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| Project Title  | Southern Root-Knot Nematode in Maturity Group 4 Soybean: Characterization of Resistance Mechanisms and Breeding for Resistance |
| PI’s Name  | Leandro Mozzoni  | E-mail  | lmozzon@uark.edu |
| PI’s Title  | Associate Professor  | Institution:  | University of Arkansas |
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| Additional PIs For this project | Dr. Travis Faske (Univ. of Arkansas) and Dr. Tristan Watson (Louisiana State University) are plant nematologists. Dr. Henry Nguyen (University of Missouri) is a molecular geneticist. Dr. Pengyin Chen (Univ. of Missouri) is a soybean breeder. |
| Research Locations (and states involved) | Columbia, MO; Portageville, MO; Fayetteville, AR; Lonoke, AR; Baton Rouge, LA |
| **Timeline:** **Current Year - FY22** | **Multi-Year Project Information** (if applicable) |
| Year 1  | Year 2  | Year 3 |
| Start Date  | March 1, 2022 |  |  |  |
| End Date  | Feb. 28, 2023 |  |  |  |
| Funds Requested  | $150,000  | $  | $  | $ |
| **Program Area (e.g., breeding, mngt.): Breeding** |
| Objectives  | i) Characterize the mechanism of resistance to SRKN by a series of time course studies for nematode maturity of known and newly-identified resistant sources ii) Genetic characterization and development of functional markers for new sources of resistance to SRKN iii) Development of breeding populations, marker-assisted selection, field testing, and deployment of MG4 soybean varieties with resistance to SRKN. |
| Justification  | Southern root-knot nematode (SRKN, *Meloidogyne incognita*) is the most important, yield-limiting nematode pest of soybean in the Southern US. Maturity Group 4 (MG4) soybean is estimated to be planted in approximately 17M acres in the US. Although SRKN is drastically aggressive to soybean plants and highly detrimental to the US soybean value chain, efforts to enhance the availability of MG4 soybean varieties resistant to SRKN have been minimal. The majority of commercial varieties are susceptible, and those that are resistant rely on a single gene and are of late maturity (MG5 and later). This project aims to characterize resistance to SRKN with the objective to identify new sources and mechanisms of resistance, to introgress such resistance into MG4 soybean varieties, and to translate these efforts to the research and farming community in terms of production meeting updates, extension publications, and deployment of resistant soybean varieties. |

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| Exp Setup  | 1. Mechanisms of resistance: A series of diverse genotypes carrying putatively different resistant genes/QTL to SRKN will be planted in the greenhouse to study the nematode ability to penetrate roots, develop, and reproduce. Two populations of nematodes will be used, and the experiments will run in simultaneous in Arkansas and Louisiana. At specific time points, roots will be assessed for reaction at infection site, and nematodes will be quantified. 2. Genetic characterization of resistance sources: Three MG 4 Plant Introductions (PI 438489B, PI 567516C and PI 567305) have been genetically mapped for SRKN resistance and the results confirmed the major QTL on chromosome 10 and chromosome 13 across all three genetic backgrounds; further work is needed to isolate the underlying gene and understand the resistance mechanism. Minor QTLs were also detected on Chromosome 8 and 17 depending on the genetic resource; further genetic characterization of the genes and resistance mechanisms involved will be done in this project. In addition, functional markers will be developed from these new resistance sources for gene introgression and stacking into MG 4 soybeans. 3. Development of breeding populations and deployment of MG4 varieties with new sources and mechanisms of SRKN resistance: a) Genotypes identified from objective 1 and 2 with novel sources or with contrasting mechanisms of resistance will be used in crosses to develop new breeding populations. Standard breeding methodologies will be used throughout the population and line development stage. Screening for SRKN reaction will be conducted on finished lines, in simultaneous with field testing for yield and other agronomic traits. b) For those genes for which molecular markers are developed in objective 2, a marker-assisted approach will be implemented at either the inbreeding stage (Arkansas) or pure-line stage (Missouri) to enrich or select individuals with greater probability of SRKN resistance. |
| Summary  | Southern root-knot nematode is the most important, yield-limiting nematode pest of soybean in the Southern US. However, the majority of commercially available MG4 varieties are susceptible. Moreover, it is not known the mechanism by which soybean resistance to SRKN occurs. This project aims to characterize mechanisms and sources of resistance to SRKN and incorporate them into MG4 soybean varieties. Multi-disciplinary research approaches between nematology, plant breeding, and molecular biology will be utilized for this project. |
| Key Metrics  | • At least 3 soybean genotypes with unique SRKN resistance genes or resistance mechanisms are expected to be identified by end of project duration. • About 3 new advanced breeding lines/cultivars with early maturity, high yield and SRKN resistance are expected to be identified by end of project duration. |

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| Expected Deliverables | • A peer-reviewed publication submitted to the Journal of Nematology (or similar) with the results of the identification of mechanisms of resistance to SRKN (Objective 1). • Extension publication(s) on soybean resistance mechanisms to SRKN (Objective 1). • A peer-reviewed publication submitted to Crop Science Journal (or similar) with the results of the genetic characterization of soybean resistance (Objective 2). • A peer-reviewed publication submitted to Crop Science Journal (or similar) with the development of molecular markers in breeder-friendly platforms (like KASP®) for implementation in MAS to stack or introgress new sources or mechanisms of resistance (Objective 2). • Variety/Germplasm release notifications for soybean lines with SRKN resistance and early maturity (Objective 3). • A field day in Lonoke, AR to showcase research results, including lines with contrasting resistance mechanisms (Objective 1), with diverse resistance sources (Objective 2), or with improved yield, early maturity, and SRKN resistance (Objective 3). |
| Benefit to midsouth farmers | The technology developed from this project, including nematode screening, soybean germplasm, genes, and molecular breeding strategies, will help the research community, private and public breeders, and producers dealing with SRKN. Resistance, deployed into earlier maturities as currently planted in the Southern US, is critical for a successful management of the disease because SRKN has been moving northwards overtime. In addition, successful long-term value of SRKN resistance occurs when multiple resistance mechanisms are deployed and/or multiple resistance genes for SRKN are stacked; this project will enable generate the knowledge and products necessary to protect SRKN resistance durability. In all, the outcomes of this project will help maintain the competitive position of US agriculture in worldwide soybean production.  |
| Progress Made  | New project submission. |
| Signature of Principle Investigator  | Date: 08/02/2021 |