Targeting Mealybug with *Eco-Bb*®




Andermatt
Madumbi

Introduction

Mealybug and bio crop protection using Andermatt Madumbi's *Eco-Bb®*.

The recent approval and registration of Eco-Bb®, for the control of mealybug on pome fruit (apples, pears), citrus and grapes has attracted great interest and attention from growers.

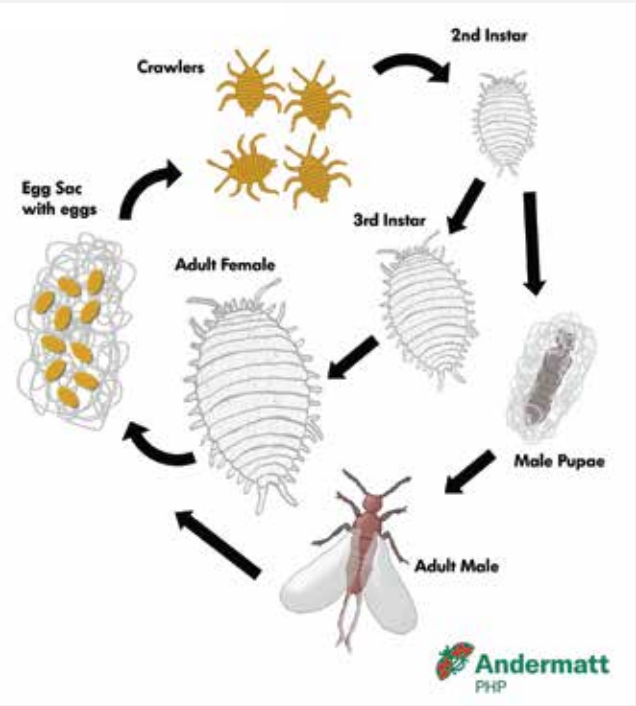
Mealybugs are one of the most important pests of citrus and vines in South Africa and are also of economic importance in many other crops such as apples, pears, mangos, macadamia nuts, blueberries, peppers and other vegetables and ornamentals.

Mealybugs can cause significant loss of revenue in the agricultural sector, especially in the citrus and grape industries. The loss may be further compounded as some mealybug species are vectors of plant viruses. Numerous countries list mealybugs as a phytosanitary pest which, if identified on export produce, the whole consignment will be destroyed.

Mealybugs are important economic pests on a wide range of cultivated and ornamental crops in agriculture and horticulture. The most important species occurring on citrus are citrus mealybug (*Planococcus citri*), oleander mealybug (*Paracoccus burnerae*) and the long-tailed mealybug (*Pseudococcus longispinus*), while the most important species occurring on grapevines is the vine mealybug (*Planococcus ficus*). Many different species of mealybugs can be found on a variety of host plants.

Mealybugs damage crops in a variety of ways including retarding plant growth, fruit malformations, cosmetic damage and fruit drop. Mealybug also secrete honeydew, a substrate for a group of fungi commonly known as sooty mould. Sooty mould attracts ants and together these visual factors are often an indication of pest infestation.

The Mealybug Life Cycle.



Source: Muller, L. & Pountney, C.A. (2013) Mealybug control in citrus orchards and vineyards: an Integrated Pest Management approach. S.A. Fruit Journal Dec/Jan 2013, pp. 40-43.

Life Cycle and Behaviour

Citrus Mealybug Life Cycle and Behaviour.

Mealybugs are sap-sucking insects with five distinct life stages (egg, 1st instar (= crawlers), 2nd, 3rd, 4th (female = instar, male = pupa), adult). Adult females are sessile and produce a white cottony ovisack, into which eggs are laid. The ovisack (2-3 mm in diameter) is visible at the posterior of the adult female (Fig. 1.1). During high infestations, females with their ovisacs attached appear as cotton-like masses on the plant, and this is one sign that an established mealybug infestation is present. One female can lay between 300 and 600 eggs in her lifetime and depending on conditions, eggs hatch after 6 to 8 days or after several weeks. On average, one female lays 29 eggs per day (Kernes, *et al*., 2001; Meyers, 1932).

First instar nymphs known as crawlers (Fig. 1.2), emerge from the ovisacs and are highly motile, seeking new sites to establish a colony; typically on the underside of leaves, on young twigs and/or on fruits. The crawlers are very small (0,25 mm) and tend to hide in crevices. Therefore, it is difficult to detect early, crawler-based infestations. All mealybug life stages, including the crawlers, secrete honeydew (Fig. 1.3), which is a sticky sugar-based liquid, often 'harvested' by ants and/or colonised by various fungi (Gill *et al*. 2012). Such fungal growth is commonly referred to as 'sooty mould' (Fig. 1.4) and includes fungal species like *Cladosporium, Penicillium* and *Alternaria*.

Only the 2nd and 3rd instars look like the adult female. The crawlers (1st instars) all look the same with no waxy covering. Males have 1st instar (crawlers), 2nd instar males (elongate with waxy covering), 3rd stage (the nymph spins a loose silken cocoon in which it pupates) and then emerges as an adult. The white sheddings may resemble a *Beauveria*-infected cadaver and must not be confused with such. Note, the exuvia/shed exoskeleton of the instars have a characteristic V-shape and differ in size according to that particular instar stage. The early instars can disperse on or between host plants by crawling, wind, droplet splatter, birds and/or by machinery and equipment (Gill *et al*. 2012).

The female adult is typically 3 mm long and coated with a white, waxy covering (Fig. 1.1). The female is wingless and only able to crawl short distances. Once settled, mealybugs insert their long, thin stylets into the host plant to extract sap. Adult females focus on feeding and egg production and are less likely to move from one host plant to another compared to the immature nymphs, especially crawlers which are very active. Females can live for up to 29 days. The male adult is winged and capable of flying from one plant to another for mating (Fig. 1.6). The adult males live for only one to two days and do not feed. Mealybug populations quickly develop into multiple-aged cohorts, which are simultaneously present (Fig.1.7).

Figure 1.1: Adult female mealybug with cottony-like ovisac and glossy yellow eggs

Figure 1.2: First instars (crawlers) and a second instar in the process of shedding

Figure 1.3: Adult female mealybug secreting a drop of honeydew from anal opening

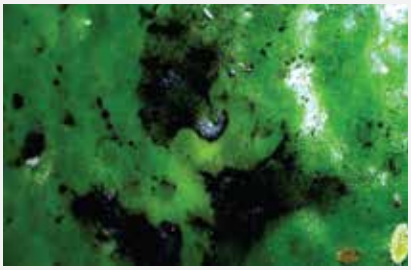


Figure 1.4: Sooty mould on mealybug-infested citrus

Figure 1.5: Mealybug nymph shedding its waxy cuticle

Figure 1.6: Adult male mealybug mating with wingless female

Figure 1.7: Mealybug colony with different life stages existing together

Using *Eco-Bb*® to Target Mealybug

Which life stages are most susceptible?

Laboratory bioassays conducted at Andermatt PHP have shown the following:

- Crawlers are highly susceptible to Eco-Bb® (Fig. 2.1) and death occurs within 3 days under favorable conditions.
- Mealybug feeding may decrease after inoculation with Eco-Bb®, but this has not been tested.
- It is possible that newly moulted instars (i.e. without the waxy layer) are also susceptible to Eco-Bb® infection, but this is still to be confirmed with further bioassays.
- Adult females have zero to low susceptibility, this is most-likely due to their waxy cuticle.
- Mealybugs co-exist with several other microorganisms, and sooty moulds, such as *Penicillium* (Fig. 2.2), can colonise the crawler cadavers following Eco-Bb® applications.

Figure 2.1: Mealybug crawler cadaver showing mycosis (fungal growth) of Eco-Bb®; not visible to the naked eye.

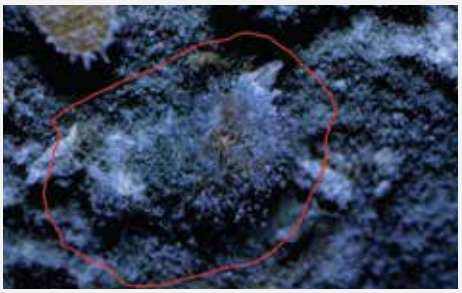


Figure 2.2: Mealybug cadaver colonised by *Penicillium* sp.

How to Optimise the Use of *Eco-Bb*® Against Mealybug

Start applications at the first sign of mealybug infestation.

It is vital that the first application be made while pest pressure is low (as soon as the infestation is first noticed), or preventatively. This will target the crawlers from the initial population, and prevent these individuals reaching the next instar or adult stages, which are less susceptible to *Beauveria bassiana*. Eco-Bb® trials on grapes against *Planococcus ficus* showed that when the first application was made early, Eco-Bb® reduced the mealybug population by up 75%, however, when the first application was made later, the efficacy declined to 24%. This illustrates the importance of starting the applications as soon as the infestation is first noticed (Fig. 2.3). When pest pressure is low, the initial application of Eco-Bb® can be at the lower dose rate and still be effective. Under higher pest pressure use the higher application rate which will provide better efficacy.

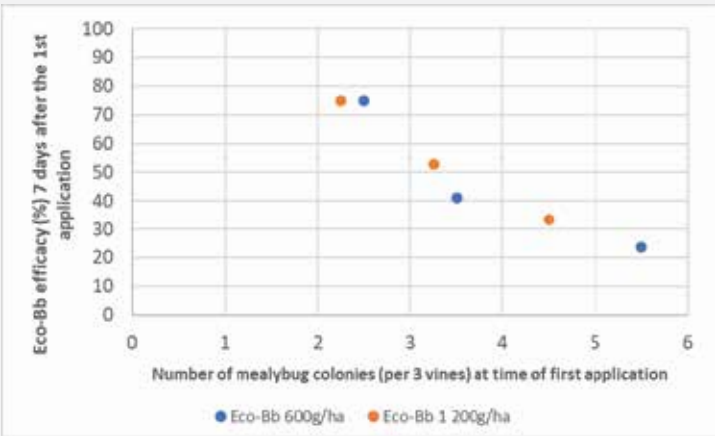


Figure 2.3: Efficacy data from three mealybug trials on grapes, showing the decrease in infestation as a percent after the first applications at low and high dose rates.

Multiple applications are required to achieve sustained efficacy.

Eco-Bb® does not kill the adult female stage and therefore females continue to produce eggs for their full lifespan (up to 29 days). Multiple applications are required to target crawlers that are continuously hatching and entering the population. Apply as a full cover spray at intervals of 7 to 14 days, depending on severity of the infestation.

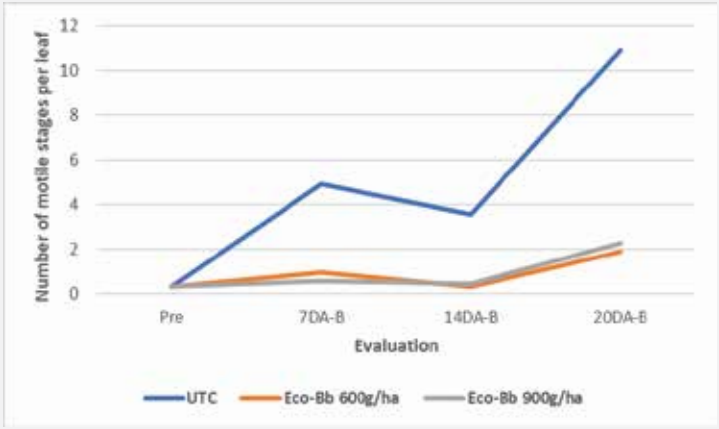


Figure 2.4: Efficacy data from a mealybug trial on stone fruit, which shows the increase in number of mealybug between 14 days after the second application and 20 days after the second application (UTC = untreated control).

Spray coverage is essential.

Mealybugs are sucking insects and use long, thin, threadlike mouthparts (stylets) to draw sap from the plant. Mealybug do not ingest Eco-Bb® and can only be infected if the spores come into direct contact with the integument (outer protective skin) of the mealybug.

Spray equipment used must provide good coverage. A compatible wetter/spreader can assist reaching the hiding places of the crawlers, such as in crevices and underneath adults within the mealybug colony.

Effective scouting.

Local scouting guidelines should be followed in order to detect early infestations. Eco-Bb® applications should start as early as possible to prevent an increase and spread of the mealybug population (mainly via crawlers).

One application is not enough.

Multiple applications will increase the efficacy provided by Eco-Bb®. Under low pest pressure, a maximum interval of 14 days should be used, and under higher pest pressure a shorter interval (7 – 10 days) is recommended.

Using the lower application rate (600 g/ha) with frequent applications will be more effective than using the high dose rate (1 kg/ha) with fewer applications. If only one or two applications are possible, then the high rate should be used.

Eco-Bb® contains a living fungus and must be treated with care.

To maximise the efficacy of Eco-Bb®, it must be handled and applied correctly:

- Maintain viability by storing Eco-Bb® in the fridge and transporting it in cool conditions. At temperatures above 35ºC, the viability of Eco-Bb® could be immediately compromised.
- Eco-Bb® must not be mixed with incompatible fungicides. Equipment used to apply these fungicides must be thoroughly cleaned before using Eco-Bb®.
- Ideally, Eco-Bb® should be sprayed in the late afternoon or evening as UV can cause the spores to become nonviable.
- The powder or solution must not be left standing in the sun.
- Do not apply Eco-Bb® when temperatures are below 15ºC or above 35ºC.

What to Expect When Using *Eco-Bb*® in the Field

Eco-Bb® will prevent an increase in the initial Mealybug population size.

The adult female stage has zero to low susceptibility to Eco-Bb® and therefore the severity of the initial mealybug infestation will only decrease once the adults reach the end of their natural lifespan, are killed by natural predators/parasitoids or other interventions. Due to their waxy coating, the later instars are also less susceptible to Eco-Bb® than the crawlers. Therefore, you will probably not notice a decrease in the size of existing mealybug colonies. In fact, to the naked eye, the colonies may appear as though they are increasing, as the individual mealybugs (not colonies) grow physically in size over time. Figure 2.5 shows a trial where mealybug severity (the size of colonies) was measured, and compared to the trial blocks treated with Eco-Bb® and a Standard Chemical treatment. A preventative or early first application is critical to ensure that the mealybug population is maintained at a low level.

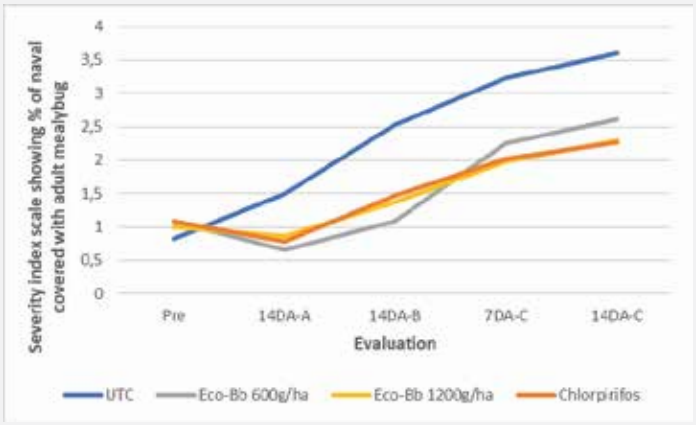


Figure 2.5: Trial data that show percentage area of the naval covered by adult mealybug increasing in the Eco-Bb® treated areas, however, compared to the untreated areas (UTC), Eco-Bb® has helped prevent the severity reaching higher levels. A similar performance was provided by the chemical reference product.

Eco-Bb® will kill the crawlers and therefore help prevent the establishment of new mealybug colonies. Figure 2.6 shows a trial where Eco-Bb® contained the spread of the mealybug population until seven days after the third application (or 21 days after the first application). Compared to the untreated control, the spread of mealybug from one fruit to another was reduced by 64%. By seven days after application four (or 28 days after the first application), the percentage of fruit infested with mealybug in the Eco-Bb® treated areas decreased, possibly due to the natural death of the adults.

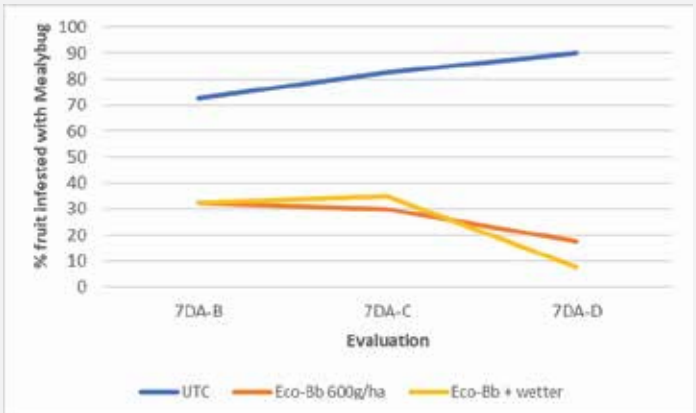


Figure 2.6: Trial data that show Eco-Bb® preventing the spread of mealybug compared to the untreated control (UTC). Seven days after the fourth application (or 28 days after the first application), the percentage fruit infested decreased in the Eco-Bb® treated areas.

Observing mycosing mealybug in the field is very difficult.

Mycosis refers to the outgrowth of Eco-Bb® from the insect's body and the formation of spores on the outside of the insect cadaver. In the case of mealybug, to observe this in the field is almost impossible:

- Eco-Bb® mainly effects the crawlers, which are only 0,2 mm in size. Therefore, to the naked eye, or even under a field magnifying glass, observing mycosing crawlers will be very difficult;
- The crawlers may be killed before inserting their mouthpart into the plant, and thus can fall or be blown off the plant;
- As the mealybug nymph progresses into a new instar, it sheds its skin, leaving behind a white waxy shedding. Without a microscope and knowledge of how to identify *Beauveria bassiana,* these sheddings can easily be misidentified as mycosing cadavers.
- Mealybug that are killed by Eco-Bb®, can be colonised by other fungi also present on the infested plant/fruit, especially by *Penicillium* spp. (Fig. 2.2).

Instead of looking for mycosing insects as an indication that Eco-Bb® is working, rather observe whether areas of the plant that were not infested at the time of application have new colonies established. As Eco-Bb® is most effective against the crawlers, it should prevent the active crawlers from moving into non-infested areas and establishing new colonies.

Andermatt Madumbi Team, working at an apple orchard in the Western Cape.

Mealybug infestation on citrus crop.

Sraying apple orchards in the Western Cape.

Why Use *Eco-Bb*® Against Mealybug?

- Eco-Bb® can help break the mealybug life cycle by targeting the first instar. The crawler stage is most susceptible and early applications are key to effective suppression.
- Once adults are present, multiple applications are required to target newly hatched crawlers. Be aware that once a colony is established, it is likely that all life stages will be present.
- Independent laboratory tests have shown that Eco-Bb® is not harmful to parasitoid wasps used as biological control agents for different species of mealybug, *Anagyrus* spp. In fact they should be complementary, as *Anagyrus* will target the second and third instars and adult females, which are more difficult to suppress with Eco-Bb®, and *Anagyrus* does not target the crawlers.
- Eco-Bb® does not have MRL constraints and can be used up until harvest.
- Eco-Bb® is non-toxic and it is safe to continue work in the orchard immediately after spraying.
- Eco-Bb® has a unique and complex mode of action, as such it is an excellent resistance management tool.
- Contact is critical to efficacy. Area specific sprays are most effective.

For more information visit www.andermatt.co.za or contact your local Andermatt Madumbi Biospecialist.

Lemon treated with Eco-Bb® at early infestation.

Untreated lemon with severe mealybug infestation.

Registered uses:

Pest	Crop type	Dose rate	Remarks
Whitefly	Beans, tomatoes, cucumbers, brinjals	300 – 600 g/ha is recommended depending on spray volume, crop, growth stage and pest severity.	Apply as a full cover spray every 7-14 days depending on the severity of the pest. Apply at early stage of infestation for best results.
Phthorimaea (Tuta) absoluta	Tomatoes		
Leafminer *(Liriomyza spp.)*	Potatoes		
Red spider mites	Beans, tomatoes, cucumbers, brinjals		
Red spider mites	Stone fruit (peaches, plums, nectarines, cherries)	600 – 1000 g/ha depending on size of tree and degree of infestation.	Apply as a full cover spray, contact with pest is desired for maximum effect. Apply at an early stage of infestation to optimize efficacy. Repeat application every 7-14 days or use in an IPM programme. A minimum of three applications is recommended. The higher rate is preferred on large trees, high spray volume application or when pest severity is high.
Woolly whitefly	Citrus		Apply as a full cover spray, contact with pest is desired for maximum effect. The higher rate is preferred on large trees, high spray volume application or when pest severity is high. Apply at an early stage of infestation to optimize efficacy. Ensure coverage of lower leaf surface. Repeat application every 7-14 days if necessary.
False codling moth (FCM)	Table grapes, pomegranates, avocados; litchis; citrus; stone fruit (apricots, cherries (sweet and sour), nectarines, peaches, plums and prunes); tree nuts (almonds, cashews, hazelnuts, macadamia nuts, pecans, pistachio nuts, walnuts, coconut, brazil nuts and pine nuts)		Apply as a full cover spray, contact with pest is desired for maximum effect. Apply when moth activity peaks or eggs or larvae are first noted. Repeat application every 10-14 days or use in an IPM programme. The higher rate is preferred on large trees, high spray volume application or when pest severity is high.
Mealybug	Pome fruit (apples, pears); citrus; grapes		Apply as a full cover spray, from when the pest is first noticed. Ensure coverage of lower leaf surface – contact with pest is desired for maximum effect. Repeat application every 7-14 days. A minimum of three applications is recommended. In severe cases repeat application until the pest is no longer present, or use in an IPM programme. The higher rate is preferred on large trees, for high spray volume application or when pest severity is high. Target crawler stage for maximum efficacy.

Available in: 40 g, 300 g, 1 kg, 5 kg.

Eco-Bb® contains *Beauveria bassiana*. Reg. No. L8469, Act No. 36 of 1947. Andermatt PHP (Pty) Ltd, PO Box 207, Nottingham Road, 3280, KwaZulu Natal, South Africa. Reg. No. 2003/007987/07.

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Inspected by ECOCERT SA F-32600
Product allowed for use in organic agriculture according to EC regulation 2018/848, 2021/1165 and the NOP.

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