The role of inflorescence photosynthesis in competitive ability and fecundity of an agricultural weed, *Avena fatua*

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1. Introduction

- *Avena fatua* is considered one of the ten most problematic annual weeds in temperate agriculture and is an especially serious weed in cereal crops such as barley and wheat.
- The high reproductive capacity of *A. fatua,* which is its capacity to produce a great number of seeds able to stay vital for longer, with the ability to grow tall make it highly competitive with cereal crops, leading to important yield losses.
- We propose that inflorescence photosynthesis can overcome the trade-off between growth and reproduction as it enables continued carbon gain. Furthermore, we hypothesize that optimising traits associated with earlier vegetative development of cereals may be a more attainable prospect for weed suppression.

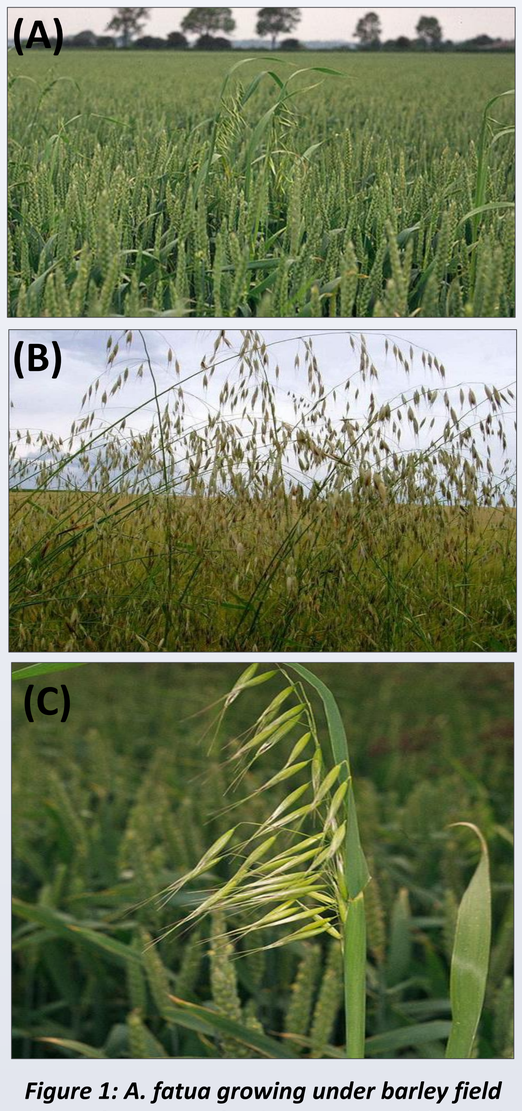

Figure 1: A. fatua growing under barley field (A), the reproductive stage (B) and inflorescence organs of A. fatua (C)

2. Methodology

- This study focuses on *A. fatua* (wild oat) as one the most detrimental annual grass weeds widely distributed in the south and east of Ireland. *A. fatua* seeds from East Cork were grown in a glasshouse equipped with light and temperature regulating system.
- From the start of the reproductive phase, photosynthetic activity of *A. fatua* floral organs was determined following the CO_2 fixation by the leaves (particularly flag leaves) and spikelets, measured using an infra-red gas analyser (IRGA) and backed up by chlorophyll fluorescence measurement (F_v/F_m, ΦPSII and NPQ) using PAM fluorometry.
- The photosynthesis analysis was complemented by transcriptomic analysis of mRNA-Seq samples collected from the flag leaf and inflorescence organs to focus on protein-coding genes.
- Competition between barley and *A. fatua* during vegetative development was examined to identify plant developmental traits that can be used as proxies for competitive capacity. Competition will be further monitored using a state-of-art high-throughput phenotyping platform.

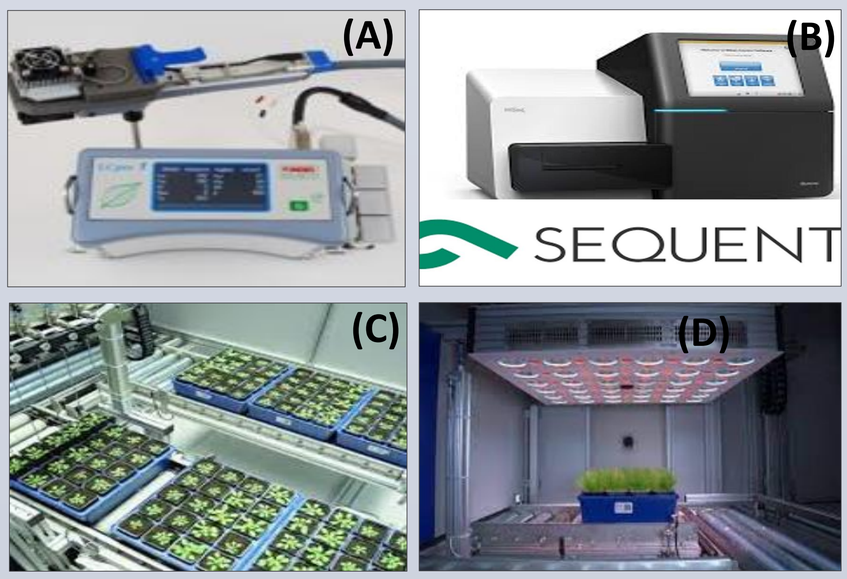

Figure 2: IRGA machine (A), Sequencing platform (B) and phenotyping platform (PlantScreen SC System, Photon System Instruments) in UCD (C) and (D)

3. Results

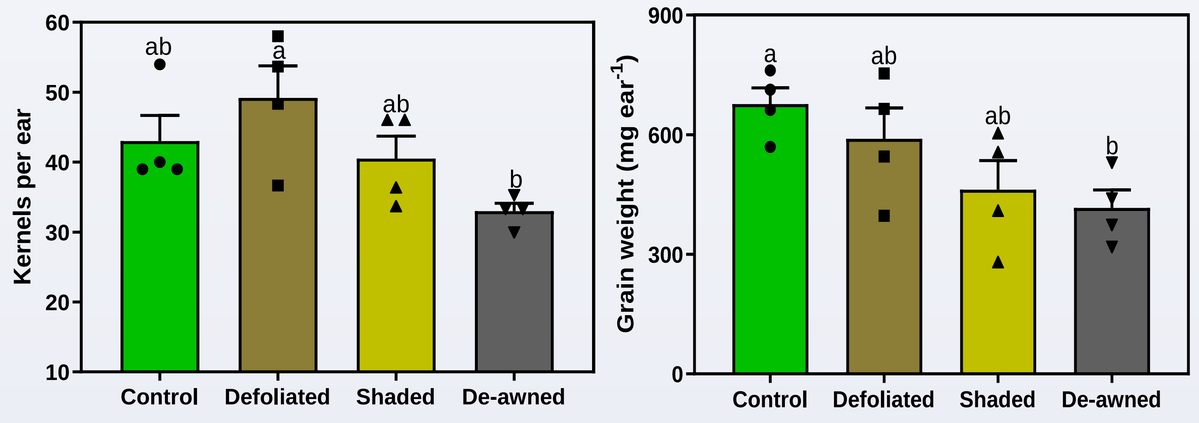

Figure 3: Effect of source-sink manipulation on A. fatua yield production; Tukey's test P < 0.05

- Following the removal of inflorescence organ (awn), a decrease of both kernel number and total weight of kernels was observed compared to controls and defoliation (Fig 3).
- A comparison of preliminary mRNA-Seq analysis reveals higher expression of genes involved in lipid oxidation but lower expression of some photosynthetic genes in the glumes compared to leaves (Fig 4).
- Initial analysis of competition with spring barley (RGT) shows only small competing effects of *A. fatua* on barley over the growing period, although *A. fatua* exhibits a significantly taller plant height with smaller leaf/tiller numbers compared to spring barley under low competitive pressure as compared to the field conditions (Fig 5).

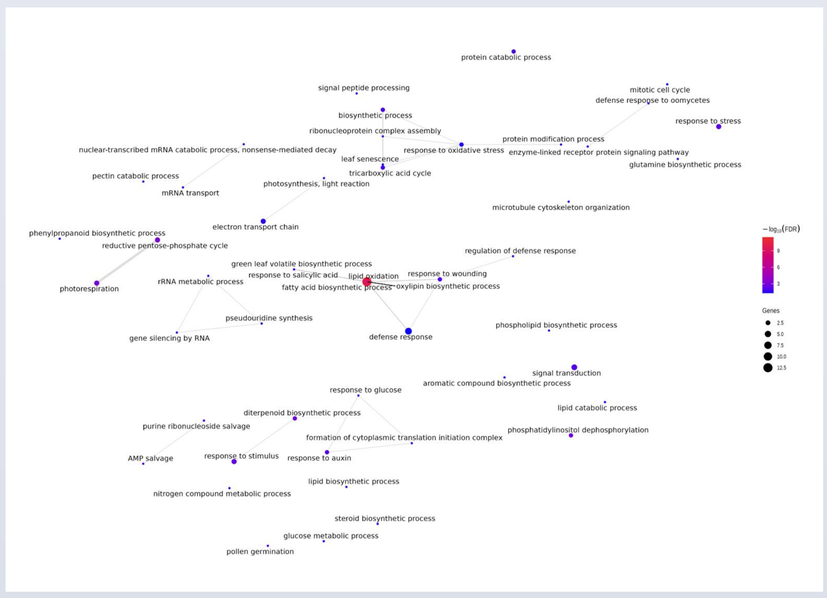

Figure 4: Network analysis of biological processes underpinned by genes expressed in the glumes compared to the leaves

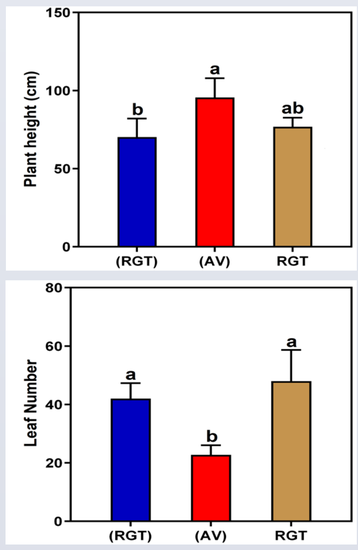

Figure 5: Effect of the competition on plant height and leaf number of A. fatua and barley; Tukey's test P < 0.05

4. Conclusions

- The decrease of seed number in response to de-awning of *A. fatua* suggests that awns contribute to photosynthetic carbon gain for seed production.
- The differences in photosynthetic genes expression between different inflorescence organs will be further explored to unravel the photosynthetic function of each inflorescence organ.
- First results from competition experiments suggest that crop traits such as plant height and number of leaves (early vigour) may be of importance in weed suppression.

References

- Wingler, A., & Sandel, B. (2023). Relationships of the competitor, stress tolerator, ruderal functional strategies of grass species with lifespan, photosynthetic type, naturalization and climate. ***AoB Plants*, 15.**
- Gnan, S., Marsh, T., & Kover, P. X. (2017) Inflorescence photosynthetic contribution to fitness releases *Arabidopsis thaliana* plants from trade-offs constraints on early flowering. ***Plos One, 12.***

Acknowledgements

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