



Grower Summary

SF 167

Understanding the causes
of crumbly fruit in red
raspberry

Annual 2017

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AHDB Horticulture is a Division of the Agriculture and Horticulture Development Board.

Project title: Understanding the causes of crumbly fruit in red raspberry

Project number: SF 167

Project leader: Julie Graham – The James Hutton Institute

Report: 1st year report

Previous report: None

Key staff: Luca Scolari

Location of project: Invergowrie, Dundee, DD2 5DA, Scotland, UK

Industry Representative: Louise Sutherland

Date project commenced: 01/10/2016

Date project completed (or expected completion date): 30/09/2019

GROWER SUMMARY

Headline

- Progress is being made in improving our understanding of the causes of crumbly fruit disorder in raspberry.

Background and expected deliverables

In defining a strategy for studying and resolving the problem of crumbly raspberry fruits, we must first ask; what is the crumbly fruit condition?

Little scientific literature is available on this specific topic and above all no standard definition is available. In a previous published paper '*Towards an understanding of the control of crumbly fruit in red raspberry*' (Graham *et al.*, 2015), the authors refer to it as a condition linked with pollen abortion and embryo sac degeneration causing drupelets to be generally reduced in number but greatly enlarged or, in the case of small reductions, cohere imperfectly so the fruit crumbles when it is picked. To solve or understand this problem, every aspect related to it is important. An understanding of the flower and fruit anatomy as well as of the processes leading to fruit set and developments is essential.

Raspberry fruits are formed from an aggregation of multiple fertilized ovaries each of which is referred to as a drupelet as it becomes fleshy. It is thought that crumbly fruit 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. There have been a number of causes suggested for the condition. It is known that infection with certain viruses can increase the likelihood that fruits become crumbly (Jennings, 1988). Raspberry Bushy Dwarf Virus (RBDV) affects pollen reducing its capacity to induce fruit-set and can lead to failure of almost half of all drupelets to set (Murant *et al.*, 1974; Daubeny *et al.*, 1978).

A genetic cause has also been demonstrated where the crumbly phenotype arises from virus-tested mother plants (Jennings, 1988). Studies have also shown that extensive tissue culturing of plants may increase the emergence of the condition (Jennings, 1988). Additionally, environmental conditions appear to play an important role with variations in the extent of crumbliness apparent from year to year (A. Dolan *pers. comm.*).

Although no standard definition is available, a common interpretation of the phenomenon is required to address the issue and find a solution. For such reasons, two new definitions of crumbly fruit have been proposed:

Crumbly Fruit Condition (CFC) only affecting plants where all the fruits are symptomatic year after year; this is an undefined disease or genetic disorder.

Malformed Fruit Disorder (MFD) only involving plants displaying malformed fruit that resemble crumbly fruit in their appearance but where the symptoms are intermittent within a year or over the subsequent years. **MFD** plants display uneven fruit set, generally at the very beginning of fruit production and this occurs mainly on the top lateral shoots. Fewer symptoms are observed as the season progresses and more flowers and fruits are produced by the plant resulting in little or no loss of yield.

These new definitions will be included in an online survey that will be launched in late autumn 2017 to gather information from growers on the varieties grown, location of the plantations, **CFC** and/or **MFD** affected plants, origin of plants and agronomic procedures used. The results will help to estimate the spread of crumbly fruit.

The practical research in this Ph.D. studentship project intends to define the trigger(s) of the condition by inducing crumbly fruit on raspberry plants grown both in optimal conditions (i.e. growth room and glasshouse) and sub-optimal conditions (i.e. field). The induction of crumbly fruit will allow the study of the genetic and physiological control behind this condition. The project will then be divided into three main work activities:

1. crumbly fruit induction
2. hormones profiling
3. gene expression.

Understanding these factors will help to identify genes linked to crumbly disorder which in turn could provide tools to help the selection of new varieties which are free and/or resistant to the disorder. Alternatively, hormonal/chemical treatments could be developed to be used on plants during their growth phase to avoid crumbly fruit.

Summary of the project and main conclusions

Early work in the first year of this Ph.D. project has induced crumbly fruit in a growth chamber by removing the carpels of the flower. This has demonstrated that their removal and/or wounding of the receptacle can trigger crumbly fruit in raspberry plants. Data from both glasshouse and field experiments seem very promising too. At the time of writing, data is still being analysed.

Financial benefits

According to Defra's horticultural statistics in 2013, the UK produced 13,800 tonnes of raspberries which were worth £89.6 million. It is estimated that a further 10% of fruit may have been marketed had it not been discarded due to crumbly fruit disorder and this would have increased the total to 15,180 tonnes, representing an extra £9 million.

The study and comprehension of the physiological and genetic causes behind crumbly fruit represent a starting point for developing a new test method for the condition which is faster and more reliable than the current fruiting test. The molecular knowledge gained from this project could be utilised in the UK Raspberry Breeding Programme to select new varieties which are free from the disorder or at least more resistant to this condition. Developing varieties which are free from the disorder could therefore increase the value of the UK crop by £9 million per annum.

Action points for growers

- At this stage of the project, no action points for growers have been identified.