

## **Deciphering genetic and physiological mechanisms that enhance nitrogen use efficiency and seed oil accumulation in camelina**

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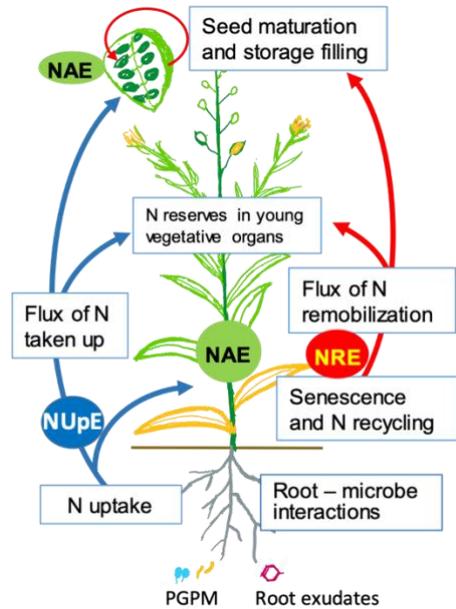
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**Project Goals: Camelina is a Brassica oilseed crop that has great potential to become a sustainable source of bioenergy in the US. However, the low nitrogen use efficiency and the low seed and oil yield compared to other major oilseed crops hinder this potential. The goal of this project is to decipher the genetic and physiological mechanisms that determine the nitrogen use efficiency and oilseed yield during the most critical processes of the camelina life cycle: 1) how camelina, in partnership with soil microbes, maximizes its ability to absorb and assimilate nitrogen into vegetative biomass; and 2) upon the transition to reproductive growth, how nitrogen is efficiently remobilized from senescing tissues (leaves and silicles) into sinks (seeds) to optimize yield potential by increasing seed size and enhancing oil synthesis.**

Camelina (*Camelina sativa*) is a promising non-food oilseed crop that provides a biofuel feedstock especially in the Northwest of the United States. Integration of camelina, a broadleaf cruciferous crop, could also improve the regions' cereal-based cropping systems and boost rural economies. This project addresses two critical challenges in camelina biology that hinder its great potential: 1) Enhancing nitrogen utilization efficiency (NUE) for economic profitability and reducing the negative environmental impact associated with nitrogen fertilization; 2) Boosting oil yield for its productivity competitiveness to other major oilseed crops such as canola.

Our overall goal is to obtain a systems-level understanding of genetic and physiological mechanisms that may be used to enhance NUE and oil accumulation in camelina; specifically how camelina plants, in partnership with beneficial soil microbes, acquire N to promote vegetative growth and biomass accumulation, then during reproductive growth remobilize N assimilates from senescing tissues to seeds, and finally utilize the C and N assimilates for the biosynthesis of seed storage products, particularly oil. We will answer some key questions in these processes based on our unique expertise and recent discoveries, which together with our other related research in camelina, have resulted in abundant genomic resources and established tools. Importantly, camelina is a closely related species to *Arabidopsis*. Our research will therefore benefit significantly from the knowledge already obtained in this latter model plant. We will achieve the following **specific objectives**:

- 1) Identify and characterize genes and gene networks in camelina that play key roles in regulating nitrogen use efficiency (NUE) and seed oil accumulation.
- 2) Define the camelina rhizobiomes, investigate their dynamics in composition and abundance responding to camelina genotypes and N conditions; and to isolate beneficial bacteria and test their functions in promoting camelina growth.
- 3) Characterize key physiological mechanisms in camelina that enhance the efficiencies of N uptake (NUpE) from soil and promote efficient N remobilization (NRE) from source to sink (developing seed) tissues, and those that enhance sink capacity (seed size and oil synthesis activity) to boost oilseed yield.



The goal will be achieved by the genomics driven approaches, including quantitative molecular genetics, comparative transcriptomics, proteomics, and metabolomics, as well as biochemical studies and metabolic flux analyses in phenotypically diverse camelina lines that are isolated from natural variation and mutants or created by transgenics.

### ***Anticipated Outcomes and Potential Impact***

This highly integrative project will provide a systems-level understanding of fundamental mechanisms in camelina that regulate nitrogen uptake, assimilation, remobilization, and seed development and oil accumulation. This knowledge is necessary for the development of next-generation high-oil-yielding camelina varieties with minimum nitrogen fertilization for sustainable bioenergy production. Besides the direct outcome of several natural and engineered camelina lines with advanced traits like large seed and high oil content, results from this research will fill knowledge gaps in many key areas of plant development, physiology and plant-microbe interactions. The basic science advancement will benefit the development of other related brassica oilseed species for sustainable production. In addition, this project will provide training opportunities for young scientists including graduate students and postdocs in genomics, biochemistry and biotechnology.

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