

Work Package 1.3: Soft Fruit Genetics and Pathology

- **Required Output 1: Characterisation and evaluation of germplasm collections which focuses on plant health improvement, improvement of the environment, sustainable agriculture and market needs including the needs of relevant export markets.**

Summary

Germplasm of raspberry and blackberry (*Rubus*) and blackcurrant (*Ribes*) require further expansion and characterisation to provide sources of novel genes controlling traits of interest for the relevant downstream breeding programmes and to meet future sustainability and climate challenges. New germplasm has been developed to provide materials for further development, with regard to environmental adaptability, quality and nutritional benefits, and resistance to infestation by pests and diseases. Further *Rubus* and *Ribes* populations will be created as required and evaluated using existing and newly developed methods. Environmentally-induced variability in fruit quality and developmental traits is being investigated

- **Required Output 2: The production of certified soft fruit nuclear stock and the development of new and improved raspberry cultivars to meet the needs of a vibrant and innovative UK industry.**

Summary

The production of certified soft fruit nuclear stock represents a statutory requirement through the Plant Health Act. As the sole source of nuclear stock in the UK we provide the industry with high health soft fruit plants of raspberry and blackcurrant for propagation. As part of ongoing development of new diagnostic tests for pathogens, the new tests for *Phytophthora* and Blackcurrant Reversion Virus are being enhanced to overcome sensitivity and reproducibility problems.

- **Required Output 3: Identification of tools (genes, markers, bioinformatics, knowledge) to allow breeders to more rapidly and accurately select crop varieties suitable for future Scottish climates.**

Summary

This work is directed towards the development of unique breeding material for raspberry and blackcurrant by combining modern genetic approaches with analysis of key traits. The first genetic maps have been developed for both raspberry and blackcurrant, and appropriate regions of these maps have been identified for important traits. Development of DNA-based markers to track important traits during the breeding process is in progress, e.g. for resistance to

the gall mite, an important carrier of virus disease. Good progress has also been made in the identification of markers for bud dormancy, which will be useful for selecting material adaptable to climate change. We are also developing rapid approaches to select blackcurrants with lower chilling requirements for flowering, again to allow adaptation to changing climates.

- **Required Output 4: Increased emphasis on developing crops with enhanced nutritional quality.**

Summary

These studies have been directed towards establishing the bioefficacy, bioavailability and durability of soft fruit and its components in the human dietary forum. Using appropriate model systems and unique SCRI germplasm we have provided validated evidence for the anticancer properties of soft fruit polyphenolic components in valid and appropriate human model systems. Furthermore, parallel studies using *in vitro* human digestion systems showed that the soft fruit polyphenols also acted on the initial digestion process, impacting beneficially on the breakdown of starchy food thereby reducing glucose release. The impact of the fruit polyphenols on gut health beyond simple nutrition was emphasised by research which highlighted their ability to inhibit the life cycle of human gut parasites. The compounds identified as being bioactive via these studies continue to be the subject of research into their stability and bioavailability.

- **Required Output 5: Improved understanding of factors contributing towards product quality including the identification of markers for key traits and genes of use by breeders.**

Summary

The driving factors for fruit quality are taste, texture and appearance but increasingly the associated health benefits are becoming important to end-users and consumers. The compounds driving the health benefits are chemically diverse, and the resulting increase in breeding targets has required new, more encompassing, detailed and rapid analytical technologies to assist the selection process. New technologies and approaches based on rapid mass spectrometry (MS) have been developed and validated using a model *Rubus* segregating cross for which fruit has been collected over 5 years. For traits such as total antioxidant capacity we have shown that levels above those of the parents can be attained. Furthermore the MS approaches to quality analysis have allowed previous undetermined health-related components to be related to the *Rubus* genetic map. The new approaches have also allowed the selection of specific lines with distinct chemical compositions that impact upon the fruit colour, an important quality trait and driver of consumer preference

- **Required Output 6: Explore the potential for extended season (early and late cropping): Science to deliver raspberry cultivars suitable for growth under protective cropping.**

Summary

The Scottish fruit industry is increasingly looking to extend the effective cropping season for raspberry from spring to late autumn, and therefore appropriately adapted varieties are required. An expanded range of raspberry material has been assessed for the selection of specifically-adapted types for growth cycle manipulation and extension of the cropping season. Material able to cope with various climate change scenarios will represent the first step in the production of new environmentally resilient cultivars. Relevant developmental traits, e.g. budbreak and flowering, have been measured in the raspberry mapping population, useful variation has been identified along with associated DNA markers.

- **Required Output 7: Development of improved aphid resistance.**

Summary

Control of virus-spreading aphids using resistant varieties is under increased threat due to climate change, protected cropping and breakdown of effective resistance genes in England and reportedly also in Scotland. New sources of resistance to the large raspberry aphid (LRA) have been found in German raspberry cultivars. Several pests and pathogens for controlling aphids in polytunnels have been identified, and other factors affecting aphid populations are under investigation. Root attack by vine weevil can compromise some types of resistance in raspberry, making some cultivars susceptible to aphid colonisation (and potentially to virus transmission). Aphid performance varied significantly on four cultivars containing the same resistance gene, indicating that the genetic background is modifying the plants susceptibility to the large raspberry aphid

- **Required Output 8: Knowledge transfer on best practice for crop health (in association with external funding).**

Summary

As increasing knowledge is developed regarding fruit pests and pathogens, it is important that this information is made available to the fruit industry in an effective way. A set of tools (pest-resistant varieties, traps and lures which catch pests without using pesticides, underpinned by knowledge about the ecology of insect-plant interactions) has been developed to control key pests with minimal pesticide inputs. Via links with externally-funded work on diseases caused by the fungus *Phytophthora idaei*, the impact of various *Phytophthora* species has been

assessed. The web-based portal Fruit Gateway (www.fruitgateway.co.uk) has been expanded to include databases on pests and diseases on soft fruit. Further development will enhance the databases for use by the fruit industry and public

- **Required Output 9: Development of crop protection strategies for key pests and diseases affecting Scottish crops, which lead to a reduction in pesticide use.**

Summary

There has in recent years been an increasing incidence of serious pests of fruit such as vine weevil, and at the same time there is pressure on growers to reduce their use of pesticides. Control methods for vine weevil that eliminate or decrease the use of pesticides are being investigated, including the potential use of raspberry cultivars less prone to weevil attack. Moreover, an understanding of the mechanisms which influence egg laying by adult vine weevils could potentially be used to develop appropriate traps or lures. A consistent preference was found for laying on the raspberry variety Glen Ample compared to Glen Moy, although strong differences in susceptibility were not detected. Integrated pest management tools, which aim to reduce pesticide use and more effectively target pest problems, have been tested on commercial farms. Effects on other pests and beneficial organisms are also under investigation. Ongoing research aims to increase the durability of aphid resistance and the use of naturally occurring biocontrol agents. Future work will optimise strategies for different regions and management systems, taking into account new/changing threats due to climate change and all-year cropping using polytunnels

- **Required Output 10: Information on host resistance and susceptibility to key diseases affecting Scottish crops which will lead to the development of durable resistance in the field.**

Summary

The durability of available resistance genes is a key factor in their utility for breeders. Aphid resistance genes differ in effectiveness according to the genetic background in which they are located. Environmental conditions (in polytunnels) affect the distribution of 3 species of aphids and important biocontrol agents. *Phytophthora* species other than *P. fragariae* var. *rubi* (causing raspberry root rot) and possibly *P. idaei* do not pose a significant threat to the Scottish industry. Raspberry germplasm with field resistance to root rot will be tested against *Phytophthora* to check for durability of resistance. Some specific types of raspberry bushy dwarf virus (RBDV) were found to overcome field resistance reported in Glen Ample. New sources of resistance are therefore required. A new DNA-based test for raspberry leaf spot virus (RLSV) will be used to identify possible resistance to this virus.

- **Required Output 11: Development of appropriate sampling strategies, of field-based diagnostics and of validated multiplexed diagnostics for key pests and diseases, for use by industry and/or government.**

Summary

The design and implementation of tests to diagnose major disease agents in soft fruit production is essential at all stages from breeding, propagation to field crop assessment. Several new tests for species of the pathogen *Phytophthora* have been designed, offering major advantages over existing methods. We are currently validating detection methods for GVBV (Gooseberry Vein Banding Virus) and BRV (Blackcurrant Reversion Virus) against biological tests and considering their future use in place of biological tests. Some Scottish raspberry viruses have been characterised in order to design DNA based diagnostic tests. Three previously-known viruses have been partially characterised and specific tests designed for them. Two new viruses have been identified, one of which appears to have very severe effects on raspberries. Novel insect sampling strategies have been developed using advanced chemical ecology products (traps, attractant lures), together with robust statistical methods which take into account distribution, temperature and humidity effects.