RNAi_safe: The efficacy and potential impact of RNAi technology on target and non-target organisms in crop protection against aphids

Merkel, Lisa[1]; Joachim, Christoph[2]; Erler, Silvio[3]; Will, Torsten[4]; Amari, Khalid[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Biosafety in Plant Biotechnology, Quedlinburg, Germany.
[2]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Field Crops and Grassland, Braunschweig, Germany.
[3]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Bee Protection, Braunschweig, Germany.
[4]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Resistance Research and Stress Tolerance, Quedlinburg, Germany.
Email of corresponding author: lisa.merkel@julius-kuehn.de

Agricultural ecosystems worldwide face an ongoing challenge from destructive pests. To address this issue, RNA interference (RNAi)-based technology, specifically external application of double-stranded RNA (dsRNA), holds promise as an emerging alternative to traditional chemical pesticides. RNAi is a highly efficient, naturally occurring process that can be tailored to target specific organisms and suppress specific genes. This customization allows for the reduction or elimination of unintended effects on non-target organisms and the environment.

RNAi-based biopesticides have demonstrated their effectiveness against pests like the pea aphid (*Acyrthosiphon pisum*) and the green peach aphid (*Myzus persicae*), which feed on phloem sap. These pests excrete gel saliva that forms a protective sheath around their mouthparts as they feed, ultimately damaging plants by depriving them of nutrients and transmitting viruses. Silencing the gene responsible for sheath formation, known as the structural sheath protein (*shp*), has been shown to hinder aphid growth, reproduction, and survival.

Our research project seeks to evaluate the potential of using dsRNA-spray applications as a means of controlling aphid infestations, while also investigating environmental exposure and the fate of dsRNA. Initially, we employed bioinformatics to identify target gene sequences that share high homology between the two pest species of interest, *A. pisum* and *M. persicae*. After aphids ingested dsRNA synthesized *in vitro* through an artificial diet, our analysis using quantitative polymerase chain reaction (qPCR) revealed a significant reduction in *shp* gene expression. Additionally, we identified suitable dsRNA sequences to silence other genes, broadening the applicability of this approach.

In the next phase of our project, we will focus on identifying potential routes of exposure and assessing the impact of applied dsRNA on non-target organisms such as honey bees, ladybugs, and other beneficial insects. Finally, we will assess the stability of the dsRNA spray at various temperatures to evaluate its effectiveness in different geographic regions and its resilience in the face of changing climatic conditions.