ISRC Research Proposal – Executive Summary

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Project title: RNA-based approaches for resistance to nematode and fungal pathogens of soybean

Dates of proposed project funding: October 1, 2015 – September 30, 2016

Summary:
Over the past few years, researchers have demonstrated that novel, exciting, and practical strategies to manage diseases caused by pathogens of plants can be developed through the application of small RNA-based technologies. These RNA-based approaches involve engineering the plant to produce small RNA molecules that specifically inactivate plant or pathogen genes. This action, if designed correctly, can make plants more resistant or directly kill or inactivate the pathogen. In either case, the outcome is reduced pathogen growth and less disease. The production of small RNAs is relatively easy to manipulate, ***but the challenge is finding the suitable plant or pathogen target at which to direct the small RNA***.

Our proposal is primarily concerned with identifying plant targets that can be manipulated to provide resistance to soybean cyst nematode (SCN) and pathogen targets that will disable the soybean rust (SBR) fungus, *Phakopsora pachyrhizi*. In addition, we are working to translate the identification of targets into a demonstration that it is possible to manipulate plant responses or directly target essential fungal genes with small RNAs to engineer new, durable resistance traits in soybean. Towards our goal of small RNA-based resistance to soybean pathogens, we propose the following two objectives:

1. Fully characterize and exploit soybean microRNAs that control plant responses to SCN.
2. Identify genes of SBR that reduce or eliminate infection when silenced.

For the SCN objective our approach is to focus on the manipulation for different soybean small RNAs, which are called microRNAs, that we have shown to play a role in the formation of a functioning feeding site for the nematode. Interfering with the production or function of these microRNAs prevents the SCN from feeding and thus reduces its ability to reproduce and cause disease. For the SBR objective, our approach is to focus on the host-induced gene silencing of *P. pachyrhizi* genes that are necessary for establishing infection. We have identified a number of *P. pachyrhizi* genes that have the ability to block soybean defense responses, which appears critical to survival of the fungus. We are targeting these genes with small RNAs that can turn off the expression of these essential fungal genes and limit the ability of *P. pachyrhizi* to grow in soybean leaves and cause disease.

Completion of the proposed project will enable us to develop and validate novel targets needed to disrupt the life cycles of two destructive soybean pathogens. Prior ISA funding has allowed us to identify important small RNA targets and to initiate the inactivation strategies. For example, we already have generated stable transgenic soybean lines expressing miRNAs and these lines now need to be further characterized genetically and evaluated for their SCN susceptibility. Similarly, RNA constructs targeting SBR genes have been generated with prior ISA report and now need to be tested and evaluated. Successful completion of the work proposed here will generate powerful tools to combat soybean's most important pathogen problems that are estimated to cause billions of dollars in annual losses in the US.