Semiochemicals: Maybe the fastest growing segment of the biopestcides market!

Pheromones are an excellent technology that can be used to make an IPM program more efficient. They are nature-identical and are no threat whatsoever to the environment. Although there are few publications stating otherwise, very few people believe in the possibility of obtaining resistance against pheromones. The pheromone market is one of trust and faith. It is often not easy to see the quality of a commercial pheromone product from the outside. The semiochemicals market has been growing over the last 5 years at a compound annual growth rate (cagr) rate in excess of 17%, which is slightly more than the total biopesticide market. The global market is estimated to be $430 million at manufacturers level in 2016. William Dunham, Managing Partner at Dunham Trimmer, Editor 2B Monthly and now a regular contributing Editor of New Ag International magazines, has the story.

THE NAME SEMIOCHEMICALS comes from the Greek word, "semeion" meaning "signal," and is a generic term used for a chemical substance or mixture that carries a message for the purpose of communication. The OECD defines semiochemicals as chemicals emitted by plants, animals, and other organisms - and synthetic analogues of such substances - that evoke a behavioral or physiological response in individuals of the same or other species. The US EPA defines pheromones for the purpose of registration as a "semiochemical produced by individuals of a species that affects the behavior of other individuals of the same species."

Semiochemical communication is divided into two broad classes: communication between individuals of the same species (intraspecific) or communication between different species (interspecific). Intraspecific communication is the main use in agriculture.

William Dunham

FIRST IDENTIFIED AND ISOLATED IN 1959

Semiochemicals have been around for years, it is just that they were not utilized or produced by man until recently. The actual existence of pheromones has been known for centuries. One thought is they were originally observed in mass bee stinging in response to a chemical released by the sting of a single bee. The first isolation and identification of an insect pheromone (silkworm moth) occurred in 1959 by German scientists.

The word pheromone comes from the Greek words, phereum, meaning to carry and horman, meaning to excite or stimulate. Pheromones are released by a member of one species to create a specific action by another member of the same species. Pheromones may also be classified on the basis of the interaction mediated, such as alarm, aggregation or sex pheromone.

The use of pheromones in agriculture for the management of pests really started its commercial entry in the 1970's with products identified for Codling Moth and Oriental Fruit moth that were used in traps for monitoring. Very small amounts of the pheromone were required – typically 1 milligram of pheromone is required for baiting a trap for 6 to 8 weeks. Such amounts could easily be synthesized in university laboratories and the use of pheromones in such traps grew quickly as diagnostic tools to detect the presence of pest species, to determine the need and timing of spray applications and to determine subsequently the success or otherwise of such treatments. Such monitoring traps undoubtedly led to a more rational use of pesticides and resolved many problems of insect pest management which had, until the advent of pheromone baited monitoring

traps, been mainly based on calendar spraying of insecticides. Since their isolation, hundreds, with estimates in the range of 1500 insect pheromones have been identified by increasingly sophisticated equipment.

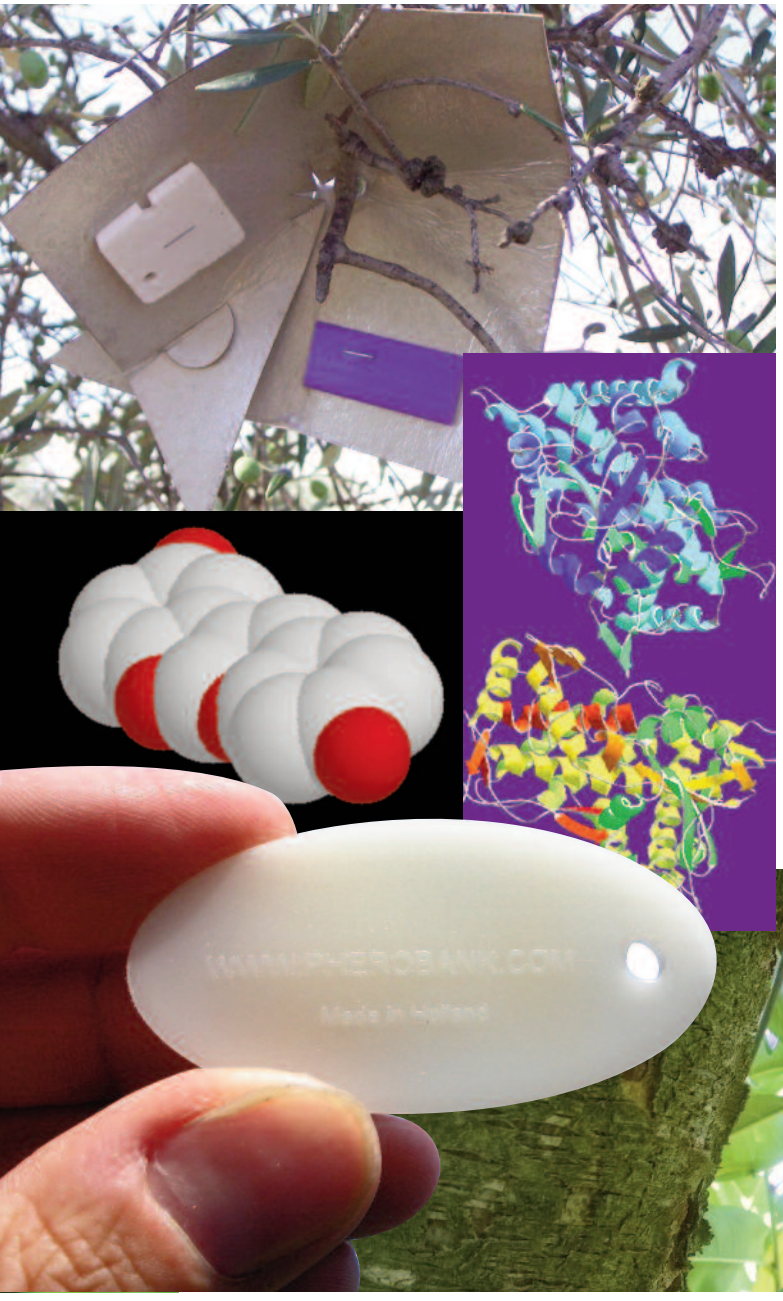
Sex pheromones are used by an organism to attract individuals of the opposite gender in order to mate or perform some other sexual reproduction function.

TWO GROUPS OF SUBSTANCES

There are two groups of semiochemicals: pheromones and allelochemicals.

Pheromones are semiochemicals produced by individuals of a species that modify the behavior of other individuals of the same species (i.e. an intraspecific effect). Straight-chained lepidopteran pheromones (SCLPs) are a group of pheromones consisting of unbranched aliphatics having a chain of nine to eighteen carbons, containing up to three double bonds, ending in an alcohol, acetate or aldehyde functional group. This structural definition encompasses the majority of known pheromones produced by insects in the order Lepidoptera, which includes butterflies and moths.

On the other hand, allelochemicals are semiochemicals produced by individuals of one species that modify the behavior of individuals of a different species (i.e. an interspecific effect). They include allomones (emitting species benefits), kairomones (receptor species benefits) and synomones (both species benefit).



TWO PRIMARY USES IN AGRICULTURAL APPLICATIONS

The use of semiochemicals in agricultural has expanded greatly over the last years with the detection and identification of more and more semiochemicals that effect more insects.

Today there is a much clearer view of the limitations and possibilities associated with semiochemicals in IPM programs. There are two primary uses of semiochemicals: 1) for detection and monitoring of pest populations; 2) for control through mating disruption, lure & kill and mass trappings. Both uses take advantage of sex pheromones on which a vast majority of insect pests rely for reproduction.

Detection and monitoring is used for early detection of the presence of insects, many times at infestation levels that would not be possible to detect without their use. This early detection and monitoring of insect populations enables a more efficient IPM program by allowing for optimizing the application timing of insecticides and calculating the efficacy of control options. Insect distribution patterns can be assessed for a particular field or location, as well as determined for the season.

Various sources indicate that nearly a quarter of the use of semiochemicals is for detection and monitoring, putting the global market value for detection and monitoring in the range of $100 million usd and covering nearly 20 million hectares. One important factor that is driving the use of semiochemicals in monitoring insect populations is the reduction in the use of conventional pesticides. Knowing the population of key pests allows for a more efficient timing of application and a more complete control with reduced pesticide use.

The use of technologies such as Remote Sensing has advanced the use of semiochemicals as an efficient tool in calculating infestation and timing of pesticide applications without having to physically monitor each trap and visit the field multiple times. Data can be sent directly to a smart phone enabling more timely decisions and saving time.

LARGEST USE: LURE & KILL, MASS TRAPPING, MATING DISRUPTION

The largest use of semiochemicals is to control insects with lure & kill, mass trappings and mating disruption.

Mass trapping using pheromones was always limited in the early years since the majority of the pheromones described were from Lepidoptera where their primary function was in attracting males. In addition, the trapping efficiency of many trap designs was often very low making it impossible to catch sufficient numbers of males to leave females unfertilized. Successful Mass Trapping has been achieved where pest populations have been low and where the attractant used has been effective on both sexes. By far the largest market for Mass Trapping

An interview with Dr Alison Hamer, Senior Consultant, Plant Protection, TSGE Consulting Europe

"Semiochemicals used in plant protection are regulated in Europe under Regulation (EC) No 1107/2009. Many semiochemicals, including around thirty Straight-Chain Lepidopteran Pheromones (SCLPs), are approved as active substances.

The data requirements for registration of semiochemicals is given in Parts A of Regulations (EU) No 283/2013 and 284/2013 which set out requirements for active substances and plant protection products. Regulation (EU) No 546/2011 specifies the uniform principles for evaluation and authorisation of plant protection products.
Special technical and other guidance documents on the content of the dossier have been developed over the years by regulatory and scientific experts of the European Commission, Member States, the European Food Safety Authority (EFSA) and the OECD Biopesticide Steering Group (BPSG). The BPSG helps OECD member countries to harmonise the methods and approaches used to assess biological pesticides and links to industry through the International Biocontrol Manufacturers Association (IBMA).
The use of published literature, along with quality GLP studies, is appropriate to address some of the data requirements.
A comprehensive literature search is mandatory and EFSA publishes comprehensive guidance on searching for and using published literature in submissions.
Guidance has recently been published which aims to provide practical solutions on how procedures and data requirements can be applied to facilitate approval of semiochemicals in Europe (SANTE/12815/2014 rev. 5.2) and this will apply to dossiers submitted from 1 January 2017.
A focus of activity for 2016 is the AIR IV renewal programme for active substances including the SCLPs. Applications must be submitted in August 2016. According to the timelines in a new draft working document, dossier submission will then be required in early 2018. This new EU Commission working document (SANTE/2016/10616-v.3) places SCLPs in a low-risk category due to their characteristics.
Registration of the use of monitoring traps is not required. Some European Member States, for example Belgium, Denmark, Netherlands and the UK have introduced policies to support biopesticide companies looking to enter the regulatory system. Whilst Member States have their own individual fees for evaluation, some offer a fee reduction to reflect the small dossier size for biopesticides including semiochemicals".

products both in Europe and North America is for bark beetle control. Good examples of successful mass trapping with Lepidoptera in Europe include Thaumetopoea pityocampa in forestry and Spodoptera littoralis in field vegetables but other examples are few and far between. Perhaps the most important example of mass trapping currently being used in Spain is that of the Mediterranean fruit fly (Ceratitis capitata) where both males and females are attracted into dry traps using a combination of ammonium acetate, trimethyl amine and putrescine in products such as the Suterra Biolure Tri-pac and Unipac. Over 26,000 ha of citrus and fruit crops are now treated using these systems in Spain.
From the active ingredient manufacturer point of view, however, these are not priority markets as the volumes of active ingredients are not substantial and often involve very small amounts of sex pheromones in the case of Lepidoptera or commodity chemicals such as those described above for Mediterranean fruit fly (ammonium acetate, trimethyl amine and putrescine).
Lure and Kill is another main market segment for semiochemicals. Any inefficiencies of capturing insects in a trap can be overcome by using a conventional insecticide as a killing agent instead of a physical device in the form of a trap. The semiochemical attracts the insect to an area of crop or to a device where it is killed with an appropriate adult insecticide. Again the technique is limited if male-attracting pheromones are used. There are, however, a number of successful products which are based on this technique and lure and kill insecticide granules which carry Z-9-tricosene, the sex pheromone of the common housefly, Musca domestica, are a case in point. The pheromone attracts both sexes and induces greater arrestment of the flies on the insecticide granules thus improving their efficiency substantially. With the identification of other non-pheromonal semiochemical attractants such as host plant chemicals, oviposition stimuli, etc, the scope for controlling insect pests using female lure and kill formulations and devices becomes much greater and many future developments are expected in this area.
For the reasons given under Mass Trapping above, this is a market which is not a priority for the active ingredient manufacturer because of the simplicity and generic nature of the molecules or because of the small volumes used.
Last but not least, mating Disruption is the third main market segment: Most of the efforts made in using semiochemicals for controlling insect pests over the last two decades have been in the field of Mating Disruption using sex pheromones of Lepidopteran pests. Mating disruption is the practice of releasing sex pheromones in order to interfere with the ability of males to locate females for mating purposes and greatly reduces the damage caused by insect larvae. We estimate the current world market for mating disruption products at the manufacturers' level to be about $300 million USD with the Codling Moth (Cydia pomonella) and various grape moth pests being the most important species where the technique has been shown to work successfully on a commercial scale.
More than a million hectares of crops and forestry are currently treated with pheromones. Because of the much larger quan-

Table 1: Regional Market Shares for Semiochemicals by Regions - US$430 million

	USA/ Canada	Europe	Latin America*	Asia/Pac	ROW	Total
2015	25%	30%	14%	27%	4%	100%

* includes Mexico

tity of active ingredient per ha required to achieve success with this technique it presents the active ingredient manufacturer with a much greater opportunity. As will also be demonstrated, mating disruption can be achieved using pheromone active ingredients of a lower purity specification than that required for Monitoring, Mass Trapping or Lure and Kill

A NON-TOXIC MODE OF ACTION

In their utilization for pest control in agriculture, semiochemicals are unique in that they do not harm insects, rather they modify behavior, interfering with the mating process. Additionally, they are species specific, meaning each individual insect species requires the development of a specific chemical that only effects that insect. The concentrations of semiochemicals used in agriculture IPM programs, are at or near the concentrations found naturally in the environment and dissipate quickly. That is the basis for registration programs designed by the various regulatory authorities around the world and that why we have the unusual situation of a synthetic chemical produced in a factory found in the biological control regulatory programs of countries. Studies have consistently shown that the use of semiochemicals in both monitoring and mating disruption does not show a significant alteration of the levels found in the environment of semiochemicals and that they dissipate rapidly to undetectable levels, resulting in a very low potential risk to the environment and human health human health.

In addition, many end use products are formulated in passive dispensers (hollow fibres, tapes) that present little direct exposure to humans and non-target organisms. All these factors minimize the risk of adverse effects from the use of semiochemicals.

The application rates are typically low and comparable to natural emissions. For purposes of pest control, releases of semiochemicals (except for perhaps repellents) are unlikely to greatly exceed natural emissions because their effectiveness is dependent on arthropod olfactory systems that are tuned to natural emission rates. Male Lepidoptera typically respond to a discrete range in ambient pheromone concentration, with the consequence that a high rate of pheromone release may be less effective than an intermediate rate of release. Controlled release technology is critical to slow down and extend effective pheromone release over the flight period of the insect, which is usually 4-8 weeks (Howse, Stevens and Jones 1998).

THE GLOBAL MARKET: SIXTY COMPANIES HAVING AN INTERNATIONAL PRESENCE

The semiochemical market is estimated to be $430 million USD worldwide at manufacturers level in 2016 (see table 1).

The semiochemicals market has been growing over the last 5 years at a compound annual growth rate (cagr) rate in excess of 17%, which is slightly more than the total biopesticide market. Key countries are the USA, Mexico, Brazil, France, Spain, Italy, Japan, China and India.

Pheromones are used for monitoring and control of several insect species. However, Codling Moth (Cydia pomonella), Gypsy Moth (Lymantria dispar) and European Grape Vine Moth (Lobesia) are the three largest markets worldwide, with European Grape Vine Moth mainly located in Europe. Therefore, given these pests the, most important crop markets are Apples, forestry and grapes. Other key targeted pests include, but are not just limited to these species: Peach Twig Borer (Anarsia lineatella); Pink Bollworm (Pectinophera gossypiella); European Grape Berry Moth (Eupoecilia ambiguella); Navel Orange Worm (Amyelois transitella); Striped Rice Stem Borer (Chilo suppressalis); Stored Product Moths---(Ephestia & Plodia); False Codling Moth (Cryptophlebia leucotreta). Other pheromones of importance are the Common House Fly (Musca domestica). New uses include for monitoring and control of Diamondback Moth (Plutella xylostella) and the Helicoverpa Species Group, which covers several different species in this group.

Moving into other insect species is a challenge both in chemistry and the understanding of pest behavioral responses to the treatment. There are several hundred produc-

An interview with Andrea Iodice, Pheromones Product Director, CBC (Europe) S.r.l., Divisione BIOGARD

CBC Group involved itself in semiochemicals and pheromones about 30 years ago as developing and marketing arm of Shin-Etsu Chemical Co. Ltd. in several territories worldwide.

"The practical application of semiochemicals in agriculture boosted in the last decade thanks to the wider application of IPM and Area-Wide Pest Management. The increased understanding of the benefits of soft pest control, abandoning wide spectrum pesticides, managing pest resistance and reducing chemical residues in crops are the strong background on which the semiochemicals became one of the essential tools in the IPM management of many fruits and vegetable crops. The semiochemicals mode of action on target pests is indirect, it just affects the pest behavior by attraction or disruption and is typically an highly selective preventive method. Controlling the target pests without the extensive use of insecticides, pheromone enables conservation biological control. Natural enemies are allowed to growth for control of both target and non-target pests. The use of semiochemicals require, then, a perfect knowledge of the pest biology and behavior to be applied with success. In order to solve the problem of possible secondary pest development in Mating Disruption fields, developing of multipurpose target pest products is the new challenge for companies.

In this direction, Biogard already developed multitarget MD products for Pome (Isomate C LR), Stone (Isomate A/OFM) and Grape (Isonet L plus, Isonet L E and Isonet L A plus).

Another important aspect of pheromone products development is related to their easiness of application.

Man power availability is increasingly becoming a key issue in several fruits & grape production areas. Our Twin Type formulations, like Isomate C TT and Isonet L A plus (see picture below) were developed even to speed up the application process. In this sense aerosol technologies can be considered one possible option if the conditions of the treated area fulfill certain characteristics related, especially, with its dimension. Isomate CM MISTER was our first registered aerosol formulation in the market".

An interview with Owen Jones: Lisk & Jones Consultants LTD, UK

Lisk and Jones Consultants Ltd is a partnership based in the UK between Owen Jones and Jenny Lisk, specialising in biopesticides, biostimulants and plant nutrition. Within the biopesticide field the partners have more than 50 years of experience in the development and use of semiochemicals in insect pest monitoring and control. The partnership provides a vital bridge to help those trying to bring new innovations from the laboratory bench to a practical solution in the field.

"The partnership has witnessed a growing interest in semiochemicals by both companies and the research community over the last five years. Factors that have contributed to this growth include:

- A growing market for semiochemical-based products – (>15% CAGR)
- Successful expansion of mating disruption sales especially in top fruit and vines. Over 1 million hectares are now estimated to be treated with pheromones for mating disruption (MD) on a global basis
- A 'lighter touch' in terms of regulatory requirements for semiochemicals by most authorities around the globe especially when compared with conventional plant protection products
- Technical innovations in the way sex pheromones are applied in the field – puffers/misters used at the rate of 2 to 3 per hectare are now used on a wide surface area of crops and these have led to a great saving in the labour required to apply the pheromones in the field
- Mating disruption is now not restricted to moths – some sucking insects such as the California Red Scale and Vine Mealybugs can now be successfully controlled using sex pheromones
- Monitoring insect pests using semiochemicals, although not a huge market in itself, has become well established and has seen some recent innovations such as remote sensing and spatial imaging which helps growers keep on top of their pest problems in a timely fashion without the need to visit the crops very often.

In my opinion, future technological innovations that will influence the growth of the semiochemical sector could include two main things.

First, the development of robust 'lure and kill' technology which focuses on attracting females or immature stages. Most pheromones described to date have been for attracting males which for a lure and kill system is not very useful if any surviving males are able to mate with several females. Kairomones will probably play an important role in this growth.

Secondly, the manufacture of semiochemicals using synthetic biology could substantially reduce their cost as active ingredients and molecules that have been abandoned for pest management purposes because of their structural complexity and cost of synthesis could become a commercial reality again because of the cost savings that are possible using this novel manufacturing technology.

ers of pheromones around the world, both large and small. However, only 50-60 companies have an international presence. Shin-Etsu (Japan), Pacific Biocontrol Corp (USA), Bedoukian Research (USA), SEDQ (Spain), Suterra (USA/Europe) and Pherobank (a Division of Plant Research International in the Netherlands) offer the world's largest collection of pheromone compounds. Shin-Etsu have by far the largest share but at least 50% of that share is used in its own formulated products. Suterra is the second largest producer but uses all that it manufactures in its own products. Bedoukian is the third largest producer of AI with all of its production sold to other companies that then formulate it into end use products. These companies develop, produce and sell pheromone lures that are used worldwide for the selective detection of (harmful) insect species. New pheromones are continuously being identified or can be identified upon request. These companies also develop, produce and sell reference pheromone compounds. Additionally, Pherobank lays claim to the world's largest collection of lepidopteran sex pheromone compounds. Almost 500 different chemicals are now commercially available from Pherobank and are used worldwide as reference for pheromone identification work. Every year other producers also bring new pheromone products to the market, to address pest problems.

It would be a likely assumption, given the continuing consolidation of the biocontrol industry in general, that we will see the semiochemical producers consolidate and merge over the next few years. Thus allowing for lower costs of goods through larger scale production.

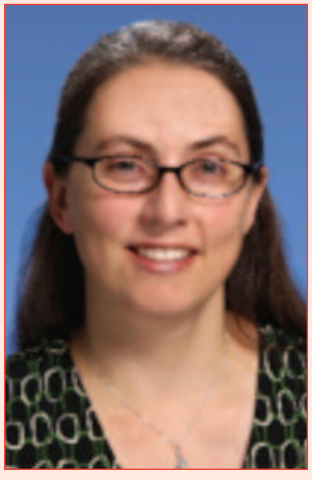
REGISTRATION UP TO 30% MORE EXPENSIVE IN EUROPE THAN IN THE USA

In the USA, EPA registration is not required for semiochemicals used in fixed-location lures for the purpose of attracting and monitoring pests and expected to have minimal impact on either the environment or human health. Such products are exempt from registration, when used as follows: (1) Semiochemicals used in pheromone traps in which they are the sole active ingredient; (2) Semiochemicals used in lures attached to trap trees; (3) Semiochemicals incorporated into pesticide formulations used in fixed location traps (semiochemical does not require registration, but formulation does)

EPA registration is required for: (1) semiochemicals contained in solid-matrix dispensers which are placed in large numbers by hand or machine (i.e. not fixed-location traps) for the purpose of pest control. These devices include, but are not limited to, the following: rubber septa dispensers, trilaminate sheets, tapes, tag, wafers, macrocapillary devices such as long tubes or fibres, protected "ropes" and twist-ties. (2) semiochemicals to be broadcast or sprayed, alone or formulated into a pesticidal bait. These products include, but are not limited to, the following: liquid flowables, flakes, microcapsules confetti formulations, microcapillary straws; cigarette filters; granular powders and unprotected "ropes".

In the EU Straight Chain Lepidopteran Pheromones (SCLPs) have already been reviewed under the EC 91/ 414 directive through a single dossier prepared by the SCLP

An interview with Amy Plato Roberts, Senior Regulatory Consultant, Technology Sciences Group Inc. (TSG)-USA



Pheromones used for biological control enjoy regulatory relief in the US, in particular for testing and for registration of Straight Chain Lepidopteran Pheromones (SCLP).

For testing, there are increased limits in acreage to the amount of testing (up to 250 acres) that can be conducted without a permit. For registration, there are specific reduced timelines and application fees established by the US EPA in the Pesticide Registration Improvement Act (PRIA), as well as blanket exemptions from the requirement of a tolerance (MRL) for inert ingredients and active ingredients. The maximum time for review is seven (7) months with an application fee of $2,554 for a new active ingredient for food use.
Further for SCLPs, the data burden is limited to product chemistry. Human health toxicity and ecotoxicity data requirements are relieved for arthropod pheromones when applied at up to a maximum use rate of 150 grams active ingredient/acre/year. As the EPA states – "The Agency acknowledges that use of certain types of pheromone products presents lower risk than conventional pesticides, and also acknowledges the unique properties of these niche-type products regarding their inherently narrow host range."
For non-SCLP pheromones or products that fall outside the established exemptions, they are regulated by US EPA as regular biochemical biopesticides, which also have reduced timelines and fees in comparison to conventional chemistries. While non-SCLPs may have a higher data burden in terms of toxicity and ecotoxocity data requirements to address, it is typical for the US EPA to accept rationales in lieu of studies based on low exposure and low toxicity.
Finally, pheromones used for monitoring and survey purposes only, as the sole ingredient in traps or monitoring systems, are completely exempt from the requirement of EPA registration.
No changes are expected to the US regulatory requirements. The EPA continues to recognize the inherent lack of risk for pheromones with the established regulatory relief".

Task Force and examined by Austria as rapporteur. A Draft Assessment Report (DAR) with the recommendation that 32 components and blends be included on Annex I of the Directive which is now a Regulation (EC 1107/2009). The DAR has been peer-reviewed by the European Foods Standards Agency (EFSA) and their report is being studied currently by DG SANTE in Brussels. We do not know what DG SANTE will make of the EFSA comments. In any case, it is very unlikely that EFSA's comments will have any effect on the Annex 1 listing of SCLPs. The SCLP Task force members include the following companies: AgriSense BCS Ltd, Agrichem Laboratories S.L., BASF, Certis Europe BV, DKSH Switzerland Ltd, Exosect Ltd, Isagro S.p.A., Russell Fine Chemicals Ltd, Sociedad Española de Dessarrollos Quimicos S. L. (SEDQ), Shin-Etsu International BV (represented by CBC Europe Ltd), and Suterra LLC.
Of these 11 companies only the last three are currently producing pheromone active ingredients on a metric ton scale. The other members purchase their active ingredients from Shin-Etsu, SEDQ or Bedoukian Research Inc. or produce small batches themselves for limited uses.
For Annex III formulated product dossiers, each member of the task force has the right to cite the Annex I listing of the active ingredients. Any non-member of the task force can also cite the Annex I listing by getting a letter of access from the task force. This can be done on a 'per Active Substance per country' basis or a letter of access that is valid for all active substances in all EU countries.
The US EPA, Canada's PMRA and the European Union's regulatory authorities have received no reports of adverse effects to human health or the environment associated with semiochemicals registered for use in mating disruption of arthropods and other applications. Most registered products are SCLPs. The data submitted for registering semiochemicals in the United States have indicated no mammalian toxicity when mammals are exposed to high doses. Available data indicate: acute oral toxicity (LD50 > 5000 mg/kg - EPA category IV, non-toxic), acute dermal toxicity (LD50 > 2000 mg/kg - EPA category IV, non-toxic), acute inhalation toxicity (LC50 generally > 5 mg/L - EPA category III-IV, practically non-toxic), no evidence of mutagenicity (Ames Salmonella assay), and minimal eye and skin irritation (Federal Register v.59, Jan.26/94). Published mammalian toxicity data on SCLPs indicate no significant acute toxicity to humans (Inscoe and Ridgway 1992). SCLPs are biodegradable by enzyme systems present in most living organisms, and should present no problems with their normal physiology. For example, the known metabolism of long-chain fatty acids predicts that SCLPs would be metabolized either by β-oxidation yielding a series of paired carbon losses or by complexing with glucuronide and excretion by the kidneys (Federal Register v.60, Aug.30/95). The US EPA has used the results of two subchronic toxicity studies as bridging data for the safety assessment of other structurally similar SCLP products submitted for registration. Published results of these studies indicated no significant health effects.
In general, although the systems for obtaining registrations are different in Europe from North America, the end point is not too dissimilar. The data requirements in Europe are slightly more extensive than in North America. Some member countries in the EU require additional studies such as environmental fate studies, and non-target organism effects. This means that the cost of the package for Europe, can be up to 30% more. In addition, the fees for reviewing the data packages are higher in Europe than in the USA. In Europe, there is also a need to demonstrate product efficacy in the country where the product is to be registered or field performance data must be available from another EU country with similar climatic conditions. Normally two years of data are required.

NEW METHODS DRIVING DOWN THE PRODUCTION AND APPLICATION COSTS

The improvements in the production efficiency of semiochemicals

An interview with Cristina Alfaro, General Manager Suterra Europe

Suterra is the world's leading provider of environmentally sustainable products for crop protection. The company is the only fully integrated enterprise of its kind in the world and continually invests in active ingredient research, large-scale synthesis, product formulation, registration, sales and technical service across six continents. Suterra is wholly owned by The Wonderful Company, a private agribusiness entity farming over 80,000 ha of nuts, fruit, vines and citrus. This relationship with the parent company provides Suterra with a strong focus on grower needs.

"Suterra's flagship products utilize naturally occurring pheromone compounds to reduce harmful pest populations through disruption of mating behaviors. In Spain, Suterra was one of the first companies to develop MD products for the Rice Stem Borer. This extremely successful product has allowed rice cultivation within the sensitive areas of protected natural parkland. Suterra's continued investment in the product and commitment to grower service has resulted in the company treating 90%+ of the rice surface in Spain.
In addition to rice products, Suterra's Checkmate® brand spans a wide variety of technologies for many different crops and pests. The company sells Puffer® aerosol emitters for pome fruit, stone fruit and nut pests in Europe, the United States and throughout the Southern Hemisphere.
Puffers® for Lobesia Botrana in vines have recently been registered for use in Italy, Spain and France. Puffers® are deployed on several hundred thousand acres around the world and are growing at 30+% per year due to their ease of deployment, season-long duration and "clean orchard"
The company recycles and refurbishes Puffer® emitters after each season as part of their mission of sustainability.
The company also offers several other product platforms to accommodate different pests and operational needs of growers. In the United States, Suterra controls Planococcus Ficus ("Vine Mealy Bug") in vineyards with both sprayable and hand-applied dispenser formulations. The company has found that both formulations are necessary to accommodate different operational needs of different growers.
Both formulations are currently being tested in Europe and the Southern Hemisphere.
Sprayable and dispenser formulations are also available in different regions around the world for vegetable pests and California Red Scale in citrus.
Attract & kill technique is also one of our main lines, offering to the market Magnet®MED, an integrated "ready to use" device for Medfly control, providing a greater convenience and installation speed as well as longer pest control period for at least 6 months.
Suterra contributes to today's sustainability trends in agriculture, as well as understand increased restrictions on MRL requirements by food processors and retailers. These insights will continue to drive the company's investment and innovation pipeline in the years ahead".

has driven the original cost of 10's of thousands of USD per kilo down to $1000 USD per kilo. This has come about by improvements in conventional synthetic chemistry. New productions methods using biotechnology methods (microbials – yeasts) could drive the cost to below $500 USD per kilo.
At the same time, new micro-encapsulated formulations have enabled the reduction of rate per hectares to less than 50 gm per hectare. Puffers & misters have also enabled rate reduction with just 2-3 per hectare and significant reductions in labor.

THE FUTURE: IN THE HANDS OF REGULATORS?

Pheromones are very specific, which can be considered an advantage because only the target species is affected. However, this quality is also one of the reasons that pheromones are not more widely used. For monitoring purposes using a pheromone and trap is free of regulation in most countries. When multiple traps per hectare are placed claiming a controlling effect then the application is subject to regulation. At that moment costs for registration are too high in comparison to the expected profit; pheromone applications may well become too expensive. The same is true for lure and kill applications.
Another possible hitch is the high prices for the active ingredients. When applied in monitoring, mass trapping or lure & kill systems, the price of the active ingredient will not become a serious limitation. When pheromones are applied in mating disruption where relative large quantities of pheromones need to be applied, the price can become a limiting factor. A promising pseudo mating disruption (or false trail following) application is the application of 1000-3000 point sources of pheromone in the field. For this application only a few grams of pheromone per hectare will be sufficient.
The pheromone market is one of trust and faith. It is often not easy to see the quality of a commercial pheromone product from the outside. Also chemical analyses do not always guarantee quality as minor impurities can seriously influence the attractiveness of the lure.
Last but not least pheromone systems require skilled persons and patience. When conventional insecticides are applied target insects are killed within a short period of time. When mass trapping is applied for example against Duponchelia fovealis sufficient suppression of the population is reached with 20 traps per hectare only after one season. Placement and monitoring is critical to the success of this strategy.
Still, and despite all the possible hindrances to the development of the market, including the presence of "snake-oil" type products, pheromones have a large potential and pheromone systems will become increasingly important. Working with pheromones is one of best tools to use in conjunction with the application of natural beneficials like predators and pollinators. A number of people in the market think that pheromone applications like mass trapping should be free of registration or only should need a limited set. Is

An interview with Francisco Torres, Portfolio Lead Trees & Vines, Certis Europe

Certis Europe includes operating units in France, Netherlands, Belgium, Italy, Spain and UK. It also has close links with Certis USA and Spiess-Urania. Certis is a member of the Mitsui and Co Group from Japan. Certis Spain, established in 2003 by Certis Europe, provides innovative Integrated Pest Management solutions to growers in Spain and Portugal, across a range of crops including protected and field vegetables, top fruit, citrus, strawberries, tobacco, olives, vines and arable crops.

"The Cidetrak system, introduced in Spain in 2016, offers season-long control of Lepidoptera Cydia pomonella and Cydia molesta, key insect pests in pome and stone fruit. In contrast to chemical insecticides traditionally used to control these pests Cidetrak uses pheromones to produce changes in the behavior of the insects, hampering the pairing of male and female moths, which results in a reduction of their populations and therefore also of damage to fruits.
Cidetrak has a number of advantages over competitive mating disruption products in terms of ease of application, saving time and labour resource, and long duration of activity of 150-160 days.
The Cidetrak diffuser resembles a puzzle piece, easily and securely attached to the branch with one hand. The active ingredients (pheromones) are incorporated into the material used to make the dispensers ensuring sustained release of pheromones throughout the season, regardless of weather conditions.
The product is permitted in organic production as part of an integrated defense strategy with microbiological insecticides such as granulosis virus and Bacillus thuringiensis (Delfin®), which are also safe to beneficial insects. Cidetrak has been in use in Italy and France for several years with very good results.
Use of Semiochemicals will continue to grow in the future. They will be used widely in the crops for which they are already registered and new products are under development for other pests in other crops.
Application technology will continue to evolve and will improve to facilitate application and to offer growers more efficient ways to apply mating disruption pheromones"

the future of the market for such "smart products" in the hands of Regulators? As is the case for many products in the biocontrol market, the future evolution of regulatory policies in the key agricultural countries worldwide will have a huge impact on the future of pheromones. The industry and authorities will have to be able to work out differences in a manner that continues to contribute to the growth in the use of sustainable products, such as pheromones. ■