PP20000: Papaya Industry Extension and Communications Project

Papaya Spray Technology Workshop

April 28th, 2022

Air Blast Spraying in Papaya

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Queensland Government

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Hort Innovation
Strategic levy investment
PAPAYA FUND

This project has been funded by Hort Innovation using the papaya research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au

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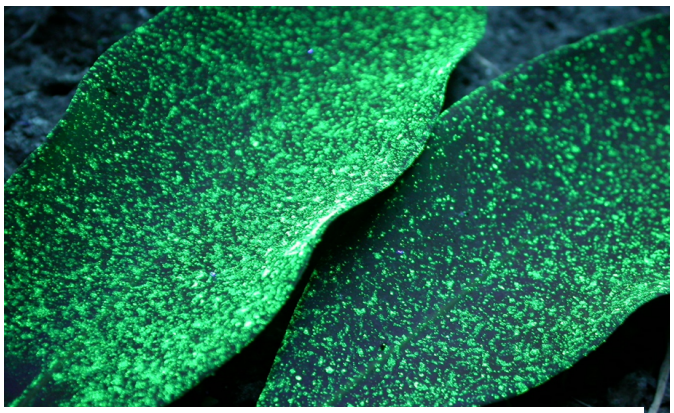
Introduction

Pest management is one of the biggest challenges in papaya production in Australia. The is a lot of pressure on growers to produce cosmetically attractive fruit for the commercial market, which relies on a thorough pest management programme.

A well calibrated sprayer underpins the success of an entire pest and disease management programme. Without achieving thorough coverage of pesticides and fungicide the results of sprays may be patchy, which often causes pests and disease to come back more rapidly than before. This can also place higher resistance pressure on chemicals.



Fluroescent dyes and UV lights are an effective way to visualise the coverage of sprayers

Papaya are rather unique compared to most other crops due to their low leaf surface area, and also, the height of their target area especially as they mature. Generally, as they mature, coverage can only be achieved on the underside of the leaf.

Feeding marks on the top of leaves due to African Spider Mite

Previously, this was not an issue, as most pests and disease habited or infected the bottom anyway. However, recently, with the rise of the African Spider Mite (*Eutetranychus africanus)* some coverage may also need to be achieved on the upper surface of the leaf.

This workshop is desgined to help growers to understand sprayers and help give a practical guide for growers to calibrate their own sprayers. But also, will explore coverage, on both the top and underside of the leaf surfaces to help give growers some options for combating different pests and diseases.

Air Displacement

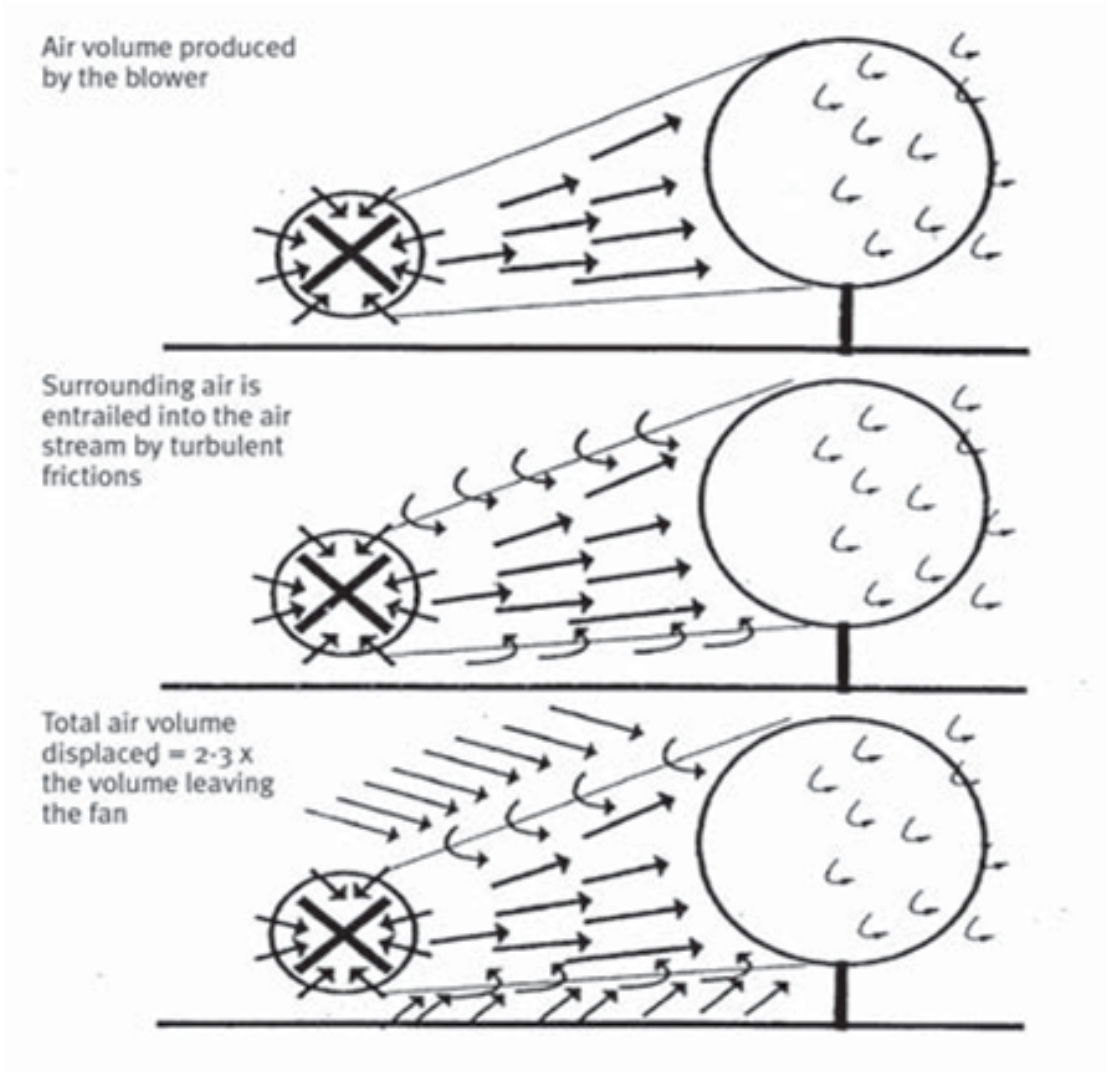
The theory behind sprayers

One of the main principles behind orchard spraying is air displacement. In essence, the sprayer is designed to displace (remove) the air in the plantation canopy and replace it with air laden with miticide droplets

Use the following formula as a guide to calculate the air requirements of a plantation:

$$\frac{1000 \times \text{Speed (km/h)} \times \text{Spray width (m)} \times \text{Tree height (m)}}{\text{3 (Leaf area factor*)}} = \text{Air volume (m}^3\text{/h)}$$

* For light foliage use factor 3.0 to 3.5. For dense foliage use factor 2.5 to 3.0



Types of Sprayers

Axial Flow

These are by far the most popular type of sprayer used in papaya. Spray droplets are made using hydraulic pressure and hollow cone nozzles. The spray droplets are deposited into the canopy via an axial flow fan. Both the pump and fan are driven by the tractor PTO.

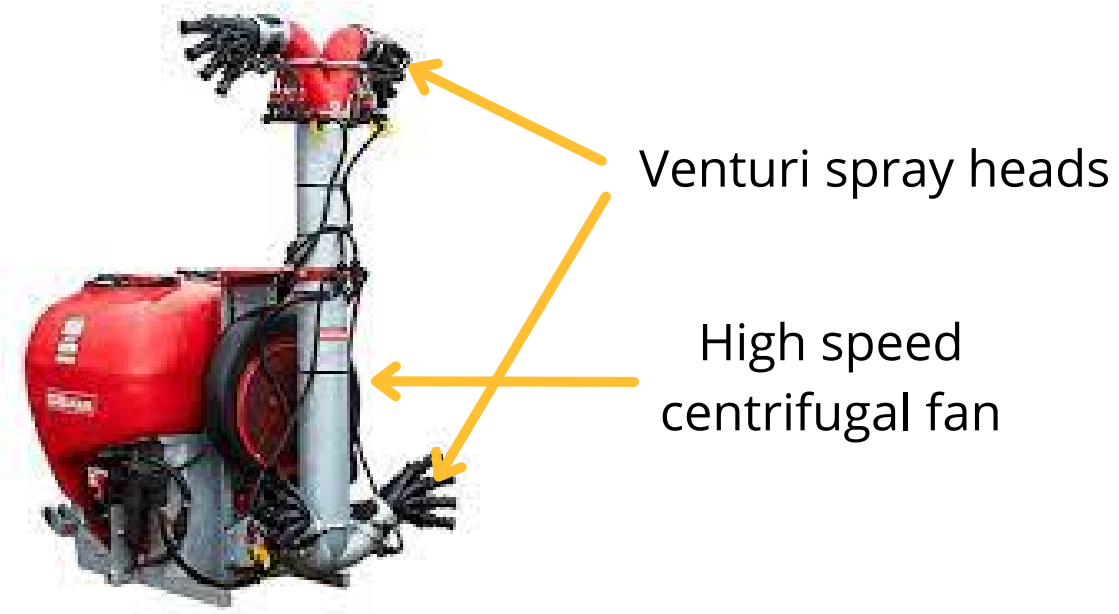
A trailed axial flow air blast sprayer suitable for larger plantations

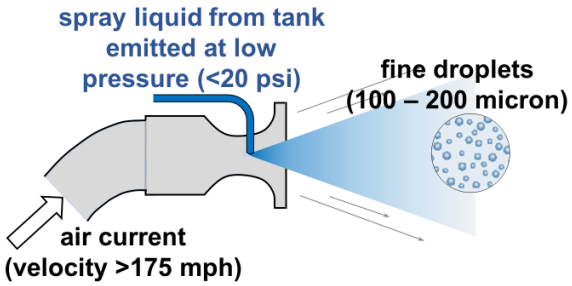
Axial flow sprayers are reliable and robust. They are also capable of delivering higher volumes per hectare which is an advantage in mite control. These sprayers produce air volumes from 25,000 to 90,000 cubic metres of air per hour.

A 3 point linkage sprayer of the type used in smaller plantations

Air Shear

These machines use high speed air to create droplets. They do not have spray nozzles but instead have a spray head with one or more venturis. Droplets are made by the chemical flowing in to the venturi at low pressures. This results in small droplets in the medium, fine, and very fine range being produced. Spray head height adjustments are easily made.





Air shear sprayers usually take more time to set up but can be an effective alternative to axial flow machines. These machines are capable of low volume application, however the recommended volumes per hectare for mite control should still be followed. Air shear machines produce air volumes of around 15,000 to 40,000 cubic metres of air per hour. The spray is generally more directed than an axial flow sprayer.

Controlled Droplet Application (CDA) sprayers

CDA sprayers produce droplets via a rotating cage or disc. The droplet size is usually governed by the rotational speed. The volume is controlled by either pump pressure, inlet orifice size or a combination of both. The mechanism is similar to a wet tyre creating a spray of droplets as it spins. The droplets created then get pushed forwards towards the target by a fan.

A CDA sprayer. This particular sprayer does not have a fan to push the droplets towards a target. The speed of spin determines the size of the droplets

With careful attention to the set up and calibration a narrow range of droplet sizes can be produced giving excellent coverage control. They tend to be specialist machines and not commonly used by papaya growers. Some manufacturers of axial flow air blast sprayers offer CDA atomizers as an option. In this situation the hydraulic nozzles are replaced by the CDA atomizers.

A micron unit is a CDA style. These units can be mounted higher on the sprayer than the standard axial flow fans. Advantages include better targeting, droplet capture and potentially less drift

Nozzles and Droplet Size

As discussed previously axial flow air blast sprayers are the most common type used for foliage spraying in papaya. The nozzles should be hollow cone or disc core types operated at least 5 bar pressure. In most instances 10 bar pressure is considered optimum. In general, the spray quality of hollow cone and disc core nozzles is in the “fine” classification.

Hollow cone nozzle and spray pattern from Teejet

Air induction hollow cone nozzle. Note the air induction holes on the side of the nozzles.

A recent development are air inclusion or air induction hollow cone nozzles. These nozzles should give adequate coverage as well as reduce the potential for drift. Always read the specifications and operating pressure requirements when selecting spray nozzles. Most nozzle catalogues are available on line or from your reseller. Standard ISO colour codes are in place for the vast majority of nozzles.

Remember spray nozzles need regular replacement, either annually or when the output varies 5% either side or the recommended output.

Category	Symbol	Colour Code	Approx VMD range
FINE	F	Orange	145-225

Spray Volumes

It is critical that adequate volumes of water are applied to the target to achieve adequate control of mites. The table below lists the minimum water volumes which should be used in a mature plantation. Volumes can be reduced in smaller non bearing plants. It may be possible to reduce volumes delivered through air shear machines as well.

Row Spacing	Minimum water volume (L/ha)
SINGLE ROWS 4.5 TO 6 M CENTRES	250 - 350
DOUBLE ROWS 5.5 TO 7.5 M CENTRES	500 - 750

Sprayer Setup and Calibration

The manufacturer's handbook and/or website will give details of recommended fan speeds and calibration methods. Axial flow air blast sprayers that have adjustable fan blades work most efficiently at angles of 40 to 45 degrees and at a PTO speed of 540 RPM. Centrifugal fans are nor adjustable and the maximum PTO speed is usually 540 RPM although there are some which operate on 1000 PTO shaft speeds. Reduced fan speed in centrifugal fans may not produce the desired droplet size. Air assisted hydraulically driven spray heads also have an optimum fan speed. Consult the manual for this data.

Establishing the correct air displacement is probably the most critical component of any sprayer set up. There needs to be enough air displaced from the canopy to give adequate coverage of the most distant underside of leaves. Tie some flagging or surveyors tape on the upper most leaves of the plant. Tape attached to the frame on the exhaust side of the fan will indicate the direction of the air blast.

Operate the sprayer without the pump operating at the desired ground speed. (Usually around 6.0 KPH or 100 metres per minute.) The tape attached to the most distant leaves should move slightly. Too much movement indicates that the there is too much air, in which case the ground speed can be increased or the fan angle decreased. If the tape does not move then slow the ground speed until the desired tape movement is observed.

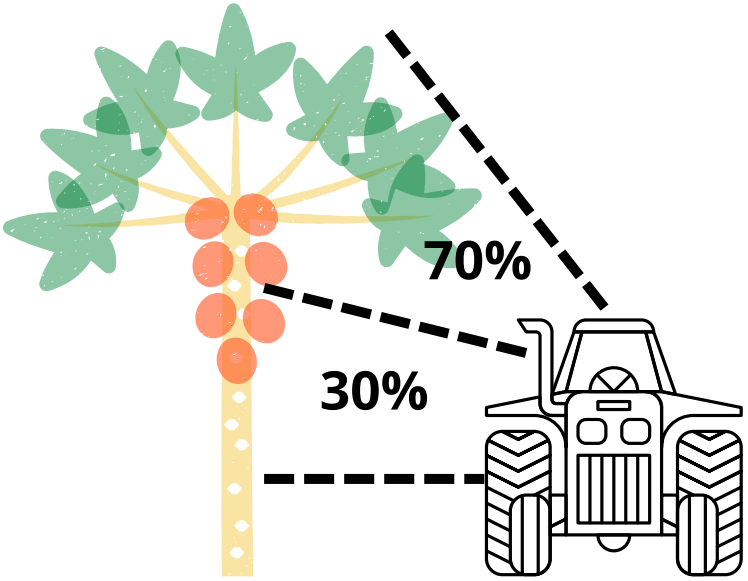
Axial fan showing a "twisting" of the air flow to the left hand side. This is quite normal an can be manage by opening the nozzles located higher on the left side of the sprayer

Air Calibration Table

Observations	Run 1	Run 2	Run 3
ENGINE RPM			
PTO RPM (540)			
GEAR			
SPEED km/h or m/min			
FAN SETTINGS (angle)			
TAPE/LEAF FLUTTER Good Acceptable Poor			

Once the fan settings and ground speeds have been calculated it is time to calculate the amount of spray per hectare the machine delivers. Always consult the chemical label as there may be limits on volume and other related statements which, by law must be followed.

On axial flow air blast machines, arrange the nozzles so that about 70% of the output is delivered to the foliage and the remainder on the trunk of mature trees. These estimates will be different on smaller trees and nozzles will need to be arranged so more spray is delivered lower down.



Highest output

Generally higher output nozzles are used at the 10 O'clock and 2 O'clock positions on axial flow air blast sprayers. Larger restrictors are used in CDA and air shear centrifugal machines at these positions as well. Air assisted spray heads can also be set to deliver higher volumes in the canopy by changing nozzles.

Axial flow air blast sprayers are the most popular in papaya production so we will use one of these machines as an example.

Firstly, select the nozzles that will achieve the required volume for mite control. This can be done by consulting the nozzle catalogue. We will use double rows at 7.0 metre centres and 500 litres per hectare as an example (see over).

Row width: 7.00m
Speed: 6km/h
Volume required: 500L/ha minimum
Pressure : 10 bar
PTO Speed: 540RPM
Fan angle: 40 degrees

LEFT-HAND SIDE			RIGHT- HAND SIDE		
Nozzle no.	**Nozzle details**	**Output (L/min)**	**Nozzle no.**	**Nozzle details**	**Output (L/min)**
1	Off	0	**1**	Off	0
2	Tx Yellow	2.80	**2**	Tx Yellow	2.80
3	TX Red	5.80	**3**	TX Red	5.80
4	TX Red	5.80	**4**	TX Red	5.80
5	TX Yellow	2.80	**5**	TX Yellow	2.80
6	TX Orange	1.36	**6**	TX Orange	1.36
7	TX Lilac	0.66	**7**	TX Lilac	0.66
8	TX Lilac	0.66	**8**	TX Lilac	0.66
9	Off	0	**9**	Off	0
10	Off	0	**10**	Off	0
TOTAL FOR LEFT			**TOTAL FOR RIGHT**		
TOTAL OUTPUT (L/min)					

The above table represents the theoretical output of new nozzles at 10 bar pressure. In practice each nozzle output is checked with a hose attached to each nozzle. Check for variation + or – 5%

There are a number of methods used for the final calibration. The simplest formula is:

$$\frac{\text{Total volume (L/min)} \times 10000}{\text{Area sprayed (sq m/min)}}$$

The example calculation would be

TOTAL OUTPUT

$$\frac{39.76 \times 10000}{7.0 \times 100}$$

ROW SIZE (CENTRE-TO CENTRE)

SPEED (m/min)
6km/h = 100 m/min

This figure would seem reasonable considering the minimum volume in this instance is 500 litres pr hectare. Final adjustments to ground speed and pressure would give an even 500 litres per hectare. A blank calibration work sheet is provided on the next page.

Calibration Worksheet

DATE	
TRACTOR	
SPRAYER TYPE	
GEAR	
ENGINE RPM	
PTO RPM	
PRESSURE	
ROW SPACING	

NOZZLE TYPE				
RECOMMENDED OUTPUT				

Sprayer Speed

Time 1:00 minutes **Distance measured** metres

Speed metres/minute

Total Output of Nozzles

LEFT-HAND SIDE			RIGHT- HAND SIDE		
Nozzle no.	**Nozzle details**	**Output (L/min)**	**Nozzle no.**	**Nozzle details**	**Output (L/min)**
1			**1**		
2			**2**		
3			**3**		
4			**4**		
5			**5**		
6			**6**		
7			**7**		
8			**8**		
9			**9**		
10			**10**		
TOTAL FOR LEFT			**TOTAL FOR RIGHT**		
TOTAL OUTPUT (L/min)					

Application volume

$$\text{Application volume (L/ha)} = \frac{\text{Total volume} \square \text{ L/min} \times \mathbf{10000}}{\text{Row Spacing} \square \text{ m} \times \text{Speed} \square \text{ m/min}}$$

$$\text{Application volume} = \square \text{ L/ha}$$