BASF
We create chemistry

Pheromone

Worldwide Technical Brochure

contents

Introduction

Pheromones take a radically different approach to insect control. Rather than interfere with the target insects' biochemistry, they disrupt the insects' behavior. Pheromones make it very difficult for the male insect to locate female insects for mating, thus limiting the opportunity for larvae to inhabit and destroy crops. This approach to pest control is commonly known as mating disruption.

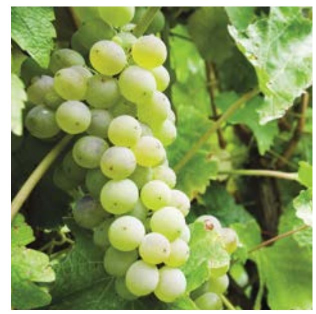
Pheromones are an optimal tool for both pest management and resistance management programs. Pheromones are applied using dispensers that time-release the product to form a pheromone cloud. The cloud is non-toxic and leaves zero-residue, making it ideal for integrated pest management as well as organic crop production. Since sex pheromones are essential to the insect mating process, the likelihood that an insect would develop resistance is unlikely.

Pheromones are species-specific and therefore have no significant acute toxicity to humans, beneficial insects or other non-target species. Pheromones provide highly specific control of economically important *Lepidoptera* (moth) species that infest pome fruits, grapes and stone fruits.

Key Features and Benefits of Pheromones:

- Novel behavioral activity
  - Ideal for integrated pest management programs and resistance management programs
  - Reduces insecticide resistance
- Zero-residue products
  - Ideal for organic crop production
- Excellent toxicological and environmental profile
  - Highly species-specific, with no significant acute toxicity to humans
  - Research indicates that beneficial insects and other non-target species are not adversely affected

BASF pheromones are registered for use in fruit production in Argentina, Brazil, Chile, the European Union, South Africa and the USA.



above:
Pheromones protect pome fruit, grapes and stone fruit from the damaging effects of multiple moth species.

physical and chemical properties

Product Brands: RAK® 1, RAK® 1 Neu, RAK® 1 Plus

Common Name	Z9-12Ac
CAS Number	16974-11-1
IUPAC Name	(Z)-9-Dodecenyl acetate
Empirical Formula	$C_{14}H_{26}O_2$

Common Name	E9-12Ac
CAS Number	35148-19-7
IUPAC Name	(E,Z)-9-Dodecenyl acetate
Empirical Formula	$C_{14}H_{26}O_2$

Product Brands: RAK® 2, RAK® 2 Plus, RAK® 2 Extra, RAK® 2 Pro

Common Name	E7,Z9-12Ac
CAS Number	54364-62-4
IUPAC Name	(E,Z)-7,9-Dodecadienyl acetate
Empirical Formula	$C_{14}H_{24}O_2$

Common Name	E7,E9-12Ac
CAS Number	54364-63-5
IUPAC Name	(E,E)-7,9-Dodecadienyl acetate
Empirical Formula	$C_{14}H_{24}O_2$

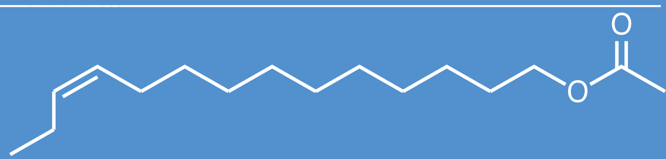
Product Brands:
RAK® 3, RAK® 3 Plus, RAK® 3 Neu, RAK® 400, RAK® 275

Common Name	E8E10-12OH
CAS Number	33956-49-9
IUPAC Name	(E,E)-8,10-Dodecadien-1-ol
Empirical Formula	$C_{12}H_{22}O$

physical and chemical properties

Product Brands: RAK® 4

Common Name	Z11-14Ac
CAS Number	20711-10-8
IUPAC Name	(Z)-11-Tetradecenylacetate
Empirical Formula	$C_{16}H_{30}O_2$



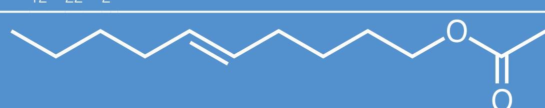
Product Brands: RAK® 5

Common Name	E8-12Ac
CAS Number	38363-29-0
IUPAC Name	(E)-8-Dodecenyl acetate
Empirical Formula	$C_{14}H_{26}O_2$

Common Name	Z8-12Ac
CAS Number	28079-04-1
IUPAC Name	(Z)-8-Dodecenyl acetate
Empirical Formula	$C_{14}H_{26}O_2$

Product Brands: RAK® 6

Common Name	E5-10Ac
CAS Number	38421-90-8
IUPAC Name	(E)-5-Decen-1-yl acetate
Empirical Formula	$C_{12}H_{22}O_2$



Common Name	E5-10OH
CAS Number	56578-18-8
IUPAC Name	(E)-5-Decen-1-ol
Empirical Formula	$C_{10}H_{20}O$

top:
Grape pheromone dispenser

above:
Orchard pheromone dispenser

Pheromone Formulations and Use

BASF pheromones come in ready-to-use, pre-filled dispensers. These dispensers do not need to be activated or opened, which means better worker safety and efficiency.

Each dispenser is comprised of two chambers. The volatile pheromone molecules passively disperse through the membrane of the chambers. One or both chambers of the dispenser may contain pheromones, depending on whether one or two pest insects are targeted. For instance, to manage the grape pests *Eupoecilia* and *Lobesia*, one chamber is filled with RAK® 1 and the other is filled with RAK® 2.

An integrated hook is molded into the dispensers. The design of the hook enables one worker to hang roughly 500 dispensers per hour. With an intended usage of 500 dispensers/hectare, one worker should be able to treat 1 hectare/hour (2.5 acres/hour).

The dispensers should be hung from the branches of fruit trees or grape vines at regular distances throughout the cultivation area, just before the flight of the first generation of moths.

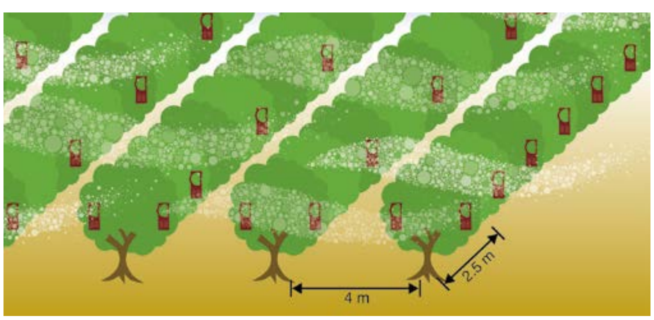
Pheromones can be used in combination with insecticide treatments as part of an integrated pest management program or as a stand-alone treatment.

Application

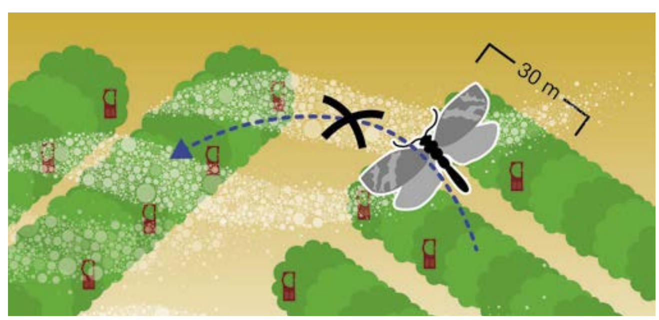
Pheromone treatment is most appropriate and efficient in bigger fruit cultivation areas, since homogenous pheromone clouds can be maintained there.

In order to stop copulated females from flying in from neighboring fields, intensive edge treatment may be necessary. In order to ensure treatment efficacy on closed cultivated areas, 30 meters of the neighboring surfaces should be treated with pheromones.

Pheromone concentrations can be compromised where trees vary dramatically in height or across an expanse of unlevel ground. In these situations a more dense alignment of dispensers should be applied.



above:
Intensive edge treatment may be necessary depending on the size of the cultivated area, tree height, or change in ground levels.



above:
When a treated area is growing near an untreated area, it may be necessary to treat neighboring surfaces as well.

top left:

Treated vineyards are protected with a pheromone cloud.

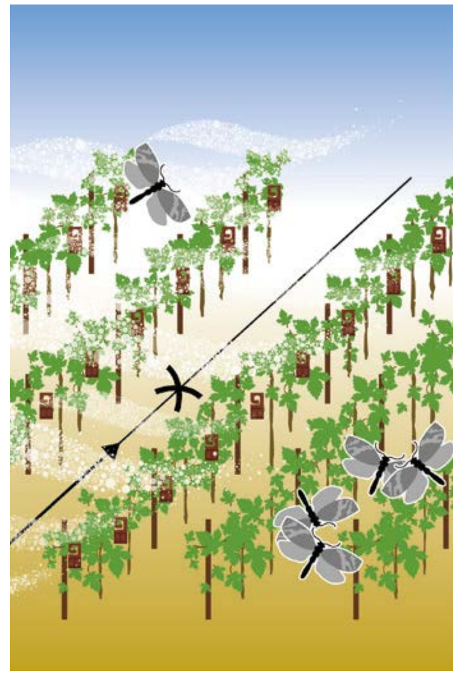
left:

Treated orchards are protected with a pheromone cloud.

Use Rate and Residue Levels

The level of airborne artificially induced pheromones is comparable or greater than levels evident during a naturally occurring insect infestation. Theoretical calculations of pheromones released by a pest species (specifically codling moths) suggest that total pheromones released during an infestation ranges from 10 mg/ha/hr to 227.5 mg/ha/hr. In contrast, pheromone dispensers release pheromones at an expected rate of 32.5 mg/ha/hr.

Residue levels following crop treatment with dispenser-released pheromones are considered to be insignificant (< 5 ppb).



above:

Treated areas disrupt the moths' ability to locate one another for mating purposes, thus protecting the crop from larvae destruction. Untreated hectares are vulnerable to infestation.

Mode of Action

Sex pheromones are chemical substances emitted by female insects and released through the air to attract males during the mating season.

Certain chemicals form a group known as the straight-chain lepidopteran pheromones used to control specific species from the order *Lepidoptera*. Their chemical structure is identical to the compounds naturally produced by female insects. Typically contained in sealed dispensers, these pheromones are constantly dispersed in minute quantities throughout the crop area, producing an invisible pheromone "cloud."

These clouds contain enough pheromones to disorient the males. No longer able to locate the pheromone trail emitted by females, the insects are unable to mate and reproduce. As a result, infestations can be prevented or significantly reduced.

Resistance Management

Because straight-chain lepidopteran pheromones are identical to sex pheromones produced by female insects and integral to the mating process, the likelihood that these insects will develop resistance to pheromones is very low.

Accordingly, pheromones are ideal components of integrated pest management and resistance management programs.

Recommendations for Crop Use

Pheromone	Crop	Pest Name: Scientific	Pest Name: Common	Country
RAK® 1 Neu	Grapes	*Eupoecilia ambiguella*	European grape berry moth	Belgium, France, Germany, Luxembourg, Switzerland
RAK® 2 Plus	Grapes	*Lobesia botrana*	European grapevine moth	Argentina, Chile, France, Spain, Switzerland
RAK® 2 Pro	Grapes	*Lobesia botrana*	European grapevine moth	Turkey
RAK® 2 Extra	Grapes	*Lobesia botrana*	European grapevine moth	Italy
Quant® LBR	Grapes	*Eupoecilia ambiguella and Lobesia botrana*	European grape berry moth and European grapevine moth	Greece
RAK® 1+2	Grapes	*Eupoecilia ambiguella and Lobesia botrana*	European grape berry moth and European grapevine moth	France, Switzerland
RAK® 1+2 Neu	Grapes	*Eupoecilia ambiguella and Lobesia botrana*	European grape berry moth and European grapevine moth	France, Italy
RAK® 1+2 M	Grapes	*Eupoecilia ambiguella and Lobesia botrana*	European grape berry moth and European grapevine moth	Germany
RAK® 3	Pome fruit	*Cydia pomonella*	Codling moth	Argentina, Austria, Belgium, Germany, Italy, Slovenia, Switzerland
RAK® 3 Neu	Pome fruit	*Cydia pomonella*	Codling moth	Netherlands
RAK® 3 Plus	Pome fruit	*Cydia pomonella*	Codling moth	Argentina
RAK® 3+4	Pome fruit	*Cydia pomonella and Adoxophyes orana*	Codling moth and Summer fruit tortrix	Belgium, Italy
RAK® 275	Pome fruit	*Cydia pomonella*	Codling moth	Chile
RAK® 400	Pome fruit	*Cydia pomonella*	Codling moth	Argentina, South Africa
RAK® 5	Stone fruit	*Grapholita molesta and Grapholita funebrana*	Oriental fruit moth and Plum fruit moth	France, Italy, Chile
RAK® CAROZOS	Stone fruit	*Grapholita molesta*	Oriental fruit moth	Chile
Cetro®	Stone fruit	*Grapholita molesta*	Oriental fruit moth	Brazil
RAK® 5 Neu	Stone fruit	*Grapholita molesta*	Oriental fruit moth	Italy
RAK® 5+6	Stone fruit	*Grapholita molesta and Anarsia lineatella*	Oriental fruit moth and Peach twig borer	Italy, Bulgaria

Always read and follow label directions.

Toxicological and Environmental Profile

Pheromones are unique among insect control products in their non-toxic, target-specific mode of action. Their pest control capabilities are evident at very low use rates and they dissipate rapidly in the environment.

For these reasons, the Organization for Economic Co-operation and Development (OECD), an intergovernmental organization of 30 countries that works to coordinate and harmonize a broad range of international policies, proposed that semiochemicals, a class of pest control molecules that includes pheromones, be regulated differently than conventional insecticide products. Specifically, the OECD proposed that regulatory approval of pheromones be simplified and governed by fewer regulations, given their relative safety profile.

The following section reviews the rationale behind the OECD guidelines.

Mammalian Toxicology

Criterion	LD_{50}	EPA category*
Acute oral toxicity	> 5000 mg/kg	IV (non-toxic)
Acute dermal toxicity	> 2000 mg/kg	IV (non-toxic)
Acute inhalation toxicity	> 5 mg/L	III-IV (practically non-toxic)

* *Data submitted to the U.S. Environmental Protection Agency (EPA) as part of regulatory approval process of semiochemicals, the majority of which have been pheromones.*

There has been no evidence of mutagenicity and minimal eye and skin irritation. Published mammalian toxicity data shows straight-chain lepidopteran pheromones have no significant acute toxicity to humans.

Aquatic Toxicology

The pure pheromone blend has a potential to harm aquatic organisms. However, the pheromone blend is safely enclosed in a dispenser system. Hence, no harmful environmental impact is expected.

top to bottom:
Caterpillar of Cydia pomoella; Cydia pomoella; Larve of Adoxophyes; and Adoxophyes orana.

Safety, Stewardship and First Aid Instructions

- **Storing and handling instructions:** Store the dispensers in their original sealed packages, protected from air, light and high temperatures. No special measures are necessary if stored and handled correctly. Ensure thorough ventilation of storage and work areas.
- **General first aid advice:** Avoid contact with skin, eyes and clothing. Remove contaminated clothing. If difficulties occur, seek medical attention. Show the container, label and/or safety data sheet to the physician.
- **If on the skin or clothing:** Wash thoroughly with soap and water. If irritation develops, seek medical attention.
- **If in eyes:** Immediately wash affected eyes for at least 15 minutes under running water with eyelids held open. Consult an eye specialist.
- **If swallowed:** Rinse mouth immediately, then drink plenty of water and seek medical attention. Do not induce vomiting unless told to do so by a poison control center or doctor. Never induce vomiting or give anything by mouth if the victim is unconscious or having convulsions.
- **Note to physician:** Treat according to symptoms. There is no known specific antidote.

We create chemistry

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