

**Project Title** The Scottish Raspberry Breeding Programme

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The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations

**AUTHENTICATION**

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

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## CONTENTS

	Page
<b>Grower Summary</b>	
Headline	1
Background and expected deliverables	1
Summary of the project and main conclusions	1
Financial benefits	3
<b>Science section</b>	
Introduction	4
Materials and Methods	4
Results and Discussion	11
Conclusions	19
Technology transfer	20
[Glossary]	21
References	21
Appendix: I – JHI Trials Data	22

# GROWER SUMMARY

## Headline

Marker assisted selection has identified 32 selections with the *Phytophthora* resistance marker, which will eliminate undesirable germplasm early in the breeding process and shorten the timescale required to develop new cultivars.

## Background and expected deliverables

In 2009, the UK raspberry industry formed a consortium to fund the National Raspberry Breeding Programme for five years. The objective of the programme is to produce improved raspberry cultivars selected for particular markets and cultural practices.

Detailed specifications of the objectives can be found in the revised objectives document. A summary of the expected deliverables from this work will include:

- New potential cultivars suitable for both fresh market production (including season extension through protected cropping) and machine harvesting for processing.
- New hybrids with improved pest and disease resistance, especially to *Phytophthora rubi* (root rot).
- Development of new cultivars will be aided by the deployment of marker assisted selection, developed at JHI, substantially reducing the time required to produce a new cultivar.
- Development of new primocane-fruiting cultivars.
- Evaluation of promising selections under commercial conditions in grower trials.

## Summary of the project and main conclusions

### *JHI Trials*

This year the following plots were under evaluation at James Hutton Institute:

- 20 genotypes in a protected site of replicated 5-plant plots (plot J25), in its fourth season.

- 30 genotypes in a protected site of replicated 5-plant plots (plot J26), in its third and final season.
- 30 genotypes in a protected site of replicated 5-plant plots (plot J7), in its second season.
- Approximately 4500 seedlings from the 2008 crossing programme.
- 450 seedlings in pots in a protected site for primocane-fruited evaluation.

A summary of the characteristics of key selections, including those already identified for on-farm trials are summarised in Table 1.

**Table 1.** Summary of characteristics of the ‘Top 5’ JHI selections in 2011

Genotype	Mean yield / stool (g)	Mean fruit size (g)	Mean Brix %	First pick date	Characteristics
0485K-1	2097	5.3	9.4	04/07/2011	Mid-season. Large, conical + glossy fruit consistent quality all season. Popular with visitors. Easy + quick to pick. Has <i>Gene H</i> . A clear winner in 2010 and 2011
0019E2	2310	6.0	9.6	11/07/2011	Late season. Enormous fruit size. Top laterals breaking at node and collapsing
0534RB1	1587	6.3	11.4	07/07/2011	Late season. Enormous fruit size – first pick >8g. Long laterals >1m, but not collapsing
0435D-3*	2833	4.6	10.4	28/06/2011	Very early with a long season, pleasant sweet flavour all season
0447C-5*	2448	6.1	9.3	18/07/2011	Late season 2-3 days earlier than Octavia, vigorous upright cane produced a good ‘hedge’ large fruit
Glen Ample	1058	4.9	8.9	11/07/2011	Flavour slightly acidic for Ample but typically easy to pick and manage
Tulameen	1075	5.3	11.8	11/07/2011	Good flavour and quality in this plot, fruit a bit too soft
Octavia	441	5.6	9.7	21/07/2011	Very late, had odd ripening problems this year, enormous fruit, pale, tearing collar, good aroma but sharp, bad raspberry beetle damage

\*Selections proposed for on-farm trials in 2012

### **Main Conclusions**

- Marker assisted selection has identified 32 genotypes with the marker for Phytophthora root rot resistance early in the breeding process.
- Glen Fyne performed very well in JHI and on-farm trials in the UK and overseas.
- Selection 0019E2 generated tremendous feedback of productive plots of large fruit and good flavour.
- Selection 0485K-1 had outstanding fruit quality in JHI plots and promising early feedback from trials.
- Four new selections 9350F3, 0453C4, 0304F6 and 0433F2 were planted in on-farm trials in the UK and Spain.
- Two new selections were identified for on-farm trials; 0435D-3 and 0447C-5.

- Primocane-fruiting selections were made from crosses made in 2009.

### **Financial benefits**

The release of cultivars with improved fruit quality and yield will result in increased class 1 fruit and increase growers' productivity. New cultivars with pest and disease resistance will lead to a reduction in pesticide applications and the costs associated with these. Reduced use of pesticides will also lessen the risk of residues occurring in harvested fruit. With the possibility of a further loss of agrochemicals as a result of EU-led policy changes, it is essential that the industry has access to resistant germplasm into the future.

### **Action points for consortia members**

- Glen Fyne continues to perform well and commercial propagation should continue.

# SCIENCE SECTION

## Introduction

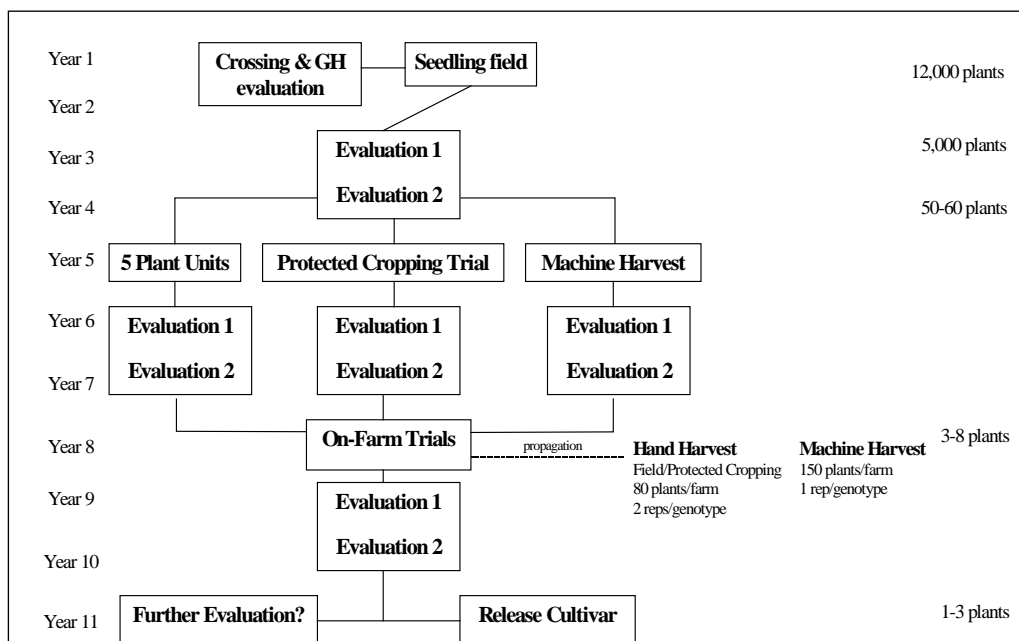
Raspberries have been bred at Mylnefield, Dundee, Scotland since the 1950's and the development of cultivars crucial to the industry's prosperity has continued at JHI to the present time. The raspberry breeding programme at JHI has been phenomenally successful and is perhaps best known for the 'Glen' series of cultivars which are grown throughout the world (Jennings and Brennan 2002).

Commercial funding between 1993 and 2000 saw the breeding programme focus upon the development of machine harvestable cultivars for processing. However, it is the fresh market sector that now represents the main area for potential growth in both field and season extension contexts. Although machine harvestable types are still under development, the primary focus is on the fresh market, selecting and developing cultivars suitable for production under a protected cropping system. This will help in identification of adapted germplasm early in the selection process, prior to commercial trialling.

## Materials and Methods

The programme is based on recurrent selection. Each year selections are made which form the basis of the next generation of crossing. As new variability for particular traits is needed, elite cultivars and selections from outside the programme are included as parents. Each year, approximately 100 crosses are made, producing 100-200 seedlings per family. With variation in germination rates, the programme begins with ~12,000 seedlings. Based on their pedigree, families will be segregating for different characteristics.





**Figure 1.** Breeding Schedule

## **Crossing**

All hybridizations in the programme are made out of season in an insect-proof glasshouse. Parents for hybridisation are identified and lifted in late autumn and given a chilling period of 7 weeks at 2°C in a vernalisation room, after potting on into 15 litre pots with a peat-based compost mix. The plants are then moved into an insect-proof glasshouse where the temperature is raised gradually from 10°C to 20°C over a three week period. Daylength is set at 16 hours. Plants break bud, produce laterals and begin to flower approximately four weeks later. Irrigation and fertigation are automated through a DI16 Dosatron.

Open flowers are collected into a Petri dish for use as a pollen source, dried at room temperature and stored with a desiccant at 4°C. Closed flower buds are emasculated with a scalpel and are ready to pollinate once the stigma have become receptive (approx. 48 hours after emasculation). The pistil is pollinated with an artist’s paint brush (Sable, size 5). All tools and hands are sterilized with absolute alcohol between crosses and all excess flower buds are removed to minimize pollen transfer in the glasshouse environment, therefore pollen bags are not required. Parent plants are sprayed for pests and diseases as appropriate for the duration of crossing.

## **Seed extraction**

Fruit from each family is collected when ripe and left in a pectinase solution overnight at room temperature. The pulp is separated from the seed by blending the mixture for 10 seconds in a domestic blender. The mixture is left to settle for one minute; viable seed will sink to the bottom and pulp and non-viable seed will float to the top. The pulp is decanted

from the viable seed. The seed is rinsed by filling the jug with tap water, leaving to settle and decanted. The rinse cycle is repeated three times, until the tap water is clear. The seed which is clean and free of any pulp, is left to dry overnight on filter paper. Dry seed are stored in glassine bags (100 x 70mm) with a desiccant at 4°C.

### **Seed scarification**

Up to 1000 seed/family are scarified in acid, assuming 15-20% germination. Remaining seed is stored in case of poor germination. Seed must be clean and dry before scarification in acid. Seed is transferred to a boiling tube (~500 seed/tube) with concentrated sulphuric acid for exactly 20minutes. Seed is rinsed by pouring the seed and acid through a metal sieve, secured by a retort stand, and rinsing with tap water for 10 minutes. Seed is submerged under the water during this period. Seed is then submerged in calcium hypochlorite solution for 6-10 days. The seed is stirred every day and the solution is changed once during this period. Once the seed coat has been scarified with acid, it is important that the seed is not left to dry out.

### **Stratification and germination**

Seed is rinsed under tap water for 10 minutes and mixed with damp vermiculite. The mixture is stored in a sealable bag at 4°C for six weeks. After this period, the seed and vermiculite is treated with GA<sub>3</sub> (3ppm) and left at room temperature overnight. The seed and vermiculite is sown onto Bulrush Brown/Black peat in a seed tray and covered with a fine layer of dry vermiculite. The trays are incubated at 20°C in Correx incubators, specially constructed at JHI, to maintain heat and humidity. Seeds begin to germinate within 7 days.

### **Spines**

Spined genotypes are eliminated early at the germination stage of the seedlings. The spine glands can be seen around the leaflets at the cotyledon stage. These are removed from families which are segregating for spines, leaving only the spine-free plants for further evaluation. All progeny are kept from crosses where plants are expected to be all spiny, due to the parents used.

### **Aphid Resistance**

Seedlings in the breeding programme are screened for the gene *A<sub>10</sub>*, conferring resistance to four biotypes of the large raspberry aphid (*Amphorophora idaei*). After the segregating families are screened for spinelessness, the remaining seedlings are pricked out and potted-on into FP9 pots with compost mix containing slow release fertilizer. These are reared in a glasshouse with a 16 hour day length at 20°C. Once plants have produced 3-4 true leaves, they are ready to be inoculated with biotype two of *A. idaei*. Two apterous *A. idaei* aphids are placed on each test plant alongside controls Malling Jewel (susceptible) and Autumn Bliss

(resistant). The plants are scored after 10-14 days; susceptible plants will have a feeding colony versus resistant plants which will have no reproducing population. Susceptible progeny in segregating families are discarded. Aphids are cultured and supplied by entomologists on-site at JHI.

### **Field planting**

After spiny and aphid-susceptible genotypes are eliminated, the remaining seedlings (~5000 individuals) are hardened-off for field planting. If the ground conditions are appropriate the seedlings are planted in late autumn, otherwise they are held in a Tygan structure until the following spring. This is a 9m, semi-permanent single-span tunnel, covered with an insect-proof mesh, instead of polythene.

Seedlings are planted 0.8m apart, with a 0.8m gap between families.

All outdoor raspberry breeding plantations at JHI are prepared and managed with the same practice. Raised beds are formed 2.5m apart with a potato bed-maker. Grass seed is sown in the alleyways. Plants are supported with a traditional post and wire system and old floricanes are cut out and new primocanes are laced-in in the traditional manner. Overhead irrigation is supplied as needed. A minimal spray programme is applied as follows in order to select for resistance/susceptibility to pathogens.

<b>Pest/Pathogen</b>	<b>Control (Active ingredient)</b>	<b>Rate/ha</b>	<b>Application</b>
Weed control	Dichlobenil	5L	February
Root rot	Fluazinam	1.5L	Spring and autumn
Cane midge	Chlorpyrifos	1L	Monitored
Raspberry beetle	Chlorpyrifos	1L	Monitored

### **Breeding and selection for tolerance to raspberry root rot**

An important objective of the breeding programme the development of cultivars with tolerance to raspberry root rot, caused by the fungus *Phytophthora rubi*. Currently, 20% of the crossing programme is dedicated to breeding for tolerance to the disease, where one parent with known resistance or tolerance is crossed with genotypes with good agronomic characteristics. Progeny are planted alongside susceptible controls in an infested plot at JHI. Seedlings are evaluated once these controls show symptoms of root rot, usually around 3-5 years after planting. Tolerant selections require further evaluation for fruit quality and yield before a cultivar can be released.

### ***First stage selection***

These plants are evaluated for two fruiting years for basic fruiting characteristics (size, shape, flavour, colour, firmness, shelf life). Around 1% of the seedlings (30-50 individuals) are selected for small replicated trials of protected hand harvest plots and, where appropriate, machine harvest plots at JHI. Once selected, root from these genotypes are lifted from the plot and given a six week vernalisation period at 4°C. Root from each selection is then sown into a shallow tray on top of Bulrush compost and germinated with bottom heat in a glasshouse set at 20°C, 16 hours daylength. These are evaluated for a further three fruiting years, alongside commercial cultivars, where more detailed assessments are made on fruit quality, yield, plant habit and tolerance to pest and disease.

### ***JHI Polytunnel***

Haygrove polytunnels have been used since 2004 to evaluate germplasm under a protected cropping system with the objective of identifying suitable cultivars early in the selection process. The 100m x 100m structure is a Spanish-style Haygrove SMART series multi-bay tunnel with thirteen bays, each spanning 7.8m, built on 2m legs. Tunnels are covered with standard 150µ Visqueen polythene. Raspberry tunnels have three rows per bay, 2.5m between rows with a 2.8m leg row. Alleyways are grassed and leg rows covered with UV-stable fabric mulch (Phormasol) to control weeds. Raised beds are formed before planting. Irrigation and fertigation is controlled by a D8 Dosatron and is fed through Ram Light tape under the bedding polythene. A commercial fertigation programme, standard for established plots of 'Glen Ample' and 'Tulameen', is used:

	Rate (L/ha/week)	Start date	Duration
N-P-K 3-2-9	80	May	16 weeks
Potassium sulphate	125	June	8 weeks

A 4m high Paraweb windbreak is erected on the west side of the tunnels to protect the structure from wind damage.

### ***Plant material***

Selections from the breeding programme are planted in replicated five-plant plots. Plants are placed at 0.8m spacing with a 0.8m gap between each genotype, giving two genotypes between each post. A continuous row of 'Glen Ample' was planted in the westernmost row of the raspberry plot as a guard.

Plants are supported with a post and wire system. A double post system is erected at row ends and mid-row to give extra support. Wire support is put in at three heights since there is large diversity between genotypes of establishment and vigour.

## Chemical application

Generally, breeding plots at JHI are kept free of chemical application to assess the resistance or susceptibility to pest and disease. After discussions in 2004, it was felt that the protected plots of raspberries should be kept free of any pathogens in order to observe optimum fruit quality and yield. The basic spraying programme is below. Additional applications will be based on observations and presented in the Results section.

Pest/Pathogen	Control ingredient)	(Active	Rate/ ha	Application	
Root rot	Fluazinam		1.5L	Spring and autumn	Standard
Raspberry beetle	Chlorpyrifos		1L	First open flowers	Monitored
Two spotted spider mite	Spidex ( <i>Phytoseiulus persimilis</i> )			Fruit season	Monitored

## Assessments

Several physical fruit quality characteristics are assessed on an arbitrary score of one to nine, where one equals poor or low intensity and nine equals excellent or high intensity, as follows:

### Characteristic

Flavour	1 = bad/off flavour	9 = fruity + aromatic with a balance of sweet/acid
Shape	1 = globular	9 = long conic
Colour	1 = v. pale	9 = v. dark/purple
Firmness	1 = v. soft	9 = v. firm
Collar	1 = v. uneven	9 = v. even with good cohesion
Pick	1 = v. difficult to plug	9 = falls off when touched
Vigour	1 = low vigour <1m	9 = v. vigorous >3m
Plant habit	1 = collapsed cane	9 = v. upright cane
Cane diseases	1 = no symptoms	9 = severe symptoms
Overall score	1 = completely inadequate	9 = perfect agronomical traits

- Total yield for each five-plant plot is picked and calculated as yield per stool.
- Fruit size is measured in grams by taking the average weight of ten fruit.
- Season is assessed by recording dates of first flower, first fruit, first pick, 50% pick and final pick.
- Number of fruit per lateral is counted on laterals from the top, middle and bottom of the plot.
- Brix is measured with a Palette 100 PR-100 digital refractometer.
- Shelf-life is measured by picking 10 fruit and storing in a lidded punnet at 4°C for seven days. Post harvest evaluations are recorded with on an arbitrary scale, as above, on brightness, uniformity, colour, firmness, mould and bleeding.
- Additional notes are recorded on flavour description, uniformity, display, comparison with control varieties, disease infection and other identifying features.

## ***Advanced Selections***

All the fruit data is collated and promising selections (usually one or two genotypes) with consistent desirable characteristics are identified as potential new cultivars, and are thus candidates for on-farm trials. Once permission has been given by the executive committee, vegetative buds are micropropagated to provide root rot-free plants to growers. This is initiated by growing primocane from root harvested in late autumn from the JHI field trial, vernalised and propagated as the root from the 'First stage selection'. Vegetative buds are initiated into micropropagation in the following spring to produce modules for field planting 12 months thereafter.

Pathogen-testing is initiated at this time to produce indexed mother stock in anticipation of commercialisation. This requires a minimum of one year, providing the plant material is at an appropriate growth stage. The mother plants must be free of all pathogens listed in the declaration, under E.P.P.O guidelines, to enter the certification scheme. Fully-tested mothers are held until a decision is made to release or discard these advanced selections.

The plants are distributed to growers within the Consortium and are trialled on diverse geographical sites and cultivation methods next to commercial cultivars for comparison. These trials are evaluated for at least two fruiting years. Growers are requested to fill out a single page 'Raspberry Trial Results Form', detailing plant establishment, cultivation and comparing the advanced selection with a control cultivar for various characteristics. The growers provide valuable feedback on how the selection performs on a commercial trial. If these advanced selections are superior to existing commercial cultivars, they will undergo commercialisation.

## **Results and Discussion**

### ***2011 Crossing Programme***

79 crosses were made early in 2011, combining various traits including; floricanes and primocane fruiting, root rot resistance, using parents with the 118b marker, fruit quality and tolerance to pests and diseases. Approximately 6,000 seedlings will undergo glasshouse screening for absence of spines, resistance to aphids before planting out in 2012. Where appropriate, progenies will be screened with the 118b root rot marker (some combining both primocane habit and root rot resistance).

### ***Review of Breeding Objectives***

After discussions in 2010, a sub-group was set up to review the breeding objectives with the intention of making the programme more focused and aiding the discard of undesirable material. This involved documenting the existing characteristics evaluated within the programme, more than 40 traits, then describing the diversity within the JHI germplasm for each trait. The industry members then prioritised these traits as 'Essential' or 'Desirable' objectives. The feedback is summarized in the Appendix I, Table 8, with yield and fruit quality traits unanimously nominated as essential, followed closely by disease resistance. The objectives will be reviewed annually.

### ***2011 Season and JHI Trials***

- The exceptionally cold winter meant that the plants achieved their chilling requirement early and were ready to break bud immediately when the early spell of warm weather came in spring.
- Unseasonably high winds in late May damaged some of the main plots, mainly through the removal of flowering laterals. Bud break from secondary buds was observed in June, and these subsequently flowered and produced fruit into September.
- Root rot and raspberry beetle were problems in the established plots, possibly exacerbated by the exceptionally wet weather experienced in Scotland throughout the fruit season.
- Late season types including Octavia had an odd ripening pattern, picking very small amounts for each pick, and many green fruit failed to ripen. Ripe fruit was unusually soft, again probably influenced by the wet conditions.
- Despite the poor conditions, the advanced selections performed well relative to the controls and the other genotypes.

This year the following plots were under evaluation at JHI:

- 30 genotypes in a protected site of replicated 5-plant plots (plot J25 and J26), in its third and final season.
- 30 genotypes in a protected site of replicated 5-plant plots (plot J7), in its second season.
- Approximately 4,500 seedlings from the 2008 crossing programme.
- 450 seedlings in pots in a protected site for primocane-fruiting evaluation.

The trial was hand-picked for yield and basic fruit quality characteristics were evaluated; size, shape, colour, firmness flavour and Brix were assessed once per week. In Appendix I, yield and season data for each plot can be found in Tables 9 and 10, ranked in order of yield. All arbitrary scores on fruit quality and plant habit are summarized in Tables 13 and 14. Shelf-life evaluations are found in Tables 15 to 18 and are ranked in order from good to poor shelf-life.

A summary of the characteristics of key selections, including those already identified for on-farm trials are summarised in Tables 2, 3 and 4. Yield from these key selections, are compared with Glen Ample, Tulameen and Octavia in Figures 1 and 2.

**Table 2.** Plot J25 (third season): Summary of characteristics of key selections at JHI

Genotype	Mean yield / stool (g)	Mean fruit size (g)	Mean Brix %	First pick date	Characteristics
<b>9350F3</b>	1271	4.2	9.7	11/07/2011	Mid-late season. Attractive, large conical fruit, excellent display, flavour sweet + mild this season, high yield, slightly blotchy
<b>0304F6</b>	1953	6.0	10.9	11/07/2011	Mid-late season. Large pale meaty fruit, strong sweet flavour with an acid edge, great display on long, strong laterals, raspberry beetle damage
<b>99111B2<sup>*</sup></b>	2130	4.1	9.0	01/07/2011	Early-mid season, dark fruit, slightly soft at end of season, very upright primocane, continues to display strong tolerance to <i>Phytophthora</i> ,
<b>Glen Fyne</b>	1489	5.1	11.1	11/07/2011	Mid season. Fruit is firm with good cohesion and has a sweet and aromatic flavour. Canes produce a high yield of good quality fruit, rep 2 dead - root rot
<b>Tulameen</b>	942	4.5	11.8	15/07/2011	Sweet, strong flavour, slightly rough and soft all season
<b>Octavia</b>	441	5.6	9.7	21/07/2011	Very late, had odd ripening problems this year, enormous fruit, pale, tearing collar, good aroma but sharp, bad raspberry beetle damage

\*Selections currently identified for on-farm trials



**Table 3.** Plot J26 (second season): Summary of characteristics of key selections at JHI

Genotype	Mean yield / stool (g)	Mean fruit size (g)	Mean Brix %	First pick date	Characteristics
<b>0453C4*</b>	1965	4.4	10.9	01/07/2011	Very early. Glossy, firm, excellent shelf-life, great sweet + floral flavour all season, good habit + display, small at end of season, rep 2 dead – root rot
<b>0433F2*</b>	1090	4.0	9.9	11/07/2011	Glossy conical fruit – looks like Tulameen, sweet + aromatic.
<b>Glen Ample</b>	956	4.9	8.9	07/07/2011	Very poor example of Ample. Short laterals and petioles, very difficult to pick, flavour acid for Ample
<b>Glen Fyne</b>	1489	5.1	11.1	11/07/2011	Mid season, large fruit, sweet + juicy, good yield but root rot symptoms in plot
<b>Octavia</b>	363	5.9	9.9	21/07/2011	Late season. Fruit clustered on very short petioles, sharp but nice aroma, some mildew on primocane
<b>Tulameen</b>	942	4.5	11.8	15/07/2011	Variable establishment, 4/5 plants with very poor quality – rough + crumbly, bleeding in punnet, superb flavour

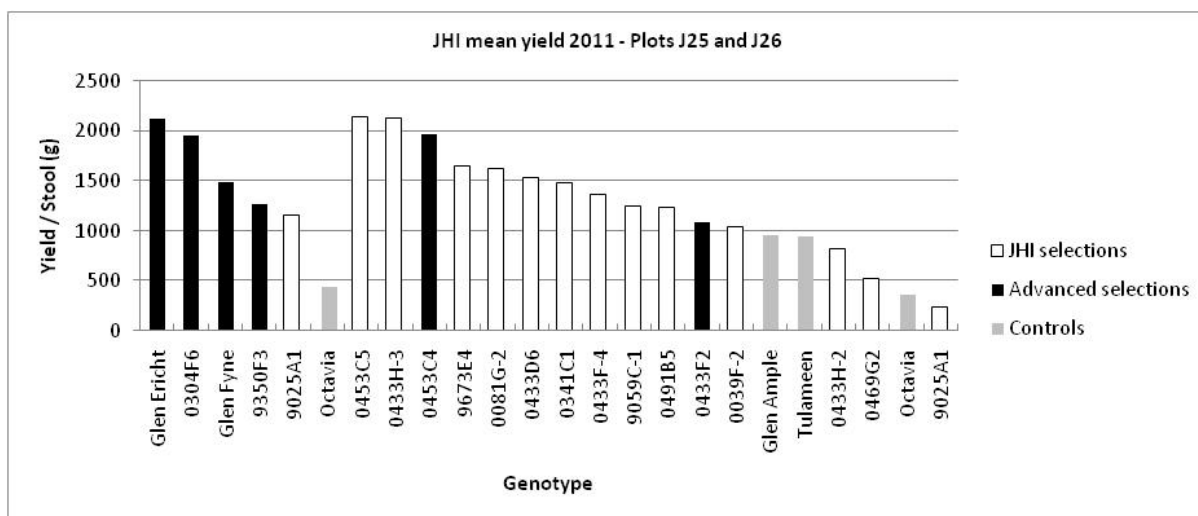
\*Selections currently identified for on-farm trials

**Table 4.** Plot J7 (first season): Summary of characteristics of key selections at JHI

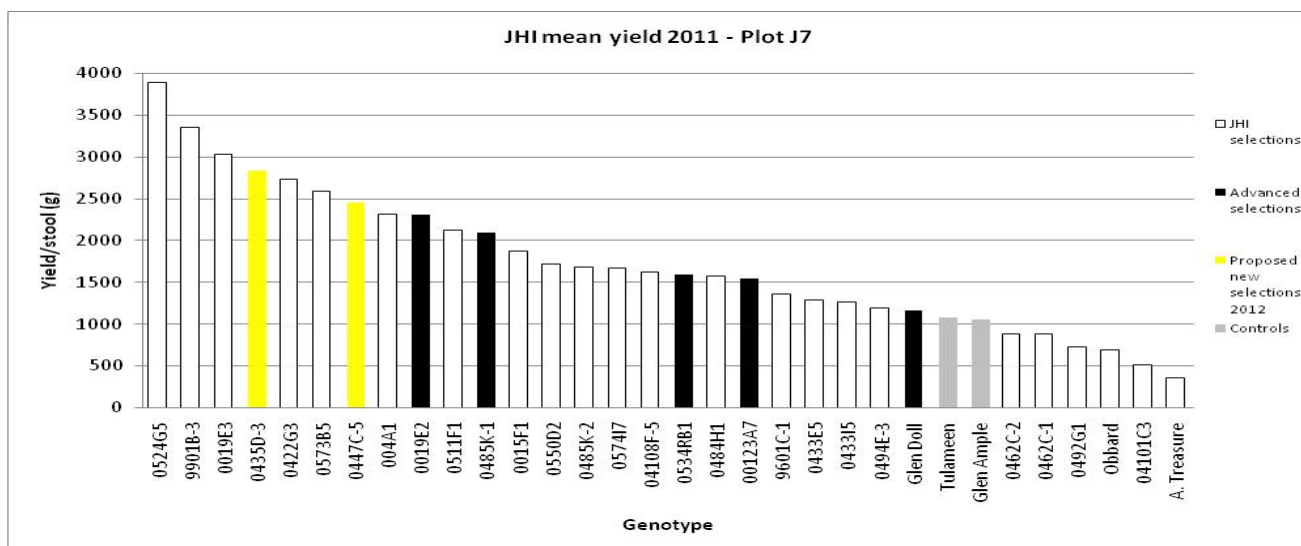
Genotype	Mean yield / stool (g)	Mean fruit size (g)	Mean Brix %	First pick date	Characteristics
<b>0485K-1</b>	2097	5.3	9.4	04/07/2011	Mid-season. Large, conical + glossy fruit consistent quality all season. Popular with visitors. Easy + quick to pick. Has <i>Gene H</i> . A clear winner in 2010 and 2011
<b>0485K-2</b>	1682	5.6	10.5	04/07/2011	Very bright shiny and long conic like sister K-1 better shelf-life but slightly less flavour. Has <i>Gene H</i>
<b>00123A7</b>	1547	5.0	11.3	11/07/2011	Very good quality and popular flavour in 2010. High brix levels all season
<b>0019E2</b>	2310	6.0	9.6	11/07/2011	Late season. Enormous fruit size. Top laterals breaking at node and collapsing
<b>0534RB1</b>	1587	6.3	11.4	07/07/2011	Late season. Enormous fruit size – first pick >8g. Long laterals >1m, but not collapsing
<b>0435D-3*</b>	2833	4.6	10.4	28/06/2011	Very early with a long season, pleasant sweet flavour all season
<b>0447C-5*</b>	2448	6.1	9.3	18/07/2011	Late season 2-3 days earlier than Octavia, large fruit,
<b>Glen Doll</b>	1166	5.2	10.8	07/07/2011	Firm and dry but sweet and fruity. Large fruit this season well displayed on long laterals
<b>Glen Ample</b>	1058	4.9	8.9	11/07/2011	Flavour slightly acidic for Ample but typically easy to pick and manage
<b>Tulameen</b>	1075	5.3	11.8	11/07/2011	Good flavour and quality in this plot, fruit a bit too soft

\*Selections proposed for on-farm trials in 2012

**Figure 2 Mean yield of selections in JHI plots J25 and J26**



**Figure 2 Mean yield of selections in JHI plot J7**



### **Fruit for the Future**

At the Fruit for the Future event this year at JHI, visitors were invited to score harvested fruit from four selections for fruit quality alongside Glen Doll, Glen Fyne and commercial cultivars. Visitors were asked to score the genotypes on a one to five scale for flavour, firmness, brightness and colour, with comments as optional. The response was good, more than fifty visitors filled in the sheets provided. Table 5 describes the preference of the visitors in order of flavour. Selection 0485K-1 was rated best for flavour despite having low aroma during that week. This was probably due to its visual appeal of large, bright berries.

**Table 5 Fruit for the Future – visitors’ evaluation results**

<b>Genotype</b>	<b>Firmness</b>	<b>Brightness</b>	<b>Flavour</b>	<b>Colour</b>	<b>Comments</b>
0485K-1	3.43	3.70	3.59	3.53	
Tulameen	3.04	3.42	3.58	3.33	
0019E2	3.67	3.36	3.44	3.85	Darkest
0485K-2	3.18	3.76	3.42	3.33	Brightest
Glen Ample	3.41	3.30	3.35	3.35	
Glen Doll	4.08	3.12	3.29	3.78	Firmest
Glen Fyne	3.29	3.57	3.03	3.24	
0435D-3	2.85	2.93	2.98	3.55	Softest
Octavia	3.14	2.94	2.85	3.03	

### ***On Farm Trials***

Since 2009, fifteen genotypes have been identified as the ‘Approved selection list’. These are listed in the Selection Status Document in Appendix I, Table 11. Four are named cultivars, another four have been discarded. The remaining seven are in the process of evaluation, planting or propagation for on-farm trials. Progress of disease-testing can be found in Table 6. All of the results from JHI and on-farm trials described below can also be found on the project Sharepoint site.

### ***Glen Fyne***

Glen Fyne performed very well on trials again this year. Off-site, on-farm triallists commented very favourably on fruit quality, particularly flavour and yield, despite the fact that *Phytophthora* has been reported on several sites. Pot production is suggested as a possibility in areas where root rot is problematic. Feedback from Spanish trials is also promising. JHI results from this season can be found in Table 2, Figure 1 and Appendix I, Tables 9 and 13. Provisional on-farm trials results can be found in Appendix II, Figure 4.

### ***Glen Ericht***

The processing cultivar Glen Ericht continued to perform well and exhibit improved tolerance to *Phytophthora* root rot compared with current commercial cultivars. Additional observations noted that it stands up well to fruit rot in the open field, is free of midge blight and has remained RBDV-free in JHI plots. JHI results from this season can be found in Table 3, Figure I, Tables 9 and 13. Provisional on-farm trials results can be found in Appendix II, Figure 3.

### ***Elite selections identified in 2008***

- **0019E2 (9059D-2 x 9668A2).** This selection is currently the most widely planted of all the genotypes, with six sites in the UK and in one in Spain. 0019E2 had the most enthusiastic feedback from on-farm trials in 2011 with several triallists reporting large fruit and good flavour. All but one triallist stated that they thought it was better than

the control and that they would plant more. In 2010, JHI trials reported fragile collapsing laterals on this genotype. This wasn't a problem in 2011. JHI results can be found in Table 4, Figure 2 and Appendix I, Tables On-farm trial results can be found in Appendix II, Figure 7.

### ***Elite selections identified in 2009***

- **9350F3 (EM5961/1 x 7826C1)**. This productive mid-late season selection performed well in JHI plots since 2008, producing large fruit with a pleasant sweet flavour all season, and producing the highest yield in 2010. This selection had a little beetle damage in 2011 but showed no root rot symptoms. JHI results from this season can be found in Table 3, Figure 1 and Appendix I, Tables 9, 13 and 15. Provisional on-farm trials results can be found in Appendix II, Figure 8.
- **0453C4 (0015D3 x 9059C-1)**. This very early season selection started picking five days before Glen Lyon and performed well in JHI plots since 2009, producing firm fruit with a good shelf-life and a sweet and floral flavour all season. JHI results from this season can be found in Table 3, Figure 1 and Appendix I, Tables 9, 13 and 15. Provisional on-farm trials results can be found in Appendix II, Figure 10.
- **0304F6 (9455F-2 x 9050RD3)**. This mid season selection has performed well in JHI trials since 2008. It has large bright pale fruit presented well on long but strong laterals and is very productive. Shelf-life is consistently good, despite suffering from beetle damage in 2011 but showed no root rot symptoms. Early comments from the HDC trial describe it as potentially too pale in colour. JHI results from this season can be found in Table 3, Figure 1 and Appendix I, Tables 9, 13 and 15. Provisional on-farm trials results can be found in Appendix I, Figure 9.
- **0433F2 (003RB1 x 0015D3)**. This early-mid season selection strongly resembles Tulameen in appearance, with large conical glossy fruit and sweet aromatic flavour. There were concerns with the firmness of the fruit in JHI plots in 2009 and 2010 but provisional results from the HDC trial didn't indicate this problem. JHI results from this season can be found in Table 3, Figure 1 and Appendix I, Tables 9, 13 and 15. Provisional on-farm trials results can be found in Appendix II, Figure 11

### ***Elite selections for on-farm trials identified in 2010, to be planted 2012***

- **0485K-1 (0030E-12 x 0039F-2)**. This mid season selection was outstanding in JHI plots with in both 2010 and 2011 seasons, producing conical fruit with a high gloss. Canes are pubescent giving tolerance to cane botrytis and spur blight. Fruit is well presented and quick to pick. Provisional results from early planted trials in Oxfordshire (HDC) are promising, describing attractive fruit with good flavour and a plot that was easy to manage. 0485K-1 proved popular at both the HDC and JHI open days (see Table 5). JHI results can be found in Table 4, Figure 2 and Appendix

I, Tables 10, 14, 16 and 18. On-farm trial results can be found in Appendix II, Figure 12.

- **0534RB1 (9764F-3 x Tulameen)**. This late season selection has enormous fruit size, up to 8g in the first week of picking. Canes are vigorous with long laterals, which don't collapse when picking. This selection suffered beetle damage late in season, leading to some botrytis. JHI results can be found in Table 4, Figure 2 and Appendix I, Tables 10, 14 and 16.

### ***Proposed new elite selections identified in 2011***

- **0435D-3 (003RB1 x 0098B4)**. This very early selection begins fruiting 4-5 days before Glen Lyon and is productive over a long season. Fruit is sweet and aromatic even at the end of June. Fruit is displayed well and is easy and quick to pick. Canes have moderate vigour, therefore easy to manage. JHI results can be found in Table 4, Figure 2 and Appendix I, Tables 10, 14 and 16.
- **0447C-5 (00123A5 x 0019B11)**. This late season selection starts fruiting 2-3 days earlier than Octavia. The plants form a good hedge with a favourable habit. Fruit is large and fills a punnet quickly. Shelf-life is excellent. JHI results can be found in Table 4, Figure 2 and Appendix I, Tables 10, 14 and 16.

**Table 6.** Selections undergoing disease testing at JHI

<b>Selection</b>	<b>Progress of pathogen testing</b>	<b>Indexed root available</b>
<b>Glen Doll</b>	Fully tested. Material in high health house	2008 (6 mothers)
<b>Glen Fyne</b>	Fully tested. Material in high health house	2008 (6 mothers)
<b>Glen Cally</b>	Fully tested. Material in high health house	2008 (6 mothers)
<b>Glen Ericht</b>	Fully tested. Material in high health house	2008 (6 mothers)
<b>9628E-3</b>	Fully tested. Material in high health house	2008 (6 mothers)
<b>9764F-3</b>	Fully tested. Material in high health house	2008 (6 mothers)
<b>00123A7</b>	Fully tested. Material in high health house	2008 (6 mothers)
<b>9911C-1</b>	Fully tested. Material in high health house	2009 (4 mothers)
<b>0019E2</b>	Fully tested. Material in high health house	2009 (4 mothers)
<b>9350F3</b>	Fully tested. Material in high health house	2010 (4 mothers)
<b>0453C4</b>	Fully tested. Material in high health house	2010 (4 mothers)
<b>0433F2</b>	Fully tested. Material in high health house	2010 (4 mothers)
<b>0304F6</b>	Fully tested. Material in high health house	2010 (4 mothers)
<b>0485K-1</b>	Fully tested. Material in high health house	2011 (2 mothers)
<b>0534RB1</b>	Plants currently under testing, expected 2012	2012
<b>0435D-3</b>	Plants to enter testing 2012	2013
<b>0447C-5</b>	Plants to enter testing 2012	2013

### ***Primocane-fruited seedlings***

In 2009, crossing increased focus on breeding primocane types. After screening for absence of spines and resistance to aphids, the seedlings were potted-on into 10L polythene pots and moved into a Haygrove polytunnel in May 2011 to establish. Since the seedlings were derived from primocane x floricanes, families showed continuous variation for fruiting habit, i.e. a proportion were primocane-fruited, floricanes-fruited and tip-fruited. Only primocane types were evaluated and floricanes or tip-fruited types were discarded from the plot. Six selections were made targeting early season and good fruit quality (see Table 7). These will be either propagated for replicated trials or used in crossing in 2012.

**Table 7. Primocane selections from JHI**

Selection	Fruit size (g)	Brix <sup>o</sup>	First fruit	
0925C-2	7.4	10.3	05/09/11	Early, large fruit, firm, easy pick
0919F-2	5.8	11.9	05/09/11	Early, firm fruit, bright colour, easy to pick
0994H-12	6.2	10.4	14/10/11	Spiny, large attractive fruit, primocane 50%
0994I-9	6.2	10.1	16/09/11	Good quality fruit and flavour until end November
0914B-2	6.4	9.8	16/09/11	Primocane 50%, large fruit, flavour ok
0973D5	5.9	11.1	22/09/11	Good quality, nice flavour

### ***Deployment of marker assisted selection in the breeding programme***

Breeding for resistance to *Phytophthora* root rot is a major objective of the breeding programme. The traditional method of selection involves screening progeny in an infestation plot at JHI, which is time-consuming and costly in terms of field resources. The Hortlink project, HL0169, headed by Julie Graham at JHI, has made it possible to shorten this process through the use of genetic markers linked to root rot resistance.

These markers were validated in 2008, and parental material with the marker was identified and used in the 2009 crossing programme. Approximately 3000 progeny from these crosses were germinated, spiny genotypes and those susceptible to the large raspberry aphid were discarded. The remaining seedlings, approximately 1,000 individuals, will be screened to identify resistant individuals very early in the breeding process.

Thirt-two selections from these progenies have been identified with the marker thus far. These have been propagated to produce 20 plants of each for planting into replicated plots in both clean and infested sites.

### ***Screening for *Phytophthora* tolerance in the field***

A field trial was set up to screen various genotypes for field tolerance to *Phytophthora* root rot. The infestation plot at JHI was of insufficient size to assess all the genotypes, therefore the trial was set up off-site with the intention to plant additional genotypes as they become

available in 2012. The following was planted at Alyth in the open field in May 2011. The genotypes are detailed in Appendix I, Table 12.

- 600 seedlings from progenies described above in single plots (individual plants).
- 32 genotypes in 5-plant plots, including elite selections, named cultivars and selections already identified with the 118b marker for *Phytophthora* resistance.

Marker assisted selection has become recently available to identify other important traits early in the selection process, namely fruit quality characteristics (Hortlink HL0170). The decision to use fruit size as the next trait was made late in 2010. These are currently in the process of validation at JHI and will be easily integrated with the markers for root rot resistance and seedlings will be screened routinely using these techniques.

### **Plans for 2012**

- Crosses will be made early in 2012, targeting root rot resistance, primocane-fruiting and quality traits.
- Seedlings from 2011 crosses will be screened as appropriate.

The following JHI plots will be fruiting and evaluated in 2012:

- Protected plot of 30 JHI selections, identified in 2008, in their third and final season.
- Protected plot of 60 JHI selections, identified in 2009 and 2010, in their first fruiting season.
- Protected plot of primocane-fruiting seedlings
- 4,000 seedlings in the open field from crosses made in 2008.
- 600 seedlings and 25 replicated selections in an infested open field trial at Alyth to assess tolerance to *Phytophthora*.

### **Conclusions**

- Marker assisted selection has identified 32 genotypes with the marker for *Phytophthora* root rot resistance early in the breeding process.
- Glen Fyne performed very well in JHI and on-farm trials in the UK and overseas.
- Selection 0019E2 generated tremendous feedback of productive plots of large fruit and good flavour.
- Selection 0485K-1 had outstanding fruit quality in JHI plots and promising early feedback from trials.
- Four new selections 9350F3, 0453C4, 0304F6 and 0433F2 were planted in on-farm trials in the UK and Spain.
- Two new selections were identified for on-farm trials; 0435D-3 and 0447C-5.
- Primocane-fruiting selections were made from crosses made in 2009.

## Technology transfer

- A presentation of the project was given at the following events:
  - SSCR Soft fruit meeting, 9 March 2011

Attendance at the following event displaying posters and leaflets, promoting the breeding programme and cultivars:

- Rubus and Ribes Symposium, Serbia 18-26 June 2011.
- Fruit Focus, EMR 20<sup>t</sup> July 2011.

## Publications

- Lye, G.C., Jennings, S.N., Osbourne, J.L. and Goulson, D. Impacts of the provision of non-native commercial *Bombus terrestris* (Hymenoptera: Apidae) colonies on yield and pollinator visitation of raspberry. *Journal of Economic Entology*. In press.
- 'Raspberry variety trials at JHI in 2010' Horticultural Development Company Factsheet 22/08, Project SF35b

## Other Knowledge Transfer

- Aberdeen University Plant Molecular Genetics students, 7 December 2010.
- Cornell University LEAD students, 8 February 2011.
- EU GenBerry meeting, INRA, Bordeaux, 15-16 March 2011.
- Visit Eurosemillas trials in Huelva, Spain, 21-23 March 2011.
- Visit English trial sites 4-5 July 2011.
- HDC raspberry trial open day, 5 July 2011.
- Wingham Wheat Club, 9 June 2011.
- Joe Stephens, Plant and Food Research, NZ, 17 June 2011.
- Jorge Soria, INIA, Uruguay, 28-29 June 2011.
- Caledonian Horticultural Society, 27 July 2011.
- Shaun MacAntsaor, TEAGASC, 28 July 2011.
- Finnish growers, 15 September 2011.



## GLOSSARY

<b>Cotyledon</b>	The embryonic leaf of a seed.
<b>Crossing</b>	The mating of individuals of different genotypes of the same species in order to promote genetic recombination.
<b>Emasculation</b>	The removal of male reproductive organs.
<b>Genotype</b>	An individual with a unique genetic constitution.
<b>Pistil</b>	The female reproductive structure of a flower, consisting of ovary, style and stigma.
<b>Progeny</b>	The resulting offspring of a cross.
<b>Seed scarification</b>	The physical disruption of the seed epispem.
<b>Seed stratification</b>	The exposure of seeds to extended cold periods prior to germination at warm temperatures.
<b>Stigma</b>	The surface of a pistil upon which the pollen grains germinate.
<b>Vernalisation</b>	A process of thermal induction in plants, in which growth and flowering are promoted by exposure to low temperatures.

## REFERENCES

Graham, J., Smith, K., Tierney, I., MacKenzie, K., Hackett, C.A. 2006. Mapping gene *H* controlling cane pubescence in raspberry and its association with resistance to cane botrytis and spur blight, rust and cane spot. *Theo. Appl. Gen.* 112: 818-831.

Lincon, R.J., Boxshall, G.A., Clark, P.F.1982. A dictionary of ecology, evolution and systematics. Cambridge University Press.

Appendix I

Table 8 Review of Breeding Objectives 2011. Industry partner feedback

Traits of interest	Consortium member						
	Hargreaves	ReDeva	ASF	Peter Thomson	Trade Solutions	CPM	
				9=high priority 1=low priority	5=high priority 1=low priority		
<b>Chilling requirement</b>	D	E	D		1	D	
<b>Season</b>	Bud break	D	D	D	2 late better	4 D	
	First flower	D	D	D	2 late better	4 D	
	First ripe fruit	D	E	D	5 late or early	3 D	
	50% pick	E	E	D	5 late or early	3 E	
	Last pick	D	E	D	1	2 D	
<b>Plant characteristics/ architecture</b>	Spines	D	D	D	2	4 E	
	Primocane emergence	D	D	D	1	3 D	
	Primocane habit (Erectness)	D	E	D	3	4 D	
	Primocane vigour (height)	D	E	D	2 high better	3 D	
	Lateral length and strength	E	E	D	3 short and strong	4 D	
	Display/ presentation of fruit	E	E	D	3	4 E	
	Ease of pick/abscission	E	E	D	3	5 E	
	Yield	E	E	E	8	5 E	
	Fruit/lateral	D	D	D	1	4 D	
	Fruit size (g)	E	E	E	8	3 E	
<b>Fruit Quality</b>	Flavour/aroma	D	E	E	9	4 E	
	Sweet/acid	E	E	E	7	4 E	
	Texture	D	E	D	5	3 D	
	Brix levels	D	D	D	5	3 E	
	Colour	E	E	E	7	3 E	
	Firmness	E	E	E	8	3-5 E	
	Gloss	D	E	D	6	2 D	
	Fruit shape	E	E	E	7	3 D	
	Uniformity of drupes	E	E	E	7	3 E	
	Fruit set	E	E	E	7	3 E	
	Druplet cohesion	E	E	E	7	3 E	
<b>Shelf life</b>	Postharvest colour, firmness,	E	E	E	9	3 E	
<b>Nutritional</b>	Phenolics, Anthocyanin levels,	D	D	D	3	4 D	
<b>Pest and disease</b>	Large raspberry aphid	D	E	D	4	4 D	
	<i>Phytophthora</i> root rot	D	D	D	6	5 D	
	Cane botrytis and spur blight	D	D	D	3	5 E	
	Scores based on natural infection of RBDV, cane spot, powdery mildew, raspberry leaf and bud mite, raspberry beetle, TSSM	D	D	D,D,D, D,D,D	4 RBDV, 2 cane spot, 2 powdery mildew, 4 leaf and bud, 3 beetle, 3 TSSM	5	
<b>Primocane-</b>	Season	E	E	D	6 early better	very early D	
<b>Processing Quality</b>	Machine harvest-ability	D	D	D	2	4 D	
	Freezing quality	D	D	D	2	4 D	
	Juicing quality	D	D	D	2	4 D	
<b>Propagation</b>		D	D	D	2	4 D	
		E = essential D = desirable					

**Table 9 Yield and quality data 2011, JHI plots planted 2007 (J25) and 2008 (J26). Ranked mean yield / stool**

Selection	First pick date	Last pick date	Mean yield/stool (g)	Mean Fruit Size (g)	Mean Brix <sup>o</sup>
Glen Ericht*	01/07/11	01/08/11	2130	4.1	9.0
0304F6*	11/07/11	28/07/11	1953	6.0	10.9
Glen Fyne*	11/07/11	25/07/11	1489	5.1	11.1
9350F3*	11/07/11	01/08/11	1271	4.2	9.7
9025A1	15/07/11	25/07/11	1153	3.6	8.4
<b>Octavia</b>	<b>21/07/11</b>	<b>08/08/11</b>	<b>441</b>	<b>5.6</b>	<b>9.7</b>
0453C5	01/07/11	25/07/11	2134	4.1	9.1
0433H-3	04/07/11	01/08/11	2122	4.4	8.9
0453C4*	01/07/11	08/08/11	1965	4.4	10.9
9673E4	04/07/11	01/08/11	1651	3.2	9.0
0081G-2	04/07/11	25/07/11	1620	4.0	7.1
0433D6	01/07/11	25/07/11	1531.3	4.8	9.6
0341C1	07/07/11	01/08/11	1476	3.1	9.5
0433F-4	04/07/11	01/08/11	1361.1	3.6	8.9
9059C-1	07/07/11	01/08/11	1247.7	4.5	9.9
0491B5	07/07/11	04/08/11	1234	3.9	9.2
0433F2*	11/07/11	01/08/11	1090	4.0	9.9
0039F-2	07/07/11	28/07/11	1034	4.4	8.5
<b>Glen Ample</b>	<b>07/07/11</b>	<b>01/08/11</b>	<b>956.1</b>	<b>4.9</b>	<b>8.9</b>
<b>Tulameen</b>	<b>15/07/11</b>	<b>01/08/11</b>	<b>942</b>	<b>4.5</b>	<b>11.8</b>
0433H-2	04/07/11	01/08/11	820	3.9	6.0
0469G2	01/07/11	21/07/11	518.6	4.8	8.3
<b>Octavia</b>	<b>21/07/11</b>	<b>15/08/11</b>	<b>363</b>	<b>5.9</b>	<b>9.9</b>
9025A1	15/07/11	25/07/11	234.7	5.5	7.2
0015B3				4.6	9.1

\*Selections in On-Farm trials

**Table 10 Yield and quality data 2011, JHI plots planted 2009 (J7). Ranked mean yield / stool**

Selection	First pick date	Last pick date	Mean yield/stool (g)	Mean Fruit Size (g)	Mean Brix <sup>o</sup>
0524G5	01/07/11	08/08/11	3887	4.4	9.3
9901B-3	07/07/11	08/08/11	3358	4.8	9.9
0019E3	01/07/11	08/08/11	3033	4.8	9.3
0435D-3**	28/06/11	01/08/11	2833	4.6	10.4
0422G3	04/07/11	28/07/11	2729	4.6	8.8
0573B5	07/07/11	04/08/11	2589	4.5	10
0447C-5**	18/07/11	15/08/11	2448	6.1	9.3
004A1	01/07/11	28/07/11	2316	4.1	9.2
0019E2*	11/07/11	08/08/11	2310	6.0	9.6
0511F1	04/07/11	04/08/11	2129	4.8	9.8
0485K-1*	04/07/11	04/08/11	2097	5.3	9.4
0015F1	18/07/11	08/08/11	1872	5.3	11.2
0550D2	04/07/11	01/08/11	1723	4.7	9.4
0485K-2	04/07/11	04/08/11	1682	5.6	10.5
0574I7	04/07/11	01/08/11	1674	4.0	7.6
04108F-5	15/07/11	08/08/11	1626.5	4.1	9.9
0534RB1*	07/07/11	08/08/11	1586.5	6.3	11.4
0484H1	01/07/11	25/07/11	1569	4.4	7
00123A7*	11/07/11	08/08/11	1547	5.0	11.3
9601C-1	01/07/11	18/07/11	1360.2	4.3	7
0433E5	04/07/11	01/08/11	1286	4.0	10.0
0433I5	01/07/11	01/08/11	1268.5	4.7	9.4
0494E-3	07/07/11	28/07/11	1192.5	5.1	9.6
Glen Doll*	07/07/11	01/08/11	1165.5	5.2	10.8
<b>Tulameen</b>	11/07/11	<b>04/08/11</b>	<b>1075</b>	<b>5.3</b>	<b>11.8</b>
<b>Glen Ample</b>	07/07/11	<b>08/08/11</b>	<b>1058</b>	<b>4.9</b>	<b>8.9</b>
0462C-2	07/07/11	01/08/11	885	6.1	9.1
0462C-1	15/07/11	01/08/11	884.5	5.8	9.4
0492G1	07/07/11	01/08/11	731.5	5.2	6.8
Obbard	01/07/11	15/07/11	695	3.8	8.0
04101C3	07/07/11	01/08/11	515	4.6	9.8
Autumn Treasure	24/06/11	11/07/11	353.5	3.3	9.3

\*Selections in On-Farm trials

\*\*Proposed new selections

**Table 11 Selection Status document**

Selection	Initial selection	2009	2010	2011	2012	2013	2014	Comments
Glen Doll	1995	G, P	G	C	C	C	C	PVR applied for in 2006
9764F-3	2000	G	■	■	■	■	■	discarded by Consortium in 2009
9628E-3	1999	G	■	■	■	■	■	discarded by Consortium in 2009
Glen Fyne	1995	R, P, G	G, P	G, P	C	C	C	PVR applied for in 2008
Glen Ericht (Pr)	2001	G1	R, G1, P	G1, P	C	C	C	PVR applied for in 2008
Glen Cally (Pr)	2001	G2	R, G2					PVR applied for in 2008
00123A7	2002	M	G	G	■	■	■	discarded by Consortium in 2010
0019E2	2002	M	M, G3	G3	G3	■	■	
9911C-1	2001	M	G	G	■	■	■	discarded by Consortium in 2010
9350F3	2004	J	M	G4	G4	G4	■	
0304F6	2005	J	M	M	G4	G4	■	
0453C4	2006	J	M	G4	G4	G4	■	
0433F2	2006	J	M	G4	G4	G4	■	
0485K-1	2007	■	J	M	G5	G5	G5	buds failed to initiate in microprop in 2011
0534RB1	2007	■	J	M	G	G	G	
0435D-3	2007	■	J	J	M	G	G	
0447C-5	2007	■	J	J	M	G	G	

**KEY**

- J JHI trials only
- M Micropropagation
- P Propagation
- G Grower trials (see below for location)
- R Release
- C Commercially available
- Pr For processing market only
- Decision required by Consortium

**Trial Locations**

**G1**

Pete Marshall, Alyth  
Peter Vinson, Faversham  
Hargreaves Plants  
Paul Harrold, Cambridge

**G2**

Pete Marshall, Alyth  
ASF, Arbroath  
Hargreaves Plants

**G3**

Pete Marshall, Alyth  
Peter Vinson, Faversham  
Hargreaves Plants  
Paul Harrold, Cambridge  
ASF, Arbroath  
Total Berry, Gaskains  
Tongeren, Belgium

**G4**

Berrygardens  
ASF, Arbroath  
HDC Trial, Oxfordshire  
CPM  
Berryworld, Fife  
Hargreaves Plants  
Total Berry, Gaskains  
Trade Solutions  
Eurosemillas, Spain  
CPM, Spain  
Tongeren, Belgium (Jeroen Kellers)  
Weinsberg, Germany (Gunhild Muster)

**G5**

HDC Trial, Oxfordshire  
Total Berry, Gaskains

**Table 12 Genotypes planted at Muirton, Alyth in May 2011**

Genotype	Total no of plants	Plot size	Notes
0912	44	singles	
0926	47	singles	
0941	25	singles	
0943	36	singles	
0954	74	singles	
0955	64	singles	
0957	42	singles	
0946	15	singles	
0945	44	singles	
0956	30	singles	
0953	53	singles	
0956	16	singles	
Glen Moy	10	5 plant plots	susceptible control
Glen Ample	10	5 plant plots	susceptible control
Glen Fyne	5	5 plant plots	susceptible control
Glen Ericht	5	5 plant plots	
R4A1	5	5 plant plots	118b marker
9351B4	5	5 plant plots	
0019E2	5	5 plant plots	Elite selection
97134RB1	5	5 plant plots	
0015B3	5	5 plant plots	
0304F6	5	5 plant plots	
0315B1	5	5 plant plots	
0453C4	5	5 plant plots	Elite selection
0485K-1	5	5 plant plots	Elite selection
9422D4	5	5 plant plots	118b marker
9025A1	5	5 plant plots	
9350F3	5	5 plant plots	Elite selection
9434F1	5	5 plant plots	118b marker
99118D3	5	5 plant plots	
0304E3	5	5 plant plots	
0534RB1	5	5 plant plots	Elite selection
0946-7	5	5 plant plots	118b marker
0957-13	5	5 plant plots	118b marker
0957-14	5	5 plant plots	118b marker
0957-24	5	5 plant plots	118b marker
0957-58	5	5 plant plots	118b marker
0957-59	5	5 plant plots	118b marker
0957-61	5	5 plant plots	118b marker
0957-64	5	5 plant plots	118b marker
R96	5	5 plant plots	118b marker / resistant control
R148	5	5 plant plots	118b marker / resistant control
R178	5	5 plant plots	118b marker / resistant control

**Table 13 JHI Polytunnel site J25 and J26. Summary of arbitrary scores and comments (ranked highest to lowest)**

<b>Selection</b>	<b>Fruit set</b>	<b>Fruit shape</b>	<b>Fruit Brightness</b>	<b>Fruit colour</b>	<b>Pick</b>	<b>Collar</b>	<b>Firm</b>	<b>Flavour</b>	<b>Overall Score</b>	<b>Notes</b>
9350F3	8	7	4.5	4.5	6	7	6	6.5	6	sweet , attractive but beetle damage, blotchy late in season, firm
0304F6	8	5.5	5	3	6	7	6.5	6.5	5.5	beetle damage - shame, good flavour - fruity with an acid edge, large + pale, no root rot symptoms
9673E4	9	4.5	7.5	5	6	8	5.5	5.5	5.5	small and shiny , very pretty, floral, too small by mid season
0015B3	8.5	6	6	4.5	5.5	6	6.5	5	5	very shiny, attractive, mild flavour, attractive, good flavour
0453C4	7.6	5.3	6	5.3	7	6.3	5.6	6.2	4.6	excellent flavour, sweet and aromatic fruit, some murly, softens late season, slight beetle damage, no root rot symptoms
0081G-2	7	5	5.5	5	6	6.5	6	5.5	4.5	sweet and floral but mild, slightly rough, some beetle damage
0039F-2	8	5.5	6	3.5	5	6	5.5	3.5	4.5	very pale, some beetle damage, acid rhubarb, some root rot
Octavia	7.5	5	4.5	4		7	6	4	4.5	like Ample, slightly acid, juicy, slightly rough, bad beetle damage, pale and meaty, acidic, root rot plant 5
Glen Fyne	7	5	5	6	5.5	7	6	8	4	slight crumble in punnet early pick, superb flavour
9059C-1	7.5	5	5.5	4.5	5	6.5	5	5	4	beetle damage, nice flavour, good acidity, variable shape, some bleeding
Glen Ample	7.5	5	5.5	5	6	5	5.5	4	4	some crumble, whole fruit nice, poor flavour
Tulameen	8	7	5	6	6	7	4	6	4	sweet and rubbery, juicy, soft and bleeding but good to eat
0341C1	9	4.5	4.5	4.5	5	7.5	4.5	6	4	too small fruit, some beetle damage, small, dark, neat, sweet

Selection	Fruit set	Fruit shape	Fruit Brightness	Fruit colour	Pick	Collar	Firm	Flavour	Overall Score	Notes
9025A1	9	5	7	6		7	7	2	4	woody flavour, darkish, round
99111B2	8	6	4	6	6	6.5	6	3	3.5	fruity + v acid, some beetle damage, prominent drupes
Glen Ample	6.5	5	5	5	6	5	5.5	3.5	3.5	fat drupes, crumbly like Ample, tearing collar, no flavour
0491B5	8	5	7	5.5	5.5	6	7	5	3.5	looks like Ericht, sweet and fruity, prominent drupes, blotchy
0433H-3	7	5	4	4.5	5	5.5	5.5	6.5	3.5	nice flavour, prominent drupes, not attractive, crumbly, some mildew
0433F2	6.5	6	5	5.5	5	5.5	3.5	6	3.5	very sweet like Tulameen, slightly rough, some beetle damage, a bit soft and some bleeding
9059C-1	8	5	5	3	5	6.5	6	4.5	3.5	like 0039F-2, slightly bleeding, sharp! beetle damage, spicy, gingery
0469G2	7	5	5	3	6	6	6	5	3	beetle damage, unattractive, blotchy, misshapen
0433F-4	7	4.5	4	4	6	6	4.5	6	3	small and rough like Prosen
0433D6	6	6	3.5	5	5.5	5.5	6	6	3	dull and blotchy, sweet, too small, crumbly and mouldy late season, great flavour
0433H-2	9	6	5.5	4	5	7	5.5	2	2.5	bad beetle damage, some mummified, bleeding
0433F-4	6	4	4.5	3.5	6	6	5.5	6.5	2.5	some beetle damage, nice flavour, small and crumbly, variable firmness
9025A1	8	5	6	6	6	8	5	2	2	dark and shiny, woody/grassy flavour, some beetle damage, some crumble
0453C5					5					misshapen



**Table 14 JHI Polytunnel site J7. Summary of arbitrary scores and comments (ranked highest to lowest)**

Selection	Fruit set	Fruit shape	Fruit Brightness	Fruit colour	Pick	Collar	Firm	Flavour	Overall Score	Pubescent cane / Gene H	Notes
0485K-2	9	7.5	8.2	3.7	5.5	7.7	6	6.5	7.7	x	some wind damaged laterals, good display, vigorous primocane, very shiny, better flavour than K-1 early season
0485K-1	8.7	7.2	8	4.2	6	8	6	5	7.2	x	very attractive punnet, shiny and uniform, very vigorous primocane - hitting top of polytunnel in leg row, some sweetness but mild, striking fruit
0435D-3	8.3	7	5.3	5	4	7.6	5.6	7	7	x	very early - almost finished picking end of July, good flavour all season, sweet and floral all season
0462C-1	8	6	7	4	5.5	7	6	6	7		Good quality but laterals badly wind damaged
0447C-5	8.5	6.7	6.2	4.2	5.5	8	6	5.7	6.7		late season - similar to Octavia, meaty and early fruit slightly murly, dry, looks productive, conical, bright, attractive, uniform, sweet
0015F1	9	5.3	5.6	4.3	6	7.6	7	6	6.3		bright and attractive, primo vigorous, patchy bud break, good display, very sweet and fruity
0433I5	8.6	6.6	5	5	6	7.3	6.3	6	6.3	x	wind damaged laterals, attractive, pointy conical like Tulameen, dry and sweet, many secondary laterals flowering
0019E3	8.4	7	6.2	5	5.5	7.6	6.4	5.4	6.2		good display, attractive, less meaty than E2, watery flavour, healthy plot, attractive, slightly blotchy, sweet and fruity
0019E2	8.7	6.7	6.2	4.5	6	8	6.5	6.2	6.2		very firm and meaty, attractive, dry but sweet, good hedge habit, beetle damage late season
0422G3	8.5	6.7	6.5	4.2	6	7.5	6	6	5.7		variable colour, floral flavour, a few blotchy, shiny and conical
0524G5	8	5.2	5.8	4.6	5.5	7.6	6.4	5.2	5.6		little beetle damage, slight collar tearing, good quality, variable shape, blotchy, dry, seedy but sweet
Glen Doll	8.6	5.3	5.3	5	7	7	7.3	5.3	5.6	x	dry, sweet and firm, bright - good display, acid late season
0550D2	8.6	5	5.3	5.3	6	6.6	5	6.3	5.6	x	small drupes, hairy, dark, wine flavour and sweet, looks like Rosa, variable firmness

Selection	Fruit set	Fruit shape	Fruit Brightness	Fruit colour	Pick	Collar	Firm	Flavour	Overall Score	Pubescent cane / Gene H	Notes
0462C-2	8.6	5.3	5	4.6	5	6.6	6.6	5.3	5.6	x	many missing laterals (wind), fruit tears when picked, nice flavour, slightly acid
04108F-5	8.2	4.7	6.5	3	6	8	6.5	5.5	5.6		variable flavour but ok, chlorotic florican leaves, very bright, orange like 39F-2, small?
0462C-1	8.5	5.5	6.2	4.7	5.5	5.7	6	4.5	5.5		bad wind damage - knocked out many laterals, good fruit quality, attractive, round like large Doll, little flavour, watery
0534RB1	8.2	7.7	5.5	5.2	5	6.7	6	6.2	5.5		slightly blotchy, enormous fruit, sweet and fruity - little juice, beetle damage on late fruit causing mould
Glen Doll	8.7	5.2	5.5	4.5	6	7.2	7.2	5.7	5.5	x	sweet, little juice, very firm, beetle damage, chlorotic florican leaves, bubblegum sweetness
0573B5	8	5.2	7	4.7	6	6.2	5.5	5.7	5.5		slightly rough, shiny like Tulameen, slightly watery, slightly blotchy, tearing collar, sweet, little juice
0534RB1	7.7	7.5	5.7	4.7	5	7	5.5	5.2	5.5		very long laterals, huge meaty fruit, sweet but not at best, some beetle damage at end of pick spoiling fruit
0511F1	8.5	6.5	6	5		7.5	6	6.5	5.5		wind damage, look again next year
Tulameen	7.3	6.6	6.3	5.3	6	6	4.3	6.3	5.3		nice quality Tulameen, not much yield?
0015F1	8.5	6.7	5.5	4.5	6	7.7	6.7	5	5.2		acid but aromatic, slightly blotchy, conical and uniform, late fruit with beetle damage, floral and sweet
0511F1	8.5	6.2	6	4.5	5.5	7.2	7.2	4.2	5		very firm, slightly dry, acid, primo in way slightly, good lateral length and display, some murly, beetle damage, mealy-dry
0433E5	8.2	5.5	4	4.7	5	7.2	6.2	6.2	5	x	primocane vigorous but obstacle for picking, lovely flavour, healthy plot, dull bloom, sweet and fruity
9901B-3	7.6	6	5.2	3.2	5	6	7	5.4	5		very productive and nice flavour but poor appearance, good display, pale and slightly murly, dry, fruity, sweet
0462C-2	8.5	5.7	5.2	4.7	5	7	6.2	3.7	5		wind-damaged laterals, attractive, good lateral display, bland, slight mildew, collar tears slightly, look again next year

Selection	Fruit set	Fruit shape	Fruit Brightness	Fruit colour	Pick	Collar	Firm	Flavour	Overall Score	Pubescent cane / Gene H	Notes
0494E-3	7.6	6.3	5.3	5.6	6	6.3	6	5.6	5		good flavour, sweet not much acid, seedy, murly late season
Tulameen	7.3	6.6	6.3	5.3	6	6	4.6	7.3	5		murly Tulameen, bleeding, tearing collar, great sweet flavour
00123A7	7.5	6.5	5.7	4.2	7	6.2	6.2	5.5	5		sweet but mild and no acidity, slightly rough late season
Obbard	9	6	7	6		8	5	4	5		floricane fruit attractive, small neat drupes, bland, pretty, too dark
0484H1	8	5	4	5		8	5	4	5		Wind damaged laterals
0433I5	8.2	6	5	4.7	5.5	7.7	6.5	4.2	4.7	x	wind damaged laterals but secondary laterals flowering, but weak, watch next year
0494E-3	7.6	6	6	5.6	7	6.6	5.6	6	4.6		wind damage, large, meaty, sweet like Tulameen flavour
004A1	8.2	4	5.7	4.7	6	6.5	6	6	4.5	x	some crumble and beetle damage, very good flavour, poor appearance, too small, sweet and fruity, long strong laterals
0492G1	9	5	7	4	6.5	8	5.3	4.3	4.3	x	pale, bright, like pale Glen Doll, juicy but poor flavour
0574I7	8	6.2	5	5.2	5.5	7.2	6	4.7	4.2		bad beetle damage, woody flavour and acid
Autumn Treasure	8	6	6	6		8	4	6	4		dark, bleeding floricane fruit but good flavour and easy pick
0573B5	7	5.6	6.3	5.6	7	6	6.6	5.3	3.6	x	round, dark, some crumble, bad beetle damage, poor quality
04101C3	7	5	5	4.5	5	5.5	6.5	5	3	x	prominent drupes, meaty, low drupe number, crumbly and deficient, remove plot
0484H1	8.5	6	5	5	3	6	8	3	2	x	chlorotic floricane, tartan berries - very uneven ripening, tearing collar, very acid

Selection	Fruit set	Fruit shape	Fruit Brightness	Fruit colour	Pick	Collar	Firm	Flavour	Overall Score	Pubescent cane / Gene H	Notes
9601C-1			2	7				3	2		laterals stripped of leaves, too dark, dull, unattractive

**Table 15 Shelf-life scores: J25 and J26 evaluated 7 days after picking, stored at 4C. Ranked from best to worst**

Selection	PH Rank	PH Bleeding	PH Brightness	PH Colour	PH Blotchy	PH Mould	PH Firm	PH Overall score	Notes
9673E4	1	1	7	4	1	1	7	8	
Octavia	2	1	5	3	1	1	7	7	
0039F-2	3	1	6	3	2	1	5	7	
0304F6	4	1	6	5	2	2	7	6	1 drupe mouldy
0015B3	5	1	6	4	2	1	6	6	
0433H-2	6	1	4	4	3	1	6	5	
0453C4	7	1	5	5	2	1	5	5	varied colour and firmness
Tulameen	8	1	6	5	2	1	5	5	slightly rough
9025A1	9	1	6	5	2	2	6	4	
9059C-1	10	1	4	4	2	1	6	4	slightly rough like Ample
0433F-4	11	1	4	4	4	1	5	4	small and rough like Prosen
Octavia	12	1	5	4	3	2	6	4	
0453C5	13	1	6	4	4	1	5	4	misshapen
0341C1	14	1	4	5	4	2	6	4	
9350F3	15	1	4	6	5	1	7	4	very blotchy, firm
0433H-3	16	1	4	5	5	2	6	3	big drupes, rough
9053B6	16	1	4	4	3	4	4	2	
Glen Ample	17	1	5	5	6	2	5	3	crumbly
0491B5	18	1	6	6	5	2	5	3	rough
0433F2	19	1	3	5	6	3	6	2	rough and dull
0433D6	20	1	6	5	6	3	4	2	
0081G-2	21	1	5	5	7	3	5	2	
99111B2	22	1	5	6	4	4	5	2	

**Table 16 Shelf-life scores: J7 evaluated 7 days after picking, stored at 4C. Ranked from best to worst**

Selection	PH Rank	PH Bleeding	PH Brightness	PH Colour	PH Blotchy	PH Mould	PH Firm	PH Overall score	Notes
04108F-5	1	1	5	3	1	1	7	9	great colour, pale but not blotchy
0485K-2	2	1	7	4	1	1	6	8	very attractive
0524G5	3	1	6	5	2	1	6	8	
0422G3	4	1	5	5	2	1	6	7	
0447C-5	5	1	6	3	2	1	6	7	large and meaty
9901B-3	6	1	4	3	3	1	6	7	good colour but slightly blotchy
0485K-1	7	1	7	5	2	1	6	7	still shiny but slightly blotchy
0511F1	8	1	5	5	3	1	7	6	slightly rough
0492G1	9	1	5	5	2	1	5	6	small and round, attractive but slightly softer
0462C-2	10	1	6	4	3	1	6	6	
0019E2	11	1	5	5	4	1	7	6	firm, large but blotchy
0433I5	12	1	5	5	3	2	6	6	1 drupe mouldy
0015F1	13	1	4	4	4	1	7	6	
0435D-3	14	1	4	5	2	1	5	5	
0462C-1	15	2	6	5	3	2	5	5	

Selection	PH Rank	PH Bleeding	PH Brightness	PH Colour	PH Blotchy	PH Mould	PH Firm	PH Overall score	Notes
0433E5	16	1	4	4	2	1	6	5	dull bloom
Glen Doll	17	1	6	6	2	1	8	5	firmest but dark
004A1	18	1	5	5	3	1	4	4	rough and softening
00123A7	19	1	5	4	2	1	6	4	slightly rough, unattractive
0573B5	20	2	6	6	3	1	4	4	
Tulameen	23	1	6	6	3	1	4	4	slightly crumbly
0550D2	24	2	5	6	2	1	5	4	variable firmness
0574I7	25	1	5	6	2	2	6	4	
0484H1	26	1	4	4	5	1	4	3	pale and blotchy
0019E3	27	1	6	5	3	3	6	3	some mould
0534RB1	28	1	6	6	4	4	6	2	very large but beetle damage causing mould
0494E-3	29	1	5	8	2	1	5	2	too dark

**Table 17 Shelf-life scores: J25 and J26 evaluated 12 days after picking, stored at 4C. Ranked from best to worst**

Selection	PH Rank	PH Bleeding	PH Brightness	PH Colour	PH Blotchy	PH Mould	PH Firm	PH Overall score	Notes
9673E4	1	1	5	4	3	2	6	6	would still eat
0015B3	2	1	4	4	2	2	6	5	
Tulameen	3	1	4	5	2	2	4	5	
0039F-2	4	1	5	3	3	5	5	5	
Octavia	5	1	4	4	3	3	6	4	
0304F6	6	1	4	5	4	4	6	4	
0341C1	7	1	4	6	3	3	5	4	
0433F-4	8	1	4	4	3	3	5	4	
0433H-2	9	1	4	4	4	4	5	4	
Glen Ample	10	1	4	5	3	3	5	4	
0491B5	11	1	4	6	3	3	5	4	
0081G-2	12	1	4	6	3	3	5	4	
0453C5	13	1	4	6	4	4	5	3	
Octavia	14	3	3	4	6	4	5	2	
9025A1	15	1	4	6	4	4	5	2	
9059C-1	17	1	4	4	2	4	4	2	
0433H-3	18	1	3	4	4	5	5	1	
9350F3	19	1	4	5	4	5	5	1	
0433D6	20	1	4	6	4	6	3	1	
99111B2	21	1	2	8	3	6	3	1	stuck to punnet
0453C4	22	1	4	7	2	6	3	1	

**18 Shelf-life scores: J7 evaluated 12 days after picking, stored at 4C. Ranked from best to worst**

Selection	PH Rank	PH Bleeding	PH Brightness	PH Colour	PH Blotchy	PH Mould	PH Firm	PH Overall score	Notes
0485K-2	1	1	6	4	1	1	6	7	still very attractive , would eat
0447C-5	2	1	6	4	2	1	5	7	large, good colour, uniform, looks just picked
0524G5	3	1	5	4	2	1	6	6	
04108F-5	4	1	5	4	1	2	5	6	1 drupe mouldy on one berry
9901B-3	5	1	4	4	1	1	5	6	
0422G3	6	1	5	5	3	1	4	5	
0019E2	7	1	5	5	2	2	6	5	
0433E5	8	1	4	5	2	2	5	5	
0015F1	9	1	5	5	3	2	6	4	
0433I5	10	1	4	6	2	2	5	4	
0485K-1	11	1	4	5	4	3	5	3	
0462C-2	12	1	5	6	2	3	5	3	
Tulameen	13	1	5	6	5	2	4	3	
Glen Doll	14	1	4	6	3	2	5	3	
0484H1	15	1	4	6	3	3	5	3	
0019E3	16	1	3	7	3	3	6	3	
004A1	17	1	3	6	3	3	4	3	
0462C-1	18	1	5	6	4	4	5	2	
0573B5	19	1	5	6	3	3	5	2	
0511F1	20	1	4	6	3	2	5	2	
00123A7	21	1	5	7	4	4	5	2	
0435D-3	22	1	3	7	4	4	5	2	
0494E-3	23	1	4	8	2	4	4	2	
0492G1	24	2	4	7	3	6	4	2	3 different moulds
0550D2	25	4	3	8	4	5	4	2	
0574I7	26	4	3	9	6	6	4	1	very blotchy

## APPENDIX II

**Figure 3 Glen Ericht summary of JHI and On-Farm trials results (1 of 2)**

### Glen Ericht

**Selection** 99111B2  
**Parents** 9422C-4 x 9434B-1  
**Markers used** Marker Rub 118b Date 2008 Result negative

### JHI field observations

A<sub>10</sub> resistance to large raspberry aphid

Shows strong field tolerance to *Phytophthora* root rot

Good tolerance to cane midge and subsequent cane blight

Moderate susceptibility to cane diseases

Susceptible to crown gall?

JHI trials	Date planted 2004			Date planted 2007				Comments
	2005	2006	2007	2008	2009	2010	2011	
<b>Yield (g/stool)</b>	1924.8	4948.3	2286.5	5101.4	2767.5	4981.5	2130.0	Very productive with a consistently higher yield than Glen Ample
<b>1st Pick</b>	05/07/05	17/07/06	16/07/07	10/07/08	02/07/09	12/07/10	01/07/11	3-5 days earlier than Ample
<b>Fruit size (g)</b>	5.2	5.7	5.7	4.4	5.3	5.1	4.1	
<b>Brix<sup>o</sup></b>	8.0	9.2	8.8	9.3	9.2	9.6	9.0	similar brix levels to Ample
<b>Colour</b>	6.0	6.0	5.6	5.5	5.6	6.3	6.0	dull red in colour
<b>Flavour</b>	2.0	4.0	3.1	2.8	3.4	3.3	3.0	processing generally fruity but very acidic
<b>Firmness</b>	6.0	7.0	6.2	5.7	5.8	6.0	6.0	consistently firm

Fruit well presented on laterals, easy to hand pick, high levels of acid make this unsuitable for eating fresh in the UK



**Glen Ericht (2 of 2)**

**Glen Ericht**

**On-farm trials**

Identified for on-farm trials 2002

Propagation 2003

	Hargreaves	Berryworld	Trade Solutions				
Production sys	soil	soil		open field /			
Results	2008	2009	2011	2008	2009	2010	2011
Control cv	Ample	Ample	Polka	Ample	Ample	Ample	Ample
Yield	similar	similar	similar	better	better	better	better
Fruit size	worse	worse	worse	worse	worse	similar	worse
Flavour	worse	worse	similar	worse	worse	worse	worse
Firmness	similar	similar	worse	similar	similar	better	better
Appearance	worse	similar	similar	better	better	similar	worse
Root rot	similar	similar	similar	better	better	better	better
Fruit rot	similar	similar	similar	better	better	better	better
Canes disease	similar	similar	similar	better	better	similar	worse
Virus	similar	similar	similar	better	better	better	better
First pick	30/06/08		26/07/11				
Last pick	21/07/08		25/09/11				
Fruit size (g)	2.5						
Overall compar	similar	worse	similar	better	better	better	
Plant more?	No	No	No	Yes	Yes	Yes	Yes*

**Comments**

In England, flavour very sharp, not suitable for general variety

Cane splits noted but no midge blight

Leaf and bud mite and cane spot infection noted, 2010 and 2011

In 2011: picks well with machine, comes of the husk 2 days before Ample, leading to much less moulds, especially in a wet season.

Disappointing results to root rot, 18 year break in roation and root rot very prevalent.

\*would plant on virgin soil

Figure 4 Glen Fyne summary of JHI and On-Farm trials results (1 of 2)

## Glen Fyne

**Selection** 9062E-1  
**Parents** 8631D-1 x 8605C-2  
**Markers used** Marker Rub 118b **Date** 2008 **Result** negative

### JHI field observations

*A*<sub>10</sub> resistance to large raspberry aphid

Spinefree

Susceptible to *Phytophthora*

Occasional infection of powdery mildew

JHI trials	Date planted 2007				Comments
	2008	2009	2010	2011	
<b>Yield (g/stool)</b>	4591.0	5539.0	4981.5	1489.0	consistently more productive than Glen Ample in tunnel and open field
<b>Ist Pick</b>	14/07/08	06/07/09	12/07/10	11/07/11	3-5 days earlier than Glen Ample
<b>Fruit size (g)</b>	5.0	5.4	5.0	5.1	
<b>Brix<sup>o</sup></b>	10.0	11.3	10.2	11.1	
<b>Colour</b>	5.3	5.0	5.3	6.0	
<b>Flavour</b>	6.0	6.4	7.0	8.0	aromatic and sweet flavour
<b>Firmness</b>	6.0	5.8	5.5	5.5	firm fruit with good cohesion

## Glen Fyne (2 of 2)

### Glen Fyne On-farm trials

Trade Solutions						Total Berry	HDC Trial
Production sys	soil				potted	soil	soil
Results	2008	2009	2010	2010	2011	2010	2011
Control cv	Ample	Ample	Ample	Cas. Delight	Ample	Ample	Tulameen*
Yield	better	better	better	better	similar	similar	better
Fruit size	similar	similar	similar	similar	similar	similar	better
Flavour	better	better	better	better	worse	better	better
Firmness	better	better	better	better	better	similar	better
Appearance	similar	similar	similar	better	similar	similar	better
Root rot	similar	similar	similar	similar	similar	similar	worse
Fruit rot	better	similar	similar	better	similar	similar	better
Canes disease	similar	similar	similar	similar	similar	similar	no problems
Virus		similar	better	similar	similar	similar	no problems
First pick date					20/05/11	14/07/10	14/06/11
Last pick date					05/07/11	16/08/10	25/07/11
Fruit size (g)					big	4.6	3.9
Brix°						10.8	
Overall comparison	better	better	better	better	better	similar	better
Plant more?	Yes	Yes	Yes	Yes	Yes	No	Yes

#### Comments

Good flavour, susceptible to *Phytophthora*

Excellent flavour

\*berry quality of Tulameen very poor

**HDC:** susceptible to yellow rust, powdery mildew and root rot. This cultivar has much to offer the industry, high yield, excellent fruit quality including flavour, easy and cheap to pick, easy and cheap to grow. Where *Phytophthora* is a problem in substrate production offers the way of producing this cultivar. End customers all like this cultivar

**Trade Solutions, potted:** Appear to lose some flavour when grown in pots (possibly need different fertiliser)

2nd crop in pot (spring 2011) was very high yielding

Pink fruit was difficult to unplug - this problem did not arise in field plot

**Trade Solutions, open field:** one spray for mildew, no botrytis sprays. Prone to leaf and bud mite

Figure 5 Glen Doll summary of JHI and On-Farm trials results

**Glen Doll**

**Selection** 9053B6  
**Parents** Glen Rosa x 8605C-2  
**Markers used** Marker Rub 118b **Date** 2008 **Result** negative

**JHI field observations**

A<sub>10</sub> resistance to large raspberry aphid  
 Spin efree  
 Moderate cane vigour  
 Habit and pick well suited to machine-harvesting

JHI trials	Date planted 2006		Date planted 2009		
	2007		2010	2011	
<b>Yield (g/stool)</b>	3476.5		2199.2	1165.5	
<b>1st Pick</b>	09/07/07		19/07/10	07/07/11	similar season to Glen Ample when protected
<b>Fruit size (g)</b>	4.9		5.4	5.2	Traditionally smaller than Glen Ample, but large in current plot
<b>Brix<sup>o</sup></b>	9.7		11.6	10.8	
<b>Colour</b>	5.3		5.0	5.0	mid-red in colour, little brightness
<b>Flavour</b>	5.3		6.3	5.3	good flavour but less intense and less juice than Glen Fyne
<b>Firmness</b>	6.8		6.3	7.3	probably the best for firmness and shelf-life in the germplasm

**On-farm trials**

	Total Berry soil	HDC Trial soil
<b>Production sys</b>		
<b>Results</b>	2010	2011
<b>Control cv</b>	Ample	Tulameen*
<b>Yield</b>	similar	worse
<b>Fruit size</b>	similar	better
<b>Flavour</b>	similar	better
<b>Firmness</b>	similar	better
<b>Appearance</b>	similar	better
<b>Root rot</b>	similar	no problems
<b>Fruit rot</b>	similar	no problems
<b>Canes disease</b>	similar	no problems
<b>Virus</b>	similar	no problems
<b>First pick date</b>	14/07/10	27/06/11
<b>Last pick date</b>	16/08/10	01/08/11
<b>Fruit size (g)</b>	4.5	
<b>Brix<sup>o</sup></b>	11.1	
<b>Overall comparison</b>	similar	better
<b>Plant more?</b>	No	Yes

**Comments** \*berry quality of Tulameen very poor  
 HDC: susceptible to yellow rust. Easy to manage, primocane very upright and well out of the way of pickers. Growth of primocane in summer 2010 was not very good in some plots which contributed to lower than normal yields for this cultivar. This cultivar has much to offer the industry, provided that current cane vigour problems can be overcome. It is cheap and easy to grow and harvest and not subject to any serious disease problems

Figure 6 Glen Cally summary of JHI and On-Farm trials results

**Glen Cally**

**Selection** 99111A1  
**Parents** 9422C-4 x 9434B-1  
**Markers used** **Marker** Rub 118b **Date** 2008 **Result** negative

**JHI field observations**

A<sub>10</sub> resistance to large raspberry aphid  
 Shows strong field tolerance to *Phytophthora* root rot  
 Moderate susceptibility to cane diseases  
 Susceptible to RBDV, infected within one season at JHI  
 Habit and ease of pick suited to machine-harvesting

JHI trials	Date planted 2004			Date planted 2007		
	2005	2006	2007	2008	2009	2010
<b>Yield (g/stool)</b>	1519.9	4948.3	2027.5	3914.4	4447.0	*
<b>Ist Pick</b>	05/07/05	17/07/06	12/07/07	14/07/08	06/07/09	*
<b>Fruit size (g)</b>	5.0	5.7	3.6	4.0	4.3	*
<b>Brix°</b>	10.1	9.2	9.3	9.1	8.1	*
<b>Colour</b>	5.0	5.0	4.3	4.0	4.6	5.5
<b>Flavour</b>	4.0	4.0	3.8	3.0	3.8	3.0
<b>Firmness</b>	5.0	8.0	6.3	4.3	5.8	5.5
			RBDV +ve			RBDV +ve

consistently more productive than Glen Ample

has raspberry aroma but is very acidic (less so than Glen Ericht)

**On-farm trials**

Production sys	Hargreaves	ASF			Trade Solutions		
	soil	potted			open field / machine-harvest		
Results	2008	2008	2009	2010	2008	2009	2010
<b>Control cv</b>	Ample	Ample	Ample	Ample	Ample	Ample	Ample
<b>Yield</b>	better	worse	similar	worse	worse	worse	worse
<b>Fruit size</b>	worse		similar	worse	worse	worse	worse
<b>Flavour</b>	similar	worse	similar	worse	worse	worse	worse
<b>Firmness</b>	better	similar	similar	worse	better	worse	better
<b>Appearance</b>	better	worse	similar	worse	worse	worse	worse
<b>Root rot</b>	better	similar	similar	better	better	better	better
<b>Fruit rot</b>	better	similar	similar	similar	similar	worse	similar
<b>Canes disease</b>	similar	similar	similar	similar	similar	similar	similar
<b>Virus</b>	similar	similar	similar	similar	similar		worse
<b>Fruit size (g)</b>	2.9			2.4		2.4	
<b>First pick date</b>	25/06/08	11/06/08		08/06/10			
<b>Last pick date</b>	19/08/08	10/08/08		16/08/10			
<b>Brix°</b>					10		
<b>Overall comparison</b>	similar	similar				similar	worse
<b>Plant more?</b>				possibly			No

**Comments** In machine plot: becoming less vigorous in 2010, yellowing leaves - RBDV?

**Figure 7 0019E2 summary of JHI and On-Farm trials results (1 of 2)**

**0019E2**

**Selection** 0019E2  
**Parents** 9059D-2 x 9668 A2  
**Markers used** **Marker** Rub 118b **Date** 2008 **Result** negative

**JHI field observations**

A<sub>10</sub> resistance to large raspberry aphid  
 Spinefree  
 Canes have a longer chilling requirement than Glen Ample  
 Vigorous canes have a large diameter

JHI trials	Date planted 2004			Date planted 2009		
	2005	2006	2007	2010	2011	
<b>Yield (g/stool)</b>	*	5269.5	2923.0	1862.5	2310.0	Vigorous cane with an upright habit, long laterals had collapsing problems in first season
<b>1st Pick</b>	*	21/07/06	16/07/07	19/07/10	11/07/11	mid-late season
<b>Fruit size (g)</b>	5.0	6.9	7.4	6.8	6.0	Very large fruit size
<b>Brix<sup>o</sup></b>	9.6	10.4	9.2	10.1	9.6	
<b>Colour</b>	5.0	5.0	5.3	5.0	4.5	mid-red with some brightness
<b>Flavour</b>	4.0	6.0	5.3	4.3	6.2	sweet flavour with little juice but very firm
<b>Firmness</b>	6.0	7.0	6.3	6.3	6.5	

## 0019E2 (2 of 2) 1

## 0019E2

## On-farm trials

Identified for on-farm trials 2007

Propagation 2008

Date planted spring 2009

Production sys	ASF			Berryworld		Trade Solutions		Hargreaves			Total Berry		Jose Carrasco, Huelva
	potted			soil		potted		soil			potted		soil
	2009	2010	2011	2010	2011	2010	2011	2009	2010	2011	2010	2011	2011
Control cv	Ample	Ample	Ample	Ample	Fyne	Ample	Ample	Tulameen	Tulameen	Ample	Ample	Ample	Lyon
Yield	similar	better	better	worse	better	similar	worse	better	worse	worse	worse	better	
Fruit size	similar	better	better	similar	better	similar	better	similar	similar	similar	similar	similar	
Flavour	similar	similar	similar	worse		similar	similar	better	similar	better	similar	better	similar
Firmness	similar	worse		better	better	similar	similar	better	similar	similar	better	better	similar
Appearance	similar	similar	better	similar	similar	worse	better	worse	similar	similar	similar	similar	similar
Root rot	similar	similar	similar	similar		better	similar	better		similar	similar	similar	similar
Fruit rot	similar	similar	similar	similar	similar	similar	similar	better	similar	similar	similar	similar	similar
Canes disease	similar	similar	similar	similar	similar	similar	better	better		similar	similar	similar	similar
Virus	similar	similar	similar	similar	similar	better	better	similar			similar	similar	similar
First pick date	20/06/09	08/06/10	26/05/10	05/07/10	05/06/11			22/06/09	30/06/10	13/06/11	28/06/10	09/06/11	15/04/10
Last pick date	07/10/09	20/08/10	01/08/11	26/07/10				03/08/09	19/07/10	22/07/11	16/08/10	18/07/11	31/05/10
Fruit size (g)		4.5	6.8		6		big	4.5		4.0	4.6	4.3	4.5
Brix°											10.3		
Overall comparison		similar	better	worse	better	worse	worse	better		similar	similar	similar	better
Plant more?		No	Yes	No	Yes	No	No	Yes	No	Yes	No	Possibly	Yes

**Comments** **Total Berry** 2010: High yield, good flavour and cohesion, nice size fruits good flavour  
2011: This

**Spain Solutions** In Spain, large strong cane but needs more feed than Glen Lyon and other genotypes  
2010: fruit bobbly, uneven drupelets, no good for supermarket

2011: huge fruit, very spindly, weary young cane growth for the next season

**HDC** \*berry quality of Tulameen very poor

This cultivar looks interesting, its very large attractive fruit have the wow factor, a long and late harvest period, could also be useful as it could be considered as a replacement for Octavia with superior flavour to this cultivar. The variability in fruit shape may be attributed to a serious frost in May 2011 affecting fruit set. The plants proved easy to manage, the primocanes were vigorous and very tall, but rather spreading in habit, the foliage very dense, however strongly ascending fruit lateral, which were well attached, presented fruit well to the pickers, the fruit was easy to detach and there were no lateral breakages during harvest.

**Figure 8 9350F3 summary of JHI and On-Farm trials results**

**9350F3**

**Selection** 9350F3  
**Parents** EM5961/1 x 7826C1  
**Markers used** Marker Rub 118b **Date** 2008 **Result** negative

**JHI field observations**

A<sub>10</sub> resistance to large raspberry aphid  
 Spinefree  
 Good habit and lateral presentation  
 No apparent P&D issues at JHI

JHI trials	Date planted 2007			
	2008	2009	2010	2011
<b>Yield (g/stool)</b>	4943.3	3776.5	6357.5	1271.0
<b>Ist Pick</b>	18/07/08	09/07/09	12/07/10	11/07/11
<b>Fruit size (g)</b>	5.3	4.7	5.4	4.2
<b>Brix<sup>o</sup></b>	9.4	9.1	8.7	9.7
<b>Colour</b>	4.7	4.0	4.7	4.5
<b>Flavour</b>	4.3	5.0	5.0	6.5
<b>Firmness</b>	5.5	6.4	6.7	6.0

**On-farm trials**

Identified for on-farm trials 2009  
 Propagation 2010

**Date planted** spring 2011

**Sites**

- 1 Berrygardens
- 2 ASF, Arbroath
- 3 CPM
- 4 CPM, Spain
- 5 Hargreaves Plants
- 6 Total Berry, Gaskains
- 7 Trade Solutions



Figure 9 0304F6 summary of JHI and On-Farm trials results

**0304F6**

**Selection** 0304F6  
**Parents** 9455F-2 x 9050RD3  
**Markers used** Marker Date Result

**JHI field observations**

*A<sub>10</sub>* resistance to large raspberry aphid  
 Spinefree  
*Gene H* gives strong tolerance to cane botrytis and spur blight  
 No apparent P&D issues at JHI

JHI trials	Date planted 2007				
	2008	2009	2010	2011	
<b>Yield (g/stool)</b>	4323.1	3835.0	5171.9	1953.0	very productive, quick and easy to hand pick
<b>1st Pick</b>	18/07/08	09/07/09	12/07/10	11/07/11	
<b>Fruit size (g)</b>	5.7	5.4	5.2	6.0	large, round berries
<b>Brix<sup>o</sup></b>	10.3	9.7	11.8	10.9	
<b>Colour</b>	3.7	3.4	3.0	3.0	very pale, pink-red, keeps colour in cold storage
<b>Flavour</b>	4.3	6.6	6.0	6.5	aromatic with a good balance of sweet and acid, meaty texture
<b>Firmness</b>	7.0	5.6	6.7	6.5	good shelf-life

**On-farm trials**

Identified for on-farm trials 2009  
 Propagation 2010

	HDC Trial	Date planted
<b>Production sys</b>	soil	spring 2011
<b>Results</b>	2011	<b>Sites</b>
<b>Control cv</b>	Tulameen*	1 HDC Trial, Oxfordshire
<b>Yield</b>		2 Berrygardens
<b>Fruit size</b>	better	3 ASF, Arbroath
<b>Flavour</b>	similar	4 CPM
<b>Firmness</b>	similar	5 CPM, Spain
<b>Appearance</b>	similar	6 Hargreaves Plants
<b>Root rot</b>	no problems	7 Total Berry, Gaskains
<b>Fruit rot</b>	no problems	8 Trade Solutions
<b>Cane disease</b>		
<b>Virus</b>	no problems	
<b>First pick date</b>	14/06/11	
<b>Last pick date</b>	18/07/11	
<b>Fruit size (g)</b>	3.8	
<b>Brix<sup>o</sup></b>		
<b>Overall comparison</b>	better	
<b>Plant more?</b>		

**Comments** \*berry quality of Tulameen very poor  
 HDC: This cultivar looks interesting, but too early to compare yield with Tulameen control as plants planted late. Fruit colour may be too pale. Plants proved easy to manage, the primocanes were vigorous, of medium height but upright-spreading in habit. Fruit laterals held horizontal to ascending displaying fruit well to pickers, the fruit was easy to detach and there were no lateral breakages during harvest.

Figure 10 0453C4 summary of JHI and On-Farm trials results

**0453C4**

**Selection** 0453C4  
**Parents** 0015D3 x 9059C-1  
**Markers used** **Marker** Rub 118b **Date** 2008 **Result** negative

**JHI field observations**

A<sub>10</sub> resistance to large raspberry aphid  
 Spinefree  
 Upright cane habit, good lateral presentation

JHI trials	Date planted 2008			
	2009	2010	2011	
<b>Yield (g/stool)</b>	3434.0	4115.0	1965.0	
<b>1st Pick</b>	29/06/09	06/07/10	01/07/11	early, similar season to Glen Lyon
<b>Fruit size (g)</b>	4.4	4.8	4.4	
<b>Brix°</b>	10.6	11.2	10.9	
<b>Colour</b>	4.6	4.5	5.3	glossy attractive fruit
<b>Flavour</b>	5.8	5.6	6.2	fruit has a pleasant sweet and floral aroma
<b>Firmness</b>	6.4	6.0	5.6	firm fruit with a good shelf-life

**On-farm trials**

Identified for on-farm trials 2009  
 Propagation 2010

	HDC Trial
<b>Production sys</b>	soil
<b>Results</b>	2011
<b>Control cv</b>	Tulameen*
<b>Yield</b>	
<b>Fruit size</b>	better
<b>Flavour</b>	worse
<b>Firmness</b>	similar
<b>Appearance</b>	similar
<b>Root rot</b>	no problems
<b>Fruit rot</b>	no problems
<b>Cane disease</b>	
<b>Virus</b>	no problems
<b>First pick date</b>	14/06/11
<b>Last pick date</b>	18/07/11
<b>Fruit size (g)</b>	4.5
<b>Brix°</b>	
<b>Overall comparison</b>	better
<b>Plant more?</b>	

**Date plan** spring 2011

- Sites**
- 1 HDC Trial, Oxfordshire
  - 2 Berygardens
  - 3 ASF, Arbroath
  - 4 CPM
  - 5 CPM, Spain
  - 6 Hargreaves Plants
  - 7 Total Berry, Gaskains
  - 8 Trade Solutions

**Comments**

\*berry quality of Tulameen very poor  
 HDC: Berry colour may be too pale. Plants produced very weak and short primocane in the summer of 2010 and of medium vigour and upright-spreading in habit in summer 2011. Fruit laterals ascending displaying fruit well to pickers, the fruit was easy to detach and there were no lateral breakages during harvest. Too early to compare yield with Tulameen.

## Figure 11 0433F2 summary of JHI and On-Farm trials results

### 0433F2

**Selection** 0433F2  
**Parents** 003RB1 x 0015D3  
**Markers used** Marker Rub 118b Date 2008 Result negative

#### JHI field observations

A<sub>10</sub> resistance to large raspberry aphid

Spinefree

JHI trials	Date planted 2008			
	2009	2010	2011	
Yield (g/stool)	1932.5	3422.8	1090.0	
1st Pick	06/07/09	12/07/10	11/07/11	
Fruit size (g)	5.0	5.1	4.0	
Brix°	10.3	11.2	9.9	
Colour	4.7	5.3	5.5	shape, gloss and appearance very similar to Tulameen
Flavour	5.7	5.6	6.0	strong sweet flavour, little acidity
Firmness	4.5	5.0	3.5	Maybe too soft

#### On-farm trials

Identified for on-farm trials 2009  
Propagation 2010

	HDC Trial	Date planted
Production sys	soil	spring 2011
Results	2011	
Control cv	Tulameen*	
Yield		1 HDC Trial, Oxfordshire
Fruit size	similar	2 Berrygardens
Flavour	similar	3 ASF, Arbroath
Firmness	better	4 CPM
Appearance	similar	5 CPM, Spain
Root rot	no problems	6 Hargreaves Plants
Fruit rot	no problems	7 Total Berry, Gaskains
Canes disease		8 Trade Solutions
Virus	no problems	
First pick date	16/06/11	
Last pick date	11/07/11	
Fruit size (g)	3.6	
Brix°		
Overall comparison	better	
Plant more?		

**Comments** \*berry quality of Tulameen very poor  
 HDC: Berry colour may be considered too pale. Plants produced very weak and short primocane in summer 2010 and of medium vigour and upright-spreading in habit in summer 2011. As so few and only very weak primocane was cropped in 2011 it was deemed too early to appraise fruiting lateral habit, strength, presentation and detachment of fruit by pickers.

**Figure 12 0485K-1 Glen Ericht summary of JHI and On-Farm trials results**

**0485K-1**

**Selection** 0485K-1  
**Parents** 0030E-12 x 0039F-2  
**Markers used** Marker **Date** **Result**

**JHI field observations**

A 10 resistance to large raspberry aphid  
 Spinefree  
 Gene H gives strong tolerance to cane botrytis and spur blight  
 Very popular at JHI fruit event  
 No apparent P&D problems so far

JHI trials	Date planted 2009		
	2010	2011	
<b>Yield (g/stool)</b>	3631.0	2097.0	good lateral presentation makes picking quick and easy
<b>1st Pick</b>	12/07/10	04/07/11	early-mid
<b>Fruit size (g)</b>	6.0	5.3	
<b>Brix°</b>	11.1	9.4	
<b>Colour</b>	4.3	4.2	pink-red, very glossy attractive fruit
<b>Flavour</b>	5.6	5.0	pleasant sweet flavour
<b>Firmness</b>	6.6	6.0	

**On-farm trials**

Identified for trials in 2010  
 Propagation in 2011, due to plant spring 2012

Production sys	Total Berry soil		HDC Trial soil
	2010	2011	2011
<b>Results</b>	Ample	Ample	Tulameen*
<b>Control cv</b>	similar	worse	
<b>Yield</b>	similar	similar	better
<b>Fruit size</b>	similar	better	better
<b>Flavour</b>	better	better	better
<b>Firmness</b>	similar		similar
<b>Appearance</b>	similar	similar	no problems
<b>Root rot</b>	similar	similar	no problems
<b>Fruit rot</b>	similar	similar	no problems
<b>Canes disease</b>	similar	similar	no problems
<b>Virus</b>	similar	similar	no problems
<b>First pick date</b>	28/06/10	30/05/11	14/06/11
<b>Last pick date</b>	16/08/10	18/07/11	11/07/11
<b>Fruit size(g)</b>	4.3	5.6	4.4
<b>Brix°</b>	11.8		
<b>Overall compari</b>	similar	similar	better
<b>Plant more?</b>	No	Yes	

**Comments** **Total Berry** Dull and musky in 2010  
 Fruit brighter this year, not always as dull and musky as it had been last year. All plant material was destroyed at the end of the 2011 fruiting season because of lack of vigour in the material that we had.

**HDC** \*berry quality of Tulameen very poor  
 This cultivar looks very interesting because it offers such early and quality fruit production excellent fruit quality including flavour, easy and cheap to pick. Plants so far appear to be easy to manage, fruit was easy to find and detach, laterals strongly appached presenting fruit well, there was however lateral breakages during harvest. Not able to compare yield with Tulameen as plants of 0485K-1 only 12 months from planting with just one or two short floricanes/plant cropping in 2011.

Appendix III

Photographs



Plate 1 Selection 0485K-1



Plate 2 Selection 0447C-5



Plate 3 Glen Ericht in a row of 5-plant plots infested with Phytophthora at JHI



Plate 4 Primocane seedlings in pots at JHI