Spray application 101: The basics of effective application

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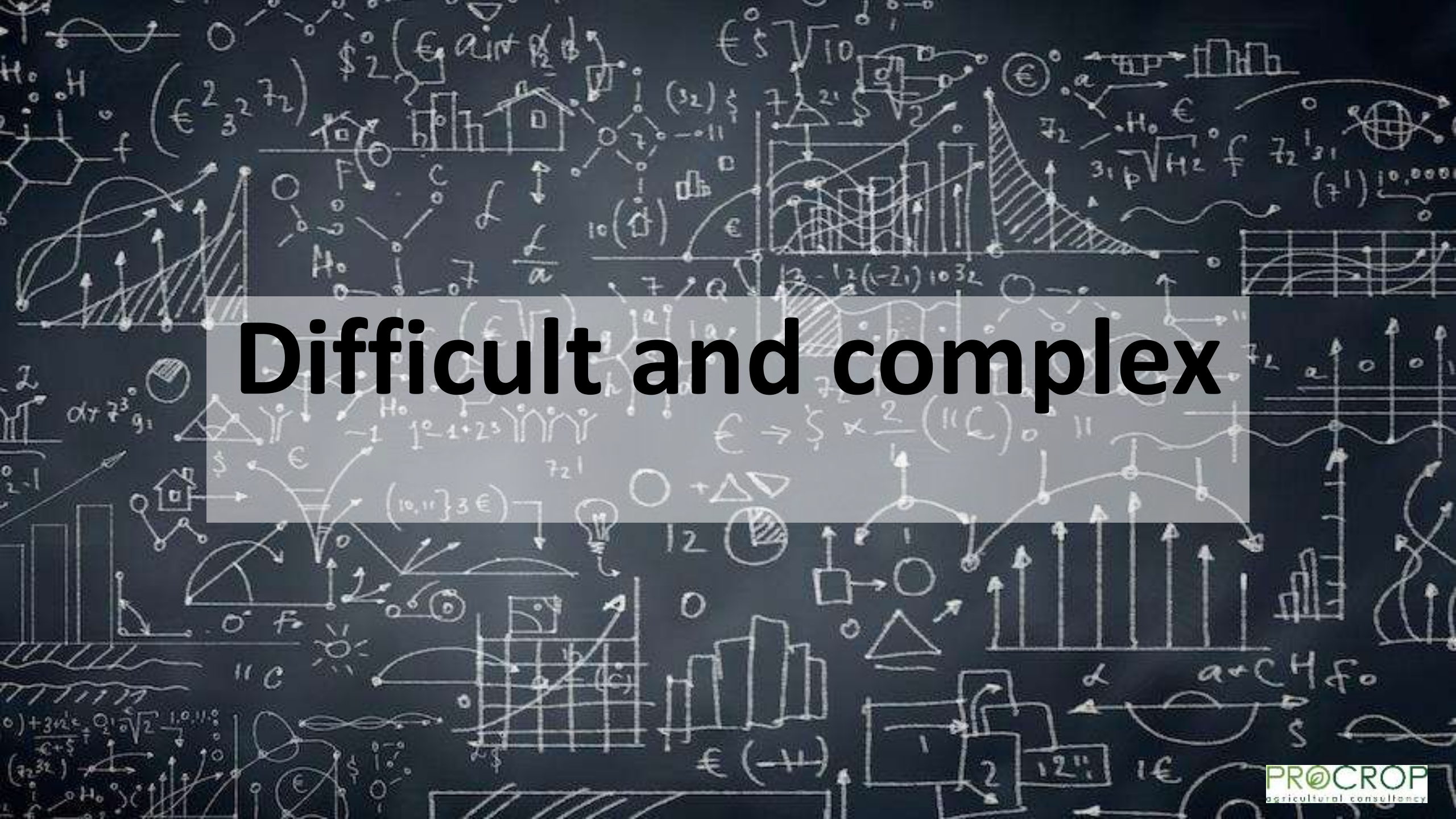
Difficult and complex

Blueberry bush is a complex target

- Canopy characteristics
  - Height, width and depth = canopy volume
  - Density – spray friendliness
- Varies between
  - Cultivars
  - Row spacing
  - Pruning strategy
  - Planting style (single, staggered or double rows)

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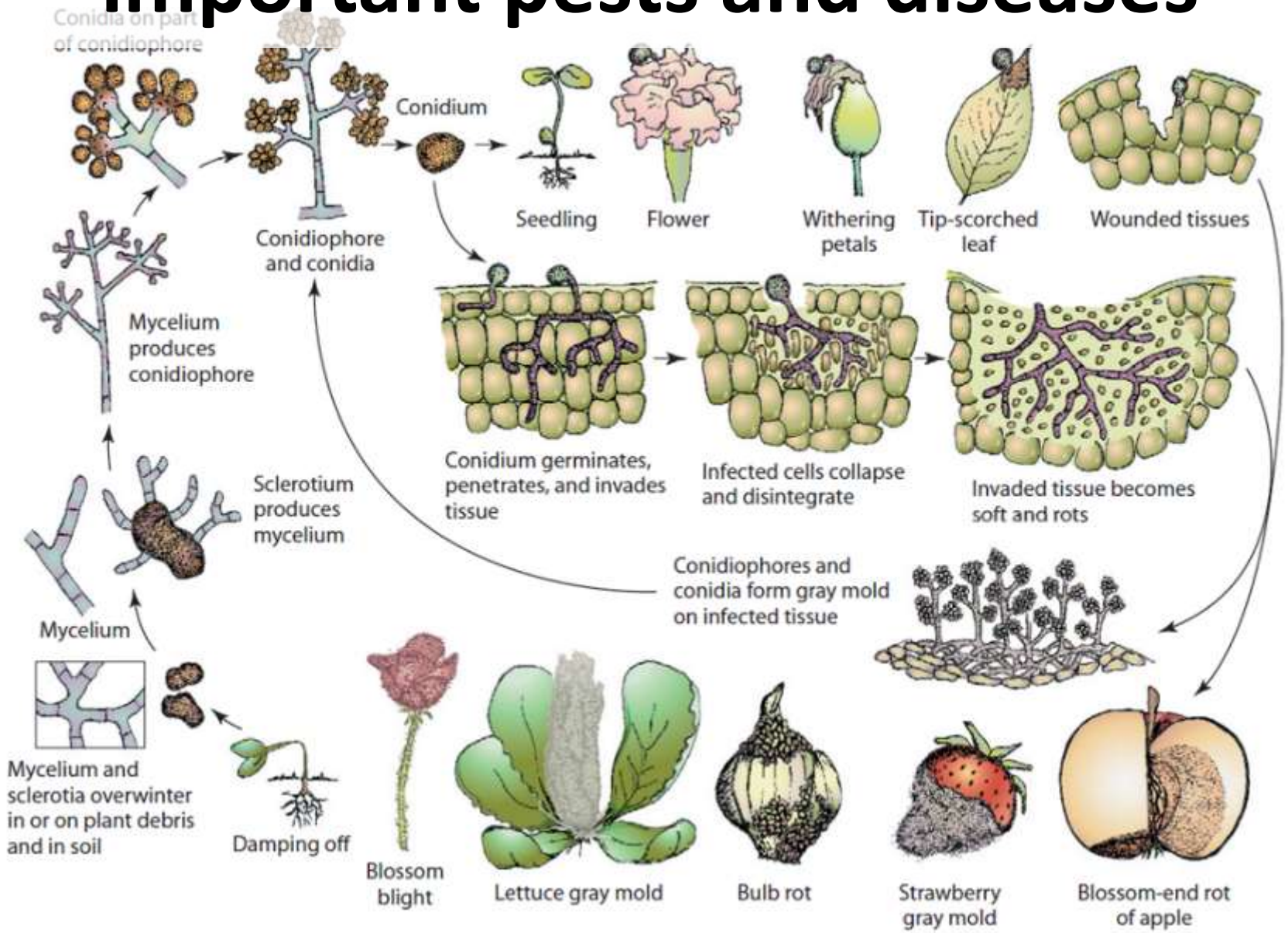
Growers confronted with important pests and diseases



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Plant protection products and application expensive

- Depending on disease or pest pressure, crop sprayed, crop destination and registered active ingredients available
- Loss of active ingredients through degregistration/banning
- Preventative vs Reactive application
- Program or strategic application
- Use of wrong or poorly maintained equipment

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Dose rate expression, use and registration

- Dose rate adaptation of active ingredients to modern trends
  - Non exsiting due to cost of reviewing registrations
  - Old registration methods
  - Forces producer to use non optimal guidelines

CROP/DISEASE	DOSAGE RATE	REMARKS
Berries: (Blackberry, Raspberry, Blueberry, Gooseberry and Strawberry) Botrytis rot (*Botrytis cinerea*)	500 ml/ha	Apply as a cover spray in 300 – 1000 ℓ water/ha from the early flowering stage up to 1 day before harvest. Repeat application after 10 - 14 days. **Apply a maximum of 2 Luna® Privilege sprays per season.**

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CROP/DISEASE	DOSAGE RATE	REMARKS
Berries (Blackb Raspbe Gooseb Strawb Botrytis (*Botrytis cinerea*)		early ation ason.

GEWAS EN PLAAG	DOSIS	OPMERKINGS
BLOUBESSIES *Botrytis cinerea*	120 mℓ /100 ℓ water in 500 tot 1000 ℓ water / ha	Dien **Scala** toe as 'n hoë volume voldekbespuiting. **Scala** mag slegs twee-maal per seisoen toegedien word tussen volblom en 3 dae vóór oes. **Scala** moet voorafgegaan en/òf opgevolg word met 'n Botrytis-middel met 'n ander werkswyse (nie-verwante chemiese Groepkode). * Sien "Weerstandswaarskuwing."

Dose rate expression, use and registration

- Dose rate adaptation of active ingredients to modern trends
  - Non exsiting due to cost of reviewing registrations
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CROP/DIS				
Strawberries	Grey mould (*Botrytis cinerea*)	2.0 L/ha	Apply Scala during flowering when conditions favour disease development. Repeat at 7 to 10 day intervals alternating with a fungicide of a different chemical group. Use the shorter application interval when disease pressure is high. **Note:** This use is subject to a CropLife Australia Resistance Management Strategy, which governs the **maximum number of applications** per season. Refer to 'Resistance Management Strategy – Strawberries' under General Instructions for guidelines. Use water volumes of 350 to 1000 L/ha depending on equipment and crop stage to ensure adequate penetration of the canopy and coverage of foliage and flowers and/or	

Pyrimethanil	Scala	400g/L SC	120ml/100L	9	5	3	8	3	Maximum 2 sprays per season. MRL San Lucar = 1.148ppm

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Spray application backbone of pre harvest disease management

Effectiveness of this process will determine the success of the harvest depending on disease pressure

- **Focus**
- **System setup (canopy adapted spraying)**
- **Calibration**
- **Dosing**

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Application effectiveness
+
PPP efficacy
=
Disease control

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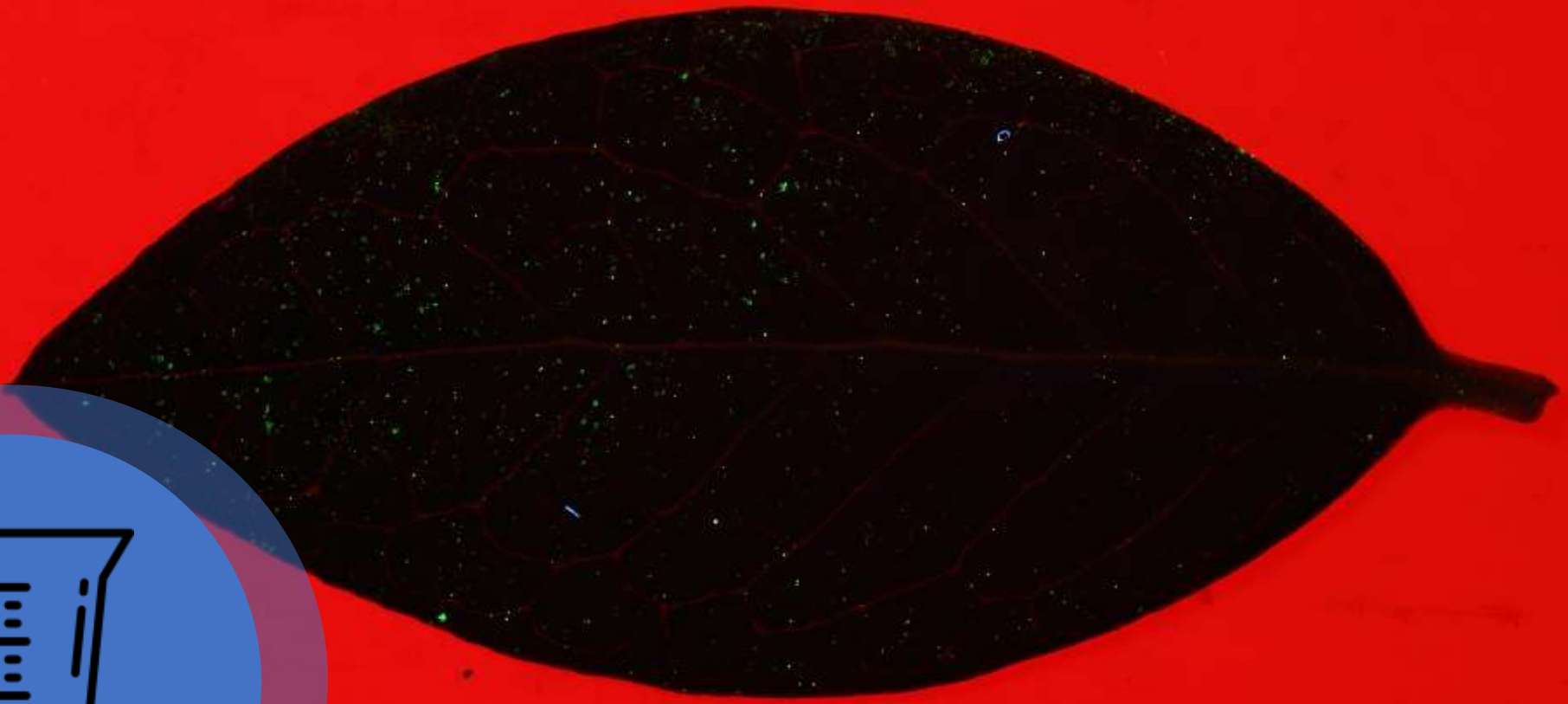
Quantity: Amount of active needed to protect/prevent/stop an infection



Deposition quantity

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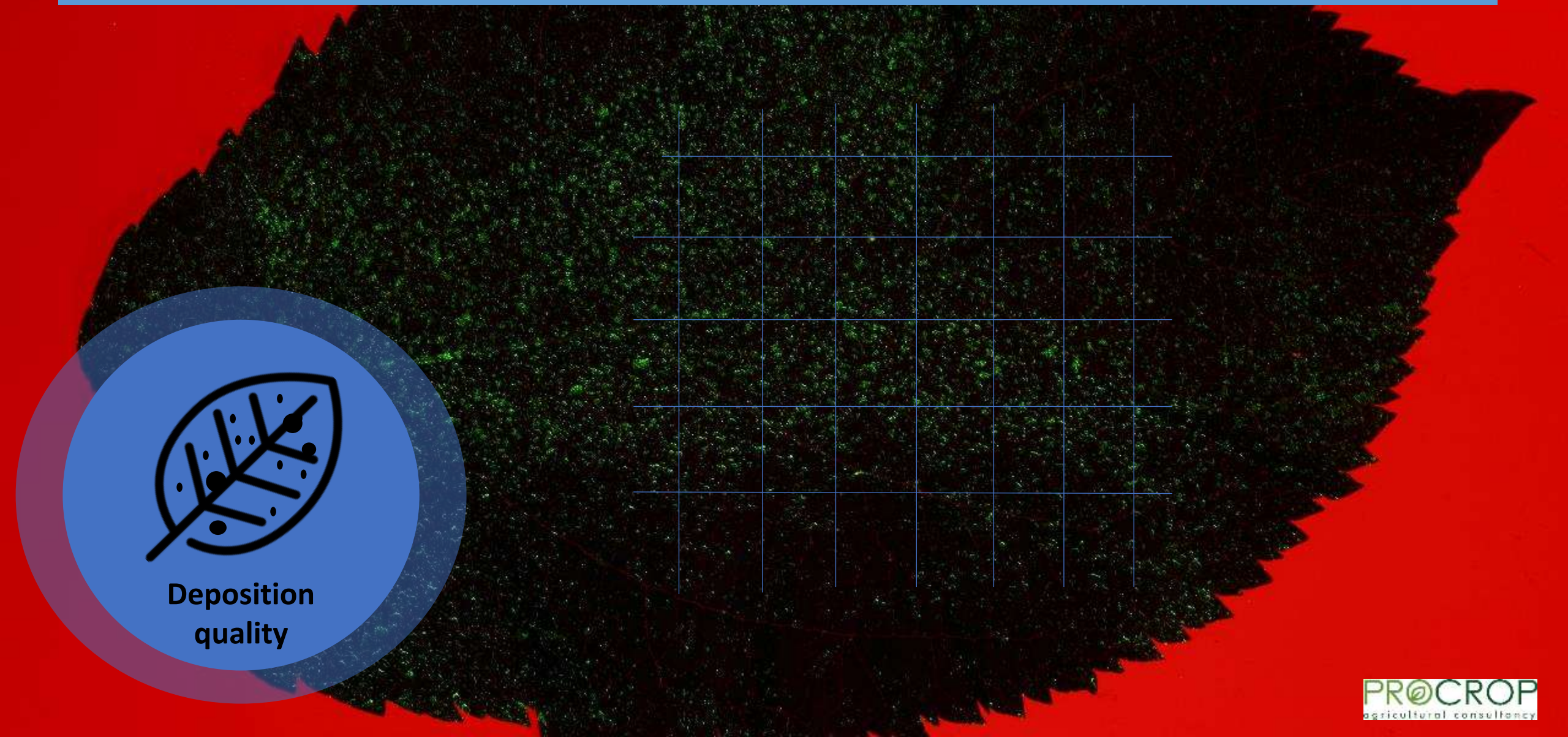
Quality: Variation of active ingredient distribution over the target surface



Deposition quality

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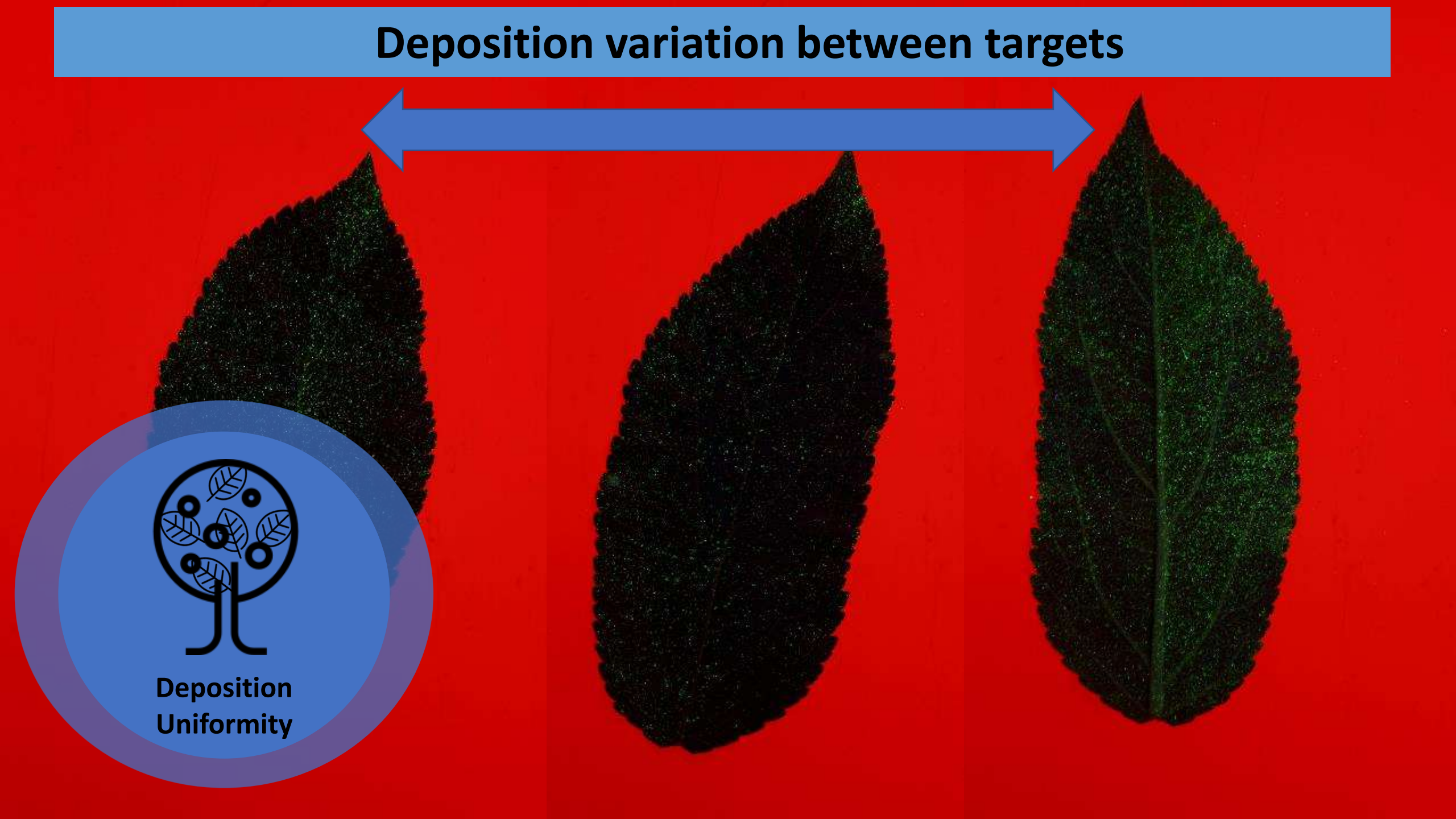
Deposition variation between targets




Setting up
for Success
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Sprayer setup and calibration

Propper sprayer setup and calibration:

- **Determine** optimal combination of application parameters for a specific canopy

- **Set up** optimal parameters

- Ensure optimal deposition, minimise losses
  - Correct quantity, quality
  - Correct target (leaves, twigs, flowers, fruit)
  - Optimal water volume

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Sprayer setup and calibration

Steps:

1. Inspection and maintenance
2. Sprayer choice
3. Canopy adapted spraying:
   - Optimal sprayer speed
   - Optimal air momentum
4. Spray volume
5. Nozzle selection and layout
6. Calibration
7. Dosing

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Where do pesticides go?

- 20-55% of 100% depositis on target
- 4-6% evaporate (depending on spraying conditions and equipment/strategy used
- 2-5% lost to endo/exo drift
- 30-70% loss to orchard, field floor/ground
- Effect is compounded with use high water volumes and dose rates

(TU Torino und FEM San Michele, modified)

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HINDSIGHT IS AN EXACT SCIENCE

Revise the previous season

- Pest and disease assessment (what, where, when, how)
- Strategy, timing and logistics
- Spray application efficacy?

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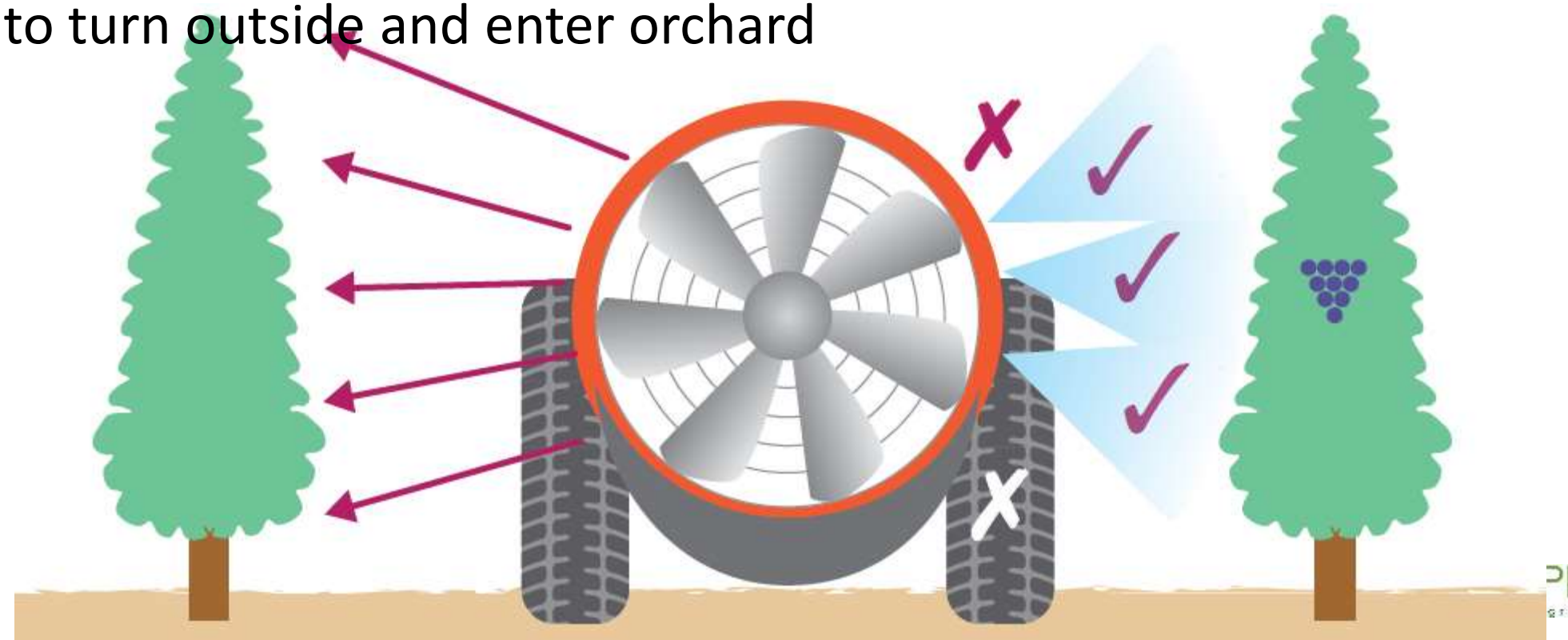
Sprayer type selection

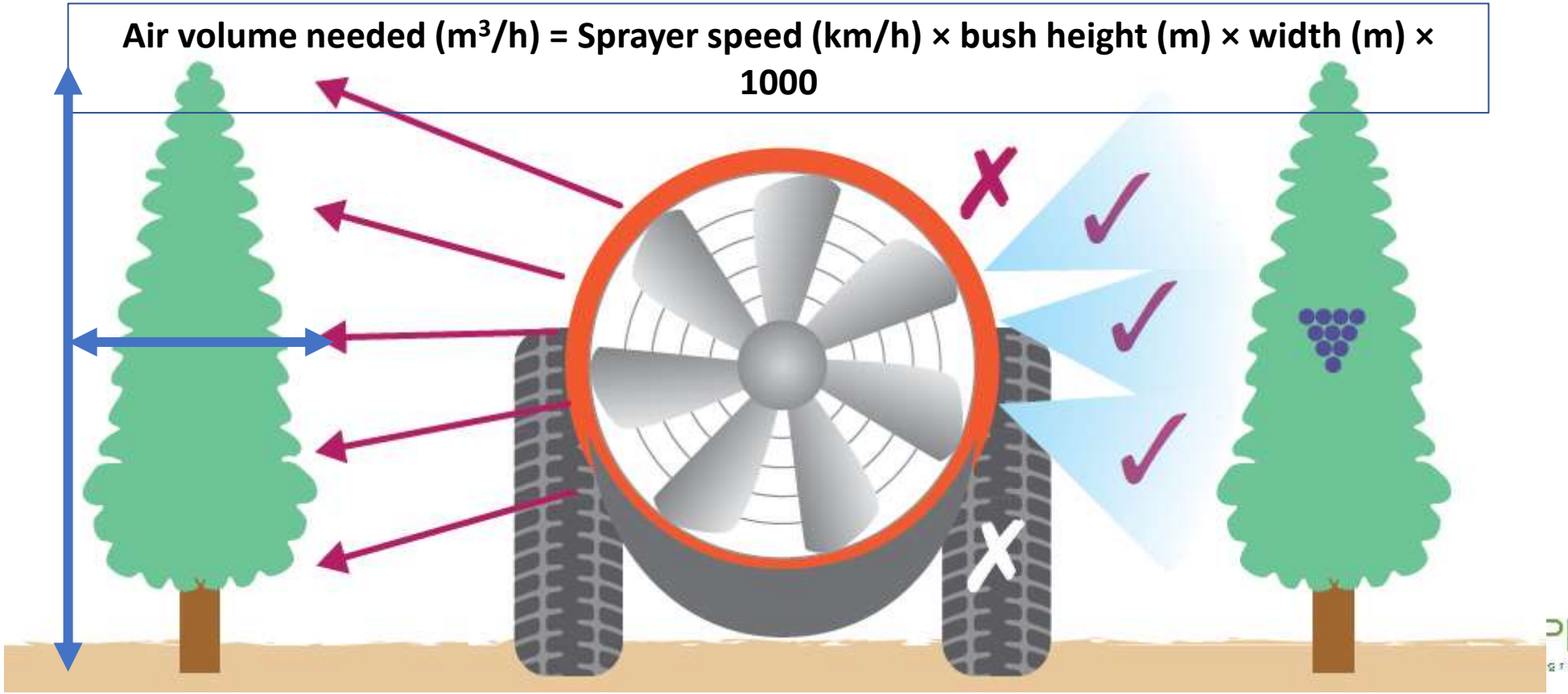
Mission: Load and carry droplets into/onto target with minimal resistance and droplet losses

- Sprayer air volume and profile must match canopy volume and profile
- Must fit into rows at maximum canopy volume
- Be able to turn outside and enter orchard



Sprayer type selection

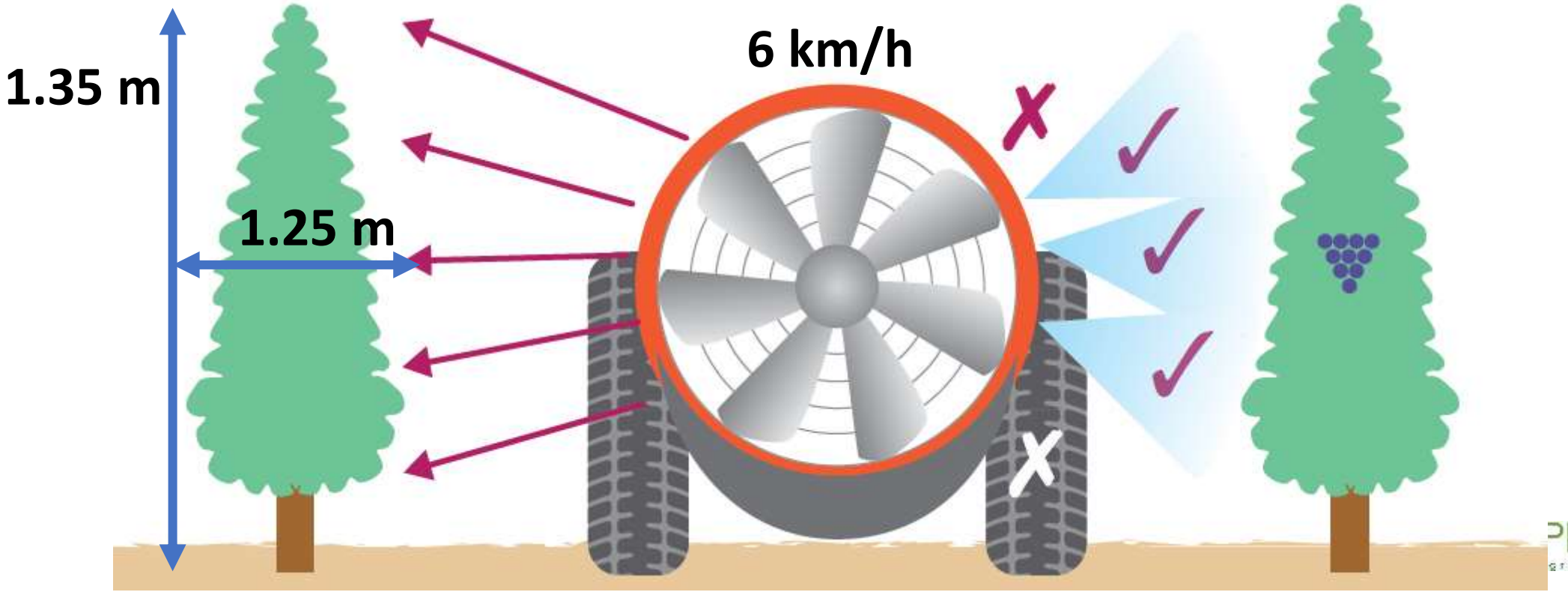
- Low profile sprayers & small towers that fits canopy height
- Air volume (m^3/h) requirement low
- Orchard floor & optimal sprayer speed?



Sprayer type selection

Air volume needed (m^3/h) = Sprayer speed (km/h) × bush height (m) × width (m) × 1000

10 125 m^3/h needed



Sprayer selection

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Sprayer selection

Canopy profile: Round

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Sprayer selection

Canopy profile: Round

Air Profile should match canopy

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Sprayer selection

Canopy profile: Round

Most cases low profile axial fan sprayers

With or without a tower

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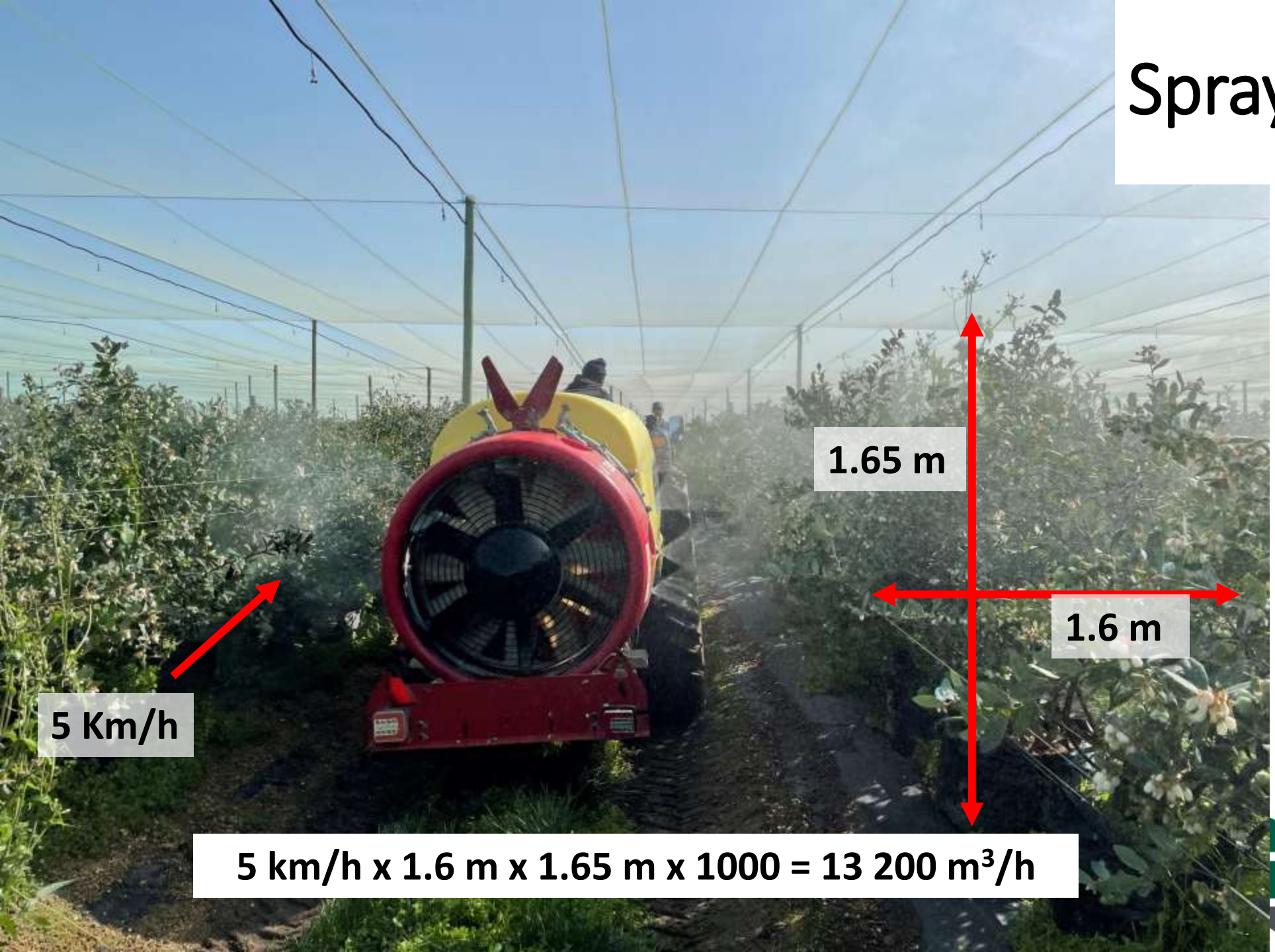
Sprayer selection

Air volume required (m^3/h)?



5 km/h x 1.6 m x 1.65 m x 1000 = 13 200 m^3/h

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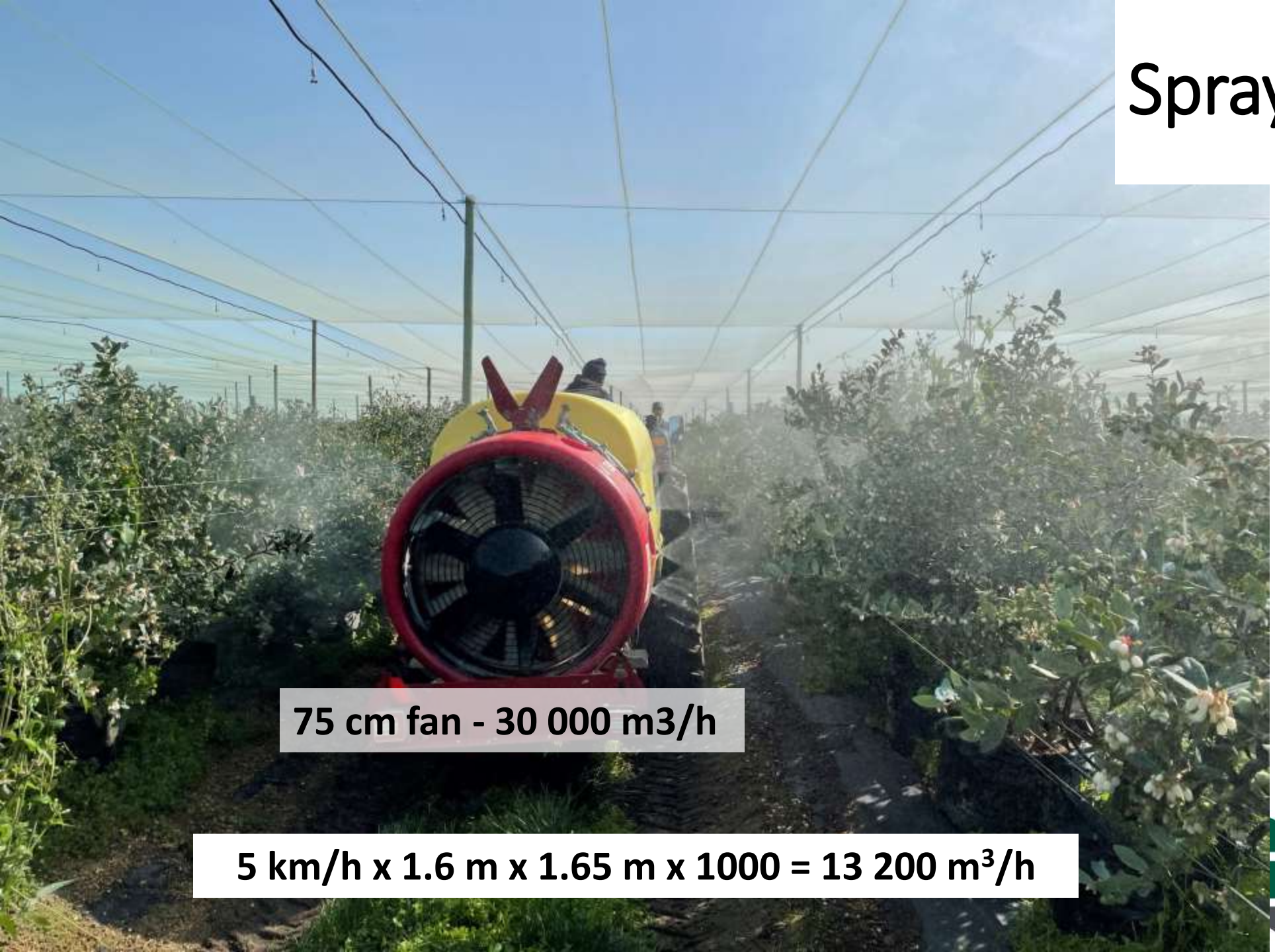
Sprayer selection

Air volume required (m^3/h)?



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Sprayer selection

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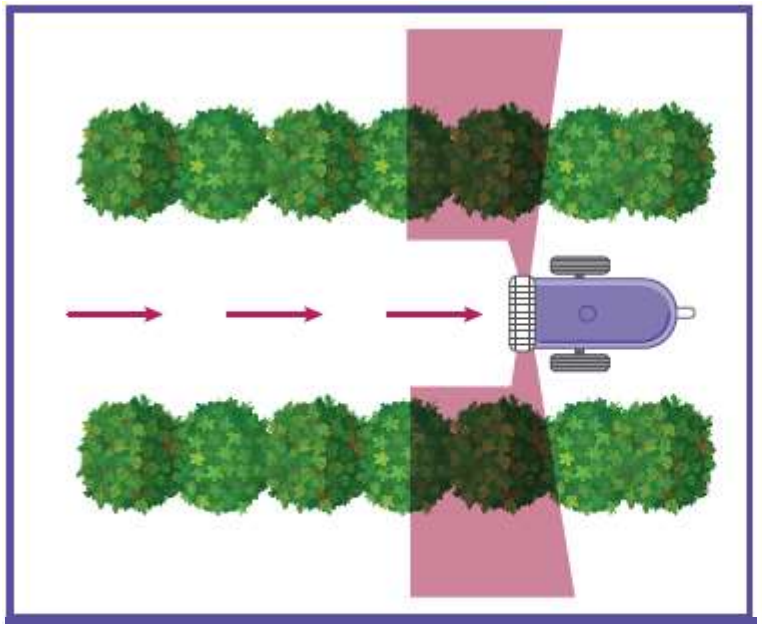
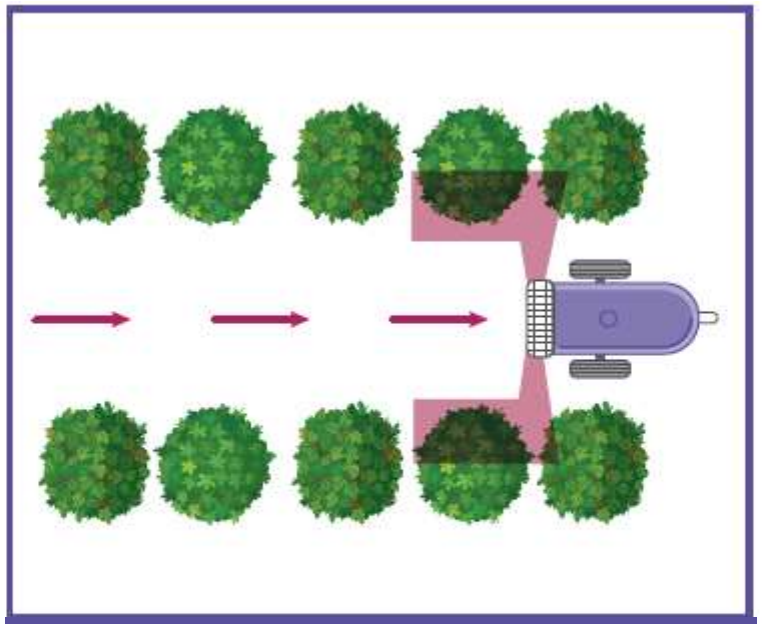
Canopy adapted spraying (CAS)

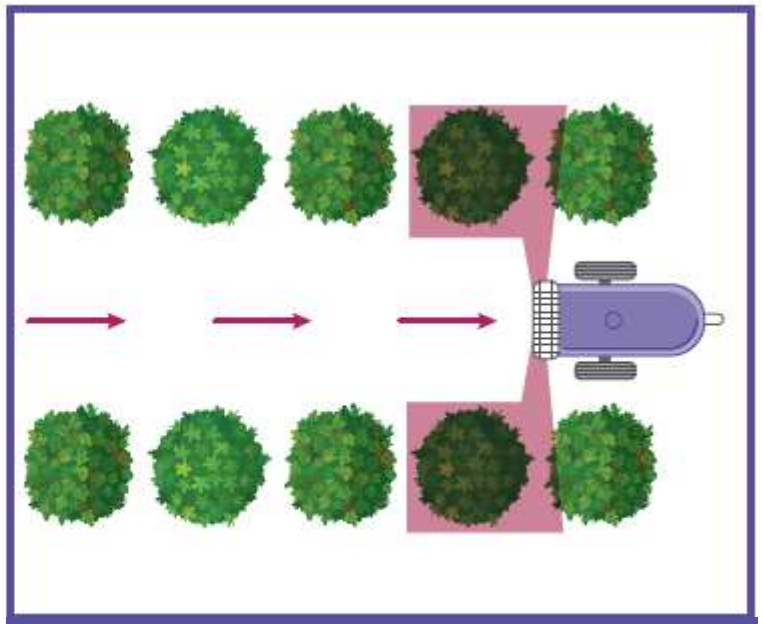
Matching sprayer speed + air output to the canopy
Purpose: Maximise the ratio of deposited droplets versus the amount released. Minimise the amount lost to blow through, blow off and drift



Air volume/speed too high, spray speed too slow, blows through bush



Air volume/speed too low, spray speed too fast, poor canopy penetration



Air volume/speed, spray speed in equilibrium, canopy penetration optimal

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Sprayer speed (CAS)

Critical factor to ensure accurate spray application

Speed depends on:

- Sprayer air volume output (m^3/h)

Allowable spray speed (km/h) = Available air volume (m^3/h)/ 1000 × bush height (m) × width (m)

- Condition and slope of orchard floor
- Row spacing
- **Logistics** (number of sprayers available *vs* effective spraying time)
- Canopy volume, complexity and density
- Target pest

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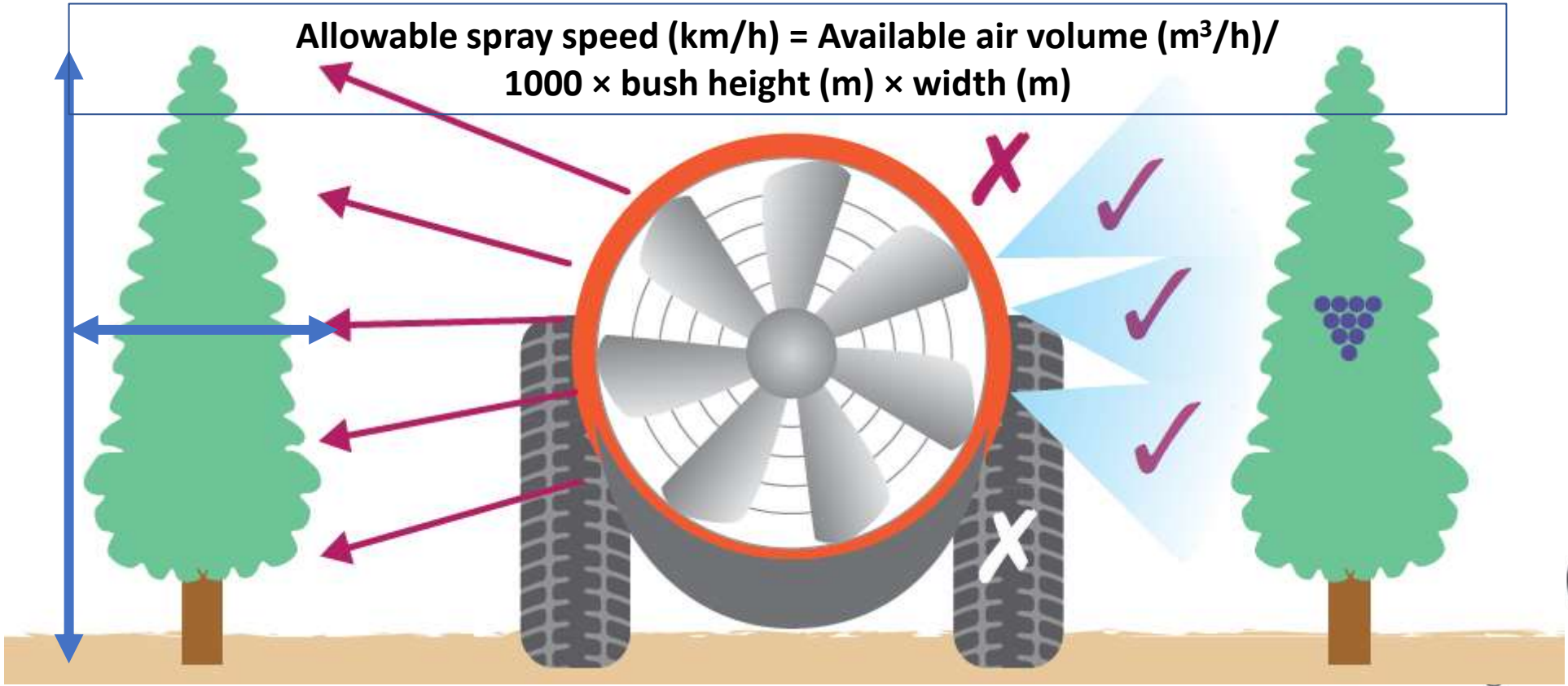
Sprayer speed (CAS)

- 750 mm Diameter fan @ 30 ˚ Pitch @ 540 PTO RPM = 30 000 m^3/h
- km/h?
- Realistic?



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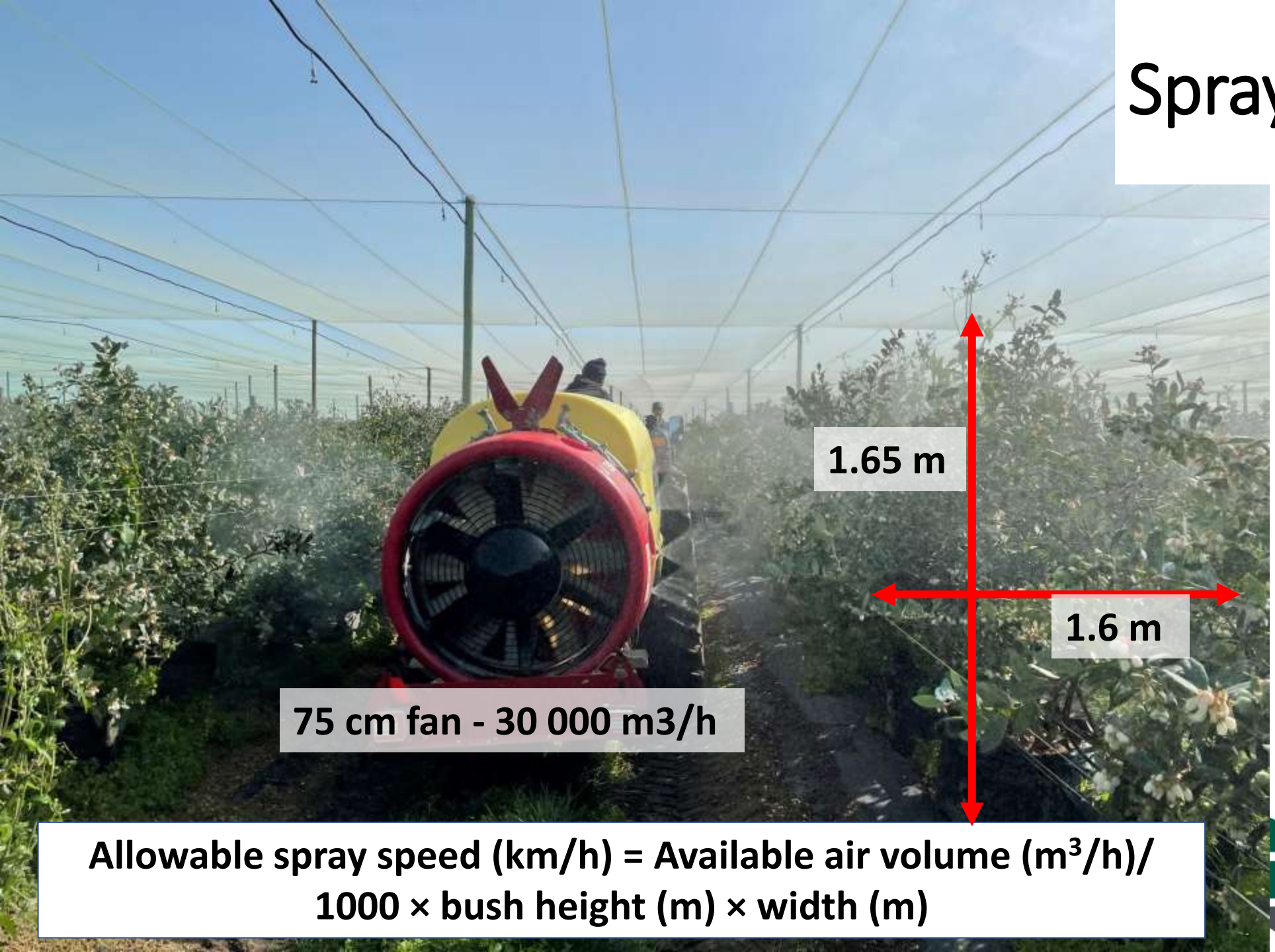
Sprayer selection



Sprayer speed?

- 11.4 km/h
- Realistic?

Allowable spray speed (km/h) = Available air volume (m^3/h)/ 1000 × bush height (m) × width (m)

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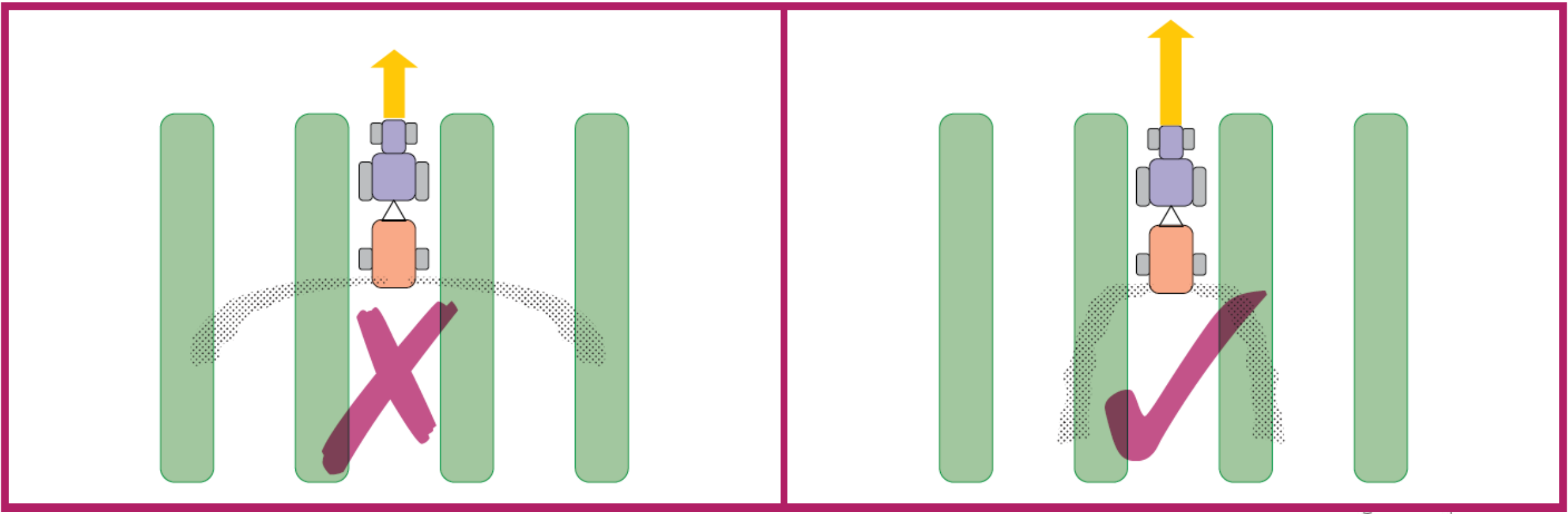
Sprayer speed (CAS)

Matching sprayer speed to canopy – evaluate visually

- Start at 540 rpm (low fan selection)
- Keep below calculated allowable ground speed



Sprayer speed (CAS)

- Tractor speed
  - Check PTO speed with tachometer
  - Determine speed with sprayer attached, 1/3 filled with clean water
  - Set PTO at desired RPM (e.g. 540 rpm)
  - Determine a range of gears
  - Use time over distance or GPS
  - Longer measurement distance reduce measurement errors

$$\text{Tractor speed (km/h)} = \frac{Distance\ (m) \times 3.6}{time\ (sec)}$$

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Air volume (CAS)

Comet APS 145 diafragmapomp @ 20 bar	
r.p.m.	ℓ/min
400	109
450	122
500	135
550	145

Matching sprayer air volume to canopy

- If speed is not enough to bend air column into canopy
- Gear selection: Low and high gear
- Blade pitch
  - Narrow angles less air (28.5 ˚)
  - Wider angles more air (38.5 ˚)
- Blade diameter
  - Larger diameter = higher air volumes
- PTO manipulation
  - Slower PTO revolutions = less air
  - Has impact on delivery and mixing capability of pump (L/min)

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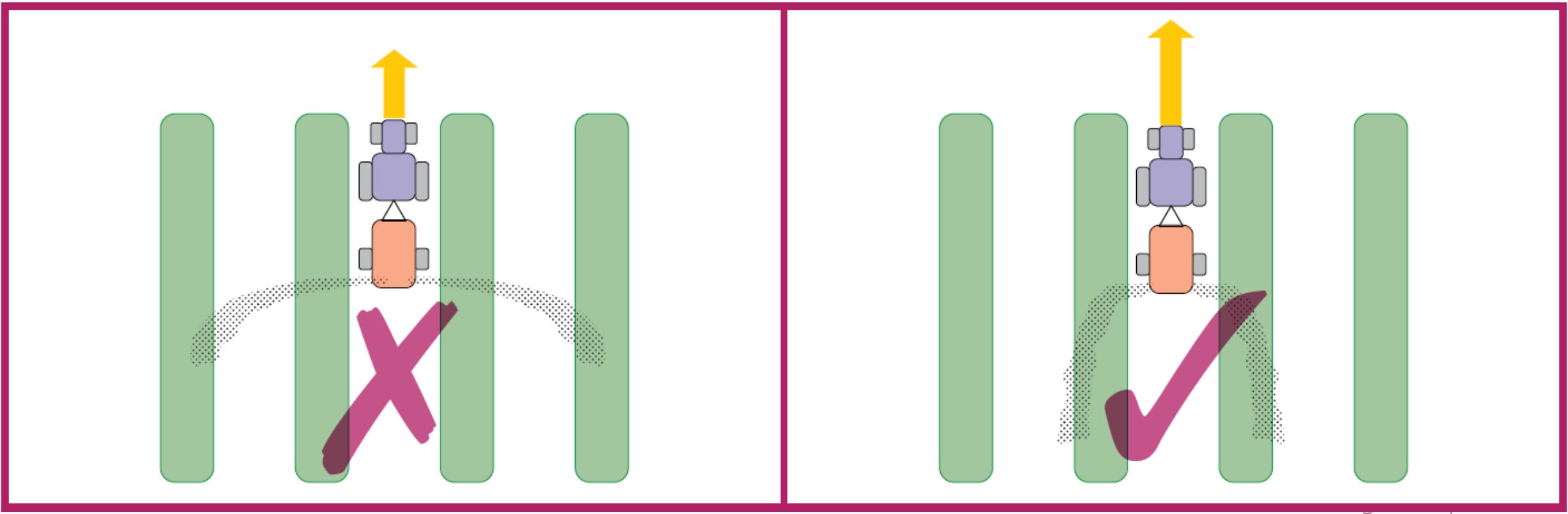
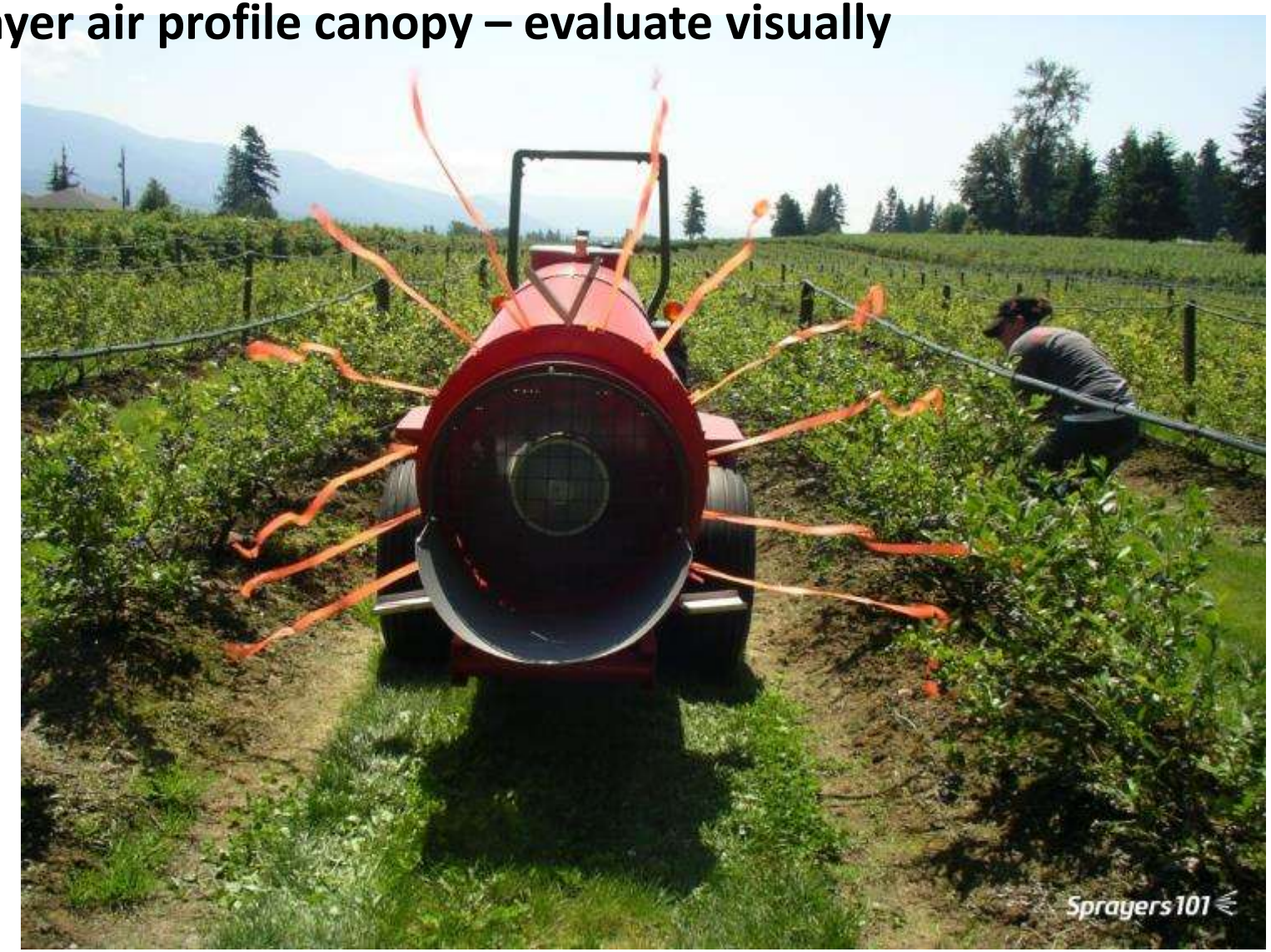
Air volume and profile (CAS)

Matching sprayer air volume canopy – evaluate visually



Air volume and profile (CAS)

Matching sprayer air profile canopy – evaluate visually



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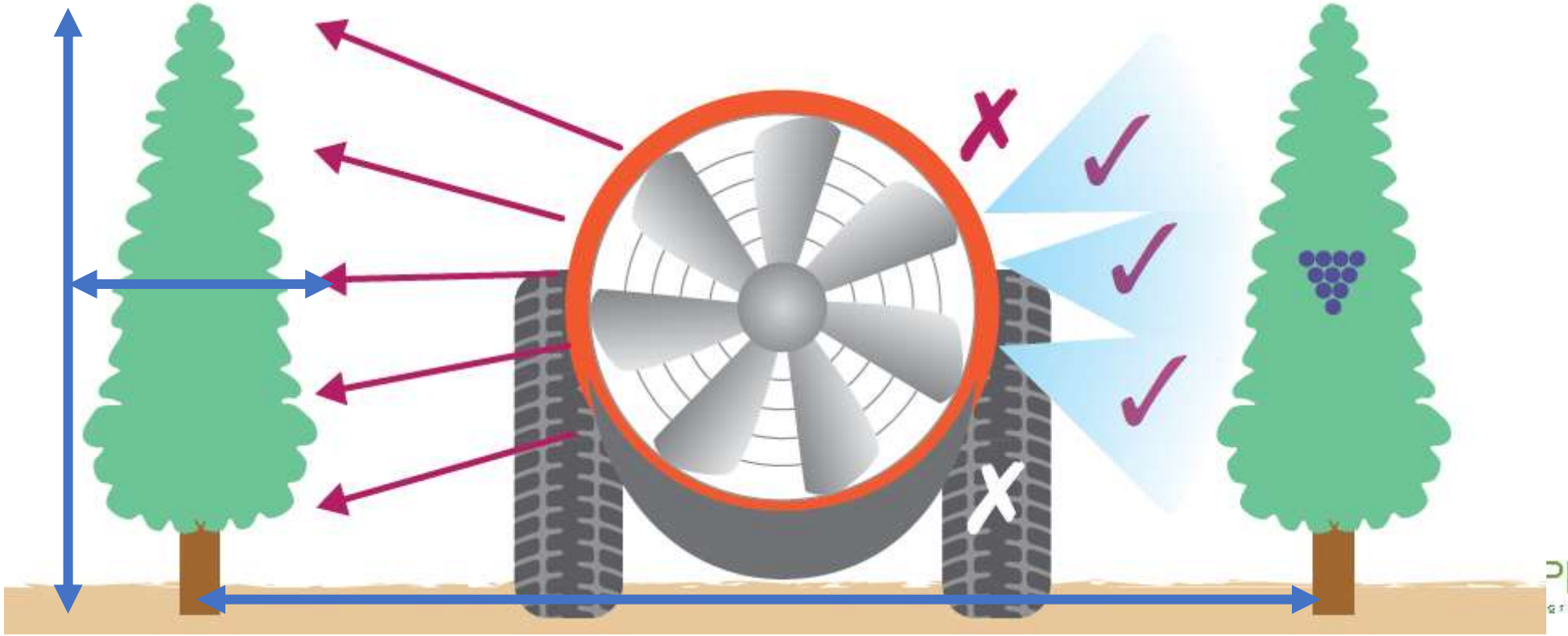
Spray volume selection

Blueberry bushes have low TRVs (Tree Row volumes)

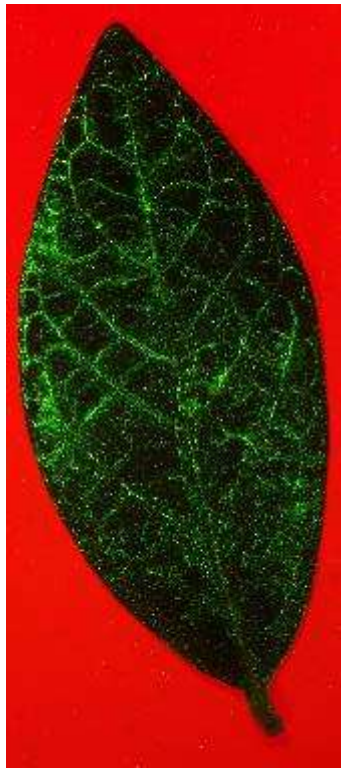
- TRV model overestimates water volume requirement in blueberries
- Label recommendations incoherent

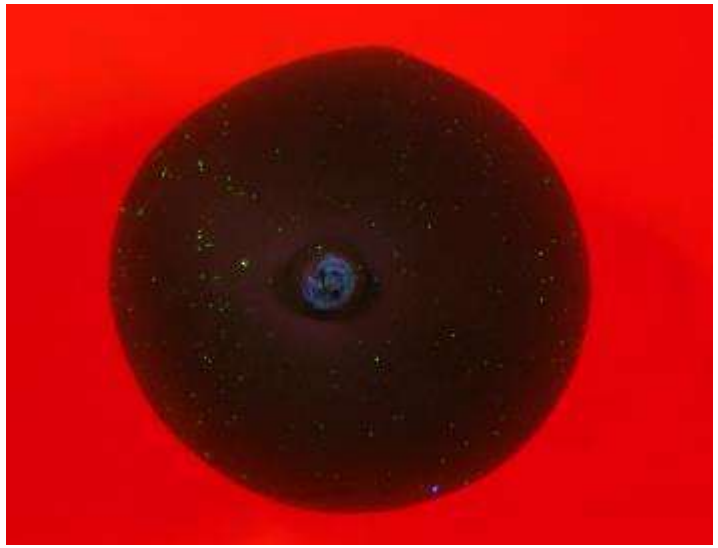


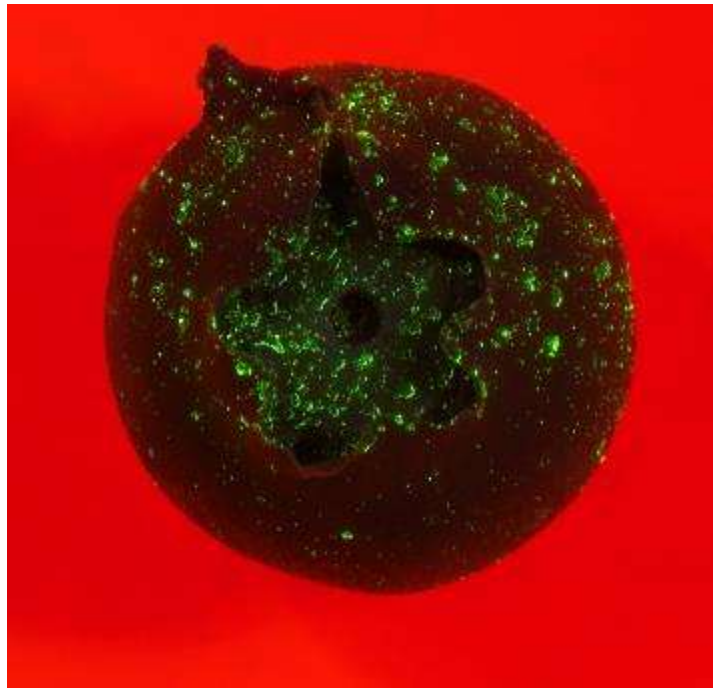
Spray volume selection

Blueberry bushes have low TRVs (Tree Row volumes)

- Current recommended spray volumes 50 – 500 L/ha low volume application
- Small, hard targets to achieve effective deposition on







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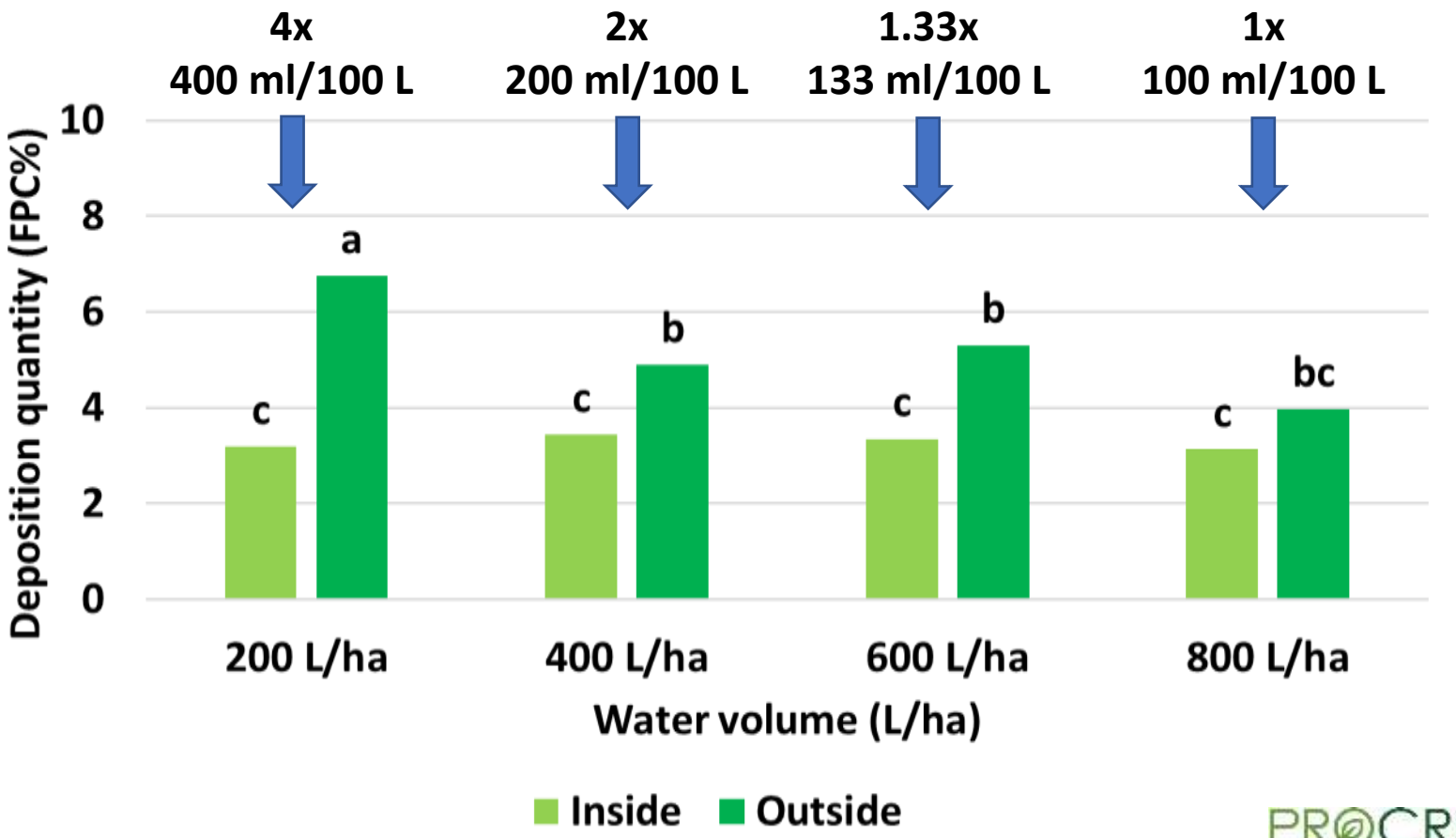
BerriesZA Spray deposition study

- Same dose per ha used (100 ml/100 L) based on TRV of 824.5 L/ha
- Similar deposition quantity (FPC%) realised
- Canopy height = 1.65m
- Canopy depth = 1.6m
- Inter row width = 3m



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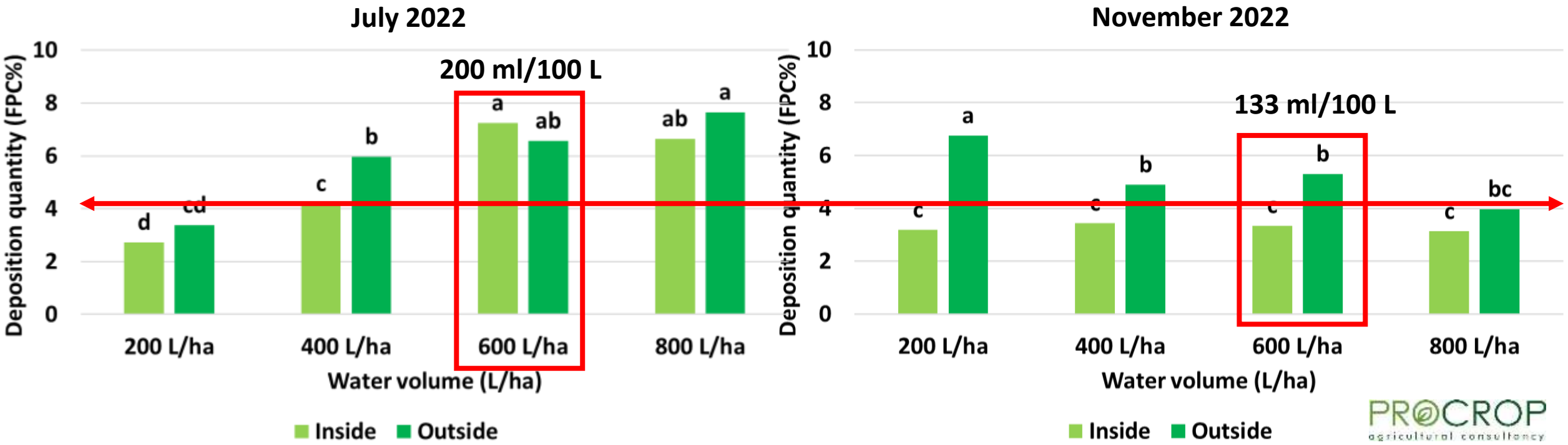
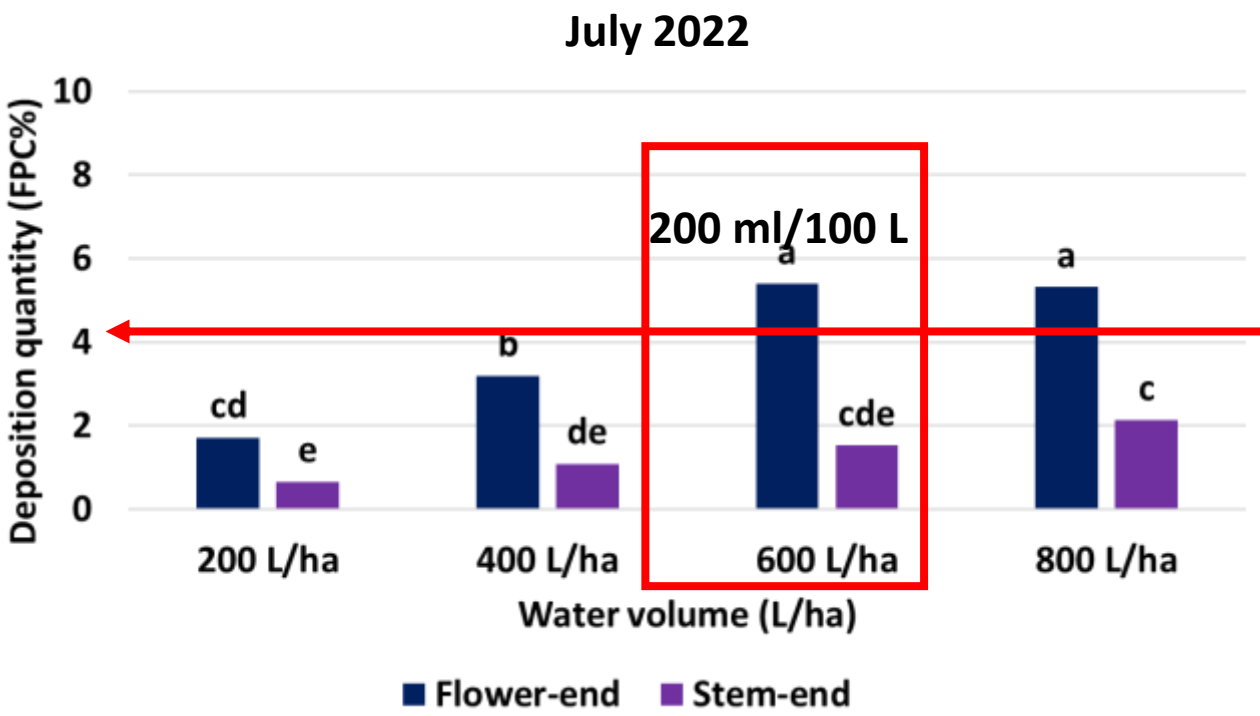
November 2022 Study – Leaves

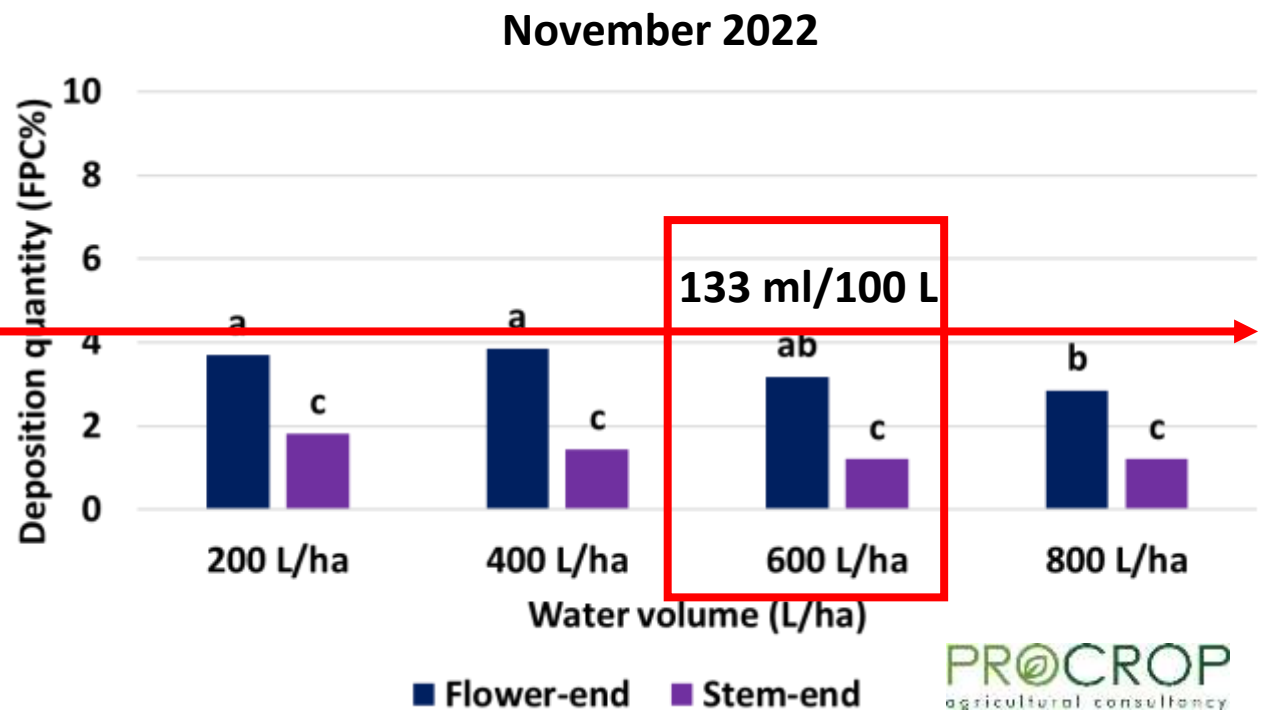
- **July vs November 2022 trials**
  - **600 L/ha higher deposition quantity July vs November**
  - **July 200 ml/100 L vs 133 ml/100 L**
  - ***Going below 2x concentration – drop of in deposition quantity***



November 2022 Study – Berries

- **Similar trend on fruit**
- **Lower deposition quantity realised on fruit**
- **Especially on stem-end**





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Spray volume selection

- **Data indicates current TRV model using 937 constant not optimal for use on blueberries to calculate point of run-off volume**
  - **Run-off already observed on outer canopy leaves at 400 L/ha**
  - **Full canopy run-off at 600 L/ha (TRV = 824 L/ha)**
- **If we assume 600 L/ha to be the ultimate point of run-off for this SPESIFIC canopy sprayed…**
  - **<u>Derive theoretic adjusted TRV model for blueberries</u>**

$$\text{Spray volume/ha} = \frac{Bush\ height\ (m) \times Bush\ depth\ (m) \times 682}{Inter\ row\ width\ (m)}$$

  - **Model needs to be evaluated first!**
    - **When using this model, 2x concentrations is recommended.**
    - **Residue study to improve dosing and residue loading on blueberries is critical**
    - **<u>Plants with heights and depth of less than 1 m still recommended not to use spray volumes less than 300 L/ha at 2x concentrations.</u>**

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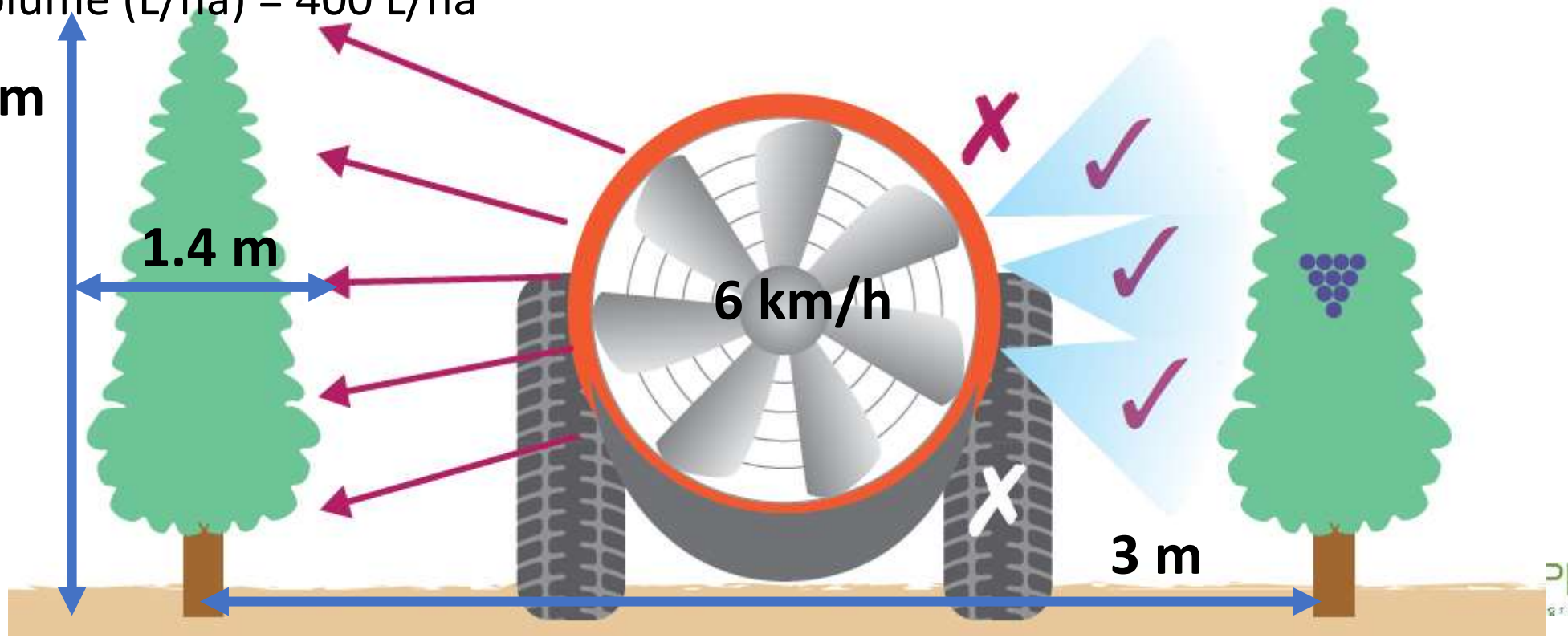
Nozzle selection

Function of

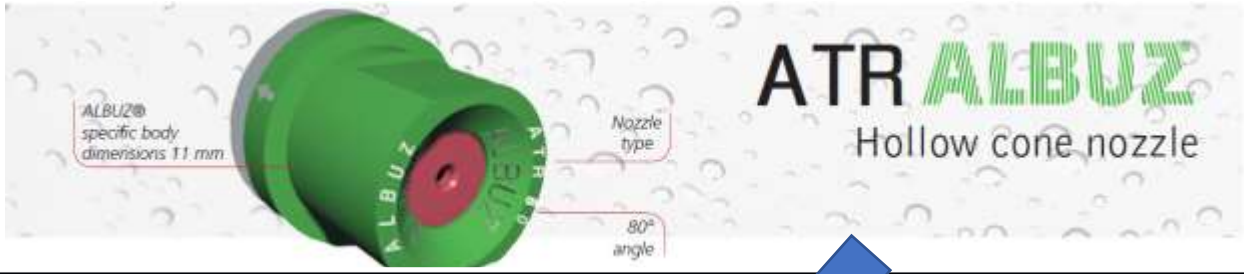
- Sprayer speed (Km/h)
- Row spacing (m)
- Spray volume (L/ha) = 400 L/ha

$$L/\min \, per \, nozzle = \frac{\text{Speed (k m/h)} \times \text{Row spacing (m)} \times \text{Spray volume (L/h a)}}{\text{Factor (600)} \times \text{No. open nozzles}}$$

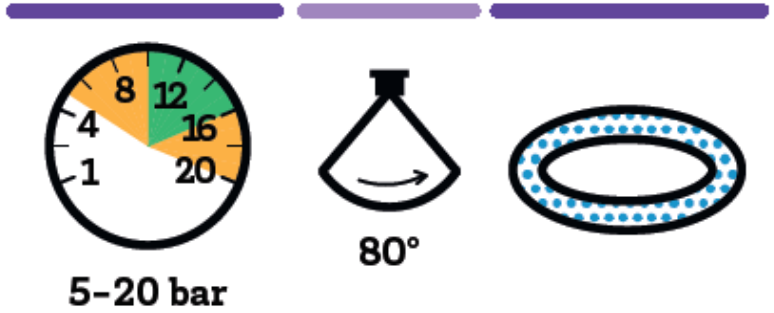
L/min per nozzle = 2 L/min



Nozzle selection



L/min = 2



bar	ATR 80°									
	WHITE	LILAC	BROWN	YELLOW	ORANGE	RED	GREY	GREEN	BLACK	BLUE
5	VF	VF	VF	VF	VF	F	F	F	F	F
7	VF	VF	VF	VF	VF	F	F	F	F	F
10	VF	VF	VF	VF	VF	F	F	F	F	F
15	VF	VF	VF	VF	VF	VF	F	F	F	F
20	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF

bar	l/mn									
	WHITE	LILAC	BROWN	YELLOW	ORANGE	RED	GREY	GREEN	BLACK	BLUE
		G 1348	G 1349	G 1350	G 1351	G 1352		G 1353		G 1354
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

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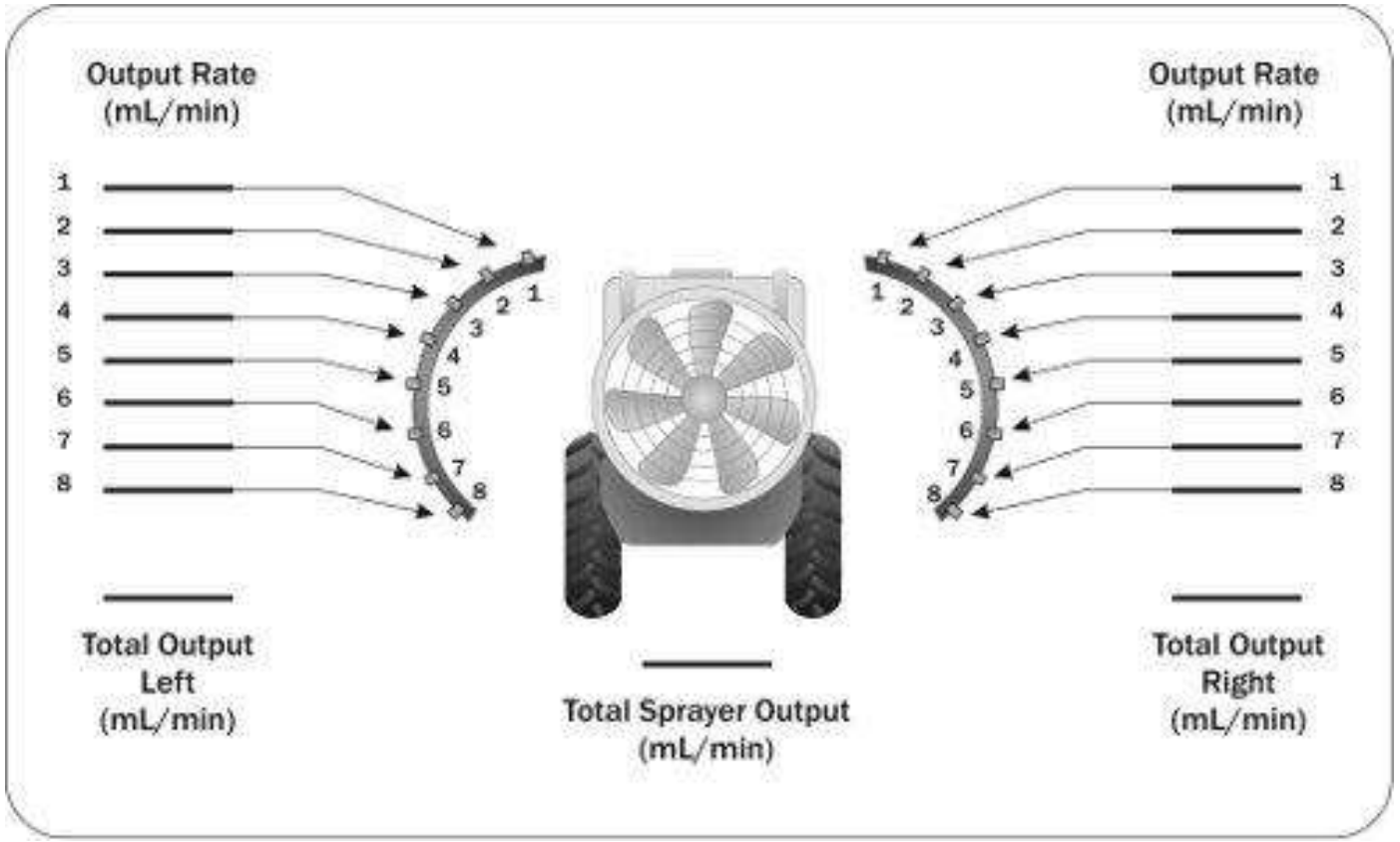
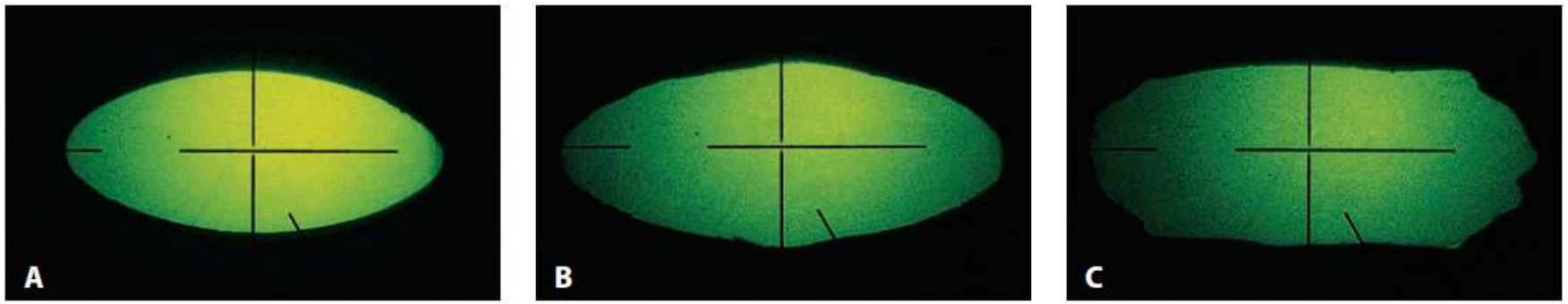
Calibration

Evaluate delivery

- +/- 5% deviation (l / min) = Adjust pressure or speed
- > 10% deviation (l / min) = replace nozzles VMD drop size spectrum is no longer accurate





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Dose rates

- Use rate per ha indicated on label

$$\text{Dose per tank} = \frac{Tank\ size\ (water\ in\ tank)l}{Spray\ volume\ (\frac{l}{ha})} \times Dose\ rate\ per\ ha$$

CROP/DISEASE	DOSAGE RATE	REMARKS
Berries: (Blackberry, Raspberry, Blueberry, Gooseberry and Strawberry) Botrytis rot (*Botrytis cinerea*)	500 ml/ha	Apply as a cover spray in 300 – 1000 ℓ water/ha from the early flowering stage up to 1 day before harvest. Repeat application after 10 - 14 days. **Apply a maximum of 2 Luna® Privilege sprays per season.**

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Dose rates

- Convert rate per 100L indicated on label to rate per ha
- OR use 2x the per 100L dose rate
  - 2 x 120 ml/100L = 240 ml/100L

$$\text{Dose per ha} = \frac{High\ volume\ need\left(\frac{L}{ha}\right) \times Dose\ rate\ per\ 100\ L}{100}$$

GEWAS EN PLAAG	DOSIS	OPMERKINGS
BLOUBESSIES *Botrytis cinerea*	120 mℓ /100 ℓ water in 500 tot 1000 ℓ water / ha	Dien **Scala** toe as 'n hoë volume voldekbespuiting. **Scala** mag slegs twee-maal per seisoen toegedien word tussen volblom en 3 dae vóór oes. **Scala** moet voorafgegaan en/òf opgevolg word met 'n Botrytis-middel met 'n ander werkswyse (nie-verwante chemiese Groepkode). * Sien "Weerstandswaarskuwing."

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Challenges

Current challenges identified

- Accurate formula for calculating spray volume and dosing
- Incoherent labels = high recommended spray volumes
- Staggered plantings increasing density
- Narrow row spacings
  - Limits late season applications
  - Dense plantings influence canopy penetration
  - Mechanical damage
- Poor spray machinery choice (high air volumes)


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Thank you

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