Wine Australia

The Australian Wine Research Institute

Liquid flow and air flow

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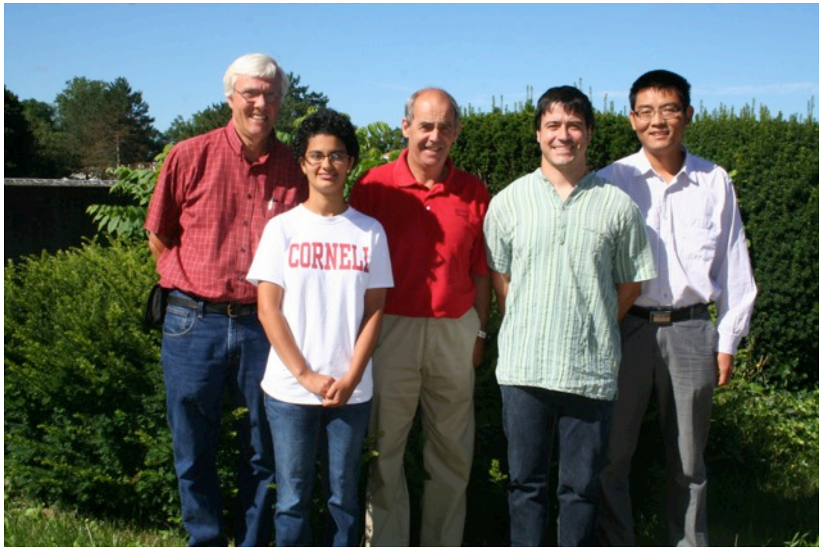
International Pesticide Application Technology at Cornell University

Improving pesticide application via engineering methods

Comparative testing of novel sprayers

Developing methods to improve deposition and reduce drift

Extension demonstrations of novel sprayers



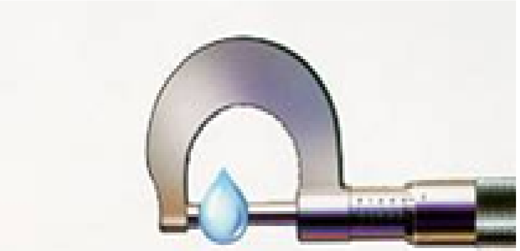
Droplets

ASAE Standard				Comparative Size		
Symbol	Category	Code	Apx. VMD	Relative Size	Comparative Size	Atomization
VF	Very Fine	Red	<100		Point of Needle	Fog
F	Fine	Orange	100-175		Human Hair (100 Microns)	Fine Mist
M	Medium	Yellow	175-250		Sewing Thread (150 Microns)	Fine Drizzle
C	Coarse	Blue	250-375			
[illegible]	[illegible]	[illegible]	[illegible]		[illegible] (420 Microns)	[illegible]
EC	Extremely Coarse	White	>450		#2 Pencil Lead (2000 Microns)	Thunderstorm

Droplets

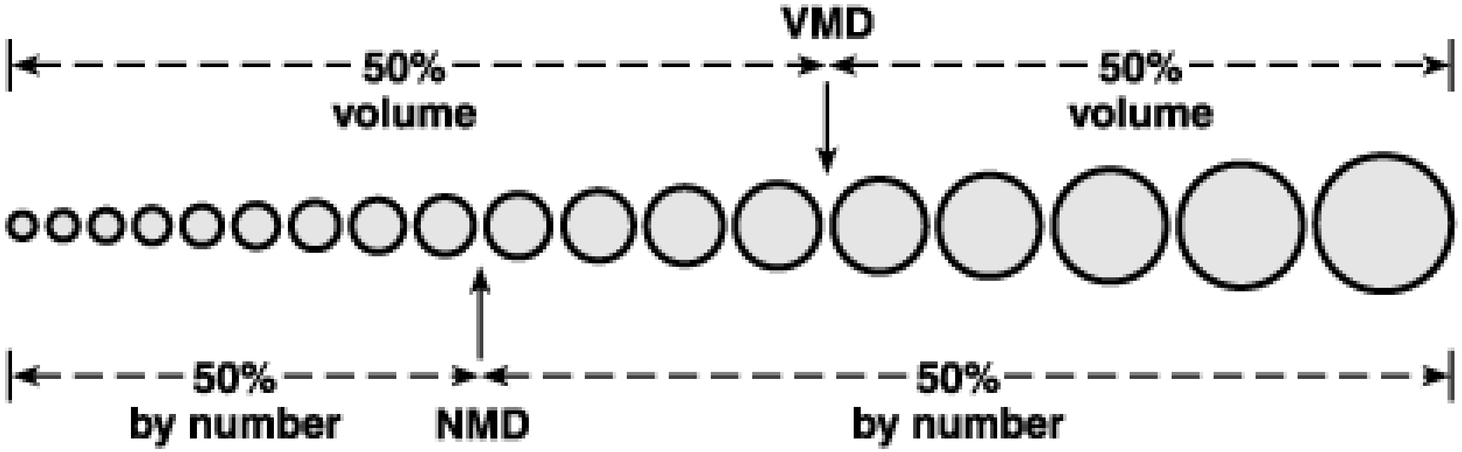
Drop Size:

Spray droplets are measured in microns and expressed as Volume Median Diameter (VMD).

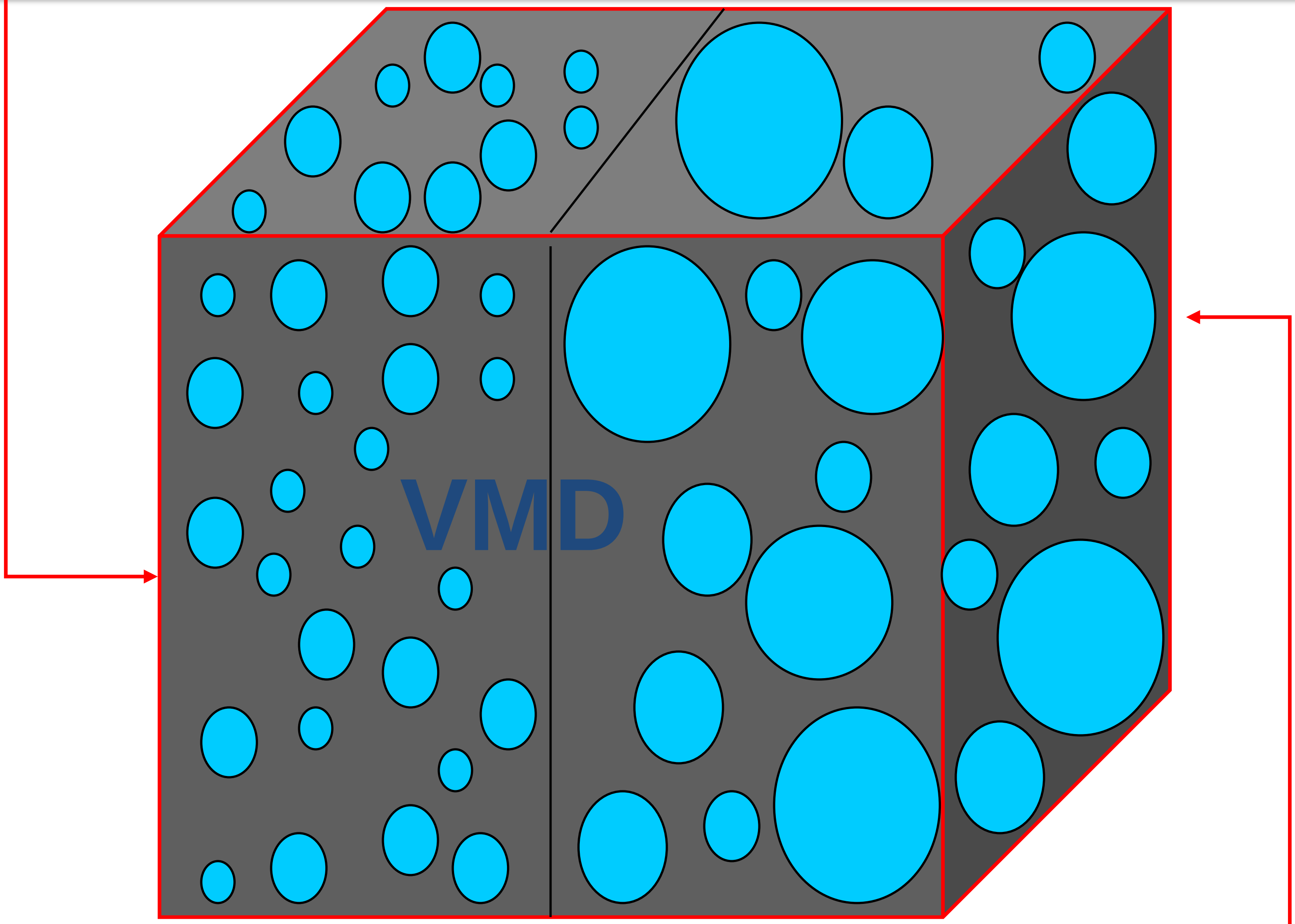


One micron (μm) =1/1000 mm

VMD or NMD ?



1/2 of spray volume = smaller droplets

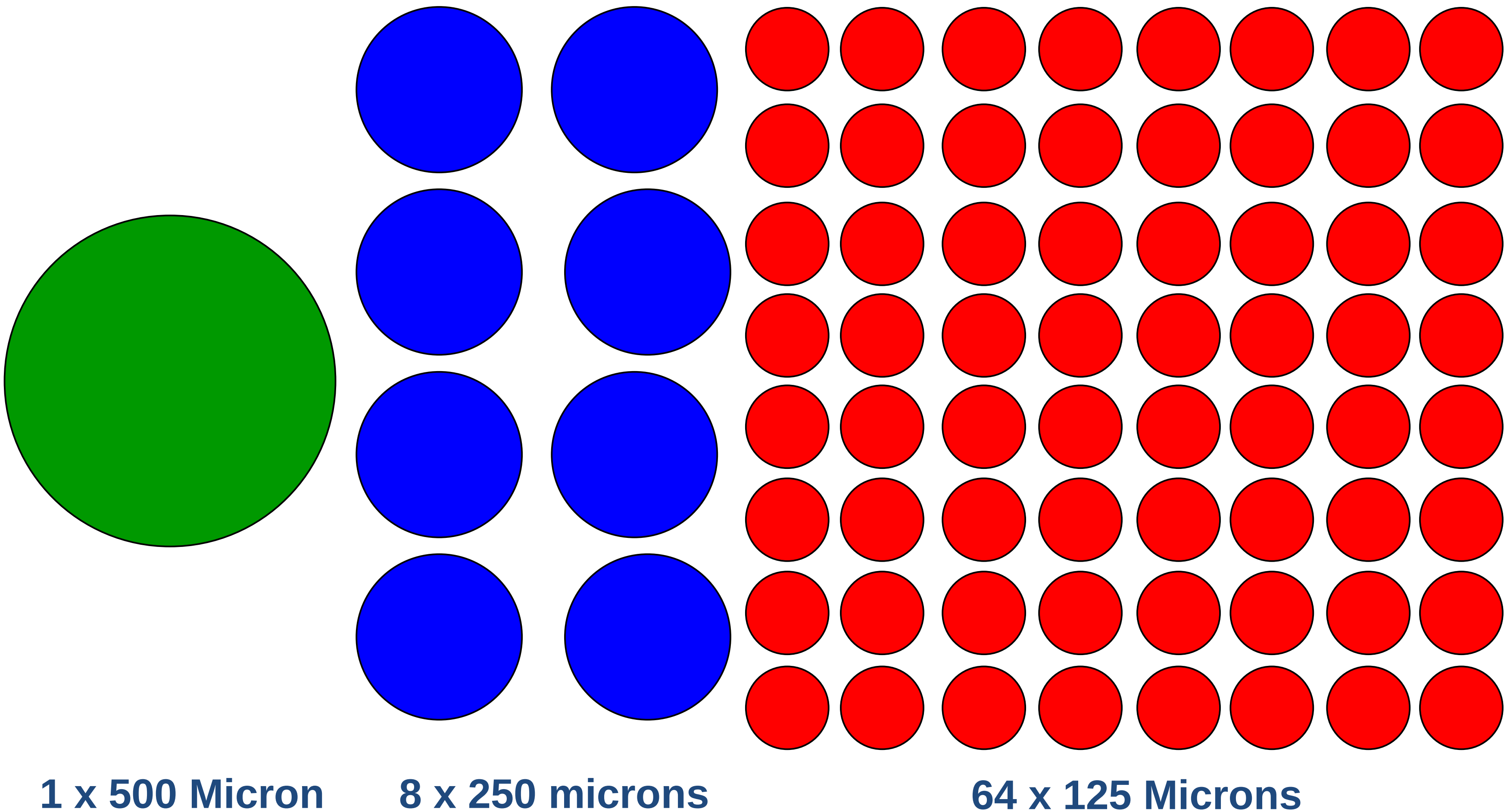


1/2 of spray volume = larger droplets

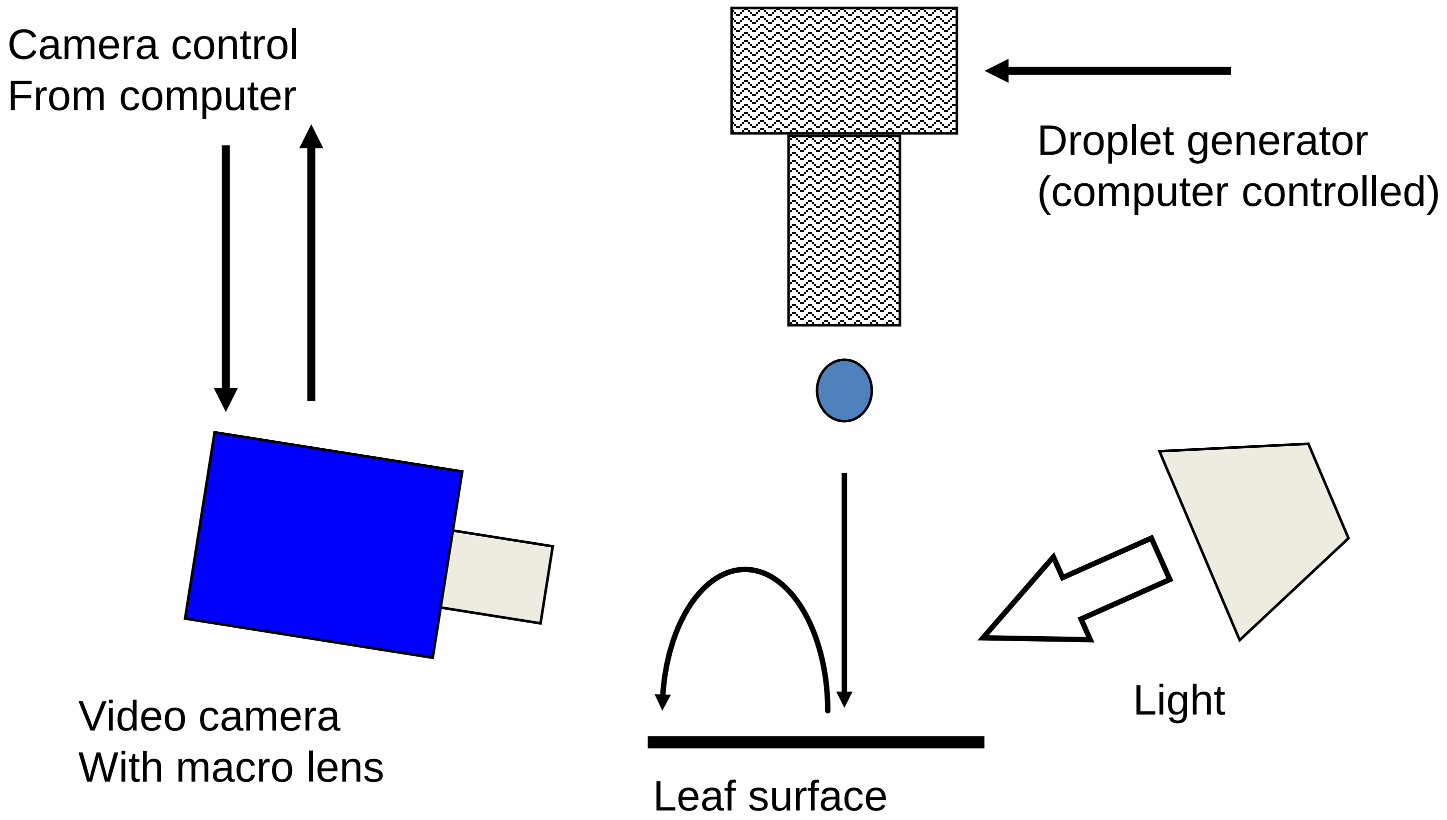
Credit: Tom Wolf

Laser Droplet Analyzer

Halving droplet size results in eight times the number of droplets

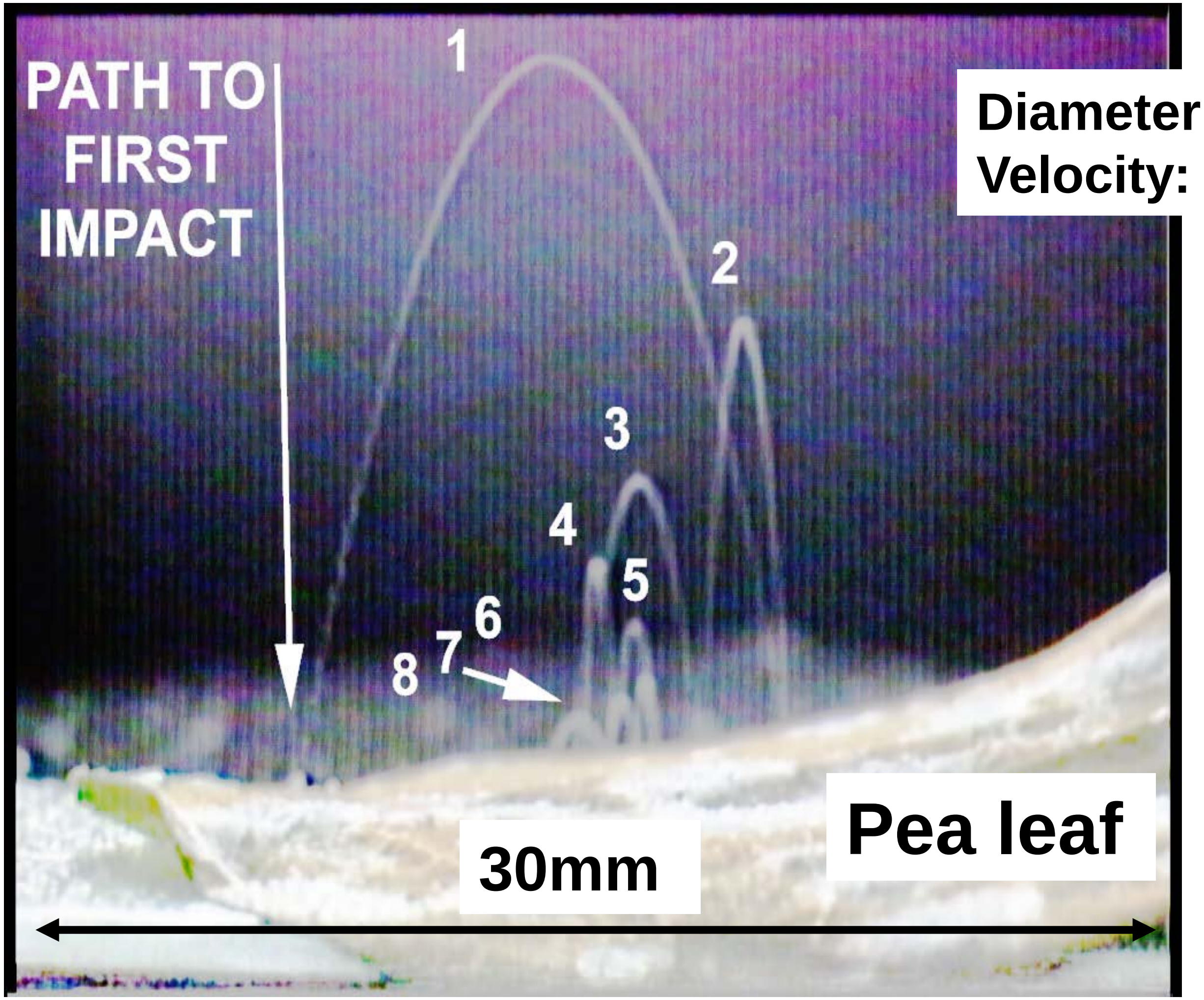


Observing droplet trajectories

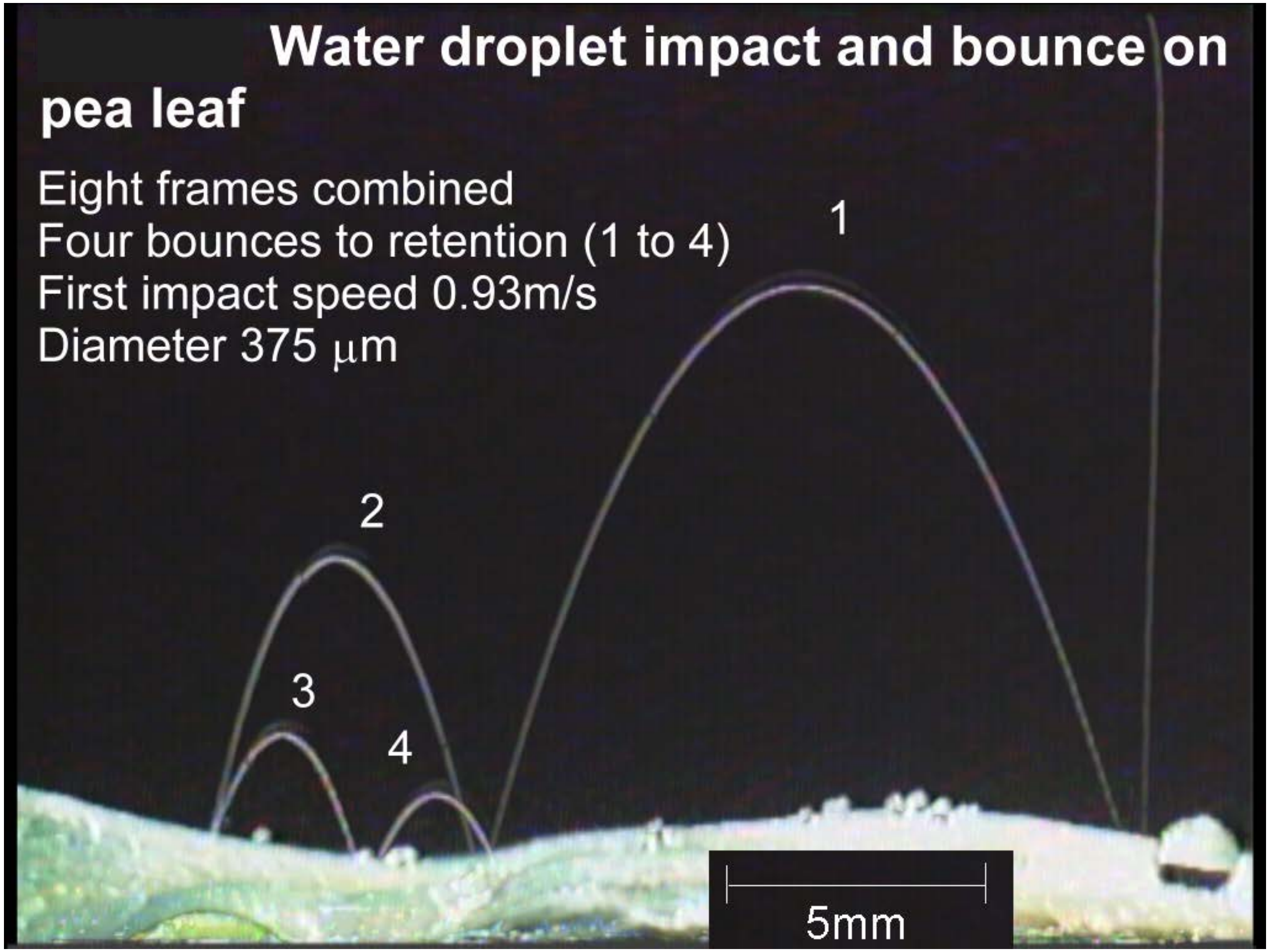


Droplets appear as streaks whose length is controlled by the shutter speed of the camera

A large water droplet bouncing on a pea leaf



A smaller water droplet bouncing on a pea leaf



Source: Application Technology Group
NYSAES, Geneva, NY

Flat fan nozzle selection

Select the correct nozzles:

Fine/Medium/Coarse

Fine **(F)** for contact products

Medium **(M)** for herbicides

Coarse **(C)** for pre-emergent herbicides

Nozzle	bar	DROP SIZE 80°	DROP SIZE 110°	CAPACITY ONE NOZZLE IN l/min	l/ha 50cm 4 km/h	5 km/h	6 km/h	7 km/h	8 km/h	10 km/h	12 km/h	16 km/h	18 km/h
XR8001 XR11001 (100)	1.0	M	F	0.23	69.0	55.2	46.0	39.4	34.5	27.6	23.0	17.3	15.3
	1.5	F	F	0.28	84.0	67.2	56.0	48.0	42.0	33.6	28.0	21.0	18.7
	2.0	F	F	0.32	96.0	76.8	64.0	54.9	48.0	38.4	32.0	24.0	21.3
	2.5	F	F	0.36	108	86.4	72.0	61.7	54.0	43.2	36.0	27.0	24.0
	3.0	F	F	0.39	117	93.6	78.0	66.9	58.5	46.8	39.0	29.3	26.0
	4.0	F	VF	0.45	135	108	90.0	77.1	67.5	54.0	45.0	33.8	30.0
XR80015 XR110015 (100)	1.0	M	F	0.34	102	81.6	68.0	58.3	51.0	40.8	34.0	25.5	22.7
	1.5	M	F	0.42	126	101	84.0	72.0	63.0	50.4	42.0	31.5	28.0
	2.0	F	F	0.48	144	115	96.0	82.3	72.0	57.6	48.0	36.0	32.0
	2.5	F	F	0.54	162	130	108	92.6	81.0	64.8	54.0	40.5	36.0
	3.0	F	F	0.59	177	142	118	101	88.5	70.8	59.0	44.3	39.3
	4.0	F	F	0.68	204	163	136	117	102	81.6	68.0	51.0	45.3
XR8002 XR11002 (50)	1.0	M	M	0.46	138	110	92.0	78.9	69.0	55.2	46.0	34.5	30.7
	1.5	M	F	0.56	168	134	112	96.0	84.0	67.2	56.0	42.0	37.3
	2.0	M	F	0.65	195	156	130	111	97.5	78.0	65.0	48.8	43.3
	2.5	M	F	0.72	216	173	144	123	108	86.4	72.0	54.0	48.0
	3.0	F	F	0.79	237	190	158	135	119	94.8	79.0	59.3	52.7
	4.0	F	F	0.91	273	218	182	156	137	109	91.0	68.3	60.7
XR110025 (50)	1.0		M	0.57	171	137	114	97.7	85.5	68.4	57.0	42.8	38.0
	1.5		M	0.70	210	168	140	120	105	84.0	70.0	52.5	46.7
	2.0		F	0.81	243	194	162	139	122	97.2	81.0	60.8	54.0
	2.5		F	0.90	270	216	180	154	135	108	90.0	67.5	60.0
	3.0		F	0.99	297	238	198	170	149	119	99.0	74.3	66.0
	4.0		F	1.14	342	274	228	195	171	137	114	85.5	76.0
XR8003 XR11003 (50)	1.0	M	M	0.68	204	163	136	117	102	81.6	68.0	51.0	45.3
	1.5	M	M	0.83	249	199	166	142	125	99.6	83.0	62.3	55.3
	2.0	M	F	0.96	288	230	192	165	144	115	96.0	72.0	64.0
	2.5	M	F	1.08	324	259	216	185	162	130	108	81.0	72.0
	3.0	M	F	1.18	354	283	236	202	177	142	118	88.5	78.7
	4.0	M	F	1.36	408	326	272	233	204	163	136	102	90.7
XR8004 XR11004 (50)	1.0	C	M	0.91	273	218	182	156	137	109	91.0	68.3	60.7
	1.5	M	M	1.12	336	269	224	192	168	134	112	84.0	74.7
	2.0	M	M	1.29	387	310	258	221	194	155	129	96.8	86.0
	2.5	M	M	1.44	432	346	288	247	216	173	144	108	96.0
	3.0	M	M	1.58	474	379	316	271	237	190	158	119	105
	4.0	M	F	1.82	546	437	364	312	273	218	182	137	121

Note: 3rd column states spray quality

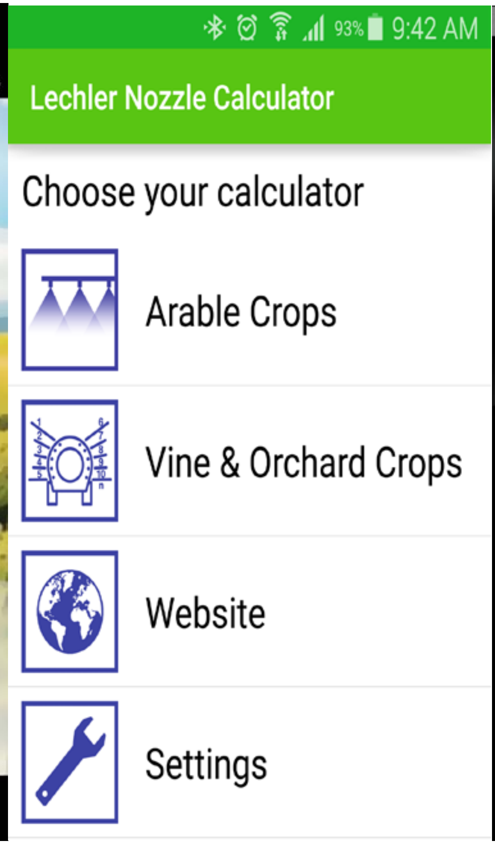
Nozzle catalogue – hollow cone

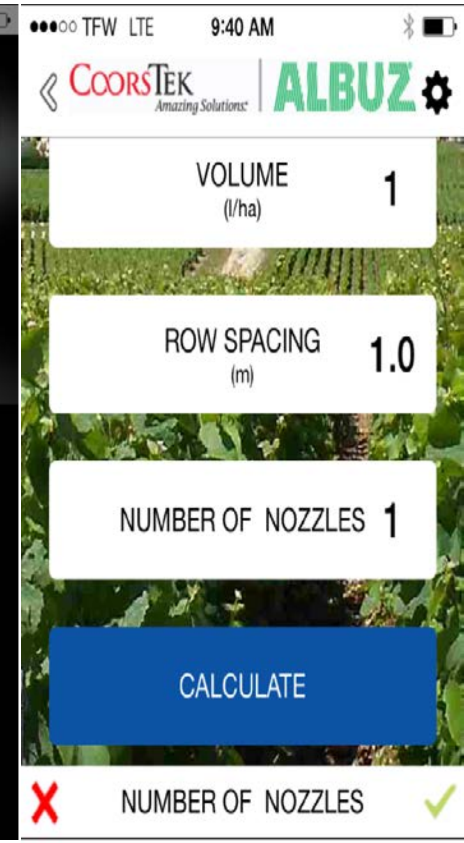
ALBUZ

FLOWRATE

bar	l/mn									
	WHITE	PINK	BROWN	YELLOW	ORANGE	RED	GREY	GREEN	BLACK	BLUE
3	0,21	0,28	0,38	0,57	0,77	1,08	1,18	1,40	1,57	1,92
4	0,24	0,32	0,43	0,65	0,89	1,24	1,35	1,60	1,80	2,20
5	0,27	0,36	0,48	0,73	0,99	1,38	1,50	1,78	2,00	2,45
6	0,29	0,39	0,52	0,80	1,08	1,51	1,63	1,94	2,18	2,67
7	0,32	0,42	0,56	0,86	1,17	1,62	1,76	2,09	2,35	2,87
8	0,34	0,45	0,60	0,92	1,24	1,73	1,87	2,22	2,50	3,06
9	0,36	0,48	0,64	0,97	1,32	1,83	1,98	2,35	2,64	3,24
10	0,38	0,50	0,67	1,03	1,39	1,92	2,08	2,47	2,78	3,40
11	0,39	0,52	0,70	1,07	1,45	2,01	2,17	2,58	2,90	3,56
12	0,41	0,55	0,73	1,12	1,51	2,09	2,26	2,69	3,03	3,71
13	0,43	0,57	0,76	1,17	1,57	2,17	2,35	2,79	3,14	3,85
14	0,44	0,59	0,79	1,21	1,63	2,25	2,43	2,89	3,26	3,99
15	0,46	0,61	0,81	1,25	1,69	2,33	2,51	2,99	3,36	4,12
16	0,47	0,63	0,84	1,29	1,74	2,40	2,59	3,08	3,47	4,25
17	0,48	0,64	0,86	1,33	1,79	2,47	2,67	3,17	3,57	4,37
18	0,50	0,66	0,89	1,37	1,84	2,54	2,74	3,25	3,67	4,49
19	0,51	0,68	0,91	1,40	1,89	2,60	2,81	3,34	3,76	4,61
20	0,52	0,70	0,93	1,44	1,94	2,67	2,88	3,42	3,85	4,72
21	0,54	0,71	0,95	1,48	1,99	2,73	2,95	3,50	3,94	4,84
22	0,55	0,73	0,98	1,51	2,03	2,79	3,01	3,57	4,03	4,94

Nozzle selection - smartphone apps





Calibration

Calibration

Calibration of airblast sprayers for vineyards

- Part 1 selecting and changing nozzles (metric version)

- Part 2 measuring liquid flow (metric version)

8 film clips on calibrating liquid flow and nozzle selection

Distance learning courses

(Cornell Univeristy)

Electronic nozzle tip testers

Patternator

Patternator

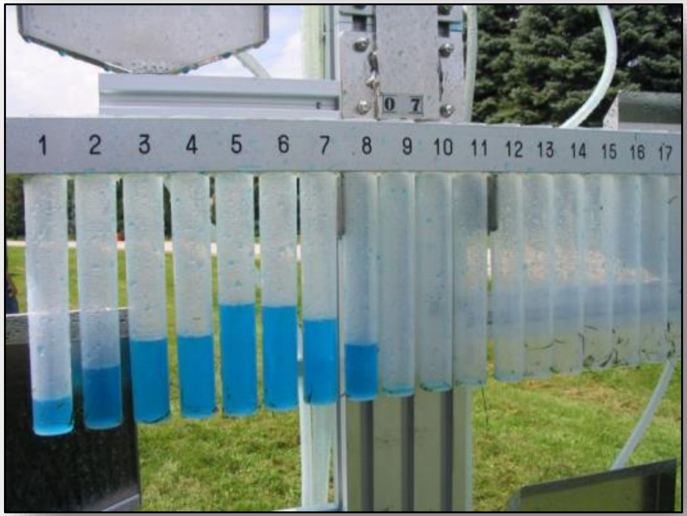
MIBO Vertical

Right side

1.Asymmetric

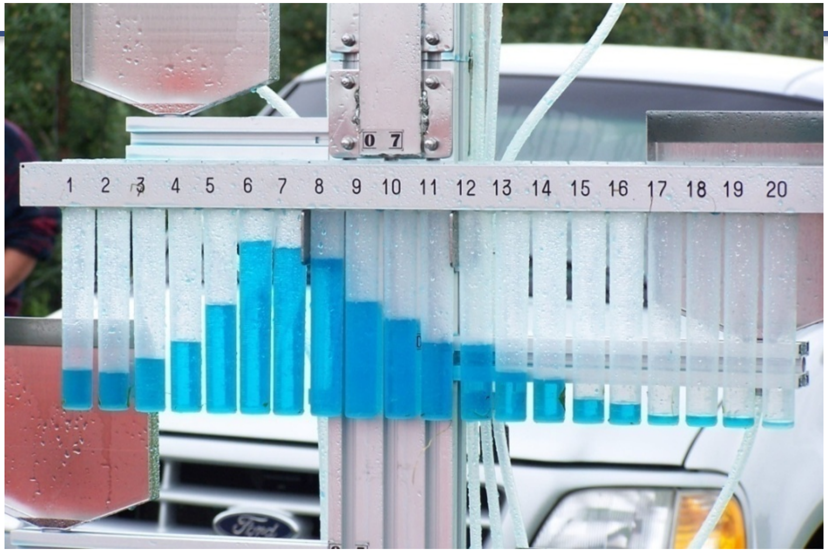
2. Overspray

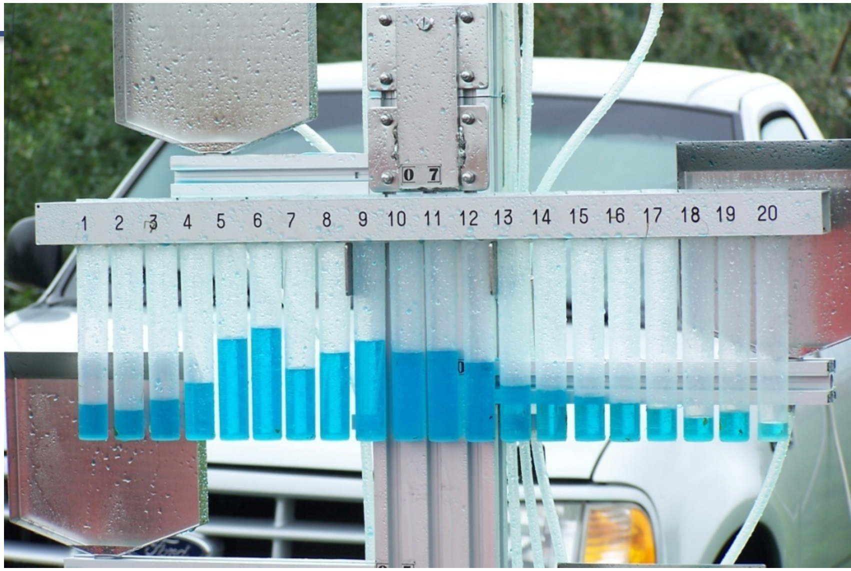
Left side

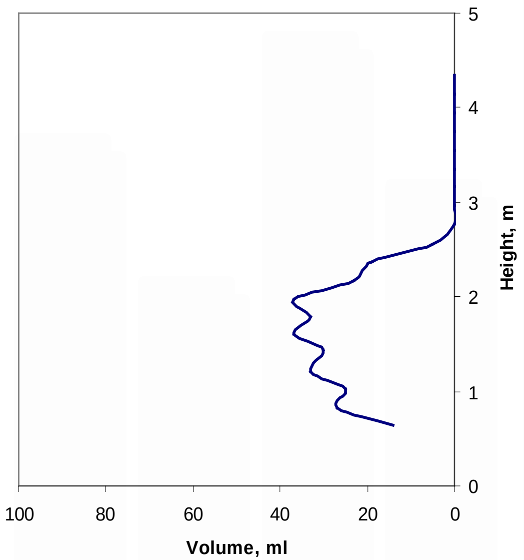


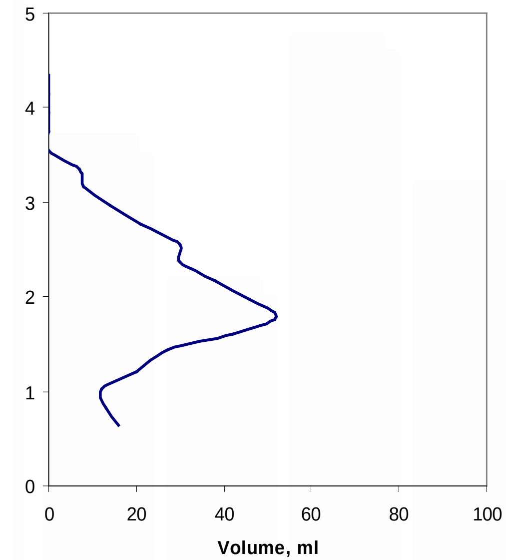
Landers, A.J., Balsari, P., Gil, E., (2012). Putting the spray onto the target – the development and demonstration of vertical patternators for fruit growers. Paper No. 121336783, ASABE.

Patternator

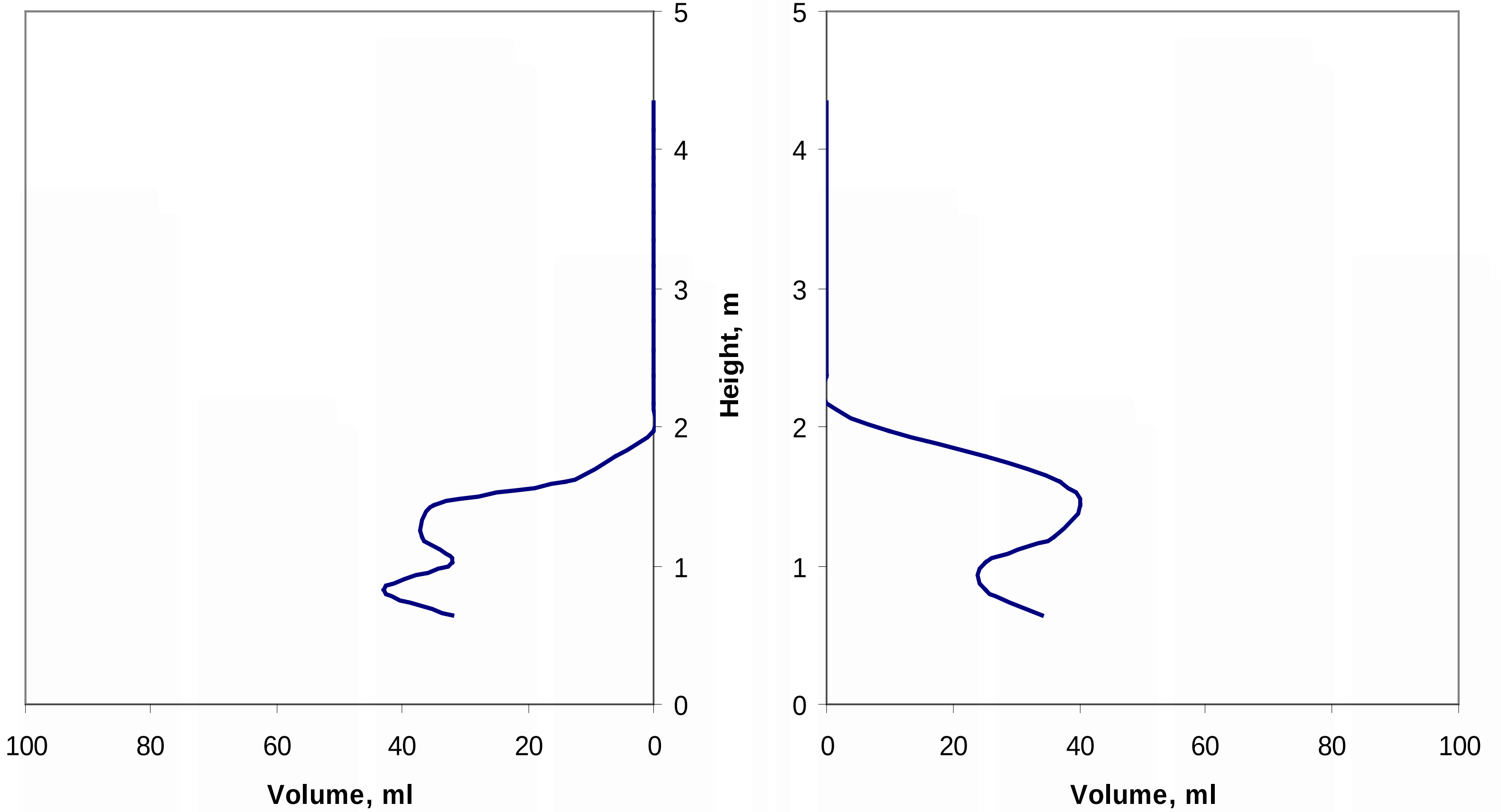








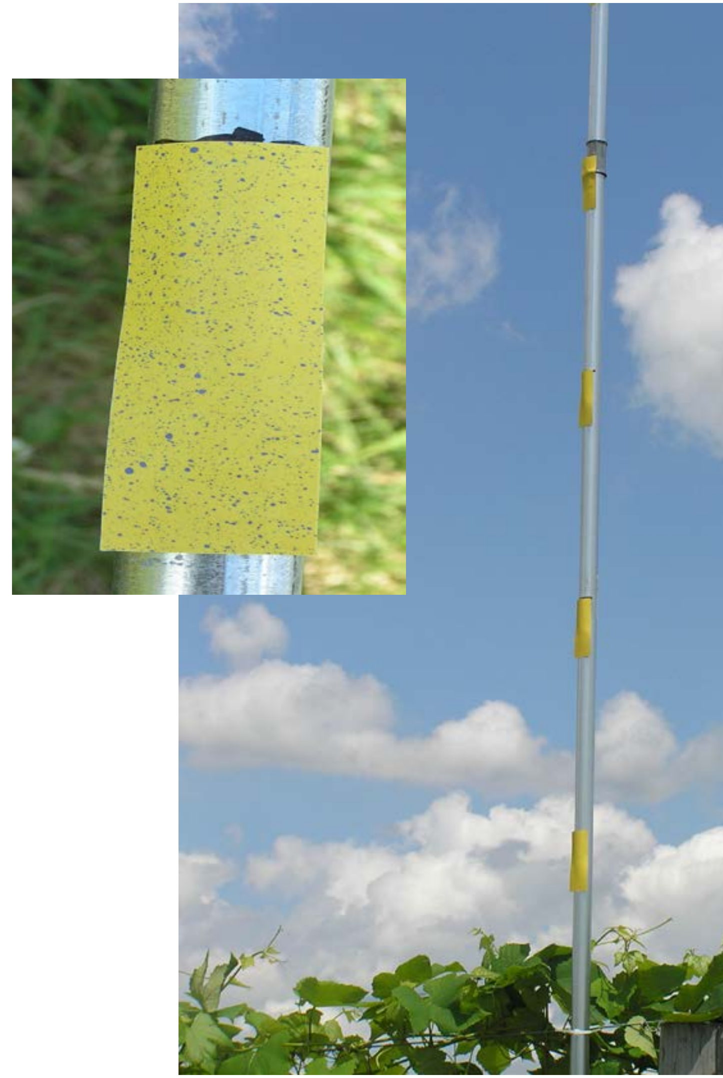
Improved setting for the canopy: adjusting nozzle orientation



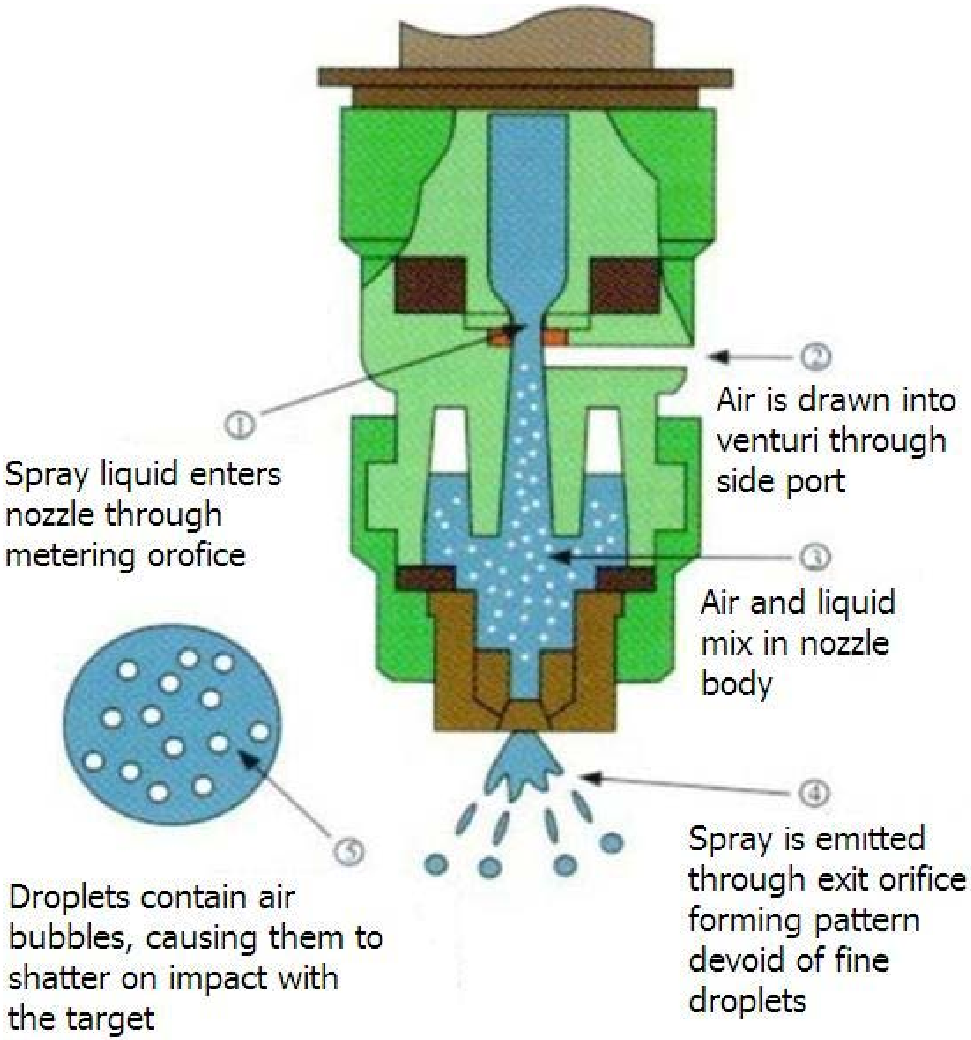
Patternator for growers to build

Patternator assembly instructions

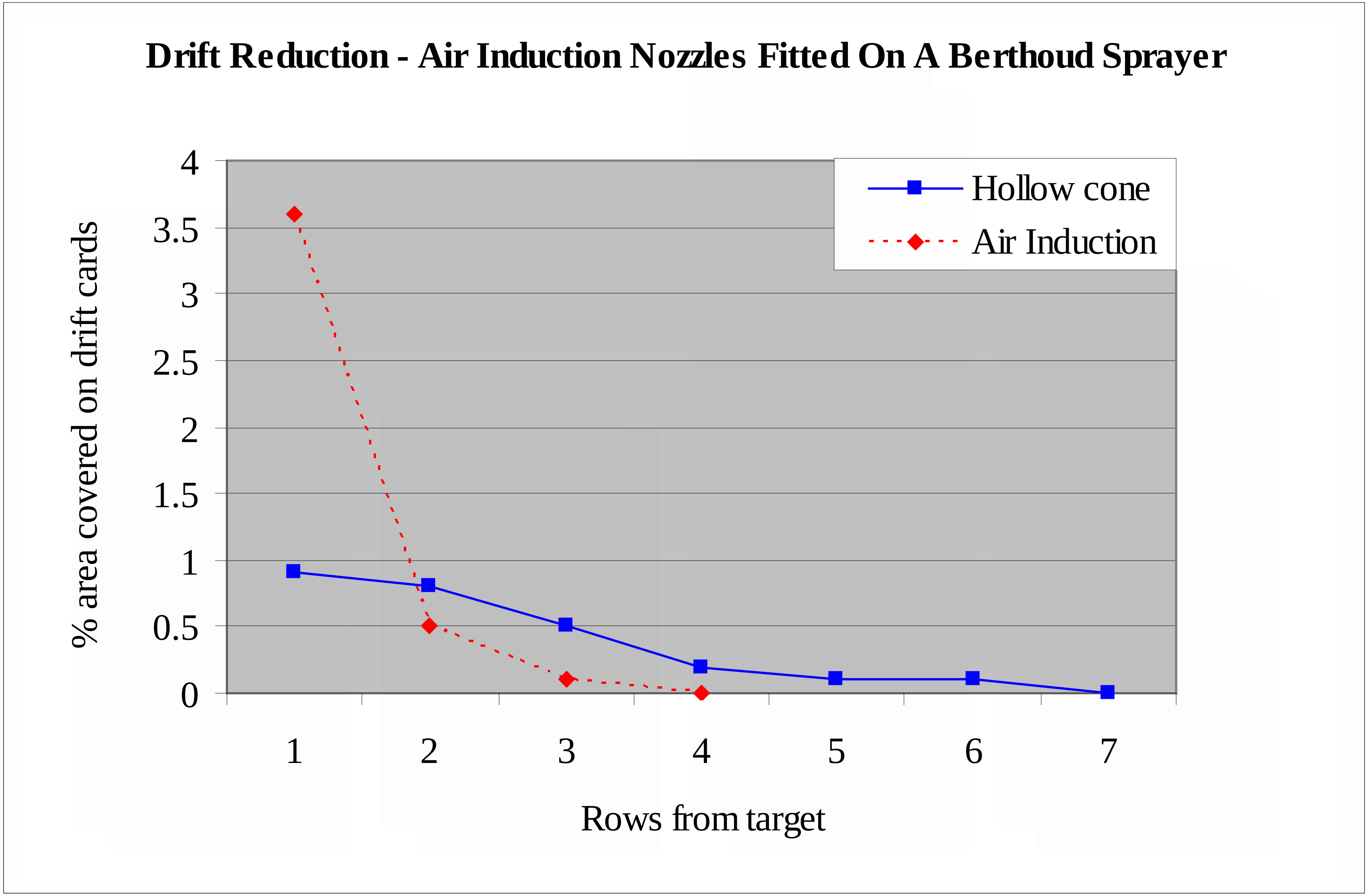
Drift poles to determine nozzle/plume direction



Air induction nozzles



Air induction nozzles



Precision application to the target zone

- Botrytis sprays to the fruit zone
- Grapevine Berry Moth sprays to the fruit zone
- Insecticide for Japanese Beetle at the top of the canopy

Target-zone sprayer

2-diaphragm pump/pressure regulator: $900
Hydraulic motor: $200
Motor to pump connector: $150

(Prices approx.)

Target-zone sprayer

Fitted to a Hazlitt 1852 CIMA sprayer

Low pressure, two diaphragm pump - 12 volt electric: $400 (approx.)

Dilution: water and agrochemical

Induction bowls and closed chemical transfer

Reduce operator exposure and environmental contamination

Why care about the air?

We change liquid flow rate with different size canopies including:

- Vine Row Volume
- Leaf Wall Area
- Dosavina
- Unit Canopy Row

Why not change airflow to match the developing canopy?

Airflow

Direction of the air
The speed of the air
The volume of air

The answer is blowing in the wind

- Transports droplets from the sprayer to the target
- Protects droplets against wind effects
- Droplet production (pneumatic sprayers)
- Provides shaking of the leaves in the canopy
- Provides good coverage on the target

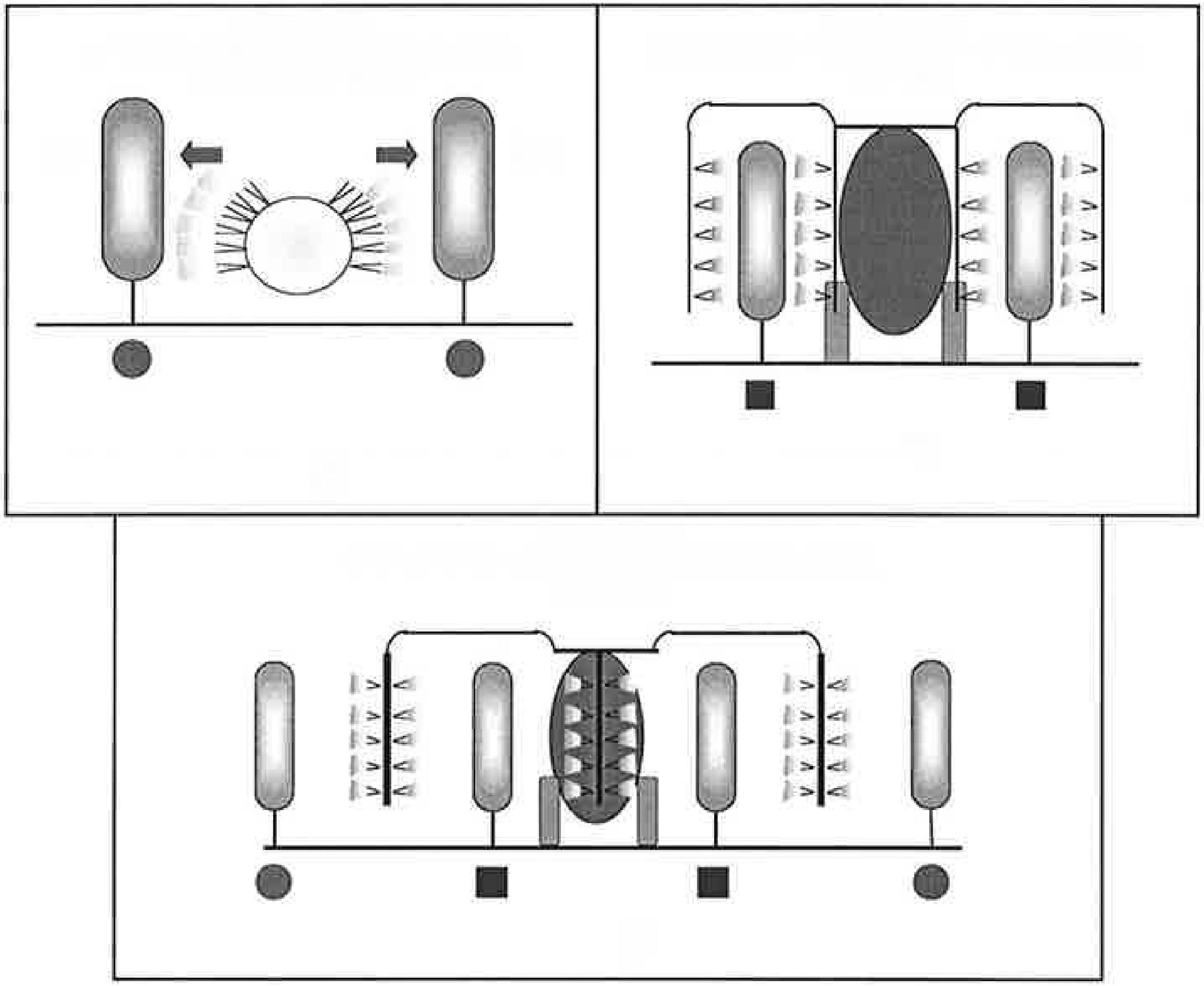
- Transports droplets through & past the target
- Excessive shaking of the canopy resulting in removing droplets already present on the target

Air direction

Deflectors and towers fitted to airblast sprayers to change air direction

Adjust airflow direction – park the plume

Air direction



Source: Balsari, P., Marucco, P. and Tamagnone, M. Workshop on spray application techniques in fruit growing, Barcelona 2005, pp.101-106

Air direction

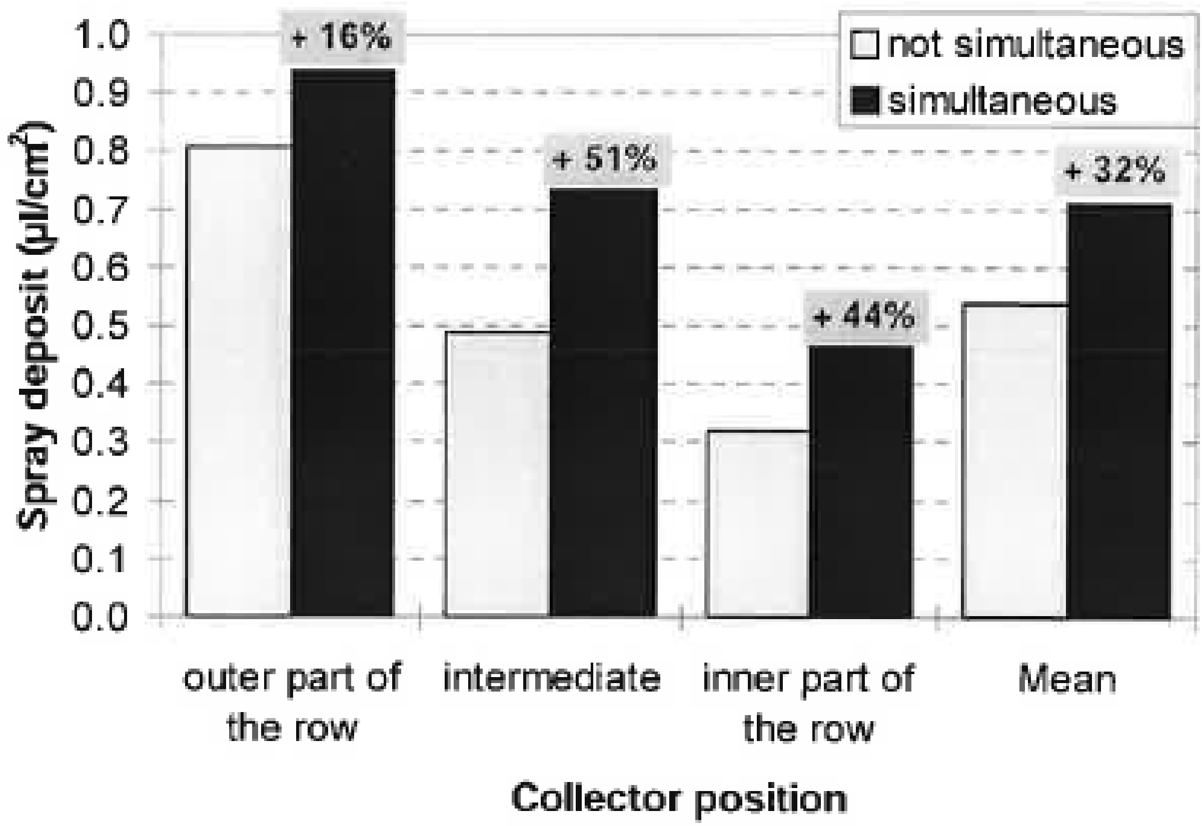


Figure 4. Spray deposits registered on the artificial collectors displayed within the canopy spraying both sides of the row simultaneously or not simultaneously

Source: Balsari, P., Marucco, P. and Tamagnone, M. Workshop on spray application techniques in fruit growing, Barcelona 2005, pp.101-106

Air direction

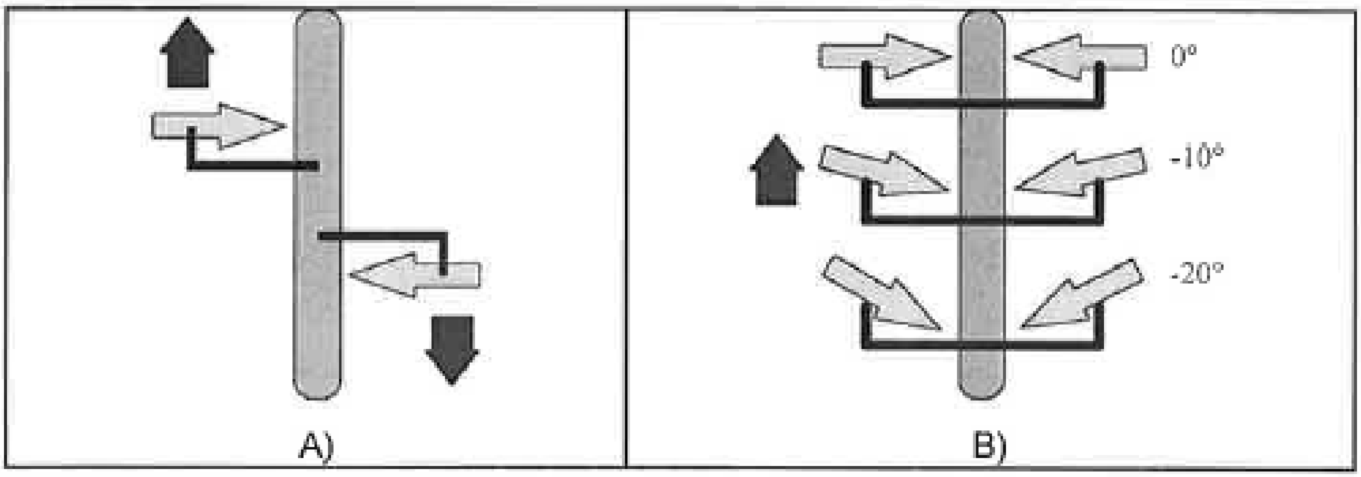


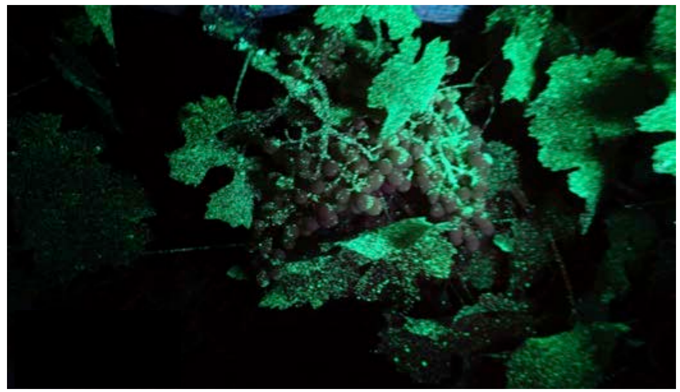
Figure 2. Schematic view of the sprayer configurations examined: A) spray distribution not simultaneous on the two side of the rows; B) spray distribution simultaneous on the two sides of the row with three different nozzles and air outlets orientation

Source: Balsari, P., Marucco, P. and Tamagnone, M. Workshop on spray application techniques in fruit growing, Barcelona 2005, pp.101-106

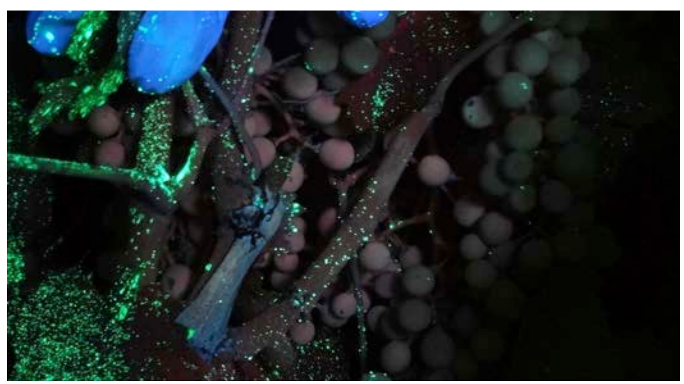
Park the plume

Air speed – grapes are the target

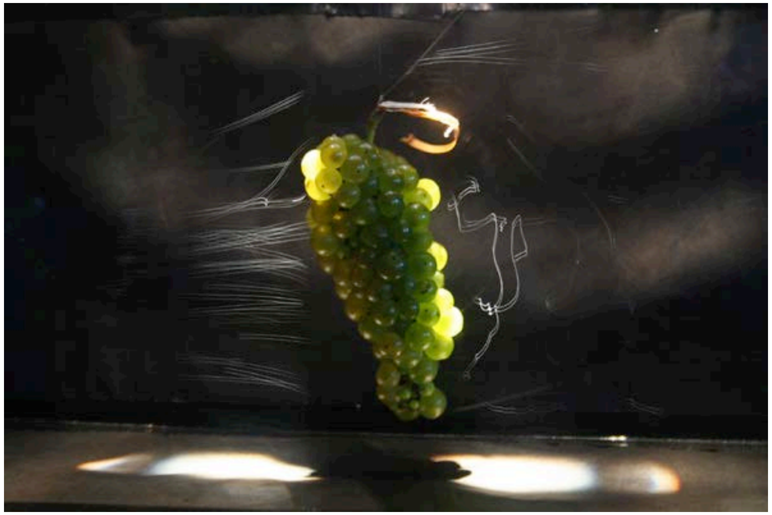
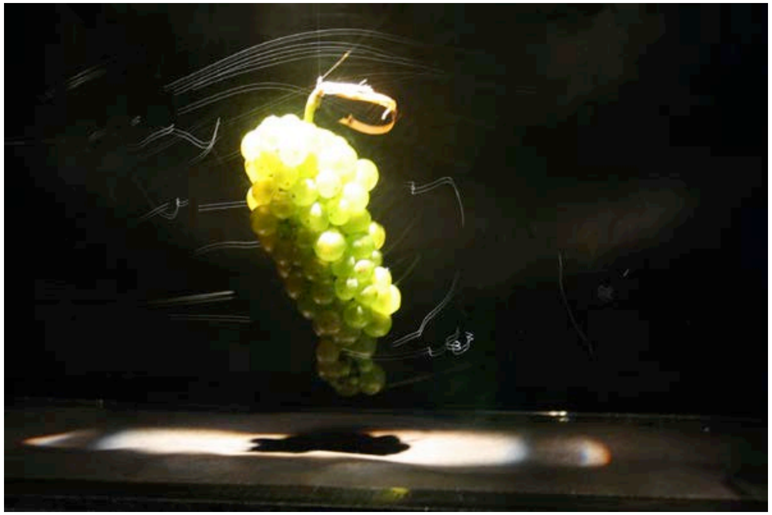
Good coverage

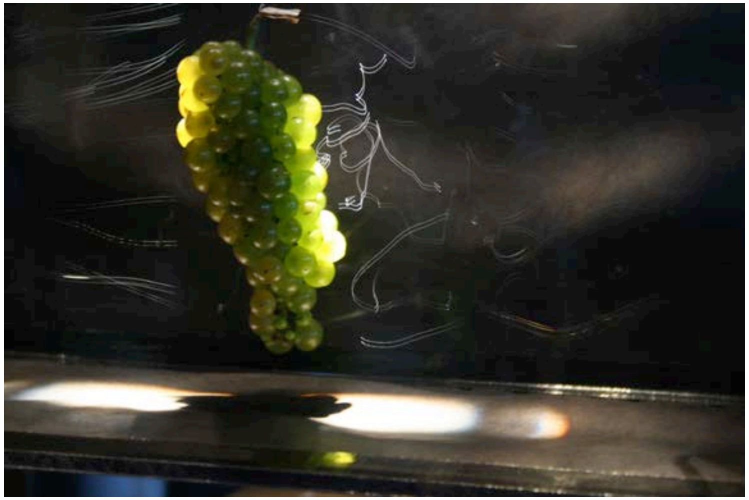


Poor coverage

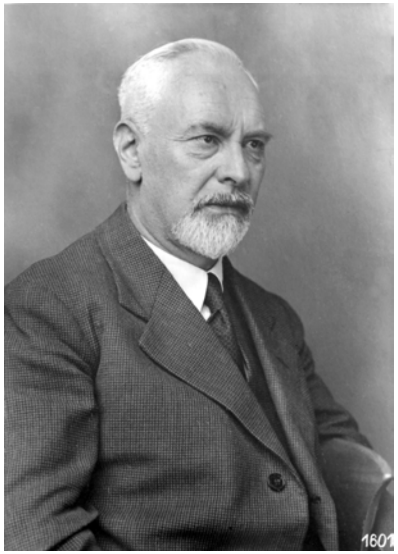


Wind tunnel observations



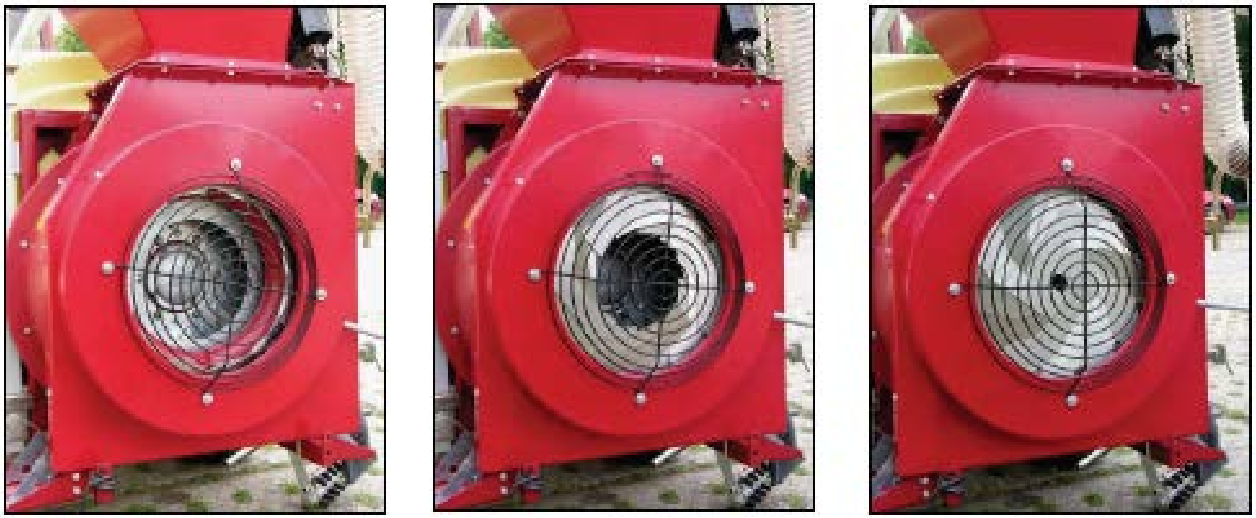
The classic horseshoe vortex



Ludwig Prandtl
1875 -1953

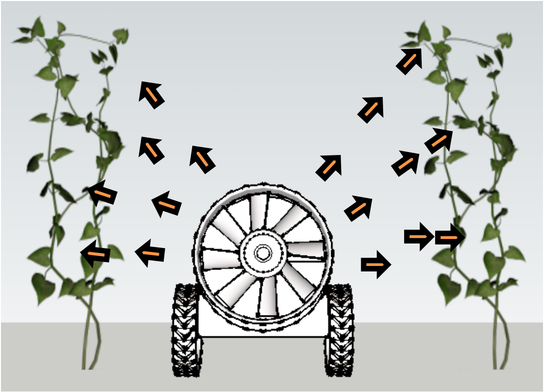
Adjusting the air volume intake

Cornell
Doughnut
(2002)

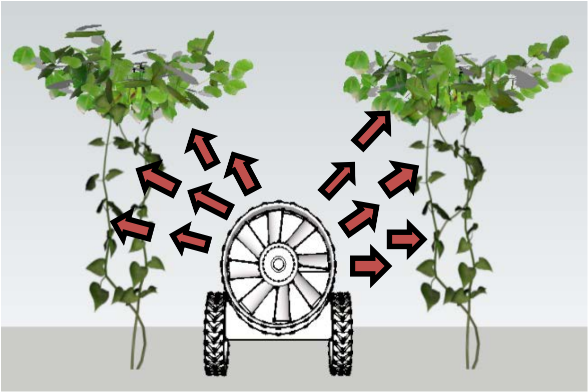


ISAFUIT project
Europe (2002-07)

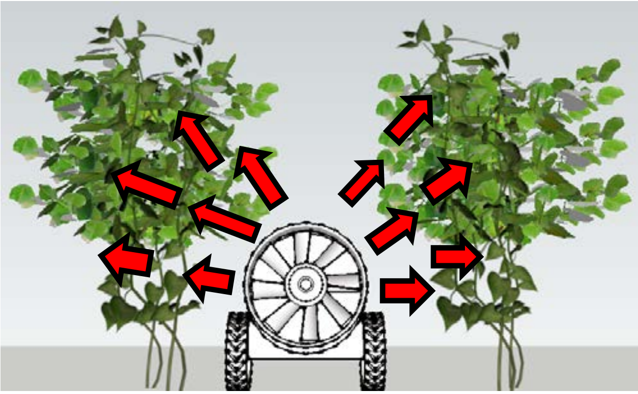
Adjustable Cornell louvre system



Early season –
Air flow reduced



Mid season –
Air flow adjusted

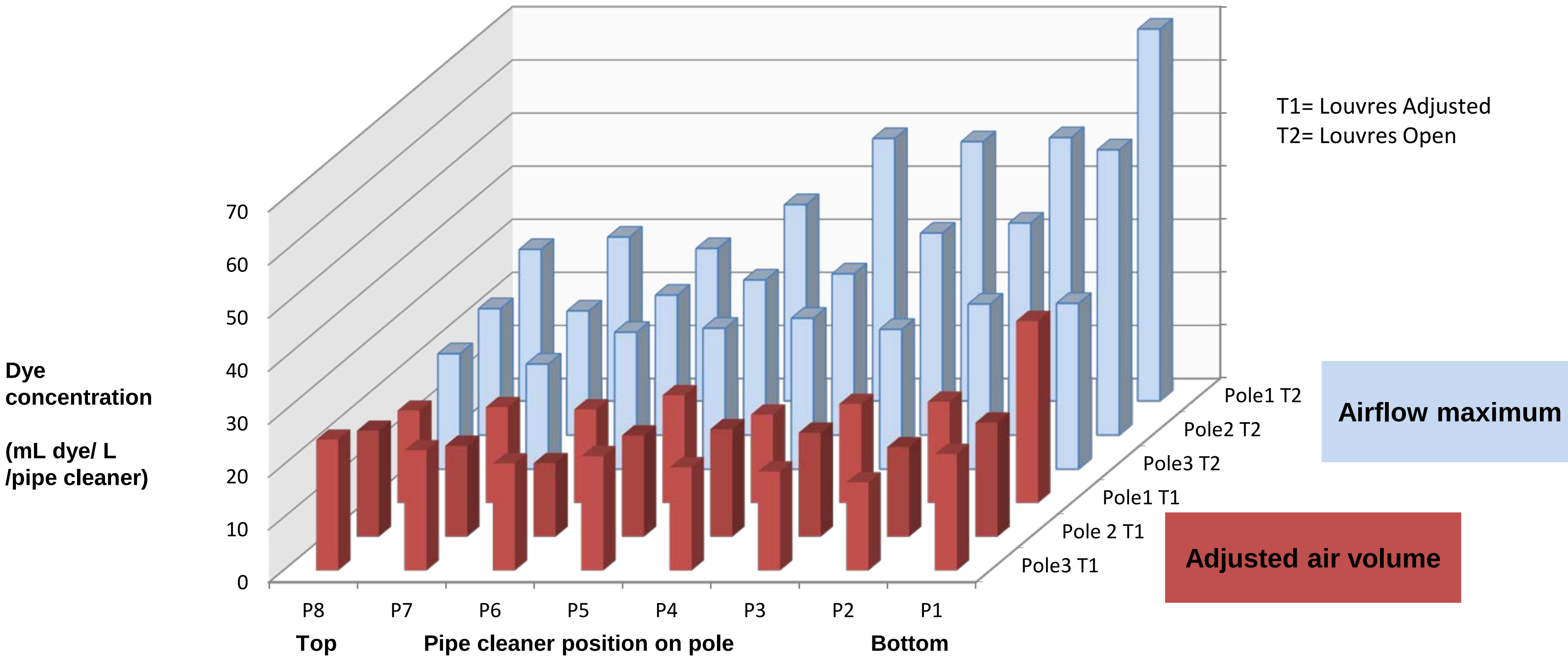


Full canopy –
Air flow fully open

Table 2. *FMC tower sprayer. Drift reduction and deposition increase in* V.vinifera *cv.Vignole vineyard*

Season	Early		Mid		Late	
Louvre position	Fully open	Adjusted	Fully open	Adjusted	Fully open	Adjusted
Drift reduction (%)	0	71	0	37	0	18
Deposition increase (%)	0	82	0	55	14	0

Drift measurements in *Vitis sp*. GR 7 vineyard 2010



Conclusions

Select the correct nozzle to provide the right size droplets

Calibrate the nozzles and spray plume

Reduce the airflow to match the canopy