Project title: NUE phenotyping system for crop germplasm

Researcher / research team: Andrew Beacham

Project overview:

Agricultural sustainability is vital to ensure provision for both a healthy population and healthy planet. Changes to agricultural inputs such as fertiliser are necessary for the benefit of producers, consumers, and the environment alike. In intensive agricultural systems, much of the nutrition applied is not used by the crop and is leached to the environment with negative consequences. Furthermore, production of mineral fertilizers has very high energy requirements and such inputs therefore represent a large proportion of production costs. This has been exacerbated in the current political climate with fertiliser prices increasing dramatically in the last year. Therefore, developing crops with improved nutrient use efficiency (NUE - the amount of biomass produced per unit of fertiliser) will help to reduce input costs for producers and their associated environmental impact. This project will develop a high-throughput rapid NUE phenotyping system for crop germplasm to permit rapid identification of crop accessions with beneficial NUE traits and accelerate the development of new improved-NUE varieties using lettuce as an example crop.

Research outcomes:

Four lettuce varieties (All Year Round, Lakeland, Little Gem, Lollo Rossa) were compared, each at three different nutrient doses (1.0x, 0.5x, 0.3x). Plants were grown in a hydroponic system and the solution analysed chemically at the start and end of each trial for the content of nitrate-N, sulphate (SO_4), chloride (Cl^-), phosphorus (P), potassium (K), magnesium (Mg), calcium (Ca) and sodium (Na). Analysing data on an individual nutrient basis did not reveal any significant changes in use efficiency with initial nutrient dose. When the four lettuce varieties were compared, it was found that Lollo Rossa exhibited a significantly ($p<0.05$) higher nitrate-N use efficiency compared to the other three varieties. No other significant differences between varieties were found for the other nutrients analysed. No significant interactions between nutrient dose and lettuce variety were. These data demonstrate the ability of the system to detect genotypic influence on NUE in this crop species.

Practical application / Sector use:

These data indicate the suitability of the assay for determining NUE variation in lettuce in a medium-throughput hydroponic system which is able to utilise a range of nutrition regimes to investigate NUE at different input rates and for multiple varieties.

Furthermore, the assay can therefore be used to allow selection of optimal germplasm and help breeders to produce more efficient varieties, reducing agricultural inputs, costs, and environmental effects. Savings can be passed through the grower, processor, and consumer stages. In addition, as hydroponic systems are a popular commercial production method for lettuce and other crops, so the assay system used here has increased real-world relevance and applicability. It is also envisioned that the assay will subsequently be adapted for additional crop species in future research.