soil and foliar products Becker Underwood was an excellent fit and has now been fully integrated into the company.
The presentation will outline the different key segments BASF is focusing on in the areas of soil, seed and foliar treatments. Furthermore it will focus on the main opportunities BASF sees in developing an integrated portfolio of biological and chemical products that are able to reliably cover a broad spectrum of farmer's needs. Beyond this we will look forward and outline how we expect the crop protection market to develop and what motivates BASF to invest into finding best possible solutions to meet these changing market demands.

SYMPOSIUM 1 (Nematodes) Monday, 14:00-16:00

Above and Belowground Interaction, Root-Shoot Interaction, Chemical Signaling

Symposium. Monday, 14:00. **5**

Small molecule signals in nematodes - common motifs and species specific modifications

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Chemical communication in nematodes via small molecule signals has been known since the 1960s. However, despite considerable efforts chemical structures have remained elusive for several decades. Recent research focusing on the model organism *Caenorhabditis elegans* has revealed a modular library of small molecule signals, the ascarosides, glycolipids of the dideoxysugar ascarylose linked to fatty acid derived side chains, that modulate nematode development and behavior. Furthermore, we have shown that production of ascaroside components is highly conserved among nematodes from different clades, life-styles and ecological niches.
Our ongoing research aims to comprehensively characterize ascaroside signaling in selected nematode species including bacteriovorus and entomopathogenic species. Identification of putative ascaroside signals is accomplished using our recently developed highly sensitive HPLC-MS/MS precursor ion screen that facilitates the detection of known and novel ascaroside components in crude nematode metabolome extracts. Novel ascarosides are subsequently isolated by SPE and HPLC and identified using a combination of HR-MS/MS and NMR techniques. We found that diverse nematode species share a large variety of common ascarosides and in addition also produce several highly species-specific derivatives. Chemical synthesis and subsequent functional characterization of these putative small molecule signals in different nematodes will reveal their importance in intra- and interspecific communication and help to decipher the evolution of ascaroside signaling in nematodes.

Symposium. Monday, 14:30. **6**

Olfactory Plasticity in Entomopathogenic Nematodes

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Many parasites, including entomopathogenic nematodes (EPNs), use host-emitted olfactory cues to locate hosts. However, how parasitic nematodes respond to host-emitted odors remains poorly understood. In particular, little is known about how parasitic nematodes integrate host odor cues with environmental cues such as temperature and intrinsic cues such as age to mediate context-appropriate host-seeking behaviors. To address this question, we are investigating the olfactory behavior of EPNs from the genera *Steinernema* and *Heterorhabditis*. We find that EPNs are attracted to the general host cue carbon dioxide under all conditions tested. However, responses to many odorants exhibit extreme olfactory plasticity as a function of IJ cultivation temperature and/or age. For example, in *Steinernema carpocapsae*, many odorants that are strongly attractive at lower temperatures are strongly repulsive at higher temperatures and vice versa. This temperature-dependent olfactory plasticity occurs in individual IJs and is reversible, since temperature-swapping IJs reverses their olfactory preferences. By contrast, other species appear to show primarily age-dependent changes in olfactory preferences, while still other species show little or no olfactory plasticity. Thus, the type and extent of olfactory plasticity varies among EPNs. In addition, we find that foraging strategy can also vary with temperature. For example, *Steinernema carpocapsae* behaves more like an ambusher at higher temperatures and more like a cruiser at lower temperatures. Some EPNs are found in geographical regions that undergo substantial seasonal temperature variation, and we hypothesize that plasticity of olfactory behavior and foraging strategy may enable EPNs to optimize host seeking under changing environmental conditions.

Symposium. Monday, 15:00. **7**

Multiple Consequences of Belowground Herbivore Induced Volatile Signals

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Plants can influence the behavior of and modify community composition of soil dwelling organisms through the exudation of organic molecules. Given the chemical complexity of the soil matrix, soil-dwelling organisms have evolved the ability to detect and respond to these cues for successful foraging. A key question is how specific these responses are and how they may evolve. Soil nematodes are a group of diverse functional and taxonomic types, which may reveal a variety of responses. Herbivore-induced volatile emissions benefit plant hosts by recruiting natural enemies of herbivorous insects. Such tritrophic interactions have been examined thoroughly in aboveground terrestrial environments. Recently, similar signals have been described in the subterranean environment, which may be of equal importance for indirect plant defense. Our work has shown that plant roots of citrus defend themselves against root herbivores by releasing an herbivore-induced plant volatile (HIPV), pregeijerene (1,5-dimethyl-cyclodeca-1,5,7-triene), that attracts naturally occurring entomopathogenic nematodes (EPNs) to larvae when applied in the field. However, the soil community is complex, containing a diversity of interspecies relationships that modulate food web assemblages. In a series of experiments we examine the specificity of this HIPV in the complex nematode community, including beneficial entomopathogenic nematodes, plant-parasitic nematodes, as well as, hyper-parasitic nematodes and nematophagous fungi. We provide the first evidence showing subterranean HIPVs behave much the

same as those aboveground, attracting not only parasitoids, but also hyperparasites and other food web members.

Symposium. Monday, 15:30. **8**

Root Zone Chemical Ecology; New Techniques for Below Ground Sampling and Analyses of Volatile Semiochemicals

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The ban of the fumigant methyl bromide has led to a need for new methods to control soil-dwelling plant pests. The use of semiochemicals is one such avenue of research since studies of plants above ground release of volatile organic compounds (VOCs) in response to herbivory have resulted in effective control methods for insect pests and also plant roots might release induced VOCs that attract organisms such as entomopathogenic nematodes. However, studies of such below ground interactions lags because of the complexity of the system. For example, in addition to plants roots, potentially important VOCs can be produced also by microorganisms, insects and nematodes and in soil VOCs are released into a virtually static airspace where they disperse solely by diffusion. To bypass this complexity root-related VOCs have been sampled by transferring roots from a pot to an artificial environment where most of the air surrounding the roots is drawn through an adsorption filter that trap VOCs, or by maceration and solvent extraction. This creates an artificial VOC profile with little relevance to the system intended to be studied. To address the need for more sensitive and less intrusive *in vivo* studies of below-ground VOC governed interactions probes were designed for direct in-soil sampling. In combination with improved thermal desorption GC/MS analyses the probes allowed short sampling times and required removal of minimal air volumes. This technique makes it possible to continuously monitor and follow the dynamics of root zoon VOCs in response to insect or nematode infestations.

CONTRIBUTED PAPERS Monday, 14:00-16:00

BACTERIA 1

Contributed paper. Monday, 14:00. **9**

Discovery of Insecticidal Proteins from Non-Bacillus Bacterial Species

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Crops expressing various *Bacillus thuringiensis*-derived insecticidal Cry protein genes have been on the market for over 15 years and have provided significant value to growers. Such products also provide a significant positive impact on the environment due to the reduced need for chemical insecticides. However, there remains the need for the discovery of alternative actives that can complement or substitute for Cry toxins. A screen of bacterial collections led to the discovery of several insecticidal protein genes with great potential for developing insect resistant crops. Two examples representing actives from non-Bacillus sources will be presented: PIP-1A is a 30 kD protein isolated form a *Pseudomonas* strain showing strong activity against hemipteran and certain lepidopteran pests. AfIP-1A and AfIP-1B is a pair of binary proteins isolated from an *Alcaligenes* strain demonstrating potent corn rootworm killing activity. Corn plants expressing this pair of proteins display high resistance to WCRW. Preliminary studies on AfIP-1A and AfIP-1B in terms of protein biochemical characteristics, insecticidal activity spectrum and insect mid-gut binding properties indicate this pair of binary proteins may function in ways similar to some Cry proteins from Bacillus sources. Our work demonstrates that bacteria that are not Bacillus can be valuable sources of insecticidal proteins.

Contributed paper. Monday, 14:15. **10**

Discovery and optimization of hemipteran-active proteins for Lygus control in cotton

James A. Baum, Waseem Akbar, Konasale Anilkumar, David Bowen, Robert S. Brown, Cathy Chay, Thomas Clark, Michael Pleau, Xiaohong Shi, Uma Sukuru, Moritz Von Rechenberg, Halong Vu, Brent Werner, Andrew Wollacott
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The plant bugs *Lygus hesperus* and *Lygus lineolaris* have emerged as economic pests of cotton in the United States. These hemipteran species are not controlled by the lepidopteran-specific insect control traits (*Bacillus thuringiensis* Cry proteins) found in genetically-modified commercial varieties of cotton. We have identified several novel Bt Cry proteins that are toxic to Lygus nymphs in artificial diet bioassays. Several of these proteins have been further modified to exhibit improved toxicity towards both Lygus species while retaining the insecticidal specificity of the parent protein. Cotton plants expressing modified Cry proteins show enhanced protection from Lygus feeding damage in the field.

Contributed paper. Monday, 14:30. **11**

Isolation and identification of potential biological control agent from *Tortrix viridana* L.(Lepidoptera: Tortricidae) pupae

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Tortrix viridana is one of the most important pest in the oak fields in Turkey. The aim of this study is to find a more effective and safe biological control agent against *Tortrix viridana.* For this purpose, pupae of *T. viridana* were collected from Artvin province, Turkey in 2013. According to the morphological, biochemical tests, API20E and API50CH panel test system and 16S rRNA gene sequence analysis, the bacterial isolates were identified as Serratia *liquefaciens* (Tv1), *Enterococcus* sp. (Tv2), *Rhodococcus erytropolis* (Tv3), *Rahnella aquatilis* (Tv4), *Curtobacterium flaccumfaciens* (Tv5), *Pseudomonas* sp. (Tv6). Future research will be tested insecticidal effects of these bacterial isolates against *T. viridana.*.