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# **AUTHENTICATION**

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

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# **GROWER SUMMARY**

## Headline

• Sainsbury's and Asda have added Glen Fyne to their approved lists for 2014.

## **Background and expected deliverables**

In 2009, the UK raspberry industry formed a consortium to fund the UK 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 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

### Floricane trials at JHI

In 2013, the following plots were evaluated at JHI:

- 60 genotypes in a protected site of replicated 5-plant plots (plot M27).
- Approximately 5,500 seedlings from the 2009 and 2010 crossing programmes.
- 700 seedlings in pots in a protected site for primocane-fruiting evaluation from crosses made in 2010 and 2011.
- A summary of the characteristics of key selections, including those already identified for on-farm trials are summarised in Tables 1 and 2. Glen Ample, Tulameen and Octavia are included as controls.

Genotype	Mean yield/ stool (g)	Mean fruit size (g)	Mean Brix %	First pick date	Characteristics
0435D-3*	2,816	4.9	10.5	12 <sup>th</sup> July	Very early season, popular sweet raspberry flavour with low acidity. Short internode length gives squat habit, making it easy to manage
Glen Ample	2,860	5.7	9.2	19 <sup>th</sup> July	Very productive in 2013. Good size and firmness, sharp flavour for Ample
Tulameen	1,589	5.1	11.2	19 <sup>th</sup> July	
0447C-5*	3,008	6.8	10.1	1 <sup>st</sup> August	Late season. Potential Octavia replacement. Large fruit with meaty texture. Received good feedback from Tescos and Morrisons
Octavia	-	-	-	-	All plants died from root rot in 2012

Table 1 Plot J7 (fourth season): Summary of characteristics of key floricane selections at JHI

\*Selections currently identified for on-farm trials

**Table 2** Plot M27 (second season): Summary of characteristics of key floricane selections at

 JHI

Genotype	Mean yield /stool (g)	Mean fruit size (g)	Mean Brix %	First pick date	Characteristics
0433F2	2,816	4.2	10.5	12 <sup>th</sup> July	Early season, good sweet flavour, low acidity, less soft than in previous years
Glen Ericht	3,569	4.8	9.6	12 <sup>th</sup> July	Crown gall symptoms on floricanes but still productive, acidic
Glen Fyne	3,877	5.4	10.2	12 <sup>th</sup> July	Good quality and flavour all season, very productive
Glen Ample	4,751	5.7	9.2	15 <sup>th</sup> July	Best yield and size for several years, flavour relatively poor – acidic
0485K-1	2,871	5.5	10.9	19 <sup>th</sup> July	Sweet with a good balance of acidity, popular with visitors
0658E-1*	3,661	6.5	8.4	19 <sup>th</sup> July	Large fruit, easy to pick, nice habit – upright, some split fruit early in the season but good quality and excellent shelf-life in the main pick
0019E2*	3,612	6.3	10.2	22 <sup>nd</sup> July	Mid-late season. Large fruit, good flavour, continuing concern over weak laterals
0658C5	5,265	7.9	9.0	22 <sup>nd</sup> July	Enormous fruit, first pick 12g berries, didn't drop below 6g all season - most productive in 2012 and 2013, excellent shelf-life, some raspberry leaf and bud mite symptoms
Glen Doll	2,580	4.5	10.3	22 <sup>nd</sup> July	Large size for Glen Doll, consistent pick, easy to manage, sweet fruit, dry with a good shelf-life
0550E4*	4,274	5.1	11.3	25 <sup>th</sup> July	Sweet all season, long strong laterals, gene H, good shelf-life
Octavia	2,643	6.3	8.7	1 <sup>st</sup> August	Late, very large fruit, acidic flavour but ok, some raspberry leaf and bud mite symptoms, healthy plot.

\*New selections proposed for on-farm trials in 2014

Approximately 700 seedlings were evaluated for primocane-fruiting habit and quality during the 2013 season. These single plant plots are from crosses made in 2010 and 2011, a combination of primocane x floricane and primocane x primocane families. These were initially screened for absence of spines and aphid resistance prior to moving into a polytunnel in 10L pots.

- The earliest selections began fruiting in late August, with the late types still flowering into October.
- The primocane pedigree of the families includes; Autumn Treasure, Erika, Brice, Amira and various open pollinated (OP) seed.
- Several selections were identified with large fruit, good quality and ease of picking (see Table 3). Brix and initial fruit size were recorded. Yield isn't recorded at this stage.
- Eight selections identified in 2012 were assessed in 5-pot plots.
- Five selections were identified for trialling in 2014.

Selection	Parents			First Fruit	Initial Fruit size (g)	Brix°	Notes
1014F1	0704F5	х	Polka	14/8/13	5.7	11.2	Open field plot, early, firm, conical and bright, flavour ok but lacks juice
1132F-12*	0462C-1	Х	Autumn Treasure	13/9/13	7.4	10.6	Firm, good colour, good shelf life but less glossy than other selections
1012C15	0704F5	х	Autumn Treasure	13/9/13	6.3	10.8	Early, long season, a few split fruit
Autumn Treasure				17/9/13	6.5	10.2	Usually best control but plants poor in 2013
Erika				17/9/13	7.4	9.8	Slightly rough quality, nice flavour early on, a few split fruit
0925B8	0304F6	x	Autumn Treasure	26/9/13	6.1	10.2	Selected in 2012, earliest of these selections, pale meaty fruit, nice flavour early in season
1132F16*	0462C-1	х	Autumn Treasure	26/9/13	8.2	9.9	Large, attractive, firm
1132E2	0462C-1	х	Autumn Treasure	26/9/13	6.0	10.1	Floral flavour, attractive, longer laterals, small size?
1104D-11	Brice	х	Autumn Treasure	26/9/13	8.2	9.4	Easy to pick, very firm but darkens quickly
0919D-7	9767RA 3	х	Autumn Treasure	30/9/13	6.6	10.9	Selected 2012, nice flavour, glossy fruit but darkens slightly in punnet
1103K1*	Autumn Treasure	х	Glen Lyon	30/9/13	6.4	9.7	Sweet but little acid, shiny fruit, attractive
11151-7*	0485K-1	х	Autumn Treasure	1/10/13	8.2	9.4	Late, large, bright, conical, firm, floral flavour, longer laterals
111611	0485K-1	Х	Brice	3/10/13	7.8	9.2	Late, good colour, glossy fruit, easy to pick, a few split fruit
1116H1*	0485K-1	x	Brice	3/10/13	7.6	9.8	Liked at UKRBC meeting, attractive with a good flavour

## Table 3 Primocane selections at JHI in 2013

\*Recommended for trials in 2014

## Main conclusions

- Glen Fyne performed exceptionally well and has been accepted on to the approved lists of Sainsbury's and Asda, but not Tesco.
- Four selections were sampled into multiple retailers during the 2013 season and produced mixed results from each supermarket. This exercise will be repeated in 2014.
- Late selection 0447C-5, a potential replacement for Octavia, performed well for a third season in a row and feedback from retailers sampling reports were promising.
- Four selections (9350F3, 0453C4, 0304F6 and 0433F2) were planted in trials in spring/summer 2011 and produced a crop in 2013. From these results and previous results from JHI the following was observed:
  - 0433F2 is soft compared with controls.
  - o 0453C4 has a small fruit size compared with controls.
  - o 0304F6 was productive and firm but had poor flavour.
  - o 9350F3 performed well in Spain but less well in UK sites.
- Plants of selections 0435D-3 and 0447C-5, identified for on-farm trials in 2011 were planted on several sites in the UK and Europe in 2013 to produce a baby crop in 2014.

# Action points for consortia members

- Plant new selection 0658C5 into on-farm trials.
- Prepare commercial release strategy for 0447C-5 and 0435D-3.

# 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 the James Hutton Institute (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.

## 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. Day length 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.



Figure 1 Breeding Schedule

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 now clean and free of any pulp, is left to dry overnight on filter paper. Dried seed is stored in glassine bags (100 x 70mm) with a dessicant at 4°C.

#### Seed scarification

Up to 1000 seeds/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 20 minutes. 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 corex 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  $A_{10}$ , 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 pottedon 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 *Amorphora 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.

Pest/Pathogen	Control (Active ingredient)	Rate/ha	Application
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

A very important objective of the breeding programme is the development of cultivars with tolerance to raspberry root rot, caused by the fungus *Phytophthora fragariae* var. *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 and fruit 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 150mu Visqueen polythene. Raspberry tunnels have three rows per bay, 2.5m between rows with a 2.8m leg row. Alleyways are grassed and legs 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	Мау	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.

## **Crop protection**

Generally, breeding plots at JHI are kept free of crop protection chemical application to assess resistance/susceptibility of 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 are based on observations and are presented in the Results section.

Pest/Pathogen	Control (Active ingredient)	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 (Phytoseiulus persimilis)		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 4C for seven days. Post-harvest evaluations are recorded with 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 Consortium 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 EPPO guidelines, to enter to certification scheme. Fully-tested mother plants 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 in a commercial trial. If these advanced selections are superior to existing commercial cultivars, they will undergo commercialisation.

## **Results and Discussion**

#### 2013 crossing programme

In 2013 75 crosses were made, targeting primocane-fruiting and resistance to *Phytophthora* root rot, focusing on parents with the 118b marker for root rot resistance. The appropriate progeny (some combining both primocane habit and root rot resistance) will be screened with this marker.

### Molecular marker deployment

- Parents with the marker for *Phytophthora* root rot resistance were identified and used as parents initially in the 2009 crossing programme.
- Approximately 3000 seedlings were screened for absence of spines and resistance to aphids, reducing numbers to ~1000 plants.
- 32 of these selections, identified with the marker, have been propagated to produce 20 plants of each for field planting in both infested (off-site) and clean sites.
- A further 12 selections have been identified and are in the process of propagation.
- Markers linked to berry size (HortLink 0170) are in the final stages of validation and will hopefully be deployed in the 2014 season.
- Markers identifying the genetics that affect fruit softening (HortLink 0195) are in the process of validation and are expected to be integrated with the root rot marker once available.
- Further crosses were made in 2010 and 2012 and plants from these crosses have been given the preliminary glasshouse-based selection and are ready to be screened with the 118b marker.

Nine selections with the marker were picked and assessed for fruit quality for the first time in 2013 (Table 4 and Appendix I, Table 10). These selections were planted in 5-plant units in 2012 and established very well, demonstrating distinct root growth and vigour compared with surrounding genotypes. Two selections, 0957/58 and 0946/12 had good quality at this early stage. These selections will be assessed in more detail and compared with controls in 2014.

Selection	Yield/Stool (g)	Brix°	Fruit size (g)	Notes
0957/58	1321	10.3	4.6	Lovely sweet aromatic flavour, slightly dull, large fruit, gene H
0946/12	1165	8.0	4.7	Flavour sweeter mid-season onwards
0957/24	962	11.1	3.0	Some split, hairy, flavour not bad
0957/26	858	10.8	2.7	Slightly dull, pretty, acid early season
0957/13	822	7.4	2.9	Small, acid
0957/64	817	8.9	4.1	
0957/14	632	12.7	2.9	Small
0957/18		10.8	4.7	Gene H, good display of fruit, late season
0946/7		11.3	4.3	Early, sweet, slightly rough, upright spawn

Table 4 Selections with root rot marker at JHI in 2013

## 2013 Fruit season and James Hutton Institute Trials

- Weather conditions from March until mid-June were unseasonably cold and dry. Cold spring temperatures meant that bud break was spread over a six week period, from mid-February until April.
- The floricane tunnels were covered in early May but the cold temperatures made little difference to fruit development compared with the open field.
- In contrast, conditions became warm and dry from June until late September.
- The first flowers opened around three weeks later than in 2012.
- First fruit from the early genotypes was a full two weeks later than 2012. Later genotypes fruited at the usual time, which allowed for a quick, condensed season.
- Yield and fruit size were exceptional. Shelf-life was generally good but flavour and brix levels were, at best, average throughout the season.
- Glen Ample had produced very large yields, the best for several years. Fruit size was good but the flavour was sharp.
- In general, the advanced selections performed well relative to the controls and the other breeding genotypes. Characteristics of the key selections compared with commercial controls are summarised in Tables 5 and 6.

- Root rot continued to be a problem in the established plots. Late genotypes suffered from raspberry beetle damage. Raspberry leaf and bud mite was present throughout the season. A large proportion of split fruit was conspicuous in some selections and cultivars. Crown gall could be seen on some genotypes.
- Two new selections stood out in JHI plots, with good eating quality and productivity: 0658E-1 and 0550E4 are recommended for future on-farm trials.

This year the following floricane plots were under evaluation at JHI:

- 60 genotypes in a protected site of replicated 5-plant plots (plot M27), in its second season.
- Approximately 5500 seedlings from the 2009 and 2010 crossing programmes.

The trials were hand-picked for yield determination and basic fruit quality characteristics were evaluated; size, shape, colour, firmness flavour and Brix were assessed once per week. In Appendix 1, season, yield, fruit size and Brix data for each plot can be found in Tables 8 and 9, where selections are ranked according to yield (highest to lowest). All arbitrary scores on fruit quality and plant habit are summarized in Tables 11 and 12. Shelf-life evaluations are found in Table 13 and are ranked from good to poor shelf-life.

Key selections from the plots, including selections currently in on-farm trials, are summarised in Tables 5 and 6. Mean yield of the selections fruiting in the plots are shown in a bar graphs in Figures 1 and 2. Photos are shown in Appendix II, Plates 1 to 6.

Genotype	Mean yield / stool (g)	Mean fruit size (g)	Mean Brix %	First pick date	Characteristics
0435D-3*	2816	4.9	10.5	12 <sup>th</sup> July	Very early season, popular sweet raspberry flavour with low acidity. Short internode length gives squat habit, easy to manage
0447C-5*	3008	6.8	10.1	1 <sup>st</sup> August	Late season. Potential Octavia replacement. Large fruit with meaty texture. Received good feedback from Tesco and Morrisons
Glen Ample	2860	5.7	9.2	19 <sup>th</sup> July	Very productive in 2013. Good size and firmness, sharp flavour for Glen Ample
Tulameen	1589	5.1	11.2	19 <sup>th</sup> July	
Octavia					All plants died from root rot in 2012

Table 5 Plot J7 (fourth season): Summary of characteristics of key floricane selections at JHI

\*Selections currently identified for on-farm trials

Table 6 Plot M27 (	second season	). Summarv	of characteristics	of ke	v selections at	JHI
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Genotype	Mean yield /stool (g)	Mean fruit size (g)	Mean Brix %	First pick date	Characteristics
0485K-1	2871	5.5	10.9	19 <sup>th</sup> July	Sweet with a good balance of acidity, popular with visitors
0433F2	2816	4.2	10.5	12 <sup>th</sup> July	Early season, good sweet flavour, low acidity, less soft than in previous years
0019E2*	3612	6.3	10.2	22 <sup>nd</sup> July	Mid-late season. Large fruit, good flavour, continuing concern over weak laterals
0658E-1*	3661	6.5	8.4	19 <sup>th</sup> July	Large fruit, easy pick, nice habit – upright, some split fruit early season but good quality and excellent shelf- life main pick
0550E4*	4274	5.1	11.3	25 <sup>th</sup> July	Sweet all season, long strong laterals, gene H, good shelf-life
0658C5	5265	7.9	9.0	22 <sup>nd</sup> July	Enormous fruit, first pick 12g berries, didn't drop <6g all season, most productive in 2012 and 2013, excellent shelf-life, some RLBM symptoms
Glen Ericht	3569	4.8	9.6	12 <sup>th</sup> July	Crown gall symptoms on floricanes but still productive, acidic
Glen Doll	2580	5.8	10.3	22 <sup>nd</sup> July	Large size for Glen Doll, consistent pick, easy managed, sweet fruit, dry with a good shelf-life
Glen Fyne	3877	5.4	10.2	12 <sup>th</sup> July	Good quality and flavour all season, very productive
Glen Ample	4751	5.7	9.2	15 <sup>th</sup> July	Best yield and size for several years, flavour relatively poor – acidic
Octavia	2643	6.3	8.7	1 <sup>st</sup> August	Late, very large fruit, acidic flavour but ok, some RLBM symptoms, healthy plot.

\*New selections proposed for on-farm trials in 2014



Figure 1 Mean yield of selections in JHI plot J7



Figure 2 Mean yield of selections in JHI plot M27

#### **On-farm selections**

Since 2002, several selections have been identified for on-farm trials. Location and distribution of these selections can be found on the UK Raspberry Breeding Consortium Sharepoint Site <u>http://collab/sites/RaspberryBreeding/default.aspx</u>. Feedback forms were sent to triallists to assess yield and fruit quality relative to control varieties. The returned forms are summarized on the Sharepoint site and some of the selections are described below.

#### 0435D-3: Early and sweet

Early selection 0435D-3, identified for trials in 2011, produced a good crop of sweet fruit in 2013. The selection has small, neat, firm fruit which is sweet with low acidity. This was well liked at Fruit for the Future and Fruit Focus events and received good feedback from Tesco, who described it as having a good sweet flavour and would like to see more next season. 0435D-3 begins picking 3-4 days before Glen Lyon and generally picks a good yield over a long season. It presents the fruit well for picking and has moderate vigour in the field but suffered bad frost damage during in 2012 and is susceptible to *Phytophthora* root rot and RBDV.

#### 0447C-5: Late season, potential Octavia replacement

Selection 0447C-5, selected for trials in 2011, has stood out as a large-fruited late genotype since it began cropping four years ago. It has a very similar cropping pattern to Octavia but finishes picking slightly later. It was difficult to compare with Octavia in 2013 as the control plot died of root rot. 0447C-5 produces large fruit with a pleasant flavour. Morrisons described big firm fruit with a good appearance and flavour, whilst Tesco liked the large fruit size and appearance and consistently good flavour. 0447C-5 has good root vigour and a neat, upright habit. It suffered raspberry beetle damage in 2012 and 2013 due the late flowering habit and timing of spraying. So far no symptoms of *Phytophthora* root rot have been seen in the plots at JHI. This was planted in several trials around the UK in 2013, some

in large scale plots of at least 1000 plants. It was also planted in Europe, including at the pcfruit trials in Belgium.

### 0019E2: Mid-late season, large, sweet fruit

This selection is currently the most widely planted of all the genotypes, with six sites in the UK, Germany and Spain. 0019E2 had the most enthusiastic feedback from on-farm trials in 2011 and 2012 with several triallists reporting large fruit, higher yield and better flavour than Glen Ample. Feedback from the multiple retailers was mixed but Sainsbury's described excellent taste with good appearance and firmness. Others reported average appearance and poor flavour. Less positive comments from the trials described variable bud break, late emerging primocane and weak laterals that need support.

## 0485K-1: Early-mid season, large shiny fruit, good shelf-life

This mid-season selection has been outstanding in JHI plots for four years on two sites, producing attractive conical glossy fruit with a good shelf-life. Plants in the trials are now established and will give a crop in 2014 so no results were available in 2013. However, the HDC trial SF41c gave highly favorable results for 0485K-1 compared with the controls in 2012. Multiple retailers gave mixed feedback but Tesco described good appearance a wish to see it again in 2014. Others gave average scores for flavour, firmness and appearance.

## Other selections on-farm trials

- 0433F2 (003RB1 x 0015D3). This early-mid season selection strongly resembles Tulameen in appearance, with large conical glossy fruit and sweet aromatic flavour. Marks and Spencer expressed an interest in this selection in 2009 but there are concerns with the firmness of the fruit in JHI plots. In the trials flavour, size and Brix levels were good, yield was less than Glen Ample and fruit was similar firmness in 2013, firmer than in previous years.
- 9350F3 (EM5961/1 x 26C1). This productive mid-late season selection performed well in JHI plots in 2008, 2009 and 2010 producing large fruit with a pleasant sweet flavour all season, and producing the highest yield in 2010. Comments cited better appearance and flavour and similar yield and size to the Glen Ample control. 9350F3 performed consistently well in the Spanish trials, with emphasis on good shelf-life, yield and flavour.
- 0453C4 (0015D3 x 9059C-1). This very early season selection started picking 5 days before Glen Lyon and performed well in JHI plots since 2009, producing firm fruit with a good shelf-life and a sweet flavour. In trials, important characteristics generally worse or similar to the commercial controls, particularly that the fruit size was small over three seasons.

• 0304F6 (9455F-2 x 9050RD3). This mid-season selection has performed well in JHI trials in 2008, 2009 and 2010. It has large bright pale fruit presented well on long but strong laterals and is very productive. In the first year of the trials, yield, fruit size and firmness were better than the controls but flavour on all sites was described as poor.

New selection 0658C5, identified for trials in November 2012, performed very well in 2013, recording the largest fruit size and yield during the season. Buds from this selection was sent to GenTech during 2013 and a small amount of plants will be available to Consortium members in spring 2014

## Proposed new elite selections for on-farm trials

Two new selections were identified for potential on-farm trials, based on their fruit quality and productivity; 0658E-1 and 0550E4. If approved by the Consortium buds will be sent to GenTech for micropropagation in spring 2014.

## Primocane seedlings

Approximately 700 seedlings were evaluated for primocane-fruiting habit and quality during the 2013 season. These single plant plots are from crosses made in 2010 and 2011, a combination of primocane x floricane and primocane x primocane families. These were initially screened for absence of spines and aphid resistance prior to moving into a polytunnel in 10L pots.

- Plants were cut back to two primocanes in February and the polytunnel was covered in March. Only spider mite control was used in this plot.
- The earliest selections began fruiting in late August, with the late types still flowering into late October.
- The primocane pedigree of the families includes; Autumn Treasure, Erika, Brice, Amira and various open pollinated (OP) seed.
- Several selections were identified with large fruit, good quality and easy pick (see Table 7). Brix and initial fruit size were recorded. Yield isn't recorded at this stage. Photos of selections are in Appendix II, Plates 7 to 12.
- Eight selections identified in 2012 were assessed in 5-pot plots. Selection 0925B8 produced a relatively early crop of pale fruit with a good flavour and received positive feedback at the primocane day in October.
- Five selections were identified for further trialling in 2014.

Selection	Parents			First Fruit	Initial Fruit size (g)	Brix°	Notes
0919D-7	9767RA3	х	Autumn Treasure	30/9/13	6.6	10.9	Selected 2012, nice flavour, glossy fruit but darkens slightly in punnet
0925B8	0304F6	х	Autumn Treasure	26/9/13	6.1	10.2	Selected in 2012, earliest of these selections, pale meaty fruit, nice flavour early in season
Autumn Treasure				17/9/13	6.5	10.2	Usually best control but plants poor in 2013
Erika				17/9/13	7.4	9.8	Slightly rough quality, nice flavour early on, a few split fruit
1132F-12*	0462C-1	х	Autumn Treasure	13/9/13	7.4	10.6	Firm, good colour, good shelf life but less glossy than other selections
1132F16*	0462C-1	х	Autumn Treasure	26/9/13	8.2	9.9	Large, attractive, firm
1132E2	0462C-1	x	Autumn Treasure	26/9/13	6.0	10.1	Floral flavour, attractive, longer laterals, small size?
1104D-11	Brice	x	Autumn Treasure	26/9/13	8.2	9.4	Easy pick, very firm but darkens quickly
1012C15	0704F5	x	Autumn Treasure	13/9/13	6.3	10.8	Early, long season, a few split fruit,
1115 <b>I-7</b> *	0485K-1	x	Autumn Treasure	1/10/13	8.2	9.4	Late, large, bright, conical, firm, floral flavour, longer laterals
1116 1	0485K-1	x	Brice	3/10/13	7.8	9.2	Late, good colour, glossy fruit, easy pick, a few split fruit
1116H1*	0485K-1	x	Brice	3/10/13	7.6	9.8	Liked at UKRBC meeting, attractive with a good flavour
1103K1*	Autumn Treasure	x	Glen Lyon	30/09/13	6.4	9.7	Sweet but little acid, shiny fruit, attractive
1014F1	0704F5	x	Polka	14/8/13	5.7	11.2	Open field plot, early, firm, conical and bright, flavour ok but lacks juice

## Table 7 Primocane selections at JHI in 2013

\*Recommended for trials in 2014

### 2014 Fruit Season

The following JHI plots will be fruiting and evaluated in 2014:

- 60 genotypes in a protected site of replicated 5-plant plots (plot M27), in its third season.
- 30 gentypes in a protected site of replicated 5-plant plots (plot M21) in its first season.
- 700 pot grown seedlings segregating for primocane-fruiting habit from crosses made in 2011 and 2012.
- Approximately 3500 seedlings from the 2010 and 2011 floricane crossing programme.

# Conclusions

- Glen Fyne performed exceptionally well and has been accepted on to the approved lists of Sainsbury and Asda.
- Four selections were sampled into multiple retailers during the season and produced mixed results from each supermarket. This exercise will be repeated in 2014.
- Late selection 0447C-5, a potential replacement for Octavia, performed well for a third season in a row and feedback from retailers sampling reports were promising.
- Four selections 9350F3, 0453C4, 0304F6 and 0433F2 were planted in trials in spring/summer 2011 and produced a crop in 2013. From these results and previous results from JHI the following was observed:
  - 0433F2 has good quality but firmness is a concern.
  - o 0453C4 has a small fruit size compared with controls.
  - o 0304F6 was productive and firm but had poor flavour.
  - 9350F3 performed well in Spain but average in UK sites.
- Plants of the early selection 0435D-3 and late season 0447C-5, identified for on-farm trials in 2011, were planted on several sites in the UK and Europe in 2013 to produce a baby crop in 2014.
- Further plants of selections 0435D-3, 0447C-5, 0019E2 and 0485K-1 will be available from RW Walpole in 2014.

# **Technology transfer**

- A presentation of the project was invited at the following events:
  - International Soft Fruit Conference, Hertogenbosch, NL, 10<sup>th</sup> January 2013
  - SSCR Soft fruit winter meeting, JHI, 5<sup>th</sup> February 2013
  - Fruit for the Future, 18<sup>th</sup> July 2013

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

• Fruit Focus, EMR, 24<sup>th</sup> July 2013

## Other Knowledge Transfer (visitors and field visits)

- John Swinney MSP Cabinet Secretary for Finance, Employment and Sustainable Growth, 8<sup>th</sup> March 2013
- Visit Spanish trials, Huelva region, 7<sup>th</sup> 10<sup>th</sup> April 2013
- Stirling University students, 25<sup>th</sup> April 2013
- Jon Knight, HDC Head of Research, 22<sup>nd</sup> May 2013
- Harvey Hall, Shekinah Berries, NZ, 10<sup>th</sup> July
- Carlos Fear and Matthias Vitten, Driscolls, 18th July 2013
- Philippe Chartier, Ciref, 19<sup>th</sup> July 2013
- Philip Shultz and Ana Costa, Royal Berries, 19<sup>th</sup> July 2013
- Tom Rogers and Juan Jose Ollero, CPM, 29<sup>th</sup> July 2013
- Charles Buddendorf, Fruitmasters, 30<sup>th</sup> July 2013
- Ad de Laat, SVZ, 2<sup>nd</sup> August 2013
- Berry Garden Growers, 7<sup>th</sup> August 2013
- Marion Durose, Angus Soft Fruits, 13<sup>th</sup> August 2013
- Finnish berry growers, 16<sup>th</sup> September 2013
- Edinburgh University Plant Science students, 13th November 2013
- EMRA/HDC Soft Fruit Day, 21<sup>st</sup> November 2013

## Media Coverage

- Original FM interview (Aberdeen radio), 18th July 2013
- Wave 102 interview (Dundee radio), 18<sup>th</sup> July 2013
- STV News, 18<sup>th</sup> July 2013
- 'Raspberry breeders hail their big breakthrough', Press and Journal, 19th July 2013
- Beechgrove Garden, BBC, 19<sup>th</sup> July 2013 (broadcast BBC1 22<sup>nd</sup> August)
- Kitchen Garden magazine, 7<sup>th</sup> August 2013
- Sunday Post, 29<sup>th</sup> September 2013
- The List, Scotland's Larder, October 2013

# Glossary

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

## References

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

# Appendix I

Selection	Bud break date	First Flower date	First pick date	Last pick date	Mean Brix°	Mean fruit size (g)	Mean yield/stool (g)
0658C5	11/03/13	07/06/13	22/07/13	15/08/13	9.0	7.9	5265
Glen Ample	11/03/13	10/06/13	15/07/13	15/08/13	9.2	5.7	4751
0658F-2	04/03/13	07/06/13	22/07/13	15/08/13	9.8	5.7	4642
0565B1	19/02/13	10/06/13	19/07/13	09/08/13	10.5	4.9	4367
0550E4	26/03/13	17/06/13	25/07/13	15/08/13	11.3	5.1	4274
0703F5	26/02/13	07/06/13	15/07/13	12/08/13	9.5	5.5	4029
0572E3	11/03/13	13/06/13	19/07/13	12/08/13	8.6	5.2	4027
9762A1	04/03/13	05/05/13	12/07/13	09/08/13	10.5	4.1	3879
Glen Fyne	12/04/13	10/06/13	12/07/13	15/08/13	10.2	5.4	3877
0671D-4	18/04/13	13/06/13	19/07/13	15/08/13	8.8	5.1	3803
9911C-1	04/03/13	05/06/13	12/07/13	05/08/13	10.1	5.6	3662
0658E-1	04/03/13	10/06/13	22/07/13	15/08/13	8.4	6.5	3661
0019E2	12/04/13	13/06/13	22/07/13	15/08/13	10.2	6.3	3612
0533G-3	04/04/13	17/06/13	25/07/13	15/08/13	10.9	5.2	3593
Glen Ericht	04/03/13	07/06/13	12/07/13	09/08/13	9.6	4.8	3569
0533G-4	26/03/13	13/06/13	25/07/13	15/08/13	10.6	4.9	3535
0493F1	04/03/13	13/06/13	22/07/13	12/08/13	10.4	4.6	3469
Malling Hestia	04/03/13	20/06/13	25/07/13	15/08/13	9.0	4.3	3330
0453C4	26/03/13	10/06/13	15/07/13	05/08/13	9.8	5.3	3275
8605C-2	19/02/13	07/06/13	15/07/13	09/08/13	9.7	4.5	3245
9455F-2	11/03/13	13/06/13	22/07/13	15/08/13	8.2	6.5	3233
0606E-4	26/02/13	07/06/13	15/07/13	09/08/13	9.8	6.2	3230
0502G-3	18/04/13	10/06/13	19/07/13	15/08/13	12.2	4.7	3171
0662D-1	04/03/13	13/06/13	15/07/13	15/08/13	10.1	5.1	3038
0663RE3	26/03/13	10/06/13	22/07/13	15/08/13	9.8	6.3	3019
9769RD1	26/02/13	13/06/13	22/07/13	15/08/13	9.9	4.4	3013
0565F3	26/02/13	10/06/13	15/07/13	09/08/13	10.5	4.1	3004
0304F6	18/04/13	13/06/13	25/07/13	09/08/13	10.1	6	2980
0546H-2	26/03/13	17/06/13	25/07/13	15/08/13	10.0	6.4	2954
9351B4	04/04/13	10/06/13	15/07/13	05/08/13	9.3	4.5	2873
0485K-1	18/04/13	10/06/13	19/07/13	15/08/13	10.9	5.5	2871
0494D2	26/02/13	17/06/13	19/07/13	05/08/13	10.1	4.2	2832
0433F2	04/03/13	05/06/13	15/07/13	05/08/13	10.5	4.2	2816
0605A4	04/03/13	07/06/13	15/07/13	05/08/13	11.0	5.6	2799
0659C5	04/03/13	07/06/13	22/07/13	15/08/13	8.6	5.1	2750

 Table 8 Floricane season, yield and quality data 2012: Plot M27, second season

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Selection	Bud break date	First Flower date	First pick date	Last pick date	Mean Brix⁰	Mean fruit size (g)	Mean yield/stool (g)
0433G7	26/02/13	05/06/13	19/07/13	09/08/13	9.9	4.9	2745
0653E6	18/04/13	17/06/13	01/08/13	22/08/13	13.0	5.9	2683
Glen Doll Walpole	21/04/13	17/06/13	22/07/13	15/08/13			2652
Octavia	21/04/13	24/06/13	01/08/13	15/08/13	8.7	6.3	2643
0427l1	26/02/13	07/06/13	15/07/13	09/08/13	9.7	6.1	2605
Glen Doll HFS	18/04/13	13/06/13	22/07/13	15/08/13	10.3	4.5	2580
0461A5			25/07/13	15/08/13	9.8	5.8	2314
0550E6	12/04/13	07/06/13	25/07/13	15/08/13	9.9	3.8	2282
0669B-1	04/03/13	13/06/13	15/07/13	05/08/13	11.0	4.3	2057
0659D6	26/03/13	13/06/13	22/07/13	15/08/13	10.0	4.7	2001
0556A4	12/04/13	05/06/13	12/07/13	15/08/13	10.4	4.9	1827
0460F-5			19/07/13	09/08/13	9.8	6.4	1784
9892G2			15/07/13	05/08/13	8.4	3.4	1653
0531RH4	19/02/13	05/06/13	22/07/13	12/08/13	9.9	4.5	1628
Tulameen	18/04/13	13/06/13	19/07/2013	09/08/13	11.2	5.1	1589
9750C1			22/07/13	12/08/13	9.2	5.6	1567
0546I1			25/07/13	12/08/13	11.4	6.5	1435
04101A5			25/07/13	15/08/13	9.1	4.4	1248
0435D-3	19/02/13	05/06/13	25/07/13	29/07/13	10.3	5.0	457
0560E11			15/07/13	25/07/13	6.9	2.5	417
0689F-1	04/03/13	07/06/13	15/07/13	15/07/08	8.8	3.9	
0694B1	26/02/13	07/06/13	15/07/13	15/07/13	9.2	3.5	
0701D6	19/02/13	05/06/13	15/07/13	15/07/13	7.1	2.9	

**Table 9** Floricane season, yield and quality data 2012: Plot J7, fourth season

Selection	Bud break date	First Flower date	First pick date	Last pick date	Mean Brix°	Mean fruit size (g)	Mean yield/stoo I (g)
0447C-5	11/03/13	24/06/13	01/08/13	30/08/13	10.1	6.8	3008
0435D-3	19/02/13	07/06/13	12/07/13	05/08/13	10.5	4.9	2816
0019E2	18/04/13	13/06/13	29/07/13	15/08/13	9.8	6.1	2090
Glen Ample	11/03/13	13/06/13	19/07/13	09/08/13	9.2	5.7	2860
Tulameen	11/03/13	13/06/13	19/07/13	09/08/15	11.2	5.1	1589

## Table 10 Selections with root rot marker 118b JHI plot M21 (ranked highest to lowest)

Selection	Fruit set	Fruit shape	Fruit brightness	Fruit colour	Pick	Collar	Firm	Flavour	Overall score	Notes
0957/58	8	4	4	4	5	8	5.5	6.5	5.5	Lovely sweet aromatic flavour, slightly dull, large fruit, gene H
0957/24	8	5	5	5	4.5	6	7	5	5	Some split, hairy, flavour not bad
0957/26	9	4	4	4	4.5	8	5.5	3.5	4.5	Slightly dull, pretty, acid early season
0957/18	9	5	5	4	6	7	6	5.5	4.5	Gene H, good display of fruit, late season
0957/14	9	5	5	4	6	7	7	5	4	Small
0946/12	8	5	6	5	5.5	5	5	5	4	Flavour sweeter mid-season onwards
0946/7	7	6	6	5	4	6	5	6	4	Early, sweet, slightly rough, upright spawn
0957/13	9	4	4	6	5	8	5	4	3	Small, acid

Selection	Rep	ane botrytis	pur blight	ruit set	ruit shape	ruit brightness	ruit colour	ick	ollar	rm	avour	LBM	SSM	ene H	verall score	Notes
		Ö	S	Ē	Ē	Ē	Ē	ā	Ú	ίΞ		R	μ	G	0	Beautiful fruit, good presentation, long laterals, sherberty, stunning on plant and in punnet, high
0485K-1	1	1	1	9	7	8	4.3	6.5	8	6	5.8		5	Н	7.3	quality
0658C5	2	7	4	8.5	7.3	5.8	4	5.5	7.3	5.5	5.5	x	1		6.5	Huge fruit, flavour okay, slightly blotchy, long strong laterals, vigorous cane, good shelf life
0502G-3	2	2	1	9	6.3	6.5	5	5.5	8	6.8	5.8		1	н	6.3	Uniform, attractive, sweet, little acid, good display, good shelf life, nice flavour
Glen Fyne	1	3	1	8.5	5.8	5.8	5.3	6.5	7	6	6		5		6.3	Good crop, sweet and fruity all season, dark at end of season?
0485K-1	2	1	1	9	7	7.8	4	7	8.3	5.5	5.5		1	н	6.3	Long laterals but strong, sherbert flavour, very attractive, acid edge, very shiney, pear-drop late season
0550E4	2	2	1	8.5	6.3	5.3	4.3	6	7	6	6		1	н	6	Long drooping laterals, great flavour all season, good shelf life, good quality, recommend for trials
0453C4	1	2	1	8.8	6.3	6.3	4.3	6	6.8	6	5.3		2		6	Early season, good flavour - sweet and floral, good hedge, pretty, short season
Glen Fyne	2	3	4	9	5.8	6	5.3	6	7.5	5.5	6		3		6	Large fruit especially early season, good flavour, juicy, good crop, sweet + fruity
0427G7	2	1	1	9	7	6	5	6	8	6	6		1	н	6	Propagate plant 5, purple aphids
0550E4	1	1	1	9	6.8	5.5	4.3	5	8	6.3	6.3		1	н	5.8	Very large, meaty, slightly blotchy, nice flavour - acid edge, long laterals - not breaking, attractive in punnet, neat fruit - like Glen Doll
0019E2	1	3	2	9	6.5	5.3	5	6.5	7	6.3	6		2		5.8	Plot 1 and 2 - Cut down, some broken laterals, good flavour, sweet, dry, rhubarby, good shelf life
0662D-1	2	1	1	8.6	5.8	5.8	3.8	7	6.8	5.8	5.2		1	н	5.8	Best flavour later in season, attractive, dry, great shelf life, good habit
Glen Doll HFS1	2	2	3	9	5.8	5	4.5	7	8	6.3	6		2		5.8	Firm, sweet, big early on, neat and 'perfect' looking rasps, good crop, hairy
Glen Doll WAL SE	2	3	4	9	5.5	5	4.5	6.5	7.5	6.5	5.8		1		5.8	Good flavour, sweet, crop top heavy and drooping laterals, firm great shelf life
0662D-1	1	1	1	8.6	6	5.2	4.2	6	7.2	6	5.6	х	1	н	5.6	Early season, long laterals strong, sweet and aromatic, neat bright, RLBM
0433F2	2	4	1	8.3	6.8	5.8	4.3	5.7	7.3	5.7	5.5		1	н	5.5	Early, very sweet - no acid, good crop, bright like Tulameen, goes small

## **Table 11** JHI Polytunnel site M27. Summary of arbitrary scores and comments (ranked highest to lowest)

Selection	Rep	Cane botrytis	Spur blight	Fruit set	Fruit shape	Fruit brightness	Fruit colour	Pick	Collar	Firm	Flavour	RLBM	ISSM	Gene H	Overall score	Notes
0658C5	1	4	3	8	7.3	6	4	 5.5	6.8	<b>6</b> .3	5	_	1		5.5	Good bush, meaty, large, bright, good crop, sweet + acid flavour
0671D-4	2	5	2	9	5.5	6.3	3.5	4	7.8	4.8	5		7	н	5.5	Sweet, little acid, long laterals, chlorotic leaves, slight pear-drop flavour, pale, good shelf life, fat recepticles, juicy, cut down pl2
0493F1	1	2	1	8.8	5.5	6.3	3.5	5.5	7	6.5	5.8		1	н	5.3	RLBM, attractive, good colour, good presentation, good hedge
0565B1	1	3	2	8	7	6	4.7	6.5	8	5	5		4		5.3	Sweet, fruity, good shelf life, RLBM, long laterals, drooping but not breaking, spindly leaves
9769RD1	1	2	1	8.7	5.5	5.5	5.5	6.5	7.3	6.8	5.5		2		5.3	Long laterals but upright and strong, nice flavour, neat fruit, blotchy in punnet
9769RD1	2	1	1	9	5.3	4.7	4.7	6	8	6.3	4.7		1		5.3	Top shelf life, good flavour early season, attractive
Glen Doll WAL AH	1	3	1	9	5.8	5.5	5	7	7.8	6.5	4.5		4		5.3	
Glen Doll HFS3	1	2	2	9	5.8	5	5.3	6	7.5	6.8	5.5		2		5.3	Large for Glen Doll, sweet, dry, great shelf life, some BD on collar, a few split fruit early pick
0461A5	1	1	1	9	6	6	4.8	6.5	7.3	6.3	4.8		1	н	5	Root rot - 2 plants left, variable size, breaking laterals, off flavour
0531RH4	1	2	1	8.8	7.5	7	4	5.5	7.3	5.8	4.5		1		5	Variable flavour, breaking petioles, little primocane growth, good shelf-life
0533G-3	1	2	1	8.3	6.5	6.5	4.5	5	7.3	6	4.3		1		5	Split fruit, meaty, dry, holes in drupes, flavour nothing special, sweet at end
0460F-5	2	5	2	9	8	7.7	6.3	4.5	8	5	6.3		2		5	
0531RH4	2	4	3	9	7	7	4.5	6	7	5	6		3		5	Small, conical, neat like 0435D-3, great shelf life, chlorotic, RR, cut down - shame
0546H-2	2	5	1	8.5	6.5	5.3	4.8	5	6.5	4.8	5.5	x	1		5	Long laterals pulling plants over, big fruit, juicy, acid, floral, large all season, collapses in storage
Glen Ample	1	2	2	8.5	5.8	5.8	4.5	5	6.8	5.5	4.8		1		5	Good crop on Glen Ample, uniform in punnet, flavour bland and watery
0669B-1	1	3	2	8.3	6	5	5.5	5	7	5.8	5.3	x	2		5	Sun scorch early pick, petioles easy broken, sweet and fruity, good presentation, sweet, hairy, dark in storage
8605C-2	1	4	2	8.8	5.8	7.5	4	6	7.5	6.5	4.5		1	н	5	Early season, glossy, sweet + mild, attractive in punnet, great shelf life
8605C-2	2	4	2	8.8	6	6.8	4.3	6	8.3	6	4.3		1	н	5	Excellent shelf life, shiny, pretty, blotchy, compact habit - short internodes, TSSM
0453C4	2	1	1	8.8	5.4	6.2	4.2	6	7.2	6.2	5		2		5	Early, firm, bright, sweet + floral, finished picking quick, good habit and presentation

Selection	Rep	Cane botrytis	Spur blight	Fruit set	Fruit shape	Fruit brightness	Fruit colour	Pick	Collar	Firm	Flavour	RLBM	ISSM	Gene H	Overall score	Notes
0546H-2	1	2	2	8.3	6.3	6	5	5	7.3	<b>5</b> .3	5.3	_	1		4.8	Long drooping laterals, good flavour, sweet + acid, uniform in punnet,
9351B4	2	1	1	8.8	4.8	5.8	4.3	6	7.7	6.3	4		1	н	4.8	Early, round, attractive, some BD, good presentation, goes small
0461A5	2	1	1	8.5	6.5	6.5	4.8	5.5	8	6.5	4.3		1	н	4.8	Root rot, botrytis, (beetle?), breaking laterals, shiney, blotchy, sweet, cut down
0671D-4	1	4	5	8.5	5.8	6.3	3.5	5	7	5	4.5	x	1	н	4.8	Variable colour, some beetle damage, attractive but variable, odd flavour, pale and bright
0663RE3	1	2	2	8.5	7	5	5.8	5	7	5.5	5		1		4.8	Many split fruit, long laterals, pretty, good flavour but dark, some split fruit at end
0658F-2	1	3	4	8	6.5	6	4	5.5	5.8	5.3	5		1		4.8	Big fruit, laterals not too long (short at top), variable shape, attractive, remove pl2, juicy
0658E-1	1	3	1	8.7	7.3	5	4	4	6.3	6	5	х	1		4.8	Some fruit split early on, large, pale, attractive, meaty, some collapsing laterals
9911C-1	1	3	1	7.8	6.2	6	4.4	6	6.4	5.6	4.8		6		4.8	Early season, sweet but watery, rust at end, short season
0658F-2	2	4	2	8.5	6.3	5.5	3.8	4.5	6	5.8	4.8		4		4.8	Very uneven ripening, many fruit per lateral, acid, drupes left on plug, sweet late season, murly
0606E-4	2	1	1	8.4	6	6	4.4	5.5	6.8	5.6	5		3	н	4.8	Early, excellent shelf life, good flavour later in season,
0658E-1	2	3	3	8.5	6.8	5.5	3.8	4.5	6.8	5.5	4.5		3		4.8	Some split fruit, very large, long laterals, juicy, mildew?
042711	2	3	2	8.5	7.5	6	5.3	5.5	7.3	5.8	4.3		1	н	4.8	Sweet early season, odd flavour later, some petioles breaking, good presentation, large meaty
0433F2	2	4	4	9	6.6	6.2	4.4	6	7.5	6.2	5		1	н	4.8	Sweet, little acid and aroma, good presentation, floral later in season, goes small at end
0653E6	1	2	2	8.7	6	5.3	5	5	6	6.3	5.7		2	Н	4.7	Weight of green fruit dragging down plant, juicy, good flavour, some rough, purple blotches on cane
0435D-3	2			8.7	6.7	5.3	4.7	6	7.3	5.7	5.7		2	н	4.7	Early seson, sweet + floral, conical, neat
9351B4	1	1	1	8	5.2	4.8	3.8	6.3	8	6.6	4.6		1	н	4.6	Round, neat, bland, short laterals, good display, tart, aromatic, good presentation, small
Glen Ample	2	3	3	7.6	5.2	5.8	5	6	5.8	5.4	4.4		2		4.6	Fat drupes, good crop, watery flavour, slightly crumbly, torn collars late season
054611	1	4	1	8	5.8	4.8	4	4.5	7	4.8	5.5		2		4.5	Slightly rough, few primocnaes, sweet, slightly soft, floral, fat drupes
054611	2	4	3	8.3	6.3	4.8	4.5	5	6.5	4.8	4.8		2		4.5	

Selection	Rep	Cane botrytis	Spur blight	Fruit set	Fruit shape	Fruit brightness	Fruit colour	Pick	Collar	Firm	Flavour	RLBM	TSSM	Gene H	Overall score	Notes
0533G-3	2	3	1	8	6.3	5.8	4	5	6.5	7.5	5		1		4.5	
0565F3	2	4	2	8.2	6	6	4.5	6	7	6.3	5		1		4.5	Early season, gingery, good flavour but rough and blotchy in punnet, variable size, RLBM?
0565B1	2	3	3	8.3	6.5	5.3	4.3	6	7.3	5.3	5.3		2		4.5	Very floral and sweet - bubblegum, slightly blotchy, dry, goes small
0605A4	1	3	2	8	5.5	6	5	4.5	7	5.5	4.8		3		4.5	Early season, some split fruit, spicy flavour - nice, sweet, round, shelf life okay
0663RE3	2	3	4	9	7.5	5.8	4.8	4.5	7.8	6	4.8				4.5	Many split fruit early season, hairy, dry, large, long conic, sweet, remove pl4
0669B-1	2	4	4	7.5	5.8	4	4.8	6	6.8	6.5	5.8		3		4.5	Slight bloom between drupes, white collar, like pastilles, aromatic and creamy
0605A4	2	6	3	8.6	5.4	6.4	5.2	5	6.6	5.4	4.8		2	н	4.5	Early, round, big drupes ~Ample, darkens in storage, some split fruit
0433G7	2	4	2	8.7	6	5.5	4.2	6	7.3	6.6	4.7		1	н	4.4	Early season, 2nd flush of flower buds mid-season, sweet and floral later, big drupes,
0460F-5	1	4	2	9	8.3	7.7	6.3	5	9	4.3	5.7		1		4.3	Very pretty but dark, long like Tayberry, soft, darkens in storage
0494D2	1	3	2	8.3	5	6	4.5	6.3	7.3	5.8	5.3		3		4.3	Flavour good late season - sweet and aromatic, juicy, variable early on, RLBM
0533G-4	1	1	2	7.8	6.3	6.8	4.5	5	7	5.8	4.3		1	н	4.3	Split fruit, shiny, floral, dry, BD, viral/blotchy, RLBM?
0550E6	1	1	1	7.8	5.3	5.8	4	5	6	5.3	5.5		1	н	4.3	Flavour good early in season, some crumble in punnet, long strong laterals
0572E3	1	1	1	9	5.8	6.3	4.8	6	7	5.8	4.5		1		4.3	Bleeding, blotchy, sweet, little acid.
0447C-5	2			8.3	6.7	4.7	5.7	5	7.5	5.7	5		1		4.3	Meaty, hairy, sweet, damage like leaf curling midge
0533G-4	2	2	1	6.7	5.3	6	4.7	6	6.3	6.3	5		1	н	4.3	Variable size and shape, some rough, nice flavour but dry in mouth, good display, dull in storage, crumbs in punnet, remove pl2
0493F1	2	1	1	8	5.3	5.3	4.7	5.5	6.7	6.3	5.3		1	н	4.3	1 plant left, good presentation, small fruit, cut down
0550E6	2	2	2	8.8	5.5	5.8	4.8	5.5	6.3	5.8	5.3		1	н	4.3	Short laterals, neat fruit, nice flavour, some split early season, goes dark in storage, short petioles, fruity
0659C5	1	2	2	8.8	6.5	5.3	4.3	6	8	6.8	3.8				4.3	Slightly blotchy, nothing special but good shelf life, good primocane vigour
0659D6	1	1	1	8.5	6.3	5.3	5.5	6	6.8	5.8	5.8				4.3	Long laterals but good presentation, slightly dark, sweet + fruity, many fruit/lateral, some split late in

Selection	Rep	Cane botrytis	Spur blight	Fruit set	Fruit shape	Fruit brightness	Fruit colour	Pick	Collar	Firm	Flavour	RLBM	TSSM	Gene H	Overall score	Notes	
																season	
9455F-2	1	4	3	8.3	6	4.7	3.7	4.5	6.3	6.7	4.3		3		4.3	Many split fruit all season, variable shape, bland, blotchy	
0019E2	2	2	3	8	5.8	6	4.8	6.5	6.8	6.5	4.5		4		4.3	Excellent shelf life, some breaking laterals, good flavour later in season	
Malling Hestia	2	5	3	8.3	4.5	5	4.8	4	6.8	6.5	4.3		5		4.3	Small, nothing special, bland, rough, cut down	
9455F-2	2	6	3	8.3	6	5	3.3	5.5	5.3	6.3	4.7		2		4.3	Long laterals drooping under weight of fruit, large, slightly blotchy, meaty, good flavour, some split fruit all season, good shelf life	
9762A1	1	2	2	9	4.6	5.2	4.8	7.5	8.8	6.2	4		1		4.2	Early season, very attractive, neat, acidic,round, too acid?	
Glen Ericht	1	2	1	8.6	5.8	4.2	5	6.5	6.6	6.2	3.6		3	н	4.2	Early season, slightly blotchy, attractive for Ericht, acidic, crown gall at floricane base, good hed	
Glen Ericht	2	3	2	8.8	5.8	4.4	5.2	7	7.6	6.8	3.6		1		4.2	Early season, dimpled drupes, like Ericht, dull - acid, very firm, good habit, nice hedge	
0703F5	2	5	3	8.2	6.3	4.7	4.5	4	7.2	6.3	4.7		1		4.2	Early season, sun scorch, slightly murly, uneven ripening, BD, some soft, some split	
0433G7	1	4	2	8.3	5.3	5.7	4	6	7	6	5.3		2	н	4	Rough, variable shape, few drupes, flavour okay	
0572E3	2	1	3	8	5.8	5.5	5.3	6.5	6.7	5	3.5		1		4	Variable shape and size, woody flavour, windrub	
0494D2	2	3	2	7.3	5.3	6	4.5	6.5	6.7	5.8	4.4		3		4	Very acid like Ericht! Good display and habit, poor primocane growth, BD on collar	
0556A4	2	3	2	8	5.3	5.7	5.7	5.5	6.7	6	5		1		4	1 plant left, small fruit, dark, tastes winey, no acidity	
Malling Hestia	1	5	2	8.7	4.7	4.7	5	4.5	7.3	6	4.3		2		4	Spiny,nothing special, small like Prosen, slightly acid, good primocane vigour, some laterals breaking, cut down	
0703F5	1	4	3	8.5	6.3	4.5	4.8	4.5	7	5	4.3		4		4	Early, rough, poor quality and odd flavour but good shelf life, perfumed at end of pick	
0556A4	1	1	2	7.4	5.6	5	5.8	5	6.5	5.6	4.8		3		3.6	Early season, bland, windrub, variable shape, goes purple, a few broken laterals	
0565F3	1	2	1	7	5	6.4	4.8	5.3	6.3	6	5		1		3.6	Early season, top fruit crumbly, pale/rough, flavour sweet late season, juicy	
04101A5	2	1	1	7.3	6.5	4.5	4.3	5.5	6.3	6.5	3.5	x	1	Н	3.5	Some split fruit, acid, BD, uneven ripening, dull, poor quality	
9750C1	1	6	4	6.5	5.3	5.5	5	3.5	4.7	6.3	3.8		1		3.3	Hard to pick, meaty, tearing collar, few new primocane, crumbly, poor	

Selection	Rep	Cane botrytis	Spur blight	Fruit set	Fruit shape	Fruit brightness	Fruit colour	Pick	Collar	Firm	Flavour	RLBM	TSSM	Gene H	Overall score	Notes	
9892G2	1	3	2	8	5.5	6	Y	5	7	4.3	3.7	x	3		3.3	Little flavour, not bad looking for yellow, uniform	
9892G2	2	4	1	8	5	5.8	7	4.5	7.3	4.4	3.8	х	1		2.8	OK for a yellow, but soft, cut down plots	
0694B1	2	2	4	8	5	4.5	6.7		7.5	5.3	4.5		3		2.5	Cut down plot, small, acid	
0689F-1	2	2	1	8	7.3	3	6.3		8	5.3	3.7		3		2.4	Purple, poor quality, cut down plot	
0694B1	1	5	3	5	5	6	7		4	5	6		2		1.7	Purple crumbs - cut down plot	
0689F-1	1	3	1	9	7	3	7.5		6	4	4		1		1.7	Dull and purple, small fruit, chlorotic, cut down plot	
0560E11	1	2	3	5	4	4	7		5	5	4		4		1.5	Purple, crumbly, stop picking, cut back plot - rubbish	
0560E11	2	4	3	3	3.5	5	5.5		3.5	4.5	3.5		2		1.3	Purple and rough, stop picking, cut down	
0701D6	1	2	3	5	3.5	5.5	5.5		6	6.5	3.5		5	н	1.3	Early fruit, dark, crumbly fruit, very chlorotic plant, stop picking	
0701D6	1	2	3	8	4	4	7.5		2	5	3	x	4		1	Early season, like purple pastels, very acid, crumbly, cut down	
0427G7	2											х	1			Dead- All plants	

Selection	Fruit set	Fruit size	Fruit shape	Fruit Brightness	Fruit colour	Pick	Collar	Firm	Flavour	SLE (general score)	Notes
											Bright and conical, slightly acid early pick but sweet and sherbet flavour later, plot healthy, good
0485K-1	8.5		7.0	7.0	4.5	6.5	8.0	5.5	5.5	6.0	hedge
0435D-3	8.5		6.5	6.0	4.5	5.5	8.0	6.5	6.5	6.0	Earliest in plot, neat and conical, sweet all season, some RR in plot, nice habit
0447C-5	7.5		6.0	5.0	4.0	6.5	7.0	6.0	6.0	5.5	Some beetle damage, slightly lumpy, nice flavour
0019E2	9.0		6.0	6.0	5.0	6.0	7.0	5.5	8.0	6.0	Great flavour - sweet and aromatic, slightly blotchy
Tulameen	7.0		7.0	6.5	5.5	5.5	6.5	4.5	7.5	5.0	Better quality this year, good flavour, soft and bleeding at end

 Table 12 JHI Polytunnel site J7. Summary of arbitrary scores and comments (ranked highest to lowest)

# Table 13 Post harvest (PH) scores (ranked overall score highest to lowest)

Selection	Rep	PH brightness	PH colour	PH uniformity	PH firm	PH overall score
9769RD1	2	6	3		7	8
0531RH4	2	6	4		6	8
0606E-4	2	6	6	7	6	8
0019E2	2	5	4	7	7	7
8605C-2	2	6	5	6	7	7
0531RH4	1	5	5	7	6	7
8605C-2	1	6	4	6	6	7
9455F-2	2	5	4	4	7	6
0703F5	1	4	6	6	6	6
0659C5	1	4	6	5	6	6
Glen Doll Walpole	1	5	5	6	6	6
Glen Doll HFS	1	5	5	6	6	6
0662D-1	2	5	5	4	6	6
0658C5	2	5	4	4	6	6
0658F-2	2	5	4	6	6	6
0427l1	2	4	6	6	6	6
0447C-5	2	4	5	7	6	6
0565B1	1	4	5	7	5	6
0460F-5	2	6	6	7	5	6
0502G-3	2	5	6		5	6
0658E-1	1	5	4	6	5	6
0671D-4	2	5	4	7	5	6
0019E2	1	4	4	5	7	5
0658F-2	1	4	4	6	7	5
9455F-2	1	5	4	4	7	5
9750C1	1	4	7	4	6	5
9769RD1	1	4	6	4	6	5
0550E4	2	4	6		6	5
0605A4	1	4	8	7	6	5
0453C4	1	5	6	4	6	5
0605A4	2	5	7	7	6	5
Glen Doll WAL SE	2	5	6	4	6	5
0435D-3	2	4	5	6	6	5
0460F-5	1	7	7	8	5	5
0565F3	1	4	6	4	5	5
9351B4	1	5	4	5	5	5
9762A1	1	4	6	5	5	5
Glen Fyne	1	4	6		5	5
0494D2	2	5	5		5	5
0565B1	2	4	6		5	5
0433G7	2	4	5		5	5
0556A4	2	4	7		5	5
0703F5	2	4	6	4	5	5
Octavia	1	3	6	6	5	5
0658E-1	2	5	4	7	4	5

Selection	Rep	PH brightness	PH colour	PH uniformity	PH firm	PH overall score
Glen Fyne	2	4	6	6	4	5
0433G7	1	4	4	3	6	4
0572E3	2	6	6		6	4
9351B4	2	5	5		6	4
0533G-3	2	4	5	3	6	4
0658C5	1	5	3	3	6	4
0659D6	1	5	6	4	6	4
9911C-1	1	5	6	4	6	4
Glen Ample	2	5	5	5	5	4
0572E3	1	5	6	3	5	4
9892G2	2	4	Y		5	4
0565F3	2	3	6		5	4
0533G-4	2	4	6		5	4
0550E6	2	3	8		5	4
0671D-4	1	4	4	4	5	4
0663RE3	1	3	8	4	5	4
0493F1	1	6	5	6	4	4
0556A4	1	3	8	7	4	4
Glen Ample	2	4	6		4	4
0493F1	2	3	6	6	4	4
0433F2	2	5	5		4	4
0663RE3	2	4	7	6	4	4
0669B-1	1	3	7	4	7	3
0453C4	2	5	6	6	6	3
Tulameen	1	5	5	6	3	3
0669B-1	2	3	8	4	5	3
0494D2	1	5	6	3	4	3

# Appendix: 2

Photographs

#### 2013 Photos of floricane selections



Plate 1 Fruit for the Future



Plate 3 0447C-5, fruiting plot



Plate 5 New selection 0658E-1



Plate 2 Selection 0447C-5



Plate 4 Long cane 0447C-5 in Austrian trials



Plate 6 New selection 0550E4

## Photos of primocane selections



Plate 7 Primocane selection 1132F16



Plate 9 Primocane selection 1104D-7



Plate 11 Primocane selection 0919D-7



Plate 8 Primocane selection 1132F-12



Plate 10 Primocane selection 0925B8



Plate 12 Primocane Erika