Studentship Project: Annual Progress Report 02/2024 to 01/2025

Student Name:	**Deborah Babalola**	**AHDB Project Number:**	**SF/TF 170**
Project Title:	**The genetics of flowering in raspberry and blackberry – what makes a primocane?**		
Lead Partner:	Berry Gardens		
Supervisor:	Felicidad Fernandez (NIAB), Professor Dan Sargent (NIAB), Professor Timo Hytönen (University of Helsinki, NIAB), Dr Matt Ordidge (University of Reading)		
Start Date:	09/01/2023	**End Date:**	08/08/2027

1. Project aims and objectives

Background:

Red raspberries (*R. idaeus*) are perennial plants with, typically, biennial canes in which fruiting can be annual (also known as primocane fruiting (PF)) or biennial (floricane or summer fruiting (SF)). The summer fruiting cultivars grow vegetatively in the first year and transition into the reproductive phase in early autumn following temperature decline and short photoperiods. They have absolute low-temperature requirements for floral initiation which is linked to bud dormancy induction. In spring of the second year when the winter dormancy is broken, SF cultivars proceed to flower development and fruiting after which the canes die. However, PF cultivars can complete vegetative growth, floral initiation during long days and at high temperatures, flower development, and fruiting in a single growing season. The expression of either of the fruiting habits is determined by a complex interaction of the cultivar's genotype and environment most importantly temperature and photoperiod. While the effect of temperatures and photoperiod on floral initiation and development has been well studied, knowledge of the genetic control of this trait is limited especially as there tends to be a tip-fruiting habit in some genotypes towards the end of the season or just before entering dormancy thereby making it challenging to classify it as a qualitative trait since both PF and SF cultivars may express the tip-fruiting habit.

Aims and Objectives:

Our current study is evaluating the PF habit quantitatively in segregating populations from inter- and intra-species crosses and working towards identifying the genomic regions that influence the expression of this trait. The specific questions are:

1. what genomic region controls the PF trait?

2. what gene (s) are differentially expressed between PF and SF at the time of floral bud initiation in PF and can be altered for PF expression?
3. Can these results be translated for Marker-Assisted Breeding?

2. Key messages emerging from the project

- Alongside temperatures and photoperiods, genotype also plays a major role in determining the fruiting habit of a raspberry cultivar.
- The functions of some genes known to have flowering regulatory roles are conserved in raspberries.
- Efficiently germinating raspberry plants from seeds is doable and helps avoid bias due to poor germination in a segregating population used for gene discovery studies.

3. Summary of results from the reporting year

The expression of the PF trait was monitored in terms of flowering and fruiting earliness, and the proportion of the total buds on the first-year cane that flowered and developed into raspberry fruits. A genetic linkage map comprising seven groups was constructed from the GBS data of a segregating population of two raspberry genotypes with contrasting fruiting habits. Candidate genes are being identified based on the information available from the genomic region.

- A genetic map of seven linkage groups was constructed using GBS-based data.
- QTLs significantly associated with PF habit were identified.
- Two segregating populations derived from intra-specie crosses and another segregation population from an inter-specie cross were germinated from seeds in vitro. They were weaned in Coir in a growth cabinet five weeks after germination, moved to the glasshouse maintained at 15°C after outgrowing the cabinet, and to the polytunnels at the end of Spring season during which the fruiting habit was evaluated. Eventually, they were transferred to an open field at the end of the growing season to evaluate canes for annuality/bienniality or winter hardiness. While 12 and 9% of the intra-specie crosses flowered and produced fruits on the first-year cane, the trait was not expressed in the inter-specie cross.
- Raspberry orthologs of some genes with flowering regulation-related roles were evaluated before and after floral bud development with an expression similar to expectation.

4. Key issues to be addressed in the next year

- Expression of genes of interest in cane segments specifically distinguishing between the shoot apical meristem and leaves at the apex.
- Evaluation of intra- and intra-specie populations for PF habit and other useful traits
- Marker development and validation in independent populations
- Data mining from GBS-based QTL mapping results

5. Outputs relating to the project

(events, press articles, conference posters or presentations, scientific papers):

Output	**Detail**
Presentation	09/07/2024- Research update at the CTP Summer Event

Presentation	18/09/2024 Poster presentation at NIAB and EMT board members' visit to NIAB East Malling
Presentation	14/05/2024 Presentation at the University of Reading Crop Science Seminar
Presentation	15/01/2025- Project update at the CTP Winter Event

6. Partners (if applicable)

Scientific partners	
Industry partners	Harriet Duncalfe (Berry Gardens)
Government sponsor	UKRI-BBSRC