Studentship Project: Annual Progress Report 02/2025 to 01/2026

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)). Floricane-fruiting cultivars grow vegetatively in the first year and transition into the reproductive phase in early autumn, as temperatures decline and photoperiods shorten. They have low-temperature requirements for floral initiation, which is linked to bud dormancy induction. In the spring of the second year, when the winter dormancy is broken and the temperature becomes warmer, the floricane-fruiting 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 fruiting habit is determined by a complex interaction between the cultivar's genotype and environmental factors, 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 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, its earliness and its intensity?

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.
- Expression patterns of some genes known to have flowering regulatory roles are conserved in raspberries, indicating similar functions.
- Expression-based identification of raspberry orthologs of some key flowering genes.
- How life cycle relates to fruiting habit in Rubus species.

3. Summary of results from the reporting year

The expression of the PF trait was monitored in terms of flowering date, fruiting earliness, and the proportion of the total buds on the first-year cane that flowered and developed into raspberry fruits. In an interspecific cross, the cane life cycle was studied.

- Two populations (PF1 & PF3) were derived from intra-specific crosses between a primocane fruiting cultivar, 'Heritage' and two floricane-fruiting cultivars, 'Tulameen Pearl' and 'Preussen', and the seeds were germinated in vitro. Only 12% and 9% of the crosses flowered and produced fruits in the first year, respectively, while the trait was not expressed in the interspecific cross (PF2 family- 'Tulameen Pearl' x *R. illecebrosus*) in the first year. However, all populations segregated for PF expression on primocanes in the second year, suggesting that meeting the juvenility requirement might underlie the lower or absent PF expression in the first year.
- In the PF1 & PF3 families, 47% and 51% of the populations, respectively, had 25% - 100% of the canes of each progeny completing their cropping, i.e. fully ripening all their fruits during the first season.
- The PF2 family produced flowers but could not develop into fruits, and the pollen germination test showed non-viability, suggesting hybrid male sterility, which often occurs in interspecific crosses.
- Some phenotypic traits, including leaf appearance, flower type, and leaflet number of compound leaves (5 - 7), from *R. illecebrosus*, were dominantly expressed.
- The PF2 family segregated for the cane life cycle (annual and biennial), and the average cane height ranged from 30.97 to 103.6cm. *R. illecebrosus* is primocane fruiting with an average height of 31cm, has an annual cane and a perennial root system.
- Segregation ratio of 52% in PF1, 43% in PF2, and 53% in PF3 flowering (at the cut-off date of mid-September) supports the reported recessive genetic control of the trait.
- Although the same source of primocane fruiting was used, only the PF1 family individuals continued flowering until scoring was halted (November, 30), while flowering stopped in the PF3 family by the end of September, implying that the maximum temperature for flower bud initiation/differentiation varies between genotypes and PF expression is rather continuous than absolute in cultivars that have the potential.

- Raspberry orthologs of key flowering genes of interest were evaluated before and after floral bud development, in various segments of the cane from the apex to the base, with an expression similar to expectation.

4. Key issues to be addressed in the next year

- Transcriptome-wide identification of differentially expressed genes during floral transition
- Mapping of the PF trait from original sources with less complicated pedigrees
- Data mining
- Marker validation in independent populations
- Thesis writing

5. Outputs relating to the project

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

Output	**Detail**
Presentation	2023-2025 - Research update at the annual CTP Summer & Winter Events
Presentation	18/09/2024 - Poster presentation at NIAB and EMT board members' visit to NIAB East Malling
Presentation	2023-2025 Presentation at the annual University of Reading Crop Science Seminar
Poster presentation	6-9/05/2025- 12th Rosaceae Genomic Conference (RGC12)

6. Partners (if applicable)

Scientific partners	Felicidad Fernandez, Dr Matt Ordidge and Professor Timo Hytonen
Industry partners	Harriet Duncalfe (Berry Gardens)
Government sponsor	UKRI-BBSRC