

Raspberry Breeding Consortium

Summary Annual Report 2019



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1. INTRODUCTION

This report describes the activities during year one of the new programme, presenting results from the breeding programme at James Hutton Institute and a summary of the results from the existing on-farm trials. It also describes knowledge transfer activities undertaken throughout the year.

2. SUMMARY OF RESULTS AND DISCUSSION

HEADLINES AND HIGHLIGHTS

- **The programme has established a new primocane trial site based at Genson in the Netherlands**
- **The programme is identifying an increase in promising floricanes and primocane selections**
- **We are seeing an increase in spinefree promising primocane selections compared to previous five years**
- **The programme is witnessing a noticeable increase in average berry size in primocane and floricanes germplasm**
- **JHL Demonstration plot is established and produced its first floricanes crop which cropped well and had a large footfall of visitors during 2019 season**

2.1. 2019 Fruit Season and Breeding Trials

- During the winter, accumulated chill hours were achieved by January 2019, but mild, and sustained temperatures >12°C fluctuated through the winter months.
- Conditions were very dry until March and mild temperatures during mid February and March triggered early bud break in the breeding plots. This was followed by a long, cold spell until June which checked the development of flowers and fruit.
- The fruiting season was generally dull, but warm, with relatively poor light levels.
- The floricanes and grow-through primocane plots began very early, in mid-June, and were productive over a long season with high brix and good eating quality.
- In contrast, the lower light levels during the summer months appeared to considerably delay the autumn crop, which was later than previous years, and a high proportion of green fruit was still to ripen in November.
- The seedlings in the open field established well in the warm, wet conditions.
- Yield, fruit size, brix and shelf-life were generally good throughout the season. Flavour was good at both the early and late end of the season. In general, the advanced selections performed well at JHI compared with commercial controls. Characteristics of the key selections are summarized in Tables 1 and 2.
- Insect pests were abundant during 2019, and high levels of non-colonising aphids could be seen from March onwards. Raspberry leaf and bud mite, two spot spider mite and pollen beetle were seen late summer. Natural predators were widespread. *Phytophthora* Root rot was persistent in the soil-grown breeding plots. Powdery mildew and rust appeared on some genotypes in late summer but at relatively low levels.

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

- 21 floricanes genotypes in a protected site of replicated 5-plant plots (M32 in their third season).
- 34 floricanes genotypes in a protected site of replicated 5-plant plots (plot L9), in their second season.
- 11 floricanes and 11 primocane genotypes in substrate in a Demonstration tunnel in their first season of long cane.
- Approximately 6000 seedlings from the 2014 - 2017 crossing programmes in the open field.

M32 Long cane raspberry breeding trial

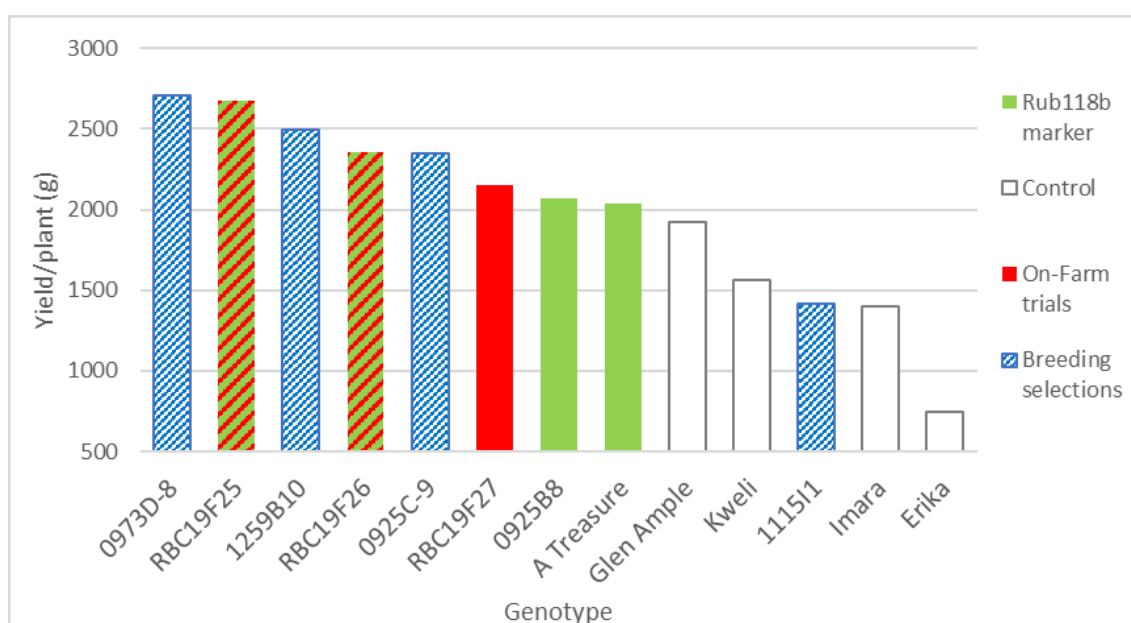
This plot was established in 2016 to assess the double-cropping ability of early stage primocane selections. This has also proved a good plot to assess the potential as varieties suitable for long cane production and, more recently, tested plants with the Rub118b marker, since the soil in the plot is infested with *Phytophthora*. Three selections identified for on-farm trials at the 2018 AGM were particularly outstanding in terms of productivity, tolerance to root rot and potential lower chill requirement: RBC19F25, RBC19F26 and RBC19F27.

Table 1 Plot M32 Soil (3rd season): Highlights of long cane selections at JHI

Genotype	Mean yield /stool (g)	Mean fruit size (g)	Mean Brix %	First pick date	Characteristics
0973D-8	2707	8.3	7.9	18 July	Fantastic fruit size and yield but flavour variable, makes superb long cane
RBC19F25*	2676	6.3	8.9	15.July	<i>Rub118b</i> marker with good flavour, easy pick, upright habit, good long cane
RBC19F26*	2359	5.7	9.6	15.July	<i>Rub118b</i> marker, good long cane, very easy pick, prolific in propagation
RBC19F27*	2149	6.0	10.0	15.July	Good field tolerance to root rot but without marker, good flavour and shelf life
Kweil	1563	4.7	10.7	11 July	Good flavour in soil plot, showing symptoms of root rot, fruit size reduces quickly
Glen Ample	1919	5.3	9.0	18 July	Showing symptoms of root rot, acidic this year

*Selections identified in November 2018 for on-farm trials

Figure 1 Mean yield of selections at JHI, plot M32 Soil (3rd season)



L9 Long cane raspberry breeding trial in soil

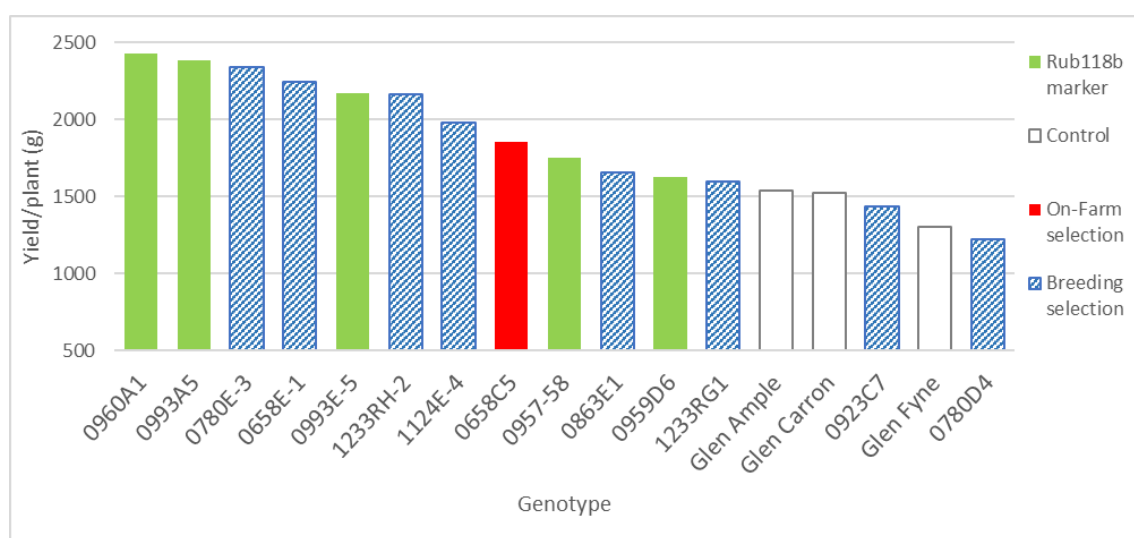
One new selection, 0993A5, stood out as a candidate for future on-farm trials. This combines the *Rub118b* marker (marker linked with root rot resistance) with high productivity, large fruit size and good quality and appearance. This is recommended for propagation for on-farm trials in 2020.

Table 2 Plot L9 Soil (2nd season): Highlights of long cane selections at JHI

Genotype	Mean yield /stool (g)	Mean fruit size (g)	Mean Brix %	First pick date	Characteristics
0993A5*	2385	6.1	11.6	11 July	<i>Rub118b</i> marker, big fruit, consistent flavour, best with marker
0780E-3	2340	5.5	11.6	18 July	Beautiful punnet of fruit, good flavour all season
0658C5	1852	6.8	11.8	11 July	Good flavour, very easy pick, maintains large size, popular with pickers
1233RH-2	2163	7.0	11.5	11 July	Huge fruit, fruit tastes and looks good in punnet and uniform after storage
Glen Ample	1540	4.2	10.5	15 July	Fruit acidic and rough

***Recommended for future trials**

Figure 2 Mean yield of floricanes at JHI, L9 Soil (2nd season)



Demonstration plot: Floricane tunnel

The JHL Demonstration plot was established in spring 2018 and is intended to showcase the best genotypes in optimum conditions in a commercial production system. Replicated plots of promising floricanes and primocane selections were propagated at JHI and established long cane during the 2018 season. The genotypes will be reviewed annually depending on performance.

The Demo comprises a bay each of 11 floricane and 11 primocane genotypes in replicated 10-plant plots. Cultivar controls are included as a comparison. The plants are grown in 10L pots in coir. The plot was covered in early April.

The first crop of the floricane genotypes were harvested and assessed in summer 2019 and this was the first evaluation of the breeding plots in coir. The following observations were made:

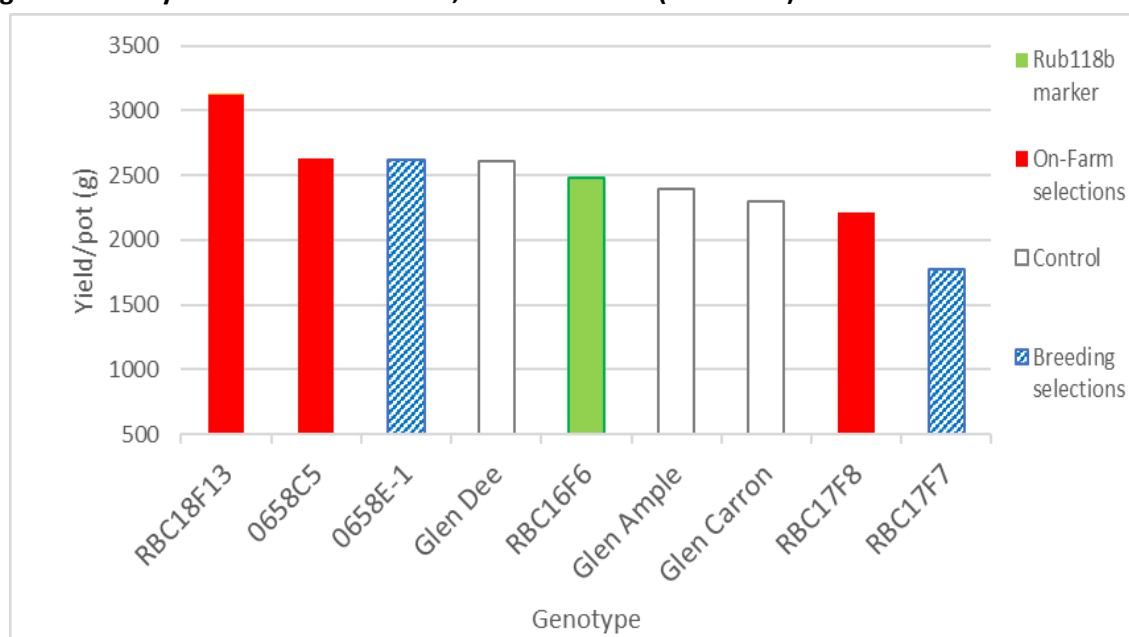
- RBC16F6 had the earliest crop, starting on 21st June, and cropped over a long season due to low laterals producing a later crop of large fruit.
- Selection 0658C5 performed well in coir, maintaining the large fruit size and good eating quality throughout the season.
- RBC18F13 was particularly productive and the only genotype to out-yield 0658C5. Fruit was scored highly for flavour and appearance in blind tasting sessions at various meetings and events.
- Glen Dee produced a surprisingly good crop with very large fruit and a superb flavour.

Table 3 Demonstration plot Coir, 1st season: Highlights of advanced selections at JHI

Genotype	Mean yield /stool (g)	Mean fruit size (g)	Mean Brix %	First pick date	Characteristics
RBC18F13	3121	6.2	11.1	1 July	Productive, sweet and juicy, good tasting feedback from visitors, maintains a good size, beautiful colour in punnet
0658C5	2625	6.0	11.2	27 June	Easy, pick, good display and habit, new cane not too vigorous, good flavour all season
Glen Dee	2604	6.4	11.0	10 July	Productive and easy to pick, maintains large fruit all season, flavour consistent
RBC16F6	2485	5.9	9.7	21 June	Rub118b marker, good long-cane growth and habit, slight coconut flavour, early crop has especially good quality
Glen Ample	2396	5.3	10.4	24 June	Bad aphid infestation from June onwards, badly suited to nutrition in plot, acidic

Genotype	Mean yield /stool (g)	Mean fruit size (g)	Mean Brix %	First pick date	Characteristics
Glen Carron	2298	5.8	11.8	21 June	Excellent eating quality, easy to pick Class I fruit, little wasted, best shelf life in Demo tunnel
RBC17F8	2208	6.7	10.8	27 June	Huge fruit, well displayed, long season consistent raspberry flavour and peach colour

Figure 3 Mean yield of selections at JHI, Demo Plot Coir (1st season)



2.2. On-Farm Selections

Once plants of promising genotypes are sent to trial sites, triallists are requested to assess yield, fruit quality and plant characteristics relative to control varieties. A summary of the trialling and testing results are described below.

Selections on existing trials

2.2.1 0658C5: Highly productive florican, economical to pick and grow This selection was originally selected in 2012 and had some crumbly fruit issues after micropropagation (described in detail in the 2018 RBC Report). After new trials from root propagation at JHI suggested that the selection continues to outperform most other genotypes in soil and substrate, the RBC agreed to retrial. In 2019 0658C5 was highly productive in the Demo plot (coir) and also came out top for flavour preference when compared with several commercial varieties in an Innovate project on flavour. Root propagated trial material will be available in 2020 for trials.

2.2.2 RBC16F6: Large-fruited, early and root rot resistant RBC16F6 is from a (florican x primocane) cross which has shown promise as an early florican. It produces large fruit, consistent over a long season, and has shown no symptoms of root rot in infested soil after five years, despite repeated flooding over two seasons. It is also the first advanced selection with promising commercial traits with the *Rub118b* marker. One triallist

described it as better overall compared with the control (Imara), with a higher yield and 'coconut' flavour. Results from the Demo plot also

- 2.2.3 RBC16P4: Primocane with high double-cropping potential.** RBC16P4 was identified by the RBC as promising in 2015 and fast-tracked into trials in 2016. The primocane crop begins late in autumn and produces long, straight cane for the following summer. In year two the floricanes break bud far down the cane, producing a high number of fruit/lateral. The fruit is easily picked at a pink stage, where it maintains a uniform appearance after storage. Fruit is glossy and eats well with a low acidity. RBC16P4 was outstanding in the initial trials at Genson in NL in September 2019.
- 2.2.4 RBC16P5: Early primocane, very large fruit.** RBC16P5 was identified and fast-tracked alongside P4 and is early season with a larger fruit size. The plant has moderate vigour at flowering time on the primocane and produces fruit in late summer. Fruit is striking with very large bright red berries and a very sweet flavour. It appears to have a very low chill requirement in comparison to RBC16P4.
- 2.2.5 RBC17F8: Productive with large fruit** Selection RBC17F8 was identified in November 2016 with high productivity and large fruit size. Issues with micropropagation delayed planting in 2018. Plants will be available for trials in spring 2020.
- 2.2.6 RBC18F13: Sweet, productive, shows field tolerance to *Phytophthora*** Identified for trials at the 2017 AGM, results from the breeding plots showed a good performance in 2018, with good feedback on flavour when presented at all of the summer events. Plants are currently in soil infested with *Phytophthora* and have shown no symptoms after four years. RBC18F13 was top for yield in the Demo plot in 2019. Plants will be available for trials in spring 2021.
- 2.2.7 RBC19P19: Spinefree primocane with large fruit.** This was identified as early and outstanding at the early-stage primocane trial at RW Walpole in autumn 2019 and was popular with visitors to the JHL Demo plot. Plants will be available in 2021.
- 2.2.8 New selections with long cane potential** The following were identified and agreed to progress into on-farm trials at the November 2018 AGM after discussions on focusing some breeding efforts on traits for long cane potential; strong straight cane, short internode length, spinefree, lower chill requirement, good bud break, prolific propagation.

2.3. Fruit Tasting

Fruit samples were picked and blindly assessed informally by industry members, visitors and James Hutton staff to broaden the number of tasters to provide feedback and support for promising genotypes. During the season, fruit samples were provided for tasting at Fruit for the Future, Fruit Focus, RBC summer meeting, other public meetings and in-house tasting at the James Hutton Institute.

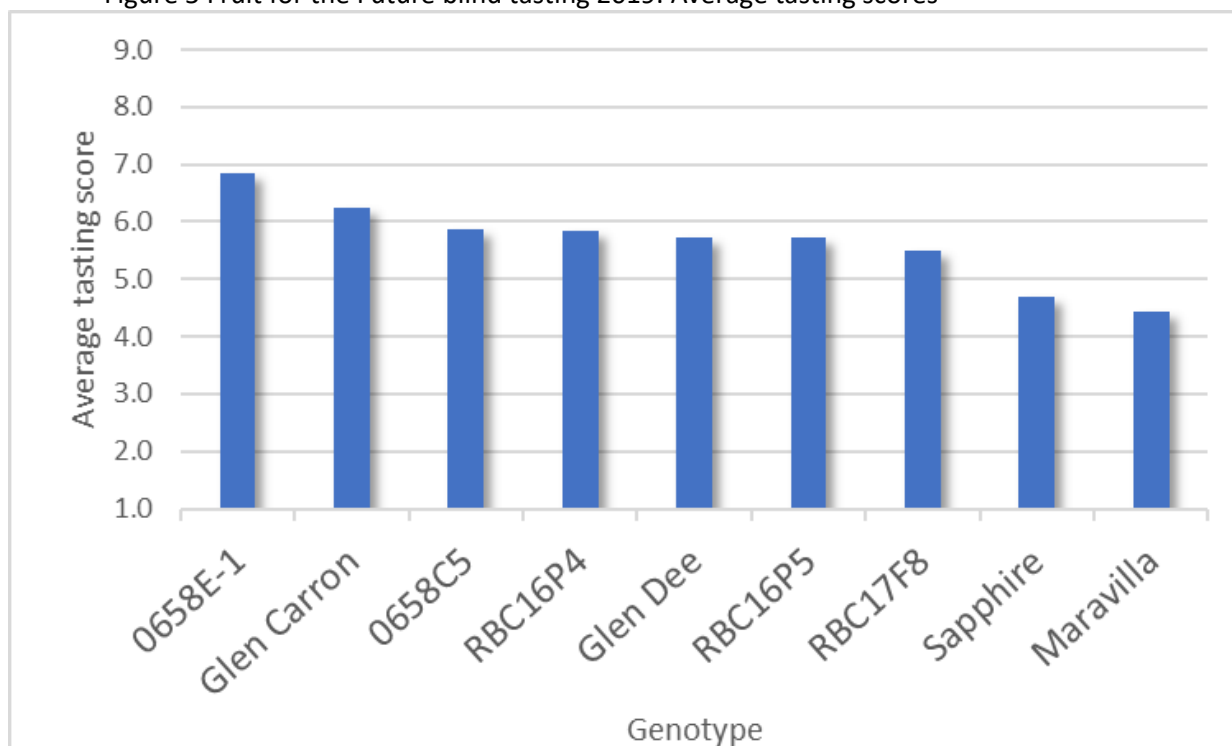
A new scoring system was introduced after discussions during an Innovate project on flavour preference. This is a simplified, hedonistic scale based on 'Likeability' and basically asks the question; 'how much do you like this sample?' (see Figure 5 below). This proved popular at public events and tasters were less intimidated compared with the previous scoring system. As a result, an increased number of people participated and completed the tasting forms.

Fruit for the Future

Fruit samples were picked for assessment as a blind tasting at the SSCR fruit event in July 2019.

- Nine genotypes, including two retailer samples, were assessed
- 63 individuals scored the fruit
- Participants were asked to score how much they liked a sample and were shown the 1-9 scale in Figure 5, where 1=dislike extremely and 9= Like extremely
- Selection 0658E-1, identified for trials in 2017, scored highest for likeability, above Glen Carron.
- Sapphire was soft and bleeding and Maravilla scored the least likeable.

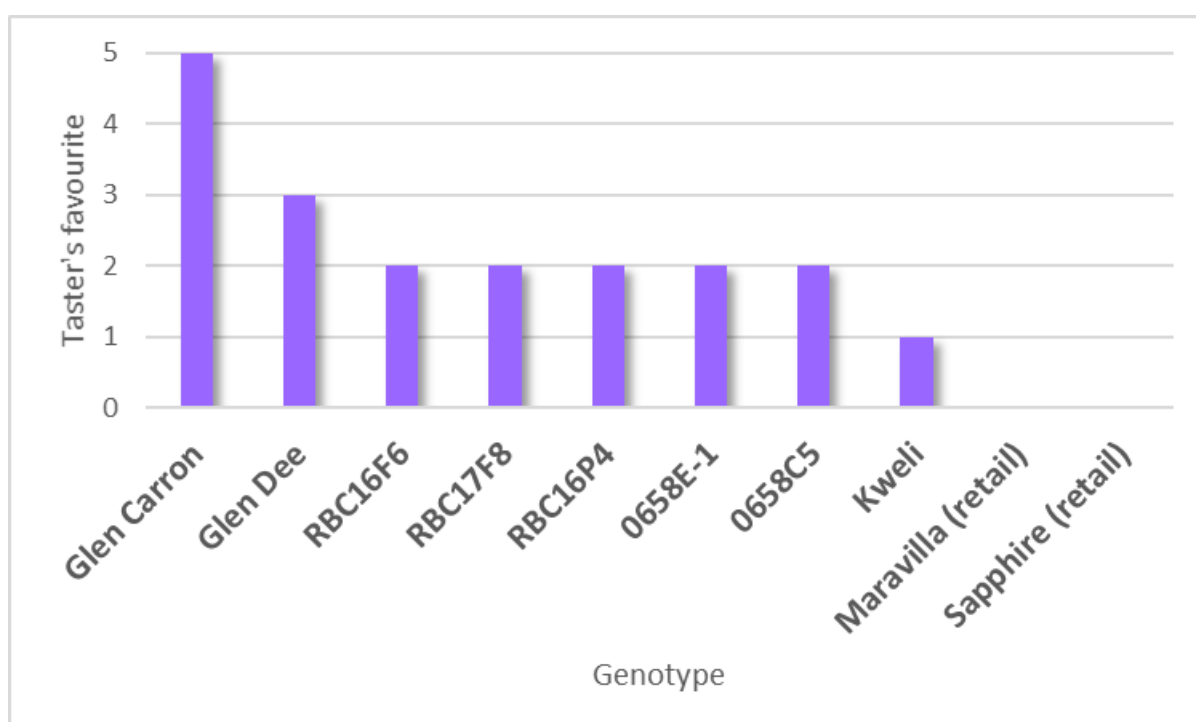
Figure 5 Fruit for the Future blind tasting 2019: Average tasting scores



RBC summer meeting

Ten coded genotypes, including two retailer sample, were chosen for benchmarking at the RBC summer meeting in July. Members were asked to score texture, appearance and flavour and asked to nominate their preferred genotype (Figure 6). Glen Carron was the favourite with five votes, followed by Glen Dee with great fruit size. Selections RBC16F6, RBC16P4, RBC17F8, 0658E-1 and 0658C5 were all equal with two votes each. The retailer samples received no votes.

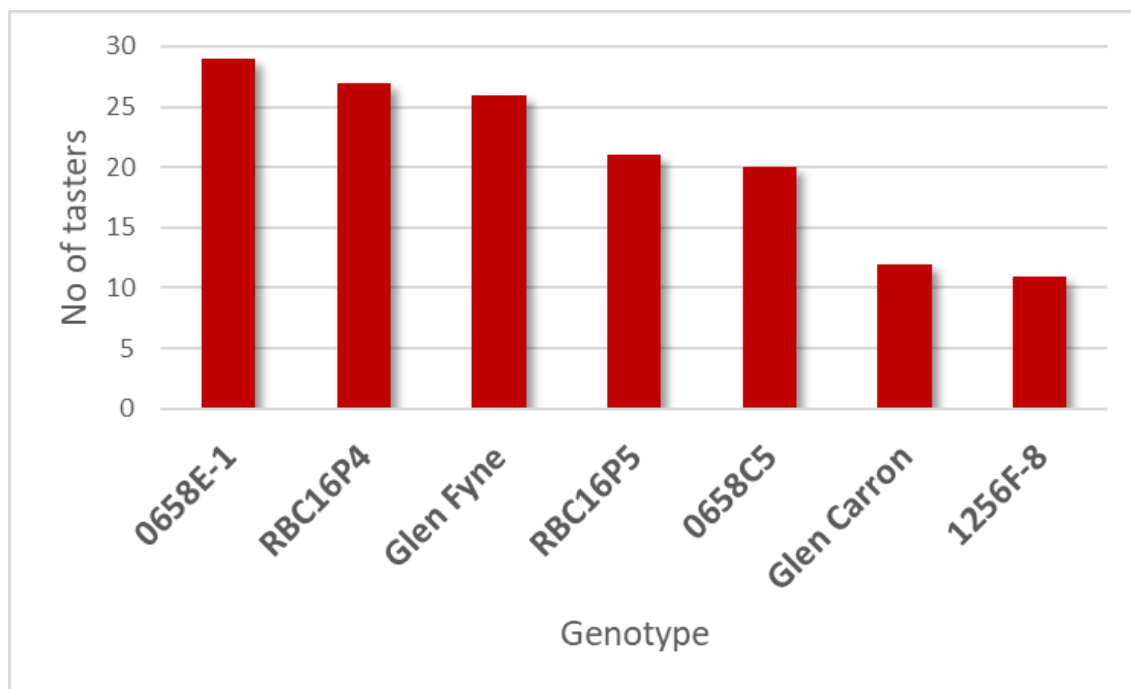
Figure 6 RBC Summer meeting blind tasting: preference results



Beer & Berries, Arbroath

The Soft Fruit group at James Hutton was invited to take a stand at a public event in Angus, Tayside. This had a footfall of ~800 visitors and was a good opportunity to acquire feedback from the general public on taste preferences across a broad demographic. The hedonistic scale was used and >125 participants completed a tasting form. Selections 0658E-1 and RBC16P4 scored very well, along with Glen Fyne, all three were sweet but had a 'fruity' flavour. Glen Carron scored surprisingly low compared with industry preference. This was a good event that JHI have the opportunity to repeat in the future.

Figure 7 Beer & Berries tasting preference



2.4. Primocane Germplasm

More than 700 primocane seedlings and more than 40 selections, including a proportion with the *Rub118b* marker, were evaluated in the breeding plots in 2019. In contrast to the early start to the florican crop, the dull, damp summer delayed flowering and fruit development in the primocanes until early September and selecting continued into the second week of November.

Demonstration Primocane Plot: Summer and Autumn cropping

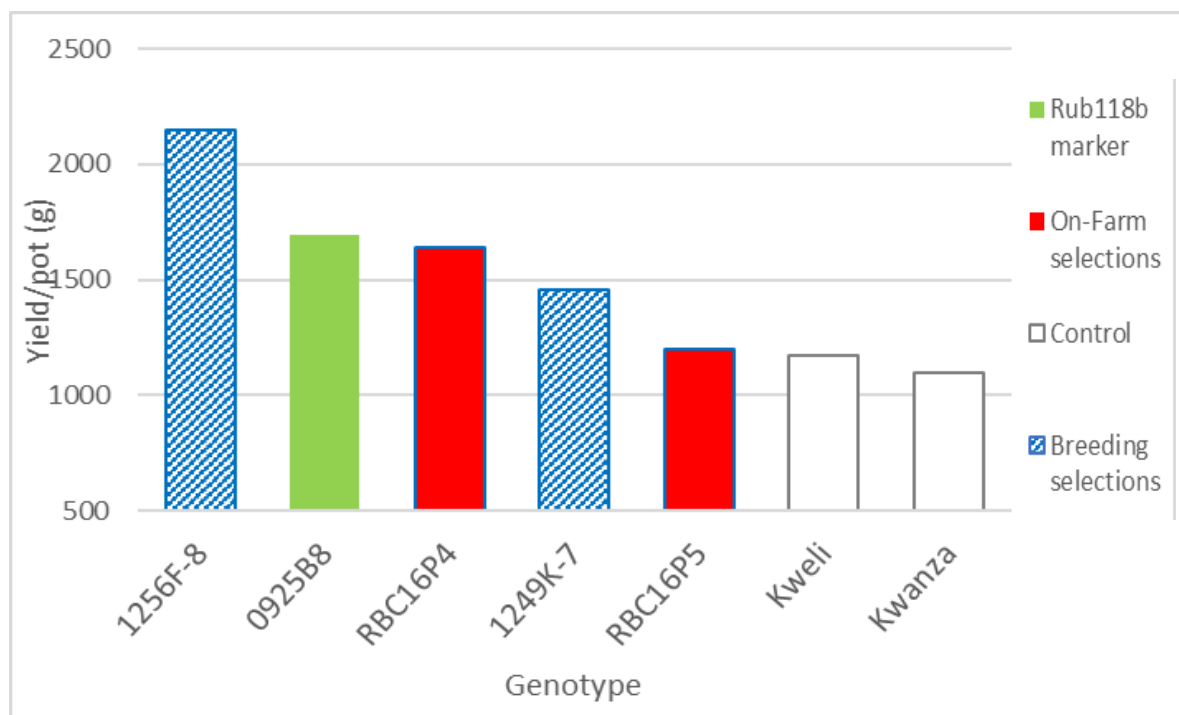
The new Demonstration plot, consisting of 11 replicated plots of primocane genotypes, produced the first crop of primocane fruit in autumn 2018. In spring 2019, five of the ten pots in each plot were cut to pot level so that half of the plot would produce a single crop on the primocanes only and, in the remaining half, the second-year cane was kept to evaluate ability of each genotype to double-crop.

Table 4 Demonstration Primocane plot; summary of summer and autumn crops in 2019

Selection	Summer Crop			Autumn Crop			Notes
	First pick 2019	Mean size (g)	Mean Brix°	First pick 2019	Mean size (g)	Mean Brix°	

	Summer Crop			Autumn Crop			
Selection	First pick 2019	Mean size (g)	Mean Brix°	First pick 2019	Mean size (g)	Mean Brix°	Notes
RBC16P4	21 June	5.4	12.2	25 Sept	6.0	11.1	Consistent flavour and quality, good feedback from visitors, summer crop long season
RBC16P5	21 June	5.6	11.6	13 Sept	6.7	9.1	Beautiful sweet autumn fruit, better than summer crop
1249K-7	21 June	5.4	11.8	28 Oct	6.2	10.5	good flavour, easy to pick, good habit and colour
1256F-8	21 June	4.4	12.8	7 Oct	5.2	9.8	productive and sweet but too small
0925B8	27 June	5.0	11.3	15 Oct	6.8	8.5	<i>Rub118b</i> marker, good quality, coconut flavour, easy to pick
Kweli	24 June	4.2	9.9	15 Oct	6.8	9.4	small and rough, poor flavour in coir, better in soil
Kwanza	24 June	6.1	11.7	7 Oct	7.9	9.8	huge fruit with beautiful colour, lower yield than expected, fruit firm but skin bleeds in storage
Imara	*	*	*	4 Oct	6.8	8.2	Autumn crop only, excellent plant habit
Polka	*	*	*	9 Sept	6.2	10.4	Good flavour, dark fruit, good flavour, softens quickly

Figure 8 Demonstration plot; Primocane summer crop on florican. Yield 2019



2.5. Primocane selections in on-farm trials

Assessment of the primocane breeding trials at James Hutton Institute can be limited in terms of seasonal conditions in Scotland where the evaluation and selection of later season autumn fruit is shortened due to reduced light and temperature. The industry partners agreed to trial selections identified early in the breeding process at a more southern location in order to identify potential new cultivars early in the process. Since 2013, chilled root was sent from pot-grown breeding plots and trialled at RW Walpole where these trials returned valuable data and feedback for 44 early-stage selections.

Selection **RBC19P19** was highlighted initially in the Norfolk trial during summer 2019 and will be propagated for RBC Members' trials in 2020.

In February 2019, a new trial site was set up in Europe by Genson in the Netherlands. Chilled root was sent from both the breeding plots and RW Walpole to establish and evaluate the selections for primocane and long cane potential. Eight genotypes (Table 5) were sent to establish in 2019 and fruit was assessed at the primocane meeting in September alongside cultivars and germplasm from other breeding programmes. A blind tasting of eight genotypes were assessed by RBC Members. A summary of tasting results and comments by the RBC are shown in Table 6. It was noted that the fruit samples were picked after a hot weekend and was in storage for 2 days before assessment. Both RBC16P4 and Versaille scored equally high but RBC16P4 was the preferred genotype during this tasting session. Fruit appearance and flavour were both very good.

Table 5 New selections identified for on-farm trials at Genson in 2019

	Pedigree			
RBC Selection	Female	x	Male	Notes
RBC19P17	Kwanza	x	0658C5	
RBC19P18	POLKA	x	0658C5	spinefree
RBC19P19	RBC16F6	x	Polka	spinefree, Rub118b marker
RBC19P20	Sapphire (OP)			spinefree
RBC19P21	0850T5	x	Polka	spinefree
RBC19P22	Kwanza	x	Polka	few spines
RBC19P23	RBC16F6	x	Polka	spinefree, Rub118b marker
RBC19P24	RBC16F6	x	Polka	spinefree, Rub118b marker

Table 6 Selections evaluated by RBC members, ranked by order of preference, best to worst

Genotype	Average flavour score (1=poor, 5=excellent)	Overall score of appearance, firmness and flavour	Comments
RBC16P4	3.1	3.4	Attractive and sweet
Versaille	3.1	3.4	Large and attractive
R1490 ('Glamour')	2.9	3.1	
RBC16P5	2.9	3.1	

Genotype	Average flavour score (1=poor, 5=excellent)	Overall score of appearance, firmness and flavour	Comments
Paris	2.4	3.0	
RBC18P14	2.7	2.9	Large, flavour flat
1132F12	1.8	2.2	Dark
Autumn Bliss	2.4	2.2	Dark, soft

2.6. Overall Conclusions

- A commercialisation plan is in progress for selections RBC16P4, RBC16P5 and RBC16F6 aiming for release on 1st April 2020.
- Three new selections were identified with good long cane potential; RBC19F25, RBC19F26, and RBC19F27. These will be propagated in 2020 for future members' trials.
- New primocane selection RBC19P19 was identified as promising in the Norfolk primocane trials and will be propagated for members' trials for future trialling.
- Five new primocane selections, including three with the marker, were identified for early stage trials in the new primocane trial in the Netherlands.
- The new Demonstration plot was established in spring 2018 to showcase the advanced floricanes and primocane selections at JHL.

3. KNOWLEDGE TRANSFER

3.1 Conferences and seminars

- The project was presented at the following events:
 - SSCR Soft Fruit winter meeting, 14th February 2019
 - Norwegian Growers' Conference, Oslo, 13th March 2019
 - Solutions for the future, Natural Resources Institute, NIAB/EMR, 28th May 2019
 - XII *Rubus* and *Ribes* Symposium, Zurich, 26th June 2019
 - SSCR/JHL Fruit for the Future, 25th July 2019

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

- ISFC, Hertogenbosch, NL, 10th January 2019
- Beer and Berries festival, Arbroath, 6th July 2019
- Fruit Focus, NIAB/EMR, 17th July 2019

3.2 Visits to trials

- Spain Trials and propagation, 12th December 2017
- Cranachan Farm, 18th April, 24th July 2018
- ASF, East Seaton Farm, 18th June 2019
- Wester Essendy, 16th July 2019
- Clockhouse Farm, Kent, 12th September 2019
- RW Walpole, Kings Lynn, 13th September 2019

3.3 Papers, articles and Media Coverage

- Sunday Mail
- Raspberry Breeding Consortium Newsletter

- ‘New fruit variety created with ‘exceptional quality’ and ‘high productivity’’, Farming UK, 16th February <https://www.farminguk.com/News/New-fruit-variety-created-with-exceptional-quality-and-high-productivity-48638.html>
- ‘Exciting raspberry varieties emerge from AHBD trials’, Fresh Produce Journal, 11th April <http://www.fruitnet.com/fpj/article/175257/exciting-raspberry-varieties-emerge-from-ahbd-trials>
- Modelling the Dormancy and Chilling Requirements in Raspberry, AHDB Knowledge4 Library ahdb.org.uk/knowledge-library/modelling-the-dormancy-and-chilling-requirements-in-raspberry

3.4 Social Media

Regular updates can be found on various social media sites:

Youtube, 'Raspberry Diaries'	https://www.youtube.com/watch?v=wR00dzQrv7Y
Twitter	https://twitter.com/jameshuttonltd?lang=en https://twitter.com/JamesHuttonInst?lang=en
LinkedIn	https://www.linkedin.com/company/james-hutton-limited/ https://www.linkedin.com/company/james-hutton-institute/
Facebook	https://www.facebook.com/JamesHuttonLtd/ https://www.facebook.com/JamesHuttonInstitute/

4. APPENDIX I

2019 Photos



Plate 1 Primocane RBC16P5, summer crop 2019



Plate 2 Primocane RBC16P4, Agronom Berries, Poland



Plate 3 Florican 0658C5 in Demo Plot July 2019



Plate 4 Long cane type RBC19F25, JHI July 2019



Plate 5 Floricane RBC18F13, JHI July 2019



Plate 6 Long cane type RBC19F26, JHI July 2019



Plate 7 Primocane RBC19P19, RW Walpole,



Plate 8 Early-stage primocane trial, Genson, NL

