprayed area to the real vine canopy size, particularly in its lower and upper portion, six nozzles per side (plot Standard position: 1,2,3,4,5 and 6 from below) and two per side (plot UCR position: 3 and 4 from below) were used. Once the travel speed was calculated, the pressure was adjusted to obtain the spray volume rates (l/ha), which had been previously calculated (table 3). This information was generated using a flow meter connected to the pump at a given volume rate.

Table 3. Spraying parameters

Treatment	Speed (km/h)	Nozzle	N. nozzle used	Pressure (bar)	Flow rate (l/min)	Volume l/ha	
						Theoretical	*Applied
A	6.67	Red	6 per side	12 bar	33.3	1000	1152
B	6.67	Blue	2 per side	9 bar	7.97	176	224

*Volumes obtained after the calibration of the sprayer

Figure 2. The sprayer was used for the trial.

2.5 Experimental Dates and Treatments

The experiment was performed twice in the same area of the vineyard. Active ingredients were chosen according to the IPM protocols of the Emilia-Romagna region. The treatments are described in table 4. The insecticide Spinosad was applied on July 7th 2006 at berries beginning to touch (vine growth stage BBCH 77) against the 2nd generation of the moth. To control the 3rd generation of *L. botrana* the insecticide Methoxyfenozide (MAC) on August 8th 2006 at berries developing color (vine growth stage BBCH 83) was used (table 4).

The 2nd and 3rd male flights were recorded by placing a pheromone trap (Traptest®, Isagro) from the first decade of June to mid-September. The trap was checked once a week. Timing of the applications was determined according to field monitoring of the phytophagous phases and the indications of the mathematical forecasting model (MRV-Lobesia). MRV-Lobesia (figure 3) is a time-delayed model, which simulates the development of three generations of the insect, according to temperature. Such model is already being adopted by the Emilia-Romagna warning system for prediction of the most important pests of the region (Bugiani *et al*., 1996).

Table 4. Treatments compared

Treatment	Applied volume (l/ha)	Active ingredients	Trade name (*)	Concentration a.i./product (g/l)	Concentration a.i. (g/hl)	Dose a.i. (g/ha)
2nd GENERATION						
A	1152	Spinosad	Success®	120	9.6	110.59
B	224	Spinosad	Success®	120	9.6	21.50
C	-	-	-	-	-	-

3rd GENERATION						
A	1152	Methoxyfenozide	Prodigy®	240	9.6	110.59
B	224	Methoxyfenozide	Prodigy®	240	9.6	21.50
C	-	-	-	-	-	-

(*) Success® (suspension concentrate; the product was applied according to the recommended dose label expression of 80 ml/hl or 800 ml/ha).

Prodigy® (suspension concentrate; the product was applied according to the recommended dose label expression of 40 ml/hl, or 400 ml/ha).

2.6 Pest Assessment

Incidence (I) and severity (S) of the European vine moth on bunches were observed eleven days after the first treatment (2nd generation) and twenty three days after the second treatment respectively. According to the phenological forecasting model, the pest assessments were done on July 18th when 75 % of the larvae of the 2nd generation were already born and on August 31st when 55% of the larvae of the 3rd and last generation were already born, finding an acceptable compromise between the beginning of the pupation and when the harvest time would begin (figure 4).

The pest assessment of the 2nd and 3rd generation was done adopting two methods. The first method was done *in situ* observing the damages (visual determination). Twenty five bunches were selected at random from each replicate (100 bunches per treatment) and assessed for pest incidence (% of bored bunches) and severity. This latter was expressed as damage level (mean number of berries per bunch) and larval density (mean number of larval nests per bunch).

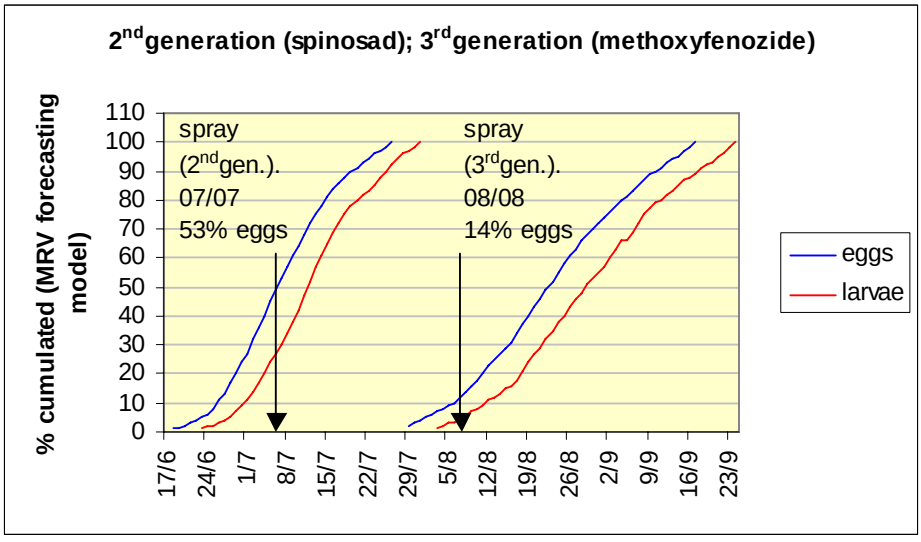

Figure 3. Timing of the application according to the phenological phases (eggs, and larvae) of the insect

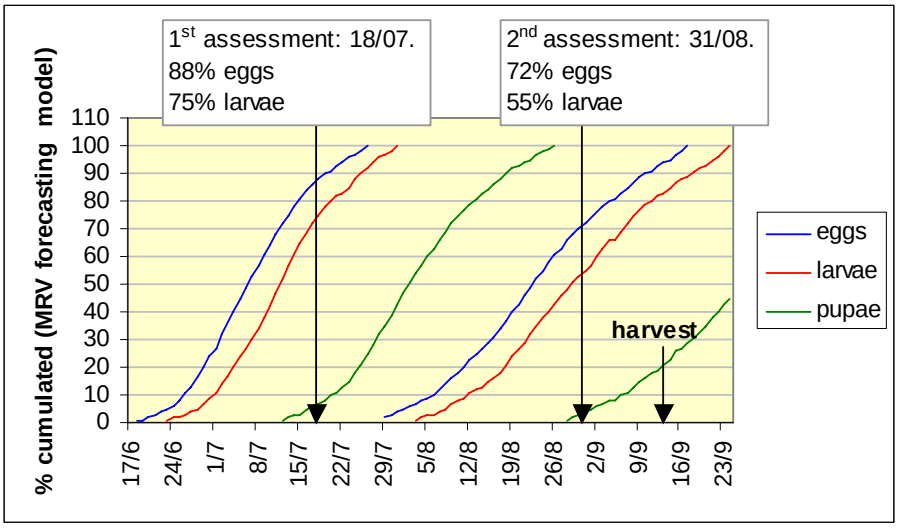

Figure 4. Assessment times related to the phenological phases (eggs, and larvae) of the insect

The second method consisted in assessing the number of survived larvae, examining ten bunches per replicate (40 bunches/treatment). A sample made of ten bunches was soaked in a sodium chloride (5%) and water solution, which was constantly stirred. After two hours the mean number of survived larvae per treatment was calculated, counting all larvae, which rose to the surface of the solution (figure 5). The assessment of the 3rd generation was done adopting only the second evaluation method because it was difficult to distinguish the damages caused by the two generations. The efficacy rate of the spraying volume techniques was obtained using Abbott's formula (Abbott W.S., 1925). The results were performed by applying the analysis of variance (one way ANOVA) to test the difference among the plots and the means were separated using LSD test ($p \leq 0.05$).

Figure 5. Second pest assessment method

3. RESULTS AND DISCUSSION

3.1 Second Pest Generation

The unsprayed bunches were severely damaged by the 2nd generation of the larvae. The incidence and severity data of the two spraying techniques were significantly lower than the data detected in the unsprayed plot (tables 7a, 7b and 8). Both the two spraying techniques (UCR and Standard) gave the similar level in controlling the moth. These results were obtained in spite of the dose of insecticide and spraying volume applied in the UCR plot which were five times lower than those used in the Standard plot. The same level of the effectiveness detected was traced back to the limited target (bunch zone) of the UCR plot.

The results also showed that the two spraying techniques did not obtain a satisfactory control of the moth (figure 6). On the one hand, the control strategy with only one application of the

insecticide (Spinosad) was suitable to compare the two spraying techniques, but on the other hand it was inadequate to control the phytophagous. This unsatisfactory pest control was related to both the heavy infestation and the long larval development, which lasted around thirty eight days (figure 3).

Table 7 a. Incidence (I) and severity (S) of the damages of *L. botrana* on bunches

	2nd generation			
Treatment	I (% of bored bunches)	Sig. level	S (mean n° of bored berries/bunch)	Sig. level
A (Standard)	47.00 b	0.0084	2.080 b	0.0055
B (UCR)	50.00 b	significant	2.050 b	significant
C (Untreated)	79.00 a		4.440 a	

Means in a column followed by the same letter do not differ significantly at the P≤0.05

Table 7 b. Severity (S) of the damages of *L. botrana* on bunches

	2nd generation			
Treatment	S (mean n° of larval nests /bunch)	Sig. level	Damage index (*)	Sig. level
A (Standard)	0.680 b	0.0061	106.12 b	0.0061
B (UCR)	0.670 b	significant	109.72 b	significant
C (Untreated)	1.430 a		363.00 a	

Means in a column followed by the same letter do not differ significantly at the P≤0.05

- These values were obtained multiplying the Intensity by the Severity (expressed as mean n° of bored berries/bunch)

Table 8. Severity of the infestation expressed as number of survived larvae

	2nd generation	
Treatment	Mean n° of survived larvae/bunch	Sig. level
A (Standard)	0.600 b	0.0058
B (UCR)	1.200 b	significant
C (Untreated)	4.150 a	

Means in a column followed by the same letter do not differ significantly at the P≤0.05

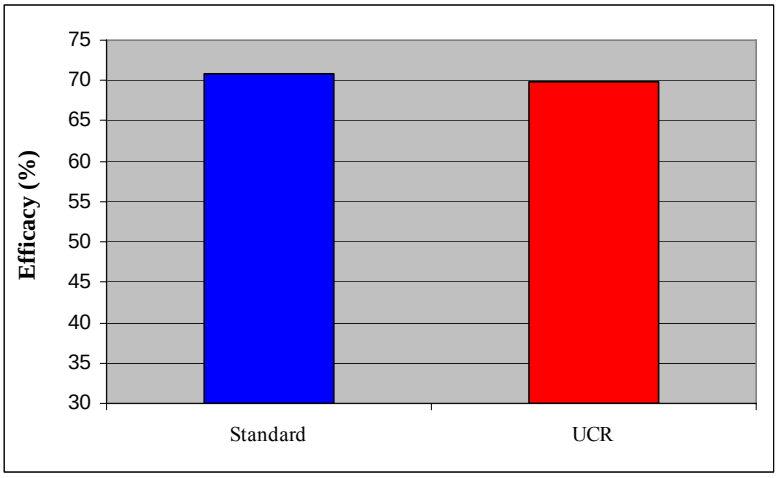

Figure 6. Comparative efficacy of the spraying techniques (Abbott %).

3.2 Third Pest Generation

The same statistical trend shown in the 2nd generation was also observed in the 3rd generation. The survey also showed an increase of the severity (mean number of survived larvae/bunch) in comparison with the 2nd generation (table 9).

Table 9. Severity of the infestation expressed as number of survived larvae

	3rd generation	
Treatment	Mean n° of survived larvae/bunch	Sig. level
A (Standard)	3.900 b	0.0175
B (UCR)	1.875 b	significant
C (Untreated)	8.275 a	

Means in a column followed by the same letter do not differ significantly at the P≤0.05

The 3rd generation obtained promising results with UCR approach as those given by the 2nd generation. Similarly to what was observed in the previous generation, the strategy control based on only one treatment with Methoxyfenozide was unable to fully control the 3rd generation of larvae. These inadequate results were due to the high population level and the long larval development, which lasted around fifty two days (figure 3).

4. CONCLUSIONS

The follow-up study in 2006, of a 3-year project regarding the potential use of the UCR method in Emilia-Romagna region wine growing areas clearly demonstrated the efficacy of the method also in sprays directed exclusively toward bunch zone.

The preliminary experiment results also underlined the following aspects:

- using one fifth of both spray volume and the plant protection products combined with UCR approach targeting only the bunch zone gave the similar level of pest control as Standard spraying practice;

- the UCR method, which has been tested against downy and powdery mildew up to now (Franchi *et al.*, 2006; Franchi *et al*., 2008), showed satisfactory results to control *Lobesia botrana;*

- to ensure an effective pest control further applications against the larval phase should have been done for each larvae generation.

5. ACKNOLEDGMENTS

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