BANANAS





- > Trust Quality
- ExpectPerformance

Innovation

This booklet contains practical information to assist in the use of SACOA products in IPM programs for Bananas.

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This booklet provides practical information to assist in the effective and safe use of SACOA products in bananas.

A FOCUS ON SACOA

SACOA Pty Ltd is a leading developer and supplier of spray oils and adjuvants in Australia.

Since our inception in 1991 we have grown to become an international Australian-owned company supported by active partnerships with world-leading manufacturers and research and development groups.

QUALITY AND SERVICE

As a committed industry leader SACOA delivers a range of assurances and services to our reseller clients including QA production facilities, ongoing research programs and extensive marketing support via brochures, guides, manuals and presentations - available in print and online.

SUSTAINABLE FARMING

Conscious of the importance of sustainable farming practices, SACOA offer a range of products perfectly suited to use in Integrated Pest Management (IPM) programs.

INNOVATIVE SOLUTIONS

Beyond their sustainable farming benefits, our range of spray oil and adjuvant products provide reliable and economically proven solutions for modern farming's many challenges.

More information on our company and our products is available at

www.sacoa.com.au

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SACOA BIOPEST® PARAFFINIC OIL



SACOA BIOPEST® (BIOPEST®) is a highly refined iso-paraffinic oil designed for use in bananas to assist in the management of pest and disease.

Independent trials conducted in New South Wales and Queensland indicated BIOPEST® to be the most effective mineral spray oil (when used in conjunction with Integrated Pest and Disease Management programs) available in Australia.

With an unmatched level of purity, BIOPEST® represents the most advanced attempt yet to provide growers with an IPM product capable of effective control whilst remaining safe to growers, plants, and the environment.



ORGANIC REGISTRATION

As a spray oil, BIOPEST[®] is ideally suited to organic farming. Organic registration for BIOPEST[®] with BFA was obtained in 2011.



IT'S CLEAR

BIOPEST® is a revolution in spray oil quality. Formulated with food-grade paraffinic oil, BIOPEST®'s clarity is a clear sign of its quality and purity. The next time you open a drum of oil, check its clarity.

Is it 'water clear'?

BIOPEST® - A REVOLUTION IN SPRAY OIL TECHNOLOGY

SACOA BIOPEST® Paraffinic Oil is designed for use on a wide range of crops, and is registered in bananas for the management of diseases such as leaf spot and leaf speckle.

AN ESSENTIAL IPM SOLUTION

BIOPEST®, as an advanced biorational pesticide and adjuvant, is an essential component of integrated pest disease management and has a proven effectiveness in controlling multiple, unrelated pests and fungal diseases simultaneously.

- Ability to modify pest behaviour
- Minimal impact on beneficial insects
- Not persistent in the environment
- Low toxicity to animals and grower
- Safe to handle
 - No pest resistance As mineral oils work at the physical level and not at the biochemical level, they do not invite resistance to develop. This valuable trait is supported by almost a century of mineral oil use in insect and disease control.
- Won't stimulate pest outbreaks like some conventional pesticides do.



WHY DOES BIOPEST® WORK BETTER?

BIOPEST® offers a uniquely pure, optimal weight oil without the potential plant damage trade-off.

HERE'S 4 REASONS WHY.

A Pure Oil - USR over 98% 1

Impurities cause damage the longer they stay on the plant surface. BIOPEST's USR rating of over 98% means it can stay plant or restricting growth.

Optimal Weight - nC24 2

BIOPEST persists on the leaf or fruit surface longer. This means more pests and disease are killed and a significantly

Quality Surfactant - Biodegradable Improves the sticking and spreading properties of the oil in a

High Paraffinic Content - 76%

Paraffinic molecules have the greatest insecticidal properties.

Efficacy + Safety More pest control per spray and for longer with less risk of plant or fruit damage.

AS A CARRIER OR ADJUVANT

BIOPEST® provides a unique combination of functions as a carrier for chemical and biological pesticides in bananas.

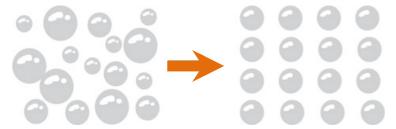
These all work to:

- Get more of the chemical or biological active evenly onto the leaves.
- Protect the active and keeping it working longer by slowing down volatilisation.

COVERAGE

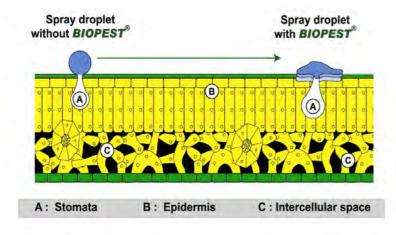
UNIFORM DROPLETS

Improves spray coverage and reduces loss through drift (small droplets) and runoff (large droplets).



SPREADING

Improves potential contact with pest and/or disease.



STICKING

Improves spray rainfastness.



BIOPEST® - THREE KEY MODES OF ACTION

As a biorational pesticide, BIOPEST® has three key uses in pest and disease management:

- Insecticide
- Fungicide
- Plant Virus Management

AS AN INSECTICIDE

1. BEHAVIOUR MODIFICATION

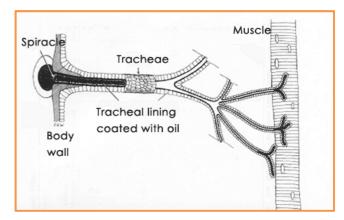
BIOPEST® deters the feeding and egg laying of pest insects. How this occurs is covered in more detail in the section on behaviour modification.

2. SUFFOCATION / DROWNING

BIOPEST® blocks the air holes (spiracles) and lines the breathing tubes (tracheae) through which insects and mites breathe.

3. POISON

In some cases, BIOPEST® may also act as a 'poison', interacting with the fatty acids of the pest and interfering with normal metabolism.



Process of oil induced suffocation/drowning: oil moves into tracheae by capillary movement.

AS A FUNGICIDE

BIOPEST helps manage a number of different fungi in two ways:

1. HOST PLANT PROTECTION

It is believed that BIOPEST® may protect the host plant by interfering with the attachment of the fungi to the plant.

2. ERADICATION OF FUNGI

It is believed that BIOPEST® may help eradicate existing fungi by targeting and breaking down the fungi's cell walls.

AS A PLANT VIRUS MANAGER

BIOPEST® is useful in managing non-persistent viruses transmitted by sucking pests such as aphids by interfering with their feeding behaviour and hence disrupting the virus transmission process. As the viruses are generally transferred via the pests' stylet (the piercing and sucking mouthpart) it is prevented from inoculating healthy plants and transmitting the virus from diseased ones.

"So significant are the behavioural effects of mineral oils that they should be regarded as the most important mode of action against arthropods."

Prof. Andrew Beattie et al, 2000

NEW LEARNINGS = NEW OPPORTUNITY

Extensive research by the University of Western Sydney over many years, has opened the door to a new understanding of how a high quality horticultural mineral oil affects insects by modifying certain key insect behaviours such as feeding and egg laying.

INSECTS SHOWN TO BE POTENTIALLY VULNERABLE				
Whitefly	Codling Moth	Leafminer	Grape Leafhopper	
Mites	Leafrollers	Aphids	Thrips	
Fruit Fly	Psyllids	Budworm	Bollworms	
Helicoverpa spp.	Lace bugs	Source: University of Western Sydney		

HOW BEHAVIOUR MODIFICATION OCCURS

- 1. In order to feed or lay eggs on a host plant, insects and mites must first detect a host plant at the chemical level. This is done through tiny, hollow hairs (sensillae) located on their mouthparts, feet and abdomen.
- 2. Inside the sensillae are nerve endings which sense specific chemicals produced by the host plant and are detected in the process of probing. Contact with these chemicals can trigger or stimulate an insect to feed or lay eggs at specific locations within the plant.
- 3. BIOPEST® plugs these sensillae. This effectively 'blinds' the insect from identifying food sources or oviposition sites.



Small hairs called sensillae

BENEFICIAL INSECTS ARE MINIMALLY AFFECTED

As beneficial insects are insect-attacking rather than plant-attacking they have evolved a different set of host detection mechanisms and are minimally affected.

This section covers key diseases affecting bananas.

BIOPEST®'S ROLE

YELLOW SIGATOKA LEAF SPOT

Mycosphaerella musicola



Banana leaves infected with severe yellow sigatoka



Yellow sigatoka leaf spot. Advanced stage lesions

DAMAGE: Yellow sigatoka leaf spot can have a devastating effect on banana production, particularly in north Queensland: The main problems are:

- Reduce effective leaf area for photosynthesis
- Delayed bunch filling and reduced bunch size
- Increase costs for spraying and deleafing
- Mixed ripening of fruit post harvest
- Restricted market access

HOW TO MANAGE: Queensland growers are legally required to control yellow sigatoka in their bananas and must give high priority to proper management of this disease.

Remember: It is vital for good disease management, to remove (ie deleaf) all leaves that have reached $\geq 5\%$ of leaf area infected.

Apart from deleafing, the following actions are recommended (modified DAFF):

- Apply registered fungicides plus BIOPEST® (where compatible) every 10-21 days, with shorter intervals during hot/humid weather when disease can spread rapidly.
- Read and follow the label on the fungicide container. Read it!
- Adhere to recommended resistance management strategies. Learn the strategies!
- Apply systemic fungicides (with BIOPEST®) during the wet season, and protectant fungicides (with BIOPEST®, where compatible) during the dry season.

YELLOW SIGATOKA LEAF SPOT - Continued

Advantages of BIOPEST® in Bananas - Safety

BIOPEST® has played a leading and effective role in managing yellow sigatoka in Australian bananas for many years - particularly in the tough growing conditions of north Queensland.

When applied according to the label, not only is BIOPEST® a very crop safe product for use on bananas, it is also totally safe to the environment. This is a claim that cannot be made so confidently for many other banana fungicides.

The positive environmental (and food) safety features of BIOPEST® should be recognised and applauded. Modern citizens and consumers are demanding the highest safety standards for food production (and food safety), and greater scrutiny of commercial farm practices - particularly into potentially adverse side effects of pesticide spraying. Banana growers should welcome this scrutiny and have no concerns, provided they follow good agricultural practices and in particular, use pesticides strictly according to the label. Widespread abuse of pesticides in an industry can threaten that industry's reputation and ultimately its existence.

Despite the fact that most bananas are grown in close relative proximity to the Great Barrier Reef (and its catchments), growers and consumers can be confident that the use of BIOPEST® on bananas, poses no threat to this fantastic, natural Australian asset.

Other Advantages of Using BIOPEST® in Bananas:

Applied alone, or with chemical fungicides (where compatible), **BIOPEST**[®] **may act to slow the development of yellow sigatoka resistance to chemical fungicides**. Some systemic fungicides (and most new fungicides) can be costly, but they are vital for good disease management. BIOPEST[®] used in spray programs can prevent the overuse of these products and **reduce the selection for resistance**. Disease resistance to BIOPEST[®] itself is externely unlikely, due to its (physical) mode of action.

Banana leaf mites

Banana leaf mites are a notorious example of a **secondary pest** that may – in response to weather or stimulation from certain chemical pesticides - increase to large numbers on leaves, reducing photosynthetic potential and leading to delayed and/or smaller bunches. In a recent large scale aerial trial (sponsored by SACOA), bananas treated with a spray program based on BIOPEST[®] (alone or with registered fungicides), developed significantly less leaf damage from mites in comparison with a spray program based around chlorothalonil. BIOPEST[®], it is believed, served to inhibit feeding of mites on the sprayed leaves, whereas chlorothalonil had no impact on the mites ability to feed and cause damage.

BUNCHY TOP (BBTV)

Banana Bunchy Top Virus (BBTV) is a serious threat to commercial banana production, with infected plants failing to produce bunches. It is also a highly infectious disease, spread by aphids (and by infected planting material).

These infections occur mainly in northern New South Wales and southern Queensland. There is no BBTV in north Queensland and strict quarantine measures are in place to keep this disease out of the northern banana growing areas.

BBTV is currently the focus of a three year project funded by the Australian Banana Growers Council, the Banana Industry Advisory Committee and Horticulture Australia Limited to work towards eradication.

BIOPEST® plays a very useful role in the BBTV eradication campaign which targets infected backyard bananas. Imidacloprid is used to kill aphids on infected plants and then the surrounding area is sprayed with BIOPEST® to safely prevent any aphids escaping and spreading the disease. Campaign personnel report very good control of banana aphids with BIOPEST®.

The banana aphid *Pentalonia nigronervosa* is endemic in north Queensland and there is the potential for BBTV to spread rapidly through banana plantations, should the virus enter the aphid population.

Regular use of BIOPEST® in north Queensland bananas (for disease control) may be advantageous because of the ability of BIOPEST® to kill and suppress aphids.



Banana aphids in the throat of a 2 metre plant, that has been sprayed with a chlorothalonil program, Innisfail (aphids are being tended by ants)



Banana aphid mud nest, in throat of a small sucker (Innisfail)

CURRENT REGISTRATION

A BIORATIONAL FUNGICIDE AND PREMIUM CARRIER

 $\mathsf{BIOPEST}^{\$}$ is currently registered for use as a carrier in bananas for the management of leaf spot and leaf speckle and as a carrier for pesticides to improve the level of kill or enhance coverage.

PEST	STATE	APPLICATION RATE	CRITICAL COMMENTS
Yellow sigatoka (Cercospora) Leaf Spot	NSW, ACT	4L	Apply in combination with mancozeb at 2.2-4.5 kg/ha in 200 to 500L of water via appropriate ground rig or 30L via aerial application. Apply at 3-4 week intervals, from December until late April.
	Qld	3.5L	In north Queensland the interval may be reduced to 10-14 days in the wet season.
Yellow Sigatoka (Cercospora) Leaf Spot, Leaf Speckle	NSW, ACT, Sth Qld, WA	5L	Apply in combination with Tilt 250 EC. Commence spraying in December and apply 4 to 5 times at 21 day intervals. Later use alternative fungicides if needed. Spray both sides of leaves.
Yellow Sigatoka (Cercospora) Leaf Spot, Leaf Speckle, Cordana leaf spot	Nth Qld	5L	Apply in combination with Tilt 250 EC. Spray every two weeks from the start of the wet season in December and make a maximum of 6 applications. Later use alternative fungicides if needed. Spray both sides of leaves.

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General Conditions	Month	Spray #	Week	Fungicide type	Products
	Oct	1	1-2	DMI	Folicur 430 SC + Biopest
	OCL	2	3-4	Protect	Biopest
Dry/warm [Mite] season Minimise mancozeb or chloro	Nov	3	5-6	DMI	Folicur 430 SC + Biopest
use to avoid mite flare. Deleaf before wet season.		4	7-9	Protec	Biopest
	D	5	10-11	Protec	Penncozeb 750 DF + Biopest
	Dec	6	12-13	DMI	Folicur 430 SC + Biopest
	2	7	14-15	Protec	Biopest
	Jan	8	16-18	DMI	Tilt 400 EC + Biopest
		9	19-20	Protec	Penncozeb 750 DF + Biopest
Humid/wet season	Feb	10	21-22	DMI	Folicur 430 SC + Biopest
high disease pressure. Maintain deleafing program	.,	11	23-24	Protec	Penncozeb 750 DF + Biopest
	Mar	12	25-26	DMI	Folicur 430 SC + Biopest
	A	13	27-28	Protec	Penncozeb 750 DF + Biopest
	Apr	14	29-30	Protec	Biopest
		15	31-32	DMI	Folicur 430 SC + Biopest
	May	16	33-35	Protec	Siganex 600 SC + Biopest
Cool/wet season	g Jun	17	36-37	Protec	Siganex 600 SC + Biopest
Slower growth but continuing high disease pressure		18	38-39	Protec	Biopest
	7.1	19	40-41	Protec	Siganex 600 SC + Biopest
	Jul	20	42-43	DMI	Tilt 400 EC + Biopest
	0.	21	44-45	Protec	Biopest
	Aug	22	46-48	Protec	Siganex 600 SC + Biopest
Dry/warm season Lower infection pressure.	6	23	49-50	Protec	Biopest
Susceptible to mite buildup	Sep	24	51-52	Protec	Biopest
	Oct	1		DMI	Folicur 430 SC + Biopest

DMI = systemic fungicide with ability to kill early infection

Protec = protectant fungicide that will prevent disease establishing, but will not kill or eradicate established disease

^{*} subject to confirmation of resistance to strobylurons

NOTES

- a. No commercial fungicides will eradicate necrotic sigatoka lesions on banana leaves. Any fungicidal suppression of necrotic lesions will only be temporary and these diseased leaves should be deleafed. Responsible members of the banana growing industry are obliged to follow this advice.
- b. To ensure effective management of yellow sigatoka, it is vital that all leaves with >5% necrotic sigatoka lesions are removed from plants regularly, at least every 4-6 weeks. Thorough deleafing contributes most to disease management during the warmer months when crop growth is highest (also when disease pressure is highest) and new leaves are produced quickly. New leaves can be kept free of disease with proper application of foliar fungicide plus BIOPEST[®].
- c. Respray intervals should follow label directions (10-14 days), particularly during the warm/humid months. If spray intervals are extended beyond the recommended maximum interval, one of the DMI products (with BIOPEST®) should be used at the next available spray opportunity. A further DMI spray may also be useful.
- d. An interval of 14 days is the maximum recommended interval for most fungicides during the warm/humid months, however growers should aim to spray at 10-12 day intervals if disease conditions are suitable for spread of infection.
- e. BIOPEST® can be applied alone at 5 L/ha to provide effective supression of and protection from disease, when the crop is well managed and free of any leaves that have necrotic sigatoka lesions. The spray interval following application of BIOPEST® should take into account the growth rates of the crop and the general disease conditions. During warmer months, 10-12 days should be the maximum interval (for respray) following an application of BIOPEST® alone.
- f. The use of BIOPEST® alone (without mancozeb) has been found to suppress the feeding of mites on banana leaves. Heavy mite feeding (ie flaring) can reduce the potential yield of a banana crop. Mite flaring is most commonly observed during the prewet season period (September-December) and is associated with the regular use of mancozeb or chlorothalonil fungicides. These fungicides should be avoided to prevent mite flaring.



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MIXING INSTRUCTIONS

- Add water to the mixing tank to allow proper agitation by pump or paddles.
- If BIOPEST® is being used as an adjuvant, add other pesticides as follow:

•If a wettable powder solution: Mix water and powder thoroughly so that powder is totally suspended in the water before the oil is added.

•If an emulsifiable formulation: Add the chemical before the oil has been to the water.

•Add oil under agitation when tank is half full. Top off with water to form a milky solution.

Maintain agitation until solution is completely used
 Note: In small equipment lacking agitator, stir or shake diluted spray frequently during application.

•Read and follow all instructions on the labels of the proposed tank mix.

•Flush fluid in sprayer hose lines back into tank reservoir if fluid is allowed to stand for more than 20 minutes.

Note: Do not use BIOPEST[®], or any other spray oil with lime sulphur or chlorothalonil within 4 weeks of an oil spray application.

THREE IMPORTANT POINTS

In addition to following the correct mixing order, three considerations are always critical to tank mixing:

- Refer to the Product Label: Always read the product label prior to use to dertermine individual product compatibility options and to confirm correct mixing orders.
- 2. Perform a Jar Test: It is always advisable to perform a jar test to confirm physical compatibility. Physical compatibility does not always ensure biological compatibility.
- **3. Agitation**: Use constant agitation in the spray tank. Use either mechanical or bypass agitation to ensure the oil remains an emulsion in the tank. Never leave a spray tank of oil + water overnight to be sprayed out the next day.

MIXING COMPATIBILITY

The following table shows popular fungicides used in bananas that are chemically compatible with BIOPEST[®]. Ensure label recommendations are followed. Those that should not be mixed are highlighted.

CHEMICAL	COMPATIBLE
Tebuconazole	\checkmark
Propiconazole	\checkmark
Trifloxystrobin	\checkmark
Pyraclostrobin	\checkmark
Pyrimethanil	\checkmark
Chlorothalonil	*
Mancozeb	✓
Lime-sulphur	*
Difenconazole	✓
Epoxyconazole	\checkmark
Natrasoap	*
Omethoate	✓

CAUTION ON MULTIPLE MIXES

Tank mixes involving multiple chemicals should be avoided where possible due to the difficulty in calculating their combined effect on pests, plant, soil and environment.

To ensure maximum crop safety when using BIOPEST® on bananas, it is vital to read and follow the label directions. The following safeguards are recommended.

SPRAY PREPARATION

Read the label thoroughly and ensure the correct concentration is selected and mixed.

Do not mix BIOPEST® with incompatible chemicals such as chlorothalonil or sulfur.

Avoid complex spray mixtures

Fill the spray tank with two-thirds of the water, then add the required amount of BIOPEST[®] whilst agitating the tank, then top up with the remaining water.

Ensure adequate and constant agitation of BIOPEST® spray mixture and do not leave the spray mix to stand for longer than 10 minutes. If you do, then vigorously agitate or stir before recommencing application.

SPRAY APPLICATION

Spray the BIOPEST® mixture immediately after preparation.

Aim to have the ${\sf BIOPEST}^{\it \&}$ spray mixture dry on the banana plants within 1 to 2 hours of application.

Avoid spraying BIOPEST® in temperatures higher than 35°C or when shade temperature is expected to exceed 32°C. Depending on weather conditions and forecasts, the most suitable time to spray is in the early morning or late afternoon.

Avoid spraying onto exposed bunches that have not been bagged with plastic bunch covers.

Avoid spraying BIOPEST[®] mixtures onto stressed bananas. Plants that are stressed from lack of water or waterlogging (or other stress factors) are more susceptible to burn.

Do not add additional emulsifiers or surfactants to the BIOPEST® spray mix.

Do not spray BIOPEST[®] mixture onto bananas that have been treated within at least 2 weeks with chlorothalonil.

Do not spray BIOPEST® in combination with propargite or within 4 weeks of a propargite application.

Do not spray BIOPEST[®] in combination with Torque[®] where rapid speed of action is required.









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