APPLICATION OF POTASSIUM PHOSPHITE ON NATIVE FLORA OF WESTERN AUSTRALIA THREATENED BY *PHYTOPHTHORA*

PRESCRIPTION MANUAL

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1. INTRODUCTION

Phytophthora cinnamomi is the most common and destructive of the eight *Phytophthora* species found in native vegetation in Western Australia.

The pathogen causes extensive "dieback" of many woodland and heathland communities as well as the jarrah forest (Shearer *et al.*, 1991). The fungus not only affects many popular Western Australian *Banksia* spp. including *B. coccinea*, *B. baxteri* and *B. hookeriana,* but also poses a great threat to a number of Declared Rare Flora (DRF) (Table 1) with some being considered at risk of extinction due to the disease (Keighery, 1992). It is estimated that over 2000 plant taxa are at risk in the south-west to a disease which is seriously out of control in many areas and over the wide range of plant communities.

In addition, the changes in vegetation directly influence the abundance and species richness of native fauna. Reduced canopy cover and decreased plant species diversity affect sources of shelter, nectar, pollen and seed necessary for survival of numerous small marsupials, birds and insects. Nichols and Watkins (1984) determined that in the *P. cinnamomi* affected forest the number of birds as well as bird species declined compared with disease-free sites.

Current strategies to control *P. cinnamomi* in plant communities in Western Australia aim to prevent and restrict spread and intensification of the pathogen to protect various conservation and economic values (Shearer and Tippett, 1989). Strategies in use include recognition of vulnerable sites, risk assessment of introduction and spread of the pathogen in a particular area and application of quarantine. Also hygienic procedures have been developed for the public and industries to help protect large areas of healthy bush from the disease. All the methods, when well integrated, minimise the introduction and spread of infection to various areas and susceptible hosts, but they are also regarded as an interim solution until better methods can be developed.

Table 1 Susceptibility of declared rare flora to *Phytophthora cinnamomi* (from Keighery, 1992).

Highly susceptible	Susceptible
Andersonia sp. (GK 8229)	*Banksia goodii*
Adenanthos cunninghamii	*B. tricuspis*
A. dobagii	*Chamelaucium erythrochlora*
A. ellipticus	*C. griffinii*
A. ileticos	*C. roycei*
A. pungens ssp. Pungens	*Darwinia collina*
A. velutinus	*D. macrostegia*
Banksia brownii	*D. meeboldii*
B. verticillata	*D. oxylepis*
Dryandra sp. (Kamballup)	*D.squarrosa*
D. *sp. (Lullfitz 3379)*	*D. wittwerorum*
Isopogon uncinatus	*D. sp. (Keighery 5732)*
Lambertia echinata ssp. Echinata	*Dryandra serratuloides*
L. fairallii	*Grevillea calliantha*
L. orbifolia	*G. saccata*
	Leucopogon obtectus

Trials conducted by CALM in the recent years (Appendix 1) have demonstrated that the fungicide potassium phosphite (phosphite) is an important and highly effective tool for the management of *Phytophthora* infected areas. The chemical has been extensively used in horticulture (mainly on avocado, citrus and pineapple) for over twenty years but its application to native plants is relatively new and limited to a number of specific trial/treatment areas established in the last 8 years.

The discovery of the potential of the fungicide to protect native vegetation and a subsequent development application technology suitable to native plants species offer not only a significant advance in knowledge but also important and highly effective management tool.

2. *SCOPE*

This document is a summary of current information on the methodology of application of the systemic fungicide mono di-potassium phosphite, commonly known as "phosphite" in the treatment of native plant communities infested with *Phytophthora cinnamomi*. Whilst prescriptions for fungal control of the pathogen appear in this manual they are intended as a guide and are limited to specific plant communities (Appendix 1). Any use outside of the specified guidelines should be first tested on a limited scale to ensure optimum result. Incorrect dosage or concentration can potentially result either in poor disease control if the chemical is applied in insufficient quantity, or chemical burning and plant death if it is used excessively. Caution must be especially applied when phosphite is to be used to control the disease affecting DRF.

Although the manual lists prescriptions for the use of the fungicide phosphite, all areas to be sprayed should be treated individually and prescription modified depending on species present, canopy structure, environmental conditions and other factors. Therefore only experienced and trained personnel should be involved in the determination of application rates and applications of the chemical should always be supervised.

Detailed research results that formed the basis for this manual are presented in "THE CONTROL OF *PHYTOPHTHORA* IN NATIVE PLANT COMMUNITIES" - final report to the Threatened Species and Communities Unit, Environment Australia, May 1997.

3. *THE FUNGICIDE PHOSPHITE*

Phosphite is an aqueous solution of mono and di-potassium phosphite. It is made by neutralising phosphonic acid with potassium hydroxide to a pH in the range of 5.7 to 6.0. The active component of the chemical is the phosphite ion (HPO_3^-). The fungicide is sold under various brand names and strengths of 20 and 40%.

The chemical is manufactured by various companies including UIM and Craig Mostyn. Although UIM chemicals were used in CALM's experimental trials, chemicals manufactured to appropriate specifications by other companies can be used. Commercial preparations are sold as FOS-JECT 200, FOLI-R-FOS 400, FOS-ACID 200 and FOS-4-PINE. The active ingredient is phosphonic acid present as the mono di-potassium phosphite at 200 and 400 g/l respectively.

In the literature and various publications, the fungicide phosphite is often referred to as "phosphonate", "phosphorous acid" or "phosphonic acid". All these names have been used to describe mono di-potassium phosphite.

Instructions for safe use of phosphite

The following instructions should be used in conjunction with the Chemical Users Manual, CALM 1984. Accidents involving swallowing, splashing in eyes or gross skin contact should be reported to medical officer.

TRADE NAME FOS-JECT 200, FOLI-R-FOS 400 , FOS-4-PINE, PHOS ACID 200, PHOS ACID 400

ACTIVE INGREDIENT	200 or 400 g/l phosphonic acid
APPEARANCE	Water clear liquid
CLASSIFICATION	Fungicide exempt schedule poison
STABILITY	Non-flammable, non-corrosive, non-explosive, stable under all normal environmental conditions. Stable in original containers for at least two years.
USE	Control of *Phytophthora*

PROTECTIVE CLOTHING

Mixing	L/S combination overalls or L/S white cotton shirt and trousers, PVC gloves and goggles
Application	L/S combination overalls or L/S white cotton shirt and trousers, PVC gloves and goggles
Personal Precautions	Avoid contact with skin and eyes. Wash skin with soap and water immediately after use and also before eating, drinking or smoking. Wash clothing regularly or when known to be contaminated.
Health Hazard	Stored in body - No Degree of toxicity: Swallowing Low Skin absorption - Low Inhalation - Low Not carcinogenic nor mutagenic

FIRST AID

Swallowing	Wash mouth out with clean water but do not induce vomiting, give water to drink and seek medical attention
Splashing in eyes	Flush eyes with clean water for at least 20 minutes, then see a doctor
Spillage over person	Remove contaminated clothing, flush skin with water, consult a doctor if irritation persists

STORAGE	Store in manufacturers containers in locked chemical store
SPILLAGE	Absorb excess in suitable absorbent and rinse area with water
CONTAINER DISPOSAL	Triple rinse and add liquid to mix, crush container and bury at recognised chemical disposal site

Synopsis of toxicology

The oral median lethal dose (LD_{50}) for 10% phosphonic acid in water is 1.58 grams of pure acid/kg body weight.

This places the Technical Active Ingredient in Class III of the WHO Classification. This classification is the slightly hazardous class and phosphonic acid is at the very low end of the scale. Twenty and 40% products have been formulated to eliminate these very slight poisonous and corrosive properties of the Technical Active Ingredient.

The formulated products are safe chemicals to use because they overcome the above mentioned hazards when neutralised. Phosphite has a pH 5.7-6.0 which is comparable with the skin. Therefore the product does not cause dermal irritation and is not corrosive to the skin, eyes etc. Contact with the skin is likely to cause only mild irritation to cuts or mucous membranes. In addition the slightly acidic pH lowers the likelihood of phytotoxicity to plants.

The LD_{50} rate for FOS-JECT 200 is of the order 23.6 grams/kg body weight and is classified not poisonous by N.H.M.R.C. Estimated LD_{50} to fish is approximately 1.5 g/l. The chemical is not broken down in animals. It is excreted in normal way. In the soil the chemical is slowly broken down to phosphate by microflora.

Application of phosphite to native plant species generally does not cause phytotoxicity when the fungicide is applied at recommended rates. Higher rates or treatments

applied under unfavourable environmental conditions or at flowering are likely to result in chemical burning of foliage and can affect reproductive capabilities of sprayed plants. Further work is required to establish the effects of phosphite application on flowering, seed setting and germination. It also appears that plant species vary in their susceptibility to phytotoxicity.

4. METHODOLOGY OF PHOSPHITE APPLICATION

The chemical can be injected into the trunk using an injector. This technique is successful with phosphite because the HPO_3^- ion is transported in the conductive tissues of the tree to the leaves and from leaves to the roots. Phosphite can also be sprayed onto the foliage using a backpack sprayer or a mister. Both of these methods of phosphite application have been proved to be excellent in controlling infections occurring in small areas where the chemical can be applied manually.

In order to control spread of infection effectively over medium to large areas, the chemical must be applied by aircraft. Aerial application of phosphite permits treatment of remote areas cost-effectively, without disturbance to the treated and neighbouring areas.

Trunk injections

The success of phosphite injections against *P. cinnamomi* root rot of avocados and other horticultural plant species prompted similar studies in native plants. Experimental trials established by CALM eight years ago clearly demonstrated that trunk injections of the fungicide are also very effective in the protection of many native plant species infected by the pathogen. As in avocado, the chemical is readily translocated in both xylem and phloem and one application of phosphite using this method have protected several *Banksia* species as well as jarrah for at least 4 years.

The technique is very cost effective and the cost of treating a tree varies between 70¢ to $2.00 depending on tree size. Also, many environmental factors that normally influence uptake and distribution of the chemical when it is applied as a foliar spray, are not likely to affect the effectiveness of injections. Trunk injections (Figure 1 and 2) can be used to treat small infections and are particularly useful in the treatment of places of special interest, picnic spots, schools or areas where only a limited number of plants have to be protected (e.g. rare flora).

Figure 1. Hydraulic injections of *Eucalyptus marginata* at Dwellingup.

Equipment

Equipment relying on either air (hypodermic syringe, Figure 2) or air compression (hydraulic injector, Figure 3) have been used to treat native trees with phosphite.

SYRINGES

Disposable 50 ml catheter tip syringes are recommended and are available through Prestige Products, 1 Delmont Place, Mandurah, ph. (08) 9581 6698 or possibly any medical supplier. New syringes should have a small hole drilled on both sides of the end of the plunger handle, opposite each other so that a locking pin can be inserted to maintain air pressure.

DRILL

Use a good quality high speed cordless electric drill with a sharp 6.5 mm steel bit. Auger or doweling bits drill the cleanest holes but they break easily and cost more than the high speed steel bits.

SPRINGS

Use a small wire loop spring approx. 60 mm long, 6 mm outside diameter, 0.7 mm diameter galvanised wire with a loop on each end. Possible supplier Boynes LA & Co. Pty. Ltd., Sarich Court Osborne Park, ph 9446 5666.

SPRING RETENSION PLATE

Use a metal strip approx. 60 mm wide and 2 mm thick, cut into 100 mm lengths, drill a small hole in each end and a 10 mm hole in the middle.

HYDRAULIC INJECTORS

Various hydraulic injectors are available but some may not be suitable for the treatment of jarrah. Rawlins Hydraulic Injector was developed in New South Wales by an avocado grower. This highly effective and robust unit consists of a 5 litre backpack reservoir, a hydraulic cylinder and lever and a tapered nozzle with a non-

return valve. Sidewinder Tree Injector manufactured by a Queensland company can also be used but it has not been evaluated for use in jarrah. F1-11 Trunk Injector has been used and it works well in *Banksia*. However the injector appears not suitable for use in jarrah as it is extremely hard to achieve a good seal. Poor seal between an injector and a tree results in loses of phosphite solution and in consequence, insufficient treatment.

Method of application

- Make a solution of 5% phosphite. For most plants (e.g. *B. coccinea* and *B. brownii*) this is the highest recommended concentration that can be used. Some species tolerate higher concentrations and rates of up to 10% can be used on jarrah and some thick-bark *Banksia* species including *B. grandis* and *B. attenuata*. Caution must be applied when choosing the right concentration as inappropriately high rate may disrupt the natural defence mechanism and result in the acceleration of infection and increased deaths compared to untreated plants. In a trial involving *B. coccinea*, injection of 5% phosphite resulted in better lesion control than a 10% mixture (Shearer, personal communication).
- Measure the circumference of the trunk of the trees at about waist height. Inject 1 ml per centimetre circumference. Use a maximum of 20 ml per syringe. A tree with a trunk circumference of 68 cm would be 68 ml, so use 4 syringes with 17 ml in each, spaced evenly around the tree. Injections are made in several places around the trunk because there is a minimal radial movement of phosphite solution across trunk tissues (Figure 2).
- Drill holes at about waist height on a slight downward angle approx. 25 mm deep. Drill into the sapwood but not through it. Some jarrah trees have very thick bark so scrape off some of the outer bark around each injection site before drilling.
- Suck up the required volume into the syringe, hold it with the nozzle up and push the plunger up to expel the air from the syringe. Place a spring plate over the nozzle. If using a hydraulic injector, follow manufacturers instructions.

- Insert the nozzle into the hole by pushing while turning to give a nice snug airtight fit. Pull back on the plunger with one hand while holding the syringe with the other hand. If there is no back pressure, air is being sucked in (you should hear it) and it will leak so screw the syringe in tighter and recheck. If there is back pressure and small bubbles appear the fluid should be taken in without leaking. The time for the fluid to be taken in varies greatly depending on the type and the health of the tree. A healthy *Banksia grandis* will take up in about 2 to 10 minutes while a sick jarrah may take 24 hours or more. If no fluid has gone in after about 1 hour then consider drilling a new hole and try again. If an injector is used, the fluid is pumped into a hole. A good seal between the nozzle and the tree wood must be obtained.

Figure 2. Trunk injection of *Banksia prionotes* at Numbung River.

- Attach springs to the plunger. This will ensure constant pressure.
- When fluid has gone, remove syringes or the injector nozzle. The holes can be filled with a silicone sealer but they will callus within 12 months even without sealing because of the trees natural ability to wall off wounds.

Timing of application

Trees can be injected at various times of the year but the best time seems to be early spring through to autumn. Optimum time of application has yet to be determined for native plants.

High volume foliar spraying

High volume foliar spraying relies on a thorough wetting of treated foliage using large particle spray. The method can be combined with trunk injection for maximum effective resistance in the treated area or used alone on plants that are unsuitable for injecting e.g. small dense shrubs or understorey species. A Hardie RY2 backpack pump (20 litre capacity) is recommended for foliar application in conjunction with flat spray nozzles (no 4110-12). This method of application is labour intensive as it requires large amounts of water being delivered and carried to the treated areas, which can be difficult and expensive in remote areas. Therefore, high volume spraying is generally suitable for the treatment of small, localised infections where good access is available.

Equipment

SPRAYERS

Knapsack sprayers (Figure 3) have been used for the experimental treatments carried out by CALM. There are two types of knapsack sprayers: those that have a separate pressurised chamber that enables constant output pressure, and those that must have spray reservoir pressurised during use. Knapsack sprayers operate at limited swath widths of around 2 metres and are generally suitable for the treatment of small plants or areas.

Backpack power misters (foggers) can also be used (Figure 4). They are portable and a flexible blower allows the machine to be operated up and down a hill. Larger trees can also be treated with power misters. Swaths of 30 metres or more can be obtained depending mainly on the type of machine being used. Misters can be powered from a 4WD vehicles but can only be used in areas that are easily accessible.

Figure 3. Back pack spraying of *Banksia brownii* at Millbrook Reserve.

Figure 4. Fogger spraying of *Banksia cuneata* at Popanyinning.

WETTING AGENT

The addition of wetting agent to fungicide solution prevents losses of the chemical. Water does not wet leaf surfaces efficiently due to the presence of hydrophobic molecules in the leaf cell wall membranes.

Various products are available but Synertrol Oil has been selected as a suitable environmentally safe, bio-degradable carrier for phosphite for the control of *P. cinnamomi* affecting native plant communities. The oil is based on food grade canola oil (832 g/l) and as such is not subject to Poison Scheduling/U.N., Hazchem Code or Dangerous Goods Class. The other ingredients include surfactants and emulsifiers.

The inclusion of Synertrol improves coverage and effective adhesion when compared to chemical drops mixed with water only. Phosphite works better because Synertrol binds well, due to its affinity with waxy leaf surfaces. This action allows more time for penetration. Synertrol surrounds the phosphite droplets ensuring they are more uniform in size and therefore less susceptible to drift and evaporation. Even distribution on the leaf surface is also achieved and it helps penetration and absorption of the chemical.

Synertrol oil must always be pre-mixed with the fungicide prior adding to the spray tank or water. The recommended amount of Synertrol is 20 to 30 ml per 10 litres of phosphite solution.

Method of application

For successful control of *Phytophthora* by foliar application a concentration of 0.2 to 0.5% is recommended. Higher concentrations may cause chemical burning of leaves. The amount of the chemical per unit area varies significantly and depends on the amount of leaf area to be sprayed. 6 l/25 m^2 was applied in CALM's experiments (Appendix 1) involving several *Banksia* species but it should be used as a guide only.

It is also recommended that a spray width of approx. 10 metres ahead of the disease front is needed for prevention of the spread of infection. If the disease front is present on a slope, wider area downslope should be treated.
Application at the prescribed rates has proven to be effective for approx. 3 years. If a follow up treatment is carried out after 4 to 6 weeks, then the effective control period would be increased.

Foliar application of phosphite should be carried out under minimal wind conditions. The fungicide should not be applied during rain and requires at least a 6 hours rain free period after application.

The rate of phosphite absorption and translocation to the roots depends on time of application and many environmental conditions. These conditions are not known and should be identified to ensure the efficacy of application.

Low volume aerial application

To control spread of infection effectively over moderately sized areas, the chemical must be applied by aircraft (Figure 5). Aerial application of phosphite permits treatment of large and remote areas cost-effectively, without disturbance to the treated or neighbouring areas. Low volume aerial spraying relies on an even application of a small volume of the chemical over the foliage. In this method of application the foliage is not thoroughly wetted.

Well organised aerial spray operations supported by efficient ground support can produce high work rates. Areas of over 100 ha per day can be treated depending mainly on the distance to a suitable landing site (frequent re-loading of the fungicide is required) and location of the treated areas. Phosphite application from the air cannot be easily compared to ground spraying, where spray trajectory and deposition are largely predictable. Spray droplets generated by aircraft's nozzles, move at speeds in excess of 160 km/h and are subject to violent air movements and therefore less predictable.

There are several factors that influence spray effectiveness including various controllable and non-controllable parameters. Time of application, application volume, droplet size, canopy structure and environmental consideration influence the efficiency to varying degree.

Timing of application

- **environmental factors**

Wind speed and direction, relative humidity and temperature can all influence spray efficiency.

The distance spray droplets travel depends upon their size, downward velocity, aircraft height and wind speed and direction. For aerial spraying some lateral air movement

Figure 5. Aerial spraying of *Banksia brownii* at South Sister.

is necessary and treatments have performed better when applied in wind speeds exceeding 10 km/h. The upper speed limit should not exceed 25km/h.

Temperature significantly affects foliar spray efficiency where water is used as the spray carrier. High temperature combined with low relative humidity rapidly reduce the size of droplets by evaporation. Also atmospheric turbulence increases as temperature rises, so treatments should not be carried in summer or during periods of increased temperatures. Low temperatures are known to significantly reduce the rate of physiological activity and leaf membrane fluidity which in turn affect ion uptake.

Further work is required to determine optimum temperature range for foliar spraying in order to maximise phosphite uptake and consequently the effectiveness of treatments.

- **phenological events**

The rates of uptake of ions by leaves are much lower than the rates of uptake by roots, since the cuticular layer severely restricts diffusion to the plasma membranes, the uptake sites. In addition, leaf uptake is affected by numerous external factors and also internal metabolic activity (sink activity).

It has been demonstrated in avocado and some agricultural species that the rate of translocation, accumulation and the concentration of phosphite in the roots depends on the changing sink strengths during the growing season (Whiley *et al.*, 1996).

The significance of source-sink relationships regulating phosphite translocation in native plant species at different stages of plant development is not known and needs to be determined to optimise timing of application and disease control.

Droplet Size

It is important to know the relationship between the volume of liquid used and the density of spray deposition on the plant because the biological efficacy of a fungicide is determined not only by rate of application but also by spray droplet size and density on the plant. Excessive increase of droplet size causes reduction in droplet density, accompanied by uneven deposition of the fungicide. Reduced droplet size increases spray drift and often results in substantial losses of the chemical and possible contamination of adjoining areas.

In our trials, droplet size (described as VMD-volume mean diameter) ranged from 100-500 μm with 70% of droplets being in the range of 200-500 μm while droplet density was 50-60 drops/cm^2. It is generally recommended that droplet VMD should be 300-500 μm as this prevents excessive drift. However, smaller droplets are preferred as they penetrate dense canopies due to good horizontal movement of the spray and are preferred in dense multi-storey plant communities. Droplet size can be increased slightly if treatments have to be carried out in excessively windy weather.

Application Rates

In our trials (Appendix 1) it was established that phosphite volumes of 30 to 60 l/ha can be applied on most native plant communities. Post fire regenerations or areas where only small plants are present as a single shrub layer (no overstorey) should be treated with lower amounts of 15 l/ha. No prescriptions are currently available for the forest areas.

The fungicide should be applied at 20 to 40% concentration rate depending on the plant species present in the area to be sprayed and canopy structure. Treatment with 40% phosphite can result in chemical burning of leaf margins in some plant species. The trials conducted by CALM demonstrated that 10 to 15% of leaf area of some non-target species was burned by the application of 40% phosphite applied at 60 l/ha.
The list of species affected/not affected by the application of the concentrated fungicide is included in Table 2 and 3.

Table 2. Species affected by the application of 40 % phosphonate at 60 l/ha. The plants had 10 to 15 % of leaf area burned.

Species	Family
Agonis hypericifolia	Myrtaceae
Eucalyptus sterii	Myrtaceae
Isopogon cuneatus	Proteaceae
Petrophile diversifolia	Proteaceae
Xanthorrhoea preissii	Xanthorrhoeaceae

Table 3 Species not affected by the application of 40% phosphonate at 60 l/ha

Species	Family
Andersonia 2PB	Epacridaceae
Banksia attenuata	Proteaceae
Banksia brownii	Proteaceae

Banksia gardneri	Proteaceae
Banksia ilicifolia	Proteaceae
Casuarina	Casuarinaceae
Daviesia fluxuosa	Papilionaceae
Dryandra formosa	Proteaceae
Dryandra sessilis	Proteaceae
Hakea cucullata	Proteaceae
Hakea lasiantha	Proteaceae
Kingia australis	Xanthorrhoeaceae

It has been demonstrated that a follow-up application prolongs and enhances the protective effect of the treatment and it is recommended that a second spraying is carried out 4 weeks after the initial application.

Wetting Agent

Synertrol Oil must be added to phosphite solution to ensure wetting of leaf surfaces. The recommended amount of Synertrol for aircraft application is 0.5 to 1 litre per 100 litres of phosphite solution. Detailed information on Synertrol are included in "High Volume Foliar Spraying - Wetting Agent" section of this guide.

Subsequent Treatments

During the course of the experimental work it was established that 10% phosphite protected plants in the field plots only for 12-18 months. Further trials sprayed with 20 and 40% phosphite ensured longer protection of at least 2 years. The trials (Appendix 1) are still continuing and will be assessed in 1997 and 1998.

The following criteria should be used to determine if subsequent spraying is required.

- the level of residual phosphite in plant tissue (relative seasonal distribution of the chemical in shoots and roots must be established in further studies)
- plant health (mortality measurements may not be effective criterion for populations of rare flora)
- plant age (the required frequency of treatment decreases with plant age). Young plants require frequent application of the fungicide due to rapid dilution of phosphite resulting from high growth rates.
- disease activity

Equipment

AIRCRAFT

Both fixed and rotary wing aircraft can be used in the application of fungicides to native plant communities but in all CALM's field trials planes were used due to non-availability of suitable helicopter in Western Australia.
The trials were treated by a local contractor (Giles Aviation-Wagin, WA) (Figure 6) and planes used in the experiments were equipped with Micronair spraying system.

Proper calibration of the aircraft must be carried out before each treatment to ensure adequate spray penetration and good coverage at all levels of plant canopy as well as uniformity of application. The calibration should include flow rate and droplet size adjustment that would mainly depend on environmental conditions at the time of spraying and type of plant community to be treated.

Figure 6. Plane used in CALM's phosphite trials (Giles Aviation).

SPRAYING SYSTEMS

- **Micronair Rotary Atomizer** is one of the most common spraying system used for spraying low volumes of liquid. The units are versatile and light enabling several of them placed on a spraying boom. The spray plumes are close and able to produce an even spray cloud.

  The Micronair RA (Figure 7) consists of a tubular cylinder gauze of 102 mm diameter, which rotates around a fixed spindle attached to a mounting bracket. The atomiser is rotated by the aircraft slipstream passing over the atomiser fan blades where speed of rotation is controlled by the blade angle in relation to the direction of travel. Full atomisation is achieved by the action of centrifugal force on the spray liquid as it is discharged from the rotary gauze cylinder.
  Micronair spraying system ensures even droplet size and was selected for all phosphite treatments carried out by CALM.

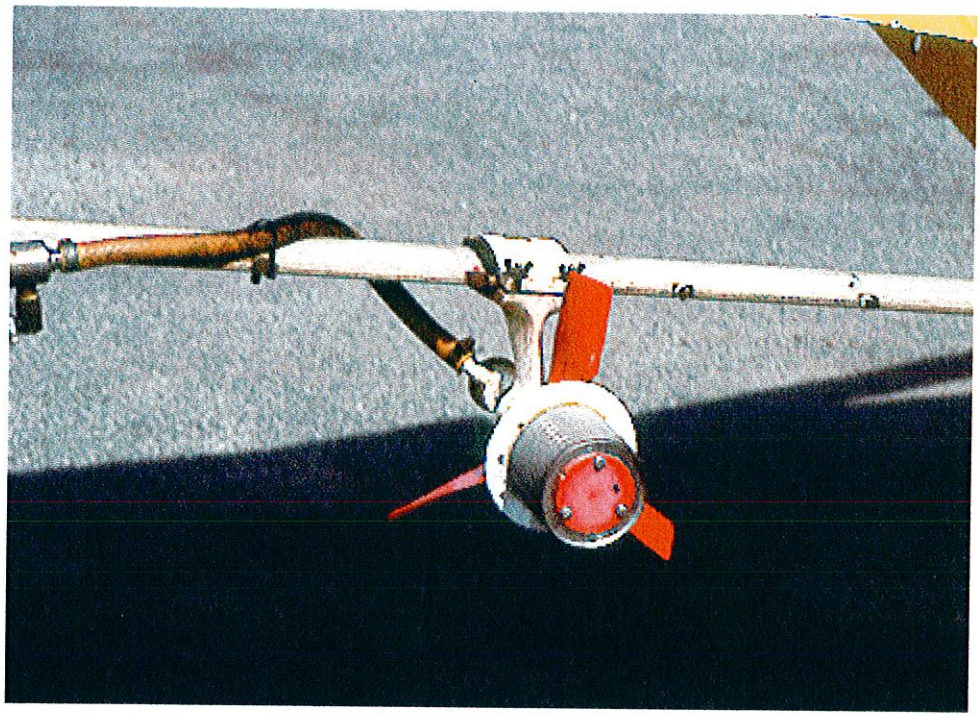

Figure 7. Micronair Rotary Atomizer spraying system.

- **CP Nozzle** can also be used for the application of fungicides. However, the nozzles generally produce a substantial proportion of droplets being smaller than 200 μm and they do not seem suitable for the use in windy conditions that prevail in the south-west.

Swath Marking

Before commencing to treat an area, a pilot should make a preliminary inspection by flying over the area to be treated to locate relevant boundaries, obstacles such as trees and overhead wires, waterways and the location of habitations.

Good aircraft alignment and therefore uniform treatment is achieved from effective field marking. All the areas should be clearly marked using balloons filled with helium gas. The balloons can be attached to metal pickets or long PVC tubes (6 m) that are forced into the ground, when spraying multi-storey communities and in areas

where trees are present. Reflective Mylar (aluminium foil) balloons are preferred as they are very visible from a large distance and are much stronger than the latex ones. The balloons should be placed in the corners of the sprayed area and along the spray pass. The distance between the balloons is critical, especially over undulating ground. Each swath should be marked to ensure complete area treatment.

Water Sensitive Paper

In order to determine the coverage of the spray within the plant canopy and droplet size, water sensitive papers are to be attached to the upper leaves and also put directly onto the ground below the trees. The use of water sensitive papers is not directly quantitative but does give a quick visual estimate of droplet size and density in various points of the plant canopy. The relationship between the volume of liquid carrier used and the density of spray deposition on the plant is important because the biological efficacy of a fungicide is determined not only by rate of application but also by spray droplet density on the plant.

5. *COST OF AERIAL APPLICATION OF PHOSPHITE*

Phosphite is sold in Australia under various brand names and currently available in 20 or 40 percent strength with 40% being available only recently.

The cost of the chemical has dropped by about half in the last four years and currently the price is around $2.85/litre of 40% strength if purchased in bulk.

40% phosphonate is actually cheaper than 20% so in situations when it is necessary to apply fungicide containing only 20% of the active ingredient, it is more cost effective to purchase the concentrated solution and dilute it to the desired strength.

In Western Australia the only registered concentrated (40%) phosphonate is sold as FOLI-R-FOS 400 and is supplied by Robert Linton Pty Ltd.

At present the cost of the concentrated (40%) chemical required to treat one hectare is $171 for single spraying when applied at 60 l/ha and $342 if a follow-up treatment is applied.

The cost of aircraft hire is around $300-500/hour. The time that is required to spray any particular area can vary considerably depending mainly on the following factors:

- size, shape and location of the treated area
- distance from the airstrip as frequent chemical and fuel reloading is required
- maximum load of the aircraft
- type of aircraft's spraying system/equipment

The above quoted cost of aircraft hire applies only to experimental applications and the cost of treatment of large areas is expected to be significantly lower.

6. *FUTURE DIRECTIONS*

Use of Helicopter in the Application of Phosphite

Helicopters are increasingly used in agriculture and forestry, offering many advantages over fixed wing aircraft spraying. Capital and operational costs are invariably higher than for fixed wing aircraft, but improved productivity, especially in smaller irregularly shaped areas or on slopes (e.g. Stirling Range), would make the cost of treatments more comparable with the cost of using a plane. In addition, the helicopter's ability to work over a wide range of speeds and from close unprepared landing sites further enhances the attractiveness of this method of application.

Aerial Application of Phosphite in the Forest Areas of Western Australia

Aerial spraying have been used to apply pesticides to forests since the 1920s and it has been demonstrated in many countries that this method of application is safe and effective method of applying chemicals to manage various forest pests.
Although fungicides are rarely applied to native forests, situations exist where fungicides are used to protect plantations. In New Zealand fungicides are applied to forests of *Pinus radiata* to control needle blight (Barry, 1993). In 1986 a total area of over 150 000 hectares was treated. The application of fungicide sprayed in very small droplets enabled good penetration and proved to be very effective in the control of the pathogen.

Prescriptions for spraying heath and shrublands described in this manual cannot be easily extended to forests because forest canopies and their structures can vary

significantly due to the difference in the relative height as well as density of overstorey, understorey and the shrub layer.

Evaluation of aerial low volume application of phosphite for the treatment and control of *Phytophthora cinnamomi* in the forests of Western Australia would require determination of droplet size, application rate and other parameters characteristic for the forest situation.

7. *SUMMARY AND RECOMMENDATION FOR FUTURE WORK*

- This document lists prescriptions for the use of fungicide phosphite in the control of *P. cinnamomi* in native plants of Western Australia, based on trials conducted over 8 years in a variety of plant communities. Recommendations for trunk injection, high volume foliar application as well as low volume aircraft spraying are given and should be used as a guide in the future treatments and implemented in the management of the pathogen in parks and reserves in the south-west of Western Australia.
- Although prescriptions are given, further work is required to determine the appropriate timing of initial and subsequent phosphite applications.

  - Application of phosphite to native plants trigger resistance in those plants in ways that are not fully understood. Although the resistance response does not appear to be directly linked to the residual phosphite levels in the plant tissue, higher application rates ensure longer protection.

  - Currently there is no information available on the ultimate fate and distribution of the phosphite ion in native plant species and factors influencing its distribution. These factors must be studied in detail in order to time phosphite applications appropriately and achieve effective, efficient and safe fungicide use. There are reports in the literature (e.g. Groussol *et al.*, 1986) that phosphite is subject to source-sink relationships in plants and the effectiveness of the chemical application depends on its timing (Whiley *et al.*, 1986).

  - The relationship between phosphite levels in shoots and roots overall and at particular times during the year is not known. The validity of assuming that all families translocate the chemical in the same way and at the same time of the year needs to be tested. Studies of distribution of the fungicide within the host are therefore essential for optimising disease control. Knowledge of the distribution

would also allow development of field sampling procedure based on sampling shoots.

- Experiments to determine the factors that control phosphite absorption and translocation in native plants need to be undertaken. Knowledge of these factors will allow timing initial fungicide applications and the follow up treatments to coincide with particular growth stages and climatic conditions and therefore permit achieving best possible efficacy of phosphite application on native flora.
- Further work is required to establish the effects of phosphite application on flowering, seed setting and germination.
- Such experiments require a series of short term trials and it is estimated that one to two years of additional work would provide necessary information and enable "fine-tuning" of the prescriptions.

8. *REFERENCES AND SOURCES OF INFORMATION*

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APPENDICES

Appendix 1

LOCATION OF OPERATIONAL/EXPERIMENTAL TRIALS CARRIED OUT BY CALM

YEAR	SPECIES TREATED	LOCATION	OPERATIONAL/ EXPERIMENTAL	METHOD
1989	*Banksia attenuata*	Cowaramup	Experimental	Injection
	Banksia coccinea	Two Peoples Bay	Experimental	Injection
	Banksia grandis	Dwellingup	Experimental	Injection
	Banksia brownii	South Sister	Experimental	Injection
	Banksia prionotes	Nambung River	Experimental	Injection
	Eucalyptus marginata	Dwellingup	Experimental	Injection
	Banksia brownii	Millbrook	Experimental	Backpack spray
	Banksia coccinea	Two Peoples Bay	Experimental	Backpack spray
	Banksia baxterii	Cheyne Beach	Experimental	Backpack spray
1992	*Banksia cuneata*	Popanyinning	Operational	Mist spray
1993	*Andersonia*	Boulder Hill	Operational	Backpack spray
	Banksia brownii	Cheyne Beach	Operational	Backpack spray
	Banksia brownii	Millbrook	Experimental	Aircraft
	Banksia brownii	South Sister	Experimental	Aircraft
	Banksia coccinea	Gull Rock	Experimental	Aircraft
1994	*Andersonia*	Boulder Hill	Operational	Backpack spray
	Banksia brownii	Cheyne Beach	Operational	Backpack spray
	Banksia brownii	Vancouver Peninsula	Operational	Mist spray
	Isopogon uncinatus	Vancouver Peninsula	Operational	Mist spray
	Banksia brownii	Hassell National Park	Operational	Mist spray
	Isopogon uncinatus	Mutton Bird Island	Operational	Mist spray
	Lambertia fairallii	Stirling Range National Park	Operational	Mist spray
	Banksia spp.	North Dandelup	Experimental	Aircraft
	Banksia telmetia	Eneabba	Experimental	ULV *
	Banksia attenuata	Eneabba	Experimental	ULV *
	Banksia menziesii	Eneabba	Experimental	ULV *
	Lambertia multiflora	Eneabba	Experimental	ULV *

1995	*Banksia brownii*	Vancouver Peninsula	Operational	Mist spray
	Banksia brownii	Hassell National Park	Operational	Mist spray
	Isopogon uncinatus	Mutton Bird Island	Operational	Mist spray
	Andersonia	Goodga River Reserve	Operational	Mist spray
	Andersonia	Boulder Hill	Operational	Mist spray
1996	*Banksia brownii*	Cheyne Beach	Operational	Backpack spray
	Banksia brownii	Hassell National Park	Operational	Mist spray
	Andersonia	Goodga River Reserve	Operational	Mist spray
	Andersonia	Boulder Hill	Operational	Mist spray
	Banksia brownii	Millbrook	Operational	Aircraft
	Banksia brownii	South Sister	Operational	Aircraft
	Banksia brownii	Waychinicup	Operational	Aircraft
	Banksia coccinea	Gull Rock	Experimental	Aircraft
	Andersonia	Boulder Hill	Operational	Aircraft
	Banksia brownii	Camp Quarinup	Operational	Aircraft
	Dryandra DRF	Capel	Operational	Aircraft
	Dryandra montana	Stirling Range National Park	Operational	Aircraft
1997	*Lambertia fairallii*	Stirling Range National Park	Operational	Aircraft
	Community Treat.	Bell Track	Operational	Aircraft

* ULV - Ultra Low Volume Application (simulated aircraft application)

DIRECTIONS FOR USE – CITRUS

Restraints

• DO NOT apply to citrus under high temperature (above 35°C), particularly if humidity is low or to moisture stressed trees.

SITUATION/CROP	DISEASE	STATE	RATE OF APPLICATION	CRITICAL COMMENTS
Young or small citrus. Nursery stock and recently transplanted trees	*Phytophthora* Root and Collar Rot. *P. nicotianae* var. *parasitica*, *P. citrophthora*.	QLD, N.S.W, S.A, N.T, VIC, W.A.Only	5 or 10mL/L sprayed to point of run-off or leaf wetness (by boom or any high volume sprayer). Use higher rate under high disease risk conditions.	1st Application: Late winter (late August) prior to flowering. 2nd Application: Autumn (late March-April) applied to mature fruit. Add a sticker filming agent such as menthene (Nu-Film 17) or a non-ionic wetting agent to the spray according to label directions. Repeat applications annually to maintain protection within the trees. Removal of fruit from affected trees will assist recovery of trees. Warning - Young container grown mandarin trees may develop leaf burn and growth retardation following foliar application of FOS-JECT 200 at the rates recommended for established trees.
Mature Citrus Where disease incidence is higher or well established for marginal soils where high *Phytophthora* pressure occurs, poorly drained soils. Low *Phytophthora* pressure only. Well drained soils			40 L/ha in 3000 to 8000L of water. Equivalent to: Low Volume 1.3 L/100 L @ 3000 L/ha OR: 160 mL/12 L/tree. High Volume: 500 mL/100 L @ 8000 L/ha OR: 160 mL/32 L/tree. 25 L/ha in 2000 to 5000 L of water. Equivalent to: Low Volume 800 mL/100 L @ 3000 L/ha OR: 100 mL/12 L/tree. High volume: 300 mL/100 L @ 8000 L/ha OR: 100 mL/32 L/tree.	

DIRECTIONS FOR USE – GRAPES

CROP	DISEASE	STATE	METHOD OF APPLICATION	RATE		CRITICAL COMMENTS
				LOW VOLUME	HIGH VOLUME	
Grapes	Downy Mildew *Plasmopara viticola*	QLD, N.S.W, VIC, S.A, TAS Only	Foliar Spray	6mL/Vine (for conditions where less than 1 litre of spray solution is applied per vine).	6mL/Vine (for conditions where 1 litre or more of spray solution is applied per vine).	Apply as soon as possible after infection and before oil spots appear, and preferably, before sporulation i.e. usually within 3 to 5 days post-infection.

Avocados, Citrus, Grapes: Nil withholding period.

NOT TO BE USED FOR ANY PURPOSE, OR IN ANY MANNER CONTRARY TO THIS LABEL UNLESS AUTHORISED BY APPROPRIATE LEGISLATION

KEEP OUT OF REACH OF CHILDREN

READ SAFETY DIRECTIONS BEFORE OPENING

FOS-JECT®

200

FUNGICIDE

6156 20

ACTIVE INGREDIENT 200 g/L PHOSPHOROUS (PHOSPHONIC) ACID present as the mono-di POTASSIUM PHOSPHITE

A SYSTEMIC FUNGICIDE FOR THE CONTROL OF ROOT ROT IN AVOCADO, ROOT AND COLLAR ROT IN ORNAMENTALS, ROOT AND COLLAR ROT IN CITRUS, CAUSED BY PHYTOPHTHORA FUNGI AND FOR THE CONTROL OF DOWNY MILDEW IN GRAPE.

ONE LITRE

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DIRECTIONS FOR USE – ORNAMENTALS

Ornamentals: FOS-JECT 200 is a systemic fungicide which is highly active against *Phytophthora* species. The product is best applied as a protectant against *Phytophthora* root and collar rot. The product has curative action against *Phytophthora* in some plant species: i.e. plants that can regenerate roots.

To avoid phytotoxicity with some plant species it is recommended that the products be tested on a few plants of each species prior to the main application.

Restraints

• DO NOT apply to ornamental plants under extremes of temperature.

• DO NOT apply when ornamental plants are dormant or stressed

CROP	DISEASE	STATE	METHOD OF APPLICATION	RATE	CRITICAL COMMENTS
Ornamentals	*Phytophthora* Root and Collar Rot	QLD, N.S.W, VIC, TAS W.A. & N.T. Only	Foliar Spray	Knapsack/Boom 5 mL/L Air blast 10 mL/L	Apply at 4-6 weekly intervals when conditions favour disease development

CROP	DISEASE	STATE	METHOD OF APPLICATION	RATE
Eucalyptus Marginata Darkasia spp	*Phytophthora* Root Rot	W.A.	Trunk Injection	1 mL per centimetre of trunk circumference measured at waist height of a mixture of one part FOS-JECT 200 to three parts water.

CRITICAL COMMENTS

Two applications six months apart are likely to be required for control.

Subsequent treatments may be required where symptoms re-appear.

Trees should be injected at waist height in at least two places using no more than 20 mL of mixture per syringe. Syringes should be evenly spaced around the circumference of the trunk.

Drill the required number of holes 20-25 mm deep with a slight downward angle into the trunk, using a sharp 6.5 mm bit.

For larger trees this means drilling holes 20 cm apart around the trunk and injecting 20 mL of the three parts water / one part FOS-JECT 200 mixture per hole.

Ensure that is a good seal between the nozzle of the syringe and the tree.

Maintain constant pressure on the plunger using either spring or heavy rubber band.

Injection may take as little as 2 minutes in a healthy tree or up to 24 hours for a badly diseased tree.

NOTE: Some species may show signs of leaf burning and leaf drop following treatment with FOS-JECT 200. Trees recover from this with time.

DIRECTIONS FOR USE – AVOCADOS

Restraints

• DO NOT prune back Avocado trees immediately before or after treatment as burning of new growth or shoots may occur.

• DO NOT inject Avocado trees in cold weather or winter months.

• DO NOT inject trees where the trunk is damaged eg. Sunburnt.

• DO NOT inject immediately above or below previous injection sites.

CROP	DISEASE	STATE	METHOD OF APPLICATION	RATE	CRITICAL COMMENTS
Avocado	*Phytophthora* Root Rot (curative treatment)	N.S.W VIC QLD, S.A. & W.A. Only	Trunk Injection	Skeletal Trees 1st year 15 mL/metre of canopy diameter. Preventative Treatment 7.5 mL of product diluted with 7.5 mL water.	Inject trees at spring shoot maturity and repeat application during summer. Ideally inject trees between 6 am and 11 am when the transpiration rate is highest and hence uptake is faster. Drill holes 5 mm in diameter and 2.5 - 5 cm deep with a slight downward angle in the trunk. Use one syringe for each 15 mL dose. Syringes should be evenly spaced around the circumference of the trunk. After absorption remove the syringe and it is not necessary to seal the hole as callusing will occur naturally. Thoroughly clean drill bits and syringes between tree injections with sodium hypochlorite (1.5%), to prevent the spread of sunblotch virus.

DO NOT re-use container. Crush and bury empty container, in an approved landfill, or bury under at least 500 mm of soil in a non-crop, non-pasture area away from water sources or homes. DO NOT burn empty containers or product.

SAFETY DIRECTIONS

May irritate the eyes and skin. Avoid contact with eyes and skin. Wash hands after use.

FIRST AID

If poisoning occurs, contact a Doctor or Poisons Information Centre.

NOTICE TO BUYER

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U.I.M.
FOSJECT 200
FUNGICIDE

FOSJECT 200

- is absorbed rapidly in the plant giving rain fast assurance
- is rapidly translocated downwards and upwards
- is not poisonous, it has a biological action
- has curative and protectant properties
- has no toxic effect on plants and foliage

FOSJECT 200 is registered for control of

- Root Rot in Avocado
- Root and Collar Rot in citrus
- Root and Crown Rot in Ornamentals
- Root Rot in Subterranean Clover
- Downy Mildew in Grapevines

Ornamentals

- Control Phytophthora root and collar rot (die-back)
- Apply as a protectant as it is often too late to treat once above ground symptoms are apparent.
- FOSJECT 200 has curative action against plants that can regenerate roots.
- Repeat FOSJECT 200 treatments to maintain protection within plants

- **DO NOT** apply to ornamental plants under extremes of temperature
- **DO NOT** apply when ornamental plants are dormant or stressed

CROP	DISEASE	STATE	METHOD OF APPLICATION	RATE	CRITICAL COMMENTS
Ornamentals	Phytophthora Root and Collar Rot	Qld,NSW, VIC, WA, TAS & NT	Foliar Spray	Knapsack / Boom 5 mL /L Air Blast 10 mL /L	Apply at 4-6 weekly intervals when conditions favour disease development

Grapevines

- Control Downy Mildew (Plasmopara viticola) infections in grape vines.
- FOSJECT 200 gives post infection control when applied as a Foliar Spray in the first 5 days following conditions conductive to Downy Mildew Infections
- Control can be obtained if FOSJECT 200 is applied up to 9 to 11 days after P. viticola infection

EXTEND CURATIVE AND PROTECTANT PERIOD.
A tank mix of FOSJECT 200 and copper oxychloride or copper hydroxide should be considered for use in post-infection control programs because this mix should provide at least 13 days post-infection control and an additional 20 days protection to sprayed foliage.
(**NOTE**: Unsprayed new growth is not protected).

CONDITIONS CONDUCIVE TO DOWNY MILDEW INFECTION

(1) PRIMARY INFECTION – conditions arising at any time:

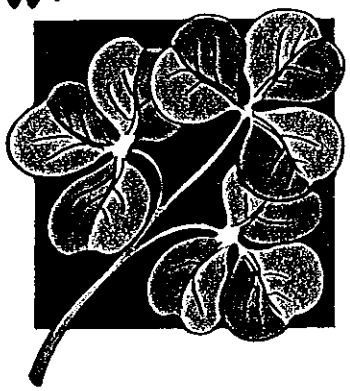
Temperature	10°C
Rainfall	10mm
Soil Wetness	24hrs
Leaf Wetness	3-4hrs at end of 24hr period with water splash

(2) SECONDARY INFECTION – Oil spots must be present from primary infection, spore must develop before infection can occur:

Temperature	11°C (minimum) for infection greater than 13°C for sporulation
Humidity	98% for at least 4hrs from midnight to dawn
Leaf Wetness	Minimum of 2hrs at dawn for infection

CROP	DISEASE	STATE	METHOD OF APPLICATION	RATE	CRITICAL COMMENTS
Grapes	Downy Mildew *Plasmopara viticola*	QLD, NSW, VIC, SA & TAS only	Foliar Spray	Apply at a rate of 6 Litres/hr. For high density vine plantings or for heavy canopy situations apply up to 8 Litres/ha.	Apply as soon as possible after infection and before oil spots appear, and preferably, before sporulation i.e. usually within 3 to 5 days post-infection.

Subterranean Clover

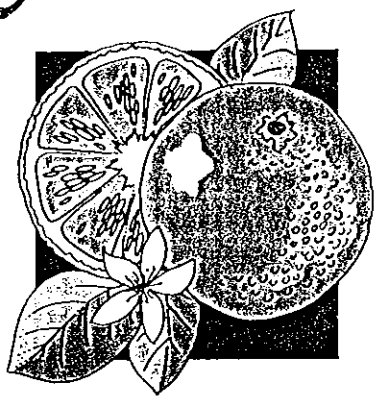


- Controls Root Rot caused by Phytophthora clandestina
- Apply to Subterranean Clover seedlings while at the cotyledon to unifoliate leaf stage
- Apply between the first and second irrigation in Autumn.

- **DO NOT** apply to Subterranean Clover at volumes which cause excessive run-off.

CROP	DISEASE	STATE	METHOD OF APPLICATION	RATE	CRITICAL COMMENTS
Subterranean clover	Root Rot *Phytophthora clandestina*	NSW, VIC, SA, WA, TAS	Foliar Spray	1.5 L/ha	Apply 8 -9 days after first irrigation but before second irrigation. Apply in Autumn when subterranean clover is at the cotyledon to unifoliate leaf growth stage.

Citrus



· Cure and protect Citrus against Phytophthora, Root and Collar Rot caused by Phytophthora nicotianae and Phytophthora citrophthora.
· FOSJECT 200 is best applied as a protectant before Foliar symptoms and Collar Rot become evident. Spray trees for an even coverage.
· **DO NOT** apply to Citrus under high temperature (above 35°C), particularly if humidity is low or to moisture stressed trees.

STIMULATION/CROP	DISEASE	STATE	RATE OF	CRITICAL COMMENTS
Young or small citrus Nursery stock and recently transplanted trees.	Phytophthora Root and Collar Rot. P. nicotianae var. parasitica, P. citrophthora.	QLD, NSW, SA, NT, VIC, WA Only.	5 or 10 mL/L sprayed to point of run-off or leaf wetness (by boom or any high volume sprayer). Use higher rate under high disease risk conditions.	1st Application: Late winter (late August) prior to flowering. 2nd Application: Autumn (late March-April) applied to mature fruit. Add a sticker filming agent such as menthene (Nu-Film 17) or a non-ionic wetting agent to the spray according to label directions. Repeat applications annually to maintain protection within the trees. Removal of fruit from affected trees will assist recovery of trees. Warning - Young container grown mandarin trees may develop leaf burn and growth retardation following foliar application of Foli-R-Fos at the rates recommended for established trees.
Mature citrus Where disease incidence is higher or well established, for marginal soils where high *Phytophthora* pressure occurs, poorly drained soils. Low pressure only. Well drained soils			40 L/ha in 3000 to 8000L of water. Equivalent to: Low volume 1.3 L/100 L @ 3000 L/ha OR: 160 mL/12 L/tree. High volume: 500 mL/100 L @ 8000 L/ha OR: 160 mL/32 L/tree. 25 L/ha in 2000 to 5000 L of water. Equivalent to: Low volume 800 mL/100 L @ 3000 L/ha OR: 1 mL/12 L/tree High Voume 300 mL/100 L @ 8000 L/ha OR: 100 mL/32 L/tree.	

MIXING

Foliar application for foliar spraying FOSJECT 200 is diluted with water. FOSJECT 200 is already formulated as a solution in a water base and mixes easily with water. When mixing use only clean uncontaminated tanks. If they have been used for herbicide application ensure they have been thoroughly decontaminated. Recycled material through the spray pump to ensure good mixing.
For citrus only add the recommended amount of product to the tank volume. Add a sticker/filming agent such as menthene (Nu-film 17) or a non-ionic wetting agent to the spray according to label directions.

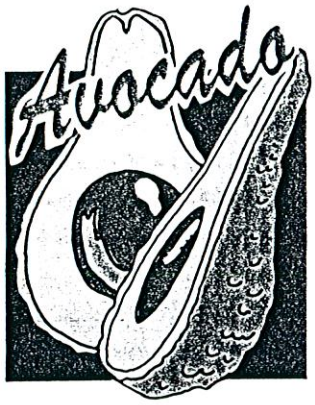
COMPATIBLE WITH:

Copper Oxychloride	Carbaryl	Dithianon	Thiram
Copper Hydroxide	Sulphur	Mancozeb	

Foliar fertilizers and nutrients
Compatible with most pesticides and active ingredients in tank mixes. If an emulsifiable concentrate is in tank mix, form the emulsion in the tank before the addition of FOSJECT 200.
Mixtures with acid salts such as zinc sulphate, copper nitrate, copper sulphate etc. are stable only for a few hours. After this time a slow crystallization commences.
Do not mix with oxidising agents.

WITHHOLDING PERIOD.

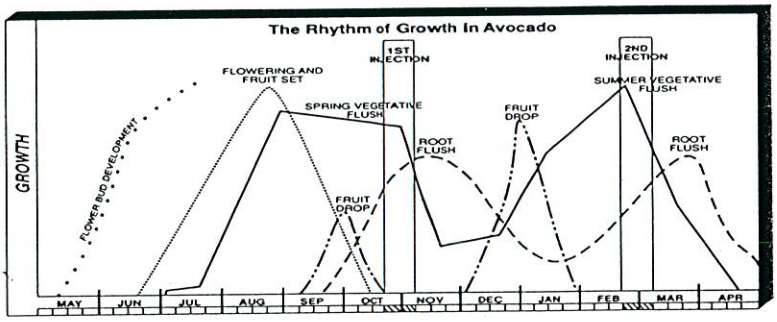
Subterranean Clover: Do not graze or feed livestock for 14 days after treatment.
Avocadoes, Citrus, Grapes: Nil withholding period.



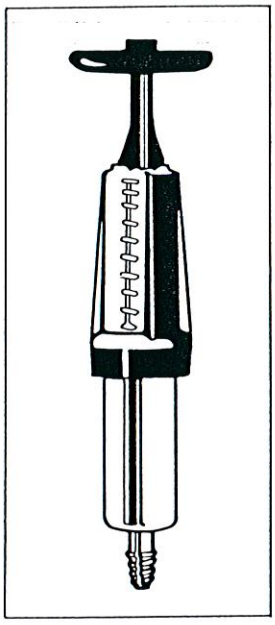
- Control and cure root and collar rot caused by Phyophthora cinnamomi.
- **DO NOT** prune back Avocado trees immediately before or after treatment as burning of new growth of shoots may occur.
- **DO NOT** inject Avocado trees in cold weather or winter months.
- **DO NOT** inject trees where the trunk is damaged eg. Sunburnt.
- **DO NOT** inject immediately above or below previous injection sites.

CROP	DISEASE	STATE	METHOD OF APPLICATION	RATE	CRITICAL COMMENTS
Avocado	*Phytophthora* Root Rot (curative treatment)	NSW. VIC, QLD, SA & WA only.	Trunk injection	Skeletal Trees 1st year: 15 mL/metre of canopy diameter Preventative Treatment 7.5 mL of product diluted with 7.5 mL water.	Inject trees when the spring vegetative flushes have greened and hardened. Injection in the summer is effective at any time but is best given from late January through to the end of February. See below for methods of injection. Withholding period nil days.

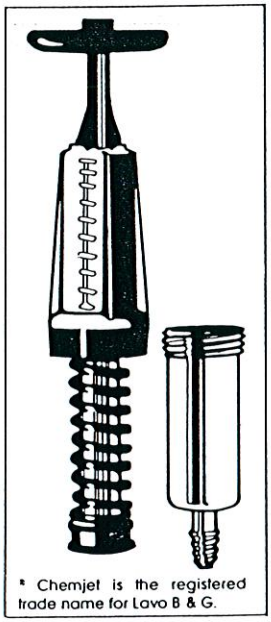
The right time to inject trees when the spring and summer vegetative flushes have greened and hardened as shown on the graph of the avocado growth pattern.



METHOD OF TREE INJECTION



1. **NUMBER OF INJECTIONS REQUIRED**
   The Chemjet® tree injector holds 20 ml of solution. To determine the correct number of injections to be given follow the instructions under DIRECTIONS FOR USE. If the tree being treated with FOS-JECT 200 has a canopy of four metres diametre the injection quantity would be 4 x 15 mL = 60 mL or 3 x 20 mL using the Chemjet tree injector.
2. **PREPARING THE HOLES**
   Using 5.6 mm (7/32") drill, prepare the appropriate number of holes in the tree trunk. Drill the holes about 200 mm from the ground and drill the number of holes required at equal spacings around the trunk.
   Drill the required number of holes about 30 to 40 mm into the trunk.
3. **MAKING THE INJECTION**
   Draw chemical into injector from FOS-JECT 200 in an open container, ensuring the screwed nipple is held under the surface. Lock the handle with an anticlock-wise turn. Screw the filled injector into the prepared hole, ensuring a good seal between the screwed nipple and the tree wood is obtained.
   Release the handle by turning clockwise.
   When injection of the fluid into the tree is complete unscrew the injector. The hole can be sealed with a plastic sealing compound if desired.
4. **CARE AFTER USE**
   Wash thoroughly in clean water and leave injector barrels in unscrewed position to relieve spring tension. If necessary apply a slight smear of silicone grease to bottom of barrel.



* Chemjet is the registered trade name for Lavo B & G.

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PROTECTION OF CROPS, NATIVE AND OTHER NON-TARGET PLANTS

When applying as a foliar spray ensure the mixture is directed only onto the target plant.

PROTECTION OF WILDLIFE, FISH, CRUSTACEA AND ENVIRONMENT

DO NOT spray FOLI-R-FOS® 400 over waterways or onto native plant growth.

DO NOT contaminate streams, rivers or waterways with the chemical or used containers.

STORAGE AND DISPOSAL AND PROTECTION OF OTHERS

Store in the closed, original container in a well ventilated area, as cool as possible. DO NOT store for prolonged periods in direct sunlight.

Triple or (preferably) pressure rinse containers before disposal. Add rinsings to spray tank. Do not dispose of undiluted chemicals on-site.

Break, crush, puncture and bury empty containers in a local authority landfill. If not available bury the containers below 500mm in a disposal pit specifically marked and set up for this purpose clear of waterways, vegetation and roots. Empty containers and product should not be burnt.

SAFETY DIRECTIONS

May irritate the eyes and skin. Avoid contact with eyes and skin. Wash hands after use.

FIRST AID

If poisoning occurs, contact a Doctor or Poisons Information Centre.

NOTICE TO BUYER

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U.I.M. AGROCHEMICALS (AUST.) PTY. LTD.
A.C.N. 010 642 896
30-42 Railway Terrace, Rocklea Qld. 4106
Telephone: (07) 3277 2077 Fax: (07) 3277 4566

1. Registered Trademark of Miller Chemical Corp.

NRA APPROVAL No.: 48147/01.

FOLI-R-FOS® 400

KEEP OUT OF REACH OF CHILDREN

READ SAFETY DIRECTIONS BEFORE OPENING

MAGNAM

m-d KP

FOLI-R-FOS® 400

FUNGICIDE

ACTIVE INGREDIENT 400 g/L PHOSPHORUS (PHOSPHONIC) ACID
present as the mono-di POTASSIUM PHOSPHITE

A SYSTEMIC FUNGICIDE FOR THE CONTROL OF ROOT ROT IN AVOCADO, ROOT AND COLLAR ROT IN ORNAMENTALS, ROOT AND COLLAR ROT IN CITRUS, ROOT ROT IN SUBTERRANEAN CLOVER CAUSED BY PHYTOPHTHORA FUNGI AND FOR THE CONTROL OF DOWNY MILDEW IN GRAPE.

MANUFACTURED AND DISTRIBUTED BY:

U.I.M. AGROCHEMICALS (AUST.) PTY. LTD.

A.C.N. 010 642 896

AUSTRALIAN AGRICULTURAL CHEMISTRY COMPANY

"THE INNOVATIVE QUEENSLANDERS"

ROCKLEA QLD. 4106 Telephone: (07) 3277 2077 Fax: (07) 3277 4566

* REGISTERED TRADE MARK OF U.I.M. AGROCHEMICALS (AUST.) PTY. LTD.

FOLI-R-FOS® 400

GENERAL INSTRUCTIONS

Citrus: FOLI-R-FOS* 400 is best applied as a PROTECTANT before foliar symptoms and collar rot become evident. Spray trees for even coverage.

Clover: Apply FOLI-R-FOS* 400 at 750 mL/ha in 200 L/ha of water. Apply to the subterranean clover seedlings while at the cotyledon to unifoliate leaf stage. Apply between the first and second irrigation in autumn.

Grapes: FOLI-R-FOS* 400 is a fungicide with strong systemic activity against downy mildew (Plasmopara viticola) infections.

CONDITIONS CONDUCIVE TO DOWNY MILDEW INFECTION

(1) PRIMARY INFECTION – Overnight conditions of:

Temperature	10°C
Rainfall	10 mm
Soil Wetness	24 hrs.
Leaf Wetness	3-4 hrs. at end of 24 hrs. period.

(2) SECONDARY INFECTION – Overnight conditions of:

Temperature	11 °C (minimum)
Humidity	98% for at least 4 hrs. from midnight to dawn
Leaf Wetness	24 hrs.

1. Apply FOLI-R-FOS* 400 within 3-6 days of conditions conducive to downy mildew infection.
2. A tank mix of FOLI-R-FOS* 400 and copper oxychloride should be considered for use in post-infection control programs because this mix should provide at least 13 days post-infection control and an additional 20 days protection to spray foliage. (NOTE: Unsprayed new growth is not protected.)

RESISTANCE TO DOWNY MILDEW

There is a possibility that resistant strains of downy mildew fungus may arise. To avoid this, alternate with other systemic fungicides or use in mixture.

Ornamentals: FOLI-R-FOS* 400 is a systemic fungicide which is highly active against *Phytophthora* species. The product is best applied as a protectant against *Phytophthora* root and collar rot. The product has curative action against *Phytophthora* in some plant species; i.e. plants that can regenerate roots.

Do not rely on FOLI-R-FOS* 400 for long term protection of nursery plants. Good nursery hygiene to exclude *Phytophthora* is advocated. In the field other factors, including the selection of well drained sites, are essential for growing *Phytophthora* susceptible species.

To avoid phytotoxicity with some plant species it is recommended that the products be tested on a few plants of each species prior to the main application.

Mixing

Foliar application: For foliar spraying FOLI-R-FOS* 400 is diluted with water. FOLI-R-FOS* 400 is already formulated as a solution in a waterbase and mixes easily with water. When mixing use only clean uncontaminated tanks. If they have been used for herbicide application ensure they have been thoroughly decontaminated. Recycle material through the spray pump to ensure good mixing.

For citrus only, add the recommended amount of product to the tank volume. Add a sticker/ filming agent such as menthone (Nu-film ' 17) or a non-ionic wetting agent to the spray according to label directions.

Trunk injection of avocados: The product is used undiluted for very sick trees and diluted 1:1 with water for preventative treatments.

Compatibility

FOLI-R-FOS* 400 at use dilution can be mixed with mancozeb, sulphur, and the foliage nutrients zinc, manganese and urea.

DIRECTIONS FOR USE — AVOCADOS

Restraints

• DO NOT prune back Avocado trees immediately before or after treatment as burning of new growth or shoots may occur. • DO NOT inject Avocado trees in cold weather or winter months. • DO NOT inject trees where the trunk is damaged eg. Sunburnt. • DO NOT inject immediately above or below previous injection sites.

CROP	DISEASE	STATE	METHOD OF APPLICATION	RATE	CRITICAL COMMENTS
Avocado	*Phytophthora* Root Rot (curative treatment)	N.S.W. VIC. QLD. S.A. & W.A. Only	Trunk Injection	**Skeletal Trees First Year** Dilute Foli-R-Fos 400 1:1 with water. Use 15 mL/metre of canopy diameter. **Preventative Treatment** Dilute Foli-R-Fos 400 1:3 with water.	Inject trees at spring shoot maturity and repeat application during summer. Ideally inject trees between 6 a.m. and 11 a.m. when the transpiration rate is highest and hence uptake is faster. Drill holes 5 mm in diameter and 2.5-5 cm deep with a slight downward angle in the trunk. Use one syringe for each 15 mL dose. Syringes should be evenly spaced around the circumference of the trunk. After absorption remove the syringe and it is not necessary to seal the hole as callusing will occur naturally. Thoroughly clean drill-bits and syringes between tree injections with sodium hypochlorite (1.5%), to prevent the spread of sunblotch viroid.

DIRECTIONS FOR USE — CITRUS

Restraints

• DO NOT apply to citrus under high temperature (above 35°C), particularly if humidity is low or to moisture stressed trees.

SITUATION/CROP	DISEASE	STATE	RATE OF APPLICATION	CRITICAL COMMENTS
Young or small citrus Nursery stock and recently transplanted trees.	*Phytophthora* Root and Collar Rot. *P. nicotianae* var. *parasitica*, *P. citrophthora*	QLD. N.S.W. S.A. N.T. VIC. W.A. Only	2.5 or 5 mL/L sprayed to point of run-off or leaf wetness (by boom or any high volume sprayer.) Use higher rate under high disease risk conditions	1st Application: Late winter (late August) prior to flowering. 2nd Application: Autumn (late March-April) applied to mature fruit. Add a sticker filming agent such as menthene (Nu-film 17 ") or a non-ionic wetting agent to the spray according to label directions. Repeat applications annually to maintain protection within the tree. Removal of fruit from affected trees will assist recovery of trees. Warning - Young container grown mandarin trees may develop leaf burn and growth retardation following foliar application of FOLI-R-FOS* 400 at the rates recommended for established trees.
Mature Citrus Where disease incidence is higher or well established, for marginal soils where high *Phytophthora* pressure occurs, poorly drained soils. Low *Phytophthora* pressure only. Well drained soils.			20 L/ha in 3000 to 6000 L of water. Equivalent to:- Low Volume 650 mL/100 L @ 3000 L/ha OR: 80 mL/12 L/tree High Volume 250 mL/100 L @ 8000 L/ha OR: 80 mL/32 L/tree 12.5 mL/ha in 2000 to 5000 litres of water. Equivalent to:- Low Volume 400 mL/100 L @ 3000 L/ha OR: 50 mL/12 L/tree. High Volume 150 mL/100 L @ 8000 L/ha OR: 50 mL/32 L/tree.	

DIRECTIONS FOR USE — ORNAMENTALS

Restraints

• DO NOT apply to ornamental plants under extremes of temperature.
• DO NOT apply when ornamental plants are dormant or stressed.

CROP	DISEASE	STATE	METHOD OF APPLICATION	RATE	CRITICAL COMMENTS
Ornamentals	*Phytophthora* Root and Collar Rot	QLD. N.S.W. VIC. TAS. W.A. & N.T. Only	Foliar Spray	Knapsack/Boom 2.5 mL/L Air Blast 5 mL/L	Apply at 4-6 weekly intervals when conditions favour disease development.

DIRECTIONS FOR USE — GRAPES

CROP	DISEASE	STATE	METHOD OF APPLICATION	RATE		CRITICAL COMMENTS
				LOW VOLUME SPRAY	HIGH VOLUME SPRAY	
Grapes	Downy Mildew *Plasmopara viticola*	QLD. N.S.W. VIC. S.A. & TAS Only	Foliar spray	3 mL/Vine (for conditions where less than 1 litre of spray solutions is applied per vine).	3 mL/L (for conditions where 1 litre or more of spray solutions is applied per vine).	Apply as soon as possible after infection and before oil spots appear, and preferably, before sporulation i.e. usually within 3 to 5 days post-infection.

DIRECTIONS FOR USE — SUBTERRANEAN CLOVER

Restraints

• DO NOT apply to Subterranean clover at volumes which cause excessive run-off.

CROP	DISEASE	STATE	METHOD OF APPLICATION	RATE	CRITICAL COMMENTS
Subterranean clover	Root Rot *Phytophthora clandestina*	N.S.W. VIC. S.A. W.A. TAS. Only	Foliar Spray	750 mL/ha	Apply 8-9 days after first irrigation but before second irrigation. Apply in Autumn when subterranean clover is at the correction to unifoliate leaf growth stage.

NOT TO BE USED FOR ANY PURPOSE, OR IN ANY MANNER, CONTRARY TO THIS LABEL UNLESS AUTHORISED UNDER APPROPRIATE LEGISLATION.

WITHHOLDING PERIOD.

Subterranean Clover: Do not graze or feed livestock for 14 days after treatment.
Avocados, Citrus, Grapes: Nil withholding period.

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New Synert

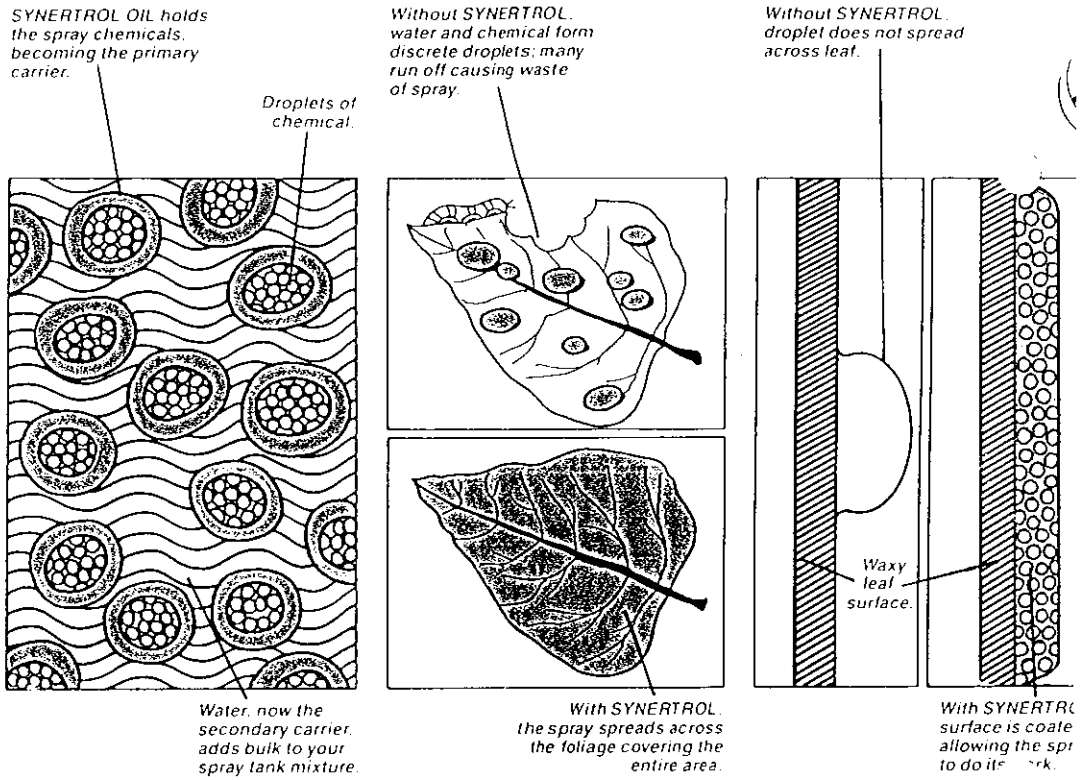
will revolutionise the efficiency of your spr

Normally when you spray, a large proportion of chemical can be wasted because water, the usual spray carrier, does not wet the leaves completely. Much of it simply runs off onto the ground, and is lost. Losses can also occur because of excessive spray drift or wash off by unexpected rain.

With SYNERTROL OIL, you can greatly improve your spraying efficiency. It helps the chemical stick onto and penetrate the target whether it is insects or weeds, or to protect your crops from fungal diseases.

Being a vegetable oil-based product, SYNERTROL OIL can be used in spraying programmes for many crops such as cereals, oil seeds, fruit, vegetables, cotton and pastures. It is also useful when mixed with chemicals which control pests on sheep and cattle to give better wetting of the fleece or hair.

SYNERTROL OIL has been developed, is grown, and made in Australia! It is easy to use, and inexpensive.



HOW SYNERTROL OIL WORKS

SYNERTROL OIL works simply by providing a natural oil carrier for your spray. SYNERTROL is mixed with the chemical and then diluted with water. It readily disperses in water and sticks to the target, holding the active ingredients to the site where they are most useful. Even on waxy difficult-to-wet leaves, sprays can be applied using less water, giving good coverage while keeping to the correct spray dose rates.

Unlike mineral oils, SYNERTROL OIL is based on a vegetable oil, with special ingredients which allow it to mix readily with water.. It combines easily with surfaces of plants and insects, making it a most effective carrier and penetrant.

A LITTLE GOES A LONG WAY...

SYNERTROL OIL adheres to plant foliage and insects much more effectively than water, spreading out in a thin layer across the treated surface. It therefore covers a much greater area, keeping your spray where it is needed, while the water runs off or evaporates.

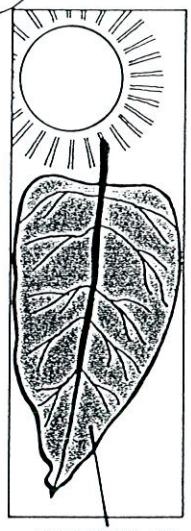
GREATER EFFECTIVENES

SYNERTROL OIL blends well with leaf and insect cuticl components because of the composition of the vegetable oil. It improves the penetration of your sprays. Because it is a natural vegetable oil, it is safe to use on all foliage at the recommended dose rates.

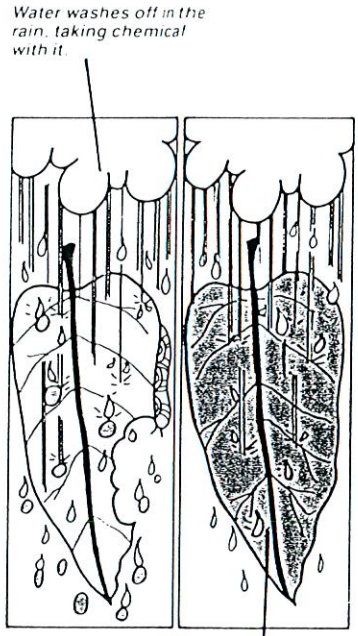
trol Oil

y & help cut your costs at the same time.

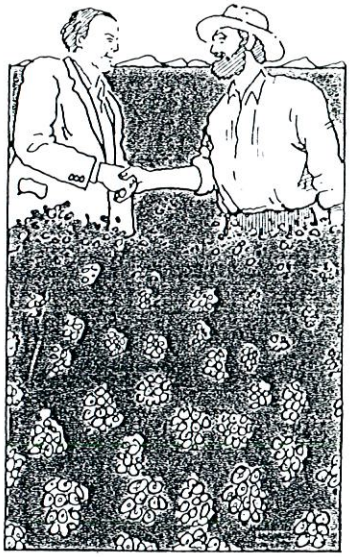
SYNERTROL OIL increases drop uniformity, minimising evaporation and drift as the spray descends, delivering more spray to the target.



SYNERTROL OIL protects your chemical from evaporation and decomposition through exposure to sunlight.



SYNERTROL OIL minimises wash off in light rain or dew, so your chemical keeps working for longer.



BETTER CONTROL OF DRIFT

SYNERTROL OIL reduces spray drift. It provides for more uniform droplet size at the nozzle and target, keeping very fine droplets to a minimum. Excessively fine droplets can result in overspray or drift, a potential source of complaint and crop damage.

You can see SYNERTROL OIL working as you spray, and as an added bonus SYNERTROL OIL also reduces offensive and toxic odours found with some spray products.

WASTE LESS WATER AND CHEMICAL!

By using SYNERTROL OIL you will significantly reduce the amount of water you use when spraying.

Because SYNERTROL OIL minimises run-off and promotes wetting and penetration, sprays can be made up in less water and applied more efficiently, and in less time.

SYNERTROL OIL will not evaporate in the sun as water does. This means your valuable chemical does not evaporate because it is protected by a layer of oil.

SYNERTROL OIL AND THE WEATHER

Once the SYNERTROL carrier spray has been applied, the oily layer repels water, and will minimise wash-off if light rain falls after spraying. SYNERTROL OIL even allows you to spray in morning dew.

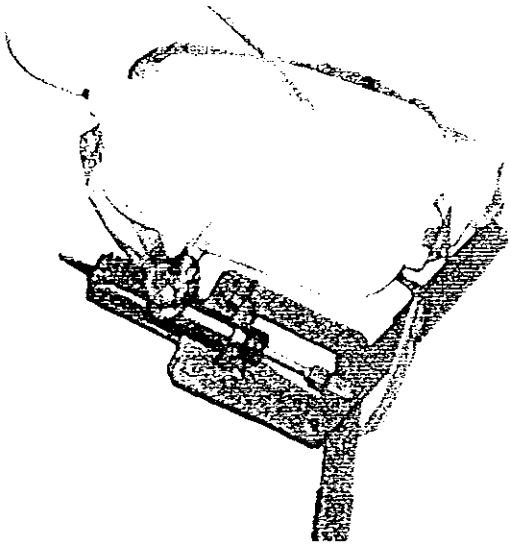
GROWN BY AUSTRALIAN FARMERS FOR AUSTRALIAN FARMERS

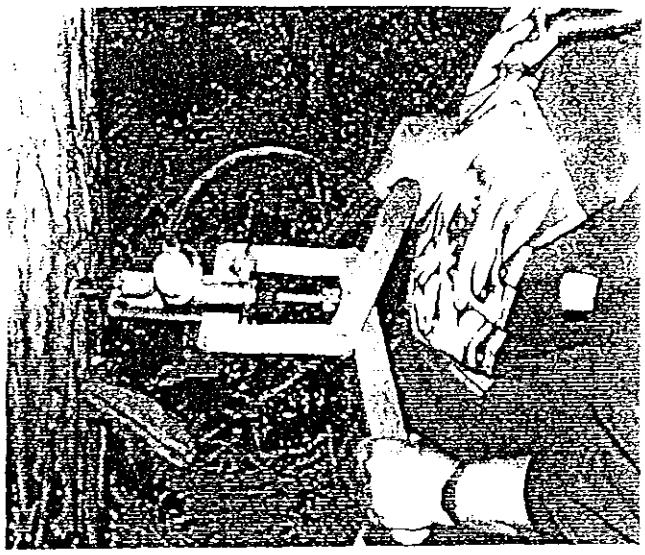
SYNERTROL OIL is based on Canola Oil grown by Australian farmers. It does not have phyto-toxic properties, nor does it react with spray chemicals. SYNERTROL OIL is safe to foliage, fruit and crops.

INOCULATION AGAINST DIEBACK

using the

F1-11 TRUNK INJECTOR





The F1-11 is:

COMPACT. 38cm x 50cm
LIGHTWEIGHT. 2.3kg dry
ROBUST. as used by Roleystone Dieback Action Group over 12 months
EFFECTIVE. 78kg/sq cm @ 10kg hand pressure
AFFORDABLE. locally made with low overheads.

THE UNIT FEATURES:

A high quality hydraulic cylinder for which parts are readily available, mounted in a welded steel frame with twin levers for easy balance. A close mounted, rigid nozzle feeds directly into the tree trunk and the inoculating fluid is fed from a soft plastic back-pack.

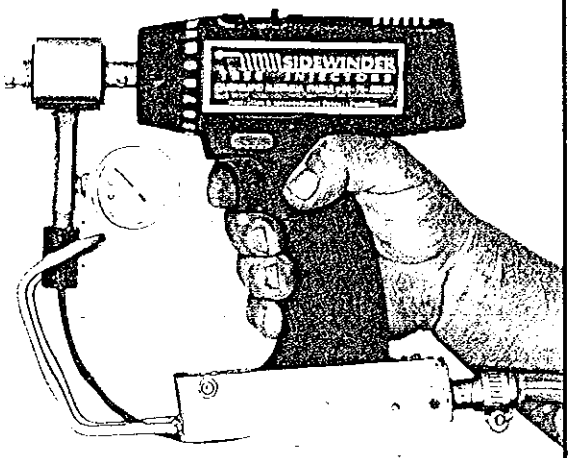
OPERATION:

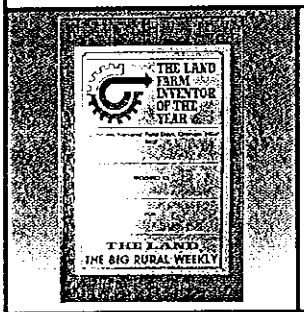
In Jarrah and Bull-Banksia trees, Fosject(TM) or similar is diluted 1:3 and injected by four strokes (20ml) into holes drilled at 20cm intervals. One litre of chemical, when diluted, is sufficient for about 30 trees of 38cm trunk diameter. The process is applicable to avacadoes, some stone fruits and other Banksias but dosage and dilutions may vary.

AVAILABLE FROM:

this injector works well in Banksia but very hard to get a good seal in jarrah

SIDEWINDER
MICRO-MACRO
TREE INJECTORS

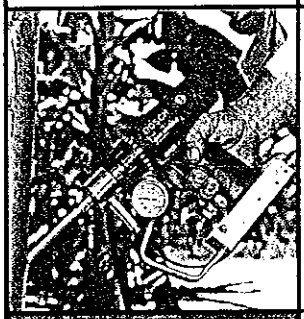




AWARD WINNING TREE INJECTION SYSTEMS

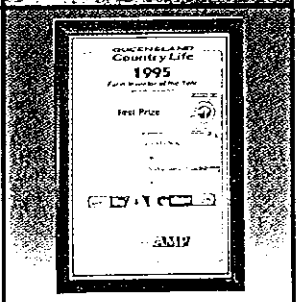
Power operated, environmentally / user friendly systems for injection of systemic pesticides, fungicides, trace elements, growth regulators or herbicides.

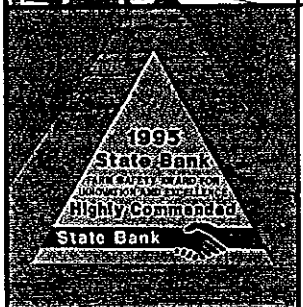
A hypodermic needle for trees.



FAST, EFFICIENT AND EASY ON THE OPERATOR

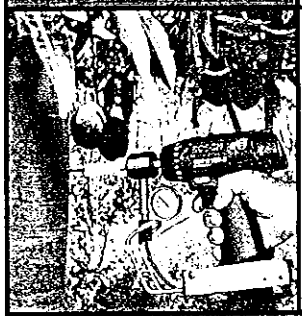
No chemical or batteries to carry. No springs to compress or levers to pull. The operator carries only the lightweight, one piece drill/injector enabling him or her to deliver up to 1000 shots per day.





MICRO-MACRO INJECTIONS FROM A SINGLE SYSTEM

Sidewinder's variable dose pumps allow accurate dosage from 2ml to 20ml per cycle. Using higher concentrations and smaller doses means faster uptake and less tissue damage.



HUGE SAVINGS IN CHEMICAL COSTS

Tree injection generally involves only minute quantities of chemical compared with airborne spray techniques, substantially reducing costs, environmental damage and risk to the operator.

NOTHING ELSE COMPARES!

SIDEWINDE
Trading as:
SID

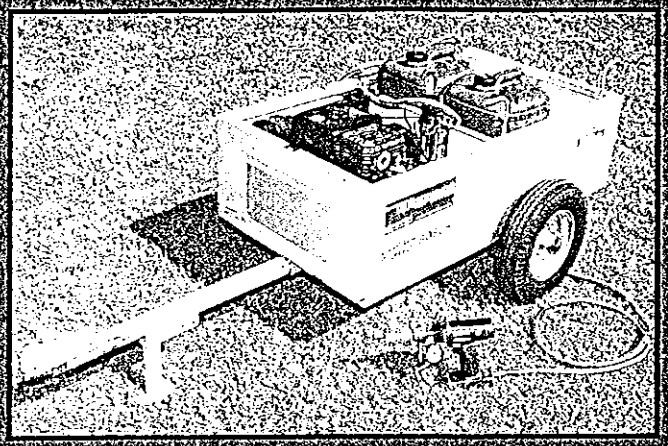
Robert Linton Pty Ltd
55 Canning Highway, Victoria Park
Western Australia, 6100
Telephone (09) 361 6922
Fax (09) 361 9215

N 069 707 811

ORS

P.O. Bo

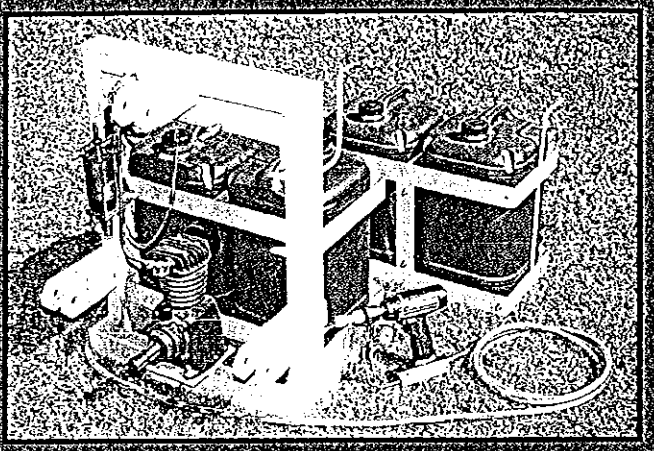
STRALIA



SELF-CONTAINED TRAILER

Vanguard 5.5 HP engine coupled to an air compressor and Bosch 12 volt alternator provides continuous power to operate dose pump and 12 volt drill/injector tool. Units include single or twin injectors, 15 metre control cables, detachable tow bar and pneumatic wheels.

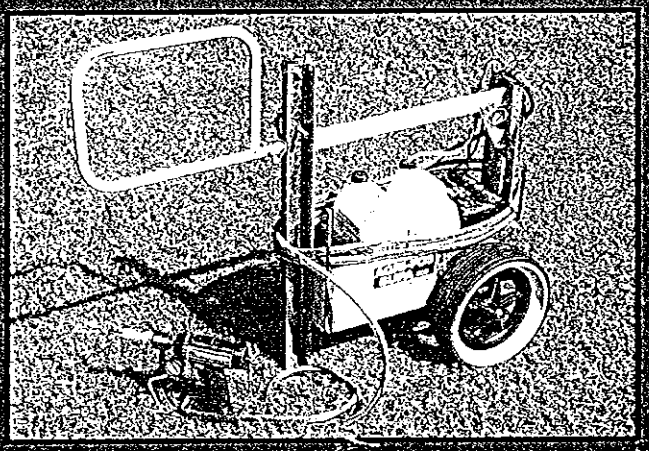
Options include 20 metre power cables, hour meter and third wheel with manual tow handle.



TRACTOR MOUNTED 3 P.L. UNIT

Feature P.T.O. driven air compressor, utilising 12 volt power from tractor. Single or dual injector systems and 15 metre power cables.

Options include 20 metre power cables, P.T.O. drive shaft.



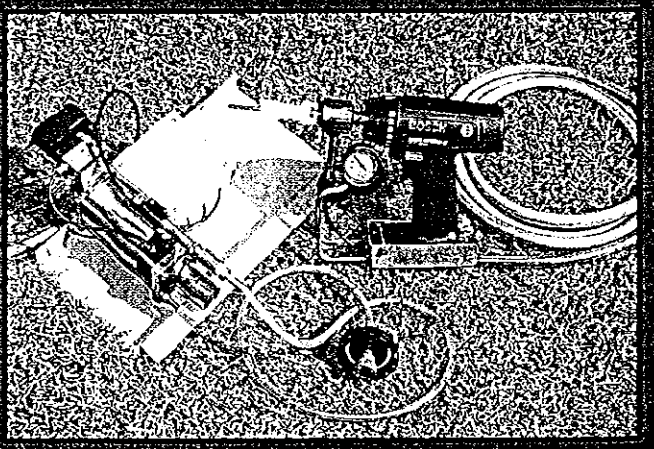
MINI TROLLEY

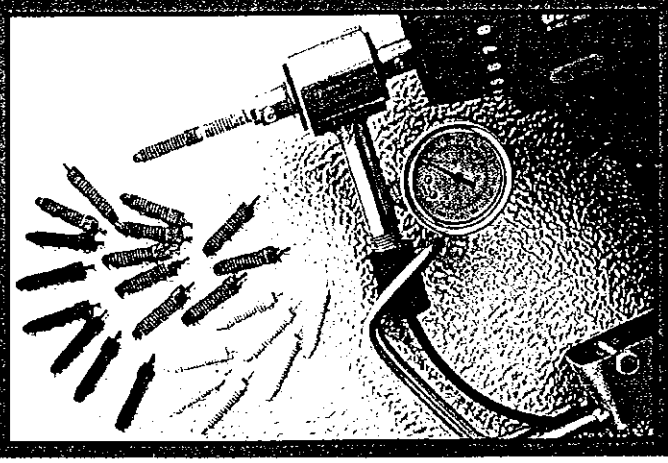
Battery - hand powered. Ideal for experimental work, small farms, arborial contractors, councils. Battery, 23 amp hr drives drill. Tow handle doubles as pump handle. Dosage from 2ml to 10ml. 6 metre power cable.

POWER KITS

For those farmers or contractors that already have portable air compressors. These units consist of single or double air operated pump mounted on a frame with drill injectors coupled via 15 metre power cable.

Optional 20 metre power cable.



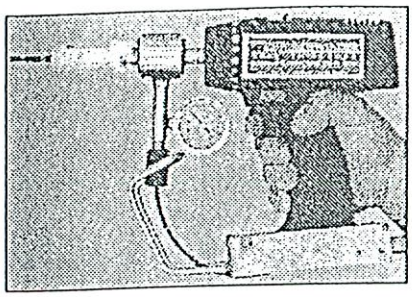


PLASTIC SEALING PLUGS

A must where potentially harmful chemicals are used in public places and where rapid healing of the injection site is desired. Screwed in by the injector tool allowing fast and effortless placement, plugs come in various colours for different seasons or chemicals.

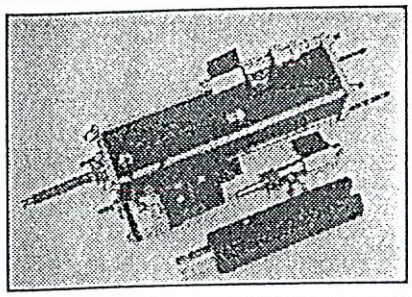
Photographs by Rod Middenway

TECHNICAL SPECIFICATIONS OF SIDEWINDER UNITS



SIDEWINDER DRILL/INJECTOR ASSEMBLY

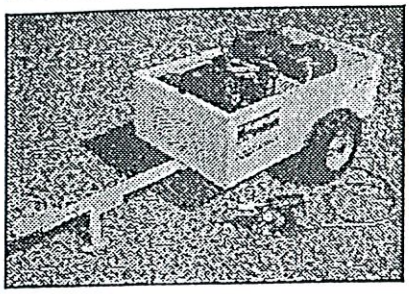
Common to all units and the heart of the Sidewinder system. Consists of a light weight 12 volt, heavy duty drill to which is fitted a purpose designed stainless steel injection nozzle and rotary fluid transfer coupling. A quick fit detachable drill bit holder and bit slip easily over the nozzle to pre-drill a 6mm. injection hole. The drill bit is specifically shaped to cut a clean hole to the correct depth.
A sealed stainless steel pressure gauge indicates injection pressure and when injection is completed.
A stainless steel base guard is attached to the drill and concealed in the bottom is the injection cycle initiation switch (all models except mini trailer unit). The operator flicks the switch and injection takes place at controlled pressure, minimising the risk of blow outs.



SIDEWINDER CHEMICAL INJECTION PUMPS

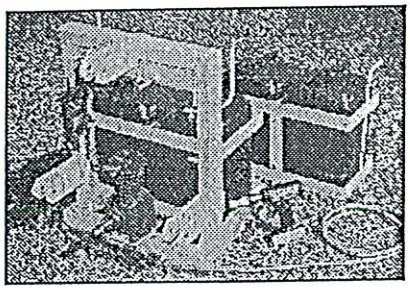
Specifically designed to provide accurate variable dose rates. They are constructed from stainless steel and polyacetel engineering grade plastics making them compatible with most horticultural chemicals and ensuring a very long and trouble free life.
Air Operated Model – provides dosages variable from 2ml to 20ml per cycle and output pressures from 250 p.s.i. to 900 p.s.i. in-built 12 volt solenoid operated air valve.
Hand Operated Model – provides dosages from 2ml to 10ml in 1ml increments.

POWER CABLE ASSEMBLIES These consist of positive and negative power wires to operate the drill injection control signal wire (except Mini Trolley Model) plus a miniature high pressure chemical transfer hose with stainless steel end fittings - all of which are encased in an outer protective P.V.C. cover.



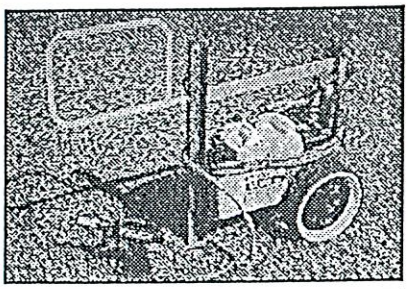
SELF CONTAINED TRAILER

Fitted with Briggs and Stratton Vanguard Series 5.5 HP engine driving an air compressor and a Bosch 12 volt alternator. This model also includes an air reservoir and pressure controls, 16 amp. hr. heavy duty battery, weatherproof electrical box housing fuses and relays. This model can be fitted with either single or dual injector systems. Standard attachments include pneumatic tyres, detachable tow bar with 50mm. tow ball coupling, foot stand and provision for 4 X 25 litre drums - 2 for chemical and 2 with swing lids to carry drill/injector assemblies when not in use. Standard control cable lengths - 15 metres.
Optional Extras: 20 metre control cable • Engine revs/hour meter, • Third wheel with manual tow handle assembly.
Note:- This versatile unit has many other uses on the farm - e.g. operating pneumatic pruners, inflating tyres, re-charging batteries in the field, running emergency lighting and or equipment.



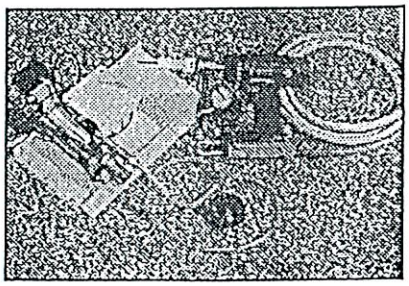
TRACTOR MOUNTED 3P.L. UNITS

This unit features P.T.O. shaft driven air compressor to operate the injector pump and utilises the 12 volt power from the tractor to drive the drill injector unit. Available with either single or dual injector systems, two or four 25 litre containers, standard power cables of 15 metres long and class one 3P.L. mountings. As with the Self Contained Trailer, the compressed air feature of this unit can have many other on farm applications. Optional Extras: 20 metre control cable



MINI HAND TROLLEY

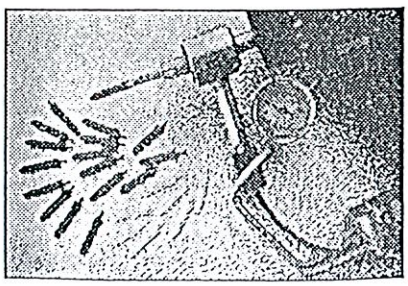
A 23 amp HR 12 volt battery provides power for the drill. Chemical injection is activated by unlocking and depressing the towing handle which in turn operates the chemical pump. Maximum output of the pump is is 10ml per stroke. For smaller injection quantities, the handle locking pin may be inserted in any of a series of holes in the handle guide frame allowing outputs from 2ml to 10mls in 1 ml increments. For towing, the lock pin may be set to allow any convenient height to suit the operator and the top section allows pumping without bending. Provision is made for two 5 litre chemical containers as well as a section to carry the drill and storage lugs to locate the power cable when not in use.
Optional Extras: 10 and 15 metre power cables.



POWER KITS

For farmers or contractors who already have mobile compressed air units.
These consist of either one or two complete injector pump assemblies mounted on a plate frame as well as electrical terminal box with fuses and control relays together with all inter-connecting wiring.
Injector pump suction hoses and suction strainers are provided. Standard power cables are 15 metres.

Optional Extras: 20 metre power cables.

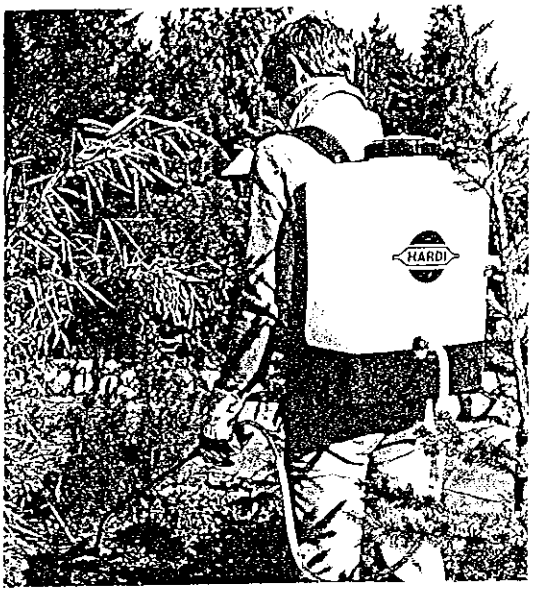


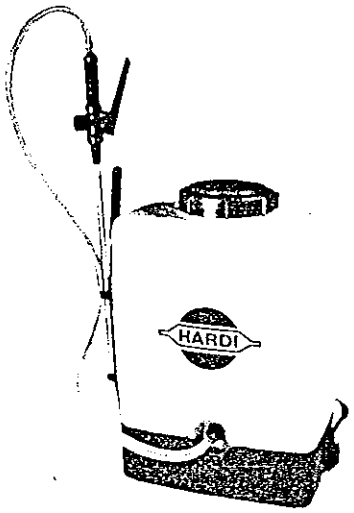
PLASTIC SEALING PLUGS

These ensure no loss of injected material from the tree and minimise the risk of entry of pathogenic fungi or wood boring insects. Plugging promotes rapid healing of the cambium layer.

We consider plugging to be a must where pesticides, etc. are injected in public areas and species that have a tendency to bleed for long periods after injection e.g. badly infected avocado trees.

Use of alternating coloured plugs with each season provides a quick and easy check of what trees have and have not been injected - particularly if contract labour is used. Standard colours are green and yellow - other colours can be made to special order.





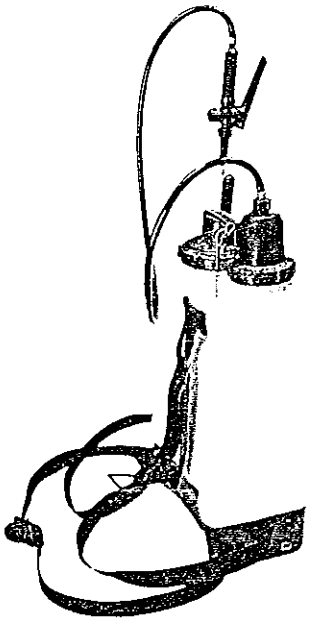
RY 2

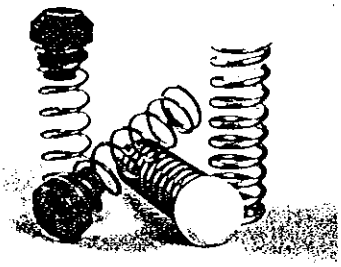
Designed to perform

Good results are dependent on good care. The RY 2 (20 litre) is designed for your yard and garden as well as for nurseries and small orchards. Rugged construction and very simple maintenance mean a long life, reliable sprayer.

Features such as long-lasting diaphragm pump, build-in Pre-set pressure relief valve (1, 2, 3 and 4 bar),light weight handlance with trigger operated on/off on the handle, polyethylene easy-clean tank, three different nozzles included as standard giving varying spray patterns, easy to adjust straps, and left or right handed operation makes the RY 2 a first class unit to give you the best results. Also included is a handy measuring jug with volume scales in metric, U.S. and imperial for accurate measuring of chemicals.

Ref.	Tank size l	Model	Measure/cm H × W × D	Weight kg
819571	20	RY 2	52 × 37 × 20	5.0
819626	20	RY 2, with hydraulic agitator	52 × 37 × 20	5.0





K 15

It's a HARDI - It's tough

Powerful, high pressure backpack sprayer, the K 15 (15 litre) is ergonomically designed for comfort and to avoid back strain. Engineered for flower gardens, lawns, trees, and difficult to reach areas. Here is a sprayer combining the demands of the professional grower and the homeowner.

With a long list of features such as high pressure piston pump, built-in pre-set pressure relief valve (1, 2, 3 and 7 bar), light weight handlance with trigger operated on/off on the handle, polyethylene easy-clean tank, three different nozzles included as standard giving varying spray patterns, left or right handed operation, easy to adjust carrying straps, and many more unique features, the K 15 is the answer for many spraying jobs.
Also included is a handy measuring jug with volume scales in metric, U.S. and imperialfor accurate measuring of chemicals.

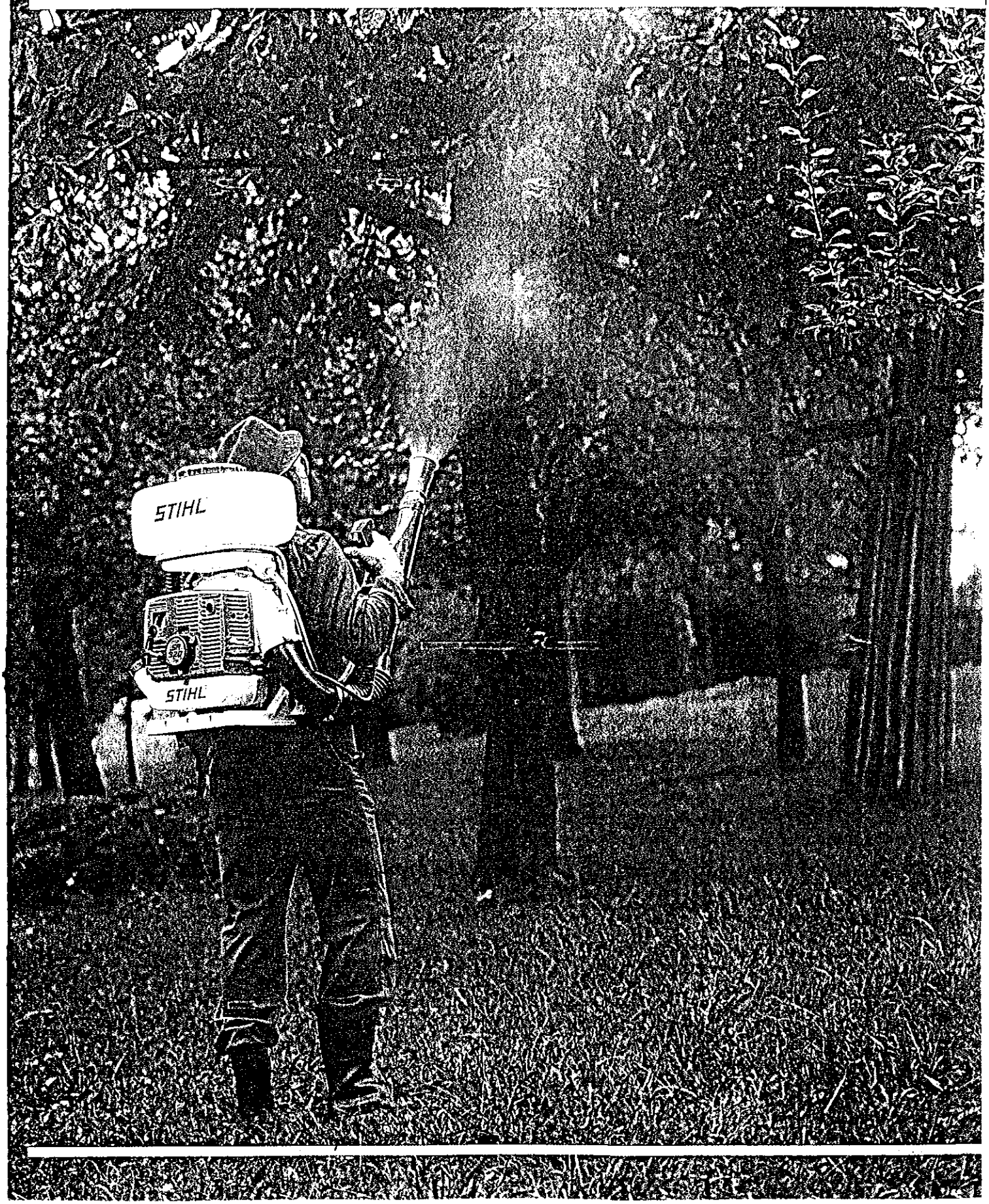
Ref.	Tank size l	Model	Measure/cm H × W × D	Weight kg
817294	15	K 15	52 × 37 × 20	4.8

Optional extras for RY 2 and K 15

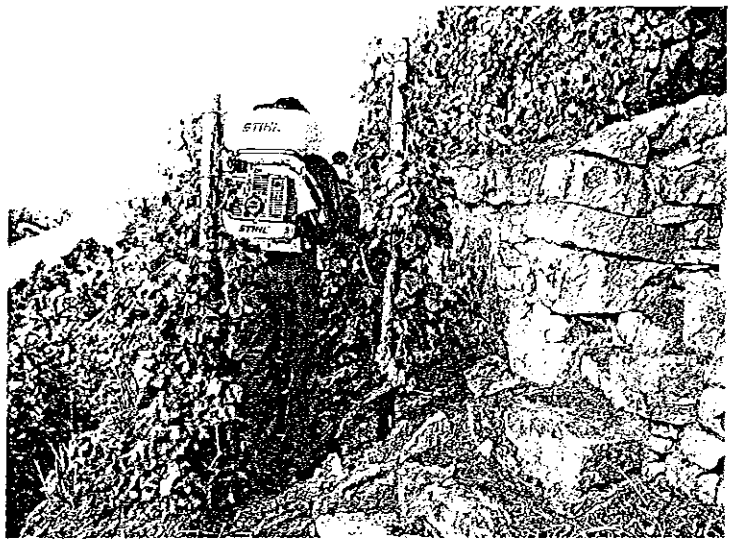
Lance extension	•
Brass lance	•
Pressure gauge	•
Spray guard	•
Adjustable nozzle	•
Spray boom	•
Special tool	•

See description page 4

STIHL SR 320 and SR 400 we have this one
Mistblowers.
Versatile range of applications, including, dusting, spreading granulate or even blow-sweeping large areas.



STIHL SR 320 and SR 400: Two backpac mistblowers for a wide range of applicat



A simple design concept makes the mistblowers easy to operate.

A powerful gasoline engine drives a fanwheel. Air is drawn in through inlets between the powerhead and backplate and expelled at high velocity through the nozzle. The chemical to be sprayed is added to the stream of air before it leaves the nozzle.

Operator comfort and ease of operation are enhanced by an efficient antivibration system and human-engineered design features. ❶ Special buffer elements are installed at precisely calculated points to absorb most of the engine's vibrations and help prevent them being transmitted to the operator's arms and back.

Convenience is enhanced by the STIHL multi-function control handle ❷ – the stop switch, throttle trigger and throttle lock lever are positioned for easy fingertip operation on the control handle. The control handle enables the operator to accurately aim the spray mist or airstream in the required direction. It also has an integral throttle trigger to control engine speed and thus the force of the airstream.

The performance of these units, combined with their versatility and portability, is the precondition for economic operation – even in difficult conditions.

One of the main applications is spraying plant control chemicals in fruit and vegetable growing. The high performance engines produce a powerful airstream which leaves the nozzle at a speed of up to 101 m/s (330 ft/sec).

The high velocity airstream is essential for spraying high trees. The spray mist of the SR 320 has a vertical range of 10 meters (33 ft), while the SR 400 can go 2 meters (6 ft) higher. This impressive spraying range enables large areas of crops to be treated quickly and economically.

The SR 320 and SR 400 can also be used for applying granular chemicals, fertilizers or even spreading fish feed. The powerful airstream is also ideal for spreading grass seed in exactly metered quantities.

In the woods, mistblowers – and other STIHL power tools – are used for tending plantations and young stands. They help prevent bark beetle infestation in unpeeled lumber or after wind breakage.

Another application or the SR 320 and SR 400 simply utilizes the power of the airstream produced by their high performance engines. They are thus capable of blow-clearing yards and other large areas.

STIHL mistblowers offer all the benefits of total portability. They an be stowed easily in a normal car and quickly taken wherever required; this means they can also be used very effectively for smaller jobs that do not justify the time and expense involved in transporting larger machines. Furthermore, they are ideal for applications under difficult operating conditions, such as steep terrain or between narrow rows of plants where tractors can't reach.

Both units are equipped with a large 14-liter (3 3/4 US gal) chemical container and a 1.5-litre (3.2 US pt) fuel tank for long periods of uninterrupted spraying.

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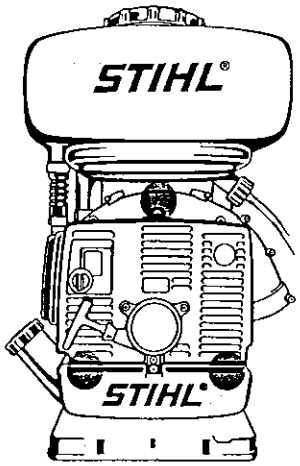

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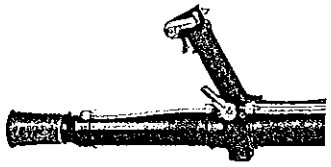

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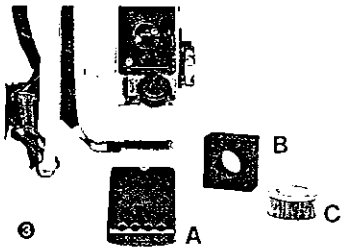

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The chemical stop cock is also positioned within easy reach of the operator's thumb.

Ease of maintenance

The SR 320 and SR 400 are exceptionally easy to maintain. All parts requiring routine maintenance are either directly accessible from outside (carburetor adjusting screws) or very quickly exposed. Replacing a broken starter rope, for example, is a five minute job.

The condition of the air filter ❸ is crucial for engine performance, fuel consumption and starting behavior. The filter housing cover **A** is quickly removed and the foam filter element **B** is simple to clean and replace.

Dust can be whirled up when the units are used as blowers. A heavy-duty filter cartridge **C** is available for such applications. It is easily fitted to both mistblowers.

Main specifications at a glance

Engine
Single cylinder two-stroke air-cooled engine with special impregnated cylinder bore

	SR 320	SR 400
Displacement:	2.74 cu.in (44.9 cc)	3.45 cu.in (56.5 cc)

Fuel system

Carburetor:	All position diaphragm carburetor with integral fuel pump; easily accessible adjusting screws
Fuel tank capacity:	3.17 US pt (1.5 L)
Fuel mixture:	Normal petrol (leaded): 1:40 with STIHL 1:40 engine oil, 1:25 with other branded two-stroke engine oils
	Unleaded petrol: Use only STIHL 1:50 engine oil

Ignition system

Type:	Electronic magneto ignition system, breakerless, maintenance-free
Spark plug (suppressed):	Bosch WSR 6 F

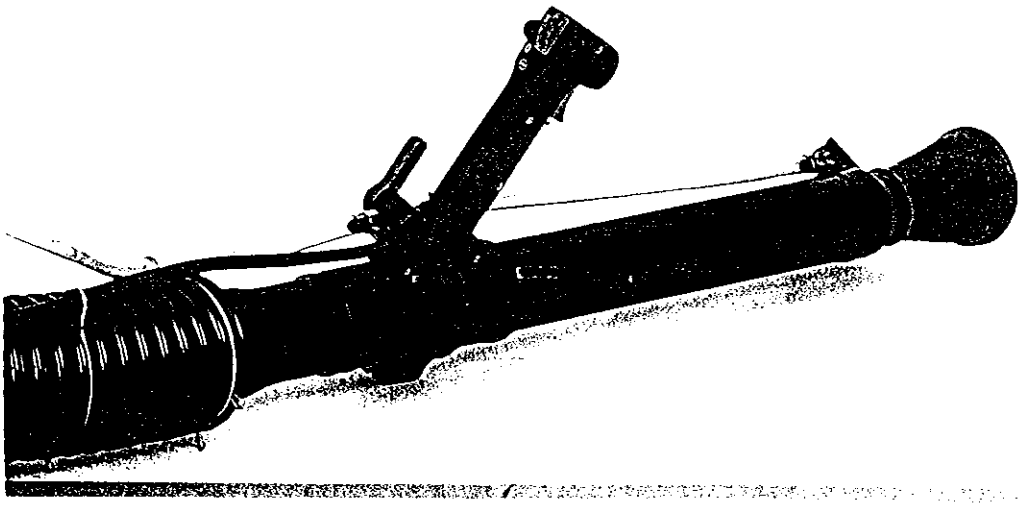
Performance data

	SR 320	SR 400
Air flow volume:	385 cfm (655 m^3/h)	421 cfm 715 m^3/h)
(at engine speed)	6,900 rpm	7,500 rpm
Air velocity:	300 ft/s (92 m/s)	330 ft/s (101 m/s)
Container capacity:	3.7 US gal. 14 L	3.7 US gal. 14 L
Spray rate:	(liquid chemical)	
without baffle screen:	4 – 57 gph (0.25 – 3.6 l/min)	
with baffle screen:	4 – 52 gph (0.25 – 3.3 l/min)	
Spraying range:	SR 320	SR 400
Horizontal:	31 ft (9.5 m)	38 ft (11.5 m)
Vertical:	33 ft (10.0 m)	39 ft (12.0 m)

Weight

SR 320/SR 400	22.9 lbs (10.4 kg)

Special accessories
Booster pump
ULV rotary nozzle (atomizer nozzle for liquids)
Spreading attachment



We will be pleased to give you more details of the STIHL line of power tools:

STIHL®
Andreas Stihl
D-7050 Waiblingen

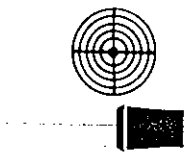
Systematic plant control: Standard equipment of units ensures efficient and environmentally compatible chemical application.

The large capacity chemical container (14 L/3.7 US gal) has an easy-to-read level indicator. This helps the user mix chemicals to exactly the required concentration. A finely graduated scale immediately shows the user how much liquid is left in the container and the rate of consumption.

A metering unit permits infinitely variable adjustment of the discharge rate for more economic use of chemicals.

Mistblowers are equipped with a diffuser nozzle. The pattern and direction of the spray can be varied with the help of three push-fit baffle screens:

❶ Tapered baffle screen. Liquid chemical is finely atomized in a broad but short cloud of spray. This avoids damage to foliage.
❷ Deflector baffle screen: Diverts spray jet at an angle and thus enables low plants to be sprayed from underneath.
❸ Dual deflector baffle screen: Splits the spray jet in two and thus enables two rows of plants to be sprayed at the same time.
● The maximum upward spraying range (approx. 10 m/33 ft or 12 m/39 ft depending on model) is achieved with the standard diffuser nozzle which produces a fine mist, i.e. without baffle screen.



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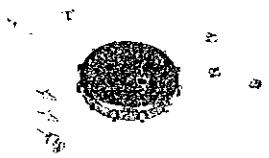
STIHL offers a complete line of accessories for large-area plant protection or more accurate chemical metering.

A booster pump ❹ is available as an option. It continuously agitates liquid chemicals which have a tendency to form sediment and thus helps avoid variations in the concentration of the mix. The booster pump keeps the chemical flow constant, irrespective of whether the unit is spraying upward or downward.

The ULV (ultra low volume) rotary nozzle ❺ operates like large atomizer. Liquids are dispersed in extremely fine droplets. This is particularly important when using small quantities of highly concentrated chemicals.



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STIHL mistblowers can be equipped with an optional spreading attachment for granular chemicals or grass seed.

Blow-sweeping is easier with the "Airbroom."

As mentioned earlier, STIHL mistblowers can also be used as blowers.

The powerful airstream clears leaves from paths, driveways or lawns. But large areas are their real domain: Mown grass or even sticky clippngs have no chance against the hurricane-force blast of air.

When used as air blowers, the SR 320 and SR 400 ideally supplement industrial sweeping and vacuum machines. Typical applications are car parks, even when they are full of cars, and sports stadiums. They blow-sweep the paper, tin cans and other debris left between and under seats by spectators.

WILDFLOWER KILLERS

by Bryan Shearer, Ray Wills and Mike Stukely

Western Australia's unique wildflowers evolved in response to environmental stresses brought about by ice ages, earthquakes, flooding, fire and drought. Now they face one of the greatest threats to their existence, from seemingly insignificant, microscopic fungi belonging to a group called *Phytophthora* - the wildflower killers.

DEPARTMENT OF CONSERVATION
AND LAND MANAGEMENT

food for birds, rodents and ants, while the leaves are eaten by a specialised moth, the larvae of which are preyed upon by a wasp. The death of just these two plants has great consequences for these dependent animals.

Similar interactions occur in many other wildflower communities. About 15 per cent of South West plant species are pollinated by birds and mammals. Banksias and related wildflowers have large flowers pollinated by nectar-eating animals such as the western pygmy possum and honey possum. Seed-eating parrots might also be affected by the loss of favoured seed-producing species such as banksias or hakeas.

Populations of bird or mammal pollinators may dwindle as the plants on which they depend are eliminated. If only a few plants remain, there may not be enough food to sustain the pollinators. If the pollinators disappear, the few remaining plants may never set seed, despite having survived the killer fungi. In this way, death of susceptible species may reduce the numbers of pollinators essential to the survival of more resistant plants such as the endangered rose mallee (*Eucalyptus rhodantha*), and can thus affect neighbouring communities as well. However, we still have to learn a lot more about the interactions within wildflower communities in order to determine the true cost of dieback disease.

WHY SO VULNERABLE?

The *Phytophthora* fungi can attack at least 1 000 plant species throughout the world. Because the killer fungi were only recently introduced to WA, the State's wildflowers have little resistance to infection. Our wildflowers have adapted to poor soils and drought by developing extensive specialised root systems for maximum intake of nutrients and water, but that is precisely what makes them vulnerable to the killer fungi.

Western Australian climate and soils provide many favourable environments for the fungi. *Phytophthora* species thrive in warm, moist conditions during autumn and spring. Rainy winters create wet conditions that allow infectious spores to survive and spread in moist soil picked up by vehicles and in flowing water. Moist conditions are created for most of the year above hard pans deep in the soil. Thus, even though the surface soil may be dry, millions of infectious spores may be produced and distributed deep in the soil. Warm temperatures in summer also favour rapid fungal growth along the root systems of infected plants and result in the infection of new hosts through root-to-root contact.

MANAGING THE DISEASE

Dieback disease is everybody's problem. Effective control depends on the combined efforts of the public, assorted industries, and federal, state and local government. The more people know about the disease, the more they can do to prevent its spread. Rotary International District 9460 and a newly formed Northern Sandplains Dieback Working Party are helping the government increase public awareness and training.

Mapping the extent of the disease is an essential first step in effective prevention. The dieback mapping system developed by CALM staff for the jarrah forest is one of the most effective disease detection techniques in the world. This system is based on the interpretation of colour aerial photographs and is now also used to map dieback distribution in wildflower communities.

Quarantine and hygiene procedures have been developed in areas managed by CALM. Roads and tracks in national parks, reserves and forest have been closed to stop the infection from being introduced into healthy areas with susceptible and endangered wildflowers. Everyone can apply their own quarantine by keeping to all-weather roads, especially during wet weather.

Clean work practices also help to prevent the movement of infected soil, plant material and water into healthy areas. A package of hygienic procedures is used to minimise the consequences

Above:
A CALM officer injects an acorn banksia (*B. prionotes*) with phosphorous acid.
Photo - Bryan Shearer

Far left (above):
Animal species such as honey possums that use susceptible plants for food are also affected by dieback.
Photo - Michael Morcombe

Far left (below):
The rare rose mallee is fairly resistant to the disease.
Photo - Jiri Lochman

Left (above):
Flowering understorey of the jarrah forest - honeybush dies out, leaving only the resistant wattle, prickly moses.
Photo - Marie Lochman

Left (below):
Fox banksia (*Banksia sphaerocarpa*) is susceptible.
Photo - Michael Morcombe

should any one procedure accidentally fail. These include cleaning machinery, vehicles and footwear; controlling the movement of soil and road-making materials; minimising activities when soils are wet and sticky; disinfecting water used from streams and dams; paying attention to drainage; and carrying out essential activities only.

These methods of disease management help protect large areas of healthy bush from dieback disease, but are regarded as a holding action until better methods of controlling the disease have been developed.

FUTURE OPTIONS

At the moment, dieback fungi are usually only detected after plants have died. Remote sensing, using special detectors that sense thermal and infra-red radiation, may give early warning of infection. Trials are under way to see if healthy wildflower communities growing on soils that favour the disease can be mapped and if infected plants can be identified before they die.

Scientists now know much about how *P. cinnamomi* survives and spreads under local conditions. We need to learn more about how the other six *Phytophthora* species reproduce and survive. Determining moisture and temperature conditions that affect the ability of the fungi to produce spores, survive and infect hosts will help scientists to assess the risk of infection, and to develop hygiene maps and effective methods of control.

There may also be great potential in a host's own resistance. While many populations of susceptible species are decimated by the killer fungi, a few individuals occasionally survive. Though they often escape by chance (perhaps some subtle barrier in the soil prevented infection), some plants may have developed a genetic variation that helps them resist the fungus. If resistant individuals can be found, there is hope of replacing susceptible populations with resistant varieties. Research on resistant jarrah has shown great promise. This work will be expanded to include other key groups of plants.

Where conserving plants in the wild is not possible, tissue culture can be used to propagate and store plants at risk. This may allow us to re-establish these plants after means of controlling the killer fungi have been fully developed. Longer-term research may allow genetic engineering of the plants to include genes for resistance found in other species.

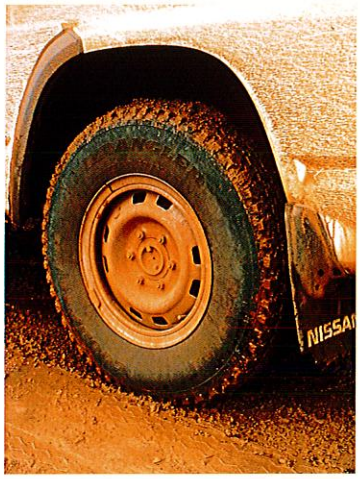
Chemotherapy is another important measure. Phosphorous acid, a cheap, biodegradable fungicide not toxic to people or animals, may be a practical way to control infection in wildflower communities. The fungicide controls all the *Phytophthora* species except *P. megasperma*. It penetrates all parts of the plant, even roots metres below the soil surface. The fungicide has a double action; it directly attacks the fungi and also boosts the plants' natural defences. Phosphorous acid protects banksias from

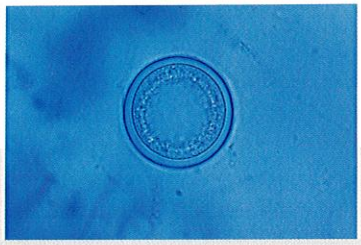
Photo - Jiri Lochman

WHAT YOU CAN DO

The fight against wildflower dieback must involve the whole community. You can help if you:

- Find out about the biology of the killer fungi.
- Become aware of where wildflower dieback already occurs and the effects the disease is having on plant communities.
- Take an interest in protecting your local piece of bush.
- Support the efforts aimed at containing the spread of the fungi and at finding a cure.
- Stop the spread by keeping to well-formed, well-drained roads and observe "road closed" signs.
- Make sure you are not a fungus carrier if you have to go off road.





Thick-walled oospores of *P. citricola*.
Photo - Bryan Shearer

infection for at least four years after being applied, and banksias already infected by the fungi can heal themselves after treatment. The fungicide can be applied to plants by injecting it in their trunks, and by spraying onto the foliage for large areas. It is currently being used to protect the feather-leaved banksia from infection.

Biological research offers hope of turning the fungi on themselves. Genetic engineering may be able to exploit weaknesses in the make-up of the fungi in order to help control them. However, such options are expensive and will take time to develop.

In the meantime, the whole community must combine to fight the killer fungi. The cost of protecting healthy plant communities is small compared to the loss of conservation, plant resource and aesthetic values caused by the disease.

Although there is as yet no cure for dieback disease, human ingenuity always provides hope for the future. Meanwhile, considerable advances in research and hygiene procedures provide a holding action. Until the wildflower-killing fungi are beaten, the preservation of some of WA's unique plants and animals will hang in the balance. ⊡

Bryan Shearer, Ray Wills, & Mike Stukely are all research scientists within CALM's plants disease program.

THE KILLING FUNGI

The seven soil-borne *Phytophthora* species that kill our wildflowers extract their food from plant tissues by a mass of microscopic threads, or **mycelium**, which forms the body of the fungi.

Given warm, moist conditions and interaction with soil microbes, the mycelium can bud off microscopic spore sacs which release millions of tiny infectious **zoospores**. This is the main way the *Phytophthora* species infect plants and reproduce. Once released, the zoospores swim over short distances or are passively moved in moist soil through human activity and in running water.

Active zoospore production occurs mainly in spring and autumn. In winter zoospores survive in moist soil but their production is limited by low temperatures. If the soil dries out in summer the fungi usually die, but can survive in infected roots or as more resistant spore types.

The mycelium may also bud-off **chlamydospores** which are larger than zoospores and can survive in soil and plant tissue for long periods, provided conditions do not become too dry. They cannot move on their own, but can be transferred in infected roots and soil particles. When conditions are favourable the chlamydospores germinate and produce mycelium and zoospores.

Thick-walled spores called **oospores** are also produced by the mycelium under certain conditions. Oospore production by *P. cinnamomi* is infrequent because two types of mycelium must grow together before they are formed. In comparison, *P. citricola* and *P. megasperma* readily produce oospores, as the fungi form the spores from the one type of mycelium. The thick-walled oospores can survive dry conditions and probably account for the wide distribution of *P. citricola* in south-western Australia.

After infection, the fungi invade root bark and form lesions of dead tissue. The fungi kill their hosts by destroying fine roots and girdling major roots or the base of the stem, depriving the plant of access to nutrients and water.

More than 80 per cent of species in the banksia family (banksias, grevilleas, dryandras, hakeas, and so on) may be killed by the fungi. The banksia family is often the most abundant group in many areas of the South West and so provides the fundamental elements of many plant communities.

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