Grower Summary

SF 167

Understanding the genetic and physiology controls of 'crumbly' fruit in red raspberry (*Rubus idaeus*)

Final report 2019 inc Extension 2020

Project title:	Understanding the genetic and physiology controls of 'crumbly' fruit in red raspberry (*Rubus idaeus*)
Project number:	SF 167
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AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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GROWER SUMMARY

Headline

- A genetic marker associated with the crumbly fruit condition has been identified for use in the UK raspberry breeding consortium at the James Hutton Institute.

Background and expected deliverables

Understanding the triggers of crumbly fruit in raspberry will allow breeding of more robust genotypes using molecular markers, modified agronomic practices based on project findings and new improved methodologies for plant health certification, leading to reduced wastage.

Raspberry fruit is an aggregation of multiple fertilized ovaries (drupelets) which in the crumbly fruit condition are abnormal. Crumbly fruit is a generic term used to describe the visual appearance of the abnormal fruit. This project identified two different forms of crumbly fruit, depending on the severity levels:

1. **Crumbly Fruit Condition (CFC)** – defined as plants where all fruits are symptomatic every season.
2. **Malformed Fruit Disorder (MFD)** - defined as plants that display crumbly fruit, but symptoms are intermittent within a season or across seasons.

The work in this project examined MFD which is both genetically and environmentally controlled. It is caused by a partial failure in one or more physiological processes concerned with fruit development, which results in the drupelets not forming properly. This is an increasing problem for the global raspberry industry.

The research in the project was based on a hypothesis that the growth of the fertilised ovaries is regulated and synchronised by a hormonal coordination process which takes place in the receptacle of the flower. The receptacle acts as a hub which controls molecular signals (plant hormones) and establishes an intense hormonal crosstalk with the fertilised ovules that helps to coordinate the fruit development.

This work aimed to study MFD through different approaches.

- A study of the differences in gene expression between crumbly and normal fruit in the progeny of a mapping population (Glen Moy x Latham) known to segregate for the crumbly fruit condition across different seasons (Graham et al. 2015).

- A study of the hormone regulation behind fruit development in artificially induced ‘crumbly’ fruits.
- A study of flower damage by bees and excess nectar from flowers preventing pollination, to determine if this may be playing a role in crumbly fruit development.

The work aimed to deliver improved understanding of what causes Malformed Fruit Disorder (MFD) and how growers might be able to overcome it in their production process. It was also hoped to identify molecular markers associated with crumbly fruit, which could be utilised in the UK raspberry breeding consortium at the James Hutton Institute to breed new cultivars with resistance to Crumbly Fruit Condition (CFC).

Summary of project and main conclusions

In studying differences in gene expression between crumbly and normal fruit, the project identified differences in gene regulation in fruit development. As a result, a genetic marker associated with the crumbly fruit condition has been identified for use in the raspberry breeding programme.

Studies of the hormone regulation allowed differences in hormone control of fruit development between crumbly and normal fruit to be identified. This could allow the development of an on-farm strategy involving hormone sprays to reduce crumbly fruit. Interfering with the regular growth of the fruit due to damage to the receptacle was shown to induce the ‘crumbly fruit’ condition producing artificial misshapen crumbly like berries.

Studies on raspberry plants grown under glasshouse conditions, with the assistance of commercial beehives to increase pollination efficiency, highlighted an interesting phenomenon. Excess floral nectar not collected by bees was observed to drip over the flower carpels (made up of the stigma, style and ovary). These became impregnated with the sticky substance and could not be pollinated. Bees are the major insect pollinator used for commercial purposes with bumble bees (*Bombus ssp*) and honeybees (*Apis mellifera*) dominating the market. Bumble bees are recommended for greenhouse-grown plants because they are better adapted to closed spaces (Andrikopoulos and Cane 2018). To further encourage bumble bees to focus exclusively in collecting pollen, commercial hives are equipped with small tanks containing artificial nectar to supply the bees at any time with this substance so they do not need to collect nectar and can concentrate on foraging only pollen. This particular hive design was specifically studied to increase pollination efficiency. In contrast to bumble bees, honeybees look for nectar when foraging.

Further investigation is required on this topic. However, the scientists suggest that it may be prudent to combine bumble bees and honeybees when pollinating commercial raspberry flowers to exploit their differing foraging behaviour. This could not only increase pollination efficiency but potentially contribute to a reduction in misshapen fruit caused by excessive nectar impregnating flower carpels.

Financial benefits

This project is unlikely to deliver any immediate financial benefit to growers. However, using our knowledge of the molecular marker for Crumbly Fruit Condition (CFC) in the raspberry breeding programme at the James Hutton Institute, will lead to the release of raspberry cultivars which do not suffer from the condition, leading to higher grade-out of Class 1 fruit in commercial raspberry plantations.

The potential to improve our knowledge and management of different bee pollinators may also help reduce the levels of Malformed Fruit Disorder (MFD) in future production systems.

Action points for growers

- Look out for the release of new raspberry cultivars in future which are known to be free from Crumbly Fruit Condition (CFC).
- Consider combining use of both bumble bees and honeybees to improve efficiency of raspberry flower pollination. This may also help to reduce the level of Malformed Fruit Disorder (MFD), although further study is required to confirm this hypothesis.