Developing breeding and selection tools to reduce spoilage of soft fruit and wastage in the supply chain

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Project Partners: The composition of the consortium brings together scientists, breeders, growers, suppliers and retailers to allow full understanding of the requirements for fruit firmness, and all are gratefully acknowledged for their contribution.

Background

Fig. 1 Red raspberry (*Rubus ideaus* L.)

In the raspberry industry, fruit softening remains the main cause of waste and lost revenue with losses at the farm gate estimated to be in six figures in a poor season. However, just a one to two day improvement in fruit shelf-life would increase the value of harvested fruit and reduce waste.

Softening of fruit is largely dependent on genes and their action under differing conditions. Breeders currently select seedlings from their crossing programmes which provide good fruit firmness and shelf-life, but as the breeding of such selections can produce random combinations of genes this can be a time-consuming process.

In order to reduce the amount of waste fruit and all associated costs, scientific tools are available to use red raspberry (*Rubus ideaus* L.) as a model crop to identify and investigate important fruit softening genes and their expression in response to stresses imposed by, for example temperature and water. This Horticulture LINK project aims to develop robust assisted breeding and selection tools that will enable breeders to accelerate development of new varieties having an extended shelf-life and thus reduce fruit spoilage.

The genetics of fruit softening have been investigated by testing samples from both field and polytunnel production using an established 'Latham' × 'Glen Moy' mapping population of 188 progeny. Fruit firmness in this population and the parents was assessed over two years using a 'breeder score' of firmness on the bush and also a QTS-25 Texture Analyzer (Fig. 2). Significant correlation between the breeder's score and three of the analyzer's quantitative calculations, and significant differences (genetic variation) among the mapping progeny for these measures of fruit firmness (traits) plus fruit mass (10 berry weights) were found.

Fig. 2 QTS-25 Texture Analyzer

Research Progress

It has been possible to assign the fruit firmness and mass trait data onto the existing Rubus genetic linkage map by quantitative trait loci (QTL) mapping analysis. This allows the regions on the seven raspberry chromosomes (or linkage groups) associated with these traits to be located and the genetic markers (genes) associated with them to be identified. Candidate genes with likely roles in raspberry fruit softening were identified and added to the Rubus linkage map. Several candidate genes, including those implicated in cell wall metabolism, and regulation of turgor pressure are significantly associated with the QTLs for breeder's firmness score and fruit mass. The association between chromosome regions for softness and the candidate genes will be examined to determine if any of these genes regulate softening.

The firmness and shelf-life characteristics of 22 different progeny with a range of 'firmness' scores (high, medium or soft) plus both parents were analyzed on the day of harvest (0 days) and then monitored after two, four and seven days storage at 4ºC using the Texture Analyzer. Six progeny were significantly firmer than all other clones during the seven day period of storage. Work is now underway to investigate the gene expression profiles of the candidate genes associated with softening QTLs in these clones and others of a softer phenotype in fruit at different ripening stages and from plants grown under different temperature and water regimes (Fig. 3).

Fig. 3 Raspberry plants grown under polytunnel for stress trial

Project Outputs

- Guidelines as to the most suitable fruit firmness required to maintain high quality fruit from farm to plate

- Markers associated with soft and firm fruit phenotypes can be added to the raspberry breeding tool-kit to speed up the development of new cultivars with desirable traits

- Knowledge of the environmental impact on gene expression will enable guidelines to be developed for optimum fruit production and growers can use the information in determining watering regimes.

Financial Benefits

- The reduction in perishable fruit as food waste to landfill in the UK will be significantly reduced

- Financial savings in the retail industry alone could reach £2.5 million annually for soft fruit with additional savings at the farm

- Increased shelf-life will further enhance the reputation of UK fruit as a high quality product.