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The results and conclusions in this report are based on an investigation conducted over one year. The conditions under which the experiment was carried out and the results obtained have been reported with detail and 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

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Commercial benefits of the project

New varieties, adapted to local conditions, are essential to keep the UK raspberry industry competitive in an increasingly competitive world market. New varieties are taken up rapidly by the UK growers and, although it takes on average 12 years to produce a new variety, a good variety can dominate the industry within 2 or 3 years of its release.

Background and objectives

The HDC project SF 8a provides a vital link between the long-term raspberry breeding programme at HRI-EM and the raspberry industry. The raspberry development programme is funded largely by the MAFF commission HH1027SSF – Genetic development of raspberry with improved pest and disease resistance – which runs from April 2000 to March 2003. A significant amount of industry funding is also provided by the East Malling Trust for Horticultural Research for a related project – Evaluating summer and primocane fruiting raspberries for agronomic characters. A smaller but critical part of industry funding comes from HDC project SF 8a, which runs from April 1997 until October 2001.

The main part of the project involves collecting and entering data from the unreplicated breeders' trials at East Malling (known as the Stage 0 Trials). A large number of summer and primocane fruiting selections are included in these trials where they are compared with the current industry standards. The aim of these trials is to identify possible future parents and to produce a short list of selections that are worthy of further trialling.

SF 8a funds a sandwich student, Miss Rachel Crossley from Manchester Metropolitan University in 2000 from April to September to assist the breeder in running the Stage 0 Trials, and other labour-intensive activities during the growing season.

The main objectives for Miss Crossley in 2000 included:

- Record germination in the 2000 primocane fruiting seedling progenies and select for spinelessness in any progenies that were segregating for spinelessness.
- Learn how to screen raspberry seedlings for resistance to the large raspberry aphid, *Amphorophora idaei*, and assist the breeder in screening the 2000 seedling population in the glasshouse.
- Learn how to make controlled crosses between raspberries in the field and assist the breeder in executing the 2000 crossing programme in the field; collect the fruit from the crosses as it ripens; extract the seed and estimate seed numbers.
- Record yield and nine aspects of fruit quality in promising summer and primocane fruiting selections chosen by the breeder (Stage 0 Trials) and enter the data into Excel for analysis.

Summary of results and conclusions

Germination and spinelessness

All 22 primocane fruiting seed lots produced in 1999 were subjected to sulphuric acid treatment in January 2000 followed by cold storage at 2-4ºC for at least 6 weeks. Previous experience had shown that primocane fruiting seed responded well to acid treatment. The seed trays were transferred to a warm glasshouse in two batches at the beginning of March and the beginning of April and germination was recorded twice a week for 5-6 weeks. The average germination was 52.6% and germination per family ranged from 87.4% to 7.7%. Seedling numbers were low in four families (6707, 6720, 6723 and 6725) and the seed trays were retained until early June. By then the required number had been potted in 6720 and 6723 and only two families were slightly short of the number required.

Three families (6710, 6715 and 6716) were intercrosses between spineless parents and all the progeny were spineless. Spinelessness is a recessive character. Thirteen families segregated either 3:1 or 1:1 for spiny:spineless and in 10 families there were sufficient seedlings to be able to pull out the spiny seedlings from the seed trays prior to potting. In

families 6719, 6723 and 6724 some spiny seedlings were removed but then germination was not high enough to continue and in these three families a mixture of spiny and spineless seedlings were planted in the field. Six families produced all spiny seedlings, but in five out of six of these families half of the seedlings were heterozygous for spinelessness although the phenotype was spiny. The majority of the primocane fruiting seedling population planted in the field in 2000 were spineless and this represents good progress in primocane fruiting material, much of which has been derived from homozygous spiny individuals like Autumn Bliss, Autumn Britten and Polana.

Screening for aphid resistance

Twenty-two primocane fruiting families, 6706-6727, germinated in spring 2000 and the seedlings were potted into individual small pots. Each seedling was inoculated with three adult *Amphorophora idaei* (strain 2) and recorded for the presence or absence of adults or nymphs after 4 or 5 days. Plants that were completely free of aphids were classified as resistant and retained, while those with aphids were classified as susceptible and used as a source of further aphids for inoculation. Any plants with one or two adults but no nymphs or a few nymphs but no adults were re-inoculated and left for another few days and mostly it was obvious whether the seedlings was resistant or susceptible. Out of 4,239 seedlings inoculated between late April and late June 2,488 were resistant and were planted in the field.

Some of the 1999 parents were of unknown aphid resistance status because of the failure of aphid screening in 1992. Observing the ratios of resistant and susceptible seedlings in their progenies it was possible to suggest which of the untested parents were resistant and which were susceptible. The mean percentage of broken or dead seedlings from the whole of the seedling population was 3.9% which was a reflection of careful handling during screening and quick throughput of families before the seedlings became too drawn and leggy.

Crossing programme

Thirty-five crosses were done in the field in May and June using HRI summer fruiting selections and three named cvs (Glen Ample, Malahat and Tulameen) as parents. Crosses were made between early, midseason, late and very late ripening types with various

complementary characters. Between 47 and 25 flowers were emasculated per cross and these resulted in between 37 and 12 well set fruit per cross. In the early crosses some whole pollinating bags were lost due to very high winds in late May. In the later crosses some canes were used which subsequently died (usually cane blight).

Estimated seed numbers ranged from 2847 – 626 seeds per cross and only two families (6739 and 6752) produced less than 1000 seeds. The crossing programme in 2000 was highly satisfactory and reasonable-sized progenies should be produced in 2001.

Stage 0 trials

Forty-two summer fruiting (SF) selections were included in the 2000 Stage 0 trials and compared with Glen Ample and Tulameen. Unfortunately the plot of Glen Moy was very poor and could not be included. The early ripening Canadian cv. Malahat was included as an early control and the midseason Qualicum included because there is commercial interest in it since the success of Tulameen. The SCRI selection 9059C1, which has performed well in the HDC trial in Surrey and which was used as a parent in 2000, was also included for comparison. The 47 SF clones were picked twice a week from 20 June to 14 August and the results are summarised in Tables 7-9.

Glen Ample performed extremely well in 2000 and none of the HRI selections produced more fruit. Two HRI selections (6507/35 and 6513/6) produced more marketable fruit than Tulameen, which also performed very well, but they were not the best for fruit quality. Six selections had overall mean fruit weights of over 4.00g; the largest fruit were from 6506/37 at 5.78g, 6505/7 at 4.90g and 6512/50 at 4.72g, compared to Glen Ample, Tulameen and Qualicum at 4.94, 4.43 and 4.18g, respectively. The fruit weights for the controls in 2000 were significantly higher than in 1999 and reflected the increased rainfall in the non-irrigated breeding plots. The large fruit size of 6506/37 and 6505/7 was recorded in 1999 and both were selected for inclusion in Meiosis trials in winter 1999/2000. The Stage 0 results in 2000 confirmed the very large fruit size of these two trial selections.

Fruit quality attributes like colour, texture and flavour are as important as fruit size and yield. Eight selections were paler red than Ample and Tulameen while seven were considered brighter. Trial selection 6506/37, which was larger than Ample and Tulameen,

had the firmest texture out of the 47 clones, had the strongest skin and showed no crumbliness over the whole season. 6506/37 was also the only selection to be rated higher than Tulameen and Ample for flavour and on the basis of this year's performance is worthy of inclusion in a future HDC replicated summer fruiting trial. It is similar in season to Ample and Tulameen. 6505/7 was also confirmed as a promising trial selection with bright red fruit with a reasonable flavour. It was a few days later than Malahat and just over a week earlier than Ample and Tulameen.

Selection 6512/50 was identified as a promising selection in 2000; it was the latest ripening clone and started picking 12 days later than Ample and Tulameen. It was firm, very cohesive (nil crumble), slightly paler red than Ample and reasonable flavour. 6512/50 had the best shelf life of the summer fruiting clones in 1999 and has the potential to extend the summer fruiting season beyond Leo and Gaia.

Thirty HRI primocane fruiting selections are being compared with the industry standard Autumn Bliss and the Polish cv. Polana. The single plot of Joan Squire in the breeding plots was very heavily infested with raspberry leaf and bud mite (*Phyllocoptes gracilis*) and the fruit was poor quality and atypical. The primocane fruiting clones started ripening in late July; the first pick was on 28 July 2000 and 14 out of 32 clones are still being picked in October. The data until the end of September has been entered in Excel.

Action points for growers

Each year approximately 50 summer fruiting and 25 primocane fruiting genotypes are included in the Breeders' Stage 0 trials and the data collected by the HDC-funded student. These data play an important role in deciding which selections should progress further, which should be used as future parents and which should be discarded. On the basis of their performance over two or three years in the Stage 0 trials, and the breeder's field records, the breeder decides which selections are worthy of further evaluation by the industry. As trialling is so expensive it is vital that only the best go on to industry-funded trials.

Since 1996 a small number of selections have been identified each season, propagated the following winter and transferred to Meiosis Ltd. In total 27 selections have been handed on to Meiosis Ltd; 10 in 1997, 5 in 1998, 7 in 1999 and 5 in 2000. Propagator members of

Meiosis Ltd. undertake further propagation prior to planting unreplicated grower trials in different regions in England. The first Meiosis trials were planted in July 1999 in Kent, Surrey, Oxford and Worcester and will fruit in 2001. More trials were planted in 2000 in Oxford and Hereford. Interested growers should contact Meiosis Ltd. and arrange to visit the trials in their area when they are cropping.

Replicated trials of promising SF selections from the HRI and SCRI programmes were planted at Thursley, Surrey, in 1996 and 1997. These trials are funded by the HDC and run by Janet Allen (SF 41). The HDC have held Open Days at this trial each year since 1998 and many growers have taken the opportunity to see the new selections and compare them with the industry standards.

Anticipated practical and financial benefits from the study

New varieties are the life-blood of the industry and the HDC project SF 8a is one link in the raspberry breeding and release chain. Five new varieties are in the pipeline which have been identified since SF 8a began in 1997. Two summer fruiting types (5928/114 and 6166/98) have been recommended for release on the basis of their performance in the HDC summer fruiting trial in Surrey (SF 41a). An apricot summer fruiting selection, 6432/71, is going ahead, largely for the amateur market, on the basis of its performance in the Stage 0 trials at East Malling in 1997 and 1998. A yellow (6220/70) and an apricot (6378/47) primocane fruiting type are currently being propagated for niche marketing following their performance as guards in the HDC primocane trial in Cambridge (SF 41).

Twenty-seven selections have been transferred for Meiosis grower trials, covering a wide range of ripening seasons, which have been identified as worthy of further trial from the Stage 0 trials at East Malling from 1997-2000.

1. INTRODUCTION

1.1 Introduction to Horticulture Research International (HRI)

HRI's mission statement is "To innovate and communicate for the benefit of consumers and producers of horticultural and other plant-based products."

HRI is a public-sector research organisation, sponsored by MAFF. It is the world's single largest team of horticultural research and development scientists and a leading source of science, technology and related knowledge. HRI's main site is in Wellsbourne, Warwickshire, and the main areas of research are strategic science, field vegetables, protected and other annual crops, mushrooms, farm woodlands, bulbs and ornamentals. There are five other HRI sites, which include East Malling in Kent where the main areas of interest are fruit, hops, hardy nursery stock, propagation, farm woodlands and a plant clinic. The Efford site, in Hampshire, deals with protected crops, micropropagation, high-health propagation, ornamentals and soft fruit. Stockbridge House, Yorkshire, where research involves protected crops, field vegetables and a plant clinic. Kirton, Lincolnshire, researches field vegetables, bulbs and seed propagation. The hop breeding programme is based at Wye College.

HRI-East Malling has grown substantially since 1913, when it was originally founded by Kent fruit growers as 'East Malling Research Station'; and following several major land purchases reached 630 acres (255ha) by 1975. It now covers approximately 550 acres (225 ha), has eight main buildings on site, a large glasshouse complex, several accessory buildings and houses and employs approximately 200 members of staff. HRI-East Malling is made up of three scientific departments; Plant Breeding and Biotechnology, Entomology and Plant Pathology and Crop Science, plus support departments including IT, Biometrics, Graphics and Photography, Library, Administration and Horticultural Services.

The Plant Breeding and Biotechnology department covers areas of research such as the genetic improvement of perennial crop species such as apple, pear, cherry, strawberry, raspberry, hops, woody ornamentals and forestry species. The main aim of these individual areas is to develop new varieties of plants via genetic modification or classical breeding

techniques with the intention of producing fruit or plants of a better standard as required by the public.

1.2 Introduction to Raspberries

The raspberry is an aggregate fruit that is composed of many small, fleshy drupelets, each left with the style and stigma (resembling hairs) on the berry surface. Raspberries belong to the genus *Rubus*, subgenus *Idaeobatus.* Between 600 and 800 *Rubus* species are recognised worldwide in 12 subgenera. The two most important subgenera are *Rubus* and *Idaeobatus*, which are divided by the ability of their mature fruits to separate from the receptacle. In *Rubus* the receptacle remains inside the fruit and is eaten, whereas in *Idaeobatus* the fleshy fruit is detached and the receptacle is left on the plant. Very few *Rubus* species are cultivated commercially but many species are collected from the wild in Asia and South America (Jennings, 1988; Thompson, 1995).

Two main *Rubus* species are used in commercial soft fruit production: the red raspberry (*Rubus idaeus)* and the blackberry (*Rubus* spp.). *Rubus idaeus* can be divided into two subspecies based on their ecotypes (Jennings, 1988). The two subspecies are the European red raspberry (*R.idaeus* subsp. *vulgatus*) and the North American and East Asian red raspberry (*R.idaeus* subsp. *strigosus*). Both subspecies are diploid but the European form has glandless and thimble-shaped fruit and the North American form has glandular inflorescences and round fruits (Jennings, 1988). Material derived from both subspecies are found wherever major raspberry breeding and cultivation has occurred and most modern-day cultivars contain both subspecies in their ancestry.

Raspberries can grow all over the UK quite successfully, but the major production areas are the South East, the West Midlands, East Anglia and Eastern Scotland (Perth and Angus). Breeders today concentrate on refining the raspberry plant with the aims of prolonging the harvesting season, introducing resistance or some degree of tolerance to various pests and diseases, producing bigger and better fruit and producing plants that are easy to manage and capable of producing consistently high yields for many years.

Raspberry fruiting extends over two seasons which themselves overlap: summer fruiting and Primocane fruiting. Summer fruiting varieties cover around 80% of the UK acreage.

They flower from early May until late June, after which they go on to fruit from mid June until mid August in the open field. New canes are produced each year from a perennial root system and the canes produced in year one flower and fruit in year two; the root system is perennial but the canes are biennial. Canes die after fruiting and are removed so that the new canes can be tied in to fruit in the following year. Primocane fruiting varieties flower from June onwards and fruit from late July until October. The yield obtained from primocane varieties is significantly less than that from summer fruiting varieties. Their root system is perennial, the canes are annual and are cut down to ground level over winter, the new spawn emerges in the following spring and starts flowering in early summer. The presence of the two fruiting seasons means that the raspberry cropping in Great Britain can exceed 18 weeks, and this long season is a very important commercial factor.

1.3 The Raspberry Breeding Programme at HRI – East Malling

The 6-month placement that Rachel Crossley undertook involved working with the raspberry breeder Mrs Vicky Knight at HRI-East Malling on the long-term raspberry breeding programme. The main aim of this programme is to produce through breeding and continual selection, new summer and primocane fruiting raspberries for future growers' trials, and then to release the best of these as new varieties for the UK and overseas markets.

The raspberry breeding programme is funded mainly by the Ministry of Agriculture, Fisheries and Food (MAFF) on a rolling 3-year commission. There is also significant funding from the East Malling Trust for Horticultural Research (EMTHR), which is used to fund the more applied, commercial part of the programme. The Horticultural Development Council (HDC) also funds the 6-month placement for a student to work with the breeder at East Malling and some of the grower trials.

Between April and September, Rachel Crossley was involved in all aspects of the breeding programme and details of four major areas are given in sections 2-5.

2. SEED TREATMENT, GERMINATION AND SEGREGATION OF SPINY AND SPINELESS SEEDLINGS

2.1 Introduction

The percentage germination in raspberries varies from year to year, but is generally quite poor due to the fact that *Rubus* seeds have very hard seed coats and require a period of dormancy prior to their germination. In nature, this dormancy phase is caused by an acidic substance or substances that are inhibitory to growth, and it is broken when the seed is exposed to low winter temperatures (Jennings, 1988). The substance(s) is thought to be produced in the endosperm of the seed from whence it diffuses into other surrounding tissues and its disappearance correlates to the end of the dormancy phase.

The changes that can be made to shorten this dormancy phase are the application of treatments, such as sulphuric acid, which have the effect of scarifying or softening the seed coat in order that gaseous exchange and water uptake can occur and induce the seed's germination.

The spineless trait is desirable in raspberries for all handling purposes, such as picking and pruning, and it is possible to select for this trait soon after germination because the spiny seedlings can be recognised by glandular hairs or trichomes around the outside edge of the cotyledons. These trichomes are absent on those seedlings that develop into spineless plants.

2.2 Method

The 22 primocane fruiting seed lots produced in summer 1999 were all subjected to sulphuric acid treatment in January 2000. This comprised covering the seeds with concentrated sulphuric acid for 90 minutes in an ice bath, washing off the acid with iced water for 10 minutes and then washing under running water for another 10 minutes. The seeds were then soaked for 20 minutes in 10% bleach, and washed under running water for a further 10 minutes. Lastly, the seeds were put in distilled water in vials in the fridge and the distilled water was changed on days 2, 3, 6 and 8. During this time the phenolic substances assumed to inhibit germination leach out of the seeds and are removed by changing the water. Lastly, the seeds are air-dried overnight to facilitate handling.

The treated seeds are then sown into trays (approximately 250 per tray) and placed in a cold store at 2-4ºC for at least six weeks. Families 6706 to 6719 (batch 1) were transferred from the cold store to the glasshouse on the 6 March 2000 and families 6720 to 6727 (batch 2) were transferred on the 3 April 2000. The temperature in the glasshouse ranged from 20-25ºC and germination began after 10-14 days. Germination and the numbers of spiny and spineless seedlings were recorded twice a week from then on. Germination in batch 1 was recorded from 20 March to 13 April 2000 and batch 2 from 13 April to 9 May 2000.

The seedling selection process involved using a X10-hand lens to check for spiny seedlings in segregating families, and when found they were removed with a pair of forceps, numbers were recorded and the spiny seedlings discarded. The numbers of spineless seedlings remaining were counted and the total cumulative number of seedlings germinated per tray recorded. If any families that segregated had low germination, the spiny seedlings were retained so that sufficient seedlings were available for potting.

When the seedlings were large enough to handle, they were pricked out of the trays and planted into small pots. Either 250, 200 or 150 seedlings were potted per family and they were stood out in blocks on the glasshouse benches to grow.

2.3 Results

Table 1 shows the mean percentage germination and standard errors for each of the 22 families sown. Nine of the families had a very high percentage germination of over 70% (6706 and 6709-6716 inclusive), with family 6710 having the highest percentage germination of 87.4%.

Seven families displayed a moderately high percentage germination of between 44-57%, and six families showed a relatively poor percentage germination of 33% or less, two of which were less than 10% after seed treatment. The percentage germination in family 6723 and 6724 were 9.9 and 8.9, respectively which was poor, considering that the average germination of untreated seeds is approximately 10%.

The seed trays of families 6707, 6720, 6723 and 6725 were retained for several weeks after most other families had been potted, because insufficient numbers had germinated. This meant that every seedling that had germinated by the end of May was potted until the required number was achieved. Two hundred and fifty seedlings were required of family 6707 and after the extended germination period 186 were potted while 181 out of the 200 required were potted of family 6725. Two hundred plants were required of family 6720 and 150 of family 6723 and both these numbers were reached by the beginning of June.

Thirteen out of the 22 families were segregating for spinelessness, which is a recessive character. In ten families the two parents were homozygous spineless (ss) and heterozygous spiny (Ss) so the progeny segregated 1:1 for spiny and spineless seedlings. In three families both parents were heterozygous spiny so the progeny were 3:1 spiny and spineless. In family 6719, selection for spineless seedlings stopped on the 6 April as germination was not high enough to continue discarding the spiny seedlings. Families 6723 and 6724 were segregating 3:1, and in family 6724 selection took place once on 25 April and was stopped because of poor germination. In families 6719, 6723 and 6724 a mixture of spiny and spineless seedlings were planted in the field. Six families produced all homozygous spiny seedlings and three families produced all homozygous spineless seedlings.

2.4 Discussion

In all but two families (6723 and 6724) the percentage germination was higher than the untreated average of 10%, which indicated that the acid treatment of the seeds increased germination. An untreated control was not used in this study for a comparison since there were insufficient seeds.

It is not fully known why the percentage germination varies so much between families that were subjected to identical seed treatments. There are several possible explanations for this variation in percentage germination, one of which is that the thickness of the seed testa varies and so the seeds subsequently show altered durability to the scarification treatment. Other reasons are that the seed coat may be intact but the embryo inside it may be damaged or dead, or that there may be fungal contamination in the seed trays or compost (unlikely as the seed, soil and trays are sterilised prior to sowing), or environmental differences in the

glasshouse and cold store environments may have affected the seeds but changes in these environments are kept to a minimum.

The required number of seedlings were potted from all but two families (6707, and 6725). Although a few seedlings continued to germinate, any potted after 3 June would have been too small to plant out in July 2000. The shortfall in numbers in families 6707 and 6725 was relatively minor, so in broad terms germination was satisfactory in 2000.

The aim is to produce a high proportion of spineless seedlings for further evaluation in the field. Thirteen out of 22 families planted in 2000 are all spineless, a further three are segregating and six families are all spiny. This represents good progress towards the objective.

Table 1. Total number and percentage germination by 13 April 2000 in batch 1 and by 9 May 2000 in batch 2

Family	Total No. seeds sown	Total No. seedlings germinated	% germination	Standard error
6706	884	656	74.2	13.6
6707	621	124	20.0	0.7
6708	1385	766	55.3	7.0
6709	2880	2292	79.6	18.6
6710	1932	1688	87.4	10.6
6711	1932	1476	76.4	7.8
6712	1240	880	71.0	9.1
6713	1670	1378	82.5	2.4
6714	2184	1600	73.3	11.4
6715	952	689	72.4	7.5
6716	2488	1771	71.2	7.9
6717	2640	1364	51.7	9.9
6718	1788	804	45.0	9.8
6719	714	405	56.7	13.1
6720	1260	138	11.0	6.3
6721	2160	617	28.6	9.5
6722	2004	1068	53.3	6.9
6723	1515	116	7.7	4.9
6724	3008	268	8.9	2.4
6725	615	201	32.7	1.5
6726	1890	824	43.6	4.5
6727	2010	1110	55.2	9.8

3. SCREENING FOR RESISTANCE TO *AMPHOROPHORA IDAEI*

3.1 Introduction

Amphorophora idaei is also known as the large raspberry aphid and is the vector of four raspberry viruses that, singly or in combination, cause mosaic diseases. They include *Rubus* yellow net, black raspberry necrosis, raspberry leaf mottle and raspberry leaf spot, all of which cause gradual deterioration of the plants and loss of yield. The transmission of these viruses is semi-persistent; as the aphids feed on an infected plant they pick up the virus particles and then go on to transmit them to healthy plants. There is no known genetic immunity to these viruses, therefore the best way to control them is to eliminate the vector or select plants that have resistance to it.

Several genes for resistance to *A. idaei* have been identified and most parents used in the crossing programme at HRI- EM contain either A_{10} or A_{k4a}, (Knight 2000) both of which confer resistance to strains 1, 2, 3 and 4 of *A. idaei*. However there has been a recent occurrence of a new biotype of *A. idaei*, known as X, which is thought to have developed due to the selection pressures acting on those plants with $A_{10,}$ and up to now no resistance to biotype X has been found.

At HRI-East Malling, strain 2 of *A. idaei* is used to test for resistance in the seedlings. Aphid resistance has dominant inheritance but most parents are heterozygous for resistance. Consequently if one parent is heterozygous for aphid resistance and the other parent is susceptible then approximately 50% of the progeny will be resistant; if both parents are heterozygous resistant then 75% of their progeny will be resistant. The number of seedlings potted per family was determined by the expected segregation of resistant and susceptible individuals.

In 1992, the aphid screening was halted prematurely when the aphids were killed by mistake when an insecticide was used in an adjoining glasshouse. Most seedlings were planted untested although most progenies were expected to segregate for A_{10}. Some of these untested seedlings were used as parent in 1999.

3.2 Method

A small collection of strain 2 aphids was received from the Scottish Crop Research Institute in April 2000 to be used as the starting stock for this part of the programme. The 22 seedling families mentioned in the germination section of this report were set out in families on glasshouse benches in blocks of 50 seedlings along with two Malling Landmark raspberry plants which we used as aphid stock plants. (Malling Landmark is resistant to strains 1 and 3 but susceptible to strains 2 and 4.)

Three adult aphids (recognised by their pointed abdomen) were placed on the younger leaves of each seedling; each row was labelled with the family number, date of inoculation and number of adults received. The inoculated seedlings were then left for 4 days and the aphids asexually reproduced. The resulting nymphs were seen on the susceptible seedlings. After four days the underside of all leaves on each of the inoculated plants were inspected and the seedlings were classified using the following criteria:

- Resistant – completely free of aphids; no adults, no nymphs
- Intermediate – either one or two adults but no nymphs, or a few nymphs but no adults. If this occurred then the seedling received one more adult aphid and was left for a further four days and then reassessed.
- Susceptible – one or more adults, several nymphs

The numbers of resistant and susceptible seedlings were recorded, and the resistant seedlings were then put outside in trays to harden off prior to planting in the field. The susceptible seedlings were used as a source of further aphids for inoculation and then discarded. Some resistant seedlings were also tested for raspberry bushy dwarf virus (RBDV) using the ELISA technique.

3.3 Results

Table 2 shows the genotypes of the parents used in 1999 and the results of the screening programme for the year 2000. Table 3 shows the results of the 2000 screening programme as a percentage of the total number of seedlings tested.

If both parents were heterozygous for the *A. idaei* resistance gene, $A_{10,}$ the progeny should segregate following Mendelian genetics on a 3:1 ratio of resistant:susceptible. Looking at table 3, the numbers observed were close to the numbers expected in families 6717-6719. However, in the five other families with the same gene combination the numbers of observed were not as close to the numbers expected. In family 6711 and 6712 there were slightly more susceptibles than expected, while in families 6714, 6723 and 6724 there were more resistant seedlings than expected.

In the five families where only one parent carried the resistance gene, the progeny should segregate on a 1:1 basis of resistant:susceptible This was true of 6706, 6715 and 6722 but not of 6707 and 6713. Families 6707 and 6713 had a particularly low number of resistant seedlings being approximately half the number of those that tested susceptible.

In most of the families where one or both parents had not been tested the percentage of resistant seedlings was well over 50%. In families 6709, 6710, 6716, 6726 and 6727 the ratio of resistant:susceptible seedlings is approximately 3:1 and so it could be assumed that the not tested (NT) parents (6481/17, 6478/55, 6479/37 and 6482/12) had the A_{10} resistance gene. In family 6720 the ratio is approximately 1:1, which suggests that the NT parents 6471/98 lacked the resistance gene and were therefore susceptible. The only NT parent which gave conflicting results was 6479/37. The results for family 6708 suggest it was susceptible ($a_{10)}$ whereas the results for 6721, 6725 and 6726 suggest it was resistant ($A_{10)}$.

3.4 Discussion

After inoculating in most families, it was obvious which plants were resistant and which were susceptible. However, in family 6707 for a period of approximately two weeks there seemed to be aphids on most of the plants and so it became hard to distinguish which were resistant and which were susceptible. To combat this problem a second inoculation of aphids was applied to the queried seedlings, and they were then reassessed. This proved helpful as a distinction could then be made between the resistant and susceptible seedlings. One possible reason for this is that the aphids had overcome the resistance of the seedlings.

Misclassification may have been made in the families where the expected and actual ratios did not match. A seedling may have been recorded as susceptible when in fact it was

resistant and vice versa, or alternatively the aphids may have overcome the resistance of the seedling. Neither reason can be confirmed.

From the ratios of the relevant families, it appears likely that 6478/55, 6481/17 and 6482/112 are resistant (A_{10}), whereas 6471/98 is susceptible (a_{10}). Referring to the 1998 results, it appears that 6479/37 is resistant and three out of four progenies in 2000 support this view; only family 6708 produced an excess of susceptible seedlings that cannot be explained readily.

The mean percentage of broken or dead plants from the whole of the seedling population is only approximately 4%. This represents a very low number of lost seedlings and reflects careful handling during screening. The number of resistant seedlings required for planting as specified by the breeder was generally achieved. Out of 4,239 seedlings potted, 2,488 aphid resistant seedlings were planted in the field.

Table 2. *Amphorophora idaei* resistance genes found in the 1999 parents of the 2000 progenies and the results of the aphid screening programme in 2000

Family	Parents		*Amph*. Resistance genes		Number			
	Female	Male	Female	Male	Potted	Resistant	Suscep-tible	Broken/ dead
6706	Joan Squire	6523/8	SUS	A_{10}	250	120	115	15
6707	Polana	6523/8	SUS	A_{10}	186	70	111	5
6708	6479/37	6523/8	NT	A_{10}	200	78	112	10
6709	6481/17	6529/85	NT	A_{10}	200	150	49	1
6710	6481/17	6535/1	NT	A_{10}	200	171	28	1
6711	6523/8	6531/79	A_{10}	A_{10}	150	95	55	0
6712	6535/1	6523/8	A_{10}	A_{10}	150	105	45	0
6713	Joan Squire	6529/85	SUS	A_{10}	250	80	169	1
6714	6529/85	6220/72	A_{10}	A_{10}	150	131	19	0
6715	Joan Squire	6531/79	SUS	A_{10}	250	130	118	2
6716	6478/55	6535/1	NT	A_{10}	200	167	14	19
6717	6528/59	6531/62	A_{10}	A_{10}	150	113	23	14
6718	6528/59	6531/79	A_{10}	A_{10}	150	110	30	10
6719	6531/62	6378/19	A_{10}	A_{10}	150	95	39	16
6720	6378/19	6471/98	A_{10}	NT	222	112	102	8
6721	6479/37	6471/98	NT	NT	250	147	95	8
6722	Joan Squire	6442/139	SUS	A_{10}	250	134	113	3
6723	6378/19	6442/139	A_{10}	A_{10}	150	127	20	3
6724	6378/19	6442/155	A_{10}	A_{10}	150	132	16	2
6725	6479/37	6442/139	NT	A_{10}	201	118	57	6
6726	6479/37	6442/155	NT	A_{10}	200	156	40	4
6727	6482/112	6442/155	NT	A_{10}	200	160	26	14

Table 3. Results of the *A. idaei* screening programme in 2000 showing the percentage of resistant and susceptible seedlings, and the expected ratio, in each family

Family	Expected ratio Res:Sus	*A. idaei* resistant plants (%)	*A. idaei* susceptible plants (%)	broken/ dead (%)
6706	1:1	48.0	46.0	6.0
6707	1:1	38.0	60.0	2.7
6708	1:1 or 3:1	39.0	56.0	5.0
6709	1:1 or 3:1	75.0	24.5	0.5
6710	1:1 or 3:1	85.5	14.0	0.5
6711	3:1	63.3	36.7	0.0
6712	3:1	70.0	30.0	0.0
6713	1:1	32.0	67.6	0.4
6714	3:1	87.3	12.7	0.0
6715	1:1	52.0	47.2	0.8
6716	1:1 or 3:1	83.5	7.0	9.5
6717	3:1	75.3	15.3	9.3
6718	3:1	73.3	20.0	6.7
6719	3:1	63.3	26.0	10.7
6720	1:1 or 3:1	50.4	45.9	3.6
6721	1:1 or 3:1	58.8	38.0	3.2
6722	1:1	53.6	45.2	1.2
6723	3:1	84.6	13.3	2.0
6724	3:1	88.0	10.7	1.3
6725	1:1 or 3:1	58.7	28.3	12.4
6726	1:1 or 3:1	78.0	20.0	2.0
6727	1:1 or 3:1	80.0	13.0	7.0
Mean		65.3	30.8	3.9

4. THE YEAR 2000 CROSSING PROGRAMME

4.1 Introduction

Controlled cross-pollinations are carried out on raspberry plants in order to combine the desired characteristics of two parents and to select for the combination of desired characteristics in the progeny plants. The 2000 crossing programme involved choosing summer fruiting plants with different desirable characteristics using them as parents. This breeding strategy is known as recurrent selection

4.2 Materials and Methods

Male parents were those plants that were used as a pollen source, either directly by collecting their flowers with dehisced anthers or by extracting pollen from closed buds and leaving them in a desiccator until the pollen had dehisced. Female parents were those which were emasculated so that their pollen was removed and their styles were exposed to pollen from another plant. Pollen could then be applied in order that pollination would occur.

Once both parents had been decided upon, the next step was to prepare the female flowers. A strong flowering lateral was chosen that had between five and ten unopened large buds. The small immature buds and leaves were removed because the pollination of immature buds would fail as the style, stigma and ovaries would not be far enough advanced to be receptive and therefore the fruit would not set. To emasculate the female flower, a scalpel was dipped into ethanol in order to prevent any contamination, and one circular incision around the widest part of the bud allowed the petals, sepals and anthers to be removed to leave the styles exposed. This process was repeated for every bud on the lateral, after which the lateral was covered with a pollinating bag (in order to prevent any pollination by insects) and tied with wire around the neck of the bag, and then to a cane for support. Labelling is an essential part of pollination; each lateral used was labelled with a metal tag showing the identity of both parents, the number of buds emasculated and the date of emasculation.

The pollen from the male parent was collected in two ways. Firstly, closed but large buds were collected from the plant to be taken back to the laboratory to have the non-dehisced

anthers removed. The anthers were then put into a petri dish and left overnight to dehisce, the next day the petri dish was sealed and placed in a desiccator at 4^{o}C. Pollen extracted *via* this method is considered viable for at least 6 months and so it was used for those crosses where the female flowered at a different time to the male. If the male and female flowered at similar times then laterals were chosen on the male parent that had approximately eight to ten unopened flowers, the leaves and any open flowers were removed and the laterals were then covered with polythene bags to prevent any pollination whilst the flowers were opening.

Two to three days after emasculation, when the female flowers were receptive, the opened male flowers were collected and their anthers brushed over the receptive stigmas on the female flowers, or alternatively the pollen from the dessicator was applied lightly to the stigmas to achieve pollination. This process was carried out at 2-3 day intervals for each female flower until the fruit had started to swell, each time the bags were replaced to prevent any unwanted pollination with other pollen carried by bees. After the final pollination, the bags were left on the female plants for approximately 5-6 weeks to allow the fruit to ripen fully. The bags on the male parents were removed during this time. Between 20 and 30 fruits are required from each cross to produce enough seed for the next year's seedlings.

Ripe fruits were collected from each individual cross into labelled pots. The numbers of fruit set or failed to set and the number of fruit with less than 10 drupelets was recorded. When all fruit from each lateral on the female plant had been removed the bags and labels could be taken off. When all of the fruit from each cross had been collected, the seed could be extracted. This was done by placing the fruit into a blender with around 300ml of tap water and agitating it for a period of 10 seconds, then for a further five seconds. This resulted in a layer of pulp and non-viable seed floating on top of the water and the viable seeds settling on the bottom of the container. The seeds were then soaked on a 10% bleach solution for 2 minutes to sterilise them. The seeds were then rinsed thoroughly in running tap water and emptied onto labelled filter paper to allow them to dry. After several hours they were transferred into a sealed, labelled wax bag and placed in the fridge.

For each seed lot, an estimated number of seeds was calculated. From each seed lot three samples of 100 seeds were weighed and the average weight calculated. The total weight of

seeds was recorded and the total number estimated. Each lot was then divided into two by weight and placed into two bags in the fridge so that they will each undergo a different scarification treatment in January 2001, after which they will be sown and germinate in the spring.

4.3 Results

The results of the year 2000 crossing programme are summarised in Table 4. This table shows the number of flowers emasculated per cross, the number of fruit set well, the number of fruit that had less than 10 drupelets and the number of fruit that failed to set after pollination, plus as the estimation of the number of seeds obtained from each cross.

Ten crosses had 10 or more flowers that had failed to set. There were two main reasons for this. Firstly there were rather strong winds during the early pollination period and the weight of the bags make the laterals more susceptible to wind damage so that they broke off at the base. Secondly in the later crosses laterals were chosen which were on cane which died between pollination and harvest. Canes which look healthy in May or June can suddenly collapse, usually because they affected by the cane blight fungus.

Large differences can be seen in the number of fruit set and the estimated number of seeds produced from each cross. Only two progenies 6740 and 6743 gave 100% well set fruit, but they did not give the highest estimated number of seeds. Progeny 6759 gave the highest estimated number of seeds (2870) from the highest number of flowers and progeny 6739 gave the lowest (626) from a reasonable number of flowers. There were only two progenies that produced significantly less than 1000 seeds: 6739 gave an estimated 626 seeds and 6752 gave an estimated 810 seeds.

Table 4. Parents used in the 2000 summer fruiting crossing programme and the major objectives of each cross

Family	Parents		Major objectives of each cross
	Female	Male	
6728	Malahat	6413/59	Extra early ripening crosses using parents that are much earlier than Glen Moy
6729	Malahat	6546/20	
6730	6390/47	Malahat	
6731	6390/47	6413/59	
6732	6413/59	6488/58	
6733	6414/14	6546/20	
6734	6511/53	6488/58	
6735	6413/59	6544/80	Combining earliness plus some frost tolerance
6736	6414/14	6490/36	
6737	6544/80	6390/47	
6738	6511/22	6544/80	Combining earliness, good shelf life and frost tolerance
6739	G. Ample	6399/84	Midseason crosses combining good yield and fruit quality
6740	Tulameen	6507/56	
6741	9059C1	6507/56	
6742	6428/80	6505/7	
6743	6507/56	G. Ample	
6744	6506/37	6489/111	
6745	6343/15	Tulameen	Late ripening crosses combining yield and fruit quality
6746	6343/15	6585/1	
6747	6345/15	6428/1	
6748	6385/1	6508/135	
6749	6428/80	6343/15	
6750	6512/50	6428/1	
6751	6512/50	6428/80	
6752	6514/53	Tulameen	
6753	6514/53	6487/74	
6754	9025A1	6312/66	Combining good mechanical harvesting types from SCRI and HRI programmes
6755	9059C1	6312/66	
6756	6454/76	G. Ample	Retaining very late ripening and high numbers of flowers per lateral, while improving fruit size and colour
6757	6454/76	9059C1	
6758	6496/22	Tulameen	
6759	6496/22	6505/7	
6760	6507/35	9059C1	Intercrossing selections with good shelf life to improve shelf life further
6761	6507/35	6487/74	
6762	6508/135	6507/35	

Table 5. Results of the year 2000 summer fruiting crossing programme.

Family Number	Parents		No. flowers emasculated	Fruit			Estimated No. seeds
	Male	Female		set well	<10 drupelets	failed	
6728	Malahat	6413/59	37	31	0	6	2091
6729	Malahat	6546/20	34	30	2	2	1541
6730	6390/47	Malahat	36	33	0	1	2051
6731	6390/47	6413/59	38	27	1	10	2480
6732	6413/59	6488/58	33	25	0	8	2219
6733	6414/14	6546/20	29	26	0	3	1968
6734	6511/53	6488/58	36	34	0	2	2079
6735	6413/59	6544/80	38	28	0	10	2706
6736	6414/14	6490/36	25	12	1	13	1017
6737	6544/80	6390/47	47	31	7	8	1416
6738	6511/22	6544/80	34	17	4	13	1699
6739	G. Ample	6399/84	38	28	4	6	626
6740	Tulameen	6507/56	33	33	0	0	1423
6741	9059C1	6507/56	30	29	1	0	1609
6742	6428/80	6505/7	37	35	0	1	2486
6743	6507/56	G. Ample	31	31	0	0	2048
6744	6506/37	6489/111	31	14	0	17	2206
6745	6343/15	Tulameen	34	22	0	12	1431
6746	6343/15	6585/1	32	22	0	10	1118
6747	6345/15	6428/1	39	20	0	19	1373
6748	6385/1	6508/135	35	25	2	8	1623
6749	6428/80	6343/15	32	31	0	1	2140
6750	6512/50	6428/1	35	23	0	12	1795
6751	6512/50	6428/80	36	27	0	9	1931
6752	6514/53	Tulameen	25	22	0	3	810
6753	6514/53	6487/74	30	25	2	3	1164
6754	9025A1	6312/66	32	22	0	10	1361
6755	9059C1	6312/66	31	28	0	3	1726
6756	6454/76	G. Ample	32	26	1	5	1687
6757	6454/76	9059C1	30	25	0	5	2231
6758	6496/22	Tulameen	33	26	6	1	2012
6759	6496/22	6505/7	43	37	3	3	2870
6760	6507/35	9059C1	30	24	0	6	1346
6761	6507/35	6487/74	28	22	0	6	1988
6762	6508/135	6507/35	32	30	0	2	2847

4.4 Discussion

From the results obtained in this crossing programme, it can be seen that most families achieved a seed number of more than 1000, with some crosses giving significantly more seeds than others. The reasons for this are that the difference in fruit size means that different numbers of seeds can be produced from each fruit; pollen transfer may have been inefficient and so the seed carpel may not have been formed properly; the female stigmas may have been damaged during emasculation; and a percentage of raspberry seeds are naturally non-viable therefore reducing the number of seeds from the outset.

In four crosses, less than 30 emasculations were carried out on the female plant and this meant that there could possible be a shortage in berry numbers that set well. In 24 crosses out of the 35 less than 30 fruit set well, in only 3 (6736, 6738 and 6744) of these crosses however less than 20 fruit set well therefore showing that most families produced the required amount of fruit of between 20 and 30 berries. The number of seeds produced from the crossing programme was highly satisfactory, with 14 families giving over 2000 seeds and 19 families giving between 1000-2000 seeds to be raised in 2001.

5. THE STAGE 0 TRIALS

5.1 Introduction

Stage 0 trials are carried out on selections in the field that seem promising to the breeder for certain characteristics, namely the fruit. The fruit from each selection chosen is picked and assessed for the first time in order to see how they compare to existing varieties in fruit quality, yield and shelf life. If the stage 0 trials for a selection in one year show that the fruit are equally good or better than existing varieties then they are chosen again for the next year, if they perform well in the next year then they are propagated and sent to grower trials.

The fruit from each selection is picked from a known length of row and recorded twice a week throughout the fruiting season, usually on a Monday and Thursday. The stage 0 trials are carried out and when the fruiting season is coming to an end for each selection the picking stops. A measure of the fruiting season is found from the 5, 50 and 95% pick dates and all stage 0 trial results for each selection are compared to controls, which are selections that have been released into the industry.

Both summer fruiting and primocane fruiting selections are assessed in the stage 0 trials but only the summer fruiting selections will be discussed here because the primocane fruiting selections are still cropping.

5.2 Method

Forty-three promising summer fruiting selections were compared to four existing cultivars, Glen Ample, Tulameen, Malahat and Qualicum all of which have good fruit yield, quality and shelf life. Thirty primocane fruiting selections are presently being assessed and compared to the industry standard Autumn Bliss and the Polish cv. Polana.

A known length of row between 1.0 and 4.0 metres were measured on each selection and marked out using yellow tape. The aim was to pick a row that was a representative of the whole plot so that the yield for a certain plot size can be estimated to give kg per 10m row. Each selection was picked twice weekly from between the taped area until all fruit had been harvested. The fruit was sorted into punnets of marketable and unmarketable fruit by the

pickers, it was then weighed, a sample of 50 fruit was also weighed and if there were more than 25 berries it was assessed for 9 aspects of fruit quality, see Table 6.

Table 6. Nine raspberry quality attributes, graded on a 1-5 scale, in 2000

1. Redness				
pale	fairly pale	medium	dark	very dark
5	4	3	2	1
2. Brightness				
very bright	Bright	medium	dull	very dull
5	4	3	2	1
3. Shape				
long conical	Conical	blunt conical	roundish	round
5	4	3	2	1
4. Outline				
very even	Even	medium	irregular	very irregular
5	4	3	2	1
5. Uniformity of size				
very uniform	Uniform	medium	variable	very variable
5	4	3	2	1
6. Texture				
very firm	Firm	medium	soft	very soft
5	4	3	2	1
7. Cohesion				
all whole	mostly whole	slightly crumbly	crumbly	very crumbly
5	4	3	2	1
8. Skin strength				
none broken		1/5-3/5 broken		4/5 or all broken
5		3		1
9. Flavour				
very good,				very poor,
aromatic, strong		slightly acid,	poor,	very acid,
raspberry		moderate,	acid,	no raspberry
flavour	Good	bland	weak	flavour, foreign
5	4	3	2	1

5.3 Results

Table 7 shows the total yield of marketable and unmarketable for each selection tested in the 2000 Stage 0 trials converted to kg per 10m row. The table shows that Glen Ample has the highest marketable yield (69.25kg per 10m row) and that selection 6511/12 has the lowest (11.45kg per 10m row). Two of the breeder's selections (6507/35 and 6514/6) gave a higher marketable yield than Tulameen, and a total of 20 selections gave a higher marketable yield than Qualicum.

Two selections, 6512/50 and 6495/99 produced the highest weight of unmarketable fruit (26.94kg/10m row) and selection 6508/68 produced the lowest weight of unmarketable fruit (3.48kg/10m row). The highest total weight of fruit was produced by Glen Ample (89.17kg/10m row) and 35 of the 47 genotypes tested had a total yield of higher than 30kg/10m row.

Six selections plus Glen Ample, Tulameen and Qualicum had a mean fruit weight of more than 4.0g, with selection 6506/37 having a mean fruit weight of 5.78g over the fruiting season compared to 4.94g with Glen Ample. Selection 6493/50 had the lowest mean fruit weight of only 2.50g but still produced a total marketable fruit weight of over 30kg/10m row.

Table 8 summarises the mean quality character scores for each selection over the fruiting period. Selections 6507/35 scored over 3 for 5 quality characters and 6513/6 scored over 3 for 6 quality characters, both of which performed only slightly less well than Glen Ample in their weight of marketable yield. Selection 6506/37 performed the best as far as taste with an average flavour score of 3.86, compared with 3.82 for Tulameen; selection 6571/37 had the lowest average score for taste of 1.83. Twelve of the 43 selections that were tested performed better than all of the controls for redness; Malahat performed the best for brightness but 6 selections performed better than Glen Ample, Qualicum and Tulameen; only selection 6485/41 scored less than 4 for cohesion, showing that there was very little crumbly fruit in 2000 apart from in this selection.

Table 9 shows the 5, 50 and 95% pick dates for the 47 genotypes, ranked for season of ripening, with the earliest at the top of the table. Table 9 shows that Glen Ample and

Tulameen were very similar in season at HRI-EM in 2000 and that both are midseason/late. The Canadian cv. Malahat was the earliest ripening cv. picked in 2000 because, unfortunately, there was not a suitable plot of Glen Moy.

5.4 Discussion

Fruit size is a very important feature of raspberries due to the fact that they are picked by hand and so the larger the fruit the less needed to be picked per kilogram. Seven genotypes from the top half of the yield table had an average individual fruit weight of more than 4g which means that they would be very productive on a commercial scale. Genotypes with an average fruit size of between 2.5 and 3.0g are probably too small to be picked by hand but they could be potentially valuable for machine harvesting if they are good in other ways.

All results obtained from the 2000 Stage 0 trials will be referred to in order to decide if a selection that has performed successfully in two consecutive years Stage 0 trials will go on for grower trials, or whether a selection that has been tested for the first time in 2000 will be tested again in 2001. Finally this data will also be used by the breeder when choosing summer fruiting parents for future crosses.

Table 7. The 2000 summer fruiting genotypes, their marketable (mkt) and unmarketable (unmkt) yield and weight of 50 fruits, arranged in descending order of marketable yield

Selection	Weight of mkt fruit (Kg/10m row)	Weight of Unmkt fruit (Kg/10m row)	Total weight of fruit (Kg/10m row)	Mean weight of individual fruit (g)
Glen Ample	69.25	19.92	89.17	4.94
6507/35	45.35	15.81	61.16	4.10
6513/6	43.62	21.45	65.07	4.19
Tulameen	43.22	19.01	62.23	4.43
6487/74	39.78	18.34	58.12	3.33
6511/22	38.59	7.88	46.47	2.88
9059C1	37.89	13.29	51.19	3.47
6487/99	35.32	18.67	53.99	3.73
6571/37	33.96	18.44	52.39	2.85
6551/38	31.24	7.97	39.21	3.42
6489/131	30.15	13.92	44.07	3.99
6508/116	29.88	8.90	38.78	3.08
6517/92	29.50	6.58	36.08	2.92
6512/50	29.29	26.94	56.24	4.72
6505/7	27.94	15.64	43.58	4.90
6451/128	27.85	15.73	43.58	3.67
6490/24	27.76	18.10	45.86	3.64
6495/99	27.44	26.94	54.38	3.29
6506/37	27.34	8.26	35.60	5.78
6564/59	26.06	11.73	37.80	3.51
6564/87	25.86	5.80	31.66	3.19
6489/40	25.44	8.14	33.58	2.83
Qualicum	24.86	8.36	33.22	4.18
6494/53	24.14	12.79	36.93	3.65
6490/95	23.92	11.85	35.77	2.62
6551/40	23.90	12.94	36.83	3.55
Malahat	23.21	4.55	27.75	3.35
6544/80	22.62	2.50	25.12	3.20
6516/19	22.60	12.45	35.05	3.23
6493/50	21.73	9.48	31.21	2.50
6489/111	20.77	10.35	31.12	4.32
6495/53	19.22	15.51	34.72	3.31
6558/83	19.17	8.71	27.88	3.08
6490/108	19.14	12.71	31.85	3.33
6551/50	19.05	6.70	25.75	3.18
6508/68	18.99	3.48	22.48	3.58
6495/58	18.26	19.24	37.51	3.34
6514/64	17.82	5.34	23.16	4.19
6517/11	17.27	9.60	26.86	3.25
6504/21	16.74	9.77	26.51	3.64
6493/20	15.61	19.80	35.40	2.72
6485/41	15.50	15.89	31.39	4.54
6511/53	15.29	16.84	32.13	2.85
6551/58	15.23	7.39	22.62	3.63
6544/6	13.90	4.26	18.16	2.70
6560/17	12.69	8.70	21.39	3.82
6511/12	11.45	3.98	15.43	3.59

Table 8. The mean fruit character scores for each summer fruiting selection tested in the 2000 Stage 0 trials, arranged in descending order of marketable yield

Selection	Quality Attributes								
	Redness	Brightness	Shape	Out-line	Uni-formity	Texture	Cohesion	Skin strength	Flavour
Glen Ample	3.33	3.75	3.00	3.58	3.67	3.75	4.58	3.67	3.75
6507/35	3.36	2.45	2.91	3.36	3.09	2.91	4.91	3.73	2.91
6513/6	2.58	3.67	2.33	3.33	3.42	2.67	4.25	3.67	3.33
Tulameen	3.09	3.82	3.91	3.82	3.82	3.45	5.00	3.91	3.82
6487/74	4.44	2.67	2.22	3.56	3.33	2.56	4.56	3.67	3.11
6511/22	2.30	2.30	3.40	3.90	2.90	2.50	4.90	4.40	3.30
9059C1	3.55	3.82	2.64	3.09	3.27	3.55	5.00	3.55	3.45
6487/99	4.10	2.60	2.90	2.70	3.30	2.80	4.20	3.20	2.50
6571/37	1.75	1.17	2.25	3.25	3.42	2.92	4.50	4.00	1.83
6551/38	3.00	4.00	3.50	3.50	3.25	3.12	5.00	3.00	3.37
6489/131	3.08	2.92	3.75	3.33	3.42	3.00	5.00	3.67	3.08
6508/116	2.89	3.44	3.11	3.00	3.22	2.56	4.56	3.89	2.44
6517/92	2.00	2.00	4.00	3.75	3.50	2.87	5.00	4.50	2.62
6512/50	3.67	2.89	2.89	3.67	3.56	3.89	5.00	3.67	3.33
6505/7	3.20	3.90	4.00	3.80	3.60	3.30	4.90	3.20	3.50
6451/128	4.45	3.00	2.64	3.27	3.45	2.91	4.73	3.36	3.45
6490/24	3.27	3.64	3.82	3.45	3.36	3.27	4.64	4.09	2.82
6495/99	4.20	3.70	3.70	3.40	3.40	2.60	4.70	2.60	2.70
6506/37	3.00	3.29	4.57	3.86	4.29	4.14	5.00	4.43	3.86
6564/59	2.10	3.70	3.10	3.40	3.10	2.80	4.70	3.60	2.50
6564/87	3.09	3.45	3.45	3.64	3.09	3.27	5.00	3.73	3.27
6489/40	3.27	3.09	2.82	3.55	3.27	3.64	4.91	4.27	3.09
Qualicum	2.73	2.82	4.00	4.09	2.82	3.45	4.91	2.45	3.64
6494/53	3.50	3.90	3.70	3.10	3.30	2.70	4.60	4.00	3.60
6490/95	4.67	3.11	3.11	3.33	3.22	3.67	5.00	4.78	3.22
6551/40	2.60	3.80	3.70	3.40	4.10	3.00	4.30	3.00	2.70
Malahat	3.00	4.37	3.37	3.50	3.62	3.25	4.75	3.25	3.37
6544/80	3.12	2.37	3.62	3.62	3.37	3.37	4.62	3.75	3.12
6516/19	3.12	3.00	3.30	3.40	3.10	2.30	4.70	4.00	3.50
6493/50	3.60	2.60	3.30	3.20	4.00	3.00	4.30	4.80	2.40
6489/111	2.36	3.55	3.91	3.73	3.27	3.36	4.82	3.36	3.18
6495/53	2.60	4.30	3.80	3.50	3.00	3.10	4.50	3.60	3.40
6558/83	2.25	2.62	3.50	3.37	2.50	4.00	5.00	4.00	3.12
6490/108	3.00	3.89	3.67	3.11	3.22	3.00	4.67	2.78	2.56
6551/50	2.75	3.00	3.50	2.62	3.50	3.12	4.25	3.25	2.75
6508/68	3.17	4.33	3.33	4.00	2.67	4.00	5.00	4.33	3.17
6495/58	3.12	4.00	4.12	3.87	2.87	2.75	4.87	3.00	3.12
6514/64	2.17	3.00	3.67	3.83	2.67	3.67	5.00	4.00	3.00
6517/11	3.00	2.33	3.89	3.33	3.22	3.00	5.00	3.89	2.56
6504/21	4.40	3.40	4.00	2.80	3.20	3.20	4.40	3.80	2.80
6493/20	3.00	3.50	3.10	2.60	2.50	3.00	4.20	4.00	2.70
6485/41	2.89	3.33	3.11	3.33	3.44	3.44	4.89	4.78	3.56
6511/53	3.00	2.50	2.87	2.62	3.37	2.62	3.00	4.00	2.50
6551/58	4.12	3.75	3.50	3.50	3.50	3.25	4.87	2.00	3.00
6544/6	2.14	2.57	4.43	3.71	3.43	2.29	4.71	3.86	2.14
6560/17	3.00	2.11	3.44	3.11	3.56	3.44	4.33	4.11	2.22
6511/12	2.83	3.33	3.83	3.33	3.33	1.50	4.67	3.67	3.00

Table 9. The 5%, 50% and 95% pick dates of the Stage 0 entries, arranged in descending order of ripening season

Selection	5% Pick	50% Pick	95% Pick
6544/6	12-Jun	26-Jun	09-Jul
6551/58	18-Jun	30-Jun	12-Jul
6544/80	19-Jun	30-Jun	11-Jul
Malahat	20-Jun	01-Jul	12-Jul
6551/38	20-Jun	03-Jul	11-Jul
6511/12	21-Jun	30-Jun	11-Jul
9059C1	21-Jun	04-Jul	20-Jul
6551/40	21-Jun	05-Jul	17-Jul
6511/53	21-Jun	05-Jul	18-Jul
6505/7	22-Jun	05-Jul	20-Jul
6517/92	23-Jun	05-Jul	15-Jul
6489/40	24-Jun	06-Jul	20-Jul
6493/50	24-Jun	06-Jul	21-Jul
6511/22	25-Jun	06-Jul	20-Jul
6490/95	25-Jun	07-Jul	21-Jul
6508/116	26-Jun	06-Jul	20-Jul
Qualicum	26-Jun	10-Jul	24-Jul
6507/35	26-Jun	11-Jul	27-Jul
6564/87	26-Jun	12-Jul	26-Jul
6489/11	26-Jun	13-Jul	30-Jul
6504/21	28-Jun	06-Jul	12-Jul
6508/68	28-Jun	07-Jul	16-Jul
6490/108	28-Jun	13-Jul	29-Jul
6571/37	28-Jun	16-Jul	04-Aug
6517/11	29-Jun	10-Jul	23-Jul
6495/53	29-Jun	10-Jul	26-Jul
6506/37	29-Jun	12-Jul	22-Jul
6513/6	29-Jun	12-Jul	30-Jul
6490/24	29-Jun	13-Jul	26-Jul
Tulameen	30-Jun	11-Jul	29-Jul
6485/41	30-Jun	12-Jul	26-Jul
Glen Ample	30-Jun	12-Jul	28-Jul
6489/131	30-Jun	14-Jul	03-Aug
6516/19	30-Jun	15-Jul	31-Jul
6551/50	02-Jul	13-Jul	23-Jul
6451/128	02-Jul	13-Jul	30-Jul
6494/53	02-Jul	14-Jul	27-Jul
6564/59	02-Jul	14-Jul	28-Jul
6560/17	02-Jul	18-Jul	01-Aug
6558/83	04-Jul	14-Jul	25-Jul
6495/99	04-Jul	14-Jul	30-Jul
6487/74	05-Jul	13-Jul	29-Jul
6514/64	05-Jul	14-Jul	23-Jul
6493/20	05-Jul	16-Jul	30-Jul
6487/99	05-Jul	16-Jul	03-Aug
6495/58	06-Jul	18-Jul	04-Aug
6512/50	11-Jul	23-Jul	08-Aug

6. CONCLUSIONS

The main objectives for the HDC project SF 8a for the 6 months from April to September 2000 were all met, in full and on time.

- Germination was good in the 22 primocane fruiting progenies and the majority of the seedlings planted in the field were spineless following selection in the seed tray.
- Screening for resistance to *Amphorophora idaei* was a success; 2,488 resistant seedlings were planted in the field in July and very few seedlings were lost during the screening procedure.
- The crossing programme in 2000 was highly satisfactory and 33 out of 35 crosses produced over 1,000 seeds per cross.
- The summer fruiting Stage 0 trials were picked and recorded from 20 June until 14 August. A few selections, which had been chosen for grower trials after the 1999 Stage 0 trials, performed well again in 2000 and some more promising selections were identified.

7. TECHNOLOGY TRANSFER

Five advanced selections (5928/114, 6166/98, 6432/71, 6220/70 and 6378/47), which have been identified in HDC replicated summer or primocane fruiting trials (SF 41) or in the Stage 0 trials at East Malling (SF 8a), are to be released and a Head Licence for marketing them is being finalised between HRI and Meiosis Ltd.

Selection 6506/37, which had been chosen for inclusion in Meiosis trials in 1999, performed very well in terms of fruit quality and will be recommended for inclusion in future replicated variety trials.

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