Project title:	The performance of new June-bearing strawberry varieties and advanced selections in raised soil beds.
Project number:	SF 134
Project leader:	Sarah Troop, Meiosis Ltd
Report:	Annual report, 2013
Previous report:	None
Key staff:	Sarah Troop, Meiosis Ltd Bradbourne House, Stable Block, East Malling, Kent, ME19 6DZ
Location of project:	New Farm Produce, Elmhurst, Lichfield, Staffordshire, WS13 8EX
Industry Representative:	Stephen McGuffie, New Farm Produce
Date project commenced:	1 April 2012
Date project to be completed:	30 September 2014

DISCLAIMER

AHDB, operating through its HDC division seeks to ensure that the information contained within this document is accurate at the time of printing. No warranty is given in respect thereof and, to the maximum extent permitted by law the Agriculture and Horticulture Development Board accepts no liability for loss, damage or injury howsoever caused (including that caused by negligence) or suffered directly or indirectly in relation to information and opinions contained in or omitted from this document.

[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 described herein and that the report represents a true and accurate record of the results obtained.

[Name]
[Position]
[Organisation]

Signature ..... Date .....

[Name]
[Position]
[Organisation]

Signature ..... Date .....

Report authorised by:

[Name]
[Position]
[Organisation]

Signature ..... Date .....

[Name]
[Position]
[Organisation]

Signature ..... Date .....

CONTENTS

GROWER SUMMARY

Headline

- A number of strawberry varieties in this trial have the potential for successful production in the UK

Background

The variety Elsanta has been used as the standard June-bearing strawberry variety in field soil production in the UK for over 25 years. However, it has a number of limitations for growers in that it produces a significant proportion of small/medium sized and misshapen fruits, resulting in a poor grade-out of Class 1 fruit. In addition, it offers little in the way of insect pest or disease resistance, making it difficult to grow in some field soils or cropping situations.

There is a need to identify new and improved June-bearing varieties, which offer viable alternatives to Elsanta, which are not only commercially acceptable to UK growers but also to all market outlets also.

The specific aim of the project is to find a variety which in soil culture, reliably produces larger berries than Elsanta with a higher proportion of regular shaped class 1 fruit and some pest and disease resistance, thereby increasing profitability without requiring any major change to the current production system.

Varieties selected for inclusion in this trial come from the East Malling Strawberry Breeding club and other European breeding programmes. It is believed that by restricting the trial to European varieties, the candidates will be better suited to UK growing conditions and the UK marketplace. Where possible varieties have been selected that have no exclusivity to grower groups. The standard varieties Elsanta and the more recently bred Malling Centenary, were included for comparison.

Trial details and results of the 2013 60-day crop

For full results of the 60-day crop in 2013, refer to the full trial report. A brief summary of the trial and results in 2013 are included in this Grower Summary section.

Varieties included in the trial

Details of the varieties selected for inclusion in the trial along with their origin, season of production and plant types chosen for establishing the trial are included in the table below:

Variety/ Selection	**Breeder**	**Country**	**Season**	**Plant Type**
Flair	Goossens Flevoplants BV	Netherlands	Early	Tray 9cm x 7cm
Vibrant	East Malling Research	UK	Early	Tray 9cm x 7cm
EM1905	East Malling Research	UK	Early	Tray 9cm x 7cm
Capriss	CIREF	France	Early-mid	Tray 9cm x 7cm
FC15	CRA-FRF	France	Early-mid	Tray 9cm x 7cm
Malling Centenary	East Malling Research	UK	Early-mid	Medium waiting bed
CIR903	CIREF	France	Early-mid	Tray 9cm x 7cm
Elsanta	Plant Research International (PRI)	Netherlands	Mid	Tray 9cm x 7cm
EM1746	East Malling Research	UK	Mid-late	Tray 9cm x 7cm
EM1990	East Malling Research	UK	Mid-late	Tray 9cm x 7cm
EM1942	East Malling Research	UK	Mid-late	Tray 9cm x 7cm
FF1005 (Vivaldi)	Fresh Forward	Netherlands	Late	Heavy waiting bed
FF1004	Fresh Forward	Netherlands	Late	Heavy waiting bed

Trial details

New Farm Produce hosted the variety trial on their Hanch site in Staffordshire. Particular thanks are extended to Stephen McGuffie of New Farm Produce for his support with the trial. The field used for the trial had grown raspberry plants in the previous year. Raised beds were formed in autumn 2012, fumigated with Basamid and covered in black polythene. The trial was planted in the middle of a commercial crop of first year Malling Centenary and second year Elegance. The area selected was as uniform as possible in terms of aspect, slope, drainage and soil type with no edge effects. The trial was located in the centre three '2-row beds' of a five-bed tunnel. Fertigation and crop protection were managed by New

Farm Produce, receiving the same treatment as the surrounding commercial crop of Malling Centenary.

Plants were planted in March 2013 at a spacing of 40 cm between plants and 35 cm between rows (density of 24,500 plants/ha). Each plot contained 20 plants. The trial was established in a randomized block design, with three replicates per variety. The crop was covered by a Spanish tunnel at from the start of picking. Fruit started picking on 17th June and continued until 8th August.

Plant characteristics

Records of plant vigour and growth characteristics are listed in the table below.

Variety	% Establish-ment in 2013	Plant vigour 1 = low 5 = very vigorous	Runner production 1 = none 5 = prolific	Av. crown number per plant	Av. truss number per plant	Av. flower number per truss	Powdery mildew 1 = none 5 = high incidence
Flair	100	3.0	3.0	3.75	5	12	3.0
Vibrant	98.34	2.5	3.0	3.0	3	8	2.0
EM1905	98.34	4.0	3.0	3.5	2	6	1.5
Capriss	100	4.5	3.0	3.5	5	7	1.0
FC15	100	4.0	3.5	4	2	6	1.0
Malling Centenary	100	4.0	3.0	3.5	2	6.5	1.0
CIR903	96.67	4.5	5.0	5.5	5.5	12	1.0
Elsanta	96.67	3.0	1.0	3.5	3	11	2.5
EM1746	100	2.5	2.5	3.5	2	12	2.5
EM1990	100	3.0	2.5	4.5	1	7.5	3.0
EM1942	100	4.0	2.5	3.75	3	8	1.0
FF1005	100	5.0	4.0	4.25	2	11.5	2.0
FF1004	100	5.0	3.5	3.5	4	14	1.5

Yield records

Season of production, yields, grade-out and fruit size are summarized in the table below:

Variety	50% harvest date	Total yield g/plant	Class 1 Yield g/plant	Class 1 yield as a % of Elsanta	% Class 1	Class 1 Berry Size %		
						Extra large >45 mm	Large 35-45 mm	Medium 25-35 mm
FF1005 *	12/07/13	657	531	164%	80.5	4.91	34.77	60.32
FF1004 *	17/07/13	605	496	153%	82.0	18.17	49.18	32.65
CIR903	12/07/13	593	491	152%	82.8	4.82	39.04	56.40
Flair	02/07/13	394	351	109%	89.3	5.08	55.40	39.52
Vibrant	05/07/13	354	331	102%	93.7	4.05	68.35	27.60
Elsanta	09/07/13	405	323	100%	79.7	3.95	55.56	40.49
Malling Centenary*	09/07/13	306	300	93%	97.9	16.24	61.22	22.55
FC15	08/07/13	311	283	88%	91.0	27.39	48.43	24.18
EM1942	14/07/13	290	275	85%	94.8	9.18	52.42	38.40
EM1990	10/07/13	254	248	77%	97.5	16.13	60.54	23.30
Capriss	07/07/13	268	237	73%	88.0	3.26	46.14	50.60
EM1746	11/07/13	304	236	73%	78.0	0.80	49.22	49.97
EM1905	05/07/13	224	219	68%	97.5	12.57	62.76	24.67

The final results from this project will not be available until late summer 2014 when a full picture of each of the varieties' fruit yield, fruit quality, plant habit, disease susceptibility and seasonality of production will be presented. The discussion that follows is based only on the results available from year 1; the conclusions drawn may therefore differ to those in the final report.

In the project's first year, FF1004, FF1005 and CIR903 produced the highest total and class 1 yields. However, CIR903 showed a susceptibility to crown rot (*Phytophthora cactorum*) and had disappointing fruit quality including the flavour and brix levels, which will limit its use. The flavour of FF1004 was not liked as much as Elsanta. FF1005 had a dark red skin colour with a lower than average shelf life.

Over 70% of fruit produced by Vibrant, Malling Centenary, FC15, EM1990 and EM1905 was of large fruit size, whilst class 1 percentages were all over 70%. The class 1 yield produced by EM1905 was the lowest in trial at only 68% that of Elsanta, though it does have an early season which may compensate for this yield deficit. The class 1 yield of Malling Centenary was similar to Elsanta despite the use of medium waiting bed plants in trial.

Flair had a similar total yield and berry size to Elsanta though class 1 percentage was better. However, the skin firmness and shelf life was lower than Elsanta.

Malling Centenary and EM1990 were the varieties with the best overall performance in terms of fruit quality attributes including good brix levels and eating qualities.

At this mid-point in the trial, there are many varieties/selections with yield results similar to Elsanta and of these some stand out in terms of fruit quality. More information is required from the 2014 harvest before any decisions can be made as to the suitability for UK production of any of these varieties.

Seasonality will be key to determining whether some of the above varieties will succeed in UK production and have the potential to produce improved returns to the grower over the currently grown varieties.

Conclusions

In this first year of the project the following conclusions are drawn from 60-day cropping of 12 varieties in raised bed soil culture when compared to Elsanta:

- FF1004, FF1005 and CIR903 produced significantly higher fruit yields than Elsanta and the other nine varieties/selections in trial, though each had fruit quality concerns.
- Malling Centenary and EM1990 produced the best overall fruit quality, outperforming Elsanta and the other 9 varieties/selections in trial.
- CIR903 suffered from crown rot (*Phytophthora cactorum*) and had poor fruit flavour and shelf life; it is unlikely to be recommended for UK production.
- A number of varieties in trial have the potential for successful production in the UK but their seasonality and main crop performance will be the deciding factor for profitable production.
- The second year main crop results are required before any firm conclusions can be drawn.

SCIENCE SECTION

Year 1 Trial Report

Introduction

One of the most widely used strawberry production systems in the UK is two-row raised bed soil culture. There are many June-bearing varieties currently suited to this type of production system. Each year new varieties are released into the industry from breeding programmes worldwide, some of which may provide the UK grower with improved performance over existing varieties.

Strawberry variety trials allow new selections from the UK and overseas to be assessed in commercial conditions and compared to existing varieties used by UK growers. The use of uniform planting material on a site providing the typical environmental and cultural growing conditions allows true comparisons to be made and provides a good assessment of varieties' commercial potential in the UK. New varieties may offer improvements through season extension, increased productivity, harvest efficiency and/or improvements in fruit quality characteristics such as berry size, flavour and shelf life.

Elsanta has been the standard variety used in field soil production for the last 25 years as it produces fruit of a quality which is widely acceptable to most market outlets and it lends itself to manipulation for season extension. However, Elsanta has a number of limitations. It produces a high proportion of medium size berries which leads to higher picking costs. It has a tendency to produce misshapen fruit caused by sensitivity to cool temperatures at flowering and it has little resistance to any of the main strawberry pests or pathogens of note in UK production.

This project has been commissioned by the HDC soft fruit panel to assess some of the most promising new selections from the EMR Strawberry Breeding Club (which HDC part funds) along with some recently named varieties from other European breeding programmes. The data gathered will allow growers to identify varieties that best suit their growing system and ultimate market outlet, so reducing the risk a grower takes when choosing to use a new variety.

The specific aim of the project is to find a variety which in soil culture, reliably produces larger berries than Elsanta with a higher proportion of regular shaped class 1 fruit and some pest and disease resistance, thereby increasing profitability without requiring any major change to the current production system.

Varieties selected for inclusion in this trial come from the East Malling Strawberry Breeding club and other European breeding programmes. It is believed that by restricting the trial to European varieties, the candidates will be better suited to UK growing conditions and the UK marketplace. Where possible varieties have been selected that have no exclusivity to grower groups. The standard varieties Elsanta and the more recently bred Malling Centenary, were included for comparison.

Varieties and numbered selections

Table 1 lists the varieties included in the trial, their origin, season of production and plant types.

Table 1: Varieties and numbered selections included in the trial

Variety/ Selection	Breeder	Country	Season	Plant Type
Flair	Goossens Flevoplants BV	Netherlands	Early	Tray 9cm x 7cm
Vibrant	East Malling Research	UK	Early	Tray 9cm x 7cm
EM1905	East Malling Research	UK	Early	Tray 9cm x 7cm
Capriss	CIREF	France	Early-mid	Tray 9cm x 7cm
FC15	CRA-FRF	France	Early-mid	Tray 9cm x 7cm
Malling Centenary	East Malling Research	UK	Early-mid	Medium waiting bed
CIR903	CIREF	France	Early-mid	Tray 9cm x 7cm
Elsanta	Plant Research International (PRI)	Netherlands	Mid	Tray 9cm x 7cm
EM1746	East Malling Research	UK	Mid-late	Tray 9cm x 7cm
EM1990	East Malling Research	UK	Mid-late	Tray 9cm x 7cm
EM1942	East Malling Research	UK	Mid-late	Tray 9cm x 7cm
FF1005 (Vivaldi)	Fresh Forward	Netherlands	Late	Heavy waiting bed
FF1004	Fresh Forward	Netherlands	Late	Heavy waiting bed

Trial site details

New Farm Produce hosted the variety trial on their Hanch site in Staffordshire. Particular thanks are extended to Stephen McGuffie of New Farm Produce for his support with the trial.

The field used for the trial had grown raspberry plants in the previous year. Raised beds were formed in autumn 2012, fumigated with Basamid and covered in black polythene. The trial was planted in the middle of a commercial crop of first year Malling Centenary and second year Elegance. The area selected was as uniform as possible in terms of aspect, slope, drainage and soil type with no edge effects.

The trial was located in the centre three '2-row beds' of a five-bed tunnel. Fertigation and crop protection were managed by New Farm Produce, receiving the same treatment as the surrounding commercial crop of Malling Centenary.

Production details

Planting date:	Between 14th & 18th March 2013.
Protection:	The trial was covered with polythene at fruiting only.
Fertigation:	Two T tapes supplied water and feed to each bed.
Crop protection:	As for the surrounding commercial Malling Centenary crop.
Runners cut:	Twice during the season.
Leaf removal:	None.
Year 1 harvest:	25th June (week 26) to 6th August 2013 (week 32). 7 weeks in total.
Year 2 harvest:	2014
Harvest frequency:	Picked 3 times a week for the majority of harvest.
Plant assessments:	Plant vigour score (1 = poor, 5 = very vigorous). Plant habit description Runner production (score 1 = none, 5 prolific) Truss number (counted) Incidence of powdery mildew (*Podosphaera aphanis*) on leaves score (1 = none, 5 very high)

Fruit yield:	Recorded in the berry size categories: Class 1 (>45mm extra large; large 35-45mm; medium 25-35mm); Class 2 (<25mm and misshapes) at each of the harvest dates.

Fruit quality assessments were made on at least four dates during the two harvests for:

(Appendix 9.1)	External berry colour score
	(1 =light orange; 8 = dark wine red)
	Berry appearance score
	(1 = unattractive; 9 = attractive)
	Berry shape
	(score 1-9)
	Berry shape uniformity score
	(1 = irregular; 9 = uniform)
	Skin firmness score
	(1 = soft; 9 = firm)
	Shelf life score, 7 days @ 3-6 deg C
	(1 = poor; 9 = excellent)
	Flavour score
	(1 =poor; 9 = excellent)
	Brix readings on 3 berries on at least 4 dates during peak harvest.
Photographs:	Plants pre and post planting.
(Appendix 9.2)	Plants at the flowering stage.
	Year 1 plants in fruit.
	Six berries per variety at 3 dates during harvest.
	Berry sections.
	Fruit fresh picked versus post cold storage.

Tray plants of all varieties were ordered for the trial in February 2012. However, on delivery, three varieties namely Malling Centenary, FF1004 and FF1005, were available only as waiting bed plants. FF1004 and FF1005 were heavy waiting beds and Malling Centenary medium waiting beds. These three varieties were included in the trial but the 60-day year 1 fruit yields are not directly comparable to the other ten varieties in the trial.

Trial design

Trial type:	Raised bed soil production with fertigation covered by a Spanish tunnel at fruiting only.
Previous cropping:	Raspberry
Soil preparation:	Beds formed, fumigated with Basamid in autumn 2012 and covered with black polythene.
Trial design:	Randomised block using 3 replicates.
Varieties:	12 new and near-market varieties/selections as detailed in table 1.
Plant types:	9 varieties as tray plants; where tray plants were not available 3 varieties were supplied as waiting bed plants - see table 1.
Trial controls:	Elsanta tray plants.
Plot size:	20 plants per plot/replicate, 60 plants in total per variety.
Plant spacing:	40cm in-row, 35cm between row spacing.
Plants/hectare:	24,500
Statistical analysis:	Fruit yields were analysed by statistician Dr David Simpson, EMR *(see appendix 9.3 for the statistical report).*

Trial results and data collected

The trial established well in spring 2013 although there were two plants losses, one from Vibrant in replicate 1 and one from EM1905 in replicate 2. These deaths occurred soon after planting and were not easily attributed to disease. In May it was noted that the plants of CIR903 and Elsanta in replicate 3 were showing signs of stunting. The fruit formed to thumb nail size but then the plants almost ceased growth. Examination showed that the roots had not grown out of the root ball and were blackened, which suggested that they had experienced water stress during establishment. The plots were adjacent to one another within the trial. CIR903 plants also showed visual evidence of crown rot (*Phytophthora cactorum*) infection. By harvest 2013 the fruit produced from both these varieties was very small and leathery and many of the plants were suffering dieback. The data collected from replicate 3 has therefore been excluded from the yield data presented in this report.

Spring 2013 experienced temperatures below normal from planting through to mid-June. This delayed plant development. The first flowers were seen on Capriss, CIR903 and Flair during the second week of May but it was not until a month later that all varieties were flowering. The first ripe berries were present on 19th June despite the early planting date.

The weather then turned hot in July. From the first week in July, temperatures rose above 20˚C each day. The maximum temperature of 29.9˚C was reached on 22nd July. The average 24 hour temperature was above 20˚C on 8th July and remained between 18˚C and 22.7˚C for most of July. This sudden temperature increase led to quick development of the fruit, with harvest beginning on 17th June and continuing until 8th August.

Plant Characteristics

The most vigorous varieties **Capriss** and **CIR903** were from the CIREF breeding programme in France. They had leafy vigorous growth. CIR903 was dense and compact in habit with small leaves, very floriferous with 5.5 trusses per plant on average. Capriss had a more open habit with long trusses but fewer flowers per truss than CIR903.

Table 2: Plant characteristics

Variety	% Establish-ment in 2013	Plant vigour 1 = low 5 = very vigorous	Runner production 1 = none 5 = prolific	Av. crown number per plant	Av. truss number per plant	Av. flower number per truss	Powdery mildew 1 = none 5 = high incidence
Flair	100	3.0	3.0	3.75	5	12	3.0
Vibrant	98.34	2.5	3.0	3.0	3	8	2.0
EM1905	98.34	4.0	3.0	3.5	2	6	1.5
Capriss	100	4.5	3.0	3.5	5	7	1.0
FC15	100	4.0	3.5	4	2	6	1.0
Malling Centenary	100	4.0	3.0	3.5	2	6.5	1.0
CIR903	96.67	4.5	5.0	5.5	5.5	12	1.0
Elsanta	96.67	3.0	1.0	3.5	3	11	2.5
EM1746	100	2.5	2.5	3.5	2	12	2.5
EM1990	100	3.0	2.5	4.5	1	7.5	3.0
EM1942	100	4.0	2.5	3.75	3	8	1.0
FF1005	100	5.0	4.0	4.25	2	11.5	2.0
FF1004	100	5.0	3.5	3.5	4	14	1.5

The later selections **FF1004** and **FF1005** also showed vigorous plant growth. FF1004, the later of the two had a dense, leafy, compact habit whilst FF1005 had very tall upright bushy plant growth with large leaves. FF1005 produced fewer trusses than FF1004 but flower numbers per truss were high. It went on to produce a high proportion of medium to small berries.

The early season **FC15** and **EM1905** both produced two trusses per plant on average, with a low flower number per truss, which resulted in both producing a high percentage of large berries. FC15 produced large, leathery, glossy leaves with high vigour. EM1905 had an upright, open plant habit with vigorous growth and large floppy leaves. Plants had variable size within the plots.

Vibrant produced three trusses per plant on average. These were characteristically long and had eight flowers per truss. Plant habit was upright with sparse foliage growth; flowers were large, bold and held well above the foliage.

The mid to late season **EM1746** and **EM1990** had moderate vigour and truss numbers. EM1990 had only one truss per plant on average with 7.5 flowers; this resulted in a high proportion of large berries produced. Trusses were long and foliage growth was sparse. Mildew was seen on the leaves whilst the plants were fruiting. EM1746 had large leathery glossy leaves, some showing distorted scorched edges, and plant habit was compact.

EM1942 had dark green, matt leaves with vigorous, dense, leafy plant growth.

Malling Centenary had vigorous, upright, tall plant growth with large glossy leaves. On average two trusses were recorded per plant. It should be noted that the plants used were medium waiting beds, therefore not as large as the other varieties in trial.

Flair produced plants with moderate vigour and an open habit. Leaves had long thin petioles and were soft, drooping and curled. On average five trusses were produced per plant, which were complicated in nature with an average 12 flowers per truss. Mildew was seen on the plants at fruiting.

Disease

Powdery mildew (*Podosphaera aphanis*) was observed on the foliage of EM1990 and Flair at fruiting, to a greater degree than on the Elsanta plants. Of the other varieties in trial, some mildew was noted on the foliage at the end of harvest but it was not observed on the harvested fruit.

CIR903 suffered badly from crown rot (*Phytophthora cactorum*) particularly in replicate 3, which may have been exacerbated by water stress. No other disease problems were noted in trial.

2013 Yield Results (Year 1)

The first year's harvest commenced 17th June, 2013. Temperatures during the eight weeks of pick were high. Harvest continued until 8th August. The fruit was picked three times a week. At each pick, class 1 fruit (>25mm) was weighed into three size categories: medium 25-35mm, large 35-45mm and extra large >45mm and the class 2 fruit consisting mainly of small (<25mm) and misshapen fruit was also recorded.

Table 3 shows the year 1 yield data gathered. All plants except FF1004, FF1005 and Malling Centenary were planted as tray plants. FF1004 and FF1005 were planted as heavy waiting bed plants and Malling Centenary as medium waiting bed. Though the use of heavy waiting bed plants did not appear to cause any yield reduction, the use of medium waiting bed plants may have reduced the yield of Malling Centenary compared to the other varieties in the trial.

Of the three replicates in the trial, replicate 3 produced the least consistent data. Plants of CIR903 and Elsanta suffered from poor stunted growth in replicate 3 and produced significantly lower fruit yields than replicates 1 and 2. The plots of Malling Centenary and Vibrant, which were either side of the CIR903 and Elsanta plots, also suffered lower yields. Therefore replicate 3 yield data for these varieties has not been included in Table 3.

The Elsanta tray plant control produced an average total yield of 405g per plant and class 1 yield of 323g per plant with a class 1 percentage of 79.7%. 59.5% of the class 1 fruit was >35mm.

Table 3: 2013 Year 1 Fruit Yield data (listed by Class 1 yield)

** FF1004 and FF1005 were planted as heavy waiting bed plants. Malling Centenary was a medium waiting bed plant. All other varieties in the trial were tray plants.*

Variety	50% harvest date	Total yield g/plant	Class 1 Yield g/plant	Class 1 yield as a % of Elsanta	% Class 1	Class 1 Berry Size %		
						Extra large >45 mm	Large 35-45 mm	Medium 25-35 mm
FF1005 *	12/07/13	657	531	164%	80.5	4.91	34.77	60.32
FF1004 *	17/07/13	605	496	153%	82.0	18.17	49.18	32.65
CIR903	12/07/13	593	491	152%	82.8	4.82	39.04	56.40
Flair	02/07/13	394	351	109%	89.3	5.08	55.40	39.52
Vibrant	05/07/13	354	331	102%	93.7	4.05	68.35	27.60
Elsanta	09/07/13	405	323	100%	79.7	3.95	55.56	40.49
Malling Centenary*	09/07/13	306	300	93%	97.9	16.24	61.22	22.55
FC15	08/07/13	311	283	88%	91.0	27.39	48.43	24.18
EM1942	14/07/13	290	275	85%	94.8	9.18	52.42	38.40
EM1990	10/07/13	254	248	77%	97.5	16.13	60.54	23.30
Capriss	07/07/13	268	237	73%	88.0	3.26	46.14	50.60
EM1746	11/07/13	304	236	73%	78.0	0.80	49.22	49.97
EM1905	05/07/13	224	219	68%	97.5	12.57	62.76	24.67

Figure 1: Year 1 Fruit Yield

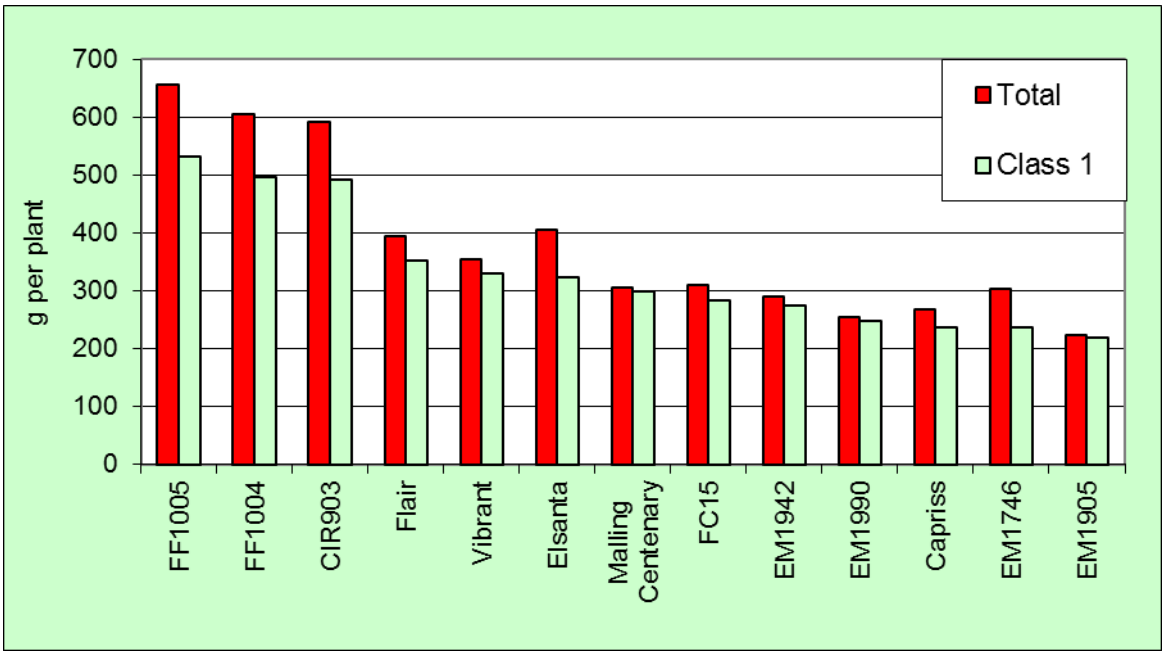
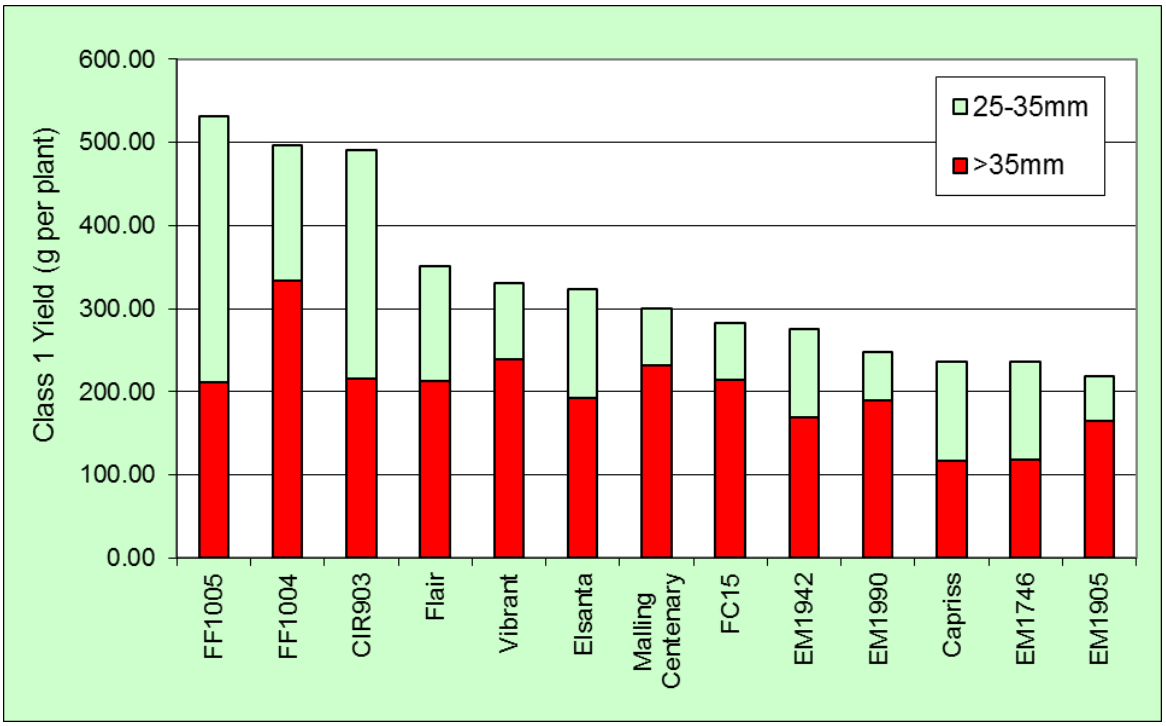
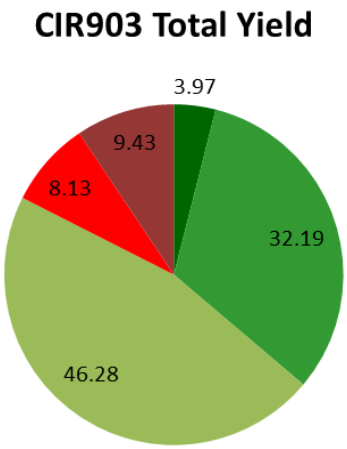


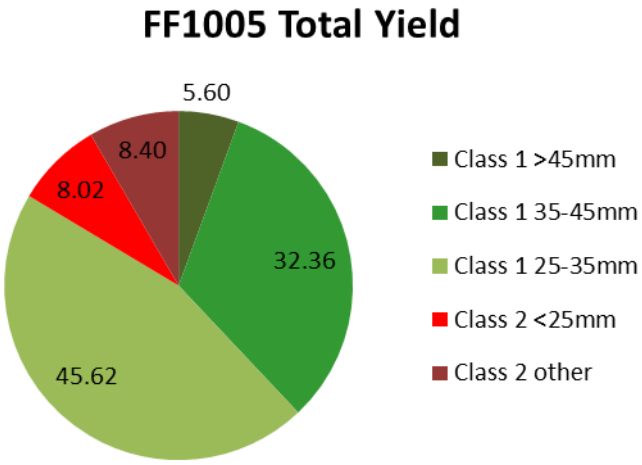
Figure 2: Year 1 Class 1 Berry Size



FF1005, FF1004 and CIR903 produced significantly higher total and class 1 yields than Elsanta and all other varieties. FF1005 achieved the highest average class 1 yield, 64% higher than that of Elsanta. The class 1 percentage was 80.5% though the majority of class 1 fruit produced fell into the medium berry size category (25-35mm diameter). At 60% this was the variety with the highest proportion of medium size fruit. Class 2 fruit was equally split between small fruit below 25mm and misshapen fruit.

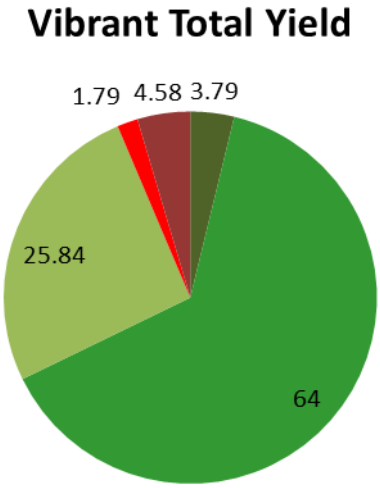
CIR903 also had a large proportion of medium size fruit in the class 1 category (56%).

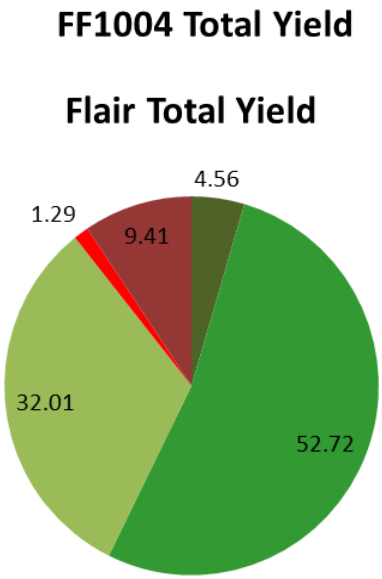




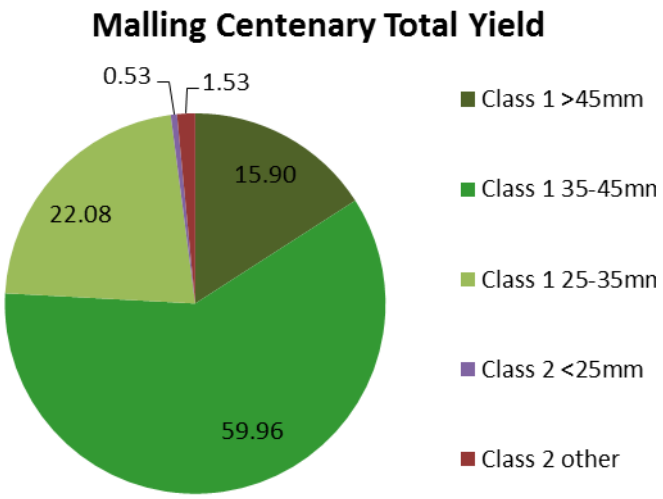
67% of FF1004 fruit was >35mm and of this 18% was extremely large in size. The class 2 consisted of misshapen mainly large fruit.

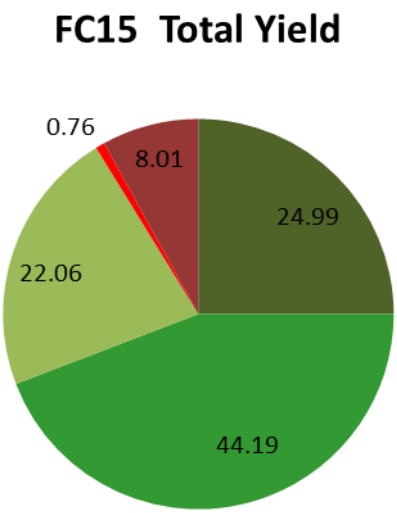
The class 1 yields produced by Flair, Vibrant, Malling Centenary, FC15 and EM1942 were not significantly different to Elsanta, although over 70% of Vibrant, Malling Centenary and FC15 fruit was >35mm in size and 27% of FC15's fruit was greater than 45mm.



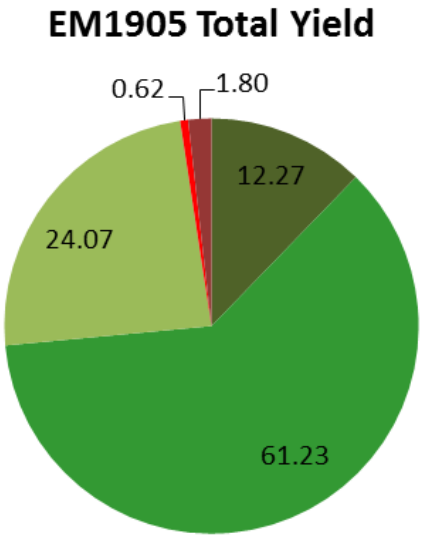


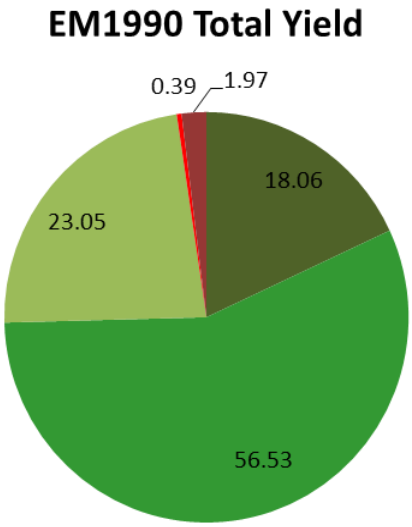
Vibrant, Malling Centenary, FC15 and EM1942 had class 1 percentages over 90%.





EM1990, Capriss, EM1746 and EM1905 produced significantly lower class 1 fruit yields than Elsanta. Of these both EM1990 and EM1905 produced over 70% large fruit (>35mm) of which 16% was >45mm for EM1990 and 12% of EM1905.





Fruit Quality

Fruit quality including Brix readings were assessed on at least four dates during harvest. Shelf-life was assessed on two dates after seven days in cold store. Photographs were taken of the fruit on the plant, in the punnet, sliced and post cold storage. The mean variety scores for each assessment are given in Table 3; these include the results recorded at the trial open day in mid-July.

Of all the varieties in the trial, Malling Centenary and EM1990 had consistently high scores for all quality attributes measured. Capriss and CIR903 had the lowest scores overall.

The average brix reading for Elsanta was 8.9; its flavour was consistently sweet through the harvest period. EM1746, EM1990, Capriss, EM1942, Malling Centenary and Flair all produced average Brix readings above that of Elsanta whilst Vibrant, CIR903 and FF1005 had readings below 8.0.

The flavour score for Elsanta was 7.5. Only Malling Centenary and EM1990 had average flavour scores higher than Elsanta. CIR903 was acidic at most picks and had the lowest flavour score of 4.0, whilst FC15 and FF1004 scored below 6.0.

Table 3: Fruit Quality

Variety	External berry colour 1 = light orange 8 = dark wine-red	Uniformity of berry shape 1 = irregular 9 = uniform	Skin firmness 1 = soft 9 = firm	Berry appearance 1 = poor 9 = excellent	Fruit flavour 1 = poor 9= excellent	Shelf life 1 = poor 9 = excellent	Mean Brix (sugar content)
Flair	7.6	7.8	6.6	5.5	7.0	4.0	9.3
Vibrant	7.9	8.0	7.0	7.5	7.0	7.5	7.5
EM1905	8.0	8.5	6.8	7.5	7.0	7.0	8.9
Capriss	5.3	4.0	6.2	5.5	6.8	4.0	9.7
FC15	5.0	7.8	7.4	7.0	4.8	5.0	8.3
Malling Centenary	6.0	8.5	8.0	8.5	8.0	7.8	9.3
CIR903	6.5	7.0	6.5	4.5	4.0	4.0	7.3
Elsanta	7.0	6.5	7.0	6.0	7.5	6.5	8.9
EM1746	5.8	7.0	7.5	8.5	6.5	7.0	10.0
EM1990	6.8	8.5	7.7	8.5	7.9	7.0	10.1
EM1942	6.0	8.0	7.2	7.5	6.0	5.5	9.4
FF1005	8.6	6.8	7.0	7.0	6.0	4.0	7.8
FF1004	7.3	7.0	6.5	5.0	5.5	7.0	8.5

Flair, Capriss, CIR903 and FF1004 scored the lowest for shelf life. FC15 and EM1942 also scored below Elsanta. Bruising and darkening of colour were the main reasons for the low scores. The weather was hot during most of the harvest period which led to quick deterioration in fruit quality and therefore lower scores than expected for many varieties.

FF1005 had the darkest skin colour of all the varieties in the trial. EM1905, Vibrant and Flair were also darker than Elsanta.

Only Capriss had a more irregular berry shape than Elsanta.

Discussion

The final results from this project will not be available until late summer 2014 when a full picture of each of the varieties' fruit yield, fruit quality, plant habit, disease susceptibility and seasonality of production will be presented. The discussion that follows is based only on the results available from year 1; the conclusions drawn may therefore differ to those in the final report.

In the project's first year, FF1004, FF1005 and CIR903 produced the highest total and class 1 yields. However, CIR903 showed a susceptibility to crown rot (*Phytophthora cactorum*) and had disappointing fruit quality including the flavour and brix levels, which will limit its use. The flavour of FF1004 was not liked as much as Elsanta. FF1005 had a dark red skin colour with a lower than average shelf life.

Over 70% of fruit produced by Vibrant, Malling Centenary, FC15, EM1990 and EM1905 was of large fruit size, whilst class 1 percentages were all over 70%. The class 1 yield produced by EM1905 was the lowest in trial at only 68% that of Elsanta, though it does have an early season which may compensate for this yield deficit. The class 1 yield of Malling Centenary was similar to Elsanta despite the use of medium waiting bed plants in trial.

Flair had a similar total yield and berry size to Elsanta though class 1 percentage was better. However, the skin firmness and shelf life was lower than Elsanta.

Malling Centenary and EM1990 were the varieties with the best overall performance in terms of fruit quality attributes including good brix levels and eating qualities.

At this mid-point in the trial, there are many varieties/selections with yield results similar to Elsanta and of these some stand out in terms of fruit quality. More information is required from the 2014 harvest before any decisions can be made as to the suitability for UK production of any of these varieties.

Seasonality will be key to determining whether some of the above varieties will succeed in UK production and have the potential to produce improved returns to the grower over the currently grown varieties.

Conclusions

In this first year of the project the following conclusions are drawn from 60-day cropping of 12 varieties in raised bed soil culture when compared to Elsanta:

.

- FF1004, FF1005 and CIR903 produced significantly higher fruit yields than Elsanta and the other nine varieties/selections in trial, though each had fruit quality concerns.

- Malling Centenary and EM1990 produced the best overall fruit quality, outperforming Elsanta and the other 9 varieties/selections in trial.

- CIR903 suffered from crown rot (*Phytophthora cactorum*) and had poor fruit flavour and shelf life; it is unlikely to be recommended for UK production.

- A number of varieties in trial have the potential for successful production in the UK but their seasonality and main crop performance will be the deciding factor for profitable production.

- The second year main crop results are required before any firm conclusions can be drawn.

Appendices

Assessments

Plant number
Count plants at planting, pre-harvest, post harvest

Plant vigour
1 = very poor vigour/plant growth
5 = very vigorous plant growth

Disease susceptibility (specify disease)
1 = very high susceptibility/plant death
5 = no visual symptoms of disease

Plant habit
Description

Fruit display
Description

Number of trusses per plant
Assess 3 or 4 plants per plot, calculate mean

Number of flowers per truss
Assess 3 or 4 plants per plot, calculate mean

Fruit yield
Net weight in grams per plot of fruit harvested at each harvest date:
Divide fruit into Class 1 (>25mm no misshapes)
Class 2 fruit (<25mm plus misshapen fruit)
Class 1 may be further divided into medium size 25-35mm; large 35-45mm; extra large >45mm.
Waste (any damaged fruit)

Berry weight
Weigh 3 berries from each size category, 4 times during the season.

Berry appearance
Visual assessment of fruit in punnet to include colour, shape, size, skin, gloss, seeds, calyx.
1 = very unattractive
9 = very attractive

Berry colour

1 = White	4 = Brick red	7 = Cardinal red
2 = Light orange	5 = Bright red	8 = Wine red
3 = Darker orange	6 = Blood red	9 = Dark wine red

Berry shape

1 = Oblate	4 = Ovoid	7 = Necked
2 = Globose	5 = Cordiform	8 = Long wedge
3 = Globose conic	6 = Long conic	9 = Short wedge

Berry shape uniformity

1 = very irregular
9 = very uniform/regular

Berry firmness

Rub berry skin between index finger and thumb with slight pressure, count number of rubs required to break skin.
1 = very soft/sensitive
9 = very firm

Fruit flavour

1 = Unpleasant	4 = bland	7 = very sweet
2 = very acidic	5 = acceptable	8 = mildly aromatic
3 = mildly acidic	6 = pleasant/sweet	9 = very aromatic

Brix

Cut berry in half; squeeze juice from one half onto refractometer. Close cover, read scale. Wipe clean after each reading.
At least 3 berries per plot sampled from 4 harvest dates.

Shelf life

7 days at 3-6C or state method used
1 = Very poor
9 = Very good/no deterioration

Photographs

Year 1 60-day plants at fruiting (Replicate 1)

Flair

Vibrant

EM1905

Capriss

FC15

EM

Malling Centenary

CIR903

EM1942

FF1005

FF1004

Display of six berries

Vibrant

Flair

EM1905

Capriss

FC15

Malling Centenary

FF1004

EM1746

EM1990

CIR903

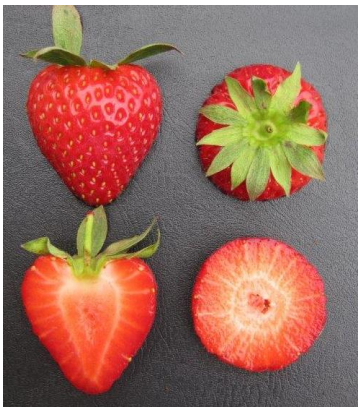
EM1942

FF1005

Berry sections

Flair

Vibrant

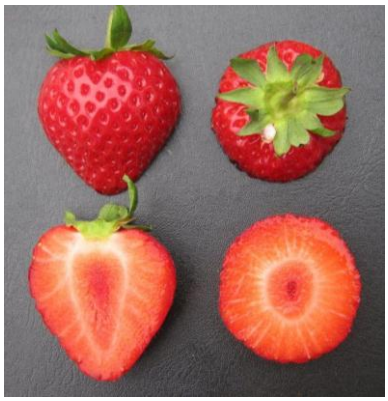


EM1905

Capriss

FC15

Malling Centenary

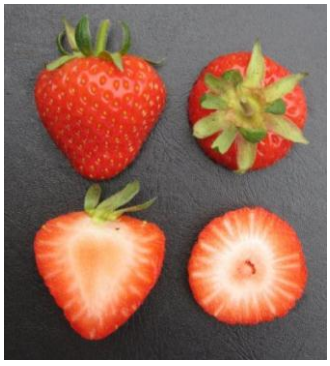


EM1746

EM1990

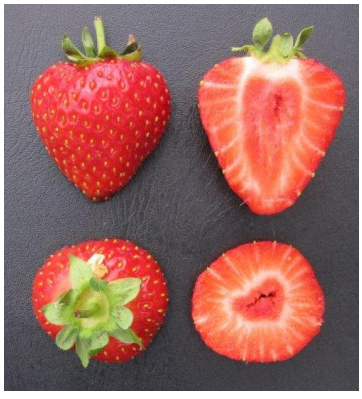
CIR903

EM1942



FF1005

FF1004



Overhead view of Year 1 plots on 29th July 2013 (Replicate 1)

Flair

Vibrant

EM1990

Capriss

FC15

Malling Centenary

EM1746

EM1990

CIR903

EM1942

FF1004

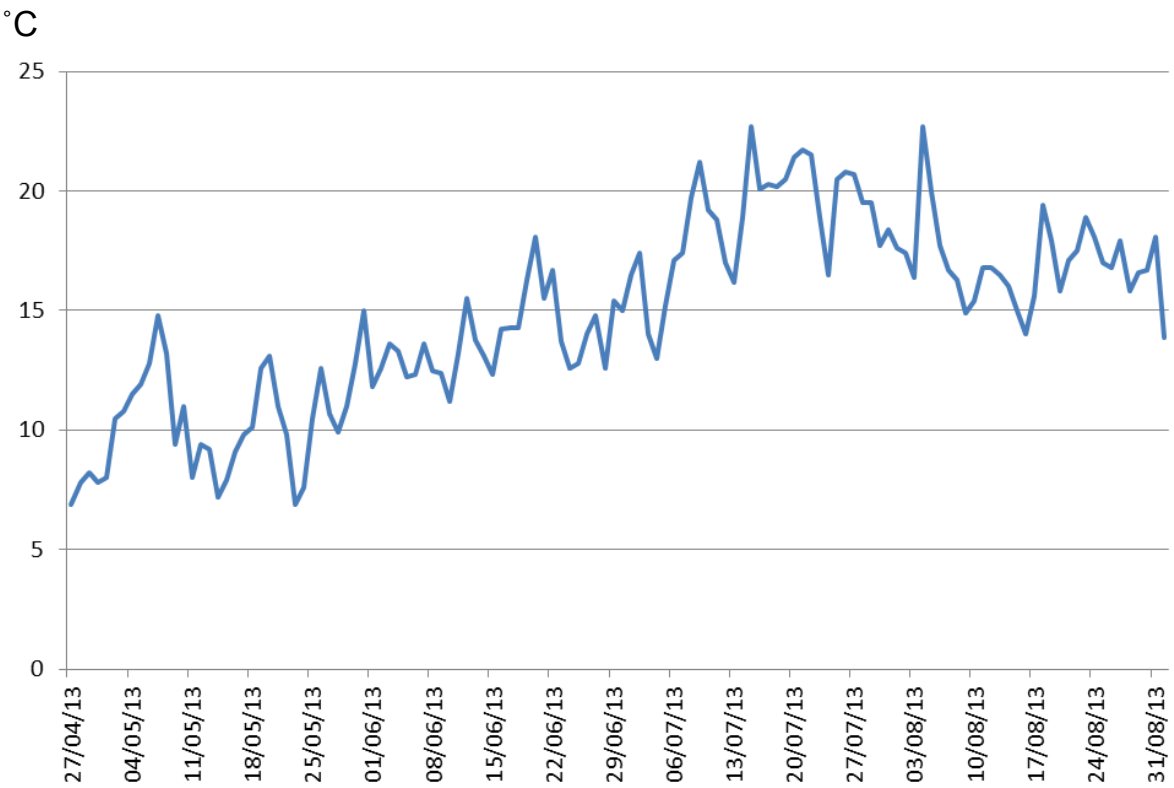
FF1005

Control variety Elsanta

Year 1 Photographs of the Control variety Elsanta:

Average 24 hour temperature

The average 24 hour temperature was calculated from data collected at New Farm between May 2013 and September 2013.



Year 1 Statistical Summary

The following pages detail the statistical analysis and interpretation of the Year 1 fruit yield results. The categories analysed are Total Yield, Class 1, Percentage class 1 and Percentage large fruit (>35mm).

Block.*Units* stratum					
Variety	12	809639.	67470.	36.63	<.001
Residual	24	44206.	1842.		
Total	38	863356.			

Tables of means

Variate: **TOTAL YIELD**

Grand mean 367.5

Variety	**Capriss**	**Centenary**	**CIR903**	Elsanta	**EM1746**	**EM1905**	**EM1942**
	263.8	**285.1**	**591.0**	402.2	**258.0**	**215.7**	**284.8**

Variety	**EM1990**	**FC15**	**FF1004**	**FF1005**	Flair	Vibrant
	237.9	**310.5**	**600.9**	**655.2**	333.0	339.2

CIR903, FF1004 and FF1005 had significantly higher total yield than Elsanta and all other varieties in the trial
The total yield of Flair and Vibrant was not significantly different from Elsanta
The other seven varieties all had significantly lower total yield than Elsanta

Standard errors of differences of means

Table	Variety
rep.	3
d.f.	24
s.e.d.	35.04

Least significant differences of means (5% level)

Table	Variety
rep.	3
d.f.	24
l.s.d.	72.32

Analysis of variance

Variate: **CLASS 1 YIELD**

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	9072.	4536.	2.50	
Block.*Units* stratum					
Variety	12	451229.	37602.	20.74	<.001
Residual	24	43512.	1813.		
Total	38	503813.			

Tables of means

Variate: **CLASS 1 YIELD**

Grand mean 320.1

Variety	**Capriss**	Centenary	**CIR903**	Elsanta	**EM1746**	**EM1905**	EM1942
	233.1	277.9	**489.2**	321.1	**197.0**	**210.7**	271.2

Variety	**EM1990**	FC15	**FF1004**	**FF1005**	Flair	Vibrant
	231.9	283.2	**492.0**	**529.8**	303.4	320.2

CIR903, FF1004 and FF1005 had significantly higher Class 1 yield than Elsanta and all other varieties in the trial
Capriss, EM1746, EM1905 and EM1990 had significantly lower Class 1 yield than Elsanta
The other five varieties were not significantly different from Elsanta

Standard errors of differences of means

Table	Variety
rep.	3
d.f.	24
s.e.d.	34.77

Least significant differences of means (5% level)

Table	Variety
rep.	3
d.f.	24
l.s.d.	71.75

Analysis of variance

Variate: **PERCENTAGE CLASS 1**

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	11.257	5.628	1.06	
Block.*Units* stratum					
Variety	12	2163.740	180.312	33.99	<.001
Residual	24	127.303	5.304		
Total	38	2302.300			

Tables of means

Variate: **% CLASS 1**

Grand mean 88.80

Variety	**Capriss**	**Centenary**	CIR903	Elsanta	EM1746	**EM1905**	**EM1942**
	87.97	**97.43**	82.87	79.90	76.00	**97.67**	**96.20**

Variety	**EM1990**	**FC15**	FF1004	FF1005	**Flair**	**Vibrant**
	97.40	**91.00**	81.83	80.50	**91.10**	**94.53**

Capriss, Centenary, EM1905, EM1942, EM1990, FC15, Flair and Vibrant all had a significantly higher percentage of Class 1 fruit than Elsanta
The other four varieties were not significantly different from Elsanta

Standard errors of differences of means

Table	Variety
rep.	3
d.f.	24
s.e.d.	1.880

Least significant differences of means (5% level)

Table	Variety
rep.	3
d.f.	24
l.s.d.	3.881

Analysis of variance

Variate: **PERCENTAGE LARGE BERRIES >35MM**

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	291.15	145.57	1.68	
Block.*Units* stratum					
Variety	12	6925.21	577.10	6.67	<.001
Residual	24	2077.68	86.57		
Total	38	9294.04			

Tables of means

Variate: **% LARGE > 35mm**

Grand mean 60.17

Variety	Capriss	Centenary	**CIR903**	Elsanta	**EM1746**	**EM1905**	EM1942
	48.57	73.79	**43.46**	58.94	**40.43**	**74.58**	60.88

Variety	**EM1990**	**FC15**	FF1004	**FF1005**	Flair	Vibrant
	77.41	**75.30**	67.25	**38.25**	56.79	66.61

EM1905, EM1990 and FC15 had a significantly higher percentage of large berries (>35mm) than Elsanta
CIR903, EM1746 and FF1005 had a significantly lower percentage of large berries (>35mm) than Elsanta
The other six varieties were not significantly different from Elsanta

Standard errors of differences of means

Table	Variety
rep.	3
d.f.	24
s.e.d.	7.597

Least significant differences of means (5% level)

Table	Variety
rep.	3
d.f.	24
l.s.d.	15.679