Periodic Reporting for period 1 - nEUROSTRESSPEP (Novel biocontrol agents for insect pests from neuroendocrinology)

Reporting period: 2015-06-01 to 2016-11-30

Summary of the context and overall objectives of the project

For the global population, production of safe and nutritious food is a main pillar for Food Security. To achieve this, sustainable and resilient agricultural practices, with lower impact on the environment, are required. However, Food Security is critically impacted by insects, both as major pollinators and as destroyers of the world's crops; and also of animal health, as vectors of disease. Insecticides are thus used to control insect pests, which range across all production sectors, including agriculture, horticulture and forestry. Insecticide use has resulted in several problems including resistance by insects and environmental costs. Also, pests adapt and new pests emerge. There is thus a need for new, more selective (and thus 'greener') ways of controlling insect pest species whilst protecting beneficial insects. nEUROSTRESSPEP will develop new small protein ‘mimetics’, similar in function to the insects’ own small protein hormones, which will interfere with insects’ survival ability. These may be developed as new classes of environmentally-friendly insect control agents targeted to specific groups of insects, whilst protecting beneficial insects; and which do not engender insect resistance.

nEUROSTRESSPEP will contribute to Food Security for societal needs through a multi-actor approach, with sustained interaction between the general public, farmers, growers, policy makers, scientists and industry, which will also influence policy design and meet consumers' needs and preferences. Finally, technology is a major economic and societal driver for the EU and globally. nEUROSTRESSPEP will strengthen the competitiveness and growth of companies by generating new foundational knowledge towards innovation.

nEUROSTRESSPEP’s objectives are to:
• provide a more efficient and careful husbanding of limited resources while minimizing adverse societal impact across agriculture, horticulture and forestry, together with the bio-based industries
• develop integrated mechanisms of response measures (practical solutions), ranging from prevention of entry to novel Integrated Pest Management approaches
• deliver novel, ‘green’ neuropeptide-based insect pest biocontrol tools

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

The consortium as a whole has successfully maintained or has access to, 23 different pest and model insect species which are used for our studies. Comparison of neuropeptides between insect species provides a rationale for selecting neuropeptides for detailed further study towards specificity. We have sampled and curated thousands of peptide sequences in hundreds of species, representing 97% of insect species and have developed a new, publicly-available database for insect neuropeptides.
We have analysed or generated several insect transcriptomes, including from beneficial, and also alien, invasive, insect species; and have also reconciled genomics/transcriptomics data with peptidomics, which has allowed complete and accurate prediction and identification of neuropeptide precursor sequences; and of specific classes of neuropeptides including all bioactive neuropeptides. We have also established fast and accurate protocols for insect species-specific neuropeptides and extended novel technologies in peptide binding across species. Finally, we have successfully established and extended insect synthetic biology approaches for several insect species.

A range of functional studies for assessments for insect survival, as well as molecular studies, have been performed across a wide range of insects in response to several neuropeptide classes. Knockdown and/or-over-expression of neuropeptide gene expression in insects has also provided evidence for the importance of specific neuropeptides for organisinal fitness. These efforts resulted in confirmation and/or discovery of several highly suitable candidates as neuropeptide mimetics (analogues). Critical evaluation of the data obtained so far has also confirmed the originally chosen suite of neuropeptides as excellent candidates in the framework of the project, some of which can be positioned as species/order-specific insect biocontrol agents. Market analysis has also been achieved and suggests that the targets chosen are valid and represent the major pests for which new control methods will be of greatest value.

Several neuropeptide analogues have now been synthesized and tested for their ability to interfere with insect survival, together with assays to precisely determine the most selective analogues that are also being investigated for stability and bioavailability. Preliminary experiments on novel formulations for peptide analogues are also in progress. Those will be used to test the most potent and bio-stable analogues in cage and field experiments later in the project.

nEUROSTRESSPEP has been disseminated widely, from policy events to exhibitions for the general public in at least 30 events at national and international levels. nEUROSTRESSPEP has been represented in the popular press, at scientific conferences, trade fairs, exhibitions and science fairs, and at policy events.

**Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)**

In the 18 months of the project, nEUROSTRESSPEP has achieved progress beyond the State-of-the-Art in the following areas, which are described in the Technical report.

- Genomic filtering and curation across 97% of insect species to identify order/species-specificity of neuropeptides.
- Accurate and fast approaches for species-specific neuropeptide identification and spatial distribution using novel methods in mass spectrometry.
- Neuropeptide mapping revealing new insights into neuropeptide function in different insect pest species.
- Insect synthetic biology and genetic modification of insect pest species.
- Number and range of availability of peptide mimetics (analogues).
- Functional assessment of peptide analogues across multiple insect species.
- Market and data analysis for insect pests (current and future threats) and crops, based on cost of current control measures.

During the 18-month period, there have been sustained interactions with the agency partners in the consortium. We have also initiated discussions, presentations and exhibitions between, and to, the general public, farmers, growers, policy makers, scientists, and industry. This will continue in a sustained way for the next phase of the project and will be essential in filling gaps in our knowledge, driving research - and in doing so will influence policy design.

Towards social impact, we have significantly increased female representation in nEUROSTRESSPEP from time of submission; have encouraged female scientists to actively engage in dissemination, communication and outreach activities, and have also continued to encourage greater participation of women in activities across the programme.

Towards economic impact, the routes to market appropriate for the food, horticulture and forestry sectors have been explored, using qualitative socioeconomic research methods that capitalise on the nEUROSTRESSPEP team’s strong links with stakeholders across these sectors. nEUROSTRESSPEP has also strengthened the competitiveness and growth of companies by generating new foundational knowledge towards innovation. During the 18 month period, nEUROSTRESSPEP company partners have all developed innovation capacity via nEUROSTRESSPEP tasks. This is expected to develop further, as we have linked the
State-of-the-Art innovation of nEUROSTRESSPEP to market needs.

Related information

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