EVALUATION OF A CONTROLLED DROPLET SPRAYER TO CONTROL DISEASE AND INSECTS ON GRAPES IN NEW YORK

A report to the Viticultural Consortium

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Introduction

The deposition and drift of pesticides from air blast sprayers gives rise to concern amongst all associated with the countryside and food production. In the growing season of 1999 a team of researchers from Cornell University conducted trials into the efficiency of a novel sprayer, the Proptec, in comparison to the traditional air blast sprayer.

The research team

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Objectives

1. To improve the standard of crop spraying and the understanding of safer pesticide application

2. To evaluate the efficiency and effectiveness of the Proptec controlled droplet application sprayer at reducing disease and insect populations in vineyards.

3. Collect data to provide a greater understanding of how droplet size affects the control of disease and insects.

4. To assist farmers in their selection of appropriate technology to reduce pesticide use and minimise environmental pollution.

Materials and methods

Increasing the Volume Median Diameter (VMD) will certainly reduce drift, but too large a droplet will bounce off the leaves to the ground, thus causing pollution, wasting money and resulting in less product on the target. A novel spraying technique, the Proptec sprayer, creates small droplets which can be directed into the crop canopy. The Proptec sprayer is a Controlled Droplet Applicator (CDA) using a rotary cage to create droplets. Liquid is fed into a high-speed spinning cage, centrifugal forces spread the liquid and throw it from the periphery. Fitting the units to a boom and driving the rotary cage with a hydraulic motor provides the centrifugal force. The majority of droplets, (95% approximately), are the same size, depending upon flow rate and cage speed. A small propellor provides air movement and the position of the unit on the boom dictates air direction. Directed deposition should reduce drift and the Proptec sprayer was chosen for comparison with air blast sprayers on two farms, one in Forestville NY and the other in Naples NY. Air inclusion nozzles also reduce drift from herbicide sprayers, so it was decided to fit them to air blast sprayers and monitor their effectiveness on the farm in Naples.

Sites

Two vineyards were used for the trials, one grower, Jim Merritt of Forestville, had mechanically hedged vineyards of Concord grapes, providing a very dense canopy, the other grower, Canandaigua Wine Co at Naples, had hand-pruned Niagra grapes, providing a more open canopy.

The site at Forestville comprised 2 large plots of 11 rows each, replicated twice. The site at Naples comprised 2 large plots of 23 rows each, replicated twice. Due to the very hot summer resulting in very low insect and disease pressure, only three applications were made during the growing season at Forestville and two applications on Naples.

On both farms trials were conducted using a Berthoud air blast sprayer using 50 gpa and a Proptec sprayer using 50 gpa. Forward speed was 3 - 3.5 mph.

On Forestville wind speed was between 3-5 mph and predominately 45^o to the direction of travel during the trial, humidity was low (40%), average temperature was 70^{o}F**.** At Naples the wind speed averaged 3-6 mph and was approximately 90^o to the target row with 55% humidity and 75^{o}F**.**

Sprayers

A Berthoud trailed air blast sprayer was fitted with D4 discs and no.25 swirl plates to apply pesticides in a conventional mode at both farms.
A Proptec mounted sprayer was fitted with a flow regulator plate no. 89 and operated at 138kPa on both farms.
For drift comparison at Naples, one side of the Berthoud sprayer was fitted with five A/I 110-025-VS (Spraying Systems) air inclusion nozzles, operating at 345kPa.

Air inclusion nozzles use a small venturi to draw in air as the liquid passes through the nozzle. The resulting droplets contain air bubbles. The large droplets, 455 microns VMD don't bounce off the leaves as the entrained air bubbles absorb the shock of the droplets hitting the leaves.

All the sprayers in all the trials used the same application rate of 50 gpa, travelling at 3- 3.5 mph and were calibrated before use.

Procedure

Drift was measured in all the trials by placing water sensitive paper cards, 2" by 1" (Spraying Systems) on collecting trays located on the top of the canopy of each row. Four collecting trays, each holding two cards, were placed at 10m intervals along the row. Collecting trays were placed on 8 rows from the target row. Each sprayer was filled with clean water and passed the target row applying water at 50 gpa.

The cards were allowed to dry and were collected post application. The cards were placed on a HP 6200C desktop scanner and the images were analysed using a WRK Dropletscan image programme. The image analysis programme was used to quantify droplet size and % area covered.

Deposition in the vineyard trials on both farms was measured using Sequestrene 330Fe, an iron micronutrient, as a tracer incorporated into the spray solution. Leaf samples were collected before each application to provide background quantities of iron and after each spray application and analysed for traces of iron at Cornell University ICP analytical laboratory using an atomic absorption spectrophotometer

A two way analysis of variance was performed to detect significant differences between treatments. Tukey's HSD method of pair wise comparisons was used to detect differences within a treatment. All hypothesis tests were performed at the 0.05 level.

Arthrodpod Evaluations

Arthropods were evaluated at both sites for leafhoppers, mites and grape berry moth. At both sites, and for all plots, most arthropod numbers were extremely low throughout the season. The only exception was a significant population of grape plume moth at the Naples site. However, this infestation occurred well before the Proptect sprayer was functional. No insecticides were applied at the Naples site while one application of methyl parathion (2 qts/acre) was applied at the Merrit site (17 June). Because numbers were so low at these sites in 1999, sprayer efficacy could not be evaluated for arthropods.

Disease Evaluations

The incidence and severity of powdery mildew were evaluated at both sites by examining 50 leaves (5 per cane x 10 canes) in each replicate plot and estimating the percentage area of each leaf infected; the incidence of internode infection by Phomopsis was evaluated at both sites by examining 40 internodes (the basl four per cane x 10 canes) in each replicate plot. At the Forestville site only, the incidence of Phomopsis rachis infection was evaluated by examining 50 clusters per plot. At the Naples site only, the incidence and severity of downy mildew was evaluated by examining 50 leaves per plot (5 leaves per cane x 10 canes) and estimating the percentage area of each leaf infected; the incidence and severity of Phomopsis fruit rot was evaluated by estimating the percentage area infected for each of 25 clusters per plot. Data were subjected to analysis of variance, and means were separated using the Waller-Duncan k-ratio t-test ($P = 0.05$). Evaluations were conducted were conducted on September 3 and 8 and naples and Forestville, respectively.

Results

Table 1. *Drift cards: Forestville and Canandaigua*

	%area covered on		Cards		
	FORESTVILLE		NAPLES		
Row from Target	Berthoud	Proptec	Proptec	Berthoud	Berthoud & Air inclusion
1	1.5	0.1	0.7	0.9	3.6
2	0.8	0.0	0.2	0.8	0.5
3	0.5		0.1	0.5	0.1
4	0.3		0	0.2	0
5	0.3			0.1	
6	0.1			0.1	
7	0.0			0	

Table 2. *Deposition results from Forestville*

Fe deposits ppm

Treatment	Position	Forestville					
		4/6/99		17/7/99		30/7/99	
Berthoud	Top	0.0	(11.32)	9.42	(22.27)	18.2	(28.25)
	Middle	34.52	(11.08)	35.87	(46.93)	24.78	(37.02)
	Bottom	48.45	(10.93)	52.42	(9.11)	42.5	(18.90)
	Internal	53.28	(12.32)	82.25	(11.52)	72.57	(25.36)
	Av.	33.15	(25.28)	44.99	(35.94)	39.51	(32.55)
Proptec	Top	12.71	(10.46)	0.0	(19.84)	7.06	(2.35)
	Middle	17.23	(6.44)	12.56	(5.37)	5.91	(4.17)
	Bottom	23.28	(7.36)	14.39	(3.78)	23.95	(11.34)
	Internal	49.34	(7.84)	66.01	(4.79)	46.95	(15.35)
	Av.	25.64	(16.37)	22.59	(28.57)	20.97	(19.27)

(Std. Deviation)

Table 3. Deposition results from Naples

Fe deposits, ppm

Treatment	Position	Naples 16/6/99	Std. dev	17/7/99	Std.dev.
Berthoud	Top	11.11	5.66	43.56	32.45
50 gpa	Middle	18.23	2.02	25.01	15.44
	Bottom	28.41	33.73	0	9.18
	Av.	19.25	18.71	15.71	34.42
Proptec	Top	8.08	5.61	36.68	14.94
50gpa	Middle	18.26	7.67	23.18	11.83
	Bottom	31.02	40.98	2.09	3.62
	Av.	19.12	23.27	20.65	17.94
Proptec	Top	6.38	2.43	49.57	25.84
30 gpa	Middle	17.22	15.44	24.92	6.66
	Bottom	188.4	94.3	5.65	14.84
	Av,	70.67	100.51	26.72	24.42

Table 4. Disease control at Forestville (cv. 'Concord')

	Powdery mildew (%)		Phomopsis infection	
Sprayer	Leaves	Lf. area	% Internodes	% Rachises
Air blast	58.0	9.3	11.7	8.3
PropTec	64.4	8.8	4.2	3.3

No significant difference (*P* = 0.05) between sprayers for any measure of disease control

Table 5. Disease control at Naples (cv. 'Niagara)

Application	% Powdery mildew		% Downy mildew		Phomopsis (%)	
	Leaves	Leaf area	Leaves	Leaf area	Clusters	Clstr area
Air blast, 50 gpa	32.0 a	3.7 ns	17.3 ns	1.6 ns	42.7 a	5.1 ns
PropTec, 50 gpa	8.7 b	0.3	14.0	0.6	20.0 ab	2.1
PropTec, 30 gpa	12.0 ab	0.9	20.0	1.5	17.3 b	1.5

Values represent the average from three replicate plots per treatment. Values within a column not followed by a common letter are significantly different ($P = 0.05$). ns = no significant differnce.

Discussion

Spray drift of pesticides is an important and costly problem facing pesticide applicators. Drift results in damage to susceptible off target crops, environmental contamination to water courses and a lower than intended rate to the target crop, thus reducing the effectiveness of the pesticide. Pesticide drift also affects neighbouring properties, often leading to concern and debate.

On both farms, drift from the air blast sprayer was detected up to 6 rows from the target. Drift was greatly reduced from the Proptec. The air inclusion nozzles also reduced drift compared with the air blast sprayer.

Smaller droplets (<100um) may be projected 10m or more vertically. For hydraulic nozzles found on air blast sprayers, 45% maybe in the 30-100um. Research shows that deposition efficiencies are typically only 55% of the applied spray.

The effectiveness of the air inclusion nozzles maybe lost due to the air stream disrupting the air bubbles, breaking them into smaller droplets which are then carried further. Further trials are needed to see if the position of the nozzles, in relation to the wind direction from the fan, has any effect on drift. Altering the angle of attack of the airflow relative to the crop, i.e. at angles of 30-45^{o} to the rear of the sprayer can influence the spray deposit and the level of drift.

It is interesting to note the effectiveness of the Proptec at 30 gpa, compared with 50 gpa. The literature review in Italy shows the highest deposition on foliage was recorded for the combination of low spray rate and low air flow rate in a hedgerow vineyard (54.2-56.7%) when using an axial fan sprayer. Research in the USA also found that in all cases air inclusion nozzles produced larger droplets with a smaller portion of the spectrum containing drift prone droplets and reduced drift on herbicide sprayers.

Atmospheric conditions influence the effectiveness of crop spraying. When water is used as a carrier, evapouration can be a major problem. As drops become smaller, <150um, the ratio of surface area to volume increases resulting in a high evapouration rate. Very small droplets, <50um, can evapourate fully to the core and can be carried away in wind currents.

Strong winds (v>6mph) can result in drift. Conversely the total absence of wind (v<1mph) can be dangerous, especially in temperature inversion conditions that typically occur on very hot days. A spray cloud may remain airborne and when air currents appear, spray may be deposited some distance from the intended target.

Measuring drift from vineyards is very difficult due to changing wind direction, velocity, canopy profile and tracer. There are probably as many techniques to measure drift as there are researchers conducting drift studies. Water sensitive card targets were successful in trials conducted by other USA researchers and the percent area coverage appeared to be most reliable.

At Forestville there was no significant difference between the sprayers during the first two applications as the canopy was still growing. There was a significant difference in the final application when the Berthoud gave better deposition. There was a significant difference between positions within the canopy. At Naples there was no significant difference between sprayers. There was a significant difference between positions in the canopy.

The deposition results, using iron micronutrients, showed the Proptec to be similar, but not significantly better than the air blast sprayer. The major difference was on the internal deposition from the Proptec at Forestville.

The results on drift and deposition will benefit the viticulture industry by giving a good insight into the performance of two types of crop sprayer. The new Proptec, performs to certain expectations;-

a) more accurate application of product in certain conditions
b) less drift, therefore reducing public concern
c) less water used, resulting in greater output and better timeliness

Disease pressure was light at the Forestville site, and there was no difference between the sprayers relative to the control provided. In contrast, the PropTec unit provided significantly better control of both powdery mildew and Phomopsis fruit rot at the Naples site. Differences in disease control between the 30 gpa and 50 gpa application volumes with this unit were minor and were not statistically significant, i.e., they could not reliably be attributed to factors other than variability among replicate plots.

These are preliminary results from one season of use, further research, particularly when weather conditions are different is necessary to give a greater understanding.

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