

**7 WORLDS AG**

Growing together for a sustainable future.

# DISEASE AND INSECT MANAGEMENT STRATEGY IN ALMONDS

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# INTRODUCTION

The purpose of this document is to provide an explanation as to the workings of protectant fungicides which are integral to disease management and how best to get optimum fungicidal value from the variety of brands on offer.

7 Worlds Ag supports the Almond Industry as traditional sponsors of the National Conference, and by offering Technical Support to individual organisations.

Considerable R&D resource has been allocated to label extensions and an array of products yet to be released in order to provide a complete Disease and Insect Management Solution.

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# PROTECTANT FUNGICIDES: HOW DO THEY WORK?

All Protectant Fungicides rely on excellent coverage and tenacity in order to optimise fungicidal value.

Particle size (in microns) is a key feature which determines coverage, ultimately determining effectiveness and fungicidal value.

## COVERAGE

Number of Particles per gram of Product

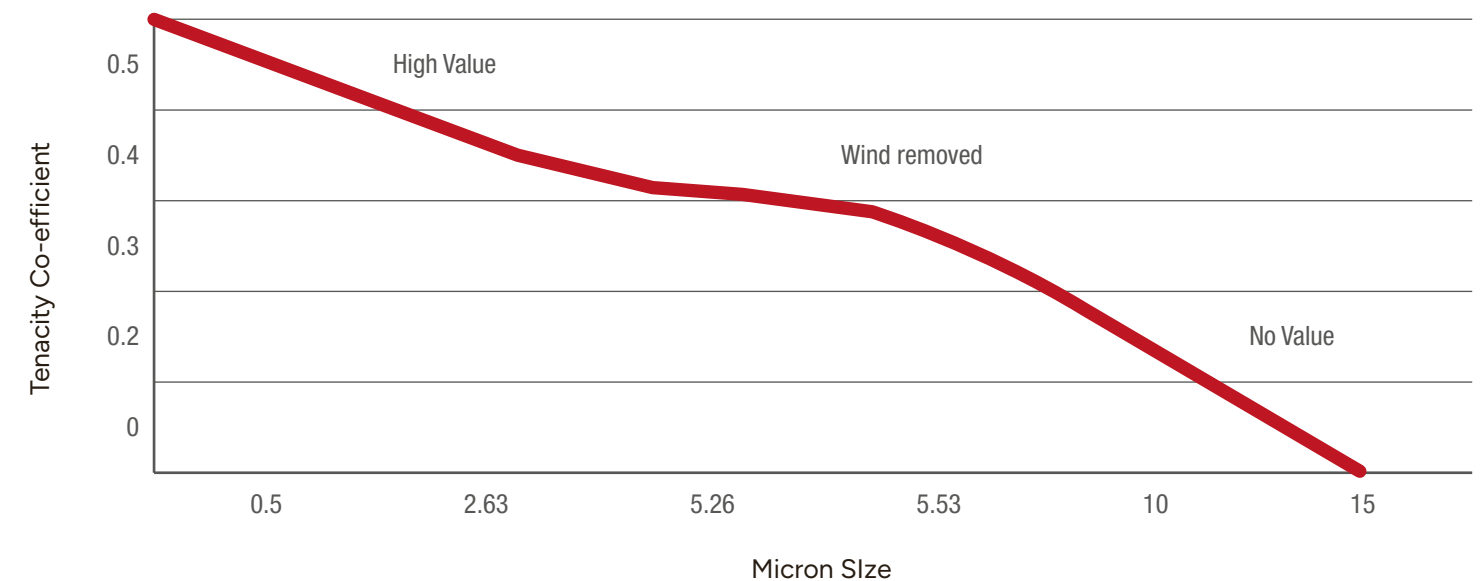


## TENACITY – THE ABILITY TO STICK TO THE PLANT LEAF & TISSUE SURFACE

Protectant Fungicides must remain on the plant in order to perform a fungicidal / bacterial function. Any particles that fall off the protected plant surface will no longer provide protection.

The smaller the particle the greater the ability to stick, and this slide illustrates the effect particle sizing has on tenacity ranging from 0.5 micron (highest adhesion) to 10 – 15 micron (lowest).

Any particle 10 micron and above has no value at all.





## RAIN

Rain removes deposits considerably faster than wind, but wind is more prolonged than rain.

- 40% removal after the first 6mm of rain
- 4% removal after the next 6mm of rain
- 1 – 2% removal after the next 6mm of rain

## WIND

Wind alone will reduce deposits by 50% after 27 days.

Reference: Summers & Thomas

The addition of a non-ionic surfactant reduces water tension. Spread and tenacity is improved considerably.

Refer section on adjuvants.



The above statistics are a generalisation. Every formulation behaves differently.

## MODE OF ACTION & LENGTH OF CONTROL

Protectant Fungicides must be applied onto the plant surface – BEFORE – any infection.

Copper formulations degrade in acidic solutions and are unstable in highly alkaline solutions. It is therefore essential that the spray solution is maintained at the 6.8 – 7.4 pH range.

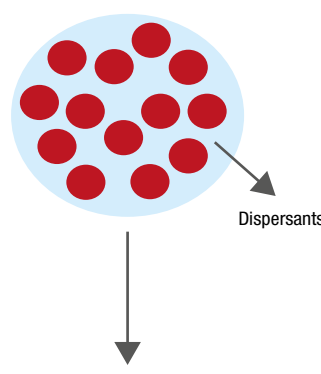
On contact with water the wettable granule will disperse and revert to its powder form which then “sticks” to plant surfaces.

### THE STARTING POINT

#### Granule:

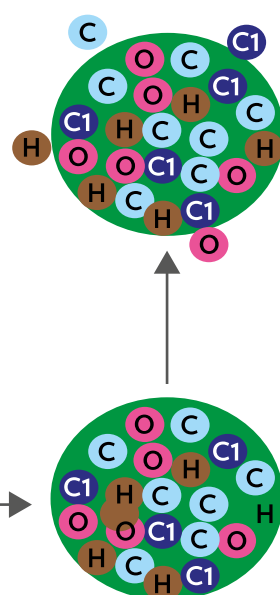
Compressed individual powder particles.

Which disperse when coming into contact with water.



#### Powder Particle:

Comprising molecules of Copper Oxychloride or Copper Hydroxide.



### PARTICLE DEGRADING

#### Molecule Disintegrating:

(Bioactive)

“Active” Copper = copper on the outside of the molecule or atoms of copper breaking free.

#### Molecule:

COC  
COH

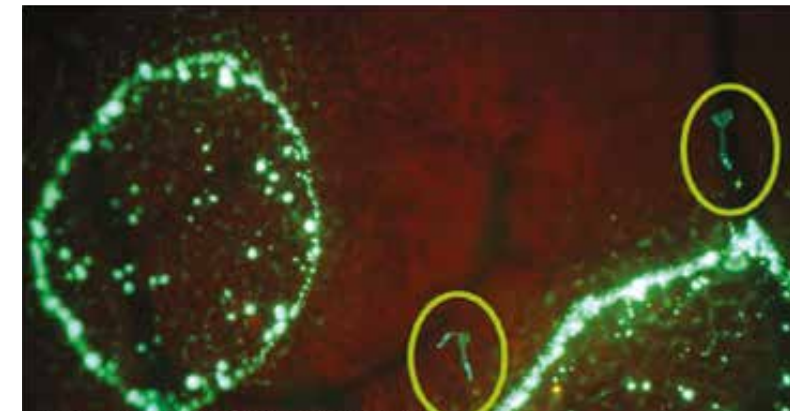
Once the spray droplets dry, the particle remains in a fixed position on the plant tissue and acts as a copper ion reservoir. Degradation of the particle and the release of the copper ion requires moisture, which is a combination of water and weak organic acids that exist on the plant leaf surface.

For this reason, we suggest using the more soluble forms such as Hydrocop WG, 7 Worlds Ag Bordeaux WG or 7 Worlds Ag Tribasic Liquid in the dryer conditions and the less soluble forms such as Coppox WG or Ag Copp 750 WG in moist conditions.

The steady release of copper ions occurs over a period of several weeks and the rate of release depends on the formulation type, the particle size and the moisture conditions.

The particle will deteriorate under certain conditions

- The actual particle releasing ions
- Rain
- Wind
- Leaf abrasion
- Expansion of leaf / fruit.



### RUN OFF

Spores germinating between copper particles due to poor coverage

## SOLUBILITY & THE RATE OF COPPER ION RELEASE

At a pH of 7, these products are virtually insoluble in water.

As the pH of the water decreases the solubility of the copper particle increases, leading to an increase in the release of copper ions – and hence the caution of using acidic based foliar fertilisers. Too fast a copper ion release will lead to crop effect.

Assuming the same particle sizing, Coppox WG/WP would be the least soluble formulation and therefore the longest acting – whereas 7 Worlds Ag Tribasic Liquid would be the most active form, but least residual.

COPPER PRODUCTS - SOLUBILITY IN WATER			
MORE SOLUBLE ↓	Copper Oxychloride	<10 <sup>-5</sup> mg/L	(Coppox WG/WP)
	Cuprous Oxide	0.64 mg/L	(Ag Copp 750 WG)
	Copper Hydroxide	2.9 mg/L	(Hydrocop WG)
	Tri Basic Copper Sulphate	3.42 mg/L	(7 Worlds Ag Bordeaux WG) (7 Worlds Ag Tribasic Liquid)

## 7 WORLDS AG COPPER-BASED FUNGICIDE RANGE

All of the 7 Worlds Ag Copper-based Products are produced using very high grades of copper as the raw material and, as a result, undesirable heavy metals are extremely low to non-existent.

Hydrocop WG, 7 Worlds Ag Bordeaux WG and Ag Copp 750 WG are Certified through NASAA for Organic Input and this again demonstrates the quality of the products.



## ENVIRONMENTAL IMPACT

Consideration is given during manufacturing to ensure minimal impact on the environment. This includes waste water disposal and air pollution.

All products are manufactured to ISO 9001:2008 Standards.

All formulations, with the exception of Coppox WP and 7 Worlds Ag Tribasic Liquid, are wettable granules, which substantially reduce the OH&S risk to the operator.

The production time of a WG formulation is approximately two and a half times that of a WP formulation. Consequently the production output is reduced, which then impacts on the cost.

Despite this, we feel OH&S is far more important than the additional or lost production volumes.

Mammalian Toxicity = low

Honey Bee Toxicity = low

## WHICH COPPER FORMULATION TO USE?

There are numerous brands and formulation types available to growers, hence the dilemma. When making this choice consider seasonal conditions and growth stage.

The overriding suggestion would be to "...stick to known and recognised brands..."

## CONSIDERATIONS:

### 1. SEASONAL CONDITIONS:

- If dry, use the more "soluble" of the four types, i.e. Hydrocop WG or 7 Worlds Ag Bordeaux WG or 7 Worlds Ag Tribasic Liquid.
- If wet – and that includes heavy dew on a daily basis, rain showers, mist, etc. – use the less soluble forms: i.e. Coppox WG/WP or Ag Copp 750 WG.

Note: The more soluble forms perform in any conditions.

Any formulation can be used, however the less soluble forms will provide greater value. Coppox, for example, provides 100gm active copper vs Hydrocop WG at 52.5gms.

Refer Comparative Table of copper decreasing with increased solubility.

Product	Rate per 100 Litres of Water	
	Label Rate	Active Copper (g)
Coppox WG/WP	200g	100.0
Ag Copp 750 WG	105g	78.75
7 Worlds Ag Bordeaux WG	280g	56.0
7 Worlds Ag Tribasic Liquid	280g	53.2
Hydrocop WG	105g	52.5

## 2. GROWTH STAGE:

Plant tissue is most vulnerable to infection when tissue has been damaged. The presence of moisture and nutrients in the exposed, damaged part are an ideal media for pathogen infection. Consequently, the most critical application times should be just prior to or during all stages where damaged tissue is exposed:

### ALMOND GROWTH STAGE

- Leaf Fall: Hydrocop WG or Coppox WG
- Bud swell/cracking: 7 Worlds Ag Bordeaux WG (very long lasting)
- Post Petal Fall: Hydrocop WG
- Throughout the growing season: Hydrocop WG

The different formulations can be used at any of the above stages, however these are the preferred formulations given each set of circumstances.

The different formulations have their strengths and weaknesses and in summary there is no single "silver bullet". Thought should be given to selecting the most effective option given your particular circumstances.

Extensive trial programs are designed to develop correct label rates and timings, in relation to crop safety and product efficiency.

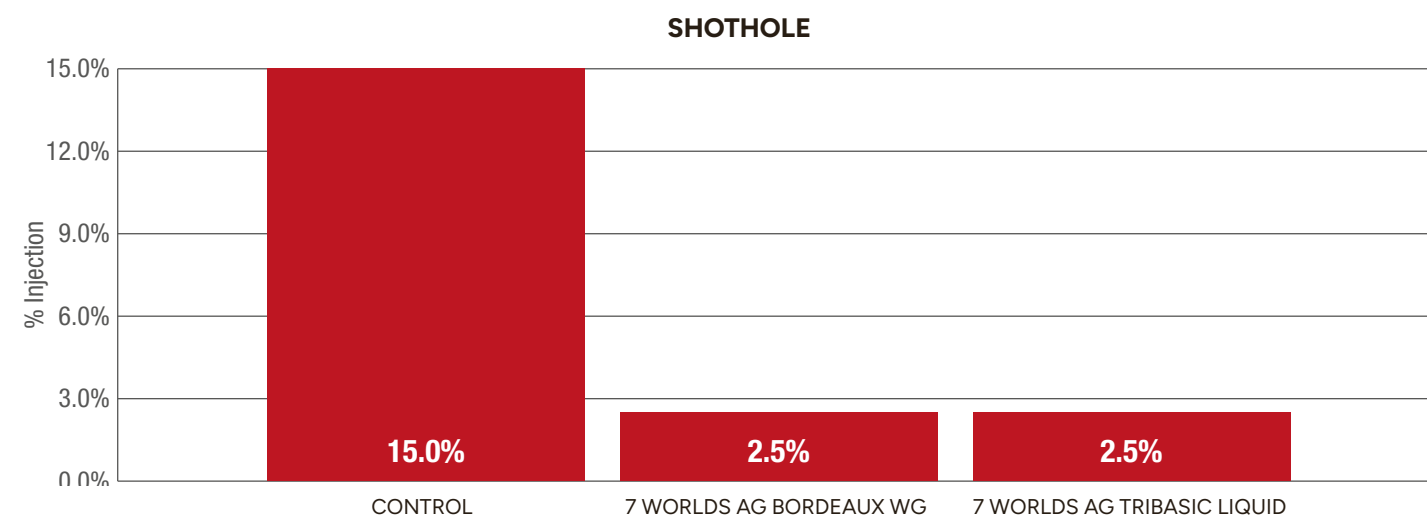
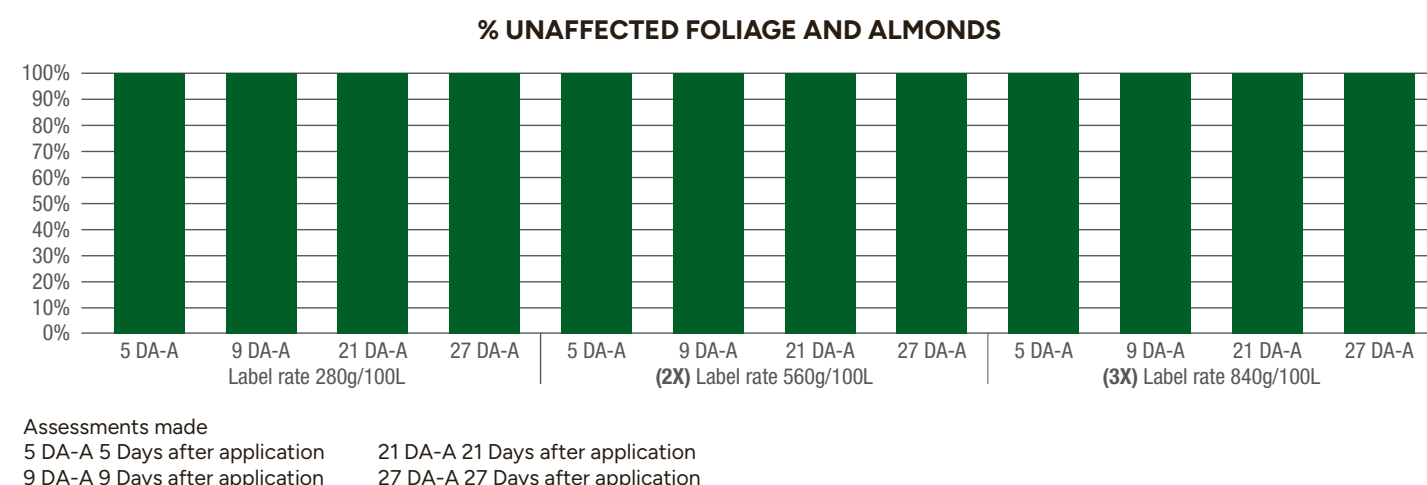
The trial results below have been performed with Copper ONLY and the addition of other products or foliar fertilisers could alter the results and cause phytotoxicity.

Almond Crop Safety Graph

7 Worlds Ag Bordeaux 200g/kg Tri-basic copper sulphate

There was no foliage or almond crop phytotoxicity at label rate, 2 times label rate and 3 times label rate

Trial Location: Kialla, Victoria, Australia 2017/2018





## OTHER PRODUCTS USED IN ALMONDS

### FUNGICIDES

- 7 WORLDS AG CAPTAN 800 WG – 800g/kg Captan
- FORTUNA GLOBE 750 WG – 750g/kg Mancozeb
- CROP DOC 600 – 600g/L Phosphorous (Phosphonic) Acid

Note: Approval rates do vary – refer to the product label.

### 7 WORLDS AG CAPTAN 800 WG – 800g/kg CAPTAN

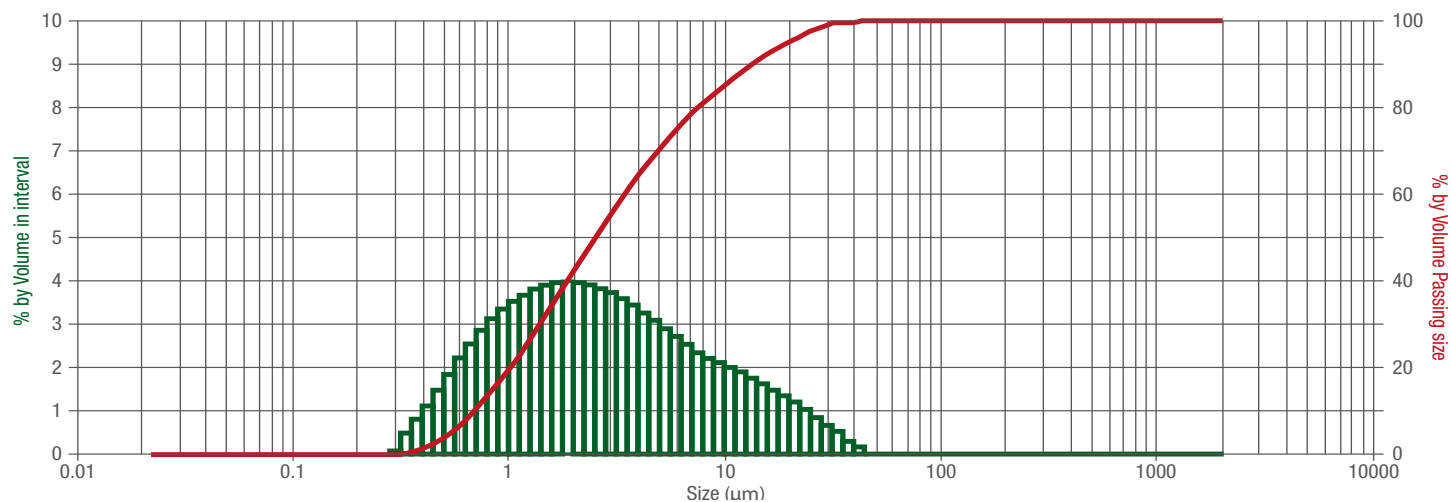
7 Worlds Ag Captan 800 WG is Approved for use on Almonds and several other crops.

#### MODE OF ACTION

7 Worlds Ag Captan 800 WG is a protectant fungicide with some curative properties and no adverse effect on Bees.

Being predominantly a protective fungicide, coverage is critical, hence the need for an ultra-fine particle sizing (at 2.1 micron).

Low solubility: 3.3mg/l in water, which is similar to the solubility of 7 Worlds Ag Bordeaux, and for that reason similar considerations apply.



#### LABEL RATE FOR 7 WORLDS AG CAPTAN 800 WG

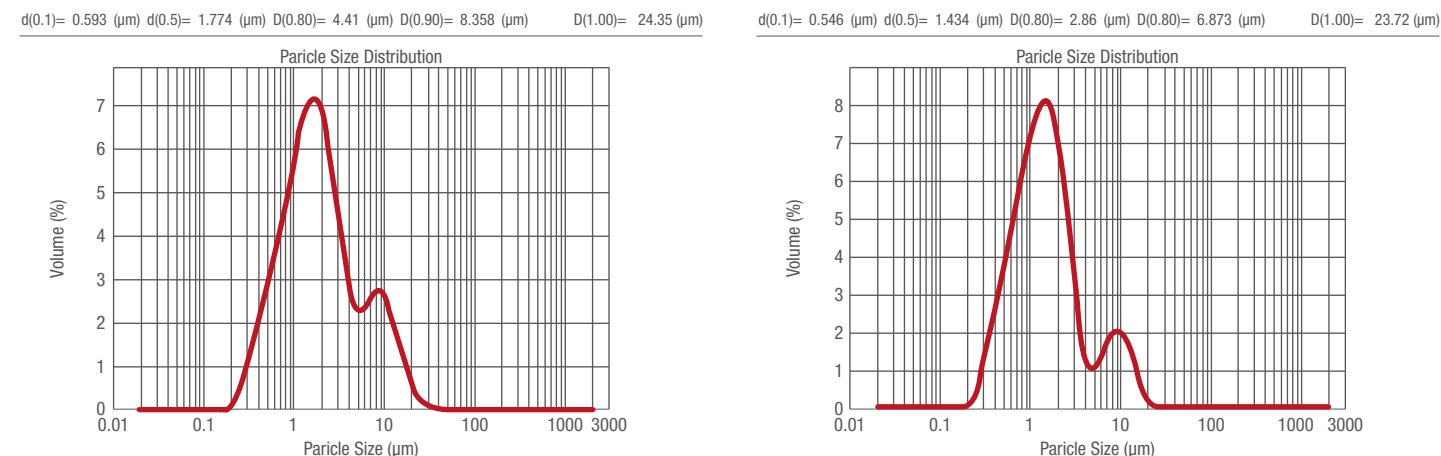
RATE				CRITICAL COMMENTS
In the following table, all rates are given for dilute spraying. For concentrate spraying, refer to the Mixing/Application section.				For all uses in this table apply by dilute or concentrate spraying equipment. Apply the same total amount of product to the target crop whether applying this product by dilute or concentrate spraying methods. DO NOT use at concentrate rates greater than 250g/100L water.
CROP	DISEASE	STATE	RATE/100L	
Almonds	Anthraxnose (Colletotrichum acutatum) Blossom blight (Monolinia laxa) Shot hole (Wilsonomyces carpophilum)	NSW, Vic & SA only	Dilute spraying 200 g/100 L (maximum spray volume 2000L/ha) Concentrate spraying Refer to the Mixing/Application section	
				Apply a total of 3 applications commencing at petal fall followed by applications at 2-3 week and 4-5 week intervals after the start of petal fall. Use the shorter intervals under higher disease pressure. 7 Worlds Ag Captan 800 WG Fungicide should be used as part of an integrated control program, using applications of other approved fungicides. <b>DO NOT APPLY AFTER THE END OF PETAL FALL. DO NOT GRAZE ANY TREATED AREA OR CUT FOR STOCK FOOD.</b>



### FORTUNA GLOBE 750 WG – 750g/kg MANCOZEB

Mancozeb, like the copper formulations is a Protectant Fungicide and for this reason it will follow the same principles as explained in the copper formulations.

Mancozeb is also widely used on a number of different crops, including almond crops.



#### MANUFACTURE & ENVIRONMENTAL IMPACT

- Fortuna Globe 750 WG is manufactured to European Standards using European ingredients:
  - > Manufacturing Site - Accreditation Standards:
    - ISO 9001: 2008
    - ISO 14001: 2004
    - ISO 18001: 2007
  - > Satisfies the EU requirement for waste water disposal
- The impurity: Ethylenethiourea (ETU) is exceptionally low at maximum 0.055%.
- Bee toxicity: Very low: 208 – 400µg per bee.
- Breaks down rapidly in the soil and has little to no effect on earth worms.
- Contains both manganese (15%) and zinc (1.5%) and has an ultra-low solubility in water.

#### RAIN-FAST

Mancozeb formulations are traditionally extremely unstable on plant tissue\*. Steps have therefore been taken in the Fortuna Globe 750WG Formulation to significantly improve rain-fastness, resulting in a tenacious product.

\* Reference: Rain Fastness and Persistence of Fungicides for Control of Alternaria Brown Spot of Citrus – by A. Vicent, et al

#### DISEASE CONTROL

Fortuna Globe 750 WG controls a very wide range of diseases in a large number of crops, including almonds.

When copper + Fortuna Globe 750 WG + 7 Worlds Ag Captan 800 WG are mixed, all diseases would be covered.

#### BOTRYOSPHERA CANKER (ALSO KNOWN AS BOT CANKER)

A series of both protectant and systemic fungicides were trialled against this pathogen. Mancozeb was confirmed as the more effective protectant fungicide on this organism.

Refer article: Evaluation of Fungicides for the management of Botryosphaeria die back diseases of grape vines – by Nicolas T Anponsah et al.





## CROP DOC 600

A Systemic Fungicide, CROP DOC 600 is a specifically formulated 600 g/L Phosphorous (Phosphinic) Acid present as Mono (and) Di Potassium Phosphite. As a result of this formulation it is a nearly neutral pH product, which aids in plant uptake, movement and disease control. A near neutral pH will also help with product compatibility, when mixing with product such as coppers.

CROP DOC 600 is rapidly transported from the point of entry throughout the plant to the site of infection. This is especially important when dealing with root and tissue acting diseases. The mode of action combines both toxicity to the infection as well as aiding natural plant defenses.

CROP DOC 600 is short lived in the plant, it oxidises to Phosphate, which is a high demand macro-nutrient required for plant growth. This rapid breakdown to plant available nutrients gives it a short withholding period.

CROP DOC 600 is now registered for suppression of Phytophthora.

Crop & Situation	Disease	State	Treatment method	Rate	Critical Comments
ALMONDS	Suppression of <i>Phytophthora</i> spp	All States	Foliar spray	333 mL/100L	Ensure thorough coverage of foliage and branches. Spray to point of run-off using air blast sprayer or equivalent equipment. <b>DO NOT</b> apply more than two (2) application per season. <b>DO NOT</b> apply after hull split. <b>DO NOT</b> apply under high temperatures, particularly if humidity is low.
			Irrigation	5.2 L/ha	Ensure even mixing with irrigation water. <b>DO NOT</b> apply more than two (2) application per season. <b>DO NOT</b> apply after hull split. <b>DO NOT</b> apply under high temperatures, particularly if humidity is low.

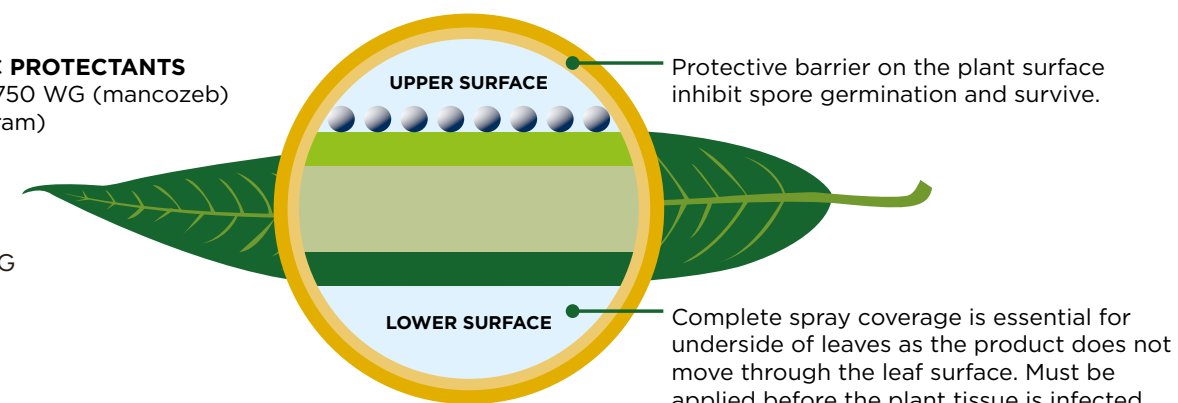
### SUMMARY OF EFFECTIVE FUNGICIDES ON VARIOUS DISEASES ACROSS ALL CROPS REGISTERED IN ALMONDS.

Product	Leaf Curl	Shothole	Blossom Blight (Brown Rot)	Rust	Anthracnose	Freckle (Scab)	Phytophthora (suppression)
Bordeaux WG	✓	✓					
Hydrocop WG	✓	✓					
Tribasic Liquid SC	✓	✓					
Coppox WG	✓	✓					
Ag Copp 750 WG	✓	✓					
Oxydul DF	✓	✓					
Captan 800 WG		✓	✓	✓	✓	✓	
Fortuna Globe 750 WG		✓	✓	✓		✓	
Lime Sulphur		✓	✓				
Crop Doc 600							✓

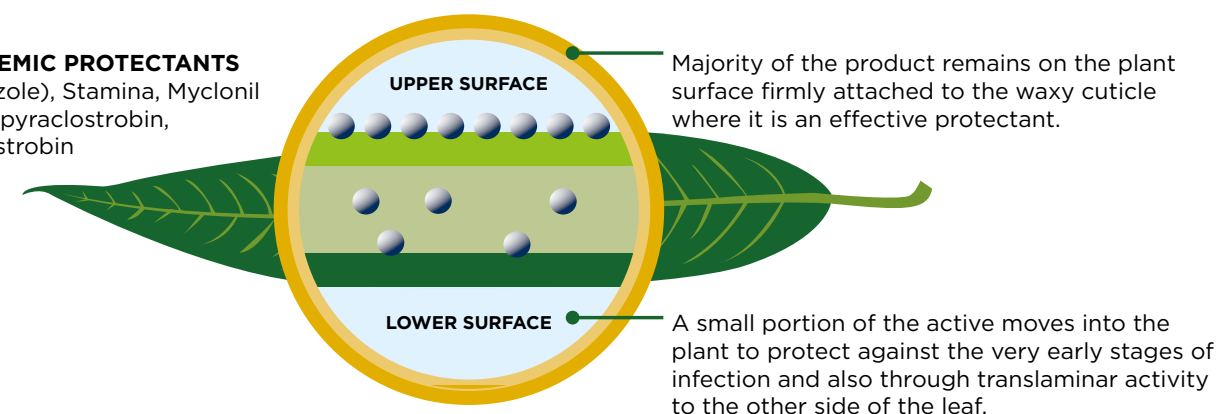
\* Always read the label before use

## FUNGICIDE PERFORMANCE – THE EFFECT OF SYSTEMICITY

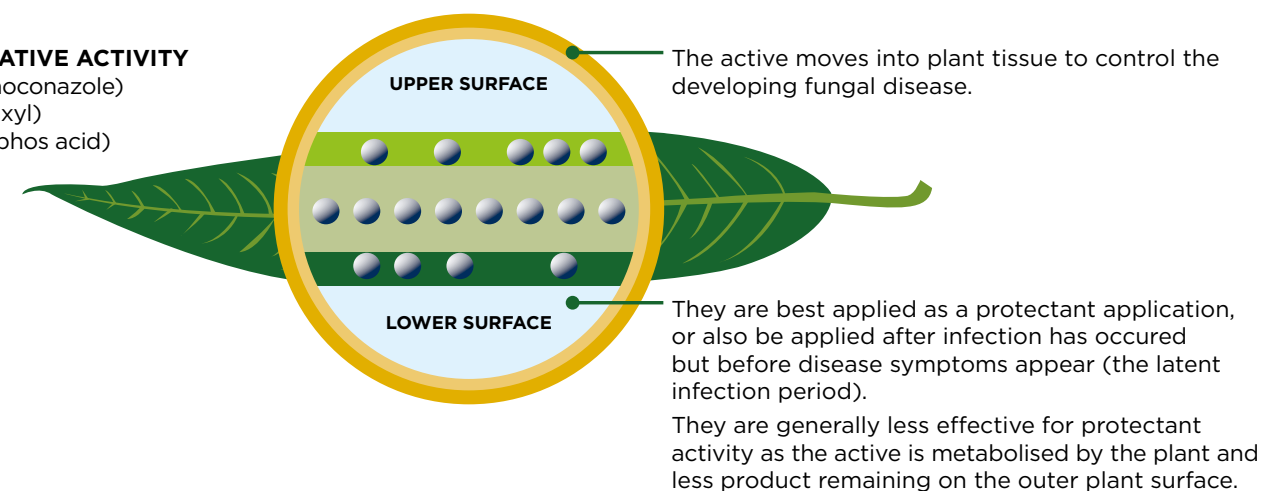
**NON SYSTEMIC PROTECTANTS**  
Fortuna Globe 750 WG (mancozeb)  
Fruitcote (metiram)  
Bordeaux WG,  
Coppox WG,  
Hydrocop WG,  
Tribasic Liquid  
Ag Copp 750 WG



**LOCALLY SYSTEMIC PROTECTANTS**  
Pearl (penconazole), Stamina, Myclonil (myclobutanil), pyraclostrobin, boscalid, azoxystrobin



**SYSTEMIC CURATIVE ACTIVITY**  
Kingfisher (difenoconazole)  
Metman (metalaxyl)  
Crop Doc 600 (phos acid)





## INSECTICIDES USED IN ALMONDS

### PEREGRINE 240g/L METHOXYFENOZIDE

Peregrine is a group 18 insecticide, the active Methoxyfenozide belongs to the diacylhydrazine class of insecticides and has a novel mode of action. The chemical mimics the action of the molting hormone of Lepidopterous (moths, butterflies) larvae.

Peregrine Insecticide is non-systemic: once applied has residual activity for up to 21 days.

Methoxyfenozide is considered soft on non-target organisms, including a wide range of non-target and beneficial insects, which makes it ideal for IPM programs.

Peregrine Insecticide is registered in Almonds for the control of Carob Moth.

In Almonds, Peregrine should be used in a program targeting both 1st generation (Early post flowering, Aug-Sept) and 2nd generation (Hull split).

When using Peregrine to control Carob Moth in Almonds, larvae (caterpillars) may not appear to die for 3-6 day following the application. During this time they will not feed. Carob Moth eggs will be controlled, and new egg lays on treated surfaces do not hatch, or larvae do not survive.

Peregrine should be applied with a wetting agent, such as Agral 600.

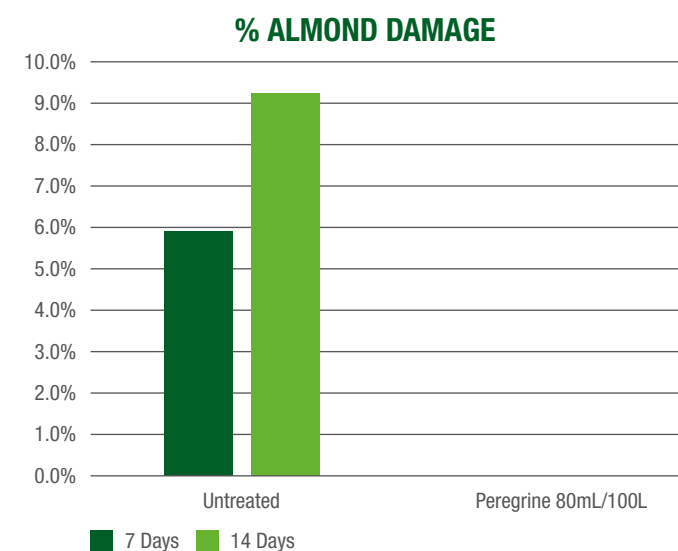
#### LABEL RATE FOR PEREGRINE 240g/L METHOXYFENOZIDE

CROP	PEST	RATE/100 L	CRITICAL COMMENTS
Almonds	Carob Moth (1st generation)	80 mL + Water	Practice good orchard hygiene with the removal of mummified fruit in winter. Early post-flower application: At the beginning of the season (Aug- Sep), carefully monitor pheromone traps for peak adult pest incidence of 1st generation. Once regular field scouting indicates egg laying and newly hatched larvae apply a maximum of 3 sprays of Peregrine Insecticide at a minimum of 10 day intervals between sprays. Apply to complete coverage. Refer to Wetting Agents in the General Instructions section for more information.
	Carob Moth (2nd generation)		Hull-split application: Peregrine Insecticide should be applied at the start of hull split (2-5% of the almond hull sutures open). Carefully monitor pheromone traps for peak activity of 2nd generation moths. Continue field scouting for egg-laying activity, and apply Peregrine Insecticide to coincide with the initiation of egg hatch. Apply to ensure complete coverage of all foliage and fruit (hull/shell) surfaces. Concentrate spraying is not appropriate for this pest. Do not apply less than 2000 L/ha water.

#### PEREGRINE INSECTICIDE TRIAL RESULTS

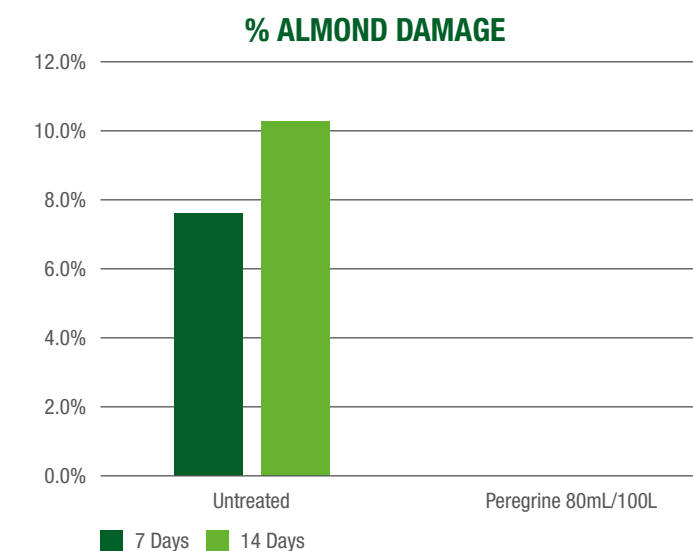
##### Trial 1

Robinvale Victoria - 2016/2017  
Peregrine Rate 80mL/100L  
Adjuvant: Agral 600 at 0.01% of water volume  
There was no phytotoxicity effect from Peregrine in the trial



##### Trial 2

Wood Wood, Victoria - 2016/2017  
Peregrine Rate 80mL/100L  
Adjuvant: Agral 600 at 0.01% of water volume  
There was no phytotoxicity effect from Peregrine in the trial



#### SUMMARY OF EFFECTIVE INSECTICIDE ON VARIOUS INSECT PESTS ACROSS ALL CROPS REGISTERED IN.

Product	Carob Moth (eggs and larvae)	Light Brown Apple Moth	Leafroller	Macadamia Nutborer	Macadamia Flower Caterpillars
Peregrine	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓

Peregrine is a Group 18 Insecticide and therefore useful in any Resistance Management Program.

Peregrine is non-systemic and has residual activity up to 21 days.

The active ingredient is soft on beneficial insects including bees.





# IMPORTANT CONSIDERATIONS

## CROP SAFETY & LIQUID NUTRIENTS

Numerous efficacy and crop safety trials have been carried out over several years and at times, in challenging weather conditions. Both label rates and twice label rates have been used in all crop safety trials. In every trial crop safety has been assessed and in every instance there has been ZERO crop effect at the label rates.

Water should be tested prior to the addition of the copper formulation and pH adjusted accordingly, then measured after applying the copper to double check.

Copper can be applied in conjunction with a range of liquid nutrients however, be cautious with the acidic based foliar nutrients such as Ligno-Sulfonates, Sulphates, etc.

## ADJUVANTS – INCLUDING WETTERS

The ingredients in any WG Formulation total 100%. The major portion in the formulation is the copper in one form or the other.

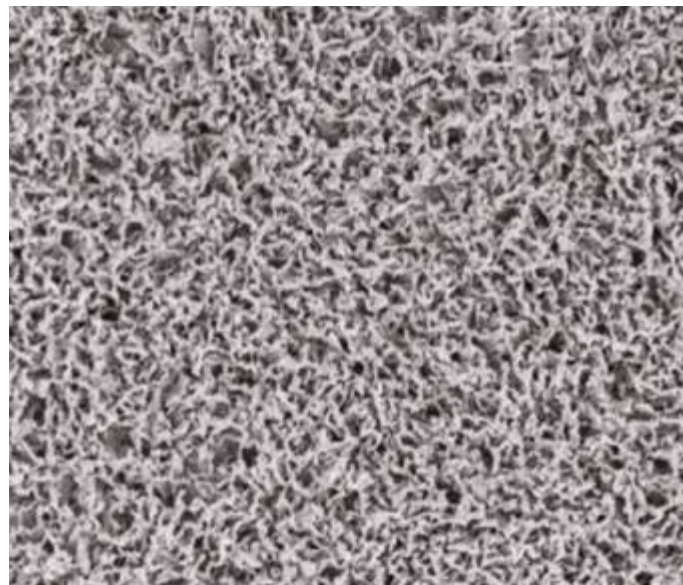
Example: Coppox WG: 860gm of copper oxychloride of which 50% is copper.

**There is therefore insufficient “space” in the formulation to add sufficient surfactant to lower the surface tension of the spray droplet.**

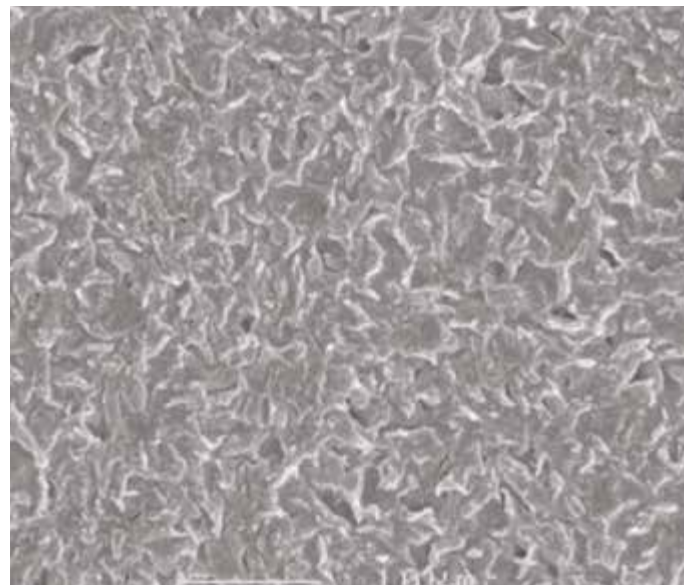
**Consequently, the additional of a “soft” nonaggressive, non-ionic wetting agent such as viti-wet is essential to maintaining crop safety and improve coverage.**



An incorrect choice of a wetting agent will result in damaging the all important plant cuticle and this will result in points of entry for pathogens.



Intact Plant Cuticle



Damaged Cuticle allowing pathogen points of entry

# FUNGICIDE AND INSECTICIDE APPLICATION TIMES:

The critical timing for any application of a protectant fungicide is whenever a “wound” appears on the plant, such as:

- Leaf fall
- Petal fall
- Buds cracking
- Pruning etc

Damaged tissue contains the ideal medium of moisture / nutrients for pathogens and infection will occur rapidly if such an ideal environment is present.

Copper-based formulations can be added to a number of different products in the spraying program, therefore saving application costs. Refer to respective labels for compatibilities.

## WINTER APPLICATION

This is the only growth stage whereby the trunk / twigs are fully exposed and spray mix is able to cover the entire tree – filling the cracks / crevices. This will result in excellent protection for an extended period, and destroying the carry over spores in winter reduces disease pressure in spring.

Any of the coppers can be used at this stage but our suggestion would be for 7 Worlds Ag Bordeaux WG due to its long lasting capability and its compatibility with oils.

Higher than usual water rates should be used, in conjunction with compatible oils and wetter.

Applied to past runoff in order to fill the cracks and crevices in the bark.

Suggested water rates: 3000 Litres per Hectare

## BUD SWELL/BUD CRACKING

Tree movement in spring coincides with spores coming out of their dormant phase.

This is a strategic, essential application time.

At this growth stage we recommend 7 Worlds Ag Bordeaux WG.

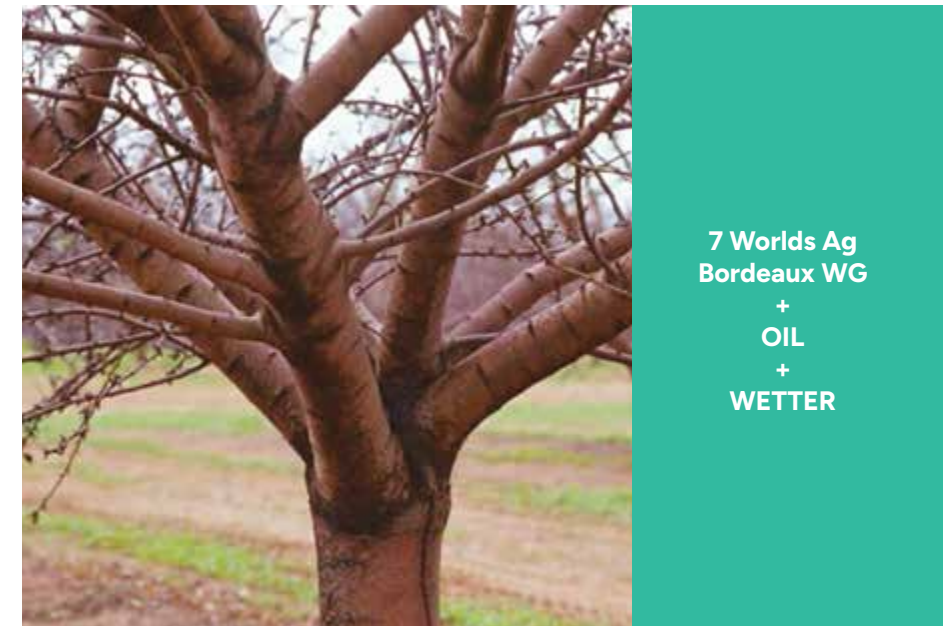


Photo courtesy the Almond Board – [www.australianalmonds.com.au](http://www.australianalmonds.com.au)



## EARLY POST-FLOWERING

Following good orchard management practises over the winter, Carob moth (1st generation) numbers should be monitored, once regular field scouting indicates egg laying and newly hatched larvae. Peregrine Insecticide should be applied.

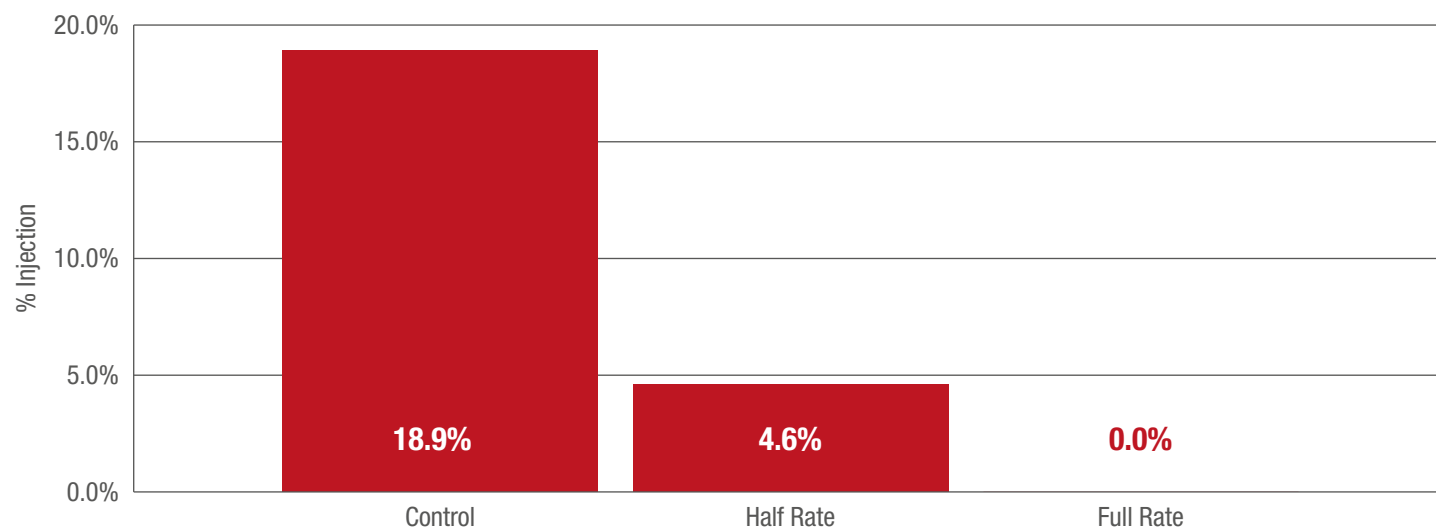
## POST PETAL FALL AND THROUGH THE GROWING SEASON

Hydrocop WG is registered to be applied for post-flowering applications, 5-7 days after petal fall is complete. Apply at 10-14 day intervals as the season dictates, to a maximum of 4 applications.

Top up applications should be applied within 21 days in order to maintain effectiveness. Frequent top-ups in conjunction with fungicides (7 Worlds Ag Captan 800 WG and Fortuna Globe 750 WG) are far more effective than infrequent applications.

**To optimise fungicidal activity, full label rates must be used.** Using less than the label rate will compromise effectiveness. An average of 4 trials on Monilinia were conducted and in each case varying rates were used. These trials clearly demonstrated that using less than the label rate resulted in reduced effectiveness of the product.

**BLOSSOM BLIGHT - CAPTAN 800WG**



## HULL SPLIT

Carob moth (2nd generation) numbers should be monitored carefully, Peregrine Insecticide should be applied at the start of hull split (2-5% of the almond hull suture open). Peregrine Insecticide should be applied at the initiation of the egg hatching. Do not use more than 3 spays per season of Peregrine or Group 18 insecticides.

## POST HARVEST APPLICATION – PRE-WINTER

There is a considerable period between the pre-harvest fungicide application and first use for the following scenarios. During this time, pathogen numbers build up and this can lead to an early infection and high disease pressure.

Stone fruit growers recognise the risk and consequently have a post-harvest "clean-up strategy".

The recommendation for copper applications in stone fruit crops (at this time) are:

- 25-50% leaf fall
- Apply again at 90-100% leaf fall

## PRODUCTS OF USE TO THE ALMOND GROWER



## NOTES

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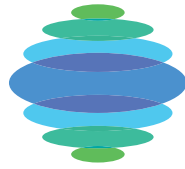
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