

Studentship Project: Annual Progress Report 01/2023 to 10/2023

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 Jim Dunwell (University of Reading), Dr Matt Ordidge (University of Reading)		
Start Date:	09/01/2023	End Date:	08/08/2027

1. Project aims and objectives

Raspberry is one of the many plant species that regulate flowering time in response to seasonal cues. By default, the crop has perennial root systems from which biennial canes are initiated. In the first year of growth, canes of summer fruiting (SF) varieties are mainly vegetative. Lower temperatures and shorter day lengths in late autumn trigger floral bud initiation in SF raspberries, after which the canes become dormant. In the spring of the second year, SF varieties develop floral buds and produce fruit. In contrast, primocane or autumn fruiting varieties are able to complete shoot growth, floral bud initiation and fruit development in a single growing season independent of any of these environmental factors. Primocane fruiting (PF) raspberry varieties offer the much-needed extended fruiting season, especially for the fresh market, in response to the quest for all-year-round raspberry availability. Additional advantages include increased income from late-season fruits, reduced production costs, and avoidance of winter killing. The PF trait is believed to be under a complex genetic control with significant environmental influence on its expression. Primocane fruiting habit in raspberries was documented as early as the 18th century. Since then, there have been deliberate attempts to breed for the trait, but very little is known about the gene(s) controlling these fruiting habits. Therefore, this study is focused on identifying the genes/pathways that mediate raspberry response to environmental and endogenous cues that influence floral bud initiation. This study aims to:

- i. understand the genomic region(s) influencing the primocane fruiting habit in raspberries.
- ii. develop a gene editing protocol for raspberry and
- iii. identify PF sources from the pedigree of the parents of the segregating populations.

2. Key messages emerging from the project

The planned approach to understanding the genetics of the PF habit in raspberry includes QTL mapping of the genomic region(s) controlling the trait using existing populations segregating for this trait and other newly developed segregating populations that involve parents from other *Rubus* genera known to express the PF habit. Subsequently, gene expression studies and allele-specific marker development and validations will be carried out to provide useful tools for the introgression of the PF trait into existing raspberry varieties with excellent agronomic and other end-user characteristics.

The results described in this summary report are interim and relate to one year. In all cases, the reports refer to projects that extend over a number of years.

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3. Summary of results from the reporting year

- The data collected at intervals from existing segregating populations (EM7140, EM7127 and AR02 families) for PF phenotyping showed variability in the expression of the PF trait between plants. Of the two canes maintained per plant stand in the EM7140 family this year, very few seedlings expressed the PF trait in only one cane, a few others maintained SF habit in both canes, while most expressed PF in both canes but with varying degrees of intensity. This expression pattern further buttresses the impact of flowering earliness in parental lines on PF expression in offspring. Most seedlings in the EM7127 were SF, PF expression was weaker, and the canes became dormant earlier compared to the EM7140 family. No new floral bud development was recorded at the onset of dormancy, which tallied with the drop in temperature, and neither of the parents of the EM7127 family is known to have expressed the PF trait. However, similar to the EM7140 family, partial PF expression was observed in some seedlings. The third family, AR02, showed a PF expression and vigour similar to the EM7140 family with extended fruiting season, but 11% of the open flowers could not make it to fruit maturity. Overall, the proportion of seedlings expressing the PF habit increases with years.
- Following quality control analysis of the offspring using two microsatellite marker panels, GBS libraries of parental lines and two populations segregating for the PF trait were prepared and sequenced. GBS data was trimmed and aligned to the *Rubus idaeus* cv. 'Malling Jewel' genome assembly and SNP calling was completed.
- Multiple populations were developed from crosses between cultivars from different *Rubus* genus with contrasting fruiting habits.
- A raspberry seed germination method was optimised and adapted to weaning in low-cost soilless media.

4. Key issues to be addressed in the next year

- Establishment of the newly developed segregating populations
- QTL mapping
- Gene expression analysis based on the QTL mapping
- Marker development and validation in independent populations
- Pedigree mapping

5. Outputs relating to the project

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

Output	Detail
Presentation	29/06/2023- Project presentation to the East Malling Rubus Breeding Consortium
Presentation	05/07/2023-Presentation at the CTP summer meeting
Presentation	07/11/2023- Presentation during PhD symposium at the University of Reading
Presentation	24/01/2024-Project presentation at the CTP Winter Event

6. Partners (if applicable)

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