HORTICULTURE RESEARCH INTERNATIONAL

EFFORD

Report to:

Horticultural Development Council
18 Lavant Street
Petersfield
Hampshire
GU32 3EW

Tel: 0703 63736
Fax: 0703 65394

HRI Contract Manager:

Miss M A Scott
Horticulture Research International Efford
Lymington
Hampshire
SO41 0LZ

Tel: 0590 673341
Fax: 0590 671553

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CONTRACT REPORT

New Everbearing Strawberry Variety Trials at HRI Efford 1991 and 1992

Undertaken for Horticultural Development Council Project SF 18

PRINCIPAL WORKERS

HRI EFFORD

Mr C M Burgess BSc Hons (Hort), M.I.Hort (Author of report)	Trials Officer
Mr C F Smith	Assistant Scientific Officer
Mr N J Long	Foreman, Outdoor Crops
Mr D R W Joblin	Chargehand, Soft Fruit Crops

HRI EAST MALLING

Miss Gail Kingswell BSc DipManStudies	Statistician

AUTHENTICATION

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

Signature ....Margaret A. Scott.....

Margaret A Scott
Deputy Head of Station

Date 27/7/93

Report authorised by .....
Signature

M R Shipway
Head of Station

HRI Efford
Lymington
Hants
SO41 OLZ

Date 27/7/93

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HDC SF 18 (part)

New Everbearing Strawberry Variety Trials at HRI Efford 1991 and 1992

C M Burgess

HRI Efford

Co-ordinator : Mr D Goodwin

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RELEVANCE TO GROWERS AND PRACTICAL APPLICATION

Application

Two separate trials, cropped in 1991 and 1992, tested new everbearing cultivars from the HRI East Malling breeding programme. The cultivar Calypso, now commercially available, was of similar cropping season to Rapella and has given equally good yields but of significantly improved quality. Tango, available from autumn 1993, has outyielded Rapella by up to 40% with a much earlier cropping season from a spring planting, which should make a valuable contribution towards 'bridging the gap' between mainseason and everbearing crops.

Summary

The standard everbearing cultivar Rapella, while capable of producing good yields, frequently fails to meet supermarket standards for quality of fruit. Supermarkets in particular prefer consignments of the high quality mainseason cultivar Elsanta, which involves growers in more expensive production techniques to crop them 'out of season' to supply this market. The overall objective of these trials was to assess the performance of three new everbearing cultivars, bred at HRI East Malling, against the current standard Rapella. The new cultivars all originated from a Selva x Rapella cross, intended to combine some of the characteristics of Selva such as firmness and fruit size with the good yield potential of Rapella, with hopefully some improvements over both cultivars in fruit shape, disease resistance, cropping season etc. As both autumn and spring plantings are currently used in the industry, assessment of the possible effect this might have on performance was a secondary objective.

Two separate single year trials were carried out with cropping in 1991 and 1992. Typical double row polythene mulched raised bed culture was employed using pot raised plants and a final deblossoming at the end of May. Rapella was compared with the East Malling seedlings Tango (SBJ 1 / EMR 25), SBJ 7 (EMR 26), and Calypso (SBJ 2 / EMR 28). Planting dates of 10/9/90 and 23/4/91 were compared in Trial 1 whereas a single spring planting on 23/4/92 was used for Trial 2.

Overall, yields were good in both trials but particularly so from Trial 2 with mean Class 1 yields of Rapella at 861 g/plant in 1991 and 1423 g/plant in 1992 from the spring plantings (equivalent to 22.7 and 37.4 tonnes/ha respectively). It is believed that soil and bed preparation under ideal conditions, the use of 2 trickle lines per bed, and the large vigorous planting material used were the main ingredients contributing to the excellent growth and yields in the second trial. Tango produced the greatest yield in both years with a 36% and 10% improvement in Class 1 totals over Rapella from the spring plantings of Trials 1 and 2. Generally other cultivars did not differ significantly in yield from Rapella, but as a proportion of the whole crop including Class 2 and waste, the new cultivars and Calypso in particular produced higher proportions of Class 1 fruit. Fruit size was also better from the new selections, particularly with Tango. Calypso had the firmest fruit and Rapella the softest with Tango and SBJ 7 showing similar or slightly better firmness than Rapella. This trend appeared to be reflected in post harvest shelf life tests in Trial 2 where Rapella decayed the fastest and Calypso the slowest. Tango and SBJ 7 were capable of producing particularly well shaped fruit while Calypso showed some shape defects but was better than Rapella. Calypso had very good flavour, Tango could be acidic but was acceptable, and SBJ 7 was of average flavour as was Rapella. Tango and SBJ 7 had a brighter colour than Calypso and Rapella, and SBJ 7 in particular, did not darken excessively when ripe.

Cropping seasons are summarised by the weekly yield profile graphs. Autumn planting produced the greatest spread of cropping season between cultivars, with Tango and SBJ 7 cropping much earlier than Rapella and Calypso. Spring planting did not affect the season of the early cultivars much, but advanced Calypso and Rapella, concentrating cropping into late July and August. Nevertheless, Tango in particular still retained a useful degree of earliness over the other cultivars and maintained a spread of picking from spring planting. French Tunnels were used to protect late fruit in Trial 2, however rain during August before covering encouraged *Botrytis* infection to develop and cause subsequent losses of some fruit in this trial. Powdery mildew was not a serious problem in these trials, but grower trial experience of Calypso indicates that infection is restricted to the leaves rather than affecting berries as happens with Rapella.

HDC project SF 33 is investigating the responses of everbearing cultivars to different fertigation regimes in 1993.

Action Points

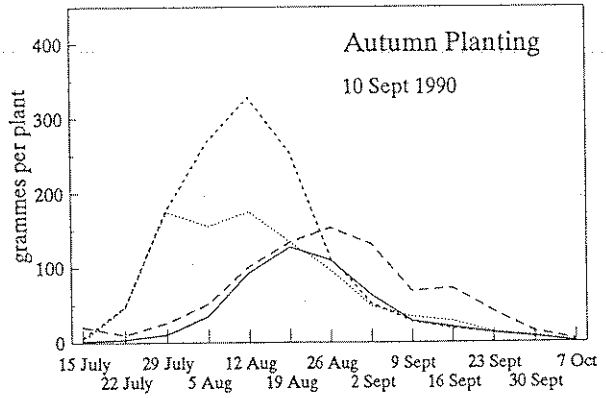
- Calypso is already commercially available and Tango will be available for 1994 cropping if endorsed following grower trials in 1993.

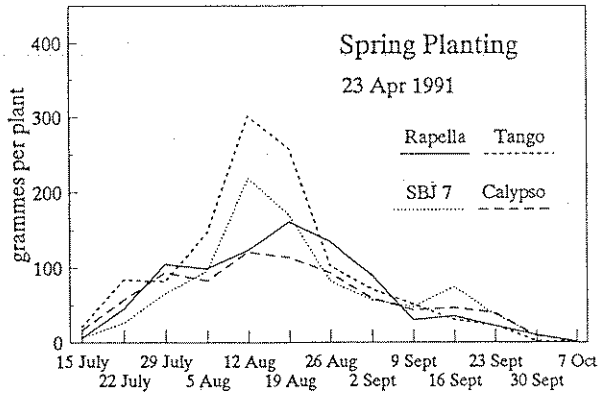
- Use Tango and Calypso as complementary cultivars to 'bridge the gap' between the traditional mainseason and everbearing cropping seasons, maintain continuity of supply, and supersede Rapella for quality.

- Use spring planting as standard to bring Calypso cropping into the late July and August season, but consider autumn planting for a proportion of your area if it is desirable to spread and even out the picking further.

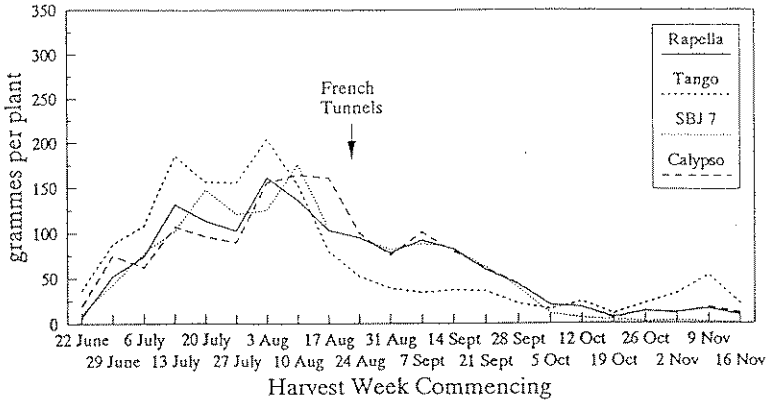
- If French Tunnels are used for everbearers, erect them early (eg first week of August) to maximise their benefits.

Yield Profile Trial 1 1991
Weekly totals Class 1





Yield Profile Trial 2 1992
Weekly Totals Class 1
Planted 23 April 1992



INTRODUCTION

The production of late season strawberries has become well established over the past 10 - 15 years in response to consumer demand for fruit outside the traditional June - early July mainseason period. Production in recent years has mainly been geared to meet the expansion of supermarket sales over this period. The use of everbearing cultivars of strawberries remains an economical and popular cropping method, but the availability of good quality everbearer fruit at the right time to meet stringent supermarket demands remains a problem. The excellent quality mainseason cultivar Elsanta has become a supermarket standard which is not matched by the most popularly grown everbearer Rapella, particularly regarding fruit firmness, shape and colour. Supermarkets therefore prefer to stick to consignments of Elsanta wherever possible. There is also a natural gap in cropping season between the end of mainseason Elsanta (typically early July) and the start of Rapella's season (typically late July / early August). Consequently growers are currently required to undertake expensive production techniques to extend Elsanta's cropping season in order to maintain continuity of supply. The development of an everbearing cultivar that would meet supermarket standards for fruit quality, start cropping earlier, while maintaining good yields would clearly make a significant impact on the profitability of late season production.

The overall objective of these trials was to assess the performance of three new everbearing cultivars, bred at HRI East Malling, against the current everbearer standard Rapella. The new cultivars all originated from a Selva x Rapella cross, intended to combine some of the characteristics of Selva such as firmness and fruit size with the good yield potential of Rapella, with hopefully some improvements over both cultivars in fruit shape, disease resistance, cropping season etc. As both autumn and spring plantings are currently used in the industry, assessment of the possible effect this might have on performance was a secondary objective.

MATERIALS AND METHODS - TRIAL 1 CROPPED 1991

Site

Field S7 (North), HRI Efford. A fine sandy silt loam of the Ludford soil series.

Treatments

Cultivars

A. Rapella
B. Tango (SBJ 1 / EMR 25)
C. SBJ 7 (EMR 26)
D. Calypso (SBJ 2 / EMR 28)

Planting Date

1. Autumn 1990 (12/9/90)
2. Spring 1991 (23/4/91)

Design and Layout

Factorial trial; 4 cultivars x 2 planting dates = 8 treatments in total. A randomised block layout with four replicates was used to give a total of 32 plots.

See Appendix I, p. 31 for planting plan and layout. Twenty four plants per plot were arranged in staggered double rows 400 mm apart with 500 mm between plants in the row. Raised beds running north-south were spaced at 1.52 m centres with a guard bed either side of the recorded plots. Overall plant density was 26,316 plants/ha (10,650 plants/acre).

General Culture

Details of the major cultural operations are given in Appendix II, p. 32.

Plants were propagated from mother plants grown in peat bags under glass. Cuttings, inserted into 7K Optipots (0.25 l) into 'Universal' Levington compost on 10 August 1990, were rooted under mist for 10-12 days before being weaned and moved outside. Plants were then liquid fed with 200 mg/l N : 60 mg/l : P_2O_5 : 200 mg/l K_2O approximately twice weekly until planting in early September, or for those to be spring planted, until October. Plants held for spring planting were then moved under tunnel protection.

A soil analysis (200 mm sample) from the field site taken in early February 1989 was as follows:

pH	7.2	
P	88 mg/l	(ADAS Index 5)
K	411 mg/l	(ADAS Index 4)
Mg	127 mg/l	(ADAS Index 3)

Based on this analysis and the current recommendations for nutrition of everbearing strawberries, 40 kg/ha N + 50 kg/ha K_20 + 75 kg/ha Mg was applied as a base dressing of Kieserite Plus and Nitram before raised beds were made and black polythene mulched at the end of August 1990. After both planting dates several waterings were applied by hand lance to settle soil around the compost rootballs, and overhead sprinkler applications were applied following the Autumn planting on five occasions until late September. Subsequent irrigations from Spring 1991 were applied via a single line of Evaflow S trickle irrigation tube down the centre of each bed (Appendix III, p. 34). Irrometer soil tensiometers at 150 mm and 300 mm depths replicated at two sites were used to determine irrigation requirements. Irrigation frequencies and quantities applied were aimed at maintaining soil moisture tensions below 40-50 cBars (kPa).

Plants of both planting dates were deblossomed by hand during the autumn as required, and again in Spring until the third week in May to delay cropping until mid July onwards as per normal commercial practice. Potted plants for spring planting were cold stored at approximately 4.0 °C for one month from mid January to ensure that plants received sufficient winter chilling. Previous trials elsewhere had shown that there could be problems with normal development from spring planted everbearers held under cold glass or polythene during mild winters.

Potted plants for the spring planting treatment were again liquid fed with 200 mg/l N : 60 mg/l P_20_5 : 200 mg/l K_20 approximately twice weekly from late March to late April before planting. No subsequent fertigation in the field was given to this trial.

Plants in the field were derunnered in early June and early July. Standard recommended sprays for pest and disease control were used as outlined in (Appendix II, p. 32) with the use of *Phytoseiulus* predators for two spotted spider mite control. Simazine and propyzamide (Kerb 50 W) residual herbicides were applied to the alleys, but planting holes were weeded by hand. Alleys were strawed in July prior to picking. 'Truss pruning' was adopted in this trial, ie.

a truss was removed once there was no fruit > 25 mm diameter left on it to develop and ripen. This helped to reduce the quantity of small berries picked and was intended to divert plant resources into succeeding trusses. No tunnel protection of late fruit was used in this trial.

Records and Analysis of Results

Fruit was picked and plot yields recorded as Class 1 and 2 according to EC standards, with Class 1 fruit size graded as large, medium and small (> 35 mm dia., 25-35 mm, and 18-25 mm respectively). Waste fruit was also recorded. Apart from the first and last two picks which were at weekly intervals, the trial was picked twice a week.

Final cumulative yields of each grade were subjected to an analysis of variance. Weekly yield totals for Class 1 and Total Crop including waste were also calculated to obtain yield profiles for each treatment. 10%, 50% and 90% pick dates were calculated.

Observations were made during cropping of fruit quality such as shape, colour, firmness and flavour, but no formal taste panels or shelf-life assessments were possible.

RESULTS - TRIAL 1

General Growth

All treatments for both autumn and spring plantings established satisfactorily, although there was a tendency for the peat compost and rootballs of the spring plantings to dry out very quickly during early and mid May even though surrounding soil in the bed remained moist. Plants may have suffered a temporary growth check at this stage until roots grew out into the soil, but subsequently grew away well. No measurements of plant size were made, but the autumn planted plants remained noticeably larger until mid-late July when the spring plantings 'caught up' and differences largely disappeared.

Crown Rot (*Phytophthora cactorum*) affected a few plants of all cultivars in plots and guard rows in late April and May and these were removed. An autumn planted plot of each of Tango and EMR 26 had up to ten affected or suspect plants and these plots were eliminated from the trial. The remaining plots were generally healthy with only the occasional missing plant removed due to Crown Rot or other causes during the trial. Mean yields were adjusted for missing plants.

Yield and Grade-out

Picking started in mid July and continued to the second week of October. There was relatively little mature fruit left to pick on any of the cultivars at this stage and coupled with low temperatures and wet weather it was decided to curtail picking at this stage. Table 1 shows the final cumulative yield of each grade for the crop.

Table 1. Final cumulative yields 1991 for each grade - g/plant*

Cultivar/ planting time		Class 1 >35 mm	25-35 mm	18-25 mm	Total	Class 2	Waste	Total Crop inc.waste
Rapella	- autumn	85	347	78	510	115	175	800
	- spring	392	426	43	861	128	236	1225
Tango	- autumn	516	653	77	1246	181	312	1739
	- spring	522	602	51	1175	188	295	1659
SBJ 7	- autumn	175	477	90	742	101	162	1006
	- spring	395	462	33	890	88	155	1133
Calypso	- autumn	251	491	86	828	86	132	1046
	- spring	355	380	41	771	78	129	1004
SED (19 df)	*(1)*	*29.5*	*51.5*	*10.2*	*78.1*	*15.0*	*23.3*	*91.4*
	(2)	*20.8*	*36.4*	*7.2*	*55.2*	*10.6*	*16.4*	*64.6*
	(3)	*14.7*	*25.7*	*5.1*	*39.1*	*7.5*	*11.6*	*45.7*
LSD (5%)	*(1)*	*62*	*108*	*21*	*164*	*31*	*49*	*191*
	(2)	*43*	*76*	*15*	*116*	*22*	*34*	*135*
	(3)	*31*	*54*	*11*	*82*	*16*	*24*	*96*
Significance	*(1)*	***	***	*NS*	**	*NS*	*NS*	**
	(2)	***	*NS*	*NS*	***	***	***	***
	(3)	***	*NS*	***	*	*NS*	*NS*	*

(1) Cultivar x planting date interaction for comparing individual means
(2) Cultivar comparisons only (ie average of both planting dates)
(3) Planting date comparisons only (ie average of cultivars within dates)

* g/plant divided by 38 = tonnes/ha
g/plant divided by 95 = tons/acre

There was a significant interaction between cultivar and planting date on the yield of large, medium, Total Class 1 and Total Crop. For Total Class 1 and Total Crop yields, this related to Rapella where the autumn planting produced a poor yield compared to the spring. For the remaining cultivars there was no significant yield differences between spring and autumn plantings.

Ignoring the poor performance of the autumn planted Rapella and taking the spring planted Rapella as a standard for comparison, there was no significant difference with the yields of SBJ 7 or Calypso, but Tango averaged a 40% yield increase over Rapella.

Spring planting produced significantly higher yields of large Class 1 fruit (> 35 mm) for Rapella, SBJ 7 and Calypso, but not for Tango. This result is also reflected in Table 2 where the quantity of large fruit is expressed as a proportion of the total yield of Class 1 fruit. Table 2 also shows the proportion of Class 1, Class 2 and waste fruit as % of the Total Crop. Although not statistically analysed, there appeared to be a better proportion of Class 1 fruit and less Class 2 (mainly poor shaped) fruit from SBJ 7 and Calypso in particular compared to Rapella.

Table 2. Trial 1: % Grade-out 1991

Cultivar/ planting time		% of Class 1 > 35 mm	% of Total Crop Class 1	Class 2	Waste
Rapella	- autumn	17	64	14	22
	- spring	45	70	11	19
Tango	- autumn	42	72	10	18
	- spring	44	71	11	18
SBJ 7	- autumn	25	74	10	16
	- spring	44	79	8	13
Calypso	- autumn	30	79	8	13
	- spring	46	77	8	15

Fruit Quality

Observations made in 1991 can be summarised as follows:-

Firmness. Calypso appeared slightly firmer than Rapella, but Tango and SBJ 7 were similar. Overall, however it was difficult to find large differences between cultivars, and no fruit was tested with a penetrometer.

Shape. Samples of fruit of both Tango and SBJ 7 had excellent shape with fairly well sunken achenes. Calypso was of better shape than Rapella, although there was a little 'grooving' on some berries. Also, like Rapella, achenes could be proud giving some fruit a 'gritty' texture at times during the season.

Colour. Tango and SBJ 7 had a noticeably brighter and paler colour when fully ripe than Calypso and Rapella. Calypso had a tendency for fruit to have white 'noses' when picked but these usually coloured up overnight.

Flavour. Calypso had excellent flavour; generally better than Rapella. Tango could be acidic and not always sweet, but nevertheless, acceptable. SBJ 7 was of average flavour.

Cropping Season

Figure 1 illustrates the cropping profiles as weekly Class 1 yield totals of the autumn and spring plantings. 10%, 50% and 90% mean pick dates are shown in Table 3.

Autumn planting produced the greatest spread in cropping season between cultivars. Rapella and Calypso were late, cropping 10-14 days after Tango and SBJ 7. Spring planting *advanced* cropping for Rapella and Calypso by 4-9 days (50% pick) and 12 days (10% pick) respectively compared to autumn planting. However, spring planting *delayed* cropping by about three days for Tango and SBJ 7 such that there was little difference in cropping season between cultivars from the spring planting in 1991.

By the end of September, Tango from both planting dates had produced another large flush of flower and green fruit, but this was too late to reach maturity before the end of picking. At this

time there was also open flower and green fruit on Calypso and slightly less on Rapella, but virtually none on SBJ 7.

Plant Habit

The vigour and size of Rapella, Calypso and SBJ 7 plants in this trial appeared similar, but Tango remained slightly shorter and more compact. Flower trusses on Tango were upright and borne above the foliage canopy. By the end of the season, plants of Tango looked much paler than the other cultivars and had a 'tired' appearance with some reddening of the older foliage.

Table 3. Trial 1 1991: Pick dates for Class 1.
Number of days difference from Rapella shown in brackets.

Cultivar/ planting time		10% pick		50% pick		90% pick	
Rapella	- autumn	10 Aug		23 Aug		10 Sept	
	- spring	29 July		19 Aug		9 Sept	
Tango	- autumn	31 July	(-10)	13 Aug	(-10)	30 Aug	(-11)
	- spring	28 July	(- 1)	16 Aug	(- 3)	6 Sept	(- 3)
SBJ 7	- autumn	29 July	(- 12)	14 Aug	(- 9)	8 Sept	(- 2)
	- spring	2 Aug	(+ 4)	18 Aug	(-1)	16 Sept	(+ 7)
Calypso	- autumn	7 Aug	(-3)	27 Aug	(+ 4)	18 Sept	(+ 8)
	- spring	27 July	(-2)	18 Aug	(- 1)	16 Sept	(+ 7)

Trial picked 19.7.91 - 10.10.91

MATERIALS AND METHODS - TRIAL 2 CROPPED 1992

Site

Field S7 (south west), HRI Efford. Soil type as Trial 1.

Treatments

Cultivars

A. Rapella

B. Tango

C. SBJ 7

D. Calypso

A single spring planting date of 23 April 1992 was used.

Design and Layout

A randomised block design with six replicates was used to give a total of 24 plots (see Appendix IV, p. 35). As Trial 1, 24 plants per plot were arranged in staggered double rows on the same plant and bed spacings.

General Culture

Appendix V, p. 36 details the main cultural operations. As Trial 1, plants were also propagated by mist rooted cuttings taken from mother plants grown in peat bags under glass. However, cuttings were inserted into module trays (QP 54) with 80 ml cells in Levington M2 compost on 31 July 1991. Plants were liquid fed with 200 mg/l N : 200 mg/l K_2O after rooting until potting on into 9K Optipots (0.57 l) on 4 September into the following growing media:

100% Medium grade Shamrock Peat

3.0 kg/m^3 Osmocote Plus (8-9 mth) (16+8+12+2 + traces)

2.4 kg/m^3 Magnesian limestone

1.2 kg/m^3 Ground limestone

Plants were held under a cold polythene tunnel overwinter. Since there was a spell of frosty weather during the last three weeks of January 1992, there was no need to artificially chill the plants in cold store. No liquid feeding was required in spring prior to planting.

Beds were made up in the field under good soil conditions in September 1992. A base dressing of 40 kg/ha N + 30 kg/ha K_20 + 50 kg/ha Mg as Nitram and Kieserite Plus was included based on a soil analysis from October 1989 as follows:

pH	6.5	
P	74 mg/l	(ADAS Index 5)
K	481 mg/l	(ADAS Index 4)
Mg	98 mg/l	(ADAS Index 2)

Precautionary fungicide sprays of copper oxychloride + metalaxyl (Ridomil Plus 50 WP) in autumn and fosetyl-aluminium (Aliette) in spring were applied to potted plants against possible Red Core or Crown Rot infections.

In late October 1991, the potted plants of all cultivars began to show a chlorosis of the younger leaves but with a green 'halo' around the margins. This was first attributed to either zinc or iron deficiency, although subsequent leaf and compost analyses showed adequate levels of both elements. A programme of Fe EDTA and zinc sulphate sprays were nevertheless applied leaving some control plants unsprayed. However these sprays appeared to have little effect as symptoms in both sprayed and unsprayed plants eventually disappeared with new growth the following spring.

After planting out, hand waterings were given frequently for about one month until late May. Subsequent irrigations were applied via two lines of Access Cricklehose per bed, each line running down the inside of each row of plants. This arrangement was installed to improve water distribution through the bed profile over the single irrigation tube used in Trial 1. Irrometer tensiometers were used to monitor irrigation requirements. With the appearance of pale foliage on Tango again in this trial, fertigation applications of 100 mg/l N : 200 mg/l K_20 were made to the whole trial starting in mid August until the end of October (see Appendix VI, p. 39).

The final deblossoming of plants occurred at the end of May. Truss pruning as used in Trial 1 was again adopted.

French tunnels were erected over the crop from late August to protect fruit and extend the picking season. Pest and disease measures are detailed in Appendix V, p. 36. Specific sprays against Thrips were required in July, and a spray for Two Spotted Spider Mite in late August.

Records and Analysis of Results

Fruit yields and grading was as for Trial 1. Picking frequency was twice per week until the trial was covered with French tunnels when three picks per week were taken. Picking frequency then dropped to twice a week in the first two weeks of October and then once a week from mid-October until the end of the trial.

In addition to ANOVA's for final cumulative yields, the cumulative yield of total Class 1 and Total Crop up to the end of July, August, September, October and the end of the trial was also analysed. Weekly yield profiles and 10%, 50% and 90% pick dates were obtained as in Trial 1.

As well as informal observations of fruit quality, samples of fruit were retained from the Monday pick weekly from 28 September to observe the incidence of post harvest rotting. Twenty six berries of each cultivar were placed in sterilised 'Hassy' cell trays and kept at ambient room temperature, and the number of berries showing any sign of post harvest decay or sporulation recorded and removed daily during the week.

RESULTS - TRIAL 2

General Growth

The potted material of all cultivars was uniform and of good size when planted, and coupled with good soil conditions it established well and made excellent early growth. A final deblossoming was made on 26 May 1992, but warm weather accelerated further flowering and fruit development, so that the first harvests started on 25 June.

Powdery Mildew was not a significant problem in this trial, although wet weather, particularly during August before tunnels were erected, caused some losses due to *Botrytis*. Despite several introductions of *Phytoseiulus* predators during the trial, a Two Spotted Spider Mite infestation built up starting on one side of the trial, requiring a bifenthrin (Talstar) spray in late August to check its spread. It was noticeable that Tango appeared to be relatively susceptible to the pest with high numbers of the mites on Tango plots adjacent to much less badly infested plots of the other cultivars. The Talstar spray was successful in eradicating the mites and there was no significant further build up of the pest during the remainder of the trial.

The rapid early growth after planting resulted in plants of all cultivars filling their 0.5 m in-row spacing and achieving virtually complete crop cover of the bed by early-mid July. Apart from Tango, the foliage of all the cultivars maintained a healthy appearance until late October when the older leaves began to naturally develop autumn colours and die. Tango showed some paler and yellowish leaf colouring from early August but leaves did not begin to die back until mid October. A leaf sample was taken from all cultivars at the end of September and analysed for major nutrients (Table 4, p. 18). Nutrient levels were adequate according to current guidelines for strawberries during fruiting. There were also no big differences between cultivars except for slightly lower K levels with Rapella. However, by this stage, the crop had received fertigation for 6 weeks prior to leaf sampling, which may have masked earlier differences.

By the end of picking in mid November there was a ring of dead leaves around the Tango plants and they appeared 'tired' and were noticeably smaller than earlier in the season, and compared to the other cultivars. Although the dieback of older leaves affected Tango plants uniformly across the trial, and thus was unlikely to be due to a soil borne disease, a plot sample was tested for Verticillium Wilt and Red Core, with negative results.

Table 4. Analyses of strawberry leaf laminae sampled 30.9.92

Cultivar	% Dry Matter	% N	% P	% K	% Mg
Rapella	28.3	2.89	0.34	1.38	0.26
Tango	29.8	2.87	0.30	1.93	0.32
SBJ 7	31.4	2.79	0.37	1.86	0.28
Calypso	29.1	2.92	0.31	1.90	0.24

Yield and Grade-out

Picking started in late June and continued until mid November, with French tunnel protection from late August onwards. Final cumulative yields are given in Table 5.

Overall, final yields were very good, and greater than for Trial 1. The mean Class 1 yield was in excess of 1.4 kg/plant, and for Total Crop including waste more than 2.1 kg/plant. For some cultivars, yields were almost double those obtained from the spring plantings in Trial 1.

Tango outyielded the other cultivars for both Class 1 and Total Crop, and gave a 10% yield increase over Rapella in this trial. Tango also produced the greatest weight of large Class 1 fruit > 35 mm and Rapella the least. As a proportional grade-out (Table 6, p. 20), SBJ 7 and Calypso had a greater overall proportion of Class 1 fruit than Rapella or Tango; Rapella produced the smallest proportion (39%) of large Class 1 berries > 35 mm while Tango and SBJ 7 both produced 49% large berries. Both the weight and proportion of Class 2 fruit was greatest for Tango. This fruit was downgraded owing mainly to poor shape. It is likely that Thrips damage to flowers early in July was responsible, when Tango had a large amount of open flower compared to the other cultivars. Tango's fruit later in the season had a lower proportion of Class 2 berries.

Table 5. Trial 2 Final Cumulative Yields 1992 for each grade - g/plant *

Cultivar	Class 1 > 35 mm	Class 1 25-35 mm	Class 1 18-25 mm	Class 1 Total	Class 2	Waste	Total Crop inc.waste
Rapella	556	794	73	1423	213	518	2154
Tango	767	763	38	1568	350	447	2365
SBJ 7	675	682	20	1377	196	438	2011
Calypso	666	759	61	1486	227	398	2111
SED (15 df)	*28.0*	*45.5*	*10.4*	*66.0*	*14.8*	*29.2*	*89.8*
LSD (5%)	*60*	*97*	*22*	*141*	*32*	*62*	*191*
Significance	***	*NS*	***	*	***	**	**

* g/plant divided by 38 = tonnes/ha
g/plant divided by 95 = tons/acre

Rapella produced a significantly greater weight and a higher proportion of waste fruit than the other cultivars. This fruit was outgraded due to mechanical damage, including bird or slug damage, *Botrytis* or other rots, and severely malformed or very small berries.

Table 6. Trial 2: % Grade-out - 1992

Cultivar	% of Class 1 > 35 mm	% of Total Crop Class 1	Class 2	Waste
Rapella	39	66	10	24
Tango	49	66	15	19
SBJ 7	49	68	10	22
Calypso	45	70	11	19

Cropping Season

Table 7 gives the Class 1 cumulative yields for the end of each of the main cropping months and up to the end of picking. Figure 2 illustrates the weekly Class 1 cropping profile, and 10%, 50% and 90% pick dates are given in Table 8.

Tango's mean Class 1 yield was significantly greater than the other cultivars for the first two months of picking when most of its crop was produced. Tango's early cropping season resulted in it outyielding Rapella by 50% and 25% by the end of July and August respectively. The other cultivars 'caught up' during September and October, and there was no significant differences between the Class 1 yields of the cultivars by the end of these two months. Tango produced a very large flush of flower in mid-late September, and although this failed to materialise as a large late crop, sufficient fruit developed and ripened for a small peak in late October and early November. As in Trial 1, SBJ 7 produced very little late flower and fruit. Thus Tango ended cropping with the largest mean yield with a statistically significant yield advantage over Rapella and SBJ 7.

Table 7. Trial 2 Class 1 Cumulative Yields 1992 - g/plant

Cultivar	end July	end Aug	end Sept	end Oct	end crop
Rapella	479	974	1321	1386	1423
% of final yield	*34*	*68*	*93*	*97*	*100*
Tango	729	1218	1382	1461	1568
% of final yield	*46*	*78*	*88*	*93*	*100*
SBJ 7	494	994	1342	1371	1377
% of final yield	*36*	*72*	*97*	*99*	*100*
Calypso	447	1027	1379	1445	1486
% of final yield	*30*	*69*	*93*	*97*	*100*
Yield SED (15 df)	*25.5*	*53.6*	*61.5*	*63.9*	*66.0*
LSD (5%)	*54*	*114*	*131*	*136*	*141*
Significance	***	***	*NS*	*NS*	*

The cropping season expressed as pick dates in Table 8 shows a 50% pick 9 days earlier than Rapella for Tango and relatively little difference in season between the other cultivars. The second half of the table illustrates the situation if picking had stopped at the end of October as might have been the case if French tunnels had not been used to extend the season.

Table 8. **Trial 2: 1992 pick dates for Class 1. Number of days difference from Rapella shown in brackets.**

Cultivar	10% pick		50% pick		90% pick	
	Dates based on the full picking period					
Rapella	10 July		9 August		25 Sept	
Tango	5 July	(-5)	31 July	(-9)	9 Oct	(+14)
SBJ 7	10 July	(0)	7 Aug	(-2)	17 Sept	(-8)
Calypso	8 July	(-2)	12 Aug	(+3)	24 Sept	(-1)
	Dates ignoring picks after the end of September					
Rapella	9 July		7 Aug		16 Sept	
Tango	3 July	(-6)	29 July	(-9)	4 Sept	(-12)
SBJ 7	9 July	(0)	7 Aug	(0)	14 Sept	(-2)
Calypso	8 July	(-1)	9 Aug	(+2)	14 Sept	(-2)

Trial picked 25.6.92 - 16.11.92

Fruit Quality

The observations made in Trial 1 were largely confirmed in Trial 2. Some of the poor shaped fruit from Tango appeared to be due to Thrips damage, although poor pollination may also have been a contributing factor. It was also observed that fully ripe samples of SBJ 7 remained brightly coloured and did not darken excessively which tended to happen with Rapella and Calypso.

Post Harvest Decay

Figure 3 illustrates the number of berries showing signs of post harvest decay over eight successive weekly samples from 28 September until final harvest on 16 November. It had been noticed that the shelf-life had been poor from some harvests of fruit earlier in September. It was thought that heavy rainfall during the corresponding flowering period for this fruit in early

August, before the crop was covered, may have increased the incidence of *Botrytis* or other infection leading to post harvest decay. Samples of fruit were therefore held to see if there was any varietal difference in decay, and whether the use of French tunnels improved the quality of later fruit.

The first sample picked on 28 September showed a rapid decay of over half the fruit after two days of all cultivars, except Calypso which was slower to deteriorate. This fruit would have developed from flowers in the last two weeks of August which were wet (see Appendix VII, p. 40). Berries from subsequent picks decayed more slowly and would have developed from flowers which were protected by the tunnels erected at the end of August.

Although only based on small samples, there was a trend from the eight successive weekly observations to indicate that Rapella decayed the most rapidly and Calypso the slowest.

DISCUSSION

Yields overall were good from both trials judged against good commercial practice, and particularly so for Trial 2 where it was felt three factors were particularly important. Firstly that beds were made up in the autumn under good conditions and the polythene mulch retained these conditions until planting; secondly that large pot raised plants were used; and finally, particular attention was given to overhead irrigation during establishment and subsequent irrigation using two trickle lines per bed.

The plant density used for these trials of 26,316 plants/ha (10,650 plants/acre) was lower than that used on many holdings, where 29,000-35,000/ha (11,740-14,160/acre) is typical. Other trials have shown that higher yields/ha, (but smaller yields per plant), can be achieved by closer spacings (most recently demonstrated by the HDC spacing trial with Calypso at HRI East Malling, SF 22). However, for high quality fruit production, avoidance of excessive interplant competition seems sensible to maintain fruit size, freedom from disease and aid picking. The size of planting material used will have a bearing on the optimum spacing chosen; in these trials the in-row spacing of 50 cm appears to have been justified by plants filling their allotted spaces and producing a high yield per ha as well as per plant. If this is so, from a one year crop, wide spacings are even more important if crops are to be retained for two years. In the East Malling trial with Calypso where smaller module plants than those planted at Efford were used, plants from an autumn planting grew larger than from a spring planting, and the proportion of large berries produced showed significant increases as plant spacing increased. More experimentation would be required to determine whether Tango yields could be further improved from closer spacings since experience in Trial 1, and previous observations at East Malling and Brogdale, indicate it can be a more compact plant than the other cultivars.

Only one years comparison was made with autumn and spring plantings, but the indication is that if the two cultivars Tango and Calypso were used, an autumn planting could be beneficial to maximise the spread of cropping. However, if the intention was to concentrate on the profitable late July and August period when demand and prices are high, then spring planting will bring a greater proportion of the crop from the late variety Calypso into this period. Also, although differences in earliness were not great from the Trial 1 spring planting, in Trial 2, where cropping overall was earlier, Tango was significantly earlier than Calypso by some 9 days (50% pick). Thus Tango's potential as an early cultivar to help bridge the gap between the mainseason and

everbearing cropping season, and Calypso to follow on with fruit of better quality than Rapella should make a significant contribution towards the continuity of supply required by many outlets.

When relating absolute cropping dates for Efford to other parts of the country, as a guide Efford is approximately one week earlier than most of Kent.

Tunnel protection was used in Trial 2 to try and assess the yield potential of the cultivars over as long a season as possible. In that trial, relatively little fruit was picked after the end of September, and it could be argued that the cost of tunnel protection was not worthwhile. However, there was an appreciable amount of fruit left unpicked at the end of cropping that might have had potential to develop and ripen quicker in other years with warmer late weather. Tunnels erected in late August proved too late in this season to prevent significant loss of fruit due to *Botrytis* during rainy weather from August onwards. French Tunnels are unlikely to greatly speed up ripening of fruit in late summer and early autumn due to the cool nights and shorter daylengths at that time, however they do protect flowers and fruit from rain and dew that would otherwise spoil before fruit matured. If the waste fruit had been reduced from 20% to 10% by covering in early August for example, this would have been worth some £10,000/ha (£4000/acre) assuming approximately 200 g/plant at £2.00/kg, and may have made the use of French Tunnels more cost effective.

It is not clear from the shelf-life observations as to how far the apparent differences in post harvest rotting shown with Rapella and Calypso were due to differences in susceptibility of the cultivars to infection *per se* by *Botrytis* or other fungi, or whether the differences were in development of the fungus after infection. There may be a correlation between fruit firmness and tendency to rot or deteriorate after picking, with softer fruit having the potential to develop post harvest rots more quickly. Powdery Mildew was not a significant problem in either of the Efford trials, but reports from grower trials indicate that while Calypso is not resistant to the disease, it is confined to the leaves and does not infect the berries, unlike Rapella where it can cause significant direct fruit losses.

Fertigation was not planned for the trial in respect of earlier experience with Rapella, however due to the pale growth shown by Tango, it was decided to start a late programme of feeds. Earlier MAFF funded nutrition trials with Rapella, Ostara and Selva at Efford and Luddington EHS's showed that maximum benefits occurred from either the use of controlled release fertiliser

or liquid feeding during the pot and early field growth stages by helping to build up a large vigorous plant. Efford's trials also indicated varietal differences in response to nitrogen, with Selva being the most responsive and Rapella the least of the three cultivars tested. With Rapella, additional nitrogen beyond a 40 kg/ha base dressing either gave no significant yield benefit or even a yield depression under the conditions of the trial. The pale growth shown by Tango may be simply a characteristic of the cultivar rather than a deficiency symptom. Alternatively it could have been in response to the heavy early fruit load carried by the plants which effectively exhausted its reserves and which might or might not have been alleviated by extra feeding early on. The response of the new cultivars in this trial to nutrition therefore needs assessing. The growth and flowering habit of Tango shows similarities to one of its parents, the day neutral Selva, and may therefore respond positively to a higher nitrogen regime. The response of a range of new everbearers to fertigation nutrition is currently being investigated at Efford project SF 33. Interestingly, Selva is known to be susceptible to Two Spotted Spider Mite infestation which was reflected in the apparent susceptibility of Tango in Trial 2, again indicating a strong affiliation to this parent.

The fruit quality of each of the new cultivars have attributes showing improvements over Rapella. Calypso in particular shows firmer fruit, although it shares Rapella's tendency to darken on ripening, as well as having some shape defects. Fruit shape was significantly better for SBJ 7 and most of the time for Tango, although firmness was not improved. There is uncertainty about Tango's pollen producing ability as it has rather small anthers. While this did not cause any obvious malformation of fruit due to poor pollination in these mixed cultivar trials, larger block plantings in grower trials in 1993 should expose any such deficiency if it exists. SBJ 7 was not selected in the early stage trials at Brogdale EHS and therefore not taken on for early naming and possible release. However its pale colour when ripe, and attractive shape make it a potentially more promising candidate for supermarket sales than Rapella, and for this reason the cultivar should not be dismissed at this stage, even if yield and fruit firmness show no distinct advantages.

In summary, Tango has the ability to outyield crop much earlier than Rapella and have a better Class 1 grade-out with better shaped fruit, although pollen production is still being assessed. Calypso has firmer and slightly better shaped fruit of good flavour with a similar yield and cropping season to Rapella. SBJ 7 while also having very attractively shaped fruit, has a preferable holding colour. Therefore all three new selections are considered to be an improvement over the standard cultivar Rapella.

CONCLUSIONS

The overall objective of these two trials was to compare the performance of three new cultivars of everbearing strawberries bred at HRI East Malling compared to the UK industry standard cultivar Rapella for late season cropping. The effect of an autumn versus spring planting date was also compared in the first trial.

1. Significant improvements have been achieved in fruit quality, cropping season and yield amongst the new cultivars over Rapella. Tango has a very high early yield of bright, large and attractive fruit. Calypso offers a direct replacement for Rapella showing improved firmness, shape and % Class 1, with an equally good yield, good flavour and a similar cropping season. SBJ 7 also has particularly well shaped fruit which does not darken on ripening, making it attractive for supermarket sales.

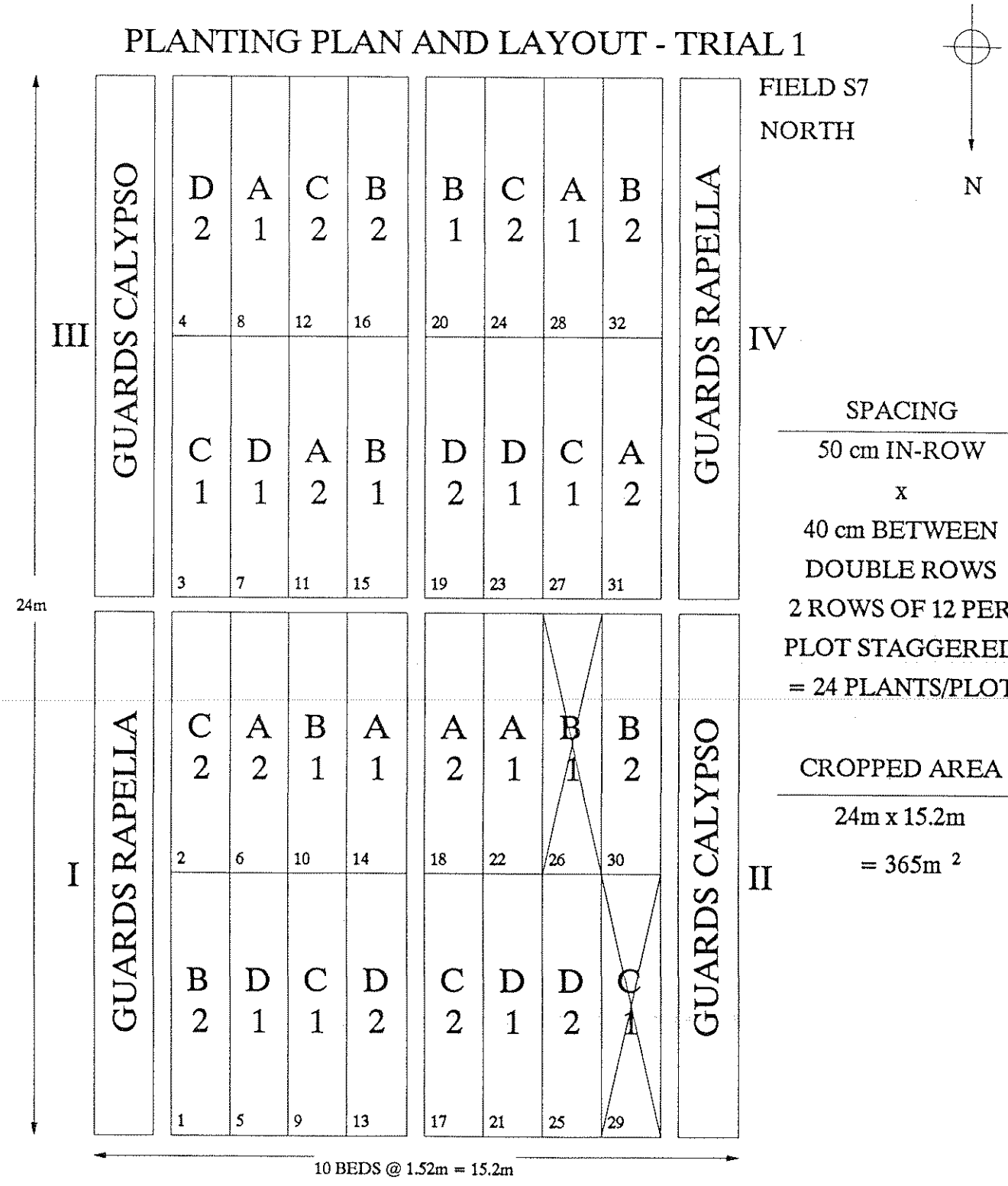
2. Results based on a single trial suggest that autumn or spring plantings may be useful in manipulating cropping seasons. Tango appears less affected by planting date remaining early, whereas autumn planted Calypso was latest, thus giving maximum spread of picking. Spring planting of Calypso, however, is recommended if highest yields are required in late July and August, and a useful spread of picking between Tango and Calypso may still be achieved.

3. There are indications that Tango, in particular, may have different nutritional requirements than other everbearing cultivars. There is thus a need for more investigation into varietal differences in the response of everbearers to nutrition.

APPENDICES

APPENDIX I

PLANTING PLAN AND LAYOUT - TRIAL 1



SPACING

50 cm IN-ROW

x

40 cm BETWEEN DOUBLE ROWS

2 ROWS OF 12 PER PLOT STAGGERED

= 24 PLANTS/PLOT

CROPPED AREA

24m x 15.2m

= 365m ^{2}

VARIETY	x	PLANTING DATE
A. RAPELLA		1. 12 SEPT 1990
B. TANGO		2. 23 APR 1991
C. SBJ 7		
D. CALYPSO		

Plots 26 and 29 eliminated following Crown Rot infection

APPENDIX II

TRIAL 1 - DIARY OF CULTURAL OPERATIONS

1990

23.8	Fallow site deep cultivated with Paraplow chisel plough.
30.8	Site rotary cultivated and base dressing applied. Beds made with Hoekstra bed maker and mulched with 50 μm black polythene.
09.9	Potted plants sprayed with chlorothalonil (Repulse 3.0 g/l H.V.) + pirimicarb (Pirimor 0.5 g/l H.V.).
12.9	Autumn planting treatment planted.
14.9	Deblossoming completed.
23.9	Alleys herbicide sprayed with Simazine flowable 3.0 l/ha + propyzamide (Kerb 50W 0.75 kg/ha).
08.10	Cypermethrin spray (Ambush C 0.25 ml/l H.V.) to both potted plants remaining for spring planting, and planted out treatments against, Aphids and Caterpillars.
10.10	Fenarimol spray (Rubigan 1.65 ml/l M.V.) for Powdery Mildew on both potted and planted out plants.
12.10	Further deblossoming of potted and field plants where required.
17.10	Dichlofluanid spray (Elvaron 3 g/l H.V.) as *Botrytis* protection to potted plants after cleaning old leaves.

1991

10.1	Further cleaning of potted plants followed by Elvaron spray (3 g/l H.V.).
11.1-12.2	Potted plants cold stored at 4° C then held under polythene tunnel.
13.2	Plants cleaned up and Elvaron spray applied (3 g/l H.V.).
15.3	Iprodione spray (Rovral 1.5 g/l H.V.) for *Botrytis*.
21.3-21.4	Liquid feeds applied approximately twice a week to potted plants.
26.3	Autumn planted stock in field cleaned of old leaves and weeded.
04.4	*Phytoseiulus* predators introduced to potted plants.
12.4	Simazine (Gesatop 500 L 2.2 l/ha) + Kerb 50W 0.75 kg/ha applied to alleys.
13.4	Potted plants sprayed with Elvaron 3 g/l H.V.
17.4	Field plants sprayed/drenched with Elvaron 3 g/l H.V.
23.4	Spring planting treatment planted.

03.5	Azinphos-methyl + demeton-S-methyl sulphone (Gusathion MS 1 pack/200 litres M.V.) spray for Aphids and Caterpillars.
21.5	Final deblossoming of trial.
22.5	Pirimicarb spray (Pirimor 0.5 g/l H.V.).
24.5	Elvaron 3 g/l + triadimefon (Bayleton 1 g/l) H.V. spray for *Botrytis* and Powdery Mildew.
30.5	*Phytoseiulus* predators introduced at approximately 1 per plant.
10.6	Derunnered trial.
11.6	Iprodione (Rovral Flo 2 mls/l) + bupirimate (Nimrod 2.5 ml/l) H.V. spray for *Botrytis* and Powdery Mildew.
18.6	Elvaron spray 3 g/l H.V.
26.6	Second introduction of *Phytoseiulus* predators at 1/plant.
02.7	Elvaron spray as above.
09.7	Trial hand weeded as required.
10.7	Rovral Flo + Nimrod spray as above.
12.7	Derunnered trial.
19.7	Alleys strawed down. Rovral Flo + Nimrod spray as above.
27.7	First harvest.
16.8	Rovral Flo + Nimrod spray as above.
11.9	Rovral Flo + Nimrod spray as above.
20.9	Repulse 3.0 g/l H.V. spray for *Botrytis* and Powdery Mildew.
2.10	Repulse spray as above.
10.10	Final pick.
24.10	Site sprayed with glyphosate (Roundup 5.5 l/ha).
11.11	Site cleared.

APPENDIX III

TRIAL 1 - IRRIGATION APPLICATIONS

The irrigation applications listed below were all applied via Evaflow-S trickle line, with quantities calculated on an irrigated area assuming a nominal mulched bed width of 0.8 m. To convert to mm per full cropped area, multiply by 0.53 (ie. 0.8÷1.52). In addition to applications via the trickle lines, overhead sprinklers were used several times after the autumn planting until late September, plus some waterings with hand lance after both plant dates.

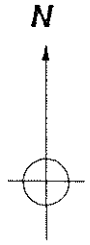
Date	**mm applied**
1990	
27.9	15
1991	
24.4	14
03.5	13
10.5	10
22.5	10
30.5	15
10.6	10
06.7	15
11.7	13
22.7	15
27.7	14
29.7	21
01.8	10
05.8	13
09.8	20
13.8	34
16.8	12
20.8	12
22.8	20
27.8	23
02.9	20
05.9	19
09.9	43
13.9	18
16.9	11
19.9	18
23.9	20
Total	**458 mm**

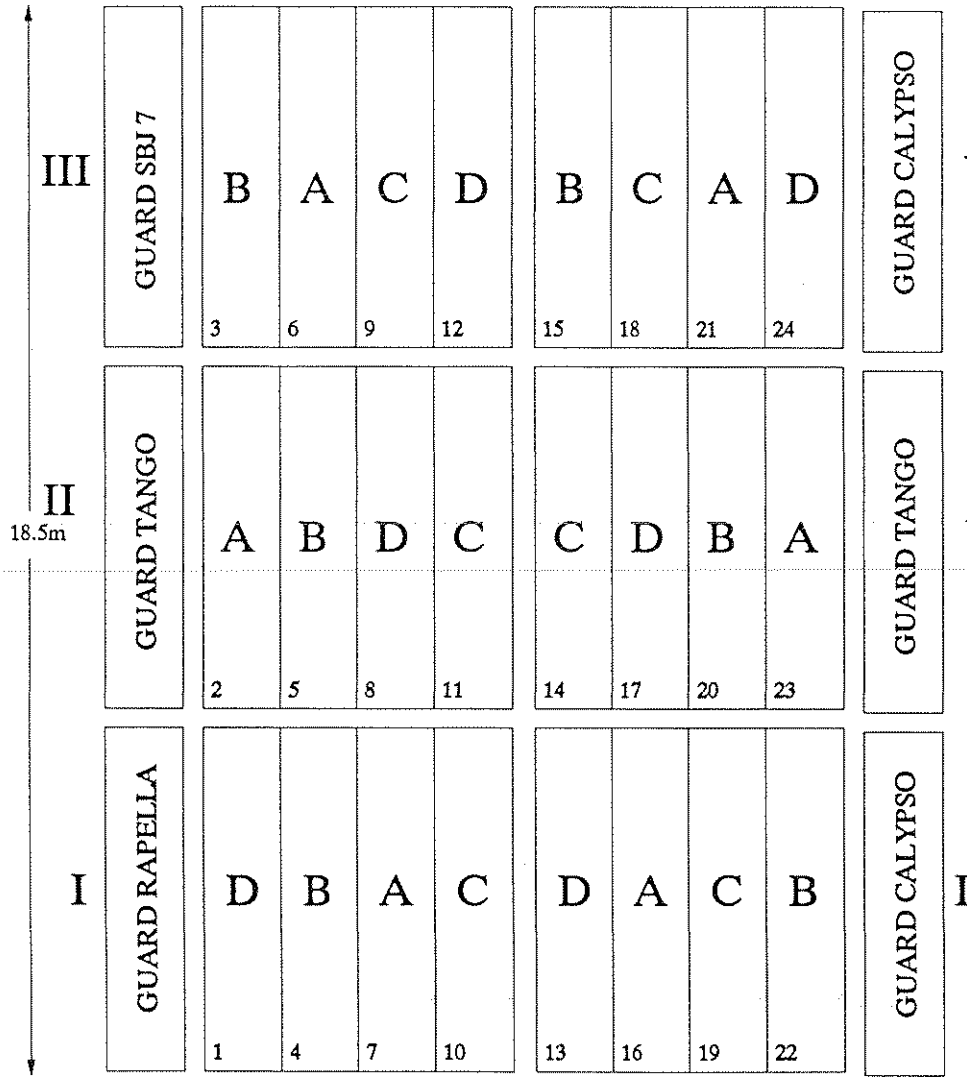
APPENDIX IV

PLANTING PLAN AND LAYOUT - TRIAL 2

FIELD S7

SOUTH WEST





10 BEDS @ 1.52m = 15.2m

SPACING

50 cm IN-ROW

x

40 cm BETWEEN DOUBLE ROWS

2 ROWS OF 12 PER PLOT STAGGERED

= 24 PLANTS/PLOT

CROPPED AREA

18.5m x 15.2m

= 281m ^{2}

VARIETY

A. RAPELLA
B. TANGO
C. SBJ 7
D. CALYPSO

APPENDIX V

TRIAL 2 - Diary of cultural operations

1990

4.9	Grass ley site sprayed with glyphosate (Roundup 5.0 l/ha).
9.9	8 mm irrigation applied.
10.9	Shallow rotary cultivation to chop turf.
13.9	Site deep cultivated with Paraplow chisel plough then rotary cultivated with spiked cultivator.
18.9	Copper oxychloride + metalaxyl drench to potted plants (Ridomil Plus 50 WP 0.825 g/m^2 in 1 litre water/m^2) as Red Core and Crown Rot protection.
19.9	Base dressing applied and incorporated with rotary cultivator. Beds raised with Hoekstra bed maker, lightly rolled and mulched with 50 μm black polythene after laying strings for subsequently pulling through irrigation tubing.
23.10	Alleys herbicide sprayed with simazine flowable 3.0 l/ha + propyzamide (Kerb 50 W 0.75 kg/ha) + paraquat/diquat (PDQ 5.5 l/ha).
24.10	Potted plants sprayed with chlorpyrifos (Dursban 4 1.0 ml/l H.V) against Caterpillars.
30.10	Chlorothalonil spray (Repulse 3.0 mls/l H.V.).
31.10	Zinc sulphate spray 2 g/5 l + wetter (0.5 ml/l Agral).
7.11	Zinc sulphate spray as above.
8.11	Iprodione spray (Rovral Flo 2.0 mls/l H.V.).
14.11	Zinc sulphate spray as above.
15.11	Iron EDTA spray 1 g/l + wetter (0.5 ml/l Agral).
22.11	Repulse spray as above.
26.11	Plants cleaned of old leaves and spaced from pot thick to half density in Empot carrier trays.
29.11	Iron spray as above.
11.12	Rovral Flo spray as above.
13.12	Iron spray as above.

1992

3.1	Dichlofluanid spray (Elvaron 3 g/l H.V).
8.1	Cleaned plants of old leaves.
17.1	Elvaron spray as above.
4.2	Further cleaning up of plants. Rovral flo spray as above.
17.3	Fosetyl-aluminium spray (Aliette 3.75 g/l H.V - approx 100 mls/m^2).
30.3	Plants deblossomed and cleaned of dead leaves.
3.4	Heptenophos (Hostaquick 0.75 ml/l H.V.) spray for Aphids.
16.4	*Phytoseiulus* predators introduced at approx 1 per plant.
23.4	Planted out into beds and deblossomed.
11.5	Repeated deblossoming.
26.5	Final deblossoming. Fenarimol spray (Rubigan 330 mls/ha in 1000 l/ha for Powdery Mildew.
28.5	*Phytoseiulus* predators introduced as above.
2.6	Dichlofluanid (Elvaron 4.5 kg/ha) + triadimefon (Bayleton 5 1.0 kg/ha in 1000 l/ha) spray for *Botrytis* and Powdery Mildew.
12.6	Iprodione (Rovral WP 1.5 kg/ha) + bupirimate (Nimrod 1.4 l/ha in 1000 l/ha spray for *Botrytis* and Powdery Mildew.
25.6	1st Harvest.
27.6	Derunnered plants, cleared any weeds from alleys and strawed down.
30.6	Rovral WP + Nimrod spray as above.
14.7	Rovral WP + Nimrod spray as above. Malathion spray (Malathion 60 1.9 mls/l) low-med vol spray targeted at flowers only to control Thrips.
25.7	Rovral WP spray only as above. Malathion spray as above.
31.7	Final Malathion spray for Thrips.
8.8	Benomyl (Benlate 1.1 kg/ha in 1000 l/ha) for Powdery Mildew.
11.8	Sulphur spray (Kumulus S 2 kg/ha in 1000 l/ha) for Powdery Mildew.
18.8	Rovral WP + Nimrod spray as above.
19.8	*Phytoseiulus* predators reintroduced; rate approx 3 per plant.
25.8	French tunnels erected for rain protection.
26.8	Kumulus S spray as above.
29.8	Bifenthrin (Talstar 0.4 l/ha) + Rovral WP 1.5 kg/ha in 1000 l/ha for 2 Spotted Spider Mite and *Botrytis*.
4.9	Rovral WP + Nimrod spray as above.

10.9	Kumulus S spray as above.
18.9	Chlorothalonil spray (Repulse 3.0 mls/l H.V.) for *Botrytis* and Powdery Mildew.
24.9	Methiocarb pellets (Draza) applied in planting holes and between plants away from fruiting trusses.
25.9	Nimrod spray as above.
2.10	Rovral WP spray as above.
8.10	Repulse spray as above.
16.10	Kumulus S spray as above.
2.11	Rovral WP + Nimrod spray as above.
16.11	Final pick.
10.12	Site cleared.

APPENDIX VI

TRIAL 2 - IRRIGATION AND FERTIGATION APPLICATIONS

Irrigation was applied via two lines of Access Cricklehose per bed. Quantities were calculated on an irrigated area assuming a nominal mulched bed width of 0.8 m as in Trial 1, and can be converted to mm per full cropped area by multiplying by 0.53. In addition to the irrigations applied via the trickle lines recorded below, frequent waterings - approximately every one to two days were applied by hand lance to establish the crop until the end of May.

Date 1992	**mm applied**	
31.5	21	
10.6	10	
18.6	15	
23.6	39	
29.6	12	
8.7	24	
16.7	15	
26.7	15	
30.7	60	
8.8	27	
15.8	10	Feed
21.8	10	Feed
27.8	10	Feed
4.9	6	
5.9	10	Feed
8.9	15	Feed
15.9	15	Feed
21.9	10	Feed
29.9	15	Feed
8.10	10	Feed
15.10	10	Feed
27.10	10	Feed

Total water + feed:

369 mm

Total feed: **125 mm** equivalent to 125 kg/ha N + 250 kg/ha K_20 based on bed area, or 66 kg/ha N + 132 kg/ha K_20 based on full crop area.

APPENDIX VII