

Project title: To assess the performance of new June-bearing strawberry varieties and advanced selections in a commercial UK substrate production system over two harvest periods.

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Project leader: Sarah Troop, Meiosis Ltd

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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

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GROWER SUMMARY

Headline

Malling Centenary gave the best all round performance in this substrate grown variety trial, producing fruit with excellent quality, large berry size and good class 1 yields.

Background

Protected table top substrate systems are an increasingly important part of the strawberry fruit production industry. For the industry to make the best use of substrate production, growing the varieties suited to this production system is a key ingredient for success.

Elsanta has been the most widely grown June-bearing variety in substrate production for some time but it has limitations. These include the production of a high proportion of medium size berries, a characteristic that leads to higher picking costs. It also has a tendency to produce misshapen fruit due to its sensitivity to cool temperatures at flowering. As production costs continue to increase, for example, through the introduction of the minimum wage, growers are looking for alternative varieties that reliably produce large berries with a high proportion of class 1 fruit. This would enable picking costs to be significantly reduced without requiring any major change to current production systems.

Around the world, there are many breeding programmes investing heavily in the development and marketing of new varieties and each year several new ones are released into the marketplace. If growers are to use these in their current substrate production systems, they must first screen their performance on one site under the same growing conditions to compare their productivity and fruit quality against the market standard. Growers particularly look for varieties which provide season extension, increased productivity, improved harvest efficiency and/or fruit quality characteristics such as berry size, flavour and shelf life.

This project (SF 128a) was set up to assess the performance of a number of new named June-bearing varieties and numbered selections in a commercially grown substrate produced strawberry crop, comparing them to the industry standard Elsanta.

Results summary

The following is a summary of information provided in the SF 128a Full Trial Report.

Table 1. Varieties and numbered selections included in the trial and planting material used

Variety/ Selection	Breeder	Country of origin	Season	Plant Type
EM1552 Malling Sunrise	East Malling Research	UK	Early	Tray 9cm x 7cm
Magnum (exclusive to Total Berry growers)	Marionnet SARL	France	Early	Tray 9cm x 7cm
Fleurette	Goossens Flevoplants	Netherlands	Early	Tray 9cm x 7cm
Garda	CRA - FRF	Italy	Early-mid	A+ plants
Malling Centenary	East Malling Research	UK	Early-mid	Tray 9cm x 7cm
EM1677 Malling Glow	East Malling Research	UK	Mid	Tray 9cm x 7cm
Elsanta	Plant Research International (PRI)	Netherlands	Mid	Tray 9cm x 7cm
EM1996	East Malling Research	UK	Mid-late	Tray 9cm x 7cm
EM1998	East Malling Research	UK	Mid-late	Tray 9cm x 7cm
EM2044	East Malling Research	UK	Mid-late	Tray 9cm x 7cm
EM2056	East Malling Research	UK	Mid-late	Tray 9cm x 7cm
Vivaldi	Fresh Forward	Netherlands	Mid-late	Tray 9cm x 7cm
Jive	Fresh Forward	Netherlands	Late	Tray 9cm x 7cm

- The thirteen June-bearing strawberry varieties/selections listed in Table 1 were planted in table-top coir substrate production in a permanently skinned enclosed polytunnel with vents and removable doors for ventilation. The trial site was at New Farm Produce in Elmhurst, Staffordshire, kindly hosted by Stephen McGuffie.
- The trial was located in the centre rows of the polytunnel, with guard plants protecting the trial on all sides. Fertigation and agrochemical inputs were managed in the same way as a commercial crop of Sonata. Tray plants were used to establish the trial, with the exception of Garda, for which only A+ plants were available. The plant quality of EM1552, EM1677, EM1996, EM1998, EM2044, EM2056 and Malling Centenary was not as good as the other varieties in trial. This adversely affected the year 1 60-day yield results of these seven selections.
- The first year harvest commenced on 30th April, 2014 and harvest continued until 30th June. The second year harvest commenced on 18th May, 2015 and continued until 13th July.

Summaries of the project results are laid out in Tables 2-4 and Figures 1-3 below.

Table 2. 2014 Year 1 60-day Fruit Yield data (listed by Class 1 yield)

Variety	50% pick date	Total yield g/plant	Class 1 yield g/plant	% Class 1	BERRY SIZE %		
					Extra-large >45mm	Large 35-45mm	Medium 25-35mm
Jive	06/05/14	603.2	567.8	94.1	8	56	36
Vivaldi	30/05/14	577.7	542.8	94.0	1	37	62
Fleurette	21/05/14	340.8	332.4	97.5	2	57	41
Elsanta	20/05/14	374.0	326.9	87.4	6	45	49
Magnum	20/05/14	330.9	314.0	95.0	4	48	48
Malling Centenary*	21/05/14	290.5	286.7	98.7	2	51	47
EM1677*	19/05/14	205.0	198.9	97.0	5	54	41
Garda**	18/05/14	203.1	177.3	87.3	1	33	66
EM1552*	14/05/14	165.9	158.7	95.7	2	40	58
EM2044*	20/05/14	156.6	153.4	98.0	4	62	34
EM1996*	22/05/14	153.3	137.3	89.6	0	60	40
EM2056*	15/05/14	131.0	128.8	98.3	24	56	20
EM1998*	19/05/14	102.5	98.3	96.3	1	57	43

* small tray plants compared to the other varieties in trial

** A+ plants

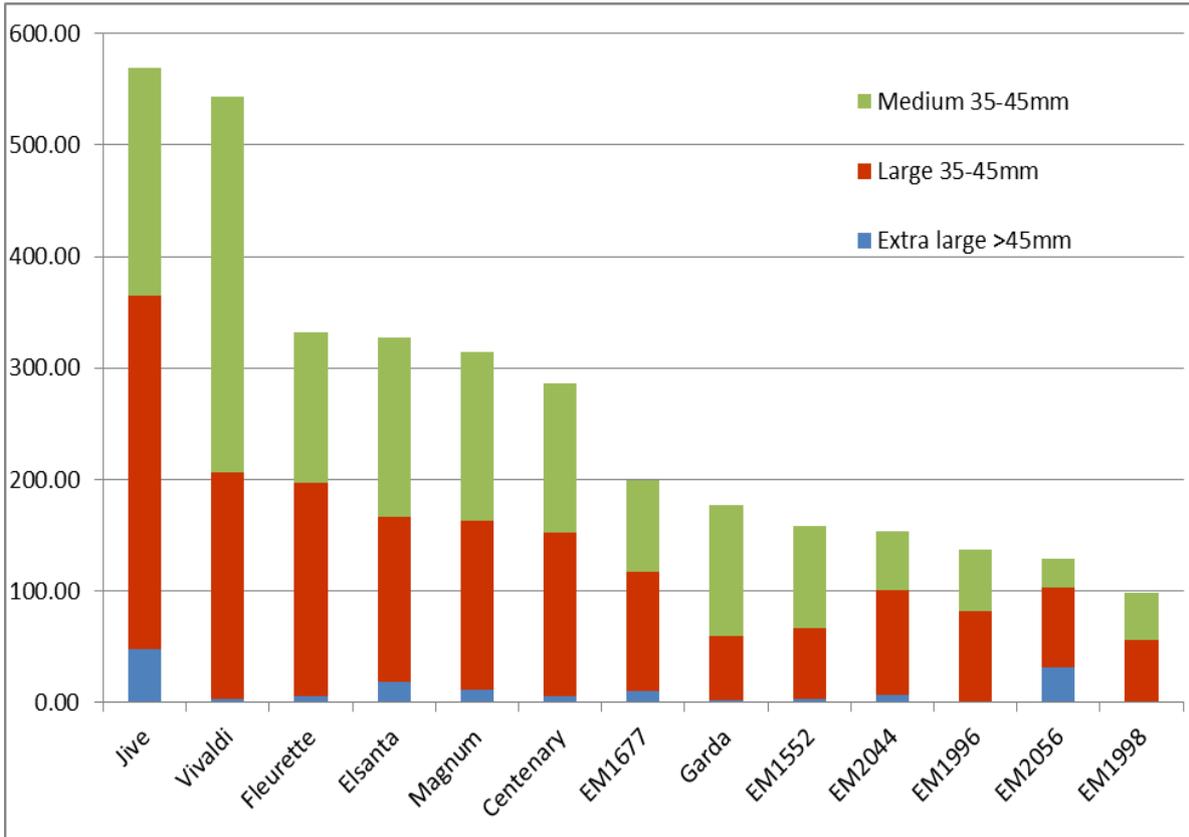


Figure 1. Year 1 60-day Class 1 Berry Size (g per plant)

Table 3. 2015 Year 2 Main Crop Fruit Yield data (*listed by Class 1 yield*)

Variety	50% pick date cv Elsanta	Yield g per plant		% Class 1	Class 1 Berry size %		
		Total	Class 1		Extra large >45mm	Large 45- 35mm	Medium 35- 25mm
EM1552	-12 days	712.9	575.4	80.7	0.4	24.3	75.3
EM1677	+1 day	799.0	555.0	69.5	0.0	15.2	84.8
Malling Centenary	-5 days	567.3	530.6	93.6	0.7	35.6	63.7
Vivaldi	+3 days	659.6	529.6	80.5	0.4	15.7	84.0
Fleurette	-5 days	592.8	519.6	87.8	1.1	24.4	74.5
EM2044	+4 days	670.9	510.9	76.3	1.1	18.9	80.0
EM1996	+5 days	621.1	466.5	75.5	0.3	18.7	81.0
Jive	+5 days	595.3	456.7	76.7	1.9	43.7	54.4
Elsanta	16/06/15	682.7	451.3	66.6	0.1	14.4	85.5
EM1998	+2 days	586.9	439.9	74.9	0.2	22.2	77.5
EM2056	+6 days	528.7	419.7	79.4	0.6	30.0	69.4
Magnum	- 5 days	528.8	399.9	75.9	0.3	20.0	79.8
Garda	-8 days	386.8	267.1	68.7	0.9	23.0	76.1

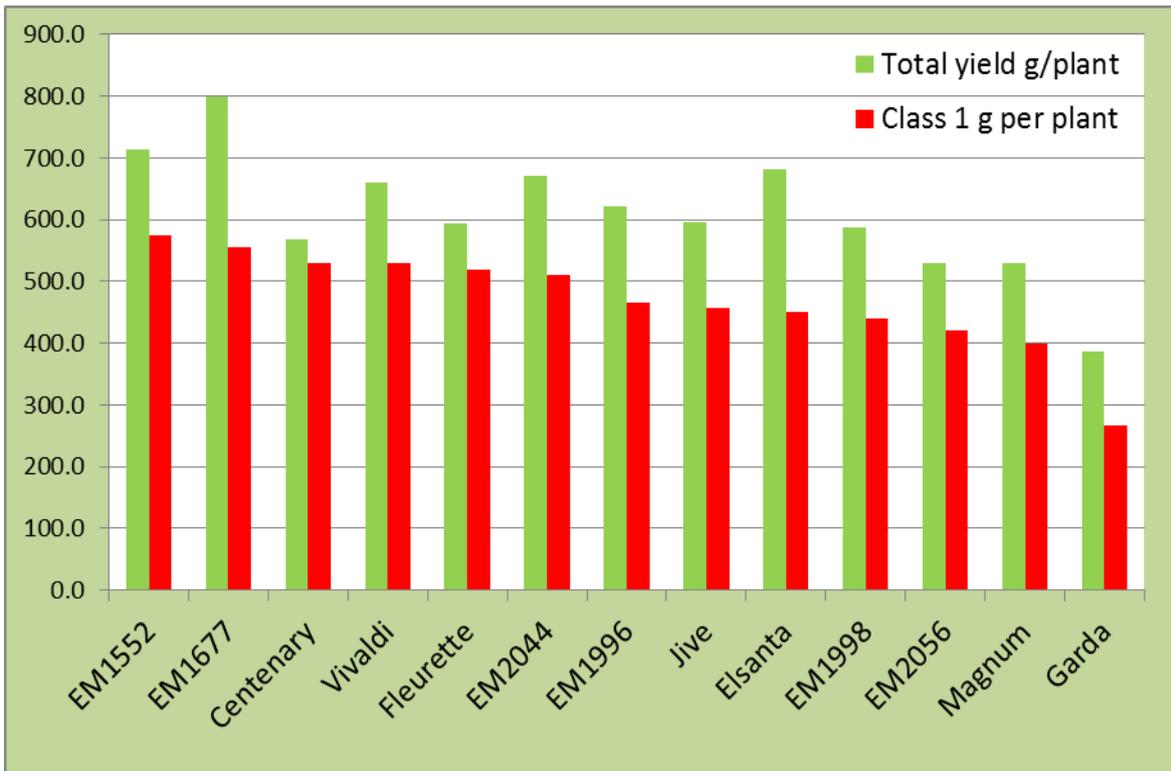


Figure 2. 2015 Year 2 Main Crop Fruit Yield (g per plant)

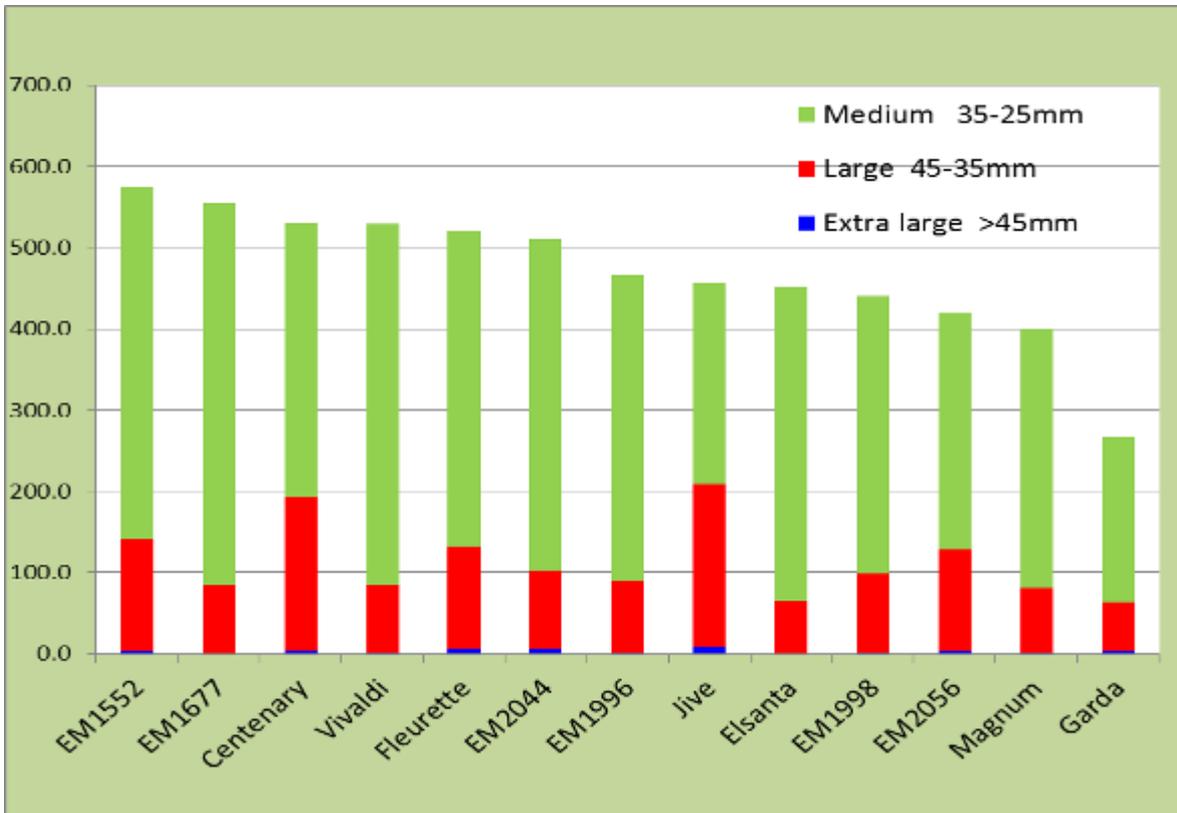


Figure 3. Year 2 Class 1 Berry Size (g per plant)

Table 4. Fruit Quality

Variety	External berry colour	Uniformity of berry shape	Firmness	Berry appearance	Fruit flavour	Shelf life	Mean Brix
	<i>1 = light orange 8 = dark wine-red</i>	<i>1 = irregular 9 = uniform</i>	<i>1 = soft 9 = firm</i>	<i>1 = poor 9 = excellent</i>	<i>1 = poor 9 = excellent</i>	<i>1 = poor 9 = excellent</i>	<i>(sugar content)</i>
EM1552	7.0	7.5	6.0	7.0	6.2	6.5	8.9
Magnum	7.5	6.5	8.0	6.5	7.4	8.0	9.3
Fleurette	5.0	7.0	7.0	7.5	6.8	7.5	7.8
Garda	7.5	7.5	8.0	7.0	6.8	6.0	9.1
Malling Centenary	6.0	8.5	8.0	9.0	8.2	7.8	8.4
EM1677	7.0	8.0	8.0	8.0	6.2	7.8	7.4
Elsanta	6.5	6.5	7.0	6.5	6.5	6.5	7.3
EM1996	6.0	7.5	7.5	7.5	7.3	7.5	9.6
EM1998	6.0	7.5	7.0	7.5	8.0	7.0	9.0
EM2044	6.0	7.5	7.5	7.5	6.5	7.8	8.2
EM2056	6.5	7.0	7.0	7.0	5.5	7.0	7.0
Vivaldi	8.0	6.5	8.0	8.0	4.3	6.0	7.0
Jive	6.0	7.0	6.5	7.0	2.0	6.5	6.6

Early season varieties: The earliest variety in trial was EM1552 (Malling Sunrise) cropping 12 days ahead of Elsanta and producing most of its yield in a two week period, an advantageous trait for an early variety. The 60-day fruit yield was low (partly due to poor plant quality), berries were only moderate in size but class 1 percentage was high. The main crop total and class 1 yields were significantly higher than Elsanta. The class 1 yield was the highest in trial. The average berry size was also better than Elsanta. The fruit had good brix levels with good colour, though it was not as firm as Elsanta, and some berries suffered from splitting under the calyx. EM1552 is a variety with low tolerance to *Verticillium*

wilt and suffered a few plant losses in trial from suspected *Phytophthora cactorum*, so it is recommended for substrate or clean soil production systems.

Garda reached its 50% pick date 8 days ahead of Elsanta whilst Malling Centenary, Magnum and Fleurette were 5 days in advance. Of these four varieties **Malling Centenary** gave the best performance with the highest total and class 1 yields in the main crop year, significantly higher than Elsanta, and a similar class 1 yield to Elsanta in the 60-day cropping season. Berry size was very good as was fruit quality. The **Garda** plants suffered badly in trial, as establishment in year one was poor and in year two a reaction to one of the crop protection sprays caused further plant stress. Fruit yield in both years was low and in shelf-life tests, the berries darkened and showed symptoms of bruising, but flavour was sweet and brix levels good.

Magnum and **Fleurette** gave similar class 1 60-day yields to Elsanta. In the main crop year, Magnum had a very disappointing yield with moderate fruit size whilst Fleurette yielded similar to Malling Centenary. Magnum was noted for its reliably sweet flavour and good brix levels and Fleurette for its light skin colour, though it did show bruising quite readily.

Midseason varieties: EM1677 (Malling Glow) and EM1998 reached the 50% pick date at a similar time to Elsanta. **EM1677 (Malling Glow)** was the best performing of the three varieties, giving the highest total yield in the main crop trial and second highest class 1 yield. Its 60-day yields are usually similar to Elsanta, however poor plant quality resulted in reduced yield in 2014. Like its parent Elegance, the berries are very attractive, with good firmness and shelf life and it has a pleasantly sweet flavour. **EM1998** gave a very low 60-day yield followed by a similar class 1 yield to Elsanta in the main crop year. The berries were moderate to small in size and sensitive to bruising.

Mid-late season varieties: Vivaldi was three days later than Elsanta, EM2044 four days later, EM1996 and Jive 5 days later and EM2056 6 days later than Elsanta.

Of these selections **EM1996** gave good fruit quality results and similar 60-day and main crop yields to Elsanta, with more medium than large size fruit. However in EMR trials, yields and fruit size have been shown to be consistently better than Elsanta.

The 60-day results show that **Jive** and **Vivaldi** produced the highest total and class 1 fruit yields, although it should be noted that plant quality was superior to that of many of the other varieties established in the trial. In the main crop year, Vivaldi also produced good yields but Jive had a similar yield to Elsanta. Of the two varieties, Jive had large fruit size though the berries suffered from splitting and cracking of the skin and flavour was disappointing with brix levels lower than Elsanta. Vivaldi looked very attractive in the punnet but had a high proportion of small size berries that were darker in colour with a weak flavour.

EM2044 produced reasonably good fruit yields. In year 1, fruit size was large but there was a high percentage of medium size fruit in year 2. Firmness and shelf life were good but the flavour was quite bland in some picks. Brix levels were higher than Elsanta on average.

EM2056 was the latest selection in trial with a 50% pick date 6 days after Elsanta. It had a high proportion of large fruit but yields were lower than Elsanta. Flavour was quite bland from most picks and the berries were quite sensitive to bruising.

Main conclusions

The following conclusions are drawn from the data collated from the 2014 60-day and 2015 main crop seasons:

- **Malling Centenary** gave the best all round performance producing fruit with excellent quality, large berry size and good class 1 yields. Improved plant quality would have helped the variety to reach its full yield potential in the 60-day cropping year. The large berry size and high percentage class 1 will provide growers with the opportunity to reduce harvest costs over the current industry standards.
- An exceptionally early cropping variety, **EM1552 (Malling Sunrise)** gave the highest yields in the main crop year with a 50% pick date 12 days ahead of Elsanta. Fruit was produced in a concentrated two week period, an ideal trait for the early season marketplace.

- With a similar early-mid season cropping to Malling Centenary, **Fleurette**, produced good fruit yields in both the 60-day and main crop years. However, the light orange berry colour readily displayed bruising on the fruit.
- **Magnum** produced consistently good fruit flavour and brix levels. The variety produced mainly medium size berries and class 1 yields were not high. The cropping season is later than Elsanta and the berries showed very good firmness. Magnum is exclusive to Total Berry and is not available to other growers.
- The midseason **EM1677 (Malling Glow)** produced good total and class 1 fruit yields in the main crop season. Berry size, colour and firmness were good, although percentage class 1 could be improved by a wider plant spacing. With good tolerance to Verticillium wilt, it may be a useful alternative to Elsanta.
- The later season **Jive** had exceptionally large fruit size and good yield in 60-day cropping, though berries did suffer from some splitting and cracking of the skin. **Vivaldi** produced very attractive fruit but the berry colour was darker than Elsanta and berry size mainly medium rather than large. Both Jive and Vivaldi had disappointingly weak flavour.
- **EM1996** and **EM2044** had similar mid-late cropping seasons. Both gave similar class 1 yields in the main crop year to Elsanta. Fruit size was medium and fruit quality generally an improvement over Elsanta.
- **Garda, EM1998** and **EM2056** were the least promising varieties in substrate culture. Each gave lower yields than Elsanta and suffered fruit quality issues. Other varieties may be better suited to UK substrate production systems.

2015 Full trial report

1.0 Introduction

Protected table top substrate systems are an increasingly important part of the strawberry fruit production industry. This production system can provide the means to overcome soil borne disease problems, extend season at both ends of the year and improve picking efficiency. For the industry to make the best use of substrate production, growing the varieties suited to this production system is a key ingredient for success.

Elsanta has been the most widely grown June-bearing variety in substrate production for some time but it has limitations. These include the production of a high proportion of medium size berries, a characteristic that leads to higher picking costs. It also has a tendency to produce misshapen fruit due to its sensitivity to cool temperatures at flowering. As production costs continue to increase, for example, through the introduction of the minimum wage, growers are looking for alternative varieties that reliably produce large berries with a high proportion of class 1 fruit. This would enable picking costs to be significantly reduced without requiring any major change to current production systems.

Around the world, there are many breeding programmes investing heavily in the development and marketing of new varieties and each year several new ones are released into the marketplace. If growers are to use these in their current substrate production systems, they must first screen their performance on one site under the same growing conditions to compare their productivity and fruit quality against the market standard. Growers particularly look for varieties which provide season extension, increased productivity, improved harvest efficiency and/or fruit quality characteristics such as berry size, flavour and shelf life.

New improved varieties enable UK strawberry growers to continue to produce a high quality product and meet the ever-increasing demands of its market outlets and consumers. Season extension is one example of how UK produced fruit can increase its share of annual UK fruit sales, whilst the introduction of new high quality varieties into the marketplace can in itself lead to an increase in demand for the fruit.

This project (SF 128a) was set up to assess the performance of a number of new named June-bearing varieties and numbered selections in a commercially grown substrate produced strawberry crop, comparing them to the industry standard Elsanta.

2.0 Varieties and numbered selections included in the project

The varieties and selections included in this trial are drawn from European breeding programmes and are considered likely to suit UK production systems and markets.

Table 5 lists the varieties and selections included in the trial, details of their breeding programmes, seasonality and plant types used.

Table 5. Varieties and numbered selections included in the trial

Variety/ Selection	Breeder	Country	Season	Plant Type
EM1552 Malling Sunrise	East Malling Research	UK	Early	Tray 9cm x 7cm
Magnum (exclusive to Total Berry growers)	Marionnet SARL	France	Early	Tray 9cm x 7cm
Fleurette	Goossens Flevoplants	Netherlands	Early	Tray 9cm x 7cm
Garda	CRA - FRF	Italy	Early-mid	A+ plants
Malling Centenary	East Malling Research	UK	Early-mid	Tray 9cm x 7cm
EM1677 Malling Glow	East Malling Research	UK	Mid	Tray 9cm x 7cm
Elsanta	Plant Research International (PRI)	Netherlands	Mid	Tray 9cm x 7cm
EM1996	East Malling Research	UK	Mid-late	Tray 9cm x 7cm
EM1998	East Malling Research	UK	Mid-late	Tray 9cm x 7cm
EM2044	East Malling Research	UK	Mid-late	Tray 9cm x 7cm
EM2056	East Malling Research	UK	Mid-late	Tray 9cm x 7cm
Vivaldi	Fresh Forward	Netherlands	Mid-late	Tray 9cm x 7cm
Jive	Fresh Forward	Netherlands	Late	Tray 9cm x 7cm

3.0 Trial site details

New Farm Produce hosted the variety trial during the 2014 and 2015 seasons on their site in Elmhurst, Staffordshire. Particular thanks are extended to Stephen McGuffie of New Farm Produce for his support with the project.

The trial was housed within a permanently skinned enclosed poly tunnel with vents and removable doors for ventilation. The tunnel contained four double rows of table top production, with the trial plants located in the centre three double rows which ran from north to south. The trial used half metre troughs filled with coir substrate. Truss supports were used and fertigation was supplied to each trough.

The trial was managed by staff at New Farm Produce. Fertigation and agrochemical inputs were managed in the same way as a commercial crop of Sonata.

4.0 Production details

Planting system:	Coir substrate table top production under protection.
Planting date:	4 th to 8 th February, 2014
Protection:	Permanent polytunnel, fully enclosed with vents and removable doors
Fertigation:	Drippers provided the fertigation to each trough
Agrochemical input:	On demand
Runners cut:	Three times during each season
Leaf removal:	Oldest leaves removed post-harvest in year 1
Year 1 harvest:	30 th April (week 18) to 30 th June 2014 (week 27) - 9 weeks
Year 2 harvest:	18 th May (week 21) to 13 th July (week 29) - 9 weeks
Harvest frequency:	Picked 2 or 3 times a week depending on fruiting stage and weather
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 (<i>Podosphaera aphanis</i>) 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 made on at least four dates during each harvest season for:

(Appendix 9.2) 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-planting
(Appendix 9.1) Year 1 plants at fruiting
Year 1 fruit in punnet
Year 1 berry sections
Year 2 plant and fruit photographs, one page per variety

5.0 Trial design

Trial type: Coir substrate table top production under protection.
Trial design: Randomised block using 3 replicates.
Varieties: 12 new and near-market varieties/selections as detailed in Table 5.
Trial control: Elsanta tray plants.
Plant types: Tray plants except for variety 'Garda' where only A+ plants were available.
Plot size: 20 plants per plot/replicate, 60 plants in total per variety.
Plant spacing: 5 plants per 0.5 metre trough.

Statistical analysis: Fruit production data was analysed by statistician Dr David Simpson, EMR in years 1 and 2. (*see appendix 9.3 and 9.4 for the statistical data*).

6.0 Trial results and data collected

The trial established well in early spring 2014 under protection.

Spring 2014 was relatively mild. There were a couple of late frosts in April but no particular variety showed any cold damage to the flowers. The early varieties started to flower in March. The first ripe berries were present on 30th April. The temperatures through May and June were moderate with no excess of heat. After fruiting the old leaves were removed and the plants thinned to 3-4 crowns prior to growth the following spring.

Winter 2014/15 was not exceptionally cold, with no late frosts to cause any damage within the trial. The trial tunnel remained closed over-winter. Bees were provided during flowering and the tunnel ventilated by opening the tunnel ends as the temperatures increased during the spring.

6.1 Plant characteristics

The plant characteristics are summarised in Table 6.

Table 6. Plant characteristics

Variety	% Plant survival	Plant vigour	Runner production	Average crown number per plant	Fruit display	Powdery mildew
		<i>1 = low 5 = very vigorous</i>	<i>1 = none 5 = prolific</i>		<i>1 = very poor 5 = excellent</i>	<i>1 = none 5 = high incidence</i>
EM1552	91.6	3.3	2.8	2.0	3.0	2
Magnum	100	3.8	2.0	3.0	3.5	0
Fleurette	95.0	4.0	3.5	4.0	3.5	2
Garda	96.6	2.8	2.0	3.0	3.0	3
Malling Centenary	98.3	3.5	3.0	2.0	4.0	0
EM1677	100	3.5	1.0	2.0	3.0	0
Elsanta	98.3	3.0	2.5	2.0	3.5	2
EM1998	100	3.5	3.5	2.5	3.5	1
EM2044	98.3	4.0	3.0	2.5	3.5	2
EM2056	100	3.8	4.0	2.0	3.0	0
Jive	100	4.0	1.5	3.0	2.5	1
Vivaldi	100	3.8	3.5	4.0	3.5	0
EM1996	100	3.8	3.5	2.5	4.0	2

Tray plants of all the EM selections, including the variety Malling Centenary, were not as well rooted on delivery as the other varieties included in the trial. This delayed establishment of the EM selections and appeared to affect subsequent fruit production as the plants did not achieve sufficient root or foliage growth before fruit production began. EM1996 suffered the most as the plants supplied were particularly small. Jive and Vivaldi tray plants were delivered as well rooted plants with good leaf growth. Growth was strong after planting, with a dense leaf canopy produced.

EM1552 had a tall, upright plant habit with moderate plant vigour and short truss length in year one probably due to the poor plant quality. In year 2 truss length was much longer giving a better fruit display. The plants were quite variable in size in year 1. There were 5 plant losses spread over all the replicates. On examination, crown rot (*Phytophthora cactorum*) looked to be the cause of the losses. Some mildew symptoms were seen on the leaves in year 1 but the fruit was not affected. The plants produced 2 crowns on average in year 1, so no crown thinning was required. The leaf petioles and trusses were thin. Fruit was accessible but sometimes found tangled in the foliage.

Magnum tray plants were well rooted at the time of planting and produced plants of good vigour with early leaf growth and no plant losses. Crowns were tall and easy to remove with no branched crowns produced. On average 3 crowns were produced per plant in year 1.

Plants had an upright habit forming compact moderate size plants with dense leaf growth in year 2. Trusses were strong and of moderate length, though the fruit was well presented to the picker. Magnum produced a very robust, sturdy plant, but showed some tip burn and inter-vein yellowing in year 2, suggesting it may require a different feeding regime to that used in the trial in order to get the best out of the variety.

Fleurette tray plants were delivered with very good root growth. Following planting, its growth was strong producing the largest plants in year 1. Two plant losses occurred in replicate 2, which may have been due to *Phytophthora cactorum*. Crowns were tall and easy to remove without damaging the plant. There were few if any branched crowns produced. The plants were tall and upright with a dense leaf canopy, glossy mid-green leaves and strong moderate to long length fruiting trusses. The plants produced on average 4 crowns in year 1. At the end of the season all plants were crown thinned to 3 crowns on average. The leaves showed some mildew towards the end of harvest in year 1 but the fruit remained clean. In year 2, no mildew was noted during harvest. Fruit was well presented to the pickers.

Garda was planted as an A+ plant. Plants had moderate to low vigour with a compact, domed leaf canopy and thick leaf petioles and trusses. Trusses were generally short giving a poor fruit display. An average of 3 crowns were produced per plant in year 1, so no crown thinning was necessary. The leaves showed some inter-vein yellowing on all replicates just

prior to flowering, probably caused by a crop protection product. This reaction may have affected subsequent growth. Mildew was seen on the leaves and fruit in late harvest.

Malling Centenary was slightly more vigorous in growth than Elsanta, producing an upright plant habit. Leaves were large, rounded and glossy. Trusses were sufficiently long to give a good fruit display though separation of truss from leaves is required. An average of 2 crowns were produced per plant in year 1, so no crown thinning was required. The new young leaf suffered tip burn from frost in April.

EM1677 had an upright, tall, leafy plant habit with good vigour. The leaves were small and glossy. No plant losses occurred in trial. Plants produced 2 crowns on average in year 1, but in year 2 many side crowns were produced. Trusses were quite long and some of the fruit became tangled in the foliage resulting in a more difficult pick. Runner production was low.

EM1996 plants had an open habit with vigorous leaf growth in year 2. Like all the EMR selections in trial, the plants were very small on delivery, which put the variety at a disadvantage in year 1. No plant losses occurred during the trial. An average of 2.5 crowns were produced per plant in year 1, so no crown thinning was necessary during year 2. The plants were tall with long leaf petioles and trusses. Fruit display was good on the long trusses. Some mildew symptoms were seen on the leaves in year 1.

EM1998 as with all the EMR selections were not as well rooted as the other varieties in trial. No plant losses occurred. EM1998 displayed an open habit, producing a tall plant with floppy leaves and long, simple trusses. The plants produced 2 to 3 crowns in year 1, so no crown thinning was necessary. Runner production was quite high. The plants remained healthy through the duration of the trial. Fruit display was good.

EM2044 produced strong, tall plants with healthy vigorous leaf growth. The plant habit was open with long trusses giving a good fruit display. However the long leaf petioles necessitated the division of fruit trusses from leaves to avoid tangling of the fruit in the foliage. One plant showed a chimera on the leaf, which also showed through on to the fruit in year 1. One plant was lost during establishment. An average of 3 crowns were produced

per plant in year 1, so no crown thinning was necessary. Mildew was noted on the foliage during harvest in year 2.

EM2056 had vigorous leafy plant growth with a compact dense plant habit, strong petioles and trusses. No plant losses occurred in trial. Trusses were moderate to short in length. Flowering occurred within the foliage and fruit was sometimes difficult to locate. Leaves were dark matt green remaining clean through the season. Many runners were produced. An average of 2 crowns per plant were produced in year 1 and branched crowns were produced.

Vivaldi had a more open, though leafy plant habit, with lighter green leaves. The crowns were tall and easy to remove. Many branched crowns were produced. The trusses were short to moderate in length with some flowers produced within the foliage. The fruit was displayed in compact bunches just under the foliage. Though easy to get at, the bunching hindered picking in some instances.

Jive produced thick, dark matt green leaves with a compact, dense plant habit in year 2. Crowns were tall and easy to remove though some were branched. Fruit was presented on moderate to short length trusses with the fruit produced within the foliage of the plant showing some misshapes. The fruit was difficult to pick from the centre of the plants which hindered picking speeds. One plant showed white streaks (chimera) on a few leaves in year 1 but the chimera did not appear on the fruit.

6.2 Disease

The trial plants received an Elsanta spray programme. The varieties Elsanta, EM1552, EM2044, Garda, Fleurette and EM1996 showed some powdery mildew (*Podosphaera aphanis*) symptoms on the leaves. The fruit of Garda showed some mildew in the later stages of harvest.

All varieties in trial showed plant survival rates of 95% or higher except for EM1552, which had a 91.6% survival rate.

The East Malling Research varieties have undergone disease trials and results indicate that EM1552 is susceptible to crown rot (*Phytophthora cactorum*). In trial EM1552 suffered five plant losses out of the sixty plants. These losses were considered to be caused by crown

rot (*Phytophthora cactorum*). EM1677 has been shown to have good resistance to Verticillium wilt with a similar susceptibility to crown rot and mildew as Elsanta. In trial it showed no disease problems. EM1996 and EM2044 have a similar susceptibility to Verticillium wilt as Elsanta, whilst EM1998 has moderate resistance to *Phytophthora cactorum*. EM2056 is resistant to crown rot and Verticillium wilt. All have a similar susceptibility to mildew as Elsanta.

Of the non-EMR varieties in trial, Fleurette had three plants losses, Garda two and Elsanta, Malling Centenary and EM2044 suffered one plant loss out of the sixty plants of each variety included in the trial.

6.3 2014 Year 1 Fruit Production Results

The first year harvest commenced on 30th April 2014 and harvest continued until 30th June. The fruit was picked three times per 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 7 shows the year 1 yield data gathered. All varieties except Garda were planted as tray plants, with A+ plants used for Garda. The East Malling Research selections plus Malling Centenary tray plants were less well rooted than the other varieties in trial. This may account for the lower yields recorded for these entries and therefore this should be taken into consideration when comparing the yield data displayed in Table 7.

Table 7. 2014 Year 1 60-day Fruit Yield data (listed by Class 1 yield)

Variety	50% pick date	Total yield g/plant	Class 1 yield g/plant	% Class 1	BERRY SIZE %		
					Extra-large >45mm	Large 35-45mm	Medium 25-35mm
Jive	06/05/14	603.2	567.8	94.1	8	56	36
Vivaldi	30/05/14	577.7	542.8	94.0	1	37	62
Fleurette	21/05/14	340.8	332.4	97.5	2	57	41
Elsanta	20/05/14	374.0	326.9	87.4	6	45	49
Magnum	20/05/14	330.9	314.0	95.0	4	48	48
Malling Centenary*	21/05/14	290.5	286.7	98.7	2	51	47
EM1677*	19/05/14	205.0	198.9	97.0	5	54	41
Garda**	18/05/14	203.1	177.3	87.3	1	33	66
EM1552*	14/05/14	165.9	158.7	95.7	2	40	58
EM2044*	20/05/14	156.6	153.4	98.0	4	62	34
EM1996*	22/05/14	153.3	137.3	89.6	0	60	40
EM2056*	15/05/14	131.0	128.8	98.3	24	56	20
EM1998*	19/05/14	102.5	98.3	96.3	1	57	43

* Smaller tray plants than the other varieties in trial,

** A+ plants

Figures 4 and 5 below summarise the fruit yields and berry sizes recorded from Year 1 (60-day crops)

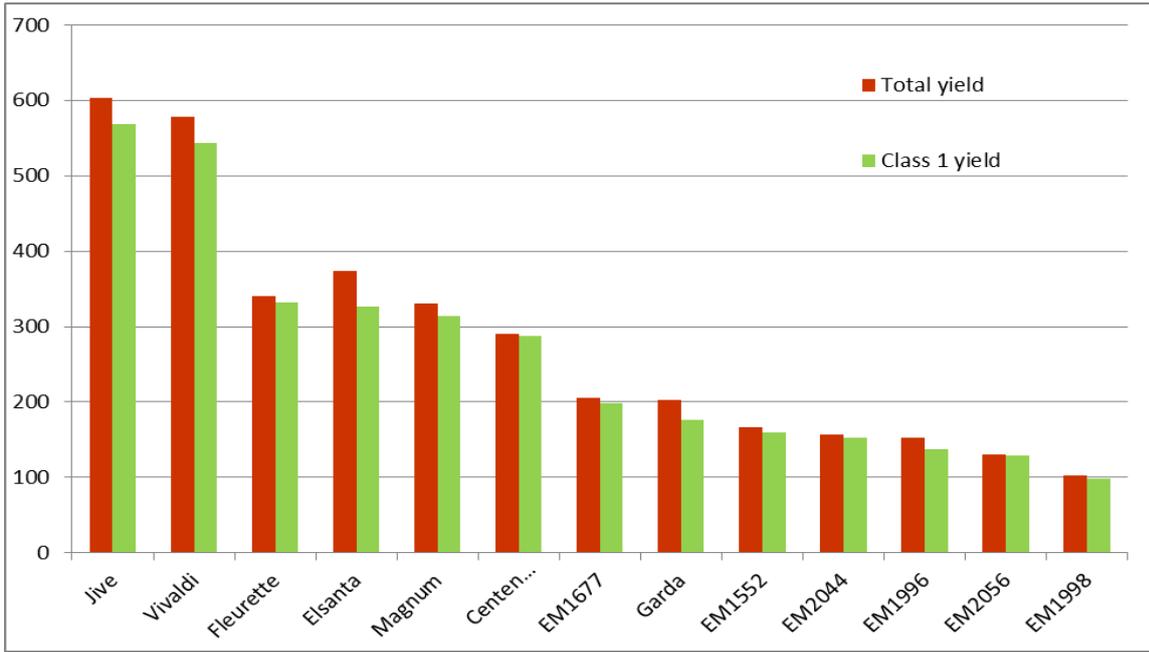


Figure 4. Year 1 Fruit Yield (*g per plant*)

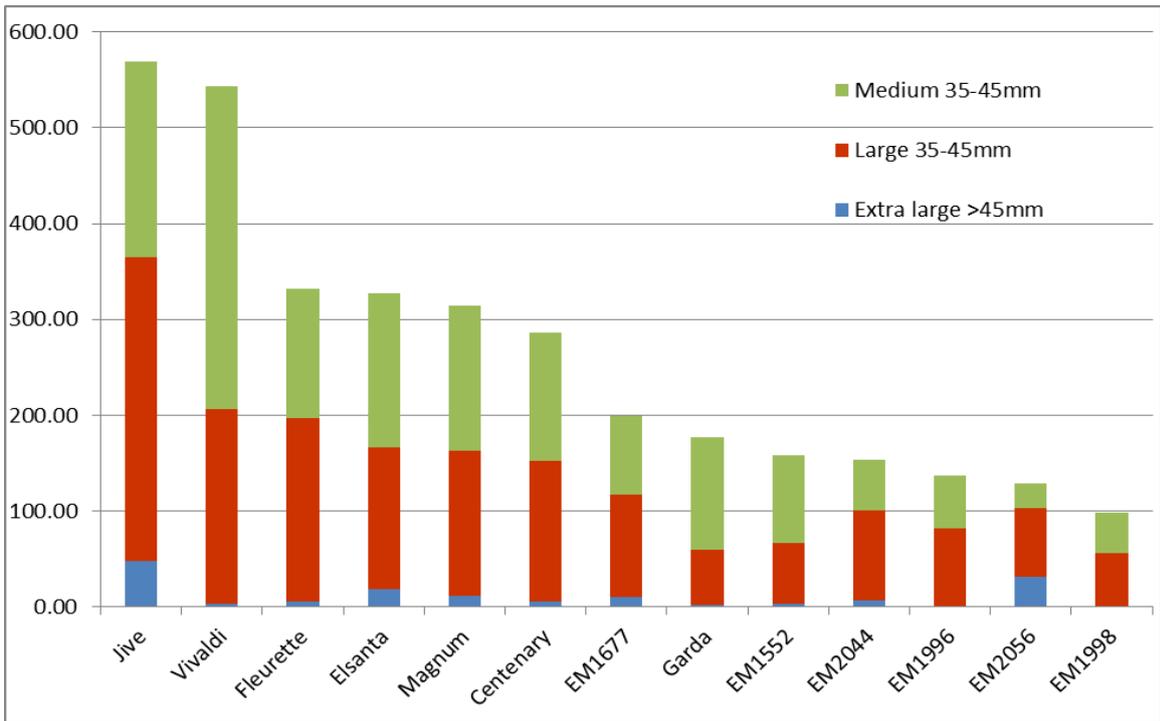


Figure 5. Year 1 Class 1 Berry Size (*g per plant*)

Each variety in trial produced relatively consistent yield data in each of the three replicates suggesting that the plants, substrate and environmental conditions were uniform within the trial.

The Elsanta tray plant control produced an average total yield of 374g per plant and class 1 yield of 326.9g per plant with a high class 1 percentage of 87.4%. The class 2 fruit mainly consisted of misshapes. 43% of the class 1 fruit was large (>35mm) in size.

In year 1 Jive and Vivaldi produced significantly higher total and class 1 yields than Elsanta and all other varieties in the trial.

The class 1 yield of Malling Centenary, Fleurette and Magnum was not significantly different to Elsanta. The other seven varieties in trial all had much lower class 1 yields than Elsanta and the other varieties.

The percentage class 1 was good for all varieties in trial, the lowest being for Garda, Elsanta and EM1996 at between 87.3% and 89.6%. All the other varieties produced 94% or higher class 1 fruit.

EM2056 produced the highest percentage of large berries (>35mm) of which 24% were in the extra-large (>45mm) size category. EM1677, EM1996, EM2044, Fleurette and Jive had a significantly higher percentage of large berries (>35mm) than Elsanta with most of the berries falling into the large (35-45mm) rather than extra-large (>45mm) category, so all were saleable.

Malling Centenary, EM1998 and Magnum produced fruit of a similar size to Elsanta, whilst EM1552, Garda and Vivaldi produced significantly smaller fruit than Elsanta.

6.4 2015 Year 2 Main Crop Fruit Production Results

The polytunnel that housed the trial over winter was fully enclosed with the doors and vents closed to protect the plants in the substrate table top system. The trays were left in their fruiting place without further protection. The plots were assessed for crown numbers and those varieties with greater than 3 or 4 crowns were thinned down to 3 / 4 crowns.

The second year harvest commenced on 18th May 2015 and harvest continued until 13th July. The fruit was picked twice or three times per week depending on the fruiting stage and weather conditions. 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 8 below shows the average year 2 yield data gathered from across the three replicates.

Table 8. 2015 Year 2 Fruit Yield data (listed by Class 1 yield)

Variety	50% pick date cv Elsanta	Yield g per plant		% Class 1	Class 1 Berry size %		
		Total	Class 1		Extra large >45mm	Large 45- 35mm	Medium 35- 25mm
EM1552	-12 days	712.9	575.4	80.7	0.4	24.3	75.3
EM1677	+1 day	799.0	555.0	69.5	0.0	15.2	84.8
Malling Centenary	-5 days	567.3	530.6	93.6	0.7	35.6	63.7
Vivaldi	+3 days	659.6	529.6	80.5	0.4	15.7	84.0
Fleurette	-5 days	592.8	519.6	87.8	1.1	24.4	74.5
EM2044	+4 days	670.9	510.9	76.3	1.1	18.9	80.0
EM1996	+5 days	621.1	466.5	75.5	0.3	18.7	81.0
Jive	+5 days	595.3	456.7	76.7	1.9	43.7	54.4
Elsanta	16/06/15	682.7	451.3	66.6	0.1	14.4	85.5
EM1998	+2 days	586.9	439.9	74.9	0.2	22.2	77.5
EM2056	+6 days	528.7	419.7	79.4	0.6	30.0	69.4
Magnum	- 5 days	528.8	399.9	75.9	0.3	20.0	79.8
Garda	-8 days	386.8	267.1	68.7	0.9	23.0	76.1

Figures 6 and 7 below summarise the fruit yields and berry sizes recorded from Year 2 (main crop).



Figure 6. 2015 Year 2 Fruit Yield (g per plant)

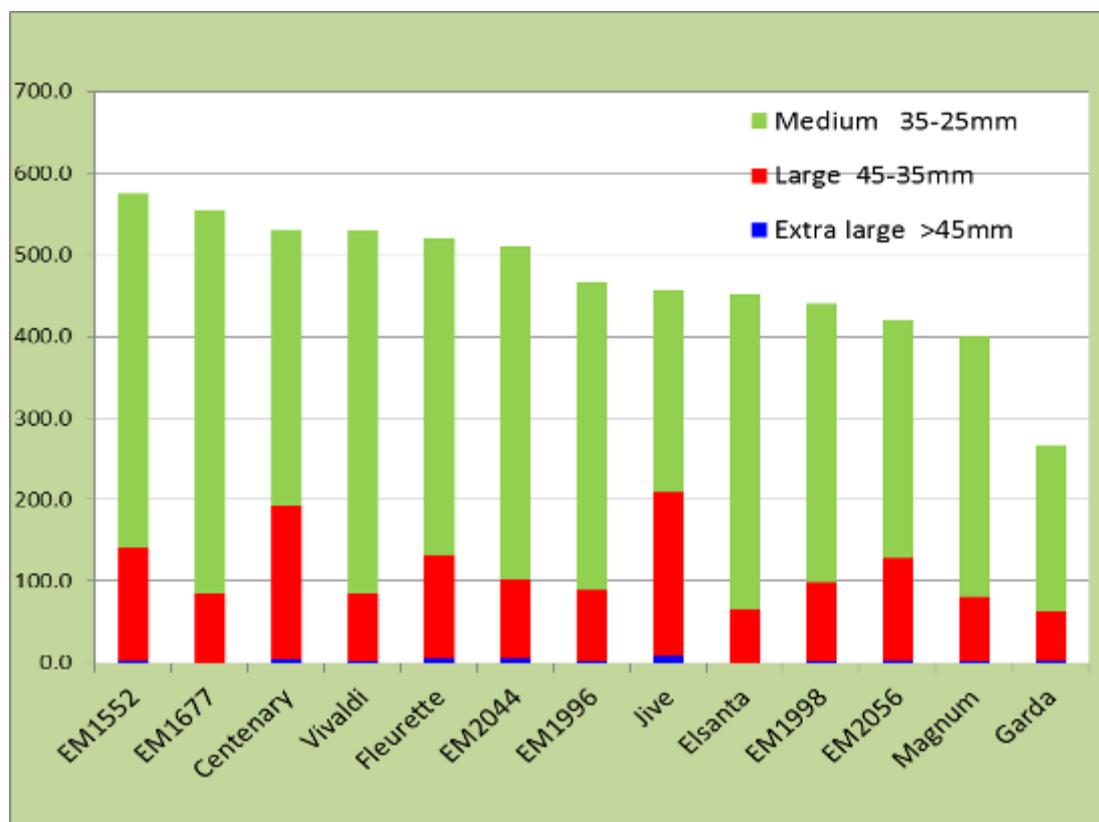


Figure 7. Year 2 Class 1 Berry Size (g per plant)

Each variety in trial produced relatively consistent yield data in each of the three replicates suggesting that the plants, substrate and environmental conditions were uniform within the trial for the year 2 harvest.

In year 2, fruit yields were not high for any variety but data is comparable between the varieties in this trial. The Elsanta tray plant control produced an average total main crop yield of 682.7g per plant and class 1 yield of 451.3g per plant with a low class 1 percentage of 66.6%. The class 2 fruit mainly consisted of misshapes and contained the second highest proportion of small fruit. Only 14.5% of the class 1 fruit was large (>35mm) in size.

Malling Centenary, EM1552, EM1677, EM2044, Fleurette and Vivaldi produced significantly higher class 1 yields than Elsanta and all the other varieties in trial. Yields were at least 13% higher with EM1552 yielding 27% more than Elsanta. EM1996, Jive, EM1998, EM2056 and Magnum class 1 fruit yields were similar to that of Elsanta.

Garda was the only variety to produce both a significantly lower class 1 and total yield than Elsanta.

EM1677 was the only variety to produce a significantly higher total yield than Elsanta. Even with a lower percentage class 1 than most other varieties in trial it still achieved a class 1 yield 23% higher than Elsanta.

EM1552, Vivaldi, EM2044 and EM1996 produced similar total yields to Elsanta. The other six varieties in trial all had much lower total yields than Elsanta.

Elsanta produced the lowest percentage of class 1 at 66.6%. Garda and EM1677 class 1 percentages were also low at 68.7% and 69.5%. Like Elsanta, EM1677 had a high proportion of misshapen fruit and small fruit <25mm, whilst the reason for the class 2 Garda fruit was down to misshapes.

Malling Centenary (93.6%) and Fleurette (87.8%) had significantly higher percentage class 1 fruit than all other varieties in the trial. Malling Centenary had the highest proportion of fruit in the class 1 size grade and suffered very few misshapes.

EM1998 suffered the highest proportion of small fruit (<25mm), second only to Elsanta, whilst Jive produced the highest number of large (35-45mm) and extra-large (>45mm) fruit at 45.6%.

Malling Centenary, EM1552, EM2056, Fleurette, Garda and Jive produced significantly more large berries than Elsanta.

6.5 Cropping profiles

The 50% pick dates show when 50% of the total fruit harvest has been picked. Elsanta reached its 50% pick date on 16th June at a similar time to EM1677 (Malling Glow), and EM1998.

EM1552 (Malling Sunrise) was the earliest fruiting variety in trial reaching its 50% pick date on 4th June, 12 days ahead of Elsanta. The majority of its fruit was picked in a three week window. Garda was 8 days ahead of Elsanta with Malling Centenary, Fleurette and Magnum 5 days ahead of Elsanta's 50% pick date. Vivaldi, EM1996, Jive and EM2056 were a few days later than Elsanta.

Figures 8 and 9 summarise the cropping profiles of all the varieties in the trial.

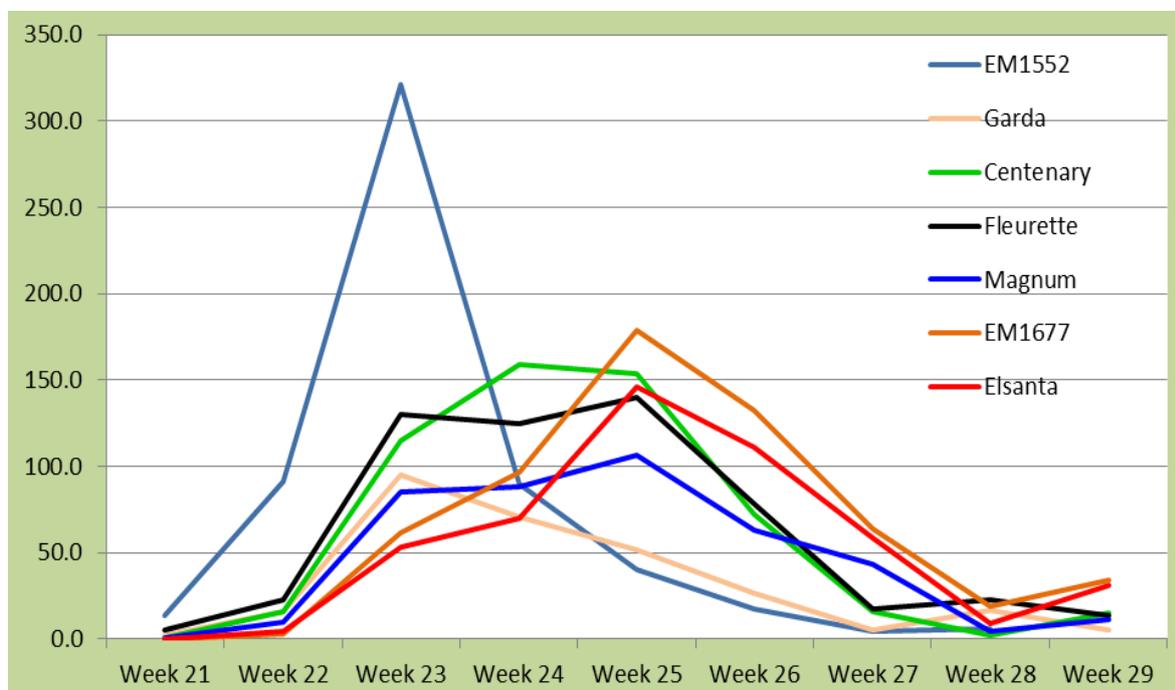


Figure 8. Early-Mid Season Variety Cropping Profiles (*Class 1 grams per plant*)

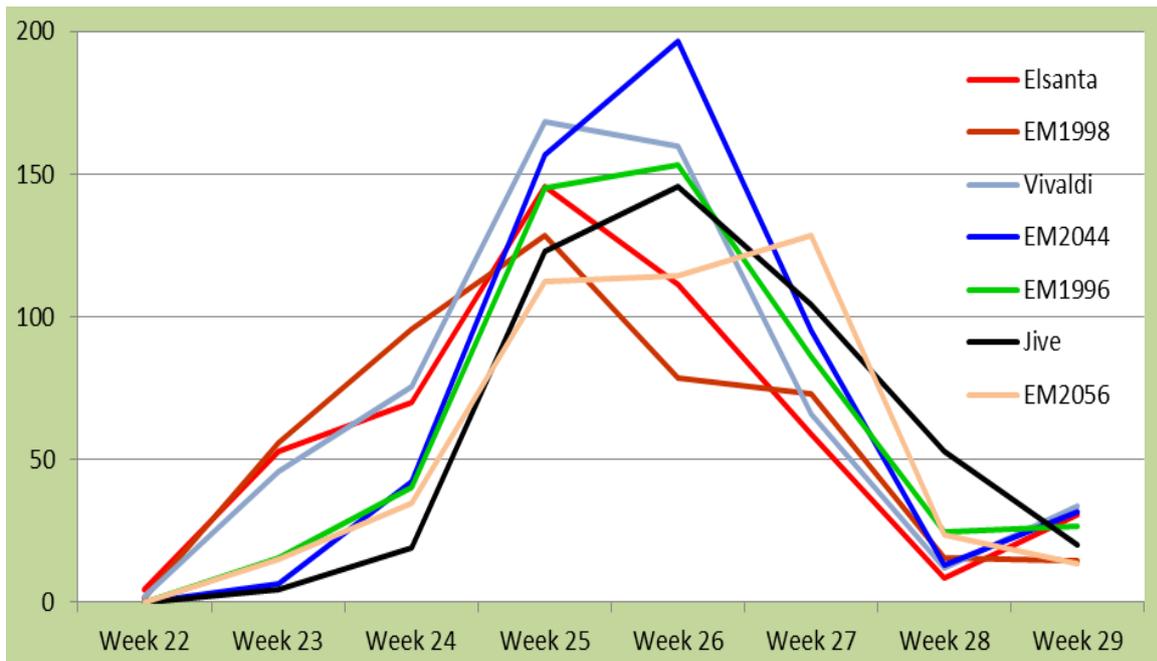


Figure 9. Mid-Late Season Variety Cropping Profiles (*Class 1 grams per plant*)

6.6 Fruit quality

Fruit quality including Brix readings were assessed on at least four dates during each harvest period and shelf-life on two dates after 7-8 days in cold store. Photographs were taken of the fruit on the plant, in the punnet, sliced and after cold storage. The mean variety scores for each assessment are given in Table 9 below.

Table 9. Fruit Quality

Variety	External berry colour	Uniformity of berry shape	Firmness	Berry appearance	Fruit flavour	Shelf life	Mean Brix
	<i>1 = light orange 8 = dark wine-red</i>	<i>1 = irregular 9 = uniform</i>	<i>1 = soft 9 = firm</i>	<i>1 = poor 9 = excellent</i>	<i>1 = poor 9 = excellent</i>	<i>1 = poor 9 = excellent</i>	<i>(sugar content)</i>
EM1552	7.0	7.5	6.0	7.0	6.2	6.5	8.9
Magnum	7.5	6.5	8.0	6.5	7.4	8.0	9.3
Fleurette	5.0	7.0	7.0	7.5	6.8	7.5	7.8
Garda	7.5	7.5	8.0	7.0	6.8	6.0	9.1
Malling Centenary	6.0	8.5	8.0	9.0	8.2	7.8	8.4
EM1677	7.0	8.0	8.0	8.0	6.2	7.8	7.4
Elsanta	6.5	6.5	7.0	6.5	6.5	6.5	7.3
EM1996	6.0	7.5	7.5	7.5	7.3	7.5	9.6
EM1998	6.0	7.5	7.0	7.5	8.0	7.0	9.0
EM2044	6.0	7.5	7.5	7.5	6.5	7.8	8.2
EM2056	6.5	7.0	7.0	7.0	5.5	7.0	7.0
Vivaldi	8.0	6.5	8.0	8.0	4.3	6.0	7.0
Jive	6.0	7.0	6.5	7.0	2.0	6.5	6.6

EM1552 berries had a conic shape, indented seeds and glossy skin. At some picks the berries showed a susceptibility to splitting under the calyx. The berries were attractive with a slightly darker colour than Elsanta. In shelf-life tests the skin showed some bruising. The texture was soft and flavour was pleasantly aromatic.

Magnum berries were pointed conic in shape with wide shoulders and a reflex calyx. There was some irregularity to the shape especially during the first couple of harvests, with the berries exhibiting a very knobbly appearance. Berry colour was darker than Elsanta with less gloss and the deeply indented seeds detracted from the appearance. The berries had good skin strength and a dense, firm flesh. Shelf-life scores were usually good with little deterioration. The flavour was usually sweet with brix levels one of the highest in trial at an average 9.3 compared with Elsanta at 7.3.

Fleurette produced attractive glossy bright uniformly orange berries with a round shape and wide shoulders. There was some irregularity to the berry shape. Berry size was moderate. Due to the orange colour, the skin showed bruising quite easily. The berries darkened slightly in shelf-life tests and showed wet bruising. Flavour was variable but usually sweet. Flesh texture was good though the berries had a hard core. Brix levels were usually higher than Elsanta.

Garda had very attractive, glossy red-orange berries with a small reflex calyx and long bi-conic shape. There was good uniformity of shape between berries. Some splitting was seen on the neck under the calyx. Early in the season, berries were quite wedge shaped. The flesh was firm and the skin showed few bruises but the skin colour darkened in storage. Flavour was quite acidic although in the main crop year, brix levels were higher than Elsanta.

Malling Centenary berries were glossy, bright orange-red with a uniformly regular conic shape. The skin had good strength and flesh was firm. In shelf-life tests the berries retained a good gloss and darkened only slightly. Flavour was pleasantly sweet with a crisp texture and brix levels consistently higher than Elsanta.

EM1677 produced attractive, very glossy bright red-orange berries with a pointed conic shape. There was some misshapen fruit due to the density of the foliage, which may be overcome by a wider plant spacing. Skin showed good strength and flesh had good firmness. Bruising became more noticeable with storage. Flavour was pleasantly sweet though at some picks it was bland. Brix levels were similar to Elsanta.

EM1996 had regular pointed conic berries with a red-orange colour slightly darker than Elsanta. The berries were very glossy with good colour uniformity and firmness. In shelf-life tests the fruit performed better than Elsanta. The flavour was sweet and brix levels good.

EM1998 had good size fruit in year 1 and year 2. Berries were very glossy and orange. Berry shape was rounded conic with wide shoulders. Flesh was quite soft with bruising showing on many berries after storage. Flavour was sweet and juicy with good brix levels.

EM2044 had attractive long pointed conic berries with a glossy red-orange skin colour. The berries had good uniformity. The skin had good strength and the flesh was firm. Flavour was quite bland at most picks with a dry texture. Brix levels were generally good.

EM2056 produced very glossy orange to orange-red opaque coloured berries with few seeds and a rounded conic shape. The skin was quite sensitive to damage in both the 60-day and main crop picks, with some bruising showing after storage. Flavour was insipid with quite a dry texture. Brix levels were similar to Elsanta in the main crop year but higher in the 60-day crop.

Vivaldi had very attractive, moderate to small sized glossy berries that were round in shape with wide shoulders. There was some irregularity in shape similar to that found in Elsanta. The calyx was small and slightly reflexed. Berry colour was darker than Elsanta. The skin was quite strong and the flesh firm. In store the berries darkened in colour but remained very glossy with little bruising. Berry texture was good but flavour was bland or sometimes slightly acidic. Brix levels were significantly lower than Elsanta in the 60-day crop but in the main crop year were only slightly lower than Elsanta.

Jive was notable for its large berry size. It had large blunt conic shaped berries with an orange-red matt skin. At the start of picking, the fruit was very large and furrowed. The skin was quite sensitive and the texture soft. Some skin splitting under the calyx and cracking of the skin was noted in both the 60-day and main crop years. The flavour was weak at most picks with very little sweetness. Brix levels were lower than Elsanta.

7.0 Discussion

Following the two harvest seasons a number of promising varieties have been identified for production in substrate culture under protection.

Those varieties that did not produce improved results over Elsanta may be better suited to alternative growing systems and feeding regimes. They may also benefit from improved plant quality to increase yields in year one or may just not have the desired attributes to compete favourably in the field or marketplace to give the UK grower and customer improved performance over the currently grown varieties.

It should be noted that the 2014 first year fruit yield results are likely to have been affected by the difference in tray plant quality.

Early season varieties: The earliest variety in trial was **EM1552 (Malling Sunrise)** cropping 12 days ahead of Elsanta and producing most of its yield in a two week period, a trait advantageous for an early variety. The 60-day fruit yield was low, which was partly due to poor plant quality at planting. Berries were only moderate in size but class 1 percentage was high. The main crop total and class 1 yields were significantly higher than Elsanta. The class 1 yield was the highest in the trial and the average berry size was also better than Elsanta. The fruit had good brix levels with good colour, though it was not as firm as Elsanta and some berries suffered from splitting under the calyx. EM1552 is a variety with low tolerance to *Verticillium* wilt and suffered a few plant losses in trial from suspected *Phytophthora cactorum* so it is recommended for substrate or clean soil production systems.

Garda reached its 50% pick date 8 days ahead of Elsanta whilst Malling Centenary, Magnum and Fleurette were 5 days in advance. Of these four varieties **Malling Centenary** gave the best performance with the highest total and class 1 yields in the main crop year, significantly higher than Elsanta. It produced a similar class 1 yield to Elsanta in the 60-day cropping season. Berry size was very good as was fruit quality. The **Garda** plants suffered badly in trial. Establishment in year one was poor and in year two a reaction to one of the crop protection sprays caused further plant stress. Fruit yields in both years was low and in shelf-life tests the berries darkened and showed bruising but flavour was sweet and brix levels good.

Magnum and **Fleurette** gave similar class 1 60-day yields to Elsanta. In the main crop year, Magnum had a very disappointing yield with moderate fruit size whilst Fleurette had a similar yield to Malling Centenary. Magnum was noted for its reliably sweet flavour and good brix levels and Fleurette for its light skin colour, though it did display bruising quite readily.

Midseason varieties: EM1677 (Malling Glow) and EM1998 reached the 50% pick date at a similar time to Elsanta. **EM1677** was the best performing of the three. It gave the highest total yield in the main crop trial and second highest class 1 yield. Its 60-day yields are usually similar to Elsanta. However, poor plant quality resulted in reduced yields in 2014. Like its parent Elegance, the berries are very attractive, with good firmness and shelf-life and flavour is pleasantly sweet. **EM1998** gave a very low 60-day yield followed by a similar class 1 yield to Elsanta in the main crop year. The berries were moderate to small in size and sensitive to bruising.

Mid-late season varieties: Vivaldi was three days later than Elsanta, EM2044 four days later, EM1996 and Jive 5 days later and EM2056 6 days later than Elsanta.

Of these selections **EM1996** gave good fruit quality results and similar 60-day and main crop yields to Elsanta with more medium than large size fruit. However in EMR trials yields and fruit size have been shown to be consistently better than Elsanta.

The 60-day results show **Jive** and **Vivaldi** produced the highest total and class 1 fruit yields. However it should be noted that plant quality was superior to that of many of the other varieties in the trial. In the main crop year, Vivaldi also produced good yields but Jive had a similar yield to Elsanta. Of the two varieties, Jive had large fruit size though the berries suffered from splitting and cracking of the skin and flavour was disappointing, with brix levels lower than Elsanta. Vivaldi looked very attractive in the punnet but had a high proportion of small size berries that were darker in colour with a weak flavour.

EM2044 produced reasonably good fruit yields. In year 1 fruit size was large but there was a high percentage of medium size fruit in year 2. Firmness and shelf-life were good but the flavour was quite bland at some picks. Brix levels were on average higher than Elsanta.

EM2056 was the latest selection in trial with a 50% pick date 6 days after Elsanta. It had a high proportion of large fruit but yields were lower than Elsanta. Flavour was bland at most picks and the berries were quite sensitive to bruising.

Main conclusions

The following conclusions are drawn from the data collated from the 2014 60-day and 2015 main crop seasons:

- **Malling Centenary** gave the best all round performance producing fruit with excellent quality, large berry size and good class 1 yields. Improved plant quality would have helped the variety to reach its full yield potential in the 60-day cropping year. The large berry size and high percentage class 1 will provide growers with the opportunity to reduce harvest costs over the current industry standards.
- An exceptionally early cropping variety, **EM1552 (Malling Sunrise)** gave the highest yields in the main crop year with a 50% pick date 12 days ahead of Elsanta. Fruit was produced in a concentrated two week period, an ideal trait for the early season marketplace.
- With a similar early-mid season cropping to Malling Centenary, **Fleurette**, produced good fruit yields in both the 60-day and main crop years. However, the light orange berry colour did show bruising quite easily.
- **Magnum** produced consistently good fruit flavour and brix levels. The variety produced mainly medium size berries and class 1 yields were not high. The cropping season is later than Elsanta and the berries showed very good firmness. Magnum is exclusive to Total Berry and is not available to other growers.
- The midseason **EM1677 (Malling Glow)** produced good total and class 1 fruit yields in the main crop season. Berry size, colour and firmness were good though

percentage class 1 could be improved by a wider plant spacing. With good tolerance to Verticillium wilt, it may be a useful alternative to Elsanta.

- The later season **Jive** had exceptionally large fruit size and good yield in 60-day cropping though berries did suffer from some splitting and cracking of the skin. **Vivaldi** produced very attractive fruit but the berry colour was darker than Elsanta and berry size mainly medium rather than large. Both Jive and Vivaldi had disappointingly weak flavour.
- **EM1996** and **EM2044** had similar mid-late cropping seasons. Both gave similar class 1 yields in the main crop year to Elsanta. Fruit size was medium and fruit quality generally an improvement over Elsanta.
- **Garda**, **EM1998** and **EM2056** were the least promising varieties in substrate culture. Each gave lower yields than Elsanta and suffered fruit quality issues. Other varieties may be better suited to UK substrate production systems.

APPENDIX

Photographs

- A Tray plants at planting

- B Year 1 60-day Fruiting plants

- C Year 1 60-day Punnet of fruit

- D Year 1 60-day Berry sections

- E Year 2 Main crop (One variety per page)

A - Tray Plants



EM1677



EM1996



EM1998



EM2056



Fleurette



Jive



Vivaldi



Magnum



Malling Centenary



Elsanta

B - Year 1 60-day fruiting plants



EM1552



EM1677



EM1996



EM1998



EM2044



EM2056



Elsanta



Fleurette



Garda



Magnum



Malling Centenary



Jive



Vivaldi

C - Year 1 60-day Fruit in punnet



EM1552



EM1677



EM1996



EM1998



EM2044



EM2056



Elsanta



Fleurette



Garda



Magnum



Malling Centenary



Jive

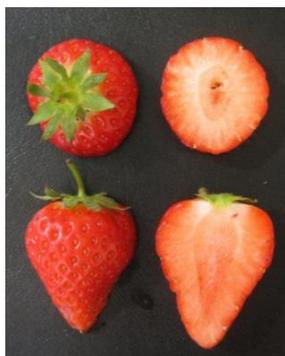


Vivaldi

D - Year 1 Berry sections



EM1552



EM1677



EM1996



EM2056



EM1998



EM2044



Vivaldi



Elsanta



Fleurette



Garda



Jive



Magnum



Malling Centenary

E

Year 2 Main crop – ELSANTA



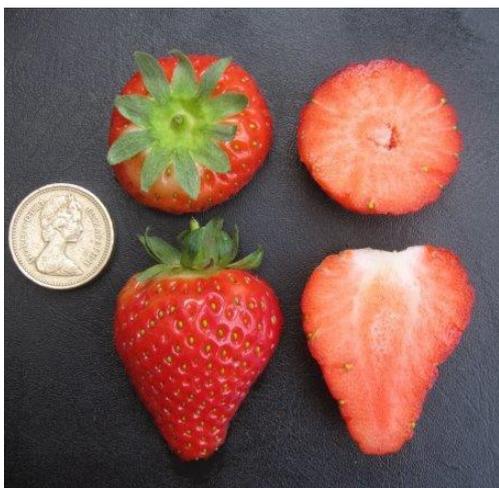
Shelf life after 7 days

Year 2 Main crop – EM1552 MALLING SUNRISE



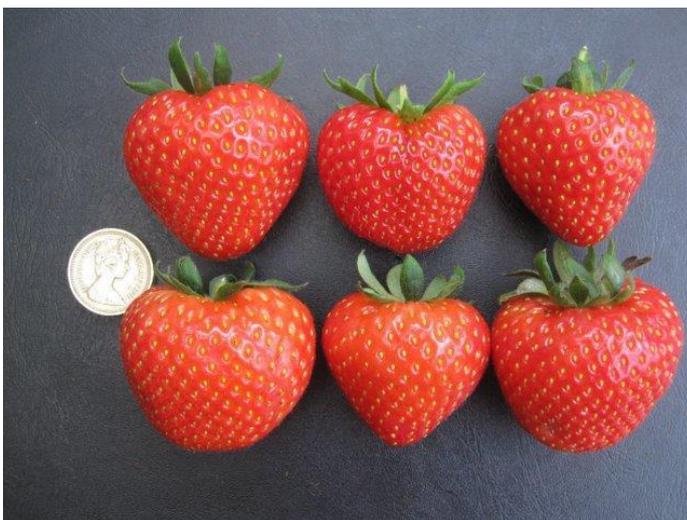
Shelf life after 7 days

Year 2 Main crop – MAGNUM



Shelf life after 7 days

Year 2 Main crop – FLEURETTE



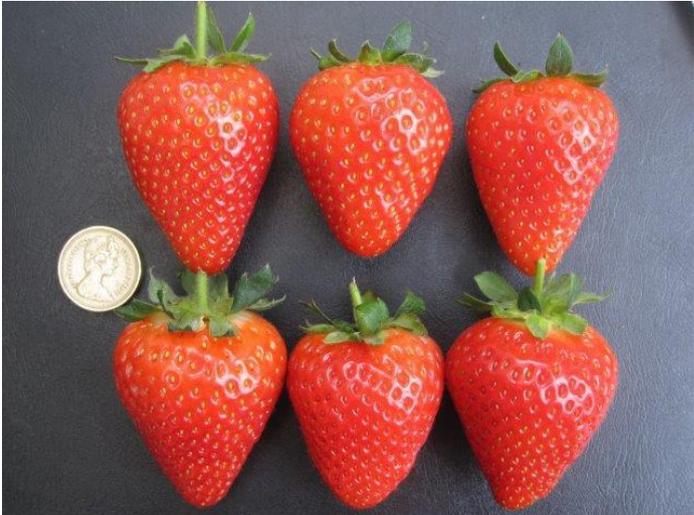
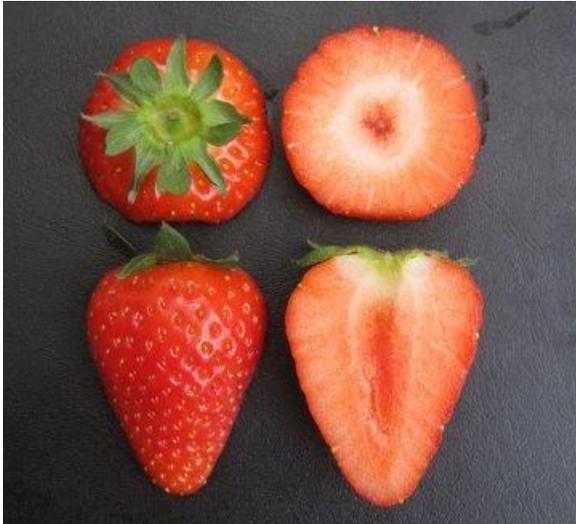
Shelf life after 7 days

Year 2 Main crop – GARDA



Shelf life after 7 days

Year 2 Main crop – MALLING CENTENARY



Shelf life after 7 days

Year 2 Main crop – EM1677 MALLING GLOW



Shelf life after 7 days

Year 2 Main crop – EM1998



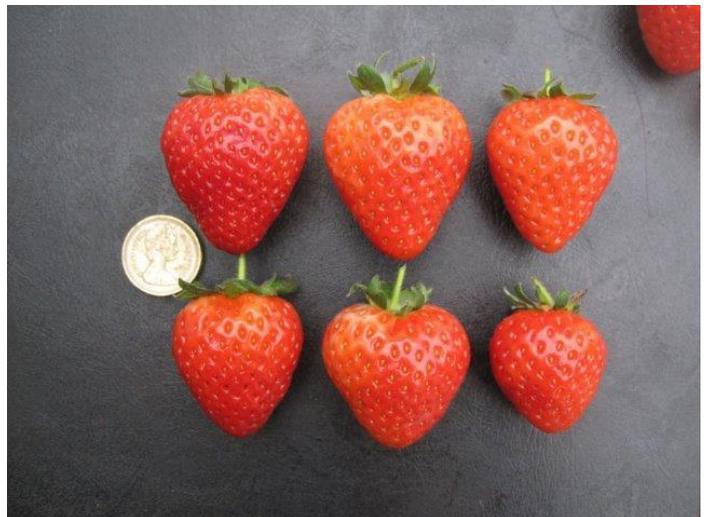
Shelf life after 7 days

Year 2 Main crop – EM2044



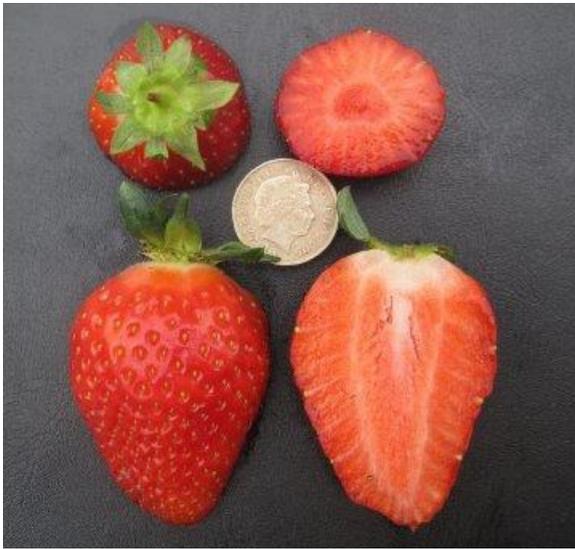
Shelf life after 7 days

Year 2 Main crop – EM2056



Shelf life after 7 days

Year 2 Main crop – JIVE



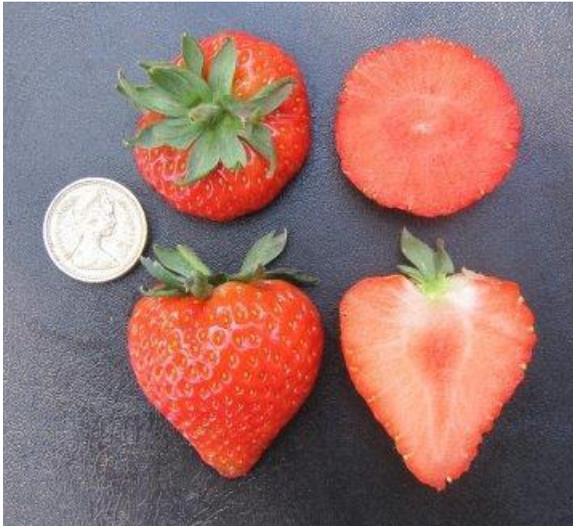
Shelf life after 7 days

Year 2 Main crop – VIVALDI



Shelf life after 7 days

Year 2 Main crop – EM1996



Shelf life after 7 days

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)
- Waste (any damaged fruit)

Class 1 may be further divided into medium size 25-35mm; large 35-45mm; extra-large >45mm.

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
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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
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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
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2014 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 yield, Percentage class 1 and Percentage large fruit (>35mm).

Analysis of variance

Variate: CLASS 1 YIELD

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	69.4	34.7	0.07	
Block.*Units* stratum					
Variety	12	835493.1	69624.4	133.64	<.001
Residual	24	12503.4	521.0		
Total	38	848065.9			

Tables of means

Variate: Class_1_Yield

Grand mean 263.3

Variety	Centenary	Elsanta	EM1552	EM1677	EM1996	EM1998	EM2044
	286.7	326.9	158.7	198.8	137.3	98.3	153.4
Variety	EM2056	Fleurette	Garda	Jive	Magnum	Vivaldi	
	128.8	332.4	177.3	567.8	314.0	542.8	

JIVE and VIVALDI had significantly higher Class 1 yield than Elsanta and all other varieties in the trial

The Class 1 yield of Centenary, Fleurette and Magnum was not significantly different from Elsanta

The other seven varieties all had significantly lower Class 1 yield than Elsanta

Standard errors of differences of means

Table	Variety
rep.	3
d.f.	24
s.e.d.	18.64

Least significant differences of means (5% level)

Table	Variety
rep.	3
d.f.	24
l.s.d.	38.46

Analysis of variance

Variate: TOTAL YIELD

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	107.5	53.8	0.11	
Block.*Units* stratum					
Variety	12	953669.2	79472.4	167.06	<.001
Residual	24	11416.9	475.7		
Total	38	965193.6			

Tables of means

Variate: Total_Yield

Grand mean 279.6

Variety	Centenary	Elsanta	EM1552	EM1677	EM1996	EM1998	EM2044
	290.5	374.0	165.9	205.0	153.3	102.5	156.6
Variety	EM2056	Fleurette	Garda	Jive	Magnum	Vivaldi	
	131.0	340.8	203.1	603.2	330.9	577.7	

JIVE and VIVALDI had significantly higher total yield than Elsanta and all other varieties in the trial

The total yield of Fleurette was not significantly different from Elsanta

The other nine 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.	17.81

Least significant differences of means (5% level)

Table	Variety
rep.	3
d.f.	24
l.s.d.	36.75

Analysis of variance

Variate: PERCENTAGE CLASS 1

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	20.161	10.080	2.34	
Block.*Units* stratum					
Variety	12	572.701	47.725	11.09	<.001
Residual	24	103.325	4.305		
Total	38	696.186			

Tables of means

Variate: %_Class_1

Grand mean 94.50

Variety	Centenary	Elsanta	EM1552	EM1677	EM1996	EM1998	EM2044
	98.69	87.38	95.67	96.98	89.60	96.26	97.95
Variety	EM2056	Fleurette	Garda	Jive	Magnum	Vivaldi	
	98.26	97.51	87.28	94.06	94.96	93.96	

The percentage Class1 of Garda and EM1996 was not significantly different from Elsanta
All other varieties had significantly higher percentage Class 1 than Elsanta

Standard errors of differences of means

Table	Variety
rep.	3
d.f.	24
s.e.d.	1.694

Least significant differences of means (5% level)

Table	Variety
rep.	3
d.f.	24
l.s.d.	3.497

Analysis of variance

Variate: PERCENTAGE LARGE BERRIES >35MM

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	182.48	91.24	4.59	
Block.*Units* stratum					
Variety	12	5500.63	458.39	23.07	<.001
Residual	24	476.87	19.87		
Total	38	6159.98			

Tables of means

Variate: %_Large

Grand mean 55.06

Variety	Centenary	Elsanta	EM1552	EM1677	EM1996	EM1998	EM2044
	53.04	50.81	42.59	59.18	59.94	57.25	65.66
Variety	EM2056	Fleurette	Garda	Jive	Magnum	Vivaldi	
	80.34	59.30	33.82	64.30	51.56	37.97	

EM2056 had a significantly higher percentage of large berries (>35mm) than all other varieties in the trial

EM1677, EM1996, EM2044, Fleurette and Jive had a significantly higher percentage of large berries (>35mm) than Elsanta

EM1552, Garda and Vivaldi had a significantly lower percentage of large berries (>35mm) than Elsanta

The other three varieties were not significantly different from Elsanta

Standard errors of differences of means

Table	Variety
rep.	3
d.f.	24
s.e.d.	3.640

Least significant differences of means (5% level)

Table	Variety
rep.	3
d.f.	24
l.s.d.	7.512

2015 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 yield, Percentage class 1 and Percentage large fruit (>35mm).

Analysis of variance

Variate: CLASS 1 YIELD

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	3706.	1853.	1.64	
Block.*Units* stratum					
Variety	12	239121.	19927.	17.62	<.001
Residual	24	27148.	1131.		
Total	38	269975.			

Tables of means

Variate: Class 1 Yield

Grand mean 471

Variety	Centenary	Elsanta	EM1552	EM1677	EM1996	EM1998	EM2044
	531	451	575	555	467	440	511
Variety	EM2056	Fleurette	Garda	Jive	Magnum	Vivaldi	
	420	520	267	457	400	530	

Centenary, EM1552, EM1677, EM2044, Fleurette and Vivaldi all had significantly higher Class 1 yield than Elsanta

Garda had a significantly lower Class 1 yield than all other varieties in the trial

The Class 1 yield of the other five varieties was not significantly different from Elsanta

Standard errors of differences of means

Table	Variety
rep.	3
d.f.	24
s.e.d.	27.46

Least significant differences of means (5% level)

Table	Variety
rep.	3
d.f.	24
l.s.d.	56.68

Analysis of variance

Variate: TOTAL YIELD

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	10652.	5326.	2.25	
Block.*Units* stratum					
Variety	12	371286.	30941.	13.06	<.001
Residual	24	56854.	2369.		
Total	38	438793.			

Tables of means

Variate: Total Yield

Grand mean 610

Variety	Centenary	Elsanta	EM1552	EM1677	EM1996	EM1998	EM2044
	567	683	713	799	621	587	671
Variety	EM2056	Fleurette	Garda	Jive	Magnum	Vivaldi	
	529	593	387	595	529	660	

EM1677 had significantly higher total yield than Elsanta

Centenary, EM1998, EM2056, Fleurette, Jive and Magnum had significantly lower total yield than Elsanta

Garda had a significantly lower total yield than all other varieties in the trial

The total yield of the other four varieties was not significantly different from Elsanta

Standard errors of differences of means

Table	Variety
rep.	3
d.f.	24
s.e.d.	39.74

Least significant differences of means (5% level)

Table	Variety
rep.	3
d.f.	24
l.s.d	82.02

Analysis of variance

Variate: PERCENTAGE CLASS 1

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	6.02	3.01	0.17	
Block.*Units* stratum					
Variety	12	1984.37	165.36	9.51	<.001
Residual	24	417.29	17.39		
Total	38	2407.69			

Tables of means

Variate: Percentage Class 1

Grand mean 77.4

Variety	Centenary	Elsanta	EM1552	EM1677	EM1996	EM1998	EM2044
	93.6	66.6	80.7	69.5	75.5	74.9	76.3
Variety	EM2056	Fleurette	Garda	Jive	Magnum	Vivaldi	
	79.4	87.8	68.7	76.7	75.9	80.5	

Centenary and Fleurette had significantly higher percentage Class 1 than all other varieties in the trial

EM1552, EM1996, EM1998, EM2044, EM2056, Jive, Magnum and Vivaldi had significantly higher percentage Class 1 than Elsanta

The percentage Class 1 of the other two varieties was not significantly different from Elsanta

Standard errors of differences of means

Table	Variety
rep.	3
d.f.	24
s.e.d.	3.40

Least significant differences of means (5% level)

Table	Variety
rep.	3
d.f.	24
l.s.d.	7.03

Analysis of variance

Variate: PERCENTAGE LARGE BERRIES (>35mm)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	3.06	1.53	0.06	
Block.*Units* stratum					
Variety	12	2894.92	241.24	9.85	<.001
Residual	24	587.63	24.48		
Total	38	3485.61			

Tables of means

Variate: %Large

Grand mean 24.2

Variety	Centenary	Elsanta	EM1552	EM1677	EM1996	EM1998	EM2044
	36.5	14.5	24.5	15.2	19.0	22.4	20.0
Variety	EM2056	Fleurette	Garda	Jive	Magnum	Vivaldi	
	30.9	25.2	24.0	45.7	20.3	16.0	

Jive had significantly higher percentage large berries than all other varieties in the trial
Centenary, EM1552, EM2056, Fleurette, Garda and Jive had significantly higher percentage large berries than Elsanta
The percentage large berries of the other six varieties was not significantly different from Elsanta

Standard errors of differences of means

Table	Variety
rep.	3
d.f.	24
s.e.d.	4.04

Least significant differences of means (5% level)

Table	Variety
rep.	3
d.f.	24
l.s.d.	8.34