GF-120*
Naturalyte* Fruit Fly Bait

Technical Bulletin

Dow AgroSciences™

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Overview

Medfly ovipositing on coffee bean
Courtesy of USDA-ARS

Tephritid fruit flies include some of the world's most destructive insect pests such as the Mediterranean fruit fly (Medfly, *Ceratitis capitata*), the Mexican fruit fly (Mexfly, *Anastrepha ludens*), the olive fruit fly (*Bactrocera oleae*), and the apple maggot (*Rhagoletis pomonella*). They frequently reach high numbers and can totally ruin the harvest of their preferred crops. They often build their populations on ornamentals, noncommercial crops, or abandoned commercial crops before migrating to cultivated crops, making their control more difficult. Microscopic eggs may also be laid in fruit nearing harvest. The presence of eggs is difficult to detect until after the consumer has purchased the fruit and they develop into larvae in the fruit. Consumers have a very low threshold for larvae or maggots in fruit and the shelf life of infested fruit is shortened. One of the biggest problems is that the flies are transported long distances as larvae in infested fruit that may be discarded in or near commercial crops where adult flies may emerge and infest new areas. Countries that are infested with many species of fruit flies are quarantined and fruit cannot be shipped to non-infested countries without expensive fumigation, radiation, cold, or heat treatments that can reduce fruit quality and shelf life. The inspection of fruit and tourists from infested areas is a major expense for governments. In some cases, such as melon fly (*Bactrocera cucurbitae*), eggs are laid in the young fruits, flowers, or even succulent stems, greatly decreasing or preventing any fruit production. The variety, quantity, and quality of fruit and vegetables available to the global economy is definitely suppressed by the presence of these pests.

A variety of methods have been used to control and even eradicate these flies from certain geographies. Initially, cover sprays of broadspectrum insecticides were used and these are still the main method of control in many areas. A targeted approach using olfactory attractants and bait sprays has also long been used in the detection, monitoring, and control of fruit flies (Jang and Light 1996). Bait sprays are an improvement over cover sprays in that they reduce the proportion of crop or land area treated and target only fruit flies. They are also compatible with additional control tactics such as sterile insect techniques (SIT) and biological control with parasitoids, sanitation, and cultural control. A benefit of adult insecticide sprays is that when adult flies are killed, damage to fruit is immediately reduced. Biological control and sterile insect technique usually require more time for their effects to reduce pest population and reduce pest damage. Historically, fruit fly baits have used food sources such as fermenting sugars (McPhail 1937) and proteins (Steiner 1952). The majority of baits have been prepared locally using various proteins as attractants that often varied over time. The toxicant, typically an organophosphate, was added to the bait during mixing, adding another variable. GF-120* Naturalyte* fruit fly bait is a prepackaged concentrated bait with a low application rate, and a reduced risk toxicant to both mammals and non-target insects. It provides improved consistency, attractiveness, and overall efficacy when compared to earlier bait-toxicant mixes. GF-120 is marketed as Success 0.02 CB in Guatemala and most Central American countries as GF-120* NF in the U.S. and additional trade names are being developed.

Composition and Origin

GF-120 was developed jointly by the USDA-ARS Fruit Quality and Fruit Insects Research Unit at Weslaco, Texas and Dow AgroSciences under a Cooperative Research and Development Agreement. Working together, Dow AgroSciences' formulation chemists and USDA scientists capitalized on initial fly bait work done at the USDA to develop optimized fruit fly bait. The optimized fruit fly bait uses commercially available ingredients subject to quality controls, stabilizers to improve shelf-life, and humectants and adjuvants to improve longevity and attractiveness of the bait once it is applied (Moreno and Mangan 2002). Plant proteins and sugars that are highly attractive and phagostimulating to many tephritid species comprise the bulk of the fruit fly bait. The toxicant in GF-120 is spinosad, a selective insect control product produced by the fermentation of a naturally occurring soil bacterium, *Saccharopolyspora spinosa*. Spinosad has an extremely favorable mammalian and environmental toxicity profile. Spinosad was registered as a reduced risk product by the US EPA in 1997 and it was the winner of the Presidential Green Chemistry Award in 1999. GF-120 provides a maximum of 80 ppm of spinosad in the final bait spray as compared to 200,000 ppm of malathion in other common bait mixtures. The combination of low use rates and low toxicity result in large margins of safety for GF-120. GF-120 NF is a slightly modified version of the original GF-120. GF-120 NF meets USDA National Organic Standards Board and the Organic Materials Research Institute (OMRI) guidelines for organic products.

Saccharopolyspora spinosa colony

Why is GF-120* Different from Earlier Baits?

Medfly feeding on bait
Courtesy of USDA-ARS

- All ingredients are included and optimized for attraction of multiple tephritid species.
- GF-120 is active for up to 10 days after application.
- GF-120 can be stored for up to 2 years without degradation.
- Industrial quality controls ensure consistent performance.
- No concentrated toxicants to handle, store, or mix.
- Spinosad is approved for organic production systems by USDA.
- GF-120 NF has been approved for organic production by OMRI.

Target Species

Dow AgroSciences is seeking registration for the following fruit fly species known to be attracted and controlled by GF-120*:

Common Name	Scientific Name
Apple maggot	*Rhagoletis pomonella*
Caribbean fruit fly	*Anastrepha suspensa*
Cherry fruit fly	*Rhagoletis cerasi*
Mediterranean fruit fly (Medfly)	*Ceratitis capitata*
Melon fly	*Bactrocera cucurbitae*
Mexican fruit fly (Mexfly)	*Anastrepha ludens*
Olive fruit fly	*Bactrocera oleae*
Oriental fruit fly	*Bactrocera dorsalis*
Queensland fruit fly	*Bactrocera tryoni*
South American fruit fly	*Anastrepha fraterculus*
Walnut husk fly	*Rhagoletis completa*

Target Crops

Spinosad formulations are registered in over 58 countries on up to 250 crops (U.S.) at rates ranging from 25 to 200 grams per hectare of active ingredient. GF-120 applications use only 0.19 to 0.38 grams per hectare (0.00017-0.00034 lbs/acre) of spinosad active. These extremely low rates are made possible because the flies are highly attracted and consume larger quantities of this gourmet fruit fly bait. The majority of GF-120 applications will target crops susceptible to fruit fly injury such as citrus, mangoes, apples, pears, peaches, and olives. However, it is often desirable to treat other crops and non-crop vegetation during fruit fly outbreaks. The goal will be to obtain labeling on as many crops as possible to enable fruit fly eradication and control programs. Check with your local Dow AgroSciences representative and government regulatory specialist to determine what is legal in your respective country.

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Properties and Use Patterns

GF-120* should be mixed with water at the ratio of 1 to 1.5- 5.0 of GF-120 to water and applied as an ultra low volume application. A typical use rate is 0.8 to 1.6 l/ha oz/acre of GF-120. Proper application techniques are needed to ensure adequate coverage and the correct dosage to obtain optimum control of the fruit flies. A large spray droplet size of 4000 to 6000 µm (4-6 mm) is recommended to optimize the length of time the bait droplet will be attractive. Fruit flies can detect the bait from several yards away, so complete coverage is less critical than with standard spray treatments.

Aerial Application	Ground Application	Ground Application
ULV	Small to Moderate-Sized Plants	Large Fruit Trees
• Coarse nozzles or open tubes to produce the majority of droplet 4-6 mm in size • 20-80 drops per meter^2	• Spot or strip sprays • Target inner canopy • Cover 1-2 meters^2	• Spot or strip sprays • Target middle to lower inner canopy • Cover 1-2 meters^2, 2 locations per tree

It is recommended to not dilute GF-120 more than the suggested guidelines or residual and attractiveness will be reduced. Coarse nozzles, low pressure, and pulse application are generally needed. Higher dilutions and smaller droplets will provide fly control in some situations, but the best performance is obtained from the larger concentrated droplets. Consult with local government and extension specialists and always follow the label for area specific recommendations. Avoid weather conditions that could result in drift to non-target areas. This product is susceptible to wash-off and will lose effectiveness if exposed to rainfall and overhead irrigation. Potential for rainfall and irrigation schedules should be considered as much as possible when planning applications. When applying by ground, target underneath leaves within the canopy or on the trunk of the plants to provide protection from wash-off. Large droplets of GF-120 will provide up to 10 days of control in ideal conditions. However, the length of control may be reduced in dusty or rainy conditions. GF-120 should be applied as soon as monitoring indicates fly presence. The damage to fruit is the direct result from oviposition of eggs and the subsequent larval development. Adult flies must be exposed to GF-120 before they complete the reproductive phase. GF-120 is most effective when applied for several weeks prior to fruit ripening, as this is when females are most aggressively feeding.

Preparing for helicopter application of GF-120 in Mexico

Helicopter application of GF-120 in Mexico

General Toxicity of GF-120

- Oral: not acutely toxic or hazardous (technical > 3738 mg/kg male rat and > 5000 mg/kg female rat)
- Dermal: not acutely toxic or hazardous (technical > 5000 mg/kg for rabbits)
- Inhalation: not acutely toxic or hazardous (technical LC_{50} is > 5.18 mg/L/4 hours)
- Honey Bees: not acutely toxic or hazardous (GF-120 acute contact > 100 µg/bee)

Osmia ribifloris, courtesy of USDA-ARS

Common Questions

Why is it not attractive and detrimental to honeybees?

GF-120* contains sugars. GF-120 emits volatile ammonia-like compounds that attract fruit flies but have been shown to repel honeybees (Tarshis Moreno 2001).

Will GF-120 replace the need for SIT programs?

No, SIT programs work best when populations of flies are low. GF-120 can be used to reduce population levels so SIT can be used for final eradication or a prophylactic treatment.

How well does GF-120 work on other species besides Medfly?

GF-120 has been demonstrated to be highly effective on most species in the laboratory and experimentally released sterile populations of several *Anastrepha* species including Mexican fruit fly and on pest populations of Medfly in the field. Bactrocera species are also responding very well to GF-120 programs in Greece, California, Hawaii, Mexico, and Australia. Additional confirmation is needed on other wild species in the field at the time of this summary.

Why do I have to use ultra low spray volumes?

The best thing about true baits is that they attract the insects and allow you to use very low levels of toxicant. The attractants and toxicant work best by keeping them concentrated. These low volume applications require some equipment changes and training, but they are much more cost effective in the end, allowing the applicator to cover larger areas more quickly.

Is GF-120 safe to plants?

GF-120 has been widely used and tested for phytotoxicity to plants and very little to no phytotoxicity has been observed or reported. Some cultivars of mangoes, figs, and peaches have had blemishes develop on the fruit directly where the droplets are and sooty mold has been observed to grow on the drops in rare instances. The low volume and targeted sprays result in only small areas being treated, reducing the concern for phytotoxicity. Another way to reduce the risk of plant injury is to use higher ratios of dilution. If there is a concern for plant safety, try a small test area before treating large numbers of plants.

Can fruit flies become resistant to spinosad?

It is possible, but fruit flies have not demonstrated a propensity for resistance development like other insects. GF-120, when applied as labeled, delivers a high dose followed by rapid degradation resulting in minimal selection pressure.

Ceratitis capitata,courtesy of USDA-ARS

Bactrocera cucurbitae, courtesy of USDA-ARS

Anastrepha ludens, courtesy of USDA-ARS

Saccharopolyspora spinosa

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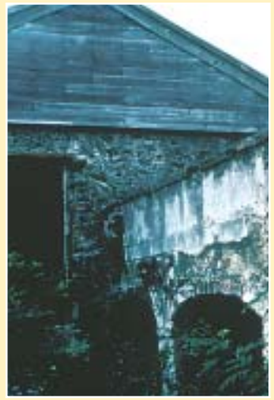
The Spinosad Story

During the late 1950's, companies including The Dow Chemical Company and Eli Lilly and Company began to actively look for naturally occurring pest control products. As a result of these efforts, a scientist from the Natural Products division of Eli Lilly while vacationing in the Caribbean in 1982 visited an abandoned rum still and collected several soil samples. These samples were returned to the laboratory to determine the presence of biological activity. Three years later the fermentation products from these samples were shown to have insecticidal activity. By 1986 Eli Lilly's scientists identified the organism producing the biologically active substances. They determined that this was a new species of actinomycete bacteria and named it *Saccharopolyspora spinosa*. Within one year, scientists had identified the most highly active metabolites of *S. spinosa*. In 1989, the Ag Products division of Eli Lilly, Elanco, was merged with The Dow Chemical Company to form DowElanco, now Dow AgroSciences.



Rum still where soil sample was collected

A highly effective formulation was identified and developed through five years of extensive testing around the world. This formulation contained a mixture of two of the most active metabolites, spinosyn A and spinosyn D. The name spinosad is derived by combining the species name, *spinosa*, with the two metabolites, A and D. In 1995, because of its favorable environmental and toxicological profile, spinosad was classified by the U.S. Environmental Protection Agency (EPA) as a reduced risk product and granted an accelerated registration review.

Today, spinosad is produced in a state-of-the-art fermentation facility in Harbor Beach, Michigan. *S. spinosa* colonies are grown using natural products such as soybean and cottonseed meal. Computers are used to control temperature, oxygen and nutrient levels to ensure maximum production of spinosyns A and D.

Spinosad fermentation vessels

Whole broth extraction units

Left and below: Harbor Beach spinosad fermentation facility

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Disclaimer

Cover Photo: *Ceratitis capitata,* courtesy of USDA-ARS

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