

# TIMOREX GOLD<sup>®</sup>

THE NEW GENERATION  
OF BIOFUNGICIDES

**stk**  
Stockton Group

The  
smart  
way  
to grow.

**Full Control of  
Black sigatoka**  
The New Generation  
of Biofungicides



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# INTRODUCTION

Timorex Gold® is a non-residue eco-friendly natural Biofungicide, with significant added values to humans and the environment.

Black sigatoka, leaf spot disease, is considered one of the most damaging and costly banana diseases caused by the *Mycosphaerella fijiensis* fungus. Banana plants damaged by Black sigatoka yield up to 50% less fruit, and control of the fungus accounts for up to 30% of total banana production costs worldwide.

Timorex Gold® is the new generation of biofungicides for the control of Black sigatoka. Timorex Gold® is a biofungicide based on a plant extract of the *Melaleuca alternifolia*, developed by Biomor, member of the Stockton Group. The natural components contained in Timorex Gold® offer multiple modes of action on fungal and bacterial cells, representing the unique fungicidal capabilities of *Melaleuca alternifolia*, bringing with it a new concept and dimension for a highly effective and sustainable control of black Sigatoka in banana and plantain.

Timorex Gold® exhibits superb prophylactic and extremely strong curative efficacy against Black sigatoka, with exceptional performance in the most intense disease pressure conditions. Timorex Gold® addresses the banana growers' requirements for efficacy, ease of use, and cost.

Timorex Gold® non residual features reduces the conventional chemical load in banana plantations caused by the intensive use of synthetic fungicides.

Timorex Gold®, with its powerful disease control capabilities promises higher yield and growth enhancement. Timorex Gold® guarantees crop production quality, such as higher number of leaves produced, higher number of leaves at harvest and increased yield.

Timorex Gold® is an eco-friendly non-residual fungicide, harmless to beneficial insects and bees, that offers human and environment safety. Timorex Gold® provides

the banana industry a unique opportunity of a safe, better and more efficient control of Black sigatoka.

Timorex Gold® is a leading product for effective Resistance Management and is widely adopted for large-scale use in the leading banana-growing countries using conventional, and organic farming.

Timorex Gold®, developed by the Stockton group, exhibits the group's 35 years of knowledge and experience in the crop protection industry by introducing the new generation of scientifically proven advanced products.

Stockton comprehensive range of expertly products and solutions ensures exceptional performance, reliability, and quality assurance standards to satisfy the evolving needs of farmers and crops, season after season worldwide.

The Stockton Group maintains global presence with a unique and highly integrated network of companies and representatives in over 30 countries. All, dedicated to delivering Stockton's hallmark combination of product excellence, applications expertise and warring, always-extrordinary customer support.

We, the "Stocktoners" , are committed to support the people we serve with the smart way to grow.

**Timorex Gold®, a proprietary multi-component natural biofungicide of the Stockton group, is covered by worldwide patents and patent applications.**

# EXECUTIVE SUMMARY

## 2.1

### Timorex Gold® benefits

- Strong prophylactic and curative activity
- Increases leaf production and yield parameters
- An effective Resistance Management Tool
- Can be applied year round without inducing fungi resistance
- Leaves no residues
- No PHI (Pre Harvest Interval) limitations
- No re-entry limitations
- Harmless to beneficial insects and bees
- Environmentally safe
- Zero toxic load
- Certified by leading organic associations
- Can be used in conventional and organic agriculture

## 2.2

### Biological profile of Timorex Gold®

Suppressive	Eliminates the colonies of <i>Mycosphaerella fijiensis</i>
Curative	Inhibits the growth and progression of lesions caused by <i>Mycosphaerella fijiensis</i>
Preventive	Prevents the germination of spores of <i>Mycosphaerella fijiensis</i>

### 2.3 Timorex Gold® is registered in the following banana growing countries:

Argentina · Guatemala · Nicaragua · Belize · Honduras  
 The Philippines · Colombia · India · Republican Dominican  
 Israel · Costa Rica · Panama · Ecuador · Mexico.

More Control  
 More Sustainability  
 More Profit



# CHEMISTRY



## 3.1 Active ingredient

Product	Plant extract from the <i>Melaleuca alternifolia</i>
Other names	Melaleuca oil, Oil of <i>Melaleuca alternifolia</i> (terpinene-4-ol type)
Chemical Class	Terpene hydrocarbones and Terpene alcohols
CAS No.	68647-73-4

## 3.2 Physico-chemical properties

Physical state	Liquid
Color	Light brown-yellow
Odor	Characteristic
pH (1% in water)	9
Density at 20° C	0.935 gr/ml
Solubility in water	Miscible
Flash Point	39° C

### 3.3 Preparation of working liquid

- Timorex Gold® is an Emulsifiable Concentrate (EC) formulation.
- Timorex Gold® in banana should be applied with mineral oil, surfactants, and water (**application recommendation in accordance to country-specific label**).
- Timorex Gold® spraying solution should be prepared in the following order: Mix the mineral oil with the surfactants for several minutes at medium–high speed (1000–1500 rpm). Slowly add water (at room temperature) and mix for several more minutes. Add recommended amount of Timorex Gold® and mix for 15 minutes. If you chose to add an adjuvant requiring pre-dilution with water, perform the dilution procedure separately and add that solution as a final ingredient.
- Environmental friendly & low Hydrophilic-Lipophilic Balance (HLB) value surfactants are preferable due to the less foaming and better stability properties.
- Timorex Gold® has an alkaline pH. Its efficacy may be affected if acidifying agents are added directly to the mixture.
- The efficacy of Timorex Gold® is not affected by water hardness (the presence of magnesium, calcium, or carbonate ions in the water). There is no need to add softening agents.



The Timorex Gold® formulation, developed expressly for the climatic conditions of the banana-growing regions, offers long-term stability. Its tailor-made formulation exhibits powerful environment-friendly & reliable Black sigatoka control.

# PRODUCT SAFETY INFORMATION



## 4.1 General

Workers' safety is one of the main factors taken into consideration when developing Timorex Gold® for the banana-production industry.

- Timorex Gold® is completely harmless to banana plantation workers.
- Timorex Gold® leaves no residue in the soil, water, or air. Its safety to the environment has been demonstrated in numerous studies conducted by leading international laboratories.
- Timorex Gold® allows for the re-establishment of populations of beneficial organisms in the plantation.

## 4.2 Active ingredient

The active ingredient of Timorex Gold® is based on a plant extract, *Melaleuca alternifolia*, obtained by steam distillation.

- *Melaleuca alternifolia* extract is classified as a low-risk substance in Europe, for which Maximum Residue Limits (MRL) are not required. The extract is in the USDA list of plant additives
- The active substance in Timorex Gold® was approved by the European Union and included in the positive list of the EU, in Annex I of Directive 91/414/EEC for the registration of pesticides.

## 4.3 Human safety

Timorex Gold® is a low toxic substance that is safe for the use by the public.

Toxicological information:

LD <sub>50</sub> , oral, rats	> 3000 mg/kg
LD <sub>50</sub> , dermal, rats	> 4000 mg/kg
LC <sub>50</sub> , inhalation, rats	> 5.4 mg/l/4h

*Melaleuca alternifolia* extract is dissipated rapidly in all biological and environmental compartments.

## 4.4 Environmental safety

The *Melaleuca alternifolia* extract's compounds leaves no residues in soil, water and air.

### 4.4.1 Effect on non-target organisms

- Timorex Gold® is non-toxic to bees and birds.
- Timorex Gold® is non-toxic to beneficial arthropods, including predatory mites, predatory bugs, and parasitic wasps.
- Timorex Gold® is readily bio-degradable in water. However, it causes some acute toxic effects to aquatic organisms but it does not cause long-term adverse effects.

## 4.5 Storage

Timorex Gold® is stable for two years if stored in its original container.

It is recommended to keep the container tightly closed in a dry, cool, and well-ventilated place. Avoid direct sun light, keep from freezing, keep at a distance from heat and flammable sources, and keep out of children's reach.

#### 4.6 5 Timorex Gold® in organic banana plantations

Timorex Gold® is considered a product allowed for use also in organic agriculture according to the requirements of European Union, NOP & JAS and is certified by the following entities:



**Timorex Gold® is the most effective fungicide used in organic.**

# BIOLOGY – MODE OF ACTION



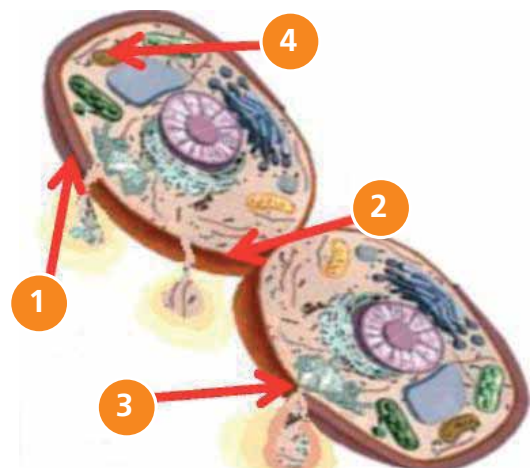
## 5.1 Multiple modes of action of *Melaleuca alternifolia*

The scientists at Stockton Group discovered the unique and powerful properties of this natural plant extract of the for plant disease control in agricultural crops. It was found to be effective against a broad spectrum of diseases in vegetables, bananas, plantains, fruit trees, and grapevines.

The natural multi components contained in *Melaleuca alternifolia* offer multiple modes of action on fungal and bacterial cells.

The fungicide and antimicrobial activity of *Melaleuca alternifolia* extract against fungal pathogens is a consequence of their ability to alter the permeability barrier of the membrane structures of living organisms in multiple modes of action:

1. Destroy cellular integrity
2. Increase membrane permeability in cell structures
3. Lead to loss of cytoplasm
4. Inhibit respiration and ion transport processes



\* Performed in yeast cells

## 5.2 Anti-fungal activity of Timorex Gold® against Black sigatoka

Timorex Gold® is a natural and environmental friendly biofungicide highly effective, protecting against *Mycosphaerella fijiensis* which causes Black sigatoka in banana.

### 5.2.1 Spore germination inhibition

In vitro studies revealed that Timorex Gold® effectively inhibits the germination of ascospores of *Mycosphaerella fijiensis* (Fig. 1). Results demonstrated that Timorex Gold® is also effective on conidia.

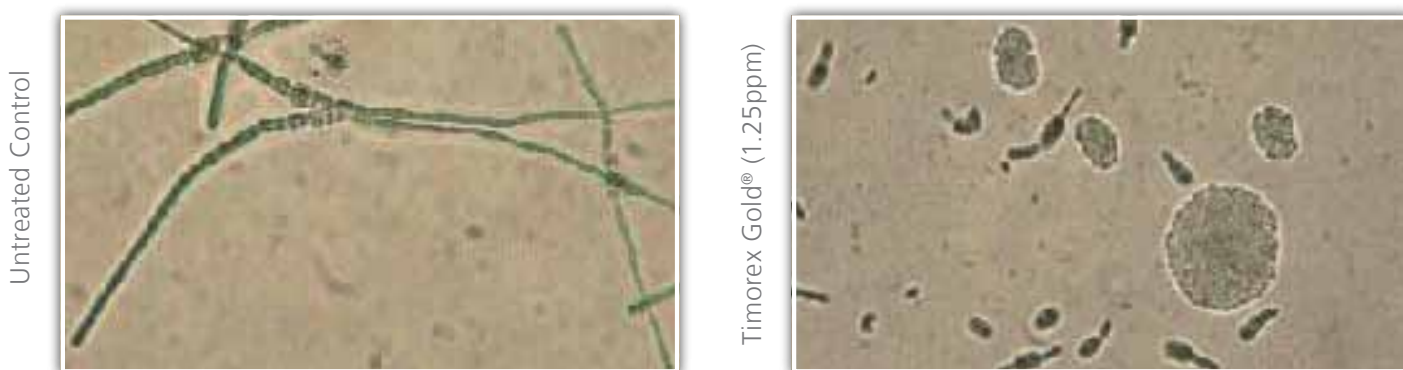


Fig.1 In vitro germination inhibition of ascospores of *Mycosphaerella fijiensis* with Timorex Gold®

### 5.2.2 Lesion development and expansion inhibition

Timorex Gold® has a prophylactic activity, as well as, outstanding inhibition of lesion expansion.

A Single Leaf Test (SLT) showed that Timorex Gold® inhibits the appearance of symptoms on leaf tissue following a single foliar application, as compared to what is observed in leaf tissue treated with dithiocarbamate (Mancozeb) treated or the untreated control.

Twenty-five days were needed for the appearance of the first early gray stage lesion, while only ten days were needed for the appearance on of the untreated leaves. This effect of Timorex Gold® was consistent for all Black sigatoka-type lesions until senescence (Fig. 2).

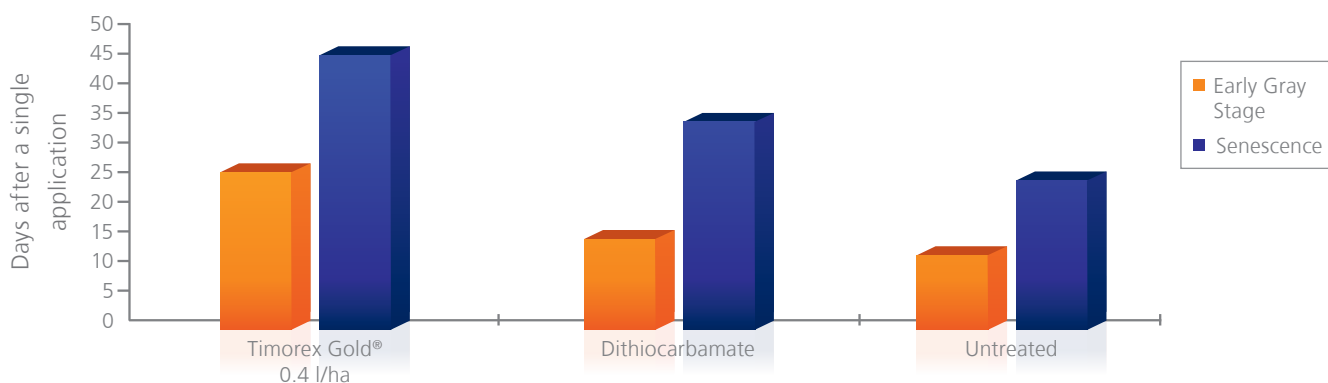


Fig.2 Effect of Timorex Gold® on development of Black sigatoka lesions, as determined by a Single Leaf Test (SLT), Philippines, 2009



### 5.2.3 Curative activity

A series of trials involving various large-scale and semi-commercial demonstration trials proved that **Timorex Gold®** has outstanding curative activity against **Black sigatoka**, as indicated in developmental stages (DS) 1 to 4 (Fig. 3).

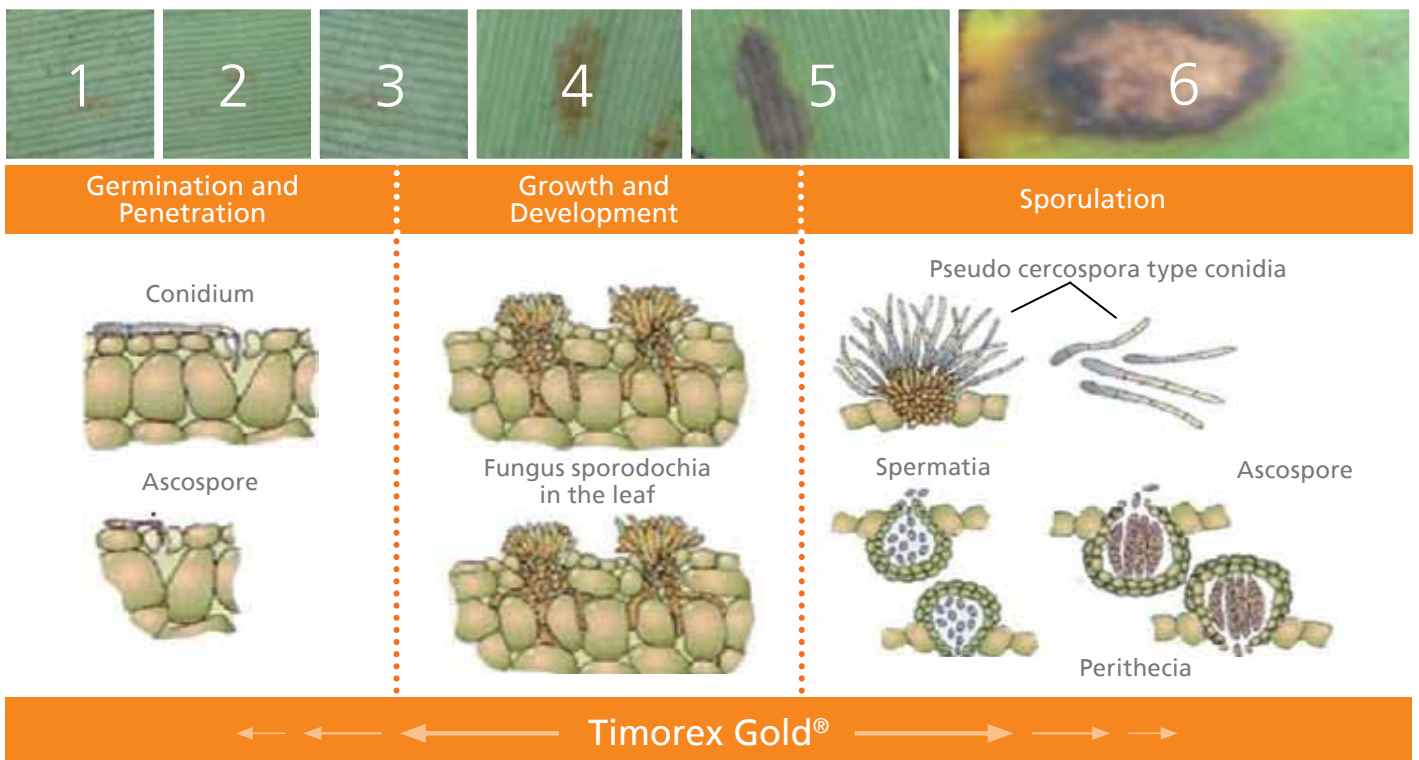


Fig.3 Developmental stages of Black sigatoka on banana leaves

Unlike chemical fungicides, which can either prevent or inhibit Black sigatoka only at stages 1 and 2, **Timorex Gold® controls Black sigatoka in stages 1, 2, 3, and 4**. Treatments with Timorex Gold® demonstrated that lesions treated with Timorex Gold® at stages 2–4 became dark brown and had no further expansion even 57 days after application (Figs. 4 a, b).

Timorex Gold® penetrates the plant tissue through the waxy layers to the mesophyll of the banana leaves. This enables the prevention and/or cure of the Black sigatoka development through contact with fungi that may be developing within the leaf's structure. The exceptional curative activity of Timorex Gold® makes it a unique fungicide and opens a new dimension in disease control that will enable growers to use it even when the disease is already visible on the banana leaves.

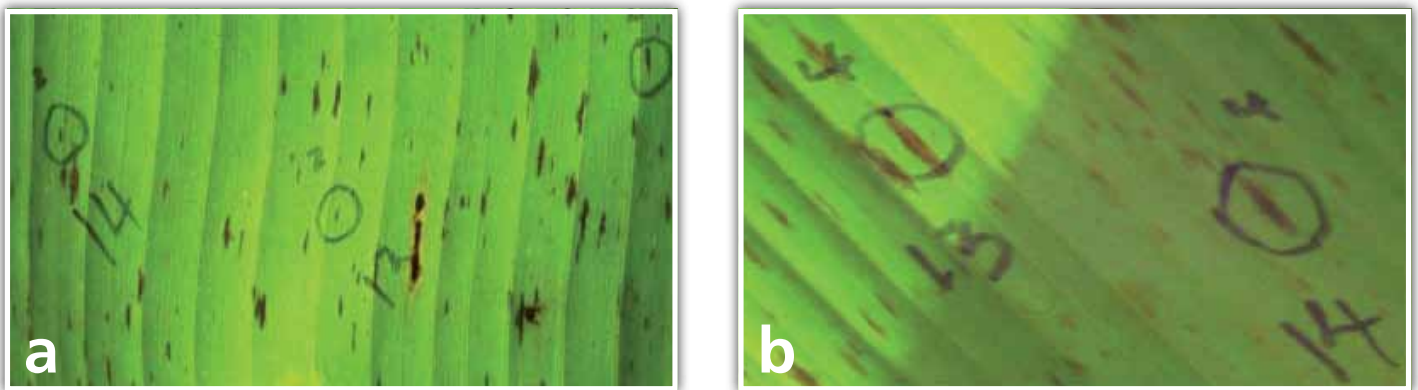


Fig. 4 Banana leaves treated with Timorex Gold® (0.5 l/ha + 7 L mineral oil) 57 days after treatment, Stages 2 - 4

#### 5.2.4 Summary

The anti-fungal activity of Timorex Gold® against *Mycosphaerella fijiensis* causing Black sigatoka (BLS) on banana is indicated by its inhibition of:

- Spore germination (conidia and ascospores)
- Mycelial growth
- Lesion development and expansion



Timorex Gold® has strong curative activity

# FIELD PERFORMANCE

## 6.1 Experimental field trials

Trials with Timorex Gold® against Black sigatoka were conducted in Ecuador, Costa Rica, Guatemala, Colombia, Mexico and the Philippines.



**CONTROL**



**TIMOREX GOLD®**

*Fig. 6 Control of Black sigatoka in banana treated by Timorex Gold®*

### 6.1.1 Control of Black sigatoka in Ecuador by Timorex Gold®

This trial was conducted on young banana plants (8 weeks old) in conventional management. Plants were arranged in randomized complete block design and underwent 4 replications/treatments. Four consecutive foliar sprays of either Timorex Gold® or systemic fungicides were applied at 14-day intervals. Disease was assessed on a weekly basis by counting the number of lesions on each leaf of each plant at each developmental stage of Black sigatoka.

Results clearly show that Timorex Gold® was as effective as difenoconazole and azoxystrobin in controlling Black sigatoka and significantly different from the non-treated control plants (*Figs. 6 a–e and 7*). All fungicides provided an excellent control and inhibited the development of lesions on all tested leaves at each of stages 2–6.

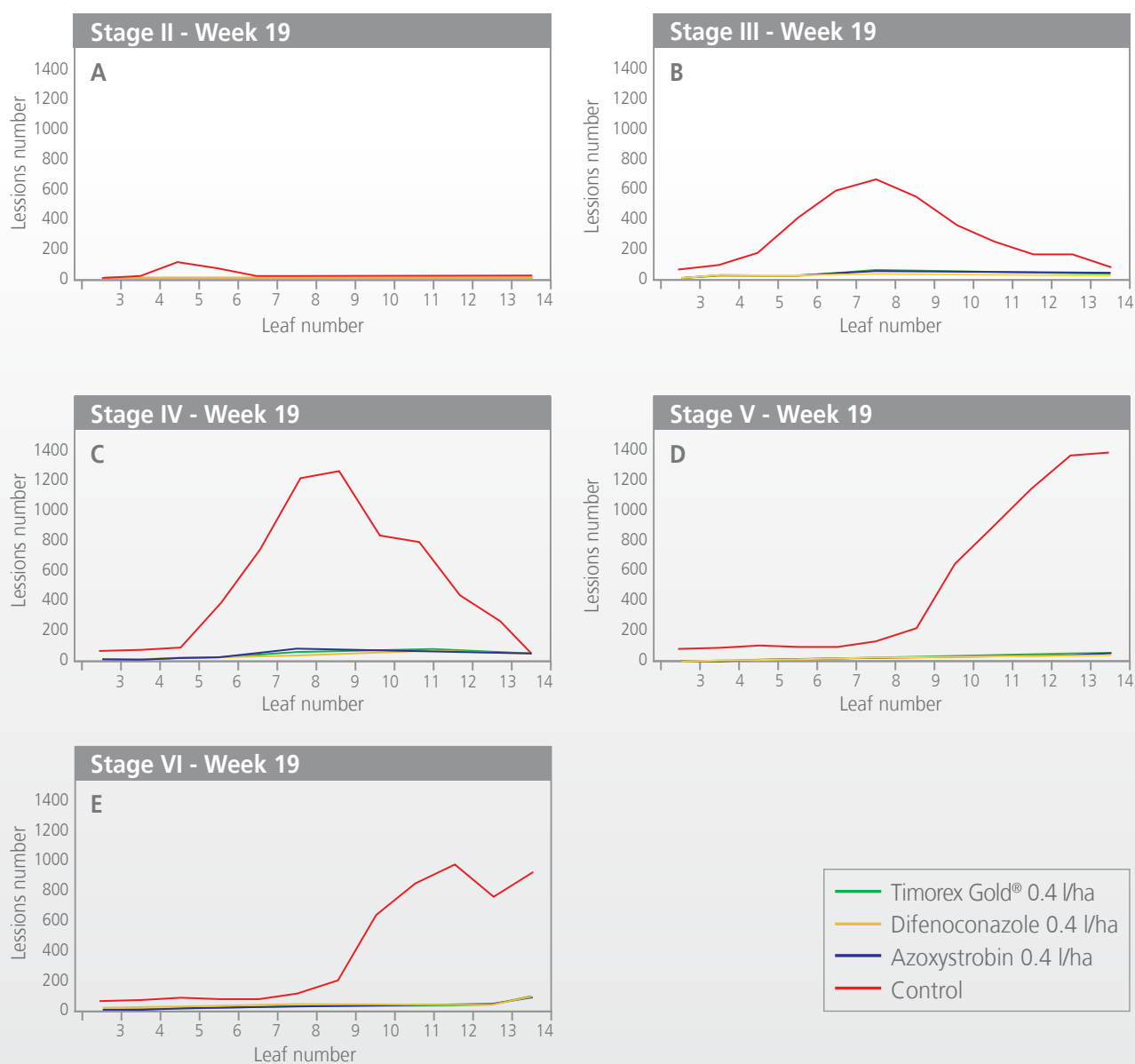


Fig. 7 a-e Effect of Timorex Gold® and systemic fungicides on control of Black sigatoka in banana (Ecuador, 2009)

## SUPPRESSIVE

Eliminates pathogenic fungi colonies

## CURATIVE

Inhibits the growth and progression of lesions

## PREVENTIVE

Prevents the germination of spores

### 6.1.2 Control of Black sigatoka in Costa Rica by Timorex Gold®

A similar trial was conducted in Costa Rica in 2007 and included 5 replications per treatment. Thirteen consecutive foliar sprays from 13.4.07 (week 14) to 18.6.07 (week 25) were applied. Timorex Gold® was similarly effective to tridemorph in controlling Black sigatoka, producing up to two leaves more than the non-treated control plants (Fig. 8)

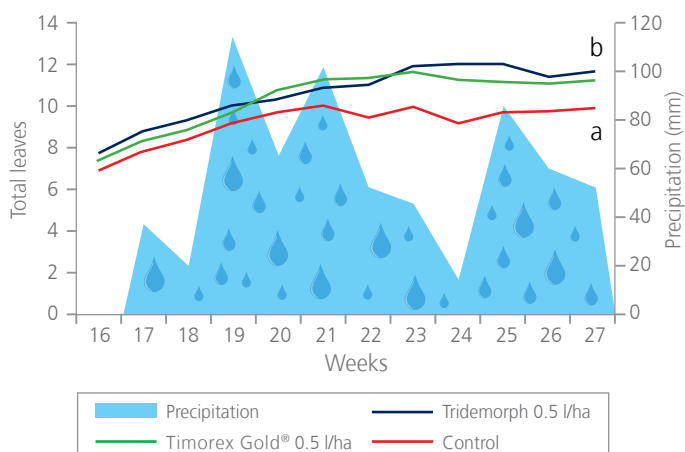


Fig. 8 Effect of Timorex Gold® and tridemorph on the control of Black sigatoka in banana (Costa Rica, 2007)

### 6.1.3 Control of Black sigatoka in Guatemala by Timorex Gold®

A similar trial conducted in Guatemala in 2009 revealed similar results, in which Timorex Gold® at 0.4 l/ha was as effective as difenoconazole and trifloxystrobin. Timorex Gold® and systemic fungicides provided significant disease control in comparison to non-treated control plants, as indicated by an increase in the number of "youngest leaves spotted" that was observed (Fig. 9).

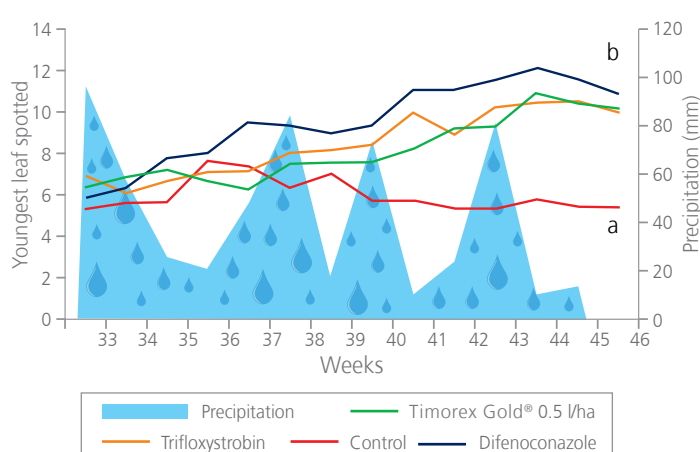


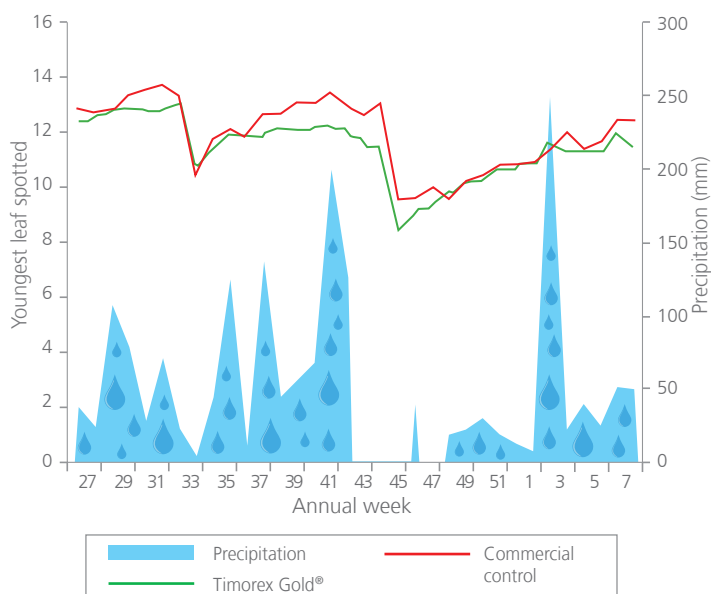
Fig. 9 Effect of Timorex Gold® and systemic fungicides on the control of Black sigatoka in banana (Guatemala, 2009)

## 6.2 Evaluation of Timorex Gold® in large scale commercial observations

Semi-commercial trials were conducted in Belize and Costa Rica, in which Timorex Gold® was used in consecutive applications or alternated with fungicides compared to the conventional commercial programs.

### 6.2.1 Belize Trial

Starting from week 27 of 2008 to week 8 of 2009, altogether more than 230 days, 32 consecutive foliar sprays of Timorex Gold® were applied to a commercial area of 134 hectares. A control commercial treatment included protectant and systemic fungicides applied in parallel dates to the treatment with Timorex Gold®. Timorex Gold® treated areas demonstrated efficacy equivalent to the control commercial treatments, as indicated by analyzing the youngest leaf spotted (Fig. 10).



**Fig. 10** Effect of Timorex Gold® on the control of Black sigatoka in a commercial area of 134 hectares (Belize, 2008-2009)



### 6.3 Effects of Timorex Gold® on leaf production, yield, and growth enhancement

Timorex Gold® treated 32 consecutive times in a commercial area of 134 hectares in Belize, surpassed the commercial practice by one additional functional leaf at harvest (Fig 11).

Vargas et al. (2009)<sup>1</sup> found that one additional functional leaf at harvest increased the yield of the banana plantation by 1 kg/bunch.

Hence increased the yield of the banana plantation by 1,700 kg/ha, meaning additional 81 banana boxes/ha.

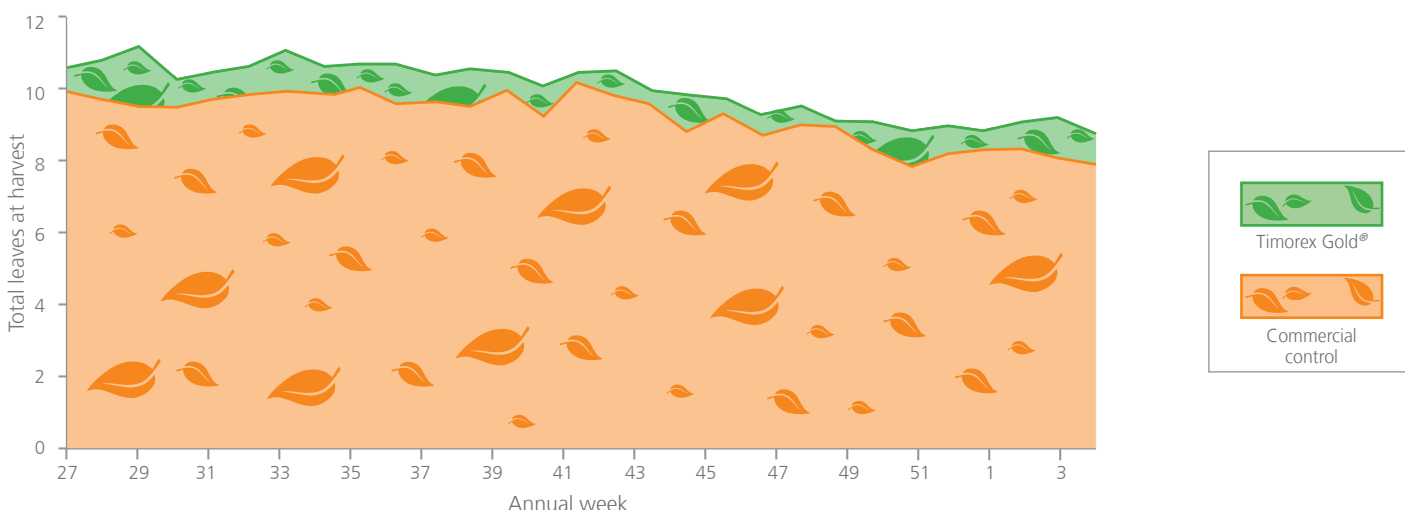


Fig. 11 Effect of Timorex Gold® on leaf production in a commercial area of 134 hectares (Belize, 2008-2009)

Plots treated with Timorex Gold® require less sanitary defoliation; the leaves reach the lower positions in a much healthier condition in comparison to those in which only chemical fungicides were used.

The larger number of green leaves resulted in heavier bunches (up to 7% more), with a greater number of hands (up to 15% more), a larger diameter in the apical hand (up to 10% more), and a larger basal diameter (up to 14% more) (Fig. 12 and Table 1).



Fig. 12 Average bunch characteristics of banana

	Program	
	Timorex Gold®	Standard chemical treatment (control)
<b>Average weight (kg)</b>	22.6	21.0
<b>Number of hands</b>	6.7	6.3
<b>Basal Grade</b>	11.2	9.6
<b>Apical Grade</b>	8.5	7.7

Tabla 1 Effect on yield and average bunch characteristics (out of 100 bunches in each program) harvest week 11 (2009)

<sup>1</sup> Vargas A., Araya M., Guzman M., Murillo G. 2009. Effect of leaf pruning at flower emergence of banana plants (Musa AAA) on fruit yield and Black sigatoka (Mycosphaerella fijiensis) disease. International Journal of Pest Management. 55(1):19-25.



# THE IMPORTANCE OF TIMOREX GOLD<sup>®</sup> IN RESISTANCE RISK MANAGEMENT

## Timorex Gold<sup>®</sup> showed no indication of resistance and/or loss of sensitivity inducement of the fungus

The plant extract of *Melaleuca alternifolia*, a multi-component compound, has multi-site functional activity and very low or no probability for developing resistance or cross-resistance in plant pathogens in general and especially in *Mycosphaerella fijiensis*.

Therefore Timorex Gold<sup>®</sup> is an essential tool to be included in a spray program to avoid-cross-resistance during the season.

To determine the sensitivity of *Mycosphaerella fijiensis* to Timorex Gold<sup>®</sup>, a study was conducted comparing the "wild" population of a plantation in Belize and the population of a plot treated with Timorex Gold<sup>®</sup> for 32 consecutive weeks (Fig. 13).

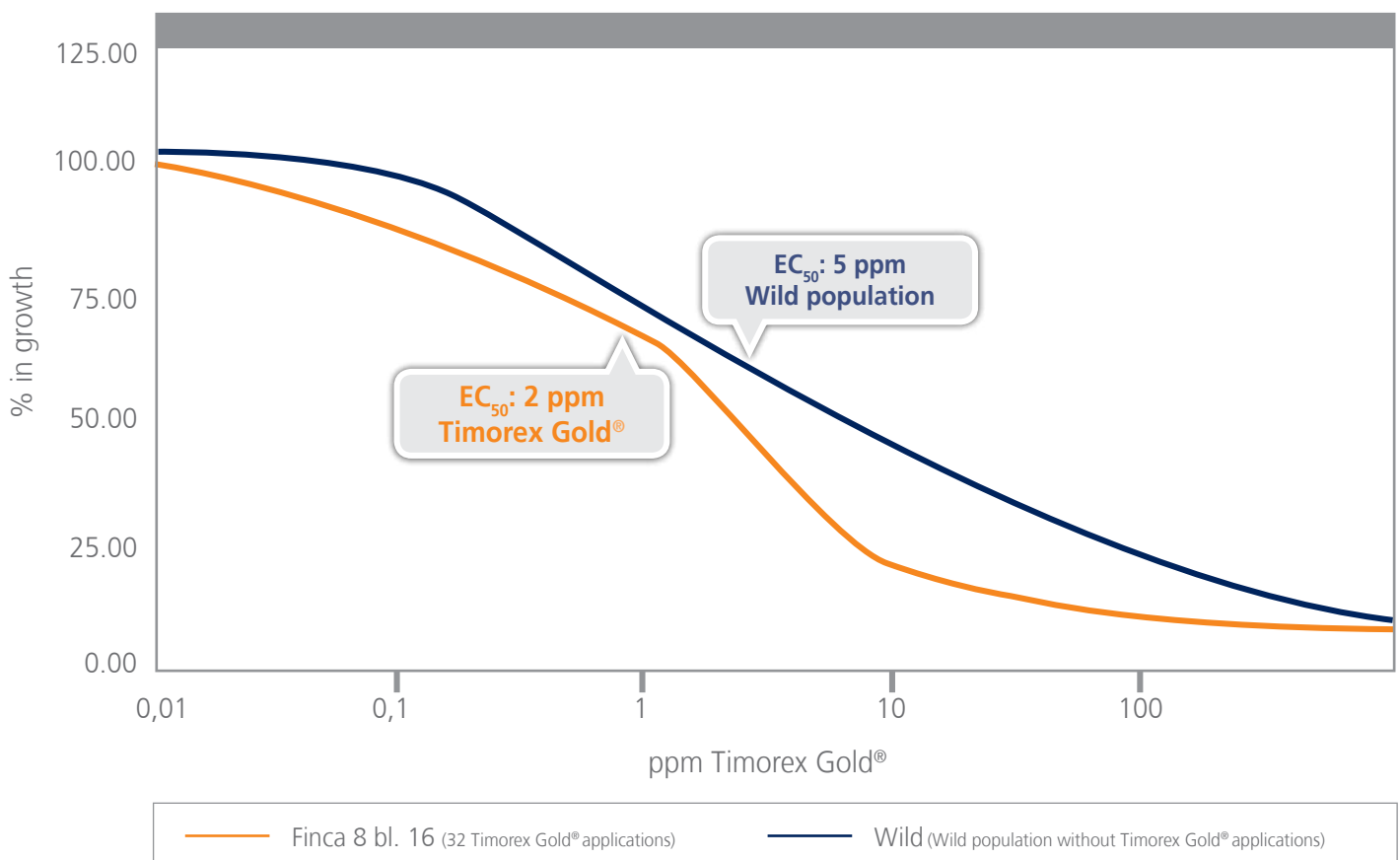
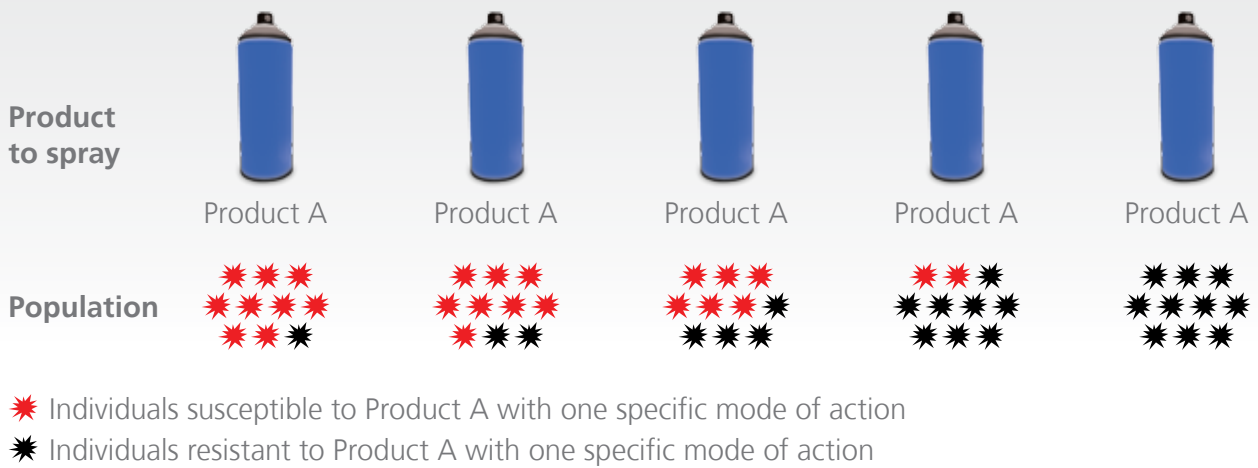


Fig. 13 Sensitivity of *Mycosphaerella fijiensis* isolates in "wild" and Timorex Gold<sup>®</sup> treated plots (Belize, 2008-2009).

This study strongly suggests that Timorex Gold® can be one of the most effective alternatives for the appropriate management of resistance and/or loss of sensitivity of Black sigatoka fungus. Timorex Gold® can be rotated in applications with products to which *Mycosphaerella fijiensis* populations have shown a loss of sensitivity. In this way, the population of individuals less sensitive to benzimidazoles, strobilurins, and/or triazoles can be reduced.

### IMPROPER POPULATION MANAGEMENT



Initially, individuals not resistant and/or susceptible to Product "A" are eliminated, but the resistant and/or non-sensitive individuals are not, as the consecutive applications of Product "A" exert a selective pressure on the population, eliminating the non-resistant and/or sensitive individuals. Therefore, the resistant individuals multiply exponentially until the initial level of the population is reached. At that point, resistance to Product "A" is complete and the product is no longer effective in controlling the fungus.

### PROPER POPULATION MANAGEMENT



Initially, the resistant and/or not sensitive individuals that escaped Product "A" are eliminated by the application of Timorex Gold, but there is always a possibility of escape of individuals resistant to Product "A". Therefore, by alternating with another Product "B" besides Timorex Gold, stabilization of the population can be achieved in a given time.

# APPLICATION EQUIPMENT AND RECOMMENDATIONS FOR USE



## 9.1 Land applications

The land application of Timorex Gold® spraying can be implemented with manual or truck-mounted/tractor-pulled mechanized ground application equipment, with customized blowers and nozzles. Use of 30 li to 80 li (mechanized) and 120 to 200 li (manual) of total solution (oil + emulsifier + Timorex Gold® + water) per hectare is recommended. Recommended dose of Timorex Gold® is 0.40 to 0.50 liter per hectare. Appropriate mixing procedures for oil emulsion should be followed.

## 9.2 Aerial applications

Timorex Gold® can be applied by airplane or helicopter and can be sprayed with conventional nozzles or micronairs at a constant hydraulic pressure. The dose of Timorex Gold® may vary from 0.4 to 0.5 liters per hectare, depending on the disease pressure.



## 9.3 Ultra Low Volume (ULV) Application

The aerial application of Timorex Gold® with Ultra Low Volume equipment is currently being developed. The Brazilian Bioaeronautic Center, in collaboration with Stockton, is developing the use of rotary disc atomizers (ARD, Atomizador Rotativo de Disco in Portuguese) in the banana-growing areas in the world.

Before using this product read and carefully observe directions, cautionary statements and other information appearing on the product label.

# ABOUT US

**THE STOCKTON GROUP** provides its customers with knowledge, expertise and experience acquired over 45 years of best practice performance in the crop protection industry. Stockton currently operates in more than 35 countries worldwide, holding over 320 product registrations of branded herbicides, fungicides and insecticides. Through **stx BIOMOR**, the Stockton Group's research and development innovation center in Israel, we manifest our commitment to meet the challenges of modern sustainable agriculture. Our global team includes leading agronomists, phytopathologists, entomologists, chemical engineers – all developing our proprietary new generation biopesticides which are incorporated into our global registration and commercial operation.

## OUR GOALS

**The Stockton Group** develops, supports and distributes new generation integrated eco-friendly practices for the challenges of modern agriculture.

We provide our diverse group of customers worldwide with smart, innovative, high quality crop protection products and services, creating a profitable and sustainable business for them.

## OUR VALUES

### Leading Innovation

We create and develop new generation crop protection solutions based on multi-pronged technologies that cater to the global needs of enhanced productivity, better and safer disease control and cost effectiveness for modern agriculture.

### Science

We combine a multi-disciplinary scientific approach with our leading edge laboratories and our professional researchers to scientifically ensure sustainable and novel ecological crop management practices.

### Responsibility

We monitor and ensure our support of legal and ethical standards and international norms, out of our commitment to sustain the environment, preserve natural resources, and support the livelihood of farmers and rural populations in the diverse market place we serve.

### Partnership

Our expertise and innovative capabilities make us a valuable partner to our customers. We provide our customers with technical support while building partnerships based on integrity and honesty, and recognizing their need to profit.

### Agility

We integrate our global operation, leading innovations and our fully-automated supply-chain system into an efficient, fast and flexible local response to the ever changing agricultural market.

# GLOBAL PRESENCE

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