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SE33 C03

ROLE OF PUSH-PUSH COMPANION PLANT VOLATILES IN THE MANAGEMENT OF THE INVASIVE FALL ARMWORM (*SPODOPTERA FRUGIPERDA*) PEST

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Fall armyworm, *Spodoptera frugiperda*, is a serious invasive pest in Africa but "Push-Pull" companion cropping can substantially reduce infestation. Our study elucidates the underpinning chemical ecology mechanisms. Headspace volatiles were collected from companion plants (*Desmodium intortum, Desmodium uncinatum* and *Brachiaria mulato II*) and used in bioassays and electrophysiological recordings with *S. frugiperda* and parasitoid wasps. Insect populations, plant damage and herbivore parasitism were assessed under field conditions. Coupled GC-electroantennogram (GC-EAG) recordings showed robust responses to certain aromatic and terpenoid volatile compounds. In wind tunnel bioassays, maize volatiles mixed with *Desmodium* volatiles were less attractive to moths than maize alone. In oviposition bioassays, *S. frugiperda* laid fewer eggs on maize when *Desmodium* volatiles were present. In an olfactometer bioassay, parasitoid wasps were attracted to the scent of both *Desmodium spp.* (intercrop) and the *Brachiaria* border crop. Our data provide evidence of the mechanisms underpinning the reduced *S. frugiperda* infestation in the Push-Pull companion cropping system i.e. volatiles from companion crops repel *S. frugiperda* while attracting its parasitoid natural enemies. These findings explain why Push-Pull field plots had fewer *S. frugiperda* larvae and lower crop damage than monocropped maize.

SE33 C04

POTENTIAL OF SELECTED ESSENTIAL OILS FOR THE CONTROL OF THE EUROPEAN TRUFFLE BEETLE (*LEIODES CINNAMOMEUS*)

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The bioactivity of 14 essential oils extracted from semi-industrial pilot plant (table 1), were tested *in vitro* against one of the most important emergent pests of truffle plantations nowadays, the so-called European Black Truffle beetle *Leiodes cinnamomeus* in terms of repellent activity and contact toxicity. First, a preliminary screening was conducted using filter paper as carrier in both assays, in order to select the most promising plant species. For this purpose, 0.5% (v/v) and 400µg/insect were the initial doses. From this screening, *Mentha rotundifolia*, *Satureja montana*, *Tanacetum vulgare* and *Origanum virens* were the most effective in contact toxicity (100%); regarding repellent activity, this effect was observed, with a certain knock-down effect in most of the species chosen due to neurotoxicity of essential oils. In the light of these results, a follow-up toxicity dose-response experiment was undergone for filter paper formulation, in parallel with different formulations (alginate encapsulation and application on cellulose microfiber dishcloth) of the above mentioned 4 essential oils for the same doses. Activity assessed on cellulose microfiber dishcloths remained the highest after lowering doses to 100µg/insect. Also, another follow-up experiment was designed to better asses repellent activity. Dose was doubled in such oils where the knock-down was the lightest and halved in those where the knock-down was stronger. Nearly every oil saw its repellent activity enhanced following this strategy, thus dose-response experiments were undergone in those where the knock-down had been the greater. Again, the same 4 essential oils returned the best bioactivity and were diluted to 1/10 of the original dose. The same alternative formulations as for the toxicity assays were tested for such 4 essential oils, with remarkable differences in the bioactivity presented.

Essential oils	Essential oils
Artemisia absinthium	Rosmarinus officinalis
Dittrichia graveolens	Salvia lavandulifolia x officinalis
Lavandin grosso	Salvia officinalis
Lavandin super	Satureja montana
Lavandula luisieri	Tanacetum vulgare
Mentha rotundifolia	Thymus vulgaris
Oreganum virens	Thymus zygis

Table 1.- Plant species from which the essential oils tested were obtained.

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SE33 C05

METABOLOMIC AND AGRONOMIC CLUSTERING OF BIOACTIVE ESSENTIAL OILS FROM CULTIVATED SPANISH AROMATIC PLANTS

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Essential oils (EOs) are volatile natural components extracted from aromatic plants with many biological activities including these related to plant protection against pests and diseases and are being considered as an alternative to synthetic pesticides. In this work, aromatic plants from 19 species belonging to different genera have been adapted to cultivation in preliminary field trials located in Aragon, Spain. These fields, with 50 plants of each species, were supplemented with drip irrigation from June to August (4 L h^{-1}, 5-6 h $week^{-1}$) for 3 years. Plants were manually harvested at 75% of blooming to evaluate yearly biomass production to be distilled in a steam distillation pilot plant, and the essential oil yield (EOY) (%)

calculated. The EOs distilled between 2017 and 2019 were analysed by GC-MS and tested against a stored product pest model (*Tribolium confusum*) in repellency, direct contact (with filter paper or crystallized cellulose as carriers) or contactless toxicity (fumigation). Thirteen of the EOs showed at least one type of bioactivity against the model insect. Some species share similar compounds that could explain their bioactivity, despite agronomic data showed significant differences. Considering chemical composition, bioactivity and agronomic performance, the EOs were grouped using Rstudio as clustering and dendrogram plotting tool, resulting in five groups. Groups 3 (thymol, carvacrol and p-cymene) and 4 (piperitenone and piperitenone oxide) hold the strongest bioactivity (lowest EC_{50} values for repellency and toxicity, respectively). Therefore, this composition-bioactivity based grouping method holds potential to predict additional bioactivities of essential oils based on their chemical compositions, rather than phylogenetic relationships. Additionally, the agronomic data gatherted for each species allows for the election of the best performing species for cultivation.

SE33 C06

COMPARISON OF EXTRACTION METHODS FOR THE DETERMINATION OF ESSENTIAL OIL CONTENT, COMPOSITION AND ANTIFUNGAL ACTIVITY OF DIFFERENT PLANT SPECIES

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Plant essential oils (EOs) are gaining interest as biopesticides for crop protection. The antifungal effect of some EOs is one of their most important crop protection properties. In addition to these direct effects on the pathogen, it has been reported that EOs can induce plant defenses (priming effects) resulting in better protection against the pathogen. Considering the growing importance of EOS as active ingredients, the domestication and cultivation of Aromatic and Medicinal Plants (AMPs) to produce chemically stable EOs contributes to species conservation, provides sustainability of the production and lower variations in active ingredients. Otherwise, the essential oil content and consequently their bioactivity can vary with development stage and by extraction methods. The aim of the study was to compare a laboratory distillation in a Clevenger apparatus and steam distillation in a pilot plant to extract EOs from plant species belonging to the genera Artemisia, Dittrichia, Geranium Lavandula, Mentha, Origanum, Rosmarinus, Salvia, Satureja, Santolina, Tanacetum and Thymus experimentally cultivated. The Eos were analyzed by GC-MS and tested in vitro against phytopathogenic fungi (spores of Alternaria alternata, Botrytis cinerea, Fusarium oxysporum) to select the most active and les phytotoxic one (against Lolium perenne) as plant candidates. Differences in activity and composition have been found between the laboratory and pilot plant extracted oils. Therefore, the semi-industrial conditions for the extraction of bioactive EOs must be optimized case by case to improve the EO content in bioactive compounds.

SE33 C07

VOLATILE COMPOUNDS FROM BACILLUS SIAMENSIS NKIT9 INHIBIT MYCELIAL GROWTH OF RHIZOCTONIA SOLANI

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*Rhizoctonia solan*i, a widespread fungus, affects crops in both greenhouse and field environments, leading to plant damping-off and fruit rot, and consequently substantial yield losses. This study explores the use of bacterial volatile organic compounds (VOCs) as an alternative to chemical pesticides to control *R. solani* infections. Bioassays conducted in sealed plates demonstrated that VOCs produced by *Bacillus siamensis* strain NKIT9 significantly inhibited *R. solani* mycelial growth by over 60%. Solid-phase microextraction-Gas chromatography-mass spectrometry (SPME-GC-MS) analysis identified more than 40 volatile compounds, including 2-Undecanone, 6-methyl-2-heptanone, Heptadecane, and β-fenchol, which are known for their antifungal properties. Among these, 2-Undecanone exhibited the highest antifungal activity against *R. solani*.