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The Effect of the Air Blast Sprayer Speed on the Chemical Distribution in Vineyard

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Abstract: A study was conducted to determine the spray deposition patterns for air blast sprayers used to apply chemicals to the canopy of Semillon grapevine in vineyard. The application carried out in 12 bars and three sprayer speed (2.1-4.9-7.7 km h^{-1}). The spray deposition was measured on the point in the different distances (1.5-3-6-9 m). Tartrazine were applied as tracer material. Maximum spray deposit was obtained 66.1 mg cm^{-2} at sprayer speed of 2.1 km h^{-1} and minimum deposit was obtained 37.1 mg cm^{-2} at sprayer speed of 7.7 km h^{-1}. The results showed that the sprayer speeds had significant effect on spray deposit distribution and increasing of the sprayer speed increased drift.

Key words: Spraying, vineyard, deposit, distribution, drift

INTRODUCTION

A major problem in applying agricultural pesticides is spray drift which can cause crop protection chemicals to be deposited in undesirable areas with serious consequences, such as damage to sensitive adjoining crops and other susceptible, off-target areas, environmental contamination, health risks to animals and people, a lower dose than intended on the target field, which can reduce the effectiveness of the pesticide, wasting pesticide and money (Nuyttens *et al.*, 2007).

Spraying is one of the most efficient methods for pesticide control. The successful application of pesticides to field crops results from proper use of equipment while considering the prevailing field conditions, morphology of the crop, target area and mobility of the pest (Mathews, 2000). Improvement in the uniformity and efficiency of chemical deposition is frequently the goal of spray application research. Production of high value fresh market fruits and vegetables requires diligent pest control practices, which often involve application of chemical pesticides (Kang *et al.*, 2004).

Generally, air blast sprayers are used on vineyard applications direct the air from a single axial-flow fan in a radial direction, occasionally resulting in a large amount of spray just blowing out and over the canopies. Air blast sprayers are used to apply pesticides, plant regulators and foliar nutrients to grapevine by applying these materials as liquids carried in large volumes of air. Air blast sprayers have adjustments the fluid and air delivery systems that permit tailoring of applications to fit a wide range of vineyard conditions.

The efficiency and cost effectiveness of pest management programs are influenced by the skills of managers and sprayer operators who evaluate vineyard conditions and alter machine settings and operating techniques to optimize performance, forward velocity and chemical selection is necessary for optimal results.

Equipment manufacturers have developed a number of approaches to providing more or less aggressive control of the spray process. Among these, air assisted spraying has been developed at various levels on boom sprayers. At one of the spectrum, there is the bi-fluid nozzle, where a low volume of pressurized air is used to assisted liquid atomization and even control spray quality, offering some control on drift (Lund, 2000).

Air blast sprayers can be a significant source of spray drift because they deliver spray horizontally and vertically towards a target area. Several factors including weather conditions, crop canopy and sprayer setup can contribute to spray drift. Droplet size is the most important factor in determining the potential for drift. Smaller droplets improve coverage but are more likely to be blown through or above a canopy. Large-droplet air-induction nozzles have been shown as means for reducing drift without significantly reducing coverage (Derksen *et al.*, 2000).

A recent trend in vineyard spray application is based on the use of non-conventional sprayers to improve the effectiveness of the treatment and reduce environmental pollution. Pesticide losses have been shown to relate mainly to poor match between the conventional air blast sprayer and plant geometry (Cross, 1991).

Salyani and Whitney (1990) studied the effect of sprayer ground speed on spray deposition at different locations within citrus canopy. Deposition of a copper hydroxide tracer was measured on citrus leaves and cotton ribbons. Results indicated no effect of ground

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speed (1.6-6.4 km h^{-1}) on mean spray deposition. However, there were large differences in deposits at different canopy locations. Deposition decreased with canopy depth.

The objectives of this study were to characterize spray deposition within the vineyard operating air blast sprayer and to determine the effect of sprayer speed on the spray deposition.

MATERIALS AND METHODS

This study was conducted in Thrace region in July 2006. The treatments were applied to Semillon grape vineyard. The vineyard spacing was 3 m between rows and 1.5 m in each row. The location of leaves was between the heights of 80 cm and 1.6 m from ground and average vine width was 1.0 m.

The sprayer tested was commercially available rear mounted air assisted machine with 760 mm diameter axial fan , driven by the power take-off (p.t.o) (Turbo 400-A, Taral company, Turkey). The two deflectors were fixed to the upper part of the fan's frame and had opened up to an angle of 45°, allowing the airflow to be adjusted to mach the canopy height. The sprayer had 8 nozzles (hollow cone) arranged circular on the fan. They were spraying at an operating pressure of 12 bars and the fan speed was 1950 min^{-1}. The liquid pressure was produced by mean of diaphragm pump and the liquid output was controlled by a constant pressure valve regulator.

The sprayer was connected to a 46 kW tractor and measured pressure, 12 bars, was constant in all the treatment. The spray flux and the spray coverage were evaluated on one side of the sprayer, always in the same sampling position in the treated rows. During the test, three repetitions were made with the sprayer at different sprayer speed, 2.1-4.9-7.7 km h^{-1}.

The grapevine were sprayed a 2 g Tartrazine (a fluorescent tracer) per 1 L water. The filter papers (Schleicher and Schull, 125 mm diameter) were used to collect the spray deposit at the different distances, 1.5-3-6-9 m. They were located in 1.5 m on leaves and in 3-6-9 m on wooden bar in the centre of treated rows (Fig. 1).

Grapevine was divided into three zones vertically (A-B-C) (Fig. 1). The filter papers of located on leaves were positioned at three heights (70-120-170 cm) using three filter papers at each height. Three of filter papers, placed on the soil (shown as D zone in Fig. 1) near the wooden frame of plants, were also used to collect the spray deposit on the ground.

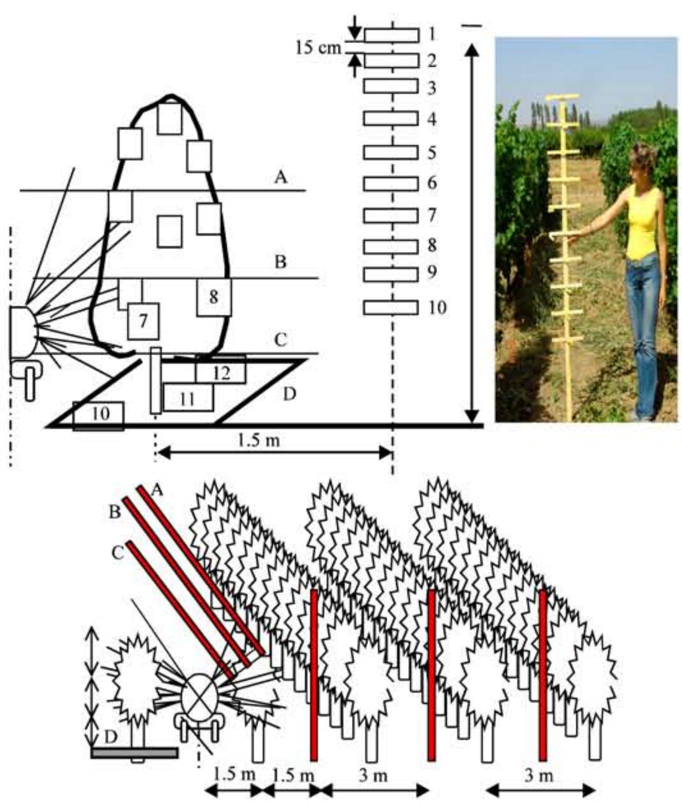

Fig. 1: Layout of filter paper collectors for evaluation of in-canopy spray deposit and off-target spray loss

The vertical wooden bar was 2 m high and had 10 height levels at the intervals (0, 15 m). There are three filter paper on the horizontal bar (length of 30 cm) at the each height. Vertical bar had 30 filter paper and 10 different heights (Fig. 1).

The samples were collected and each of them was placed into a separate plastic snap-seal container within 15 min after spray application. They were stored in the dark for further processing. The fluorescent tracer (Tartrazine) was extracted from filter paper collectors with 100 mL pure water. A tracer concentration in the extract was determined with spectrophotometer and the actual amount of tracer deposit (mg cm^{-2}) was read. Prior to analysis the background for clean paper was equal to the one obtained for washing solution (Holownicki *et al*., 2000).

Air temperature, air relative humidity and wind speed during the spray applications were recorded using Lutron AM 4202 anemometer and Testo 605 h 1 in vineyard. All the measurement was performed different point in vineyard and in height of 2 m.

Analysis of variance followed by Duncan's Multiple Range Test was applied to separate mean values of the deposit and spray loss for treatments. Coefficient of variation (CV) for spray deposit was calculated on the basis of different sprayer speed. The means for these parameters were compared at 5% level at significance.

RESULTS AND DISCUSSION

Treatments were applied during sunny day and weather conditions (Table 1). Ranges of maximum temperature during the test were 30°C applying 4.9 and 7.7 km h^{-1}. Maximum relative humidity was 69% applying 2.1 km h^{-1}. Maximum Wind velocity was measured 3.0 km h^{-1} and wind direction ranged from 130-310° (measured clockwise with winds from north = 0°).

The spray depositions on leaves were measured different sprayer speed and different levels of the height in vineyard. Effect of sprayer speeds on the spray deposition were found to be very significant (F = 5.94**). Results showed that the levels of the height in plant had not an important effect on the spray deposition (Table 2). The deposition was the highest on the level of A and at sprayer speed of 2.1 km h^{-1}.

The spray deposits on leaves of grapevine in the rows at the different levels of the height (A:70 cm, B:120 cm, C:170 cm, D: level of the ground) were measured and analyzed (Fig. 2). When the spray deposits was examined and their means were calculated, maximum spray deposit was obtained 66.1 mg cm^{-2} at sprayer speed of 2.1 km h^{-1} and minimum deposit was obtained 37.1 mg cm^{-2} at sprayer speed of 7.7 km h^{-1}.

Table 1: Weather conditions during the treatments

Sprayer speed (km h^{-1})	Temperature (°C)	Relative humidity (%)	Wind speed (km h^{-1})
2.1	27	69	1.9
4.9	30	45	2.1
7.7	30	51	3.0

Table 2: Statistics of mean values of the spray deposits

Variation sources	Error freedom degree	Error means square	F_{cal}
Repetitions	2	1.880	0.10
Sprayer speed	2	174.838	8.94**
Levels of the height	3	35.489	1.81
Sprayer speed x distance	6	9.631	0.49
Error	22	19.564	-
-Coefficient of variation (%)	36.99**		

**Highly significant

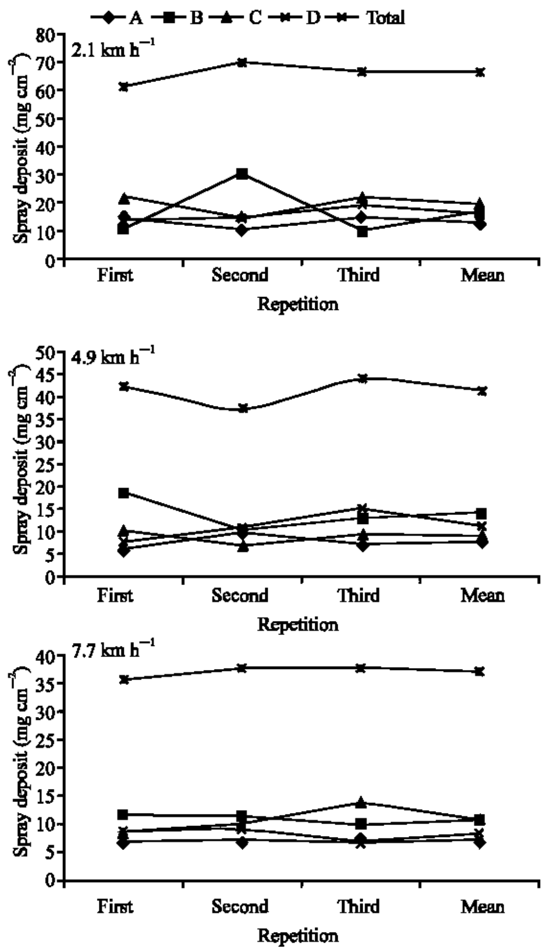

Fig. 2: Spray deposit (mg cm^{-2}) on different level of height (A: 70 cm, B: 120 cm, C: 170 cm, D: level of the ground) of plants and at the sprayer speed (2.1-4.9-7.7 km h^{-1})

Spray deposit were measured minimum of 13.9 mg cm^{-2} on the level of the A and maximum of

19.39 mg cm^{-2} on the level C at the sprayer speed of 2.1 km h^{-1}. It was measured minimum of 7.48 mg cm^{-2} on the level of the A and maximum of 13.85 mg cm^{-2} on the level B at the sprayer speed of 4.9 km h^{-1}. Minimum of 7.12 mg cm^{-2} on the level of the A and maximum of 11.06 mg cm^{-2} on the level B at the sprayer speed of 7.7 km h^{-1}. Similar results on effect of height were also reported by Salyani and Whitney (1990).

According to the results, the spray deposition on the leaf decreased by increasing sprayer speed. Generally, there was less spray deposit on the top of the plants than others. However, it was increased at the bottom part of the vines where were more density of leaves.

Maximum spray deposition (77.1 mg cm^{-2}) was obtained on the 3 m, at the sprayer speed of 2.1 km h^{-1}. It was 48.52 and 39.21 mg cm^{-2} on 3 m at 4.9 and 7.7 km h^{-1}, respectively (Fig. 3). Generally total spray deposition were highest in the 3 m. It decreased to distance from the sprayer. Increasing sprayer speed, spray deposit increases towards the 9 m. small differences in total spray deposits were found between 6-9 m.

The spray depositions were significantly affected by sprayer speed (F = 19.79**) and distance (F = 101.79**). Also there was very significant (F = 49.05**) interaction between the sprayer speed and distance. Results showed that the levels of the height in wooden bar had not an important effect on the spray deposition (Table 3).

The amount of the spray deposits was highest on the wooden bar located distances of 3 m at all sprayer speeds (Fig. 4). The maximum of the amount of the spray deposit in the distances of 3 m were 9.18 mg cm^{-2} (on the level of g), 5.8 mg cm^{-2} (on the level of d) and 5.25 mg cm^{-2} (on the level of b) at 2.1, 4.9 and 7.7 km h^{-1}, respectively.

The maximum of the amount of the spray deposit in the distances of 6 m were 3.69 mg cm^{-2} (on the level of c), 3.7 mg cm^{-2} (on the level of g) and 3.33 mg cm^{-2} (on the level of c) at 2.1, 4.9 and 7.7 km h^{-1}, respectively. The maximum of the amount of the spray deposit in the distances of 9 m were 3.5 mg cm^{-2} (on the level of e), 3.8 mg cm^{-2} (on the level of b) and 4.0 mg cm^{-2} (on the level of m) at 2.1, 4.9 and 7.7 km h^{-1}, respectively.

Spray deposit distribution at different sprayer speeds in Fig. 5 show considerable in different point in vineyard. It shows increasing drift by the sprayer speed. Spray deposit was highest near the sprayer at the same sprayer speed. However, gone far from sprayer, it was minimum. In all treatments the spray flux was characterised by a higher deposit at 2.1 km h^{-1} and on the first row (at the

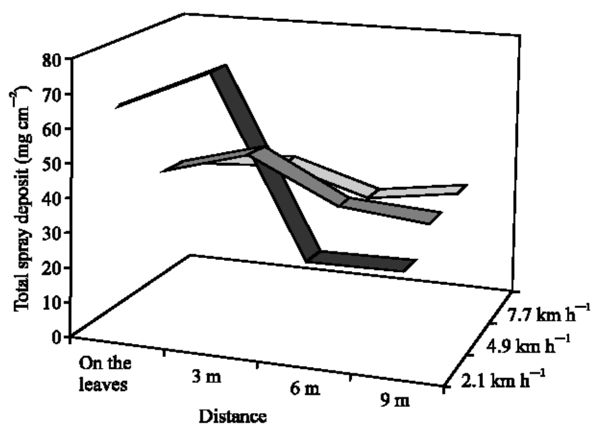

Fig. 3: Due to total spray deposit (mg cm^{-2}), spray distribution at different sprayer speed (2.1-4.9-7.7 km h^{-1}) and different distances (1.5-3.0-6.0-9.0 m)

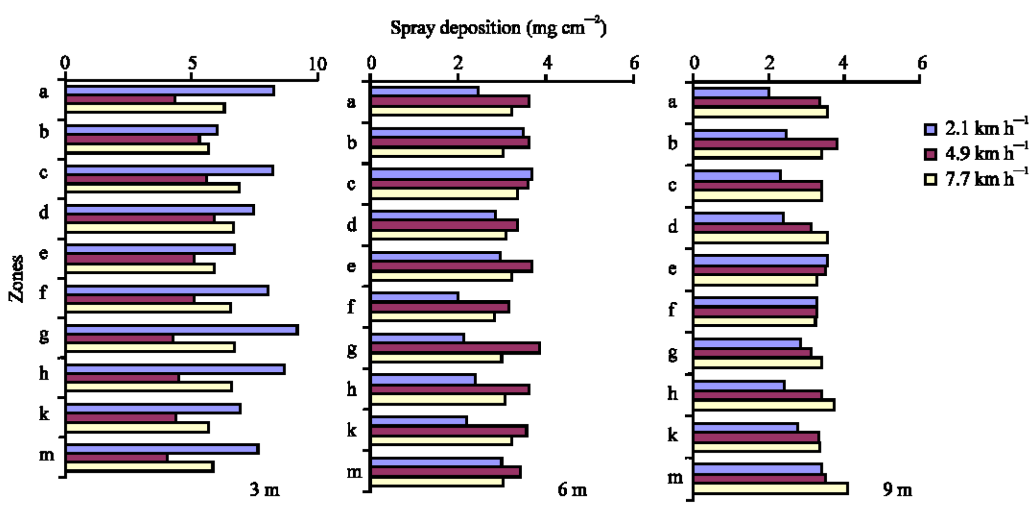

Fig. 4: The spray deposition (mg cm^{-2}) at different sprayer speeds (2.1-4.9-7.7 km h^{-1}) and on the different distances (3-6-9 m)

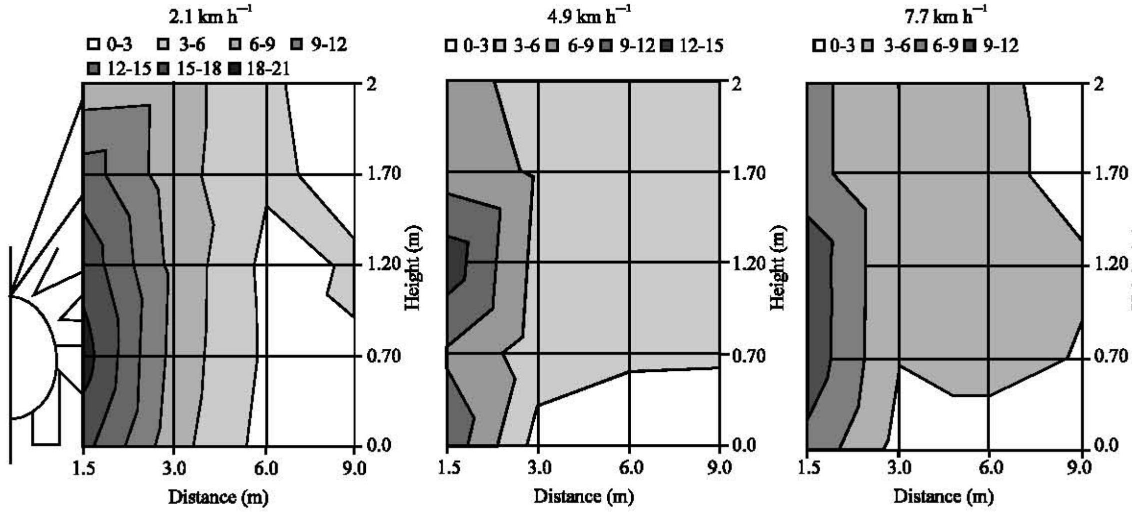

Fig. 5: Spray deposition (mg cm^{-2}) pattern on the vineyard by air blast sprayer

Table 3: Statistics of mean values of the spray deposits

Variation sources	Error freedom degree	Error means square	F_{cal}
Repetitions	2	3.320	2.46*
Sprayer speed	2	26.742	19.79**
Distance	2	137.082	101.47**
Sprayer speed x distance	4	66.269	49.05**
Level of Height	9	0.378	0.28
Sprayer speed x level of height	18	0.556	0.41
Distance x level of height	18	0.700	0.52
Sprayer speed x Distance x level of height	36	0.930	0.69
Error	178	1.351	-
Coefficient of variation (%)	30.01		

*Significant, **Highly significant

3 m). The grapevine canopies directly exposed to the sprayer speed showed good uniformity in all tests at different heights.

By increasing the driving speed, the vertical air jet is bent and distorted. This leads to the smallest droplets escaping from the spray into the atmosphere downwind of the sprayer, resulting in a higher amount of spray drift (Ghosh and Hunt, 1998).

CONCLUSIONS

Based on the results obtained with the above mentioned equipment, grapevine and sample locations, the following conclusions may be drawn from this experiment:

- Sprayer speed had significant effect on spray deposit distribution
- Increasing sprayer speed increased drift

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REFERENCES

Cross, J.V., 1991. Patternation of sprayer mass flux from axial fan airblast sprayers in the orchard. British Crop Protection Council Monograph. Air-assisted Spraying in Crop Protection, 46 (1991): 15-22.

Derksen, R., R. Fox and R. Brazee, 2000. Low Drift Application Technologies-Airblast (Fruit and Shade Canopies). Pesticide Drift Educator's Conference, October 16.

Ghosh, S. and J.C.R. Hunt, 1998. Spray jets in a cross-flow. J. Fluid Mech., 365 (1): 109-136.

Holownicki, R., A. Doruchowski, A. Godyn and W. Swiechowski, 2000. Variation of spray deposit and loss with air-jet directions applied in orchards. J. Agric. Eng. Res., 77 (2): 129-136.

Kang, T.G., D.H. Lee, C.S. Lee, S.H. Kim, G.I. Lee, W.K. Choi and S.Y. No, 2004. Spray and depositional characteristics of electrostatic nozzles for orchard sprayers. ASAE/CSAE Annual International Meeting, Page No. 041005, 1-4 August, Canada.

Lund, I., 2000. Nozzles for Drift Reduction. In Aspect of Applied Biology 57: Pesticide Application, pp: 97-102.

Matthews, G.A., 2000. A review of the use of air in atomisation of sprays, dispersion of droplets downwind and collection on crop foliage. Aspect Applied Biol., 57: 21-27.

Nuyttens, D., M. De Schampheleire, K. Baetens and B. Sonck, 2007. The influence of operator-controlled variables on spray drift from field crop sprayers. Trans. ASABE., 50 (4): 1129-1140.

Salyani, M. and J.D. Whitney, 1990. Ground speed effect on spray deposition inside citrus trees. Trans. ASAE., 33 (2): 361-366.