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Agricultural Research Centre

Department of Horticulture

60th Anniversary

ANNALES AGRICULTURAE FENNIAE, VOL. 26: 251—260 (1987)
Seria HORTICULTURA N.55 — Sarja PUUTARHAVILJELY n:o 55

WINTER INJURY TO FINNISH APPLE ORCHARDS IN 1984—85

JAAKKO SÄKÖ and MAUNO YLI-PIETILÄ

SÄKÖ, J. & YLI-PIETILÄ, M. 1987. **Winter injury to Finnish apple orchards in 1984—85.** Ann. Agric. Fenn. 26: 251—260 (Agric. Res. Centre, Dept. Hort., SF-21500 Piikkiö, Finland.)

The exceptionally cold winter of 1984—85 caused severe injuries to Finnish apple orchards. While about 79 % of all apple trees remained healthy, 13 % were severely injured and/or died. Clear differences in hardiness emerged between varieties, as well as between rootstocks. Young trees aged 5 years and less were more susceptible than older ones. Injuries were more common in low-lying than in elevated and sloping terrain. Increased winter hardiness was achieved by planting trees on low ridges which were covered with a black plastic sheet as compared to level planting.

Index words: apple trees, winter hardiness, varieties, rootstocks, ridge planting.

INTRODUCTION

Finnish topfruit production, which consists almost entirely of apple, is greatly restricted by the harsh winter climate. Extremely cold winters, which occur at approximately ten-year intervals, are a serious threat to apple orchards. In addition to injuring and killing fruit trees, cold winters cause variations in annual fruit production. Production is therefore confined to the southwest of the country, where the climate is mildest and the growing season longest.

During the last 50 years the occurrence of at least five extremely cold winters has more or less seriously damaged apple tree stands in Finland. The most extensive damage was caused in the winter of 1939—40, resulting an almost destruction (MEURMAN 1943). The winters of 1946—47, 1955—56 and 1965—66 respectively injured and killed a substantial part of Finland's apple tree stands (MEURMAN 1947, SÄKÖ 1957, SÄKÖ and PESSALA 1967). As a consequence of the two latter winters apple production decreased in area and became concentrated in the southwest part of the country. Most varieties which proved to be sensitive were then discarded.

The winter of 1984—85 was also exceptionally cold causing severe injuries to apple orchards. The low-temperature period of 1985 began in early January and continued until the end of February, the coldest February of this century (Fig. 1). Even in southwest part of country the temperature during this period dropped <35 °C remaining either or about below −30 °C for a long period. The lowest temperatures, approaching −40 °C, were measured just above

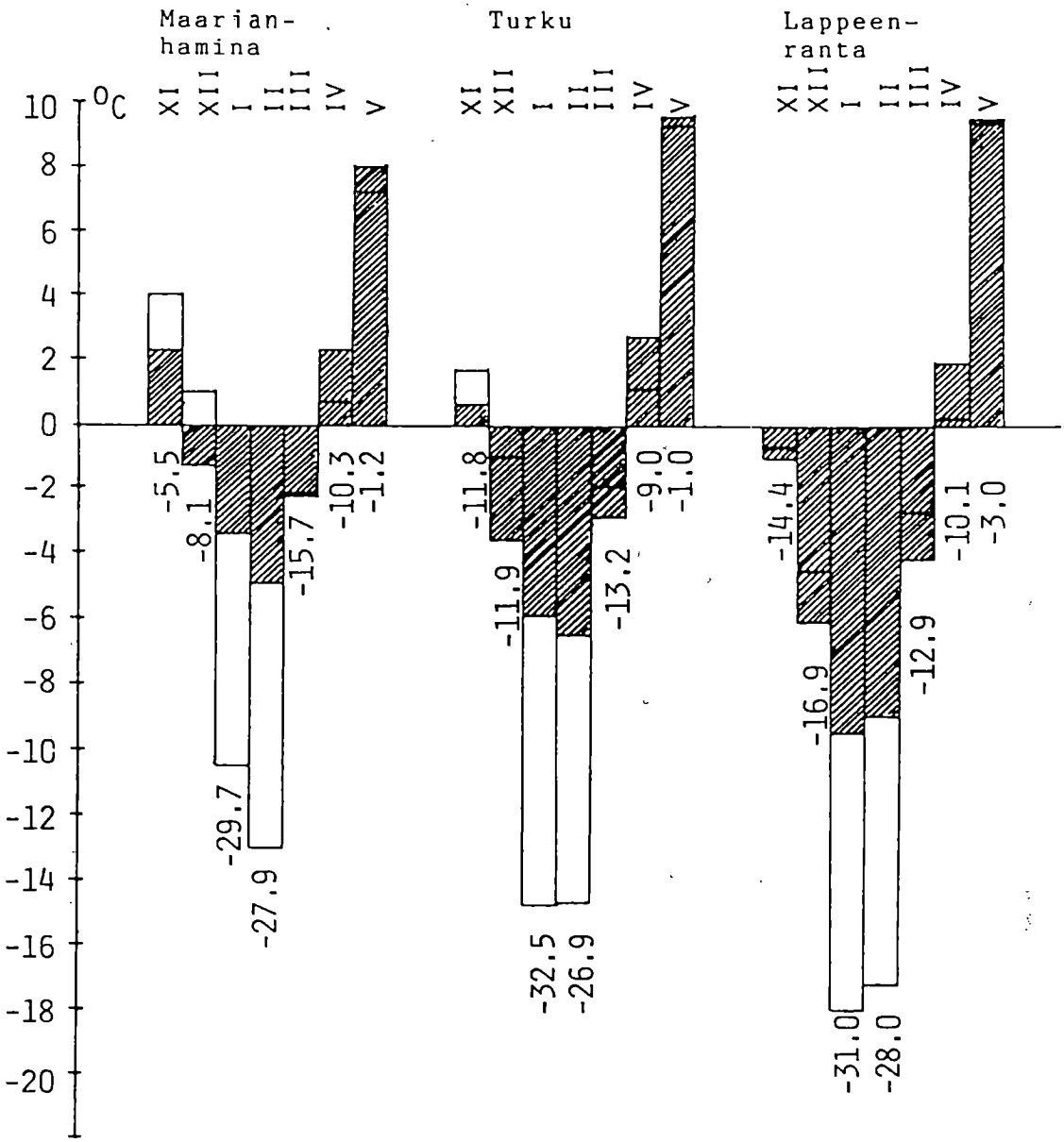

Fig. 1. Monthly mean ▭ and minimum (numerals) temperatures 1984—85 with the mean temperatures (1961—80) ▨ in South-Finland.

the snow level. Snow cover was less than normal and the soil was deeply frozen. Strong winds aggravated the injurious effect of frost on plants. On the other hand, weather conditions during early and late winter, which strongly affect the over wintering of fruit trees, were quite favourable.

This paper investigates the over wintering of apple trees in Finnish orchards following the winter of 1984—85.

MATERIAL AND METHODS

When it became obvious that winter of 1984—85 had caused injury to fruit trees, an survey was made to determine the extent of cold injuries to Finnish apple orchards. The survey was sent to 350 respondents who asked to estimate the number of trees injured and killed for various apple varieties and different rootstocks. In addition data were obtained on general orchard conditions, including soil characteristics and management, terrain relationships, (sloping versus low-lying), depth of snow cover and prevailing wind conditions. Responses were obtained from 230 fruit growers (66 %). This data was grouped according to the various fruit growing zones. In addition observations were made for checking and interpretation of the data.

RESULTS

The survey totals consisted of 131 012 apple trees of which 31 % (40 786 trees) originated from the Åland Islands and 65 % (85 113 trees) from Finland's primary fruit growing zone and 4 % from other zones. The primary zone includes the southwest coast where the climate is the mildest within the continental area. The climate of the Åland Islands is even more suitable for fruit production.

The survey revealed the relationships of apple varieties in the tree stand. The main variety Lobo, of Canadian origin, comprises 45 % of the continental and 50 % of the Åland Islands stand. The respective relationships of other commonly grown varieties are Melba 10 %, Atlas 10 % and Raike 6 %, all being Canadian in origin as well. For the most common varieties of European origin Transparente Blanche was 9 % and the Kanel apple was 5 %.

The investigation on the overwintering of 131 000 apple trees showed that 79 % of the trees remained healthy, 14 % were cold injured and 7 % died due to the winter. Such was the situation in the summer of 1985, but during the following winter a part of the tree stand further weakened and new injuries were revealed. Thus roughly 70 % of the remaining trees were regarded to be healthy.

Clear differences in winter hardiness were found among varieties. The main variety Lobo, which is considered as a winter apple in Finland, endured the 1984—85 winter quite well. Only 4 % of the trees were killed and 11 % injured, and no decline was found later (Table 1). The Melba variety suffered much more severe damage; 31 % of the trees were injured or killed. Atlas, Transparente Blanche and Raike also suffered more damage than Lobo. The weakest variety of all, however, was the Canadian summer apple Quinte; 42 % of all trees died with only 28 % remaining healthy. By 1986, almost all of these trees were dead. The varieties Kanel, Antonovka and Huvitus, as expected, survived the winter best.

Table 1. Overwintering of the most common apple varieties 1984—85 in Finland

Variety	Sound %	Injured %	Dead %
Lobo	85	11	4
Melba	69	21	10
Atlas	75	18	7
Tr. Blance	79	15	6
Raike	71	22	7
Kanel	93	5	2
Quinte	28	30	42

The new Finnish apple varieties Pirja, Maikki, Samo and Jaspi, which originated from crossings between the Canadian varieties Melba and Lobo, and the Finnish variety Huvitus, and which have been on the market for 5 years, showed good winter hardiness despite their being rather young trees still.

For most varieties, young apple trees were more severely winter injured than older trees (Fig. 2).

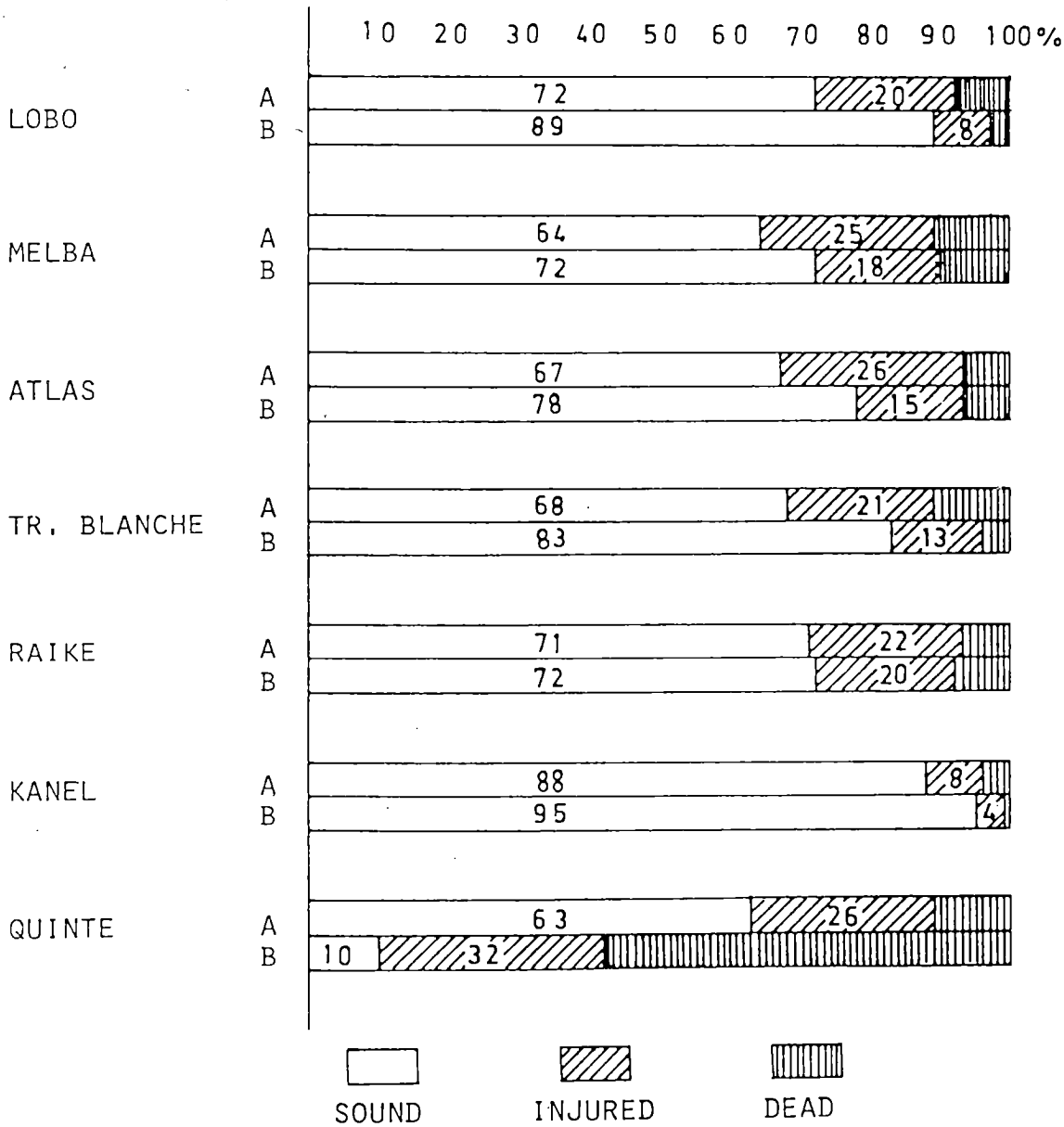

Fig. 2. Wintering of young and grownup trees of the most common apple varieties 1984—85.

A = 5 yrs or under
B = over 5 yrs

The survey attempted to evaluate the significance of rootstock as related to winter injury. However, the information obtained was so confounded that it was not possible to draw any conclusions. The effect of the rootstock on apple tree winter hardiness was apparent in experiments where trees grafted onto the Finnish clonal rootstock YP survived the winter better than those grown on Swedish A2 (Fig. 4). Less injured or dead leaf buds were noted in the young trees of YP stock than in the trees of A2 stock (Table 2). In Finland these rootstocks are common, being used almost exclusively.

The use of hardy stembuilders was again observed to be an advantageous method for the improvement of the overwintering of tender varieties. The stembuilder forms the main framework of the tree and is grafted at 2—3 years of tree age using an adapted variety onto 3—5 branches.

Table 2. Owerwintering of young apple trees (< 5 years) on YP and A2 rootstocks on ridge planting and on level ground.

In the experiment a minimum of -39,9 °C was measured at the snow surface in January, 1985.

Variety Growth base	Dead buds %		Dead trees %	
	YP	A2	YP	A2
Raike				
Ridge planting	46	46	2	2
Level ground	62	81	5	5
Red Melba				
Ridge planting	56	68	5	8
Level ground	95	85	8	8
Maikki				
Ridge planting	32	69	1	5
Level ground	69	75	4	4
Make				
Ridge planting	49	84	1	6
Level ground	89	96	8	8
Jaspi				
Ridge planting	51	58	0	0
Level ground	87	87	3	6
Samo				
Ridge planting	54	51	1	1
Level ground	63	84	3	2
Mean	63	74	44 (41/94)	58 (55/95

The overwintering of apple trees was better on elevated and sloping terrain than on level ground or on low-lying terrain (Table 3). Greater injury was observed on the lower part of the slope than in upper areas. Soil texture also had an effect on hardiness. Trees grown in sandy soils withstood the winter better compared to those grown in clay soils (Table 3). In light soils 79 % of all apple trees surveyed remained uninjured while in heavy soils 72 % were healthy.

The effect of windbreaks on the overwintering of apple trees was not clarifield by the questionnaire due to the great variation of

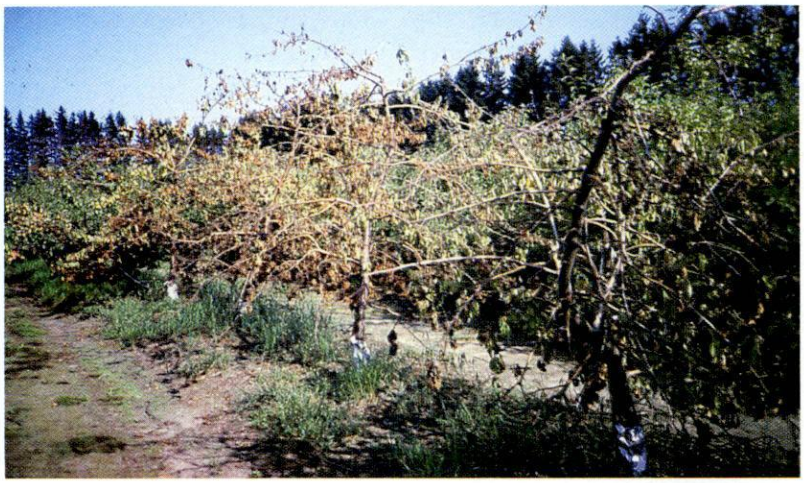

Fig. 3. Apple trees injured by the winter 1984—85. Picture taken in the summer 1986. The injuries on the branch crotches and on the trunks became worse and caused decay of the trees the following year.

Fig. 4. Maikki apple trees, left on the Swedish A_2 and right on the Finnish YP rootstocks after the winter 1984—85.

orchard conditions. However, it was observed that effective shelter from the wind appears to help apple trees endure frosts. This was especially true in the Åland Islands where heavy winds prevailed during the coldest period of the winter.

Planting the trees on a low ridge about 20—30 cm in height and a black plastic sheet coverage again found to be a useful method for the prevention of winter injuries (Table 2, Fig. 5).

Fig. 5. The wintering of Make apple trees, left in ridge planting, right on level ground.

Table 3. Effect of terrain and soil conditions on winter hardiness of apple trees.

Variety	Injured and dead trees			
	terrain		soil type	
	sloping %	low-lying %	sandy soil %	clay soil %
Lobo	14	14	12	19
Melba	30	40	31	30
Atlas	23	35	22	27
Tr. Blanche	20	24	18	24
Raike	18	55	24	41
Mean	21	34	21	28

DISCUSSION

In spite of the fact that the winter of 1984—85 was one of the coldest of this century, the damage to apple tree stands was less than which occurred in earlier severe winters of 1955—56 and 1965—66, respectively. The latter winters differed because low temperatures occurred in November and December and lasted until late March (SÄKÖ 1957, SÄKÖ and PESSALA 1967). In winter of 1984—85 the period of hard frost was restricted to midwinter. Moreover weather conditions in the autumn of 1984 were favourable for the over wintering of trees. On the other hand, the late winter of 1985 was warmer than usual.

The winter of 1984—85, however, was exceptional for its influence on apple trees. Surprisingly, many of the injuries to buds, fruit spurs and shoots partially healed during the following spring and summer. This was probably due to the fact that the period of hard frost during the winter was rather short, lasting only about six or seven weeks, and occurring in January and February when the dormancy is deepest. Probably more important still was the

fact that the winter frost period ended in late February and that March was mild. Freezing of the tissues thus ceased. As April and May were again cooler than normal, a favourable opportunity was provided for the recuperation of slightly injured buds and spurs. Obviously as the length and severity of the hard frost period was marginal, a partial recovery was thus possible. No recovery was observed in frost injured branch crotches and in the trunks, where injury, on the contrary, increased with time.

The main apple variety Lobo wintered surprisingly well. In the winter of 1965—66 Lobo suffered extensive damage, with 30 % of the trees either dead or gravely injured. Lobo is easily injured by the low temperatures occurring in November or December, especially after a wet autumn, which extends its growth period (SÄKÖ and PESSALA 1967). On the other hand, Lobo is quite hardy in the late winter because its dormancy ends late in the spring. A positive example also was the successful overwintering of the new Finnish apple varieties, Jaspi, Pirja and Samo. The hardiness of Maikki and Make was also satisfactory.

Rootstock has an important role in winter hardiness of the apple tree. The Finnish clonal rootstock YP, which originates from the Siberian crab apple *Malus baccata (L.)* Borkh. (SÄKÖ 1977), has been found to be hardier than any of the other varieties tested in Finland. Trees grafted on YP show vigorous growth similar to that of the clonal rootstock A2. YP has also been proved tolerant to the prolonged presence of an ice layer on the soil surface under conditions where A2 and M26 rootstocks were badly injured (SÄKÖ 1985).

Better overwintering of apple trees in elevated and sloping terrains compared to in low-lying areas, as well as in sandy soils as compared to clay soils has been found after previous hard winters (SÄKÖ 1957, SÄKÖ and PESSALA 1967). This is most likely a result of the fact that trees on sloping terrain and in sandy soils are exposed to more favourable temperature conditions which lead to the proper termination of vegetative growth. The survey did not reveal any difference in tree survival between clean cultivation and permanent sward in the orchards, 89 % of the trees were grown in clean cultivation and 11 % in permanent grass.

Apple trees grown on a ridge covered with a plastic sheet succeeded well in overwintering. This method has resulted in improved winter hardiness, growth, and productivity compared to cultivation on level ground (SÄKÖ and LAURINEN 1984). With ridge planting tree growth ceases earlier at the end of the season. Especially after wet autumns, trees have overwintered with less frost injury than those growing in flat soil. Better performance of the trees in ridge plantings is due to more favourable moisture conditions and to higher soil temperature as compared to planting on level ground.

The cold hardiness of an apple tree is a complex phenomenon that is influenced by many factors. There are no effective means to entirely avoid the injuries and loss of trees caused by severe winters. Winter damage depends greatly on the time when hard frost periods occur. Early winter frosts are more injurious than those of midwinter. On the other hand the preceding growing season has an important effect on the overwintering of trees. A cool season with a wet autumn usually delays dormancy and reduces cold tolerance. In Finland, where apples are produced at their northernmost limit, special attention must be paid to the hardiness of varieties and rootstocks, regardless of the fact that the availability of such material, when quality is also taken into account, is very restricted. In addition to choosing adapted plant material, it is urgent to locate apple orchards under favourable microclimatic conditions, and employ cultivation techniques which encourage winter hardiness.

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SELOSTUS

Talven 1984—85 aiheuttamat vauriot maamme omenanviljelyksillä

JAAKKO SÄKÖ ja MAUNO YLI-PIETILÄ

Maatalouden tutkimuskeskus

Ankara talvi 1984—85 aiheutti vaurioita maamme omenatarhoissa. Talvivaurioista tehtiin tiedustelu, jolloin saatiin talvehtimistietoja 131 012 omenapuusta. Näistä 31 % oli peräisin Ahvenanmaalta, 65 % mantereen I hedelmänviljelyvyöhykkeeltä ja 4 % muualta Suomesta.

Tiedustelu osoitti, että ammattiviljelijöiden omenalajikkeisto oli verrattuna aikaisempiin tuhotalviin keskittynyt muutamiin harvoihin lajikkeisiin. Koko maasta saaduissa tiedoissa Lobo-lajikkeen osuus oli 45 %, Melban 10 %, Atlaksen 10 %, Valkean Kuulaan 9 %, Raikkeen 9 % ja Kaneli-omenien 5 %.

Omenapuista vaurioitui ja kuoli yhteensä keskim. 21 %. Päälajike Lobo kesti talven verrattain hyvin, sillä sen puista vaurioitui vain 11 % ja kuoli 4 %. Melba-puista kuoli ja vaurioitui yhteensä 31 %. Myös Atlas, Valkea Kuulas ja Raike talvehtivat heikommin kuin Lobo. Useimmilla lajikkeilla nuoret omenapuut, 5-vuotiaat ja nuoremmat, kärsivät enemmän vaurioita kuin vanhemmat. Uudet kotimaiset omenapuulajikkeet Pirja, Maikki, Samo, Make ja Jaspi talvehtivat verrattain hyvin. Omenapuut selviytyivät talvesta paremmin kotimaiseen YP-perusrunkoon verrattuna kuin ruotsalaista alkuperää olevassa A_2-perusrungossa kasvaessaan.

Omenapuut talvehtivat heikommin alavilla ja tasaisilla kasvupaikoilla kuin rinnemailla ja viettävässä maastossa. Talvehtiminen onnistui myös paremmin hiekka- ja hietamaissa kuin savimaassa. Hyvällä tuulensuojalla oli suuri merkitys, sillä hyvin tuulisilla paikoilla puut kärsivät pahoja vaurioita. Harjuistutus, jossa omenapuut istutetaan n. 20—30 cm korkeaan muovilla katettuun harjuun, oli jälleen eduksi talvehtimisessa.

Omenapuiden talvivauriot jäivät odotettua vähäisemmiksi. Kova pakkanen rajoittui tammi- ja helmikuuhun, jolloin kasvien talvilepo on syvimmillään. Marras- ja joulukuussa ei esiintynyt sanottavia pakkasia ja maaliskuukin oli normaalia lämpimämpi. Toisaalta taas tavallista viileämmät huhti- ja toukokuu antoivat vaurioituneille solukoille tervehtymismahdollisuuden. Lievät vauriot paranivat. Äkillinen lämpötilan nousu ja sen myötä nopea kasvuunlähtö olisivat koituneet turmiollisiksi. Pakkasen aiheuttamat runko- ja oksavauriot eivät parantuneet, vaan päinvastoin pahenivat seuraavan talven 1985—86 aikana.

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Seria HORTICULTURA N. 56 — Sarja PUUTARHAVILJELY n:o 56

Research note

'AURA' AND 'ASTRA', FINNISH ARCTIC BRAMBLE HYBRID VARIETIES

HEIMO HIIRSALMI, SAILA JUNNILA and JAAKKO SÄKÖ

HIIRSALMI, H., JUNNILA, S. & SÄKÖ, J. 1987. **'Aura' and 'Astra', Finnish arctic bramble hybrid varieties.** Ann. Agric. Fenn. 26: 261—269. (Agric. Res. Centre, Dept. Hort., SF-21500 Piikkiö, Finland.)

In 1986 two arctic bramble hybrid selections were released for cultivation under the variety names 'Aura' and 'Astra'. They were chosen from among the progeny produced by free-pollination seeds of the Alaskan bramble, *Rubus arcticus* L. subsp. *stellatus* (Sm.) Boiv., obtained from the Öjebyn Experimental Station in Sweden in 1968. The pollinator was an undetermined strain of the arctic bramble, *Rubus arcticus* L. subsp. *arcticus*, that grew in the same experimental field among with the Alaska bramble clone. The varieties belong to the hybrid subspecies *Rubus arcticus* L. subsp. × *stellarcticus* G. Larsson.

The shoots of the arctic bramble hybrid varieties 'Aura' and 'Astra' are sturdier and higher than those of the arctic bramble. The hybrid varieties are also strong-growing and abound in shoots. Like all known natural strains of the Alaska bramble and the arctic bramble, as well as the arctic bramble varieties, they are self sterile, which necessitates parallel cultivation of both varieties for the production of berries. The cropping season for these varieties in southern Finland starts in the beginning of July, or in mid-July, and continues until mid-August. In the trials both varieties, especially 'Aura' have produced considerably bigger crops than the arctic bramble varieties. In addition they have inherited the large firm berries of the Alaska bramble and the fine aroma of the arctic bramble.

Index word: *Rubus arcticus*, *Rubus arcticus* subsp. *stellatus*, arctic bramble, Alaska bramble.

INTRODUCTION

Cultivation research into the precious wild berry, the arctic bramble (*Rubus arcticus* L.), has led to practical applications in Finland and Sweden. As a result many questions related to cultivation techniques, pollination relationships and fruiting have been settled (LARSSON 1955, RYYNÄNEN 1973, HIIRSALMI 1975).

The arctic bramble has proved to be self sterile (TAMMISOLA and RYYNÄNEN 1970) and in order to fruit it should be in a mixed population of two or more clones. With a view to field cultivation two arctic bramble clones

propagated from natural strains were simultaneously released for sale in 1972 and they were given the varietal names 'Mesma' and 'Mespi' (RYYNÄNEN 1972). In 1982 a third variety was brought under cultivation; a better cropper and cultivationwise safer variety called 'Pima', which was created by crossing the two first-mentioned varieties (RYYNÄNEN and DALMAN 1983). However, all three varieties have a host of qualities that have precluded financially profitable cultivation. For instance, the varieties are low-growing, the berries are small, their colour variable and they require a long time to ripen. Annual yield fluctuates considerably, and most often remains low. In addition the varieties are self sterile.

In order to improve culture properties the arctic bramble has been crossed with the Alaska bramble, which grows wild in the Bering Sea area. The first crossings were performed in Sweden in the 1950s and in Finland in the early 1970s (LARSSON 1969, 1970, 1980a, HIIRSALMI and SÄKÖ 1980). Phytogeographical, taxonomic, biochemical and cytogenetic studies have provided conclusive evidence that the arctic bramble and the Alaska bramble are quite closely related (LARSSON 1969, HULTEN 1971, KALLIO 1975, KOTIMÄKI and HIIRSALMI 1979). They are regarded as the subspecies *Rubus arcticus* L. subsp. *arcticus* and *Rubus arcticus* L. subsp. *stellatus* (Sm.) Boiv., respectively.

DEVELOPMENT OF SELECTIONS

Since 1968 the Agricultural Research Centre's Department of Horticulture at Piikkiö has been working on the development of arctic bramble varieties strengthened by genes from the Alaska bramble. Initially the work was focused on the progenies produced by the free-pollination seeds of the subspecies *stellatus* and the cross-seeds of the subspecies *stellatus* and *arcticus*, obtained from the Öjebyn Experimental Station in Sweden in the summer of 1968. Since 1971 the Department has also been engaged in crossing projects of its own.

The same Alaska bramble clone has been used in all research. Several different natural strains of the arctic bramble have been used in crossings by the Department of Horticulture, the 'Mesma' and 'Mespi' varieties among others. The crossindividuals with an advantageous combination of properties have also been crossed with each other and backcrossed with their progenitors.

All free-pollination progenies of the Alaska bramble clone are most probably the results of crossings, where the arctic bramble strains growing in the same trial field with the clone have acted as pollinators. The Alaska bramble is in fact practically self sterile like the arctic bramble though even internal pollination of the clone, if it occurs between different flowers, may by way of exception produce a seed (LARSSON 1969).

The gradings for selection have mainly been confined to culture properties. The following variables have been considered: flowering time, abundance of the flowering, yield, vigour of growth, growth structure cover, height of the shoots, winterhardiness and resistance of disease. In addition to the time for ripening of the berries, their size, colour, taste, aroma content, acidity and firmness have been considered. For some crossprogenies heredity of vegetative qualities has also been studied. On the basis of the results obtained with the cross-progenies and in the clone trials (HIIRSALMI and SÄKÖ 1980) the best individuals have been chosen as selections for comparative trials.

RESULTS OF COMPARATIVE TRIALS

In 1977 comparative trials with selections using the clones produced by the Swedish seeds were set up at the Department of Horticulture, at the South Savo Research Station in Mikkeli and at the North Ostrobothnia Research Station at Ruukki.

Based on the results (Tables 1—3) of these comparative trials it has been possible to offer positive proof that several selections are in many respects superior to the 'Mesma' and the 'Mespi' varieties. Some of them have been culturewise very safe and have, even in unfavourable years, produced a crop of about 20 kg/100 m^2. The berries of the best selections have been larger, darker and firmer than those of the arctic bramble. Their nectar aroma, which has always been quite prominent has not, however, attained quite the same level as in that of the arctic bramble.

The individuals chosen from among the cross-progenies of the arctic bramble and the Alaska bramble have shown better vitality than

Table 1. Results of comparative trial with arctic bramble hybrid varieties at the Department of Horticulture in 1978—1981.

Selection Clone Variety	Yield kg/100 m^2	Weight of 100 berries g	Shoot height cm	Growth structure cover %
096 ('Aura')	35	130	21	78
086	20	79	18	64
095	18	105	24	75
123 ('Astra')	16	101	22	90
107	16	91	21	66
055	15	89	18	62
074	13	74	18	45
083	13	69	17	66
stellatus clone	11	94	21	75
'Mesma'	7	61	13	29
'Mespi'	2	69	12	30

Selection Clone Variety	Berry taste 0—10	Nectar aroma 0—10	Acidity 0—10	Firmness 0—10	Colour 0—10
096 ('Aura')	6,9	5,3	4,2	6,5	6,9
086	6,4	3,7	4,2	6,3	5,9
095	7,5	5,6	3,9	7,2	6,6
123 ('Astra')	6,1	2,2	4,7	6,9	8,3
107	7,7	5,6	3,6	7,4	8,0
055	6,5	4,2	4,4	6,7	6,7
074	5,7	4,6	6,1	7,2	7,9
083	4,7	3,9	4,8	6,7	5,8
stellatus clone	6,2	0,3	4,5	7,8	8,5
'Mesma'	7,8	8,2	3,7	6,8	7,5
'Mespi'	7,7	6,4	3,1	7,0	7,7

Selections
074, 083 and 086 = *stellatus* × *arcticus;* seeds from Sweden
055, 095, 096, 107 and 123 = *stellatus* free pollination; seeds from Sweden

Berry qualities
Taste: 0—10 = very poor — very good
Nectar aroma: 0—10 = no aroma — very strong aroma
Acidity: 0—10 = very low — very high
Firmness: 0—10 = very soft — very firm
Colour: 0—10 = white/green — reddish violet

Table 2. Results of comparative trial with arctic bramble hybrid selections at the South Savo Research Station in 1978—1981.

Selection Clone Variety	Yield kg/100 m^2	Weight of 100 berries g	Shoot height cm	Growth structure cover %
095	23	140	22	83
123 ('Astra')	20	136	22	84
107	18	117	22	94
stellatus clone	15	212	22	82
083	13	89	21	88
086	13	97	23	87
'Mespi'	11	89	15	59
074	11	123	19	76
'Mesma'	10	79	20	81

Selections
See Table 1

Table 3. Results of comparative trial with arctic bramble hybrid selections at the North Ostrobothnia Research Station in 1978—1981.

Selection Clone Variety	Yield kg/100 m^2	Weight of 100 berries g	Shoot height cm	Growth structure cover %
095	38	124	18	58
123 ('Astra')	25	103	22	60
083	23	63	15	57
107	22	89	20	46
086	19	67	14	42
074	11	92	17	42
stellatus clone	6	108	15	32
'Mesma'	6	61	11	25
'Mespi'	4	57	10	22

Selection
See Table 1

the progenitors. Particular note should be taken of the rapid vegetative increase demonstrated by the cover percentage and hence the plentiful sending out of new crop-producing shoots. A large portion of the selections seems, in the same manner as the Alaska bramble, to put up a higher growth structure than the cultivated arctic bramble varieties. This is an essential improvement from the point of view of berry accessibility. Unfortunately the shoots, however, are not as upright and sturdy as those of the Alaska bramble but somewhat looser.

The time and duration of the flowering of the chosen selections have been almost the same as for the arctic bramble; about three weeks at the end of May and beginning of June. The crop ripens from the beginning of July to mid-August.

It is regrettable that all the selections studied so far have, like the arctic bramble and the Alaska bramble, been self sterile. To be sure, now and then some self-pollination seeds are produced. However, self fertility is so low that it is of no account as far as cropping is concerned.

The arctic bramble hybrid *Rubus arcticus* subsp. × *stellarcticus*

On the strength of the positive results obtained in the three comparative trials set up in 1977, selections 095, 096 and 123 were chosen for inclusion in the planting for observation instituted by the Department of Horticulture in 1982, where the above selections were compared with, among others, the Alaska bramble, wild strains of the arctic bramble and arctic bramble varieties as well as with some selections resulting from Swedish seeds and the Department's own crossings (Table 4). The planting for observation comprised 43 different clones in all. The Swedish hybrid varieties 'Anna' and 'Linda' were also included, and in 1984 varieties 'Beata' and 'Sofia' (LARSSON 1980b, 1984) were additionally planted.

Clearly culturewise the safest and, in particular, the best cropper proved to be selection 096, which in March 1986 was put on the market under the variety name 'Aura'. At the same time, selection 123 was also realeased for cultivation under the variety name 'Astra'. It is recommended chiefly as a pollination variety.

Table 4. Results of observation trial with arctic bramble hybrid selections and varieties at the Department of Horticulture in 1983—1986.

Selection Clone Variety	Average yield 1984—86 g/m²	Weight of 100 berries g	Shoot height cm	Growth structure cover %
096 ('Aura')	1249	119	24	73
72084023	969	99	26	78
095	847	101	22	72
086	753	56	19	72
72084020	598	85	24	67
123 ('Astra')	589	99	24	78
72093013	580	89	24	66
Starck strain	553	88	18	62
72092005	536	99	23	69
'Anna'	484	118	22	48
'Linda'	451	108	22	47
stellatus clone	344	125	23	65

Selection Clone Variety	Taste 1—9	Nectar aroma 0—9	Acidity 1—9	Firmness 1—9	Colour 1—9
096 ('Aura')	6,0	4,0	5,8	6,2	6,4
72084023	5,2	3,6	5,0	5,4	6,2
095	4,8	3,2	7,0	6,4	5,2
086	4,4	3,0	4,0	5,6	4,4
72084020	4,6	2,4	3,8	5,2	7,0
123 ('Astra')	4,6	3,2	6,4	6,2	7,8
72093013	4,0	2,6	6,8	6,4	6,6
Starck strain	5,4	4,2	4,8	4,0	5,4
72092005	5,6	3,4	5,0	5,8	8,2
'Anna'	5,6	4,8	4,8	6,2	6,0
'Linda'	6,8	3,5	5,0	6,2	7,2
stellatus clone	3,5	1,8	5,7	7,6	6,7

Selections
086 = *stellatus* × *arcticus;* seeds from Sweden
095, 096 and 123 = *stellatus* free pollination; seeds from Sweden
72084020 and 72084023 = 'Mespi' × *stellatus*
72092005 = *stellatus* × Tervaranta natural strain
72093013 = *stellatus* × 'Mespi'

Berry qualities
Taste: 1—9 = very poor — very good
Nectar aroma: 0—9 = no aroma — very strong aroma
Acidity: 1—9 = very low — very high
Firmness: 1—9 = very soft — very firm
Colour: 1—9 = white/green — reddish violet

The arctic bramble hybrid varieties resemble both the arctic bramble and the Alaska bramble. LARSSON (1980a) has designated this hybrid *Rubus arcticus* L. subsp. × *stellarcticus* G. Larsson.

Since all arctic bramble and arctic bramble hybrid varieties are self sterile, it is essential that at least two varieties be cultivated in parallel and that these varieties be well able to fertilize each other. In the trials performed the interpollination of the varieties 'Aura' and 'Astra' has produced good fertilization results. Selection 095 which based on the comparative trials made a good impression, has not been able to fertilize the 'Aura' variety in trial pollinations. Consequently it has not been put forward as a variety for the time being.

In the summer of 1986 the fertilization percentages of the flowers of the different varieties were calculated in the observation trial field where the probability of cross-pollination is high due to the numerous varieties and selections. The percentages turned out to be surprisingly high: 'Aura' 95,7 % and 'Astra' 94,7 %, 'Anna' 86,7 % and 'Linda' 97,8 %, and for the chosen controls the *stellatus* clone 82,0 % and the Starck natural strain 92,2 %. The result was certainly positively influenced by the exceptionally favourable weather during the flowering and the consequent activeness of the pollinators, especially the bees. This is also the explanation for the 1986 bumper crops. The 'Aura' variety produced as much as 1780 g/m^2.

Besides fruiting, the number of flowers per shoot was also determined (Fig. 1). The count was made on 10 July 1986 for each test in two 30 × 30 cm squares. The Alaska bramble, in addition to the sterile shoots, has only one-flower shoots which makes the number of flowers per shoot low, on an average 0,3 flowers/shoot. Then again the arctic bramble always has multiflower shoots also, for example the Starck natural strain has an average of 1,6 flowers/shoot. As regards this characteristic, the hybrid varieties are closer to the arctic bramble than to the Alaska bramble. The 'Aura' variety has been estimated to have on an average 1,8 flowers/shoot, and even an eight-flower shoot has been seen in this variety.

DESCRIPTION OF THE 'AURA' AND 'ASTRA' VARIETIES

The hybrid varieties 'Aura' and 'Astra' originate from free pollination in a crossing of two subspecies of the species *Rubus arcticus* L. The Alaska bramble (*Rubus arcticus* L. subsp. *stellatus* (Sm.) Boiv.) has been fertilized by pollen from an unknown arctic bramble (*Rubus arcticus* L. subsp. *arcticus*) strain. The varieties belong to the hybrid subspecies *Rubus arcticus* L. subsp. × *stellarcticus* G. Larsson. The 'Aura' and 'Astra' have at the Agricultural Research Centre's Department of Horticulture at Piikkiö been chosen from among progenies that were grown from seeds obtained in 1968 from the Öjebyn Experimental Station in Sweden.

The leaves of the 'Aura' and 'Astra' varieties are a bright green and like those of the arctic bramble, trifoliate. Compared to the arctic bramble the shoots are sturdier and higher; the average height of the growth structure is about 20 cm. The varieties are very vigorous and reproduce rapidly vegetatively bringing forth a uniform growth structure with numerous shoots. Their winter hardiness and resistance to disease have been good in the trials.

The flowering of the varieties usually starts at the end of May and peaks in southern Finland at the turn of May to June, in North Ostrobothnia in mid-June. For the 'Astra' variety flowering often begins 2—3 days later than for the 'Aura'. The flowering of both

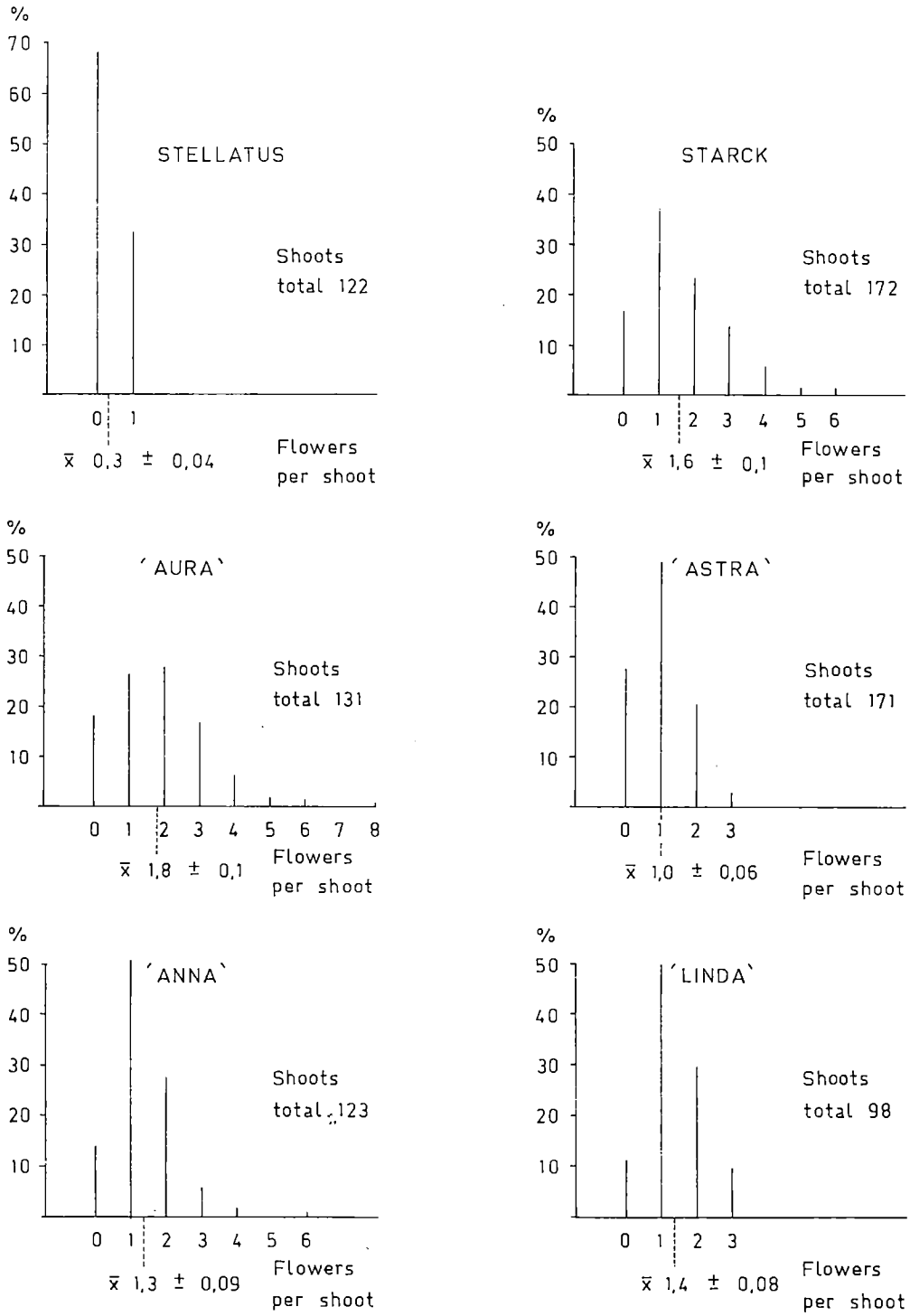

Fig. 1. Relative proportions according to number of flowers of shoots of *Rubus arcticus* subsp. *stellatus* and subsp. *arcticus* (arctic bramble natural strain Starck) clones and subsp. × *stellarcticus* varieties. The shoots were counted in two 30 × 30 cm areas.

Fig. 2. The variety 'Aura'

Fig. 3. The variety 'Astra'

varieties is abundant lasting for about 20 days; slight after-flowering occurs later, too. The flowers are purple, as they mature they fade. In general there are one to three flowers per shoot and they develop on level with the highest leaves or above them. The petals of the 'Astra' variety are narrower than those of the 'Aura'. The flowers of both are hermaphroditic, but the varieties are still self sterile.

The cropping season for these varieties starts in the beginning of July, or in mid-July, and continues until mid-August. The cropping is of slightly shorter duration for the 'Astra' variety as compared to the 'Aura' variety. 'Aura' is the

better cropper of the two; in the trials its yield has mostly exceeded 300 g/m^2, under favourable weather conditions sometimes even in excess of 1500 g/m^2. Usually 'Astra' has produced over 200 g/m^2. Both varieties have in the trials been considerably better croppers than the arctic bramble varieties 'Mesma' and 'Mespi'.

The berries of the 'Aura' and 'Astra' varieties are bigger and firmer than those of the arctic bramble. Even when ripe they remain firmly attached to the receptacle. The berries are evenly coloured; the 'Aura' variety a dark bright red, the 'Astra' variety a dark brownish red.

In the berries of these varieties the aroma of the arctic bramble is clearly detectable; the aroma being stronger in 'Aura' than in 'Astra'. In addition, the aroma typical of the Alaska bramble is detectable in both. The berries of the 'Astra' variety are more acid than those of 'Aura'.

Due to self sterility, parallel cultivation of the two varieties is essential for the production of berries. The 'Astra' variety is recommended for use chiefly as pollinator and to be planted for instance, in every third row with the 'Aura' variety producing the main crop.

The 'Aura' and 'Astra' arctic bramble hybrid varieties are especially suited for hobby and domestic cultivation. The production of virus tested plants of these varieties takes place through the Propagation Unit for Healthy Plants of the Agricultural Research Centre.

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SELOSTUS

'Aura' ja 'Astra', suomalaiset jalomaarainlajikkeet

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Maatalouden tutkimuskeskus

Vuonna 1986 laskettiin viljelyyn kaksi mesimarjahybridijalostetta lajikenimillä 'Aura' ja 'Astra'. Ne on Maatalouden tutkimuskeskuksen puutarhaosastolla Piikkiössä valittu jälkeläistöstä, joka on kasvatettu Ruotsista Öjebynin koeasemalta vuonna 1968 saaduista alaskanmesimarjan, *Rubus arcticus* L. subsp. *stellatus* (Sm.) Boiv., vapaapölytyssiemenistä. Pölyttäjänä on ollut jokin alaskanmesimarjakloonin kanssa samalla koekentällä kasvaneista mesimarjan, *Rubus arcticus* L. subsp. *arcticus,* luonnonkannoista. Risteytyksen tuloksena syntynyt kasvi on saanut nimen jalomaarain, *Rubus arcticus* L. subsp. × *stellarcticus* G. Larsson.

Jalomaarainlajikkeiden 'Aura' ja 'Astra' versot ovat tukevammat ja korkeammat kuin mesimarjalla. Risteytymälajikkeet ovat lisäksi voimakaskasvuisia ja runsasversoisia. Ne ovat kaikkien tunnettujen alaskanmesimarjan ja mesimarjan luonnonkantojen sekä mesimarjalajikkeiden tavoin itsesteriilejä, minkä vuoksi molempien lajikkeiden rinnakkainen viljely on marjojen muodostumiselle välttämätöntä. Lajikkeiden satokausi Etelä-Suomessa alkaa heinäkuun alussa tai puolivälissä jatkuen elokuun puoliväliin asti. Kumpikin lajike, ja etenkin 'Aura', on kokeissa ollut huomattavasti mesimarjalajikkeita satoisampi. Lisäksi ne ovat perineet alaskanmesimarjan kookkaat, kiinteät marjat ja niihin mesimarjan hienoa aromia.

'Aura'- ja 'Astra'-jalomaarainlajikkeet soveltuvat etenkin harraste- ja kotitarveviljelyyn. Lajikkeiden taimituotanto tapahtuu Laukaassa sijaitsevan Maatalouden tutkimuskeskuksen tervetaimiaseman kautta.

ANNALES AGRICULTURAE FENNIAE, VOL. 26: 271—274 (1987)
Seria HORTICULTURA N. 57 — Sarja PUUTARHAVILJELY n:o 57

Research note

'MINJA', A FINNISH WOOD STRAWBERRY VARIETY

HEIMO HIIRSALMI, SAILA JUNNILA and JAAKKO SÄKÖ

HIIRSALMI, H., JUNNILA, S. & SÄKÖ, J. 1987. **'Minja', a Finnish wood strawberry variety.** Ann. Agric. Fenn. 26: 271—274. (Agric. Res. Centre, Dept. Hort., SF-21500 Piikkiö, Finland.)

The wood strawberry, *Fragaria vesca* L., and the everbearing mutant, *Fragaria vesca* L. var. *semperflorens* (Duch.) Ser., are readily crossed. As a result of the crossing in 1968 of a Finnish wood strawberry strain with the German everbearing variety 'Rügen' a selection was developed, which has been released for cultivation under the varietal name 'Minja'.

The wood strawberry variety 'Minja' has a vigorous growth and its winter hardiness is good. It produces runners in abundance thus facilitating its vegetative propagation. The flowers and berries develop above the leaves. The major part of the crop is produced in July and in the first half of August, but berries ripen until the beginning of September. Hence this variety can be regarded as an everbearing variety. The summer yield has been about 300 g per metre of row. The berries are small but on an average still larger than those of wild wood strawberry. They are sweet and lightly acid to the taste with a flavor decidedly that of the wood strawberry. 'Minja' is eminently suited for hobby and domestic growing.

Index words: *Fragaria vesca*, wood strawberry, strawberry varieties, strawberry breeding.

INTRODUCTION

The wood strawberry, *Fragaria vesca* L., which is diploid (2n=14), is the most widespread species of strawberry. It grows wild in Europe, Asia and North America, and it is known as a neophyte almost all over the world (DARROW 1966, SCOTT and LAWRENCE 1975). In Finland the wood strawberry grows in the southern part of the country, doing best in sunny clearings and on the slopes of hills. It has been found to adapt comparatively well to different conditions for example to field cultivation.

Of the *Fragaria vesca* species a great number of different forms are encountered especially in America. The most important of these is, however, *Fragaria vesca* L. var. *semperflorens* (Duch.) Ser., which being photoperiodically day-neutral, fruits from early summer until late autumn. Both runnerproducing and runnerless varieties are cultivated. Of the latter, the German variety 'Rügen' is videly known.

In the Department of Horticulture of the Agricultural Research Centre at Piikkiö, a comparison under field conditions has been made between a wood strawberry strain, transplanted from a dry slope population on the grounds of the Department, and from the German everbearing variety 'Rügen' (HIIRSALMI 1975). They differ from each other in several both vegetative and generative properties. The habitus of 'Rügen' is, due to its short flower stems and leaf stalks, markedly lower than that of the wood strawberry. 'Rügen' produces only a quarter of the flowers produced by the wood strawberry, but being a remontant variety its yield is of the same order as that of the wood strawberry. In the year following planting it already produces a full crop, unlike the wood strawberry. The capacity for producing runners is, however, practically nonexistent in the 'Rügen' variety. This being the case, its growth structure is weakened rapidly and the crop level drops, and it must be replanted generally every other or third year. The propagation of 'Rügen' is either by seedlings or by division of the mother plant into daughter individuals, whereas the wood strawberry strain of the comparison produces numerous runner plantlets. The elongated, rather tasteless berries of the 'Rügen' weigh nearly twice as much as those of the wood strawberry. The small spherical berries of the wood strawberry have a particularly fine aroma.

DEVELOPMENT OF SELECTIONS

Fragaria vesca and its variant *Fragaria vesca* var. *semperflorens* are easily crossed. For this reason an attempt was made to combine the advantageous properties of the wood strawberry that grows wild in Finland and the Central European everbearing form. The crossings of the wood strawberry strain taken from the grounds of the Department of Horticulture and the 'Rügen' variety were made in 1968.

Grading of the progenies has shown that the hybrids inherited features from both progenitors (HIIRSALMI 1975). The progenies are altogether more strong-growing than the parent forms. This can be explained as hybrid vigor, which is displayed when two estranged forms of the same species are crossbred.

Taking into account all of the favourable properties, four clones were chosen from among the progenies as selections for the comparative trials. The trials show that the selections differ very slightly from each other, especially concerning berry qualities. The flowering, including after-flowering, lasts 2—3 months. Of this time, a month and a half is the period of heavy flowering. The berries ripen within just under two months; the main crop in barely one month. The duration of flowering and hence also the cropping season is for all selections clearly longer than that of the wood strawberry, but still not as long as for the 'Rügen' variety. In the comparative trial, in which the plants were spaced 33 cm apart, the crop came to 200—300 g per metre of row. This slightly exceeds the production of the progenitors. In later observation tests the crop level could be raised through closer planting. The optimum space between the plants in the row would then be 20 cm.

The berries of the chosen selections are of the same size as those of the 'Rügen' variety; the average weight, depending on the selection, being 0,7—0,8 g. They are easily separated from the calyx and are thus easy to pick regarding all selections. On the other hand, the abundance of protruding seeds is a drawback. The berries of all the selections are rather sweet and, due to the fine aroma of the wood strawberry, delicious. They are bright red on the surface.

Selection 68041010 from the crossing *Fragaria vesca* × 'Rügen' has been judged so valuable that it has been released for cultivation. It has been given the varietal name 'Minja'.

DESCRIPTION OF THE VARIETY 'MINJA'

The wood strawberry variety 'Minja' is the result of the crossing of the wild wood strawberry with 'Rügen', an everbearing variety. This crossing of the domestic wood strawberry and the everbearing Central European form of the species — *Fragaria vesca* L. × *Fragaria vesca* L. var. *semperflorens* (Duch.) Ser. — was carried out by the Department of Horticulture of the Agricultural Research Centre at Piikkiö in 1968. The wood strawberry strain came from a population growing on a dry slope on the grounds of the Department. The different properties of 'Minja' reflect features from both progenitors. Concerning several properties it is, however, clearly an intermediary.

The leaf stalks of this variety are long, as are those of the wood strawberry also, which makes its habitus higher than that of the low-growing 'Rügen' variety. The variety has a vigorous growth and its winter hardiness is good. In addition, the flower stems are long. The flowers and berries develop in the manner of the wood strawberry and, in contrast to 'Rügen', above the leaves. The surface of the leaves is a lightish green and greyish green underneath, having a downy fuzz all over. The leaf stalks and the flower stems also have puberudent hairs. Contrary to 'Rügen' 'Minja' produces runners in abundance, facilitating its vegetative propagation.

The flowering of 'Minja' generally starts at

Fig. 1. The wood strawberry variety 'Minja'.

the end of May in southern Finland and it continues up to the middle of August. The flowering is at its peak in June. The first berries often ripen at the end of June. This variety produces the biggest crop in July and at the beginning of August, but berries ripen up to the beginning of September. Thus 'Minja' like 'Rügen' is everbearing variety. The yield in the trials at the Department of Horticulture has most often been about 300 g per metre of row, corresponding to 30 kg/100 m^2.

'Minja's' berries are a bright red on the surface and nearly white inside. The seeds, small achenes, protrude from the surface of the berry. The berries are easily detached from the calyx and in firmness they take after the wood strawberry. The berries are small in size, on an average, however, they are larger than the berries of the wild wood strawberry. The weight of a hundred berries has in the trials usually been about 80 g. The berries are conical in shape, an elongated sphere or spherical; those of the early crop even flat and spherical.

The berries of the 'Minja' variety are sweet, lightly acid and their taste clearly that of the wood strawberry. Their resistance to grey mould is very good and when picked regularly there is generally no evidence of grey mould.

'Minja' is especially suitable for hobby and domestic cultivation.

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SELOSTUS

Suomalainen ahomansikkalajike 'Minja'

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Maatalouden tutkimuskeskus

Ahomansikka, *Fragaria vesca* L., ja sen jatkuvasatoinen muoto, kuukausimansikka, *Fragaria vesca* L. var. *semperflorens* (Duch.) Ser., risteytyvät vaivatta keskenään. Vuonna 1968 Maatalouden tutkimuskeskuksen puutarhaosastolla kotimaisen ahomansikkakannan ja saksalaisen 'Rügen'-kuukausimansikkalajikkeen välillä tehdyn risteytyksen tuloksena on syntynyt jaloste, joka on laskettu viljelyyn lajikenimellä 'Minja'.

'Minja'-ahomansikkalajike on voimakaskasvuinen ja sen talvenkestävyys on hyvä. Se tuottaa runsaasti rönsyjä, joten sen kasvullinen lisääminen on helppoa. Kukat ja marjat muodostuvat lehtien yläpuolelle. Suurin osa sadosta saadaan heinäkuussa ja elokuun ensimmäisellä puoliskolla, mutta marjoja kypsyy aina syyskuun alkuun asti. Lajiketta voidaan siis pitää jatkuvasatoisena. Marjat, joita kesän aikana saadaan noin 300 g rivimetriä kohti, ovat kooltaan pieniä, keskimäärin kuitenkin luonnonvaraisen ahomansikan marjoja suurempia. Ne ovat makeita, mietohappoisia ja selvästi ahomansikalta maistuvia. 'Minja'-lajike soveltuu erinomaisesti harraste- ja kotitarveviljelyyn.

ANNALES AGRICULTURAE FENNIAE, VOL. 26: 275—278 (1987)
Seria HORTICULTURA N. 58 — Sarja PUUTARHAVILJELY n:o 58

Research note

GENETIC BACKGROUND OF GREEN FRUIT COLOUR IN BLACKCURRANT.

SAILA JUNNILA and HEIMO HIIRSALMI

JUNNILA, S. & HIIRSALMI, H. 1987. **Genetic background of green fruit colour in blackcurrant.** Ann. Agric. Fenn. 26: 275—278. (Agric. Res. Centre, Dept. Hort., SF-21500 Piikkiö, Finland.)

Blackcurrants with a yellowish green fruit colour have been found among the inbred progenies produced by selfing cv. 'Öjebyn'. Seedlings with drastically reduced anthocyanin production in the berries are concluded to be homozygous recessive for one gene, v, linked with a lethal gene le. More or less commonly appearing anthocyanin dots in the green fruit skin of these seedlings indicate, however, some anthocyanin production in the green berries, the production being controlled either by environmental or genetic factors.

Index words: anthocyanin, blackcurrant, *Ribes nigrum.*

The normal dark colour of ripe blackcurrant (*Ribes nigrum*) berries is due to anthocyanin pigments. Four major anthocyanins (cyanidin-3-glucoside, cyanidin-3-rutinoside, delphinidin-3-glucoside, delphinidin-3-rutinoside) and three minor anthocyanins (cyanidin-3-sophoroside, delphinidin-3-sophoroside, pelargonidin-3-rutinoside) have been identified in blackcurrant berries (HARBORNE and HALL 1964, LE LOUS et al. 1975). Several greenish yellow and orange flavonols, flavonoids biosynthetically close to the anthocyanins, have also been isolated and identified in the fruits of the blackcurrant (LE LOUS et al. 1975). Sometimes blackcurrants with an unusual fruit colour, obviously deficient in anthocyanin pigmentation, have been found. KEEP (1975) reports white-, green- and yellow-fruited plants to be known.

The genetic control of anthocyanin biosynthesis has been investigated in several species. A number of genes affecting the production of anthocyanin have been identified and even localized, mostly in maize, but also in many other plants. Studies of anthocyanin-deficient plants have sometimes revealed that the inhibition of anthocyanin production is controlled by dominant allels (COE 1962, RUEBENBAUER and RUEBENBAUER 1977). Frequently, however, the flavonoid biosynthesis steps have been proved to be blocked by a homozygous recessive gene (BRIGGS 1966, DOONER and NELSON 1979, GANDERS et al. 1980, DOODEMAN et al. 1982, GERATS et al. 1982).

A yellow-green fruit colour in blackcurrant fruits has been postulated to be controlled by a resessive gene rb (KEEP and KNIGHT 1970). This gene was interpreted to be linked with a lethal gene l with a cross-over value of 30 % or slightly less. These results were based on self-bred progenies of a Finnish blackcurrant accession, whose origin was unknown.

As a part of the heterosis breeding program several blackcurrant cultivars have been selfed in the Department of Horticulture at the Agricultural Research Centre. Among the inbred progenies produced yellowish green-fruited blackcurrants have been found. This paper reports on some aspects of the inheritance of this fruit colour.

SELF-CROSS STUDY, RESULTS AND DISCUSSION

Yellowish green-fruited blackcurrants have frequently been found among seedlings derived from selfing cv. 'Öjebyn' (Table 1 a). Upon selfing one of these green-fruited plants (no. 038 in family 65005), only green derivatives were produced (Table 1c). Back-crossing of this plant yielded both black- and green-fruited derivatives in the approximate ratio of 1:1 (Table 1 b).

These observations support the theory that one recessive gene involved in anthocyanin biosynthesis blocks this synthesis pathway if the plant is homozygous for the allele. The gene is tentatively named v.

On the hypothesis that the absence of anthocyanin pigment in blackcurrant fruit is under the control of a single Mendelian gene, a segregation of 3 black-fruited: 1 green-fruited plant would be expected upon selfing the evidently heterozygous (V/v) parent variety 'Öjebyn'. However, the progenies produced in the selfing show a significant deficiency of homozygous recessives (green-fruited). The segregation suggests a linkage between the v and a lethal gene, as KEEP and KNIGHT (1970) have postulated a linkage between the colour gene rb and a lethal gene l. The genotype of 'Öjebyn' is thus postulated to be V Le/v le; Le and le being used to denote normal and lethal, respectively.

The segregation obtained in the self-bred families of 'Öjebyn' differs significantly (P 0,01) from that expected, when the colour gene v and the lethal gene le are assumed to be linked with a cross-over value of 30 %, which is the linkage observed between the colour and lethal genes in the study of KEEP and KNIGHT (1970). The proportion of green segregants in the self-bred progenies is only 6,1 %, against an expectation of 17,0 %. These progenies suggest a closer linkage between the colour and lethal genes, and an estimation of a 10 % cross-over value has been made. Consequently, the genes rb and v can not be considered to be identical, but mutations of separate genes controlling the biosynthesis of anthocyanins in blackcurrant berries. Alternatively, if the genes rb and v are the same, the lethal genes l and le must be separate.

The most probable genotype of the green-fruited seedling no. 65005038 would be v Le/

Table 1 a—c. Segregation for fruit colour in selfed and crossed families of blackcurrant.

Family no.	Number of derivatives Total	Green-fruited	X^2	P
a. *'Öjebyn' × self*				
Tentative genotype V Le/v le				
65005	43	2	0,235 ns	0,65
67009	98	7	0,016 ns	0,75
70018	21	0	5,732 *	0,025
75001	63	6	1,220 ns	0,25
79033	24	2	0,380 ns	0,60
80031	79	3	0,695 ns	0,45
Total	328	20	0,0009 ns	0,90
%		6,1		
b. *'Öjebyn' × 65005038*				
Tentative genotypes				
V Le/v le × v Le/v le			4,393 *	0,025
or				
V Le/v le × v Le/v Le			0,205 ns	0,65
80003	55	26		
c. *65005038 × self*				
Tentative genotype v Le/v Le				
80033	98	98		

To calculate X^2 the correction for continuity (Yates) was done and the cross-over value of 10 % was used in the expectation values. P = level of probability.

v le. Upon back-crossing this plant (Family 80003) a segregation of 26 green : 29 black was obtained (Table 1 b). This differs significantly from the ratio of 20,2 : 34,8 expected based on the cross-over value of 10 %. The segregation thus renders the linked lethal theory questionable. The genotype of individual no. 65005038 may, however, also be v Le/v Le, even though the probability of this is as low as 5,3 % for all green-fruited derivatives if the cross-over value is 10 %. This being the case, the expectation of green : black segregation would always be 1 : 1, whatever the linkage, which is in agreement with the obtained segregation.

Are rb and v really separate genes? The numerous genes known to be involved in the biosynthesis of anthocyanins make this eminently possible. A biochemical analysis for identifying the flavonoid content of the berries would reveal if the biosynthesis of anthocyanins is blocked in the same step in both materials. As rather few and small progenies were employed in both studies more selfings and back-crossings, as well as crossings between the plants used in the English study, and in this study, would also provide an answer.

It is worth noting that the synthesis of anthocyanins is not completely inhibited by the action of the gene v; homozygous plants with an anthocyanin-deficient fruit colour, in this paper termed green-fruited, do contain some anthocyanin in their berries which appears as reddish brown dots in the skin of the berries. The dots are more or less common depending on the individual as well as on the growing season and conditions. For instance, only a small proportion of the berries in adult bushes of selection no. 65005038 are dotted and even in them very few and small dots have been observed. However, more dots have been found in young plants of the same selection growing in the nursery. Variation in the amount of dots has been found to be great between the green-fruited individuals in the families presented in Table 1, but no distinct difference between the families has been observed.

Thus, also anthocyanin-deficient mutants, postulated to be homozygous recessive for allele v, are able to synthesize some amounts of anthocyanin. A similar situation has also been found in some other plants (GRIFFITHS et al. 1982, GERATS et al. 1982). In such cases also environmental factors, for instance a cool temperature or incident sunlight, have shown to be able to enhance anthocyanin formation (GANDERS et al. 1980, GRIFFITHS et al. 1982).

It has also been reported that when the main biosynthetic pathway of flavonoids is blocked by a mutant gene effect, a minor pathway still works (GERATS et al. 1982). The differences between the amount of anthocyanin dots in the berries of green-fruited seedlings may be due to different combinations of genes affecting, besides gene v, flavonoid synthesis. In maize a complex controlling of the anthocyanin pigmentation such as this has earlier been interpreted (BRIGGS 1966).

In the Department of Horticulture at the Agricultural Research Centre numerous blackcurrant varieties have been selfed and more than 4 500 derivatives from these selfings have been observed. In order to obtain pure lines, up to now three subsequent selfings in consecutive generations have been carried out with some cultivars. In addition, a great many intervarietal crossings have been performed and the progenies produced observed. However, green-fruited seedlings have been found only in the progenies of 'Öjebyn' selfed. No green-fruited derivative has been found either among the more than 1 500 seedlings produced by crossing 'Öjebyn' with other cultivars. The mutant genes giving rise to the green fruit colour are surely not limited to 'Öjebyn', but neither do they seem to be very common in blackcurrant cultivars.

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SELOSTUS

Vihreämarjaisuuden periytyminen mustaherukalla

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Maatalouden tutkimuskeskus

'Öjebyn'-mustaherukkalajikkeen itsepölytysjälkeläistöistä voidaan säännöllisesti löytää vihreämarjaisia yksilöitä. Näiden marjoissa antosyaaniväriaineiden määrä, joka normaaleissa kypsissä marjoissa on korkea, on hyvin vähäinen tai nämä väriaineet puuttuvat kokonaan. Kellertävänvihreästä väristä voidaan päätellä, että flavonoidisynteesi ei ole marjoissa kokonaan estynyt, vaan niissä esiintyy flavonoleja.

Tehtyjen testiristeytysten perusteella voidaan olettaa antosyaanisynteesin estyvän yhden geeniparin vaikutuksesta. Tälle resessiiviselle geenille, joka homotsygoottisena esiintyessään aiheuttaa marjojen vihreän värin, on annettu nimi v. Saatujen jälkeläisjakaumien perusteella värigeeni v on kytkeytynyt letaaligeeniin le. Varmuudella ei voida sulkea pois mahdollisuutta, että geeni v olisi sama kuin mustaherukalla aiemmin nimetty vihreän marjavärin aiheuttava geeni rb.

Vihreiden marjojen kuoressa toisinaan esiintyvät ruskeanpunaiset pilkut osoittavat, että antosyaanien muodostus ei näissä marjoissa ole kokonaan estynyt. Tämä rajoittunut antosyaanisynteesi voi johtua joko perinnöllisistä tai ympäristötekijöistä.

ANNALES AGRICULTURAE FENNIAE, VOL. 26: 279—283 (1987)
Seria HORTICULTURA N. 59 — Sarja PUUTARHAVILJELY n:o 59

Research note

A GREEN-FRUITED BLACKCURRANT VARIETY 'VERTTI'

SAILA JUNNILA, HEIMO HIIRSALMI and JAAKKO SÄKÖ

JUNNILA, S., HIIRSALMI, H. & SÄKÖ, J. 1987. **A green-fruited blackcurrant variety 'Vertti'.** Ann. Agric. Fenn. 26: 279—283 (Agric. Res. Centre, Dept. Hort., SF-21500 Piikkiö, Finland.)

A green-fruited blackcurrant variety designated 'Vertti' has been released for cultivation. The variety originates from self pollination of the variety 'Öjebyn'. 'Vertti' variety grows moderately forming a medium-tall, rather spreading bush. Its winter hardiness and resistance to American gooseberry mildew have been good under field conditions in southern Finland. The variety crops satisfactorily and the yield and berry size resemble those of 'Öjebyn'. The round berries of 'Vertti' lack the dark anthocyanin coloration; being yellowish-green in colour. Their flavour is typical of the blackcurrant, but rather mild. The variety is first of all recommended for home gardens.

Index words: blackcurrant variety, *Ribes nigrum*, small fruit breeding.

INTRODUCTION

Blackcurrants with green and yellow or whitish fruit have been known since the early 19th century under the varietal names *Ribes nigrum chlorocarpum* Spaeth and *R. nigrum xanthocarpum* Spaeth. At that time green-fruited cultivars were already available in England (see KEEP 1975). Some green-fruited blackcurrants have occasionally been found in Finnish home gardens, presumably being the seedlings of cultivated varieties. However, the variety 'Vertti' (Fig. 1) descriped in this paper is the first green-fruited blackcurrant to be released for sale in Finland.

SELECTION EVALUATION; MATERIAL AND METHODS

The first green-fruited blackcurrant seedlings were found by the Department of Horticulture, at the Agricultural Research Centre, among a progeny produced in 1965 by selfing cv. 'Öjebyn' (JUNNILA and HIIRSALMI 1987). Accessions of these seedlings (individuals no.

Fig. 1. The variety 'Vertti'

009 and 038 in family no. 65005) were compared with their two selected black-fruited sibs and cvs. 'Öjebyn' and 'Brödtorp'. For this observation trial two bushes per selection were planted in sandy soil in 1972. The planting distance was 2 m in the rows and 3 m between rows.

The same two green-fruited selections were also tested in a comparative trial in which four bushes per selection were evaluated. The bushes were planted in 1982 in loamy clay soil, 2 m apart in the rows, with a distance between the rows of 3 m.

The evaluation of clones was started one or two years from the planting. The time of full bloom was recorded, i.e. the time when the flowers were most abundantly open, and the time of shoot ripening was recorded, indicating the time when all the leaves had fallen. In presenting the means of these and the yield characteristics of several years, the standard errors of mean (S.E.) were calculated using the annual means of each clone.

The vegetative characteristics, viz. winter hardiness, resistance to American gooseberry mildew, growth habit and vigour, were visually rated using scores of 0—10. The highest grade corresponded to completely hardy, resistant, erect and very vigorous, respectively. Fruit quality was assessed by rating the fruit's firmness and toughness of the skin by scores from 1—3, blackcurrant aroma by scores from 1—5 and sourness by scores from 1—4. Thus a higher grade indicated a firmer fruit, thicker

skin, stronger aroma and a more sour taste.

The cultivation techniques were those commonly employed for blackcurrants in Finland, except that no fungicides were used and irrigation was restricted to the year of planting. The crop was harvested through shaking by hand with a rubber rod.

FIELD TRIAL RESULTS

The yields and berry size of the green-fruited selections no. 65005009 and 65005038 approximated those of the parent variety 'Öjebyn'; they also proved to be equal to their selected black-fruited sibs as regards these properties (Table 1). The average crops were rather low in the trial due to the youth of the plants in the first years and to the spring and early summer frosts in 1975 and 1978.

Selected offspring of 'Öjebyn' overwintered successfully in the south of Finland (60° 23′ N). Their mildew resistance was also satisfactory in the same manner as 'Öjebyn' but in contrast to the old Finnish cultivar 'Brödtrop'. No noticeable differences were found at the time of full bloom of the selections. The ripening time of the shoots varied more, also annually, and the green-fruited selection no. 65005038 proved to be tardier than no. 65005009 in this respect.

Both green-fruited selections continued cropping as well as 'Öjebyn' in the later comparative trial. This test suffered from severe drought in the summer of 1986, which reduced the yield and the size of the berries (Table 2). Both selections were still highly resistant to American gooseberry mildew and also tolerated excellently even the unusually cold winter of 1984—1985 (Table 3). The growth habit of these selections is somewhat more spreading than that of 'Öjebyn'. Growth

Table 1. Blackcurrant observation trial planted in 1972, results in 1973—1979.

Selection Variety	Yield kg/bush/year $\bar{x}$±S.E.	Wt. of 100 berries, g $\bar{x}$±S.E.	Winter hardiness 0—10 $\bar{x}$	Mildew resistance 0—10 $\bar{x}$	Onset of flowering Days from May 1 $\bar{x}$±S.E.	Time of defoliation Days from October 1 $\bar{x}$±S.E.
'Öjebyn' × self progenies						
65005009*	1,60±0,37	81,6±4,4	9,5	9,3	22,9±2,3	30,9±4,2
65005010	1,43±0,40	94,1±4,4	8,3	9,6	25,5±2,2	33,6±4,4
65005024	1,24±0,33	76,0±4,4	9,2	9,5	24,1±2,4	38,1±4,4
65005038*	1,46±0,44	82,7±6,0	8,9	9,6	23,5±2,1	38,9±3,5
'Öjebyn'	1,21±0,45	95,7±4,4	9,0	9,6	22,6±2,0	34,9±2,6
'Brödtorp'	1,19±0,42	82,2±4,6	8,6	2,0	22,1±1,9	34,1±3,8

* green-fruited selection

Scores of winter hardiness and mildew resistance, see Table 3.

Table 2. Yield and berry size of blackcurrant selections ('Öjebyn' × self) and the cultivar 'Öjebyn' in comparative trial planted in 1982. Means of four bushes per selection or variety are presented.

Selection Variety	Yield kg/bush, $\bar{x}$±S.E. 1984	1985	1986	Wt. of 100 berries g, $\bar{x}$±S.E. 1984	1985	1986
65005009	0,17±0,03	2,62±0,10	1,00±0,08	82,3±5,1	74,0±4,5	51,3±3,6
65005038	0,26±0,05	2,32±0,24	1,16±0,18	87,0±4,8	85,5±1,5	61,3±1,7
'Öjebyn'	0,27±0,09	2,16±0,18	1,44±0,03	72,8±7,1	92,8±3,8	58,5±2,1

Table 3. Vegetative and flowering characteristics of blackcurrants in comparative trial in 1984—1986.

Selection Variety	Onset of flowering Days from May 1 x̄±S.E.	Time of leaf abscission Days from October 1 x̄±S.E.	Winter hardiness 0—10	Mildew resistance 0—10	Growth habit 0—10	Vigour 0—10
65005009	29,7±5,7	26,3±5,4	9,9	10,0	5,6	8,4
65005038	31,8±5,9	28,0±4,5	9,8	9,7	6,2	7,4
'Öjebyn'	29,7±5,8	26,6±4,9	10,0	10,0	6,8	8,5

Winter hardiness 0—10: dead — no winter injury
Mildew resistance 0—10: heavily infected — completely resistant
Growth habit 0—10: very creeping — very erect
Vigour 0—10: dead — very vigorous

vigour was moderate in selection no. 65005038, compared to the quite high vigour of its parent variety.

Regarding fruit quality selection no. 65005038 was graded as more agreeable than no. 65005009 (Table 4). While it tastes like a typical blackcurrant, its flavour is however slightly milder and less sour. Especially on account of its suitability for fresh use, it was decided that selection no. 65005038 will be put on the market. In accordance with the special fruit properties mentioned above, this blackcurrant was given the varietal name 'Vertti'.

Table 4. Fruit quality of blackcurrants in comparative trial in 1984—1986.

Selection Variety	Fruit quality: Firmness 1—3	Toughness of skin 1—3	Aroma 1—5	Sourness 1—4
65005009	2,0	2,2	2,0	2,5
65005038	2,2	1,8	2,7	1,8
'Öjebyn'	1,8	1,9	2,8	2,4

Firmness 1—3: tender — firm
Toughness of skin 1—3: thin — thick
Aroma 1—5: mild — strong
Sourness 1—4: weak — very sour

THE GREEN-FRUITED BLACKCURRANT VARIETY 'VERTTI'

The green-fruited blackcurrant variety 'Vertti' derives from self pollination of the Scandinavian blackcurrant variety 'Öjebyn'. The new variety resembles the parent variety in vegetative characteristics, but the berries lack the dark anthocyanin pigments typical of the blackcurrant.

The 'Vertti' variety is medium-tall and its growth vigour is moderate. The growth habit is slightly more spreading than that of 'Öjebyn', but not as creeping as that of 'Brödtorp'. Under field conditions its resistance to American goosberry mildew has been good. It has overwintered in southern Finland very well. The time of flowering, fruit ripening and leaf fall are the same or a couple of days later than those for 'Öjebyn'. Yield and berry size are also about equal.

The berries of the 'Vertti' variety are round and when ripe yellowish-green in colour. The fruit skin is sufficiently tough for mechanical harvesting. Sometimes reddish brown dots may appear in the transparent fruit skin. Their taste is typically that of blackcurrant, but slightly milder and less sour. The berries are pleasant to eat raw owing to their special, not too strong or sour flavour, and they are also suitable for the production of juice and preserves.

The 'Vertti' variety is primarily recommended for home gardens. Distribution of the plants has been organised through the Propagation Unit for Healthy Plants at the Agricultural Research Centre.

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SELOSTUS

Vihreämarjainen mustaherukkalajike 'Vertti'

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Maatalouden tutkimuskeskus

'Öjebyn'-lajikkeen itsepölytyksestä syntyneitä vihreämarjaisia jalosteita on verrattu havaintokokein kantalajikkeeseensa sekä tummamarjaisiin sisarjalosteisiinsa. Kokeissa on havainnoitu kasvullisia ominaisuuksia kuten kasvutapaa, taudin- ja talvenkestävyyttä ja tuleentumisaikaa, sekä marjomisominaisuuksia kuten sadon määrää, marjakokoa ja marjojen laatua. Vihreämarjaisista jalosteista on no. 65005038 päätetty laskea kauppaan lajikenimellä 'Vertti'.

'Vertti'-viherherukka on hillittykasvuinen ja muodostaa keskikorkean, leveähkön pensaan. Kasvutavaltaan lajike on hieman lamoavampi kuin 'Öjebyn' mutta 'Brödtorp'-lajiketta pystympi. Viljelykokeissa lajikkeen karviaishärmänkestävyyden on todettu olevan hyvä. Se on talvehtinut Etelä-Suomessa erittäin hyvin. 'Vertti'-lajikkeen kukintakausi ja satoaika sekä lehtien putoaminen syksyllä ovat samanaikaisia tai joitakin päiviä myöhäisempiä kuin 'Öjebyn'-lajikkeella. Myös sadon määrä ja marjojen koko ovat suunnilleen samat kuin kantalajikkeella.

'Vertti'-lajikkeen marjat ovat pyöreät ja kypsinä kellanvihreät. Toisinaan voi marjojen läpikuultavassa kuoressa olla punaruskeita pilkkuja. Marjojen kiinteys on riittävä mekaaniseen sadonkorjuuseen. Niiden maku on mustaherukalle tyypillinen mutta miedompi ja vähähappoisempi. Marjat soveltuvat näin ollen erityisen hyvin tuorekäyttöön, mutta myös esimerkiksi jälkiruokien, mehun sekä hillon valmistukseen. 'Vertti'-viherherukkalajiketta suositellaan erityisesti kotipuutarhaviljelyyn.

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Seria HORTICULTURA N. 60 — Sarja PUUTARHAVILJELY n:o 60

EFFECT OF ROOTING HORMONES ON THE ROOTING OF JUVENILE *FICUS PUMILA* L. CUTTINGS

SIRKKA JUHANOJA

JUHANOJA, S. 1987. **Effect of rooting hormones on the rooting of juvenile *Ficus pumila* L. cuttings.** Ann. Agric. Fenn. 26: 285—290. (Agric. Res. Centre, Dept. Hort., SF-21500 Piikkiö, Finland.)

Ficus pumila L., the creeping fig, is usually propagated by juvenile leaf-bud cuttings. The plant can be rooted year-round, but rooting ability is poorest from November to January. If the plant is cultivated for early winter sale, it must be propagated at this time. The creeping fig is auxin sensitive throughout the year and its ability to form adventitious roots can be enhanced by indolebutyric acid (IBA) or naphtaleneacetic acid (NAA) treatments. An aqueous solution of 0,01 % IBA and a powder containing 0,2 % NAA were used in the present trial. Both treatments increased the rooting ability to about 100 % and also the number of roots was enhanced. The greatest increase was caused by IBA. Root length was affected the most by NAA.

Index words: Ficus, rooting, hormones.

INTRODUCTION

Adventitious root formation is essential for the successful asexual propagation of many woody ornamental plants. The ease of adventitious root formation is dependent upon the age of the stock plant (GARDNER 1929, SCHREIBER and KAWASE 1975) and the season in which the cuttings are taken (ROBERTS 1969).

Ficus pumila L. is a woody ornamental vine that exhibits dimorphism and differences in rooting ability between juvenile and mature forms (DAVIES and JOINER 1980, DAVIES et al. 1982). The juvenile form of *Ficus pumila* with small cordate-ovate leaves and aerial roots in the nodal areas is usually used as an ornamental plant, and the mature form with bigger elliptic or oblong-elliptic leaves and lacking in aerial roots is rare except in the greenhouses of botanical gardens. The cuttings of the juvenile form root more rapidly and the rooting percentage is higher than in the mature form (DAVIES and JOINER 1978). The creeping fig can best be propagated by leaf-bud cuttings: even one lamina with an axillary bud and, approximately, a 2,5 cm piece of stem will suffice as a cutting (DAVIES and JOINER 1978). The creeping fig is often propagated by placing 5—6 cuttings, length 8—12 cm, into a pot of 9—10 cm (PIIRAINEN 1979). New roots are easily

formed from aerial roots, but the rooting percentage is not always high. The aim of this study was to determine if the rooting can be enhanced and the rooting percentage improved by using hormones in the rooting, particularly in late autumn in order to get ready-for-sale plants early in winter.

MATERIAL AND METHODS

Ficus pumila stock plants were cultivated at the Agricultural Research Centre's Department of Horticulture in a greenhouse, where the temperature was +20 — +25 °C and the lighting natural. Misting was adjusted in accordance with sunshine. Six juvenile cuttings of about 10 cm per pot were used and each treatment consisted of ten pots, i.e. there were 60 cuttings per treatment altogether. The experiment was repeated twice. The growing medium was fertilized and limed peat. The cuttings were harvested on 23 September and on 15 October 1986, and upon removal from the stock plants they were placed in beakers containing water before potting. There were three treatments (Table 1.): control, 3-indolebutyric acid (IBA) and α-naphtaleneacetic acid (NAA, Rhizopon) treatments. IBA was used as an aqueous solution of 0,01 % (100 mg/l) and the cuttings were placed in the solution in bundles for 16 h. Rhizopon ᴿB is a powder with 0,2 % NAA, into which the cuttings were dipped. The control cuttings were placed directly into pots. During the rooting the pots were kept in a plastic tent with a high air humidity. The cuttings were analyzed when the control cuttings had grown roots to the bottom of the pot (16th October and 18th November). The rooting percentage and the number of roots were counted and the five longest roots on every cutting measured. The means were calculated and the treatments compared using the analysis of variance.

Table 1. Percentages of rooting in different treatments and times. Number of cuttings 60 in each treatment.

treatment	period /time to root d	23.9.—16.10.-86 23	15.10.—18.11.-86 34
control		33	81
0,01 % IBA 16h		100	100
0,2 % NAA		100	98

RESULTS

Both the IBA and Rhizopon treatments increased the number of cuttings significantly and improved the rooting percentage, the increase in root number being the greatest in IBA-treated cuttings (Table 2.). The difference between IBA and Rhizopon treatments was also significant. The roots on the cuttings treated with IBA were, however, thin and almost without branches, whereas the cuttings treated with NAA had thicker roots with many branches like the roots on the control cuttings, too (Fig. 1.). In the length of the roots the greatest difference was seen between the control and the NAA treatment, the roots being longest on the cuttings treated with NAA, whereas the difference between the control and the IBA treatment was significant only in the earlier trial. IBA and NAA treatments differed from each other significantly in both repetitions (Table 2.).

Table 2. Number of roots and length of the five longest roots. Differences significant at 5 % (*), 1 % (**) or 0,1 % (***) level.

period 1986	/treatment	number of roots			length of five longest roots cm		
23.9.—16.10.	control	3,63±1,06	***		4,44±0,43	*	
	0,01 % IBA	52,83±1,29	***	***	5,14±0,10	***	***
	0,2 % NAA	27,38±1,38	***		6,84±0,12		
15.10.—18.11.	control	4,60±0,51	***		7,10±0,24		
	0,01 % IBA	34,00±1,51	***	***	7,46±0,28	*	***
	0,2 % NAA	12,70±0,74			8,25±0,13		

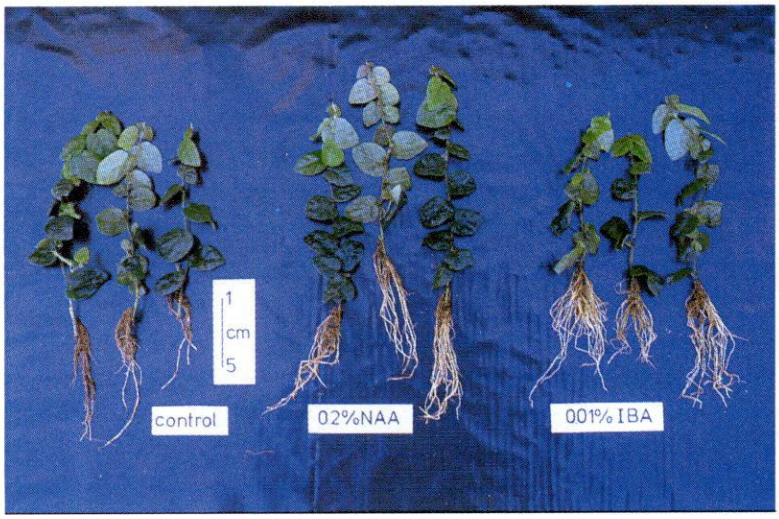

Fig. 1. Cuttings of different treatments 34 d after the treatment.

DISCUSSION

The ability to form adventitious roots alters seasonally under natural conditions. In *Ficus infectoria* Roxb., a deciduous tree with a true dormancy period, high rooting phases coincide with the resumption of growth (ANAND and HEBERLEIN 1975). The high rooting phase is auxin sensitive while the low rooting phase is auxin insensitive. In contrast *Ficus pumila*, which is an evergreen and undergoes no dormancy, is auxin sensitive throughout its seasonal rooting cycle (DAVIES 1984). The control juvenile cuttings of *Ficus pumila* show a seasonal response in the rooting and this seasonal response can be overcome with applied auxin (DAVIES 1983). The seasonal peaks in rooting response are associated with an increased cambial activity (DAVIES et al. 1982).

In this study the greatest increase in the number of roots occurred on IBA-treated cuttings. The increase was smaller in the latter trial, but the differences were equally significant in both trials. In November and January the rooting ability is the lowest in the juvenile *Ficus pumila* cuttings (DAVIES 1984), but even then the IBA-treated cuttings developed many roots, significantly more than the control cuttings, which is in agreement with the results of other studies (DAVIES 1984). In experiments

with IBA and IAA, the IBA has increased the number of roots per cutting more than the IAA (DAVIES and JOINER 1978; HIGAKI 1981; KLASS et al. 1987) and in this study the results seem equal, corresponding for IBA and NAA. The rooting percentage was higher in both the IBA and the NAA treatments (98—100 % compared to 33—81 %) than in the control cuttings. In earlier trials at the Department of Horticulture the rooting percentage of *Ficus pumila* has varied from 20 to 100 (Table 3.) even in springtime when rooting ability is usually the best (DAVIES 1984). An increase of

Table 3. Rooting percentage of control cuttings from March to June 1985.

day to start	time to root d	rooting %
5.3.	29	77
19.3.	28	100
2.4.	28	63
7.5.	30	68
21.5.	36	85
4.6.	36	53
18.6.	22	82

the rooting percentage by IBA has been published also by DAVIES and JOINER (1978) and by BONAMINIO (1983): the IBA concentrations 1000 mg/l and 100 mg/l increased the rooting percentage, but there was no difference between the effect of IBA and IAA on the rooting percentage or the root length. In this study the rooting percentage was the same with IBA and NAA, but NAA enhanced root growth more than IBA. At higher IBA concentrations root elongation has been even inhibited (DAVIES and JOINER 1980). In many experiments IBA has proved to be the most effective auxin for rooting (DAVIES and JOINER 1978; MORGAN and LAWLOR 1976; FUCHS 1986). An often used IBA concentration is 1000 mg/l sprayed onto the leaves (DAVIES and JOINER 1978, 1980; DAVIES et al. 1982; DAVIES 1983, 1984), but in this study even a 100 mg/l concentration, in which the cuttings were kept for 16 h, is able to enhance rooting. However, MORGAN and LAWLOR (1976) and BONAMINIO (1983) state that a quick dip in a solution of a higher concentration would be better than a longer treatment in a weak solution. BONAMINIO (1983) prefers a solution to a powder because it is easier to handle cuttings in bundles with a solution than with a powder. MORGAN and LAWLOR (1976) consider a powder the most effective form and spraying to be the poorest. The difference in the degree of promotive effects in the two trials of this study may be due to the season: the stock plants and the cuttings were cultivated under natural light conditions, which are poor in November at the time when the last trial was analyzed (on November 18th). Artificial ligthing might ease the situation, though the ability to form adventitious roots is poor in late autumn (DAVIES 1984).

The rooting ability of the creeping fig *Ficus pumila* can be enhanced significantly by treating the cuttings with IBA or Rhizopon during late autumn when this ability is poor under natural conditions. This is important if plants are to be cultivated for winter sale. IBA caused the greatest increase in the number of roots, but the roots were shorter and thinner than those of the NAA-treated cuttings. The roots of the IBA-treated cuttings were also poorly branched, whereas the roots on the Rhizopon treated cuttings were branched and thicker although fewer in number. Which of these root systems is better for the plant ought to be analyzed after a subsequent growth of some weeks. This remains to be examined in another experiment.

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SELOSTUS

Juurrutushormonien vaikutus *Ficus pumila* L. -pistokkaiden juurtumiseen nuoruusvaiheessa

SIRKKA JUHANOJA

Maatalouden tutkimuskeskus

Puuvartisten kasvien juurtumiskyky vaihtelee kasvin iän ja vuodenajan mukaan. Ikääntynyt kasvi juurtuu yleensä nuorta huonommin, ja pimeänä vuodenaikana juurten muodostuminen on yleensä heikkoa nuorellakin kasvilla. Kääpiköynnösviikunaa (vesiviikuna, *Ficus pumila* L.) lisätään tavallisesti 8—12 cm:n mittaisista pistokkaista, joita pistetään suoraan 9—10 cm:n myyntiruukkuun 5—6 kpl. Kääpiköynnösviikunasta käytetään yleensä koristekasvina sen nuoruusmuotoa, jolla on pienet herttamaisen soikeat lehdet ja lehtihangoissa ilmajuuria. Kypsyysmuoto suurempine lehtineen ja kukkineen on harvinainen. Nuoruusmuodon pistokkaat juurtuvat melko helposti, mutta lisättäessä kasvia alkutalven myyntiä varten joudutaan pistokkaat ottamaan aikana, jolloin juurtuvuus on heikoimmillaan. Tutkimuksessa on selvitetty, voidaanko juurtumista nopeuttaa ja juurtumisprosenttia parantaa käyttämällä apuna ns. juurrutushormoneja. Kokeissa käytettiin kahta auksiinipitoista ainetta: jauhemainen Rhizopon-valmiste sisältää naftaleenietikkahappoa (NAA) 0,2 %, ja käytetyn indolyylivoihappoliuoksen (IBA) pitoisuus oli 0,01 %. IBA-liuoksessa pis-

tokkaita pidettiin 16 h, Rhizopon-jauheeseen ne kastettiin pikaisesti. Molemmat aineet paransivat juurtumisprosentin jokseenkin 100:ksi ja lisäsivät juurten määrää merkitsevästi. Myös juurten pituus kasvoi aineitten vaikutuksesta. IBA-käsittelyn saaneet pistokkaat kasvattivat suuren määrän hennohkoja juuria, kun taas Rhizopon-käsittelyn saaneitten pistokkaitten juuret olivat käsittelemättömien juurten kaltaisia, mutta niitä oli enemmän.

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ROSE VARIETIES IN THE EXPERIMENTAL FIELD 1981—84

AARO LEHMUSHOVI

LEHMUSHOVI, A. 1987. **Rose varieties in the experimental field 1981—84.** Ann. Agric. Fenn. 26: 291—297. (Agric. Res. Centre, Dept. Hort., SF-21500 Piikkiö, Finland.)

Since 1961 the Department of Horticulture at the Agricultural Research Centre has been carrying out variety trials with group roses. The trials planted in 1981 and 1982 contained 44 rose varieties in all.

Of the white varieties 'Snowdance' and 'Swany' proved to be the best. Both were winter hardy and good concerning both flowering and growth qualities.

Of the yellow varieties 'Bright Smile' and 'Polygold' flowered copiously. However, their winter hardiness is rather poor.

Of the orange-coloured varieties 'Amsterdam' and 'Orange Sensation' are to be recommended.

The trials included a great many varieties with red flowers. Among the best were 'Tornado', 'Allotria', 'Interama', 'President Kekkonen', 'Dalli Dalli' and 'Rosamunde'. With these the flowering has been abundant and the winter hardiness fair or good. Nearly equal to these varieties are 'Ingrid Weibull', 'Montana', 'Gruss an Bayern', 'Rosi Mittermaier' and 'Tom Tom'. Many of them have been very popular roses in Finland in recent years.

Index words: rose, variety.

INTRODUCTION

The roses have still retained the position of most wanted and distinguished of ornamentals. Although the rise in costs in recent years has reduced their number in the parks of towns and rural communities roses continue to have a high standing in domestic gardens and in the ornamental flower arrangements of public institutions.

Roses are almost exclusively brought in from abroad. The imports are considerable both in number and monetarywise. The range of varieties is also very wide and many have difficulties in finding the varieties of roses that are best suited, do the best and are the most beautiful for their particular requirements.

In the Department of Horticulture at the Agricultural Research Centre (ARC) (60° 23' N, 22° 30' E) variety trials with roses have been going on since 1961 (KALLIO 1973, 1980, KALLIO and KARHINIEMI 1977). The trials are mainly concerned with finding out how different varieties would do under Finnish condi-

tions. The most important quality involved is a good winter hardiness. It is a major decisive factor when it comes to the value and viability of a rose variety in our country. Over the years a considerable number of varieties have been tried out. So far the experience gained already covers almost 300 different varieties of roses. In addition trials have, as far as practicable, also been done on ARC research stations in different parts of Finland.

MATERIAL AND METHODS

The trial launched in May 1981 contained altogether 17 rose varieties. The roses were planted in a level trial field in coarse sandy soil. The same kind of soil was used for a second variety trial with roses started a year later, which included 27 different rose varieties. Limed milled peat was used as soil improving medium on both plots. As basic fertilizer the year of planting was applied 600 kg/ha of the garden fertilizer "Puutarhan Y-lannos" (N 10 %—P 7 %—K 14 %) and subsequent years in the spring 100 g/square (0,5 m × 2,0 m) of the same fertilizer. A trial square held 5 plants, the space between plants was 0,4 m. There were 2 replications in the trials. As winter protection a 15 cm thick layer of dry milled peat was used heaped up in the region of the roses' root system at the end of November beginning of December when soil frost is setting in. The protection was supplemented by a sparse layer of fir twigs. The covering was removed at the end of April when the coldest nights were past. Plant diseases were not controlled, spraying against aphids was done as needed. The 1981 variety trial was ended in 1984 in the autumn and the 1982 trial in 1985 in the spring.

The **winter hardiness** was determined by counting in the spring the number of individual roses alive on the plants alive the preceding autumn, and by grading the frost injuries of varying degree seen in the shoots of the live roses according to a scale from 0—10 (0 = dead, 10 = no injuries).

Of the **ornamental value**-related qualities were observed, among others, the flowering time, the number of flowers (= the abundance of the flowering, the flowers that had come out each week were counted and removed), the colour of the flowers (according to the Horticultural Colour Chart) (WILSON 1938), the beauty and health of the foliage (colour and gloss) on a scale from 0—10 (0 = very poor, 10 = very good). The individual height and luxuriance (= condition) on a scale from 0—10 (0 = dead, 10 = very good) were also determined for the different varieties each year of the trial. The impressiveness of the flowering is described by a figure arrived at by calculations using the formula $d \times n \times 3{,}14 \times r^2$, where d = duration of flower (days), n = number of flowers and r = radius of flower (in decimetres). In monitoring the **susceptibility to disease** the main attention was given to black spot (*Marssonina rosae*), which has attacked nearly all varieties of roses, especially rainy summers. Ocular observations were made on a scale from 0—10 (0 = no discernible disease, 10 = completely contaminated). During the growth period the occurrance of rust, mildew and greymould has been slight.

The weather during the trial years

In 1981—84 the weather conditions were on the whole favourable for trials with roses. The summers were fairly warm and the winters temperaturewise normal or mild (Table 1). A considerable drawback were the many unusually wet early winters when as the cold set in a solid

Table 1. Average temperatures (°C) for different months during the years 1931—60 and deviations from these during the trial period 1981—85.

Month	1931—60	1981—82	1982—83	1983—84	1984—85
May	9,2	+1,9	−0,9	+1,8	+3,5
June	14,0	−0,8	−2,4	−0,3	+0,5
July	17,3	−0,6	−0,3	0,0	−2,1
August	15,9	−1,6	+0,8	−0,3	−0,9
September	11,0	−0,7	−0,2	+1,0	−0,8
October	5,6	+0,9	−0,3	+1,0	+2,1
November	1,2	−0,3	+3,2	−2,1	+0,8
December	− 2,3	−4,1	+2,6	0,0	+1,5
January	− 5,7	−4,4	+5,0	+0,6	−9,2
February	− 6,3	+0,4	−1,6	+1,4	−8,8
March	− 3,3	+3,4	+0,8	+1,1	+1,5
April	2,6	−0,2	+2,5	+1,1	−1,8

coat of ice formed on the ground.

The snow conditions were normal at other times except for the winter 1982—83 when there was little snow (Fig. 1). Then, however, the cold spells were not very long nor were there any cold peaks, which meant an almost total escape from injuries.

The winter 1984—85 was extremely cold and as a result the rose trial planted in 1982 was ended in the spring of 1985 as a large part of the trial material had been destroyed completely.

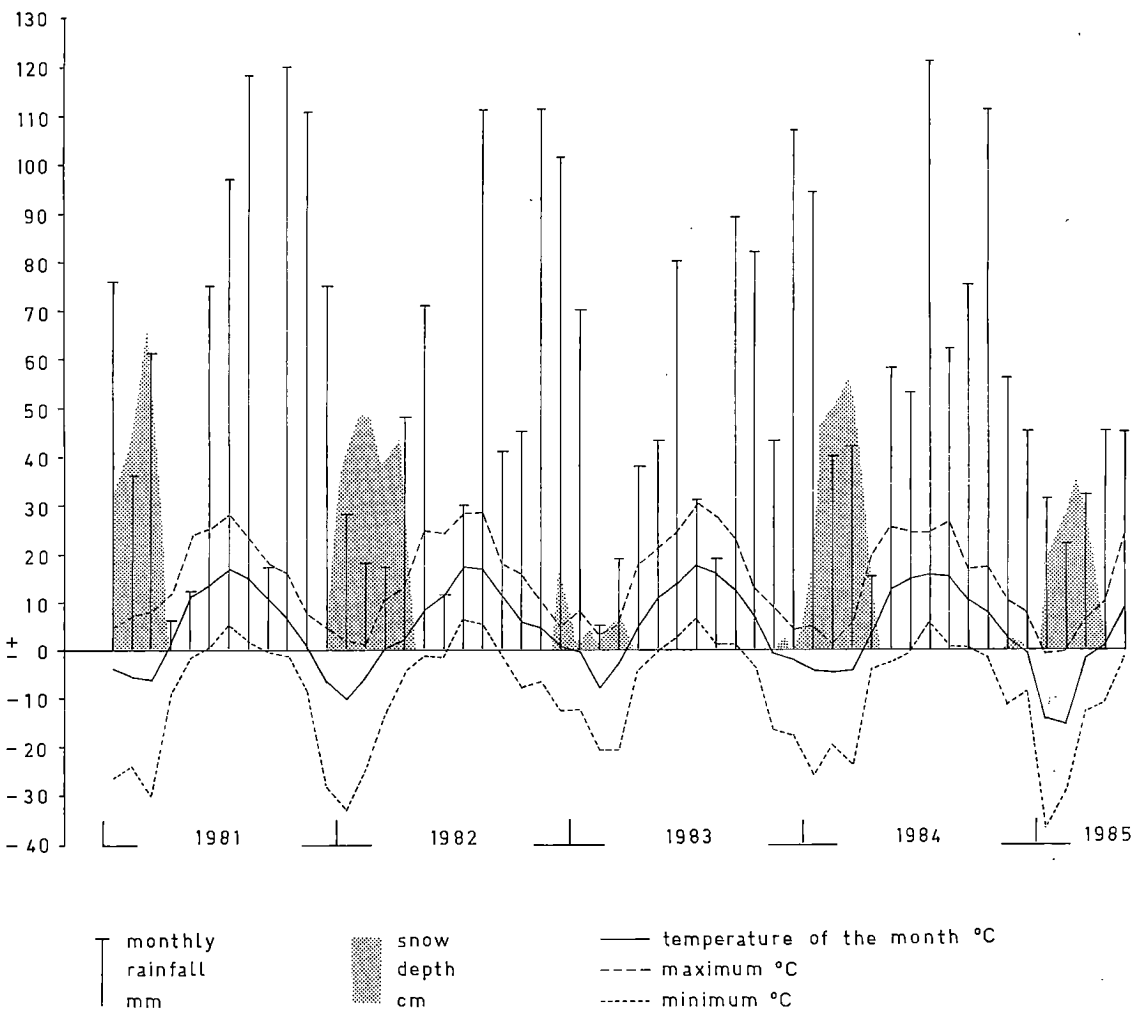

Fig. 1. Weather conditions 1981—85 (temperature, rainfall and snow depth) in the Department of Horticulture at the Agricultural Research Centre at Piikkiö.

RESULTS AND DISCUSSION

The white rose varieties have done well in the trials. Particularly their health and winter hardiness were good and the flowering abundant. The varieties 'Snowdance' and 'Helga' were above the average in the 1981 trial (Table 2). The park rose variety 'Swany' has for many

Table 2. Group rose variety trial in 1981. The results are means for 1981—84. Bush characteristics were determined at the end of August beginning of September, the flower diameter and duration in August.

Variety	Bush		Foliage		Flower	Flower	Flower	Impressive-
	height cm	condition 0—10	beauty 0—10	disease occ. 0—10	diam. mm	duration days	colour HCC	ness of flowering
Bad Wörishofen	50	8	9	2	88	12	20/geranium lake	408
City of Belfast	44	6	7	1	76	9	19/scarlet	128
Frankenland	27	7	8	0	82	10	19/scarlet	123
Golden Promise	85	5	9	0	96	5	3/aureolin	95
Gruss an Bayern	53	7	9	3	81	9	21/carmine	216
Helga	69	7	10	3	117	7	white	242
Ingrid Weibull	46	4	7	1	70	9	20/geranium lake	370
Interama	57	8	9	3	93	12	21/carmine	426
Lady Rose	68	4	10	0	115	10	18/1 vermilion	246
Lapponia	41	8	6	9	100	7	19/1 scarlet	141
Ludwigshafen am Rhein	54	5	8	0	121	8	20/1 geranium lake	144
Montana	55	8	8	4	89	9	21/carmine	227
Regensberg	31	7	8	4	81	6	24/2 tyrian rose	102
Rosi Mittermaier	60	8	7	3	83	10	17/mandarin red	215
Snowdance	63	8	9	1	91	7	white	326
Tornado	51	8	8	3	90	12	20/geranium lake	432
Träumerei	46	4	9	0	101	7	19/1 scarlet	175

Table 3. Group rose variety trial in 1982. The results are means for 1982—84.

Variety	Bush		Foliage		Flower	Flower	Flower	Impressive-
	height cm	condition 0—10	beauty 0—10	disease occ. 0—10	diam. mm	duration days	colour HCC	ness of flowering
Allotria	75	9	7	2	80	10	19 scarlet	392
Amsterdam	59	9	10	3	80	10	18 vermilion	301
Bad Füssing	51	9	7	3	91	6	20 geranium lake	230
Bambula	39	8	8	4	99	7	20/1 geranium lake	188
Blue Parfum	30	7	6	7	101	4	25/2 rose bengal	26
Bright Smile	49	8	9	1	91	5	4/1 lemon yellow	302
Burgund	71	10	6	2	137	7	21 carmine	103
Chorus	57	9	10	1	102	9	20 geranium lake	169
Coppelia	63	9	9	3	105	6	22/2 crimson	192
Dalli Dalli	63	9	9	3	78	9	21 carmine	391
Diana	54	5	9	2	114	13	4 lemon yellow	251
Duftgold	60	7	8	2	113	4	2/2 canary yellow	52
Harmonie	62	8	6	2	126	6	19/1 scarlet	127
Kalinka	64	9	8	3	100	6	19/2 scarlet	212
Las Vegas	74	8	9	2	134	6	17 mandarin red	118
Lydia	87	9	7	3	92	6	17 mandarin red	143
Orange Sensation	55	6	7	3	80	7	17 mandarin red	260
Piroschka	53	7	9	2	106	5	19/2 scarlet	106
Polygold	38	9	9	7	87	5	3/2 aureolin	202
President Kekkonen	61	8	7	2	82	10	19 scarlet	391
Rimosa	30	4	10	0	95	7	4/1 lemon yellow	69
Rosamunde	52	9	9	4	92	9	21/2 carmine	329
Sunsilk	44	4	2	2	100	8	3/1 aureolin	63
Swany	48	10	10	3	59	11	white	908
Sylvia	86	8	7	0	116	8	19/2 scarlet	118
Taora	40	7	7	4	88	10	20 geranium lake	176
Tom Tom	62	9	8	2	92	6	22/1 crimson	231

qualities been quite superior in the 1982 trial (Table 3).

The winter hardiness of the yellow varieties has generally proved to be poor (Figs. 2 and 3). The hardiest were 'Polygold', 'Duftgold', 'Golden Promise' and 'Bright Smile'. The flowering of 'Bright Smile' was in the years 1982—84 among the varieties with yellow flowers the second most abundant in the trial. Since the duration of its flowers is poor, as is the case with yellow roses, the point for impressiveness remained low. A good duration of the flowers among the yellow varieties was seen in the variety 'Diana', about 13 days. The good health of the foliage of the 'Golden Promise' variety attracted attention.

'Amsterdam' and 'Orange Sensation' are among the best of the orange-coloured varieties. They have overwintered well and flowered abundantly. The variety 'Lydia' has been a good overwinterer (Fig. 3), but the flowering was scanty. The good health and beauty of the foliage of the 'Lady Rose' variety was clearly evident, likewise the good duration of its large

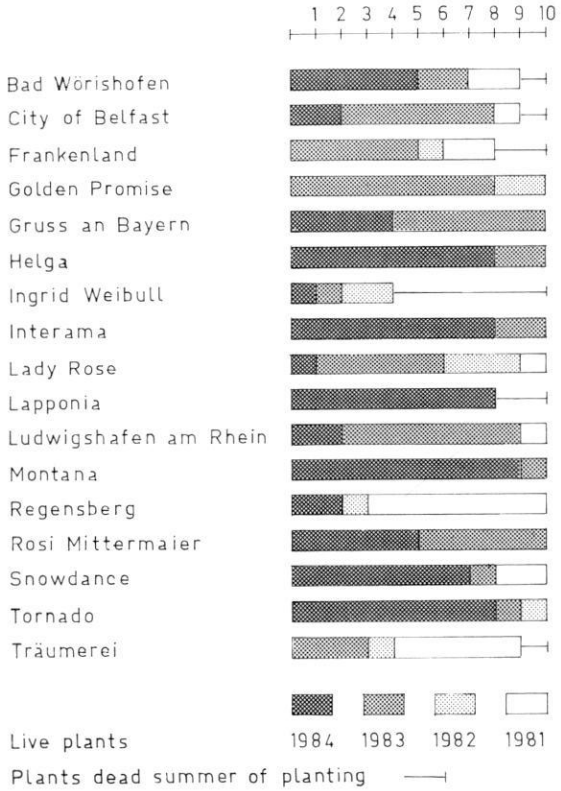

Fig. 2. Progress in 1981—84 of individual roses in variety trial of group roses planted in 1981. Originally planting comprised 10 plants/variety.

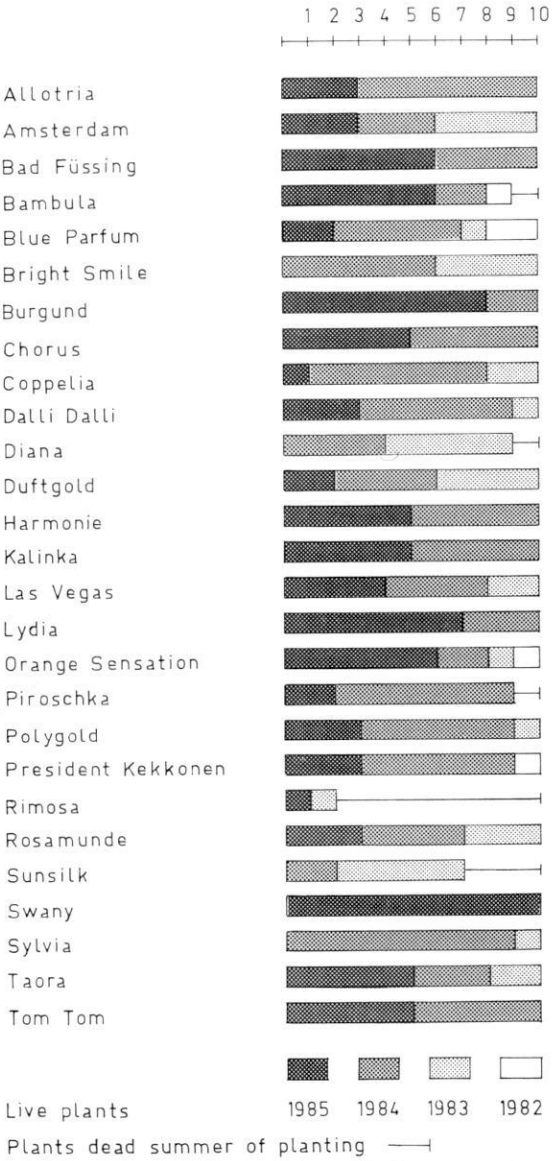

Fig. 3. Progress in 1982—85 of individual roses in variety trial of group roses planted in 1982. Originally planting comprised 10 plants/variety.

flowers (Table 2). On the other hand, the winter hardiness of this variety is rather poor.

There was a predominance of deep flame-coloured rose varieties in the 1981 trial (Table 2). Among them were also seen the best roses of the trial the 'Tornado', 'Bad Wörishofen', 'Ingrid Weibull', 'Montana' and 'Gruss an Bayern'. The best variety was for flower characteristics and impressiveness value the flame-coloured 'Tornado'. Also regarding winter hardiness it was one of the best in the trial. In an earlier, 1977—1979, trial the 'Tornado' variety, however, gave a much poorer impression of its winter hardiness (KALLIO 1980). Except for the 'Bad Wörishofen' variety these roses have indeed been very popular in recent years and they have been selling in large quantities. The winter hardiness of these varieties has been good. The bloodred variety 'Interama's winter hardiness and flower duration were good and the flowering abundant. With the 'Ludwigshafen am Rhein' variety of nearly the same colour the flowering was modest.

In the 1982 trial of the varieties with red flowers 'Allotria', 'Dalli Dalli', 'President Kekkonen', 'Rosamunde' and 'Tom Tom' (Table 3) stood out as the best regarding flowering. As to colour 'Allotria' and 'President Kekkonen' are scarlet, 'Dalli Dalli' and 'Rosamunde' are bloodred and the 'Tom Tom' variety a light carmine. All have in the trial showed a moderate profusion of flowers and the duration of the flowers has been good in all except the 'Tom Tom' variety, where it was only 6 days. Mild winters all overwintered well (Fig. 3), but the last severe winter 1984—85 caused even these varieties extensive injuries. Concerning most of them there remained in the spring of 1985 only three individuals out of the 10 plants originally put in.

The flowering was poor or very poor with the varieties 'Blue Parfum', 'Piroschka', 'Sylvia', 'Burgund', 'Chorus', 'Harmonie' and 'Taora'. However, the 'Burgund', 'Chorus' and 'Harmonie' showed a fairly good winter hardiness. 'Blue Parfum' and 'Taora' were rather disease-prone rose varieties.

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SELOSTUS

Avomaan ryhmäruusujen lajikekokeet vuosina 1981—84

AARO LEHMUSHOVI

Maatalouden tutkimuskeskus

Maatalouden tutkimuskeskuksen puutarhaosastolla on vuodesta 1961 lähtien ollut käynnissä ryhmäruusujen lajikekokeita. Kokeissa pyrittiin selvittämään eri lajikkeitten menestyminen Suomen olosuhteissa. Siihen kuuluu tärkeimpänä ominaisuutena hyvä talvenkestävyys. Se ratkaisee pitkälti jonkin ruusulajikkeen arvon ja käyttökelpoisuuden maassamme. Vuosina 1981 ja 1982 istutetuissa kokeissa oli mukana kaikkiaan 44 ruusulajiketta.

Valkoisista lajikkeista parhaiksi osoittautuivat 'Snowdance' ja 'Swany'. Molemmat olivat talvenkestäviä sekä kukinta- ja kasvuominaisuuksiltaan hyviä.

Keltaisista lajikkeista kukkivat runsaasti 'Bright Smile' ja 'Polygold'. Niiden talvenkestävyys on kuitenkin heikohko. Oranssinpunaisista suositeltavia ovat 'Amsterdam' ja 'Orange Sensation'.

Punakukkaisia lajikkeita kokeissa on ollut runsaasti. Parhaimpia näistä olivat 'Tornado', 'Allotria', 'Interama', 'President Kekkonen', 'Dalli Dalli' ja 'Rosamunde'. Näillä kukinta on ollut runsasta ja talvenkestävyys kohtalainen tai hyvä. Lähes samanveroisia lajikkeita olivat 'Ingrid Weibull', 'Montana', 'Gruss an Bayern', 'Rosi Mittermaier' ja 'Tom Tom'. Monet näistä ovat olleet Suomessa hyvin suosittuja ruusuja viime vuosina.

ANNALES AGRICULTURAE FENNIAE, VOL. 26: 299—306 (1987)
Seria HORTICULTURA N. 62 — Sarja PUUTARHAVILJELY n:o 62

CULTIVATION OF PARTHENOCARPIC PICKLING CUCUMBER VARIETIES IN A PLASTIC HOUSE

RAILI PESSALA

PESSALA, R. 1987. **Cultivation of parthenocarpic pickling cucumber varieties in a plastic house.** Ann. Agric. Fenn. 26: 299—306: (Agric. Res. Centre, Dept. Hort., SF-21500 Piikkiö, Finland.)

The genetically parthenocarpic pickling cucumber varieties 'Andrea', 'Marbel' and 'Paragon' proved to be well suited for cultivation in a plastic house and for continuous harvesting. The advantage they offer in plastic house cultivation as compared to monoecious and predominantly female flowering hybrid varieties is that there is no need to make provisions for pollination by bees. The most suitable time for planting turned out to be the end of May. In the comparison of culture media the differences in the yield of the pickling cucumbers grown in peat or coarse sand were small. Of the varieties the 'Marbel' was better than the others.

Index words: pickling cucumber, parthenocarpic varieties, plastic house, timing of planting, culture media.

INTRODUCTION

In Finland the cultivation of pickling cucumber is restricted to the southernmost parts of the country and even here there are considerable fluctuations in the annual yields due to the unfavourable weather conditions. In order to eliminate the crop fluctuations and secure the cultivation growing pickling cucumbers in lightly constructed plastic houses has been initiated.

The pickling cucumber is well suited for cultivation in a plastic house under Finnish conditions and it gives there a much higher yield than in the open (PESSALA 1981). The cultivation in a plastic house has, however, posed a problem as regards pollination arrangements since normally the fruit of the pickling cucumber is set as a result of pollination and fertilization. For the pollination to succeed it should be ensured by bringing a bee-hive close to the house. It is, however, difficult to lure the bees into the cucumber houses, particularly in early summer when the first flowers open (PESSALA 1981). Nature at this time abounds in flowering plants and the flowering of many cultivated plants occurs at this very time, too. Hence the first pistillate flowers remain unpollinated and the yield is delayed.

From the pickling cucumber have been developed parthenocarpic varieties, which produce fruit entirely without pollination and fertilization. PIKE and PETERSON (1969) have suggested that genetically parthenocarpic varie-

ties would be advantageous for mechanical harvesting because of their greater fruiting capacity, slower fruit maturity and lack of need for pollinating insects. These varieties have in fact been found to be better suited for once-over harvesting than the previously grown varieties (WELLES 1978).

The characteristics of the varieties have also studied in a manually done harvest and it was noted that the parthenocarpic varieties are suitable for multible harvesting. The intervals between the harvests can be prolonged with these varieties without the quality of the crop suffering (RUNGE 1977, JENSEN 1981).

De PONTI (1976) has stated that parthenocarpy should be considered from the point of view of glasshouse cultivation of cucumber since the culture of pickling cucumber in glasshouses entails extra risks because of the necessary pollination. An interesting observation in view of cultivation in plastic houses is the one made by WELLES (1978), according to whom parthenocarpic varieties are significantly earlier than varieties requiring pollination.

In the Department of Horticulture at the Agricultural Research Centre at Piikkiö trials were carried out in 1981—82, the purpose of which was to find out about the suitability of parthenocarpic pickling cucumber varieties for cultivation in plastic houses.

MATERIAL AND METHODS

The trials were done in a plastic house, where the covering was a 0,2 mm thick polyethylene sheet. There was no heating in the house, but for the cold spring nights temporary electrical heating was installed. Access of pollinator insects to the trial area was prevented by screening off a part of the house with a thin plastic net.

Three genetically parthenocarpic varieties were included in the trial: 'Andrea' (Nunhems Zaden), 'Marbel' (Royal Sluis) and 'Paragon' (Sluis en Groot). In the unenclosed area outside the net was also tested a monoecious variety 'Favör II' (Weibull) as well as a predominantly female flowering hybrid variety 'Tera' (Daehnfeldt), which in earlier plastic-house trials has given a good result. In addition to the variety comparison timing of the planting and the culture medium were investigated in the trials.

In the planting time trial the suitability of the parthenocarpic varieties for cultivation started early in spring was investigated and the aim was to determine the most suitable starting time for the cultivation. The testing method used was the split-plot design and there were three replications. The planting time was in the main plot and the varieties in the subplot. There were three planting times: 11.5., 25.5. and 8.6.. The corresponding sowing times were 16.4., 30.4. and 14.5., i.e. the length of the growing time for the seedlings was 25 days.

In the planting time trial was also compared the effect of pollination on the crop and the crop quality of the parthenocarpic varieties. Simultaneously with the third planting lot on June 8 a comparative research parcel was planted outside the plastic net, to where the pollinator insects had free access. A bee-hive had been placed outside the plastic house.

In the culture medium trial the growth of the varieties in peat and in coarse sand was compared. The trial was done with the split-plot design, in which the culture media were in the main plot and the varieties in the subplot. There were three replications in the trial. The culture media were tested in a space screened off by a net, i.e. the varieties could not be pollinated.

The plants were propagated in a glasshouse. The sowing was done in paperpots filled with

peat, the size of which in the planting time trial was 8 × 8 cm and in the culture medium trial 6 × 8 cm. The temperature for raising the plants was about 17 °C at night and 20—23 °C in the day-time. In 1981 the seedlings were planted in the plastic house with 130 × 50 cm spacings and in 1982 with 130 × 45 cm spacings. There were two plants per subplot in the planting time trial and three plants per subplot in the culture medium trial. The annual cultivation schedules are given in Table 1.

Table 1. Sowing, transplanting and harvesting dates of pickling cucumber in 1981—82.

Planting time trial	Sowing	Planting	Harvest
Year 1981	16.4.	11.5.	15.6.—27.8.
	30.4.	25.5.	22.6.—27.8.
	14.5.	8.6.	6.7.—27.8.
Year 1982	16.4.	11.5.	14.6.—26.8.
	30.4.	25.5.	24.6.—26.8.
	14.5.	8.6.	5.7.—26.8.
Culture media trial			
Year 1981	6.5.	28.5.	29.6.—31.8.
Year 1982	6.5.	27.5.	24.6.—26.8.

The seedlings were planted in rows and supported to grow upwards. The strings used to support the plants were tied in line with the row to wires running at a height of about 1,8 m. The growth habit was not curbed by cutting, only some shoots growing along the soil surface were removed to improve the aeration of the growth habit.

In the planting time trial the growing substrate was peat. In both trials fertilizers was added to the culture media after the results of the soil analysis values. During the growth period was applied alternate weeks calcium nitrate and a compound fertilizer, which in addition to the major nutrients (14-5-21) contains several trace elements. The fertilizers were given in the irrigation water. In June 1981 fertilizer was applied twice a week, but this was found to cause a too lush growth, especially of the 'Marbel' and 'Paragon' varieties.

No plant protection treatments were needed in the trials since the growth habits remained sound. The crop was gathered in twice a week. The total yield was sorted in three groups: I class, II class and deformed fruits. The cucumbers graded I class were 5—15 cm long and less than 45 mm thick, and those graded II class 5—20 cm long and 45—52 mm thick, where slight surface defects were allowed.

Weather conditions during the growing seasons 1981—82 are shown in Table 2. In the culture medium trial the soil temperature was observed.

Table 2. Monthly average temperatures, sums of effective temperature and hours of sunshine in 1981—82 at Piikkiö.

Month	Temperature °C Average temperature			Sum of effective temperature		Hours of sunshine, h	
	1981	1982	long term 1931—1960	1981	1982	1981	1982
May	11,1	8,3	9,2	201	107	331	219
June	13,2	11,6	14,0	247	197	186	244
July	16,7	17,0	17,3	362	372	213	324
August	14,3	16,7	15,9	289	361	157	273

RESULTS AND DISCUSSION

Varieties

The parthenocarpic pickling cucumber varieties proved reasonably high-yielding cultivated in a plastic house (Tables 3 and 4, Figs. 1 and 2). The total yield averaged 7—10 kg/m² depending on the treatment and variety. The amount clearly falls short of the results obtained earlier at Piikkiö with predominantly female flowering hybrid varieties, on an average 12 kg/m² for four years. On the other hand, in the trials carried out in 1970—73 also the

Table 3. Total and marketable yields of the parthenocarpic varieties.

Trial/Variety	Total yield, kg/m²			Marketable yield, kg/m²		
	1981	1982	average 1981—82	1981	1982	average 1981—82
Timing of planting						
'Andrea'	9,64	9,20	9,42	9,27	8,98	9,13
'Marbel'	9,43	9,64	9,54	9,26	9,46	9,36
'Paragon'	7,36	6,71	7,04	7,26	6,66	6,96
LSD/Tukey	0,15	0,20		0,15	0,20	
Culture medium						
'Andrea'	10,21	8,49	9,35	9,93	8,38	9,16
'Marbel'	9,10	7,44	8,27	8,93	7,30	8,12
'Paragon'	7,28	6,60	6,94	7,18	6,54	6,86
LSD/Tukey	0,17	0,17		0,17	0,17	

Table 4. Total and marketable yields of the parthenocarpic and control varieties in the trial where cucumber flowers were pollinated.

Variety	Total yield, kg/m²			Marketable yield, kg/m²		
	1981	1982	average 1981—82	1981	1982	average 1981—82
'Andrea'	8,96	9,28	9,12	8,29	9,22	8,76
'Marbel'	10,88	11,05	10,97	10,50	10,83	10,67
'Paragon'	6,84	7,30	7,07	6,66	7,22	6,94
'Tera'	10,33	8,31	9,32	10,05	7,92	8,99
'Favör II'	9,00	8,45	8,73	8,84	8,09	8,47

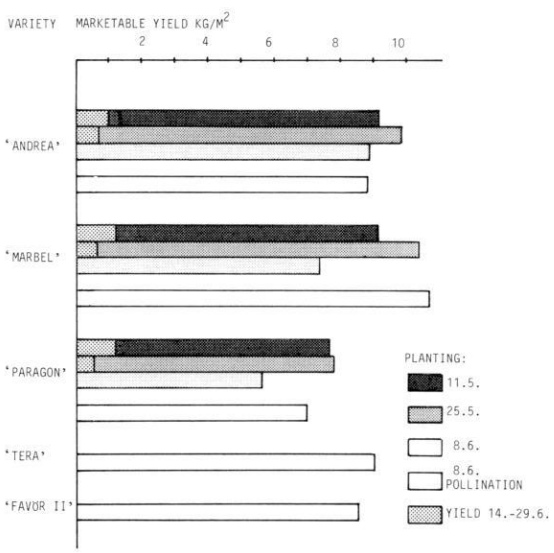

Fig. 1. Marketable yield in the planting time trial.

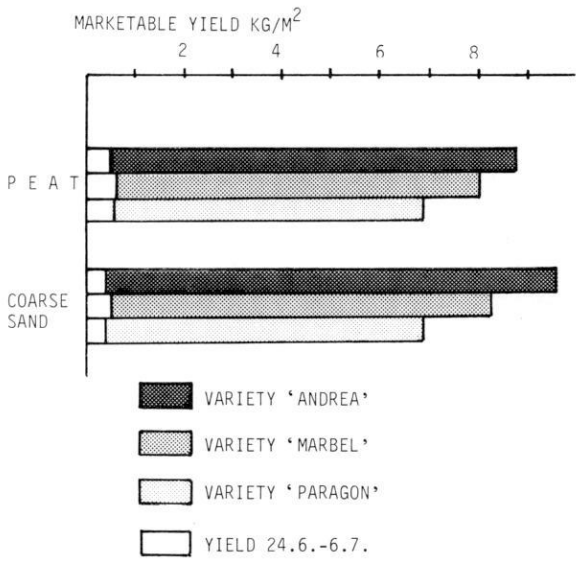

Fig. 2. Marketable yield in the culture medium trial.

variety 'Tera' produced a better result than in the present trials (PESSALA 1978).

In the planting time trial the variety 'Andrea' gave a slightly better crop than the 'Marbel' the first year. The second year 'Marbel' was significantly the better of these two varieties. In the culture medium trial the 'Andrea' produced the best total yield both years and it was significantly better than the other varieties. Both years the 'Paragon' in either trial gave a significantly poorer result than the other varieties. Also the control

varieties 'Tera' and 'Favör II' yielded a bigger crop than the 'Paragon' variety.

The volume of marketable crop with the parthenocarpic varieties was 90—100 % of the total yield (Tables 5 and 6). With the 'Marbel' and 'Paragon' varieties over 90 % of the total crop was made up of I class cucumbers. With the 'Andrea' about 17 % of the total yield was graded II class the first year, however, the second year less, 11—13 %. Also the control varieties produced a qualitywise rather poor crop in 1981. The I class cucumbers made up 81 % of the 'Tera's crop and of the crop of the variety 'Favör II' only 65 %. The following year the corresponding volumes, however, came to 92 % and 86 %.

As far as possible the cucumbers were harvested while rather small so that they would all be graded I class. Only with the 'Andrea' variety were found some over-sized fruit and otherwise as well the fruit of the 'Andrea' were bigger, according to the measurements, than the fruit of the other varieties (Table 7).

There were difficulties with the pollination by bees in the beginning of the growth period. The bees did not enter the plastic house even though containers with cucumber flowers in a sugar solution had been brought into the house to draw the bees. Thus the flowers in the first nodes of the varieties 'Tera' and 'Favör II' remained unpollinated.

Pollination has been said to be detrimental to the cropping of parthenocarpic pickling cucumber varieties. E.g. DENNA (1973) found that parthenocarpic cultivars produced significantly fewer fruit and less total fruit fresh weight when pollinated than when not pollinated. Hence the advice is to grow these varieties apart from other varieties requiring pollination. In this trial the pollination did not prove harmful for the cropping even though the first year of the trial the share of I class cucumbers in the crop of the pollinated individuals was somewhat smaller than it was for the unpollinated ones grown in isolation (Table 5). The mean weight and the size of fruit were bigger when pollinated than when not pollinated (Table 7). The pollination increased the yield both trial years of the varieties 'Marbel' and 'Paragon'. Then again the yield of the 'Andrea' variety was not affected by the pollination (Fig. 1).

There were hardly any differences between

Table 5. The amount of marketable yield, I and II class, in percentage of the total yield in the planting time trial.

Variety and planting time		I class, % 1981	I class, % 1982	II class, % 1981	II class, % 1982
'Andrea',	11.5.	78	84	20	11
	25.5.	78	84	20	13
	8.6.	85	87	12	12
'Marbel',	11.5.	95	93	4	6
	25.5.	99	92	1	6
	8.6.	97	96	1	1
'Paragon',	11.5.	90	96	9	3
	25.5.	96	98	3	2
	8.6.	98	95	2	4
Pollinated:					
'Andrea',	8.6.	79	86	14	13
'Marbel',	8.6.	85	95	12	3
'Paragon',	8.6.	92	97	5	2
'Tera',	8.6.	81	92	16	4
'Favör II',	8.6.	65	86	33	9

Table 6. The amount of marketable yield, I and II class, in percentage of the total yield in the culture media trial.

Variety and substrate		I class, % 1981	I class, % 1982	II class, % 1981	II class, % 1982
'Andrea'	coarse sand	90	83	8	15
	peat	88	87	9	12
'Marbel'	coarse sand	96	96	2	3
	peat	96	95	2	3
'Paragon'	coarse sand	97	97	2	3
	peat	98	98	1	1

Table 7. Length, diameter, diameter of seed piece and mean weight of cucumbers in average 1981—82.

Variety	Length cm	Diameter cm	Diameter of seed piece cm	Mean weight (total yield) g
'Andrea'	11,4	3,7	1,7	86
'Andrea' pollinated	11,7	3,8	2,0	96
'Marbel'	10,6	3,5	1,7	67
'Marbel' pollinated	10,5	3,8	2,0	77
'Paragon'	10,0	3,5	1,6	75
'Paragon' pollinated	10,3	3,6	1,8	78

the various cultivars in starting the crop. In WELLES' (1978) opinion the parthenocarpic varieties are significantly earlier than the nonparthenocarpic varieties, but the results obtained in the present trials did not confirm this. Compared to the control varieties the yield was, however, made earlier by the fact that the flowers of the varieties requiring pollination remained unpollinated due to the lack of bees while the parthenocarpic varieties set the first fruit parthenocarpically.

Planting time

The middle planting time, which was scheduled for the end of May, gave the best yield result with all varieties either year (Table 8, Fig. 1). The weather in the beginning of May was too cold for the growth of the pickling cucumber even though the cultivation was done in a plastic house. The influence of the weather conditions was clearly seen in the trial results. The first year the spring was warm, but the summer months were cool and cloudy. Then the first planting time May 11 gave a much better result than the planting time on June 8 and nearly as good as the best on May 25 planting time. The cool period that began in June was the reason why the average yield for the June 8 planting time remained low. The spring of 1982 was cold and the late summer again warmer than normal. Thus the lots planted on May 25 and June 8 gave a better yield result than the lot planted on May 11.

In the 'Andrea' variety's crop the differences between the planting times were smaller than with the other varieties. Also the planting on June 8 gave a relatively good yield with this variety. The 'Marbel' benefited the most from the May 25 planting. The 'Paragon' did very poorly in the June 8 planting giving an average yield of only 5,7 kg/m^2.

Culture medium

The outdoors temperature clearly affected the variation in temperature of the coarse sand more than of the peat. During daytime the temperature of the mineral soil was much higher than that of the peat, but early in the morning somewhat lower than that of the peat (Fig. 3).

The cucumber grown in coarse sand gave a somewhat bigger crop than the one grown in peat, but there were no significant differences between the crops obtained with the different

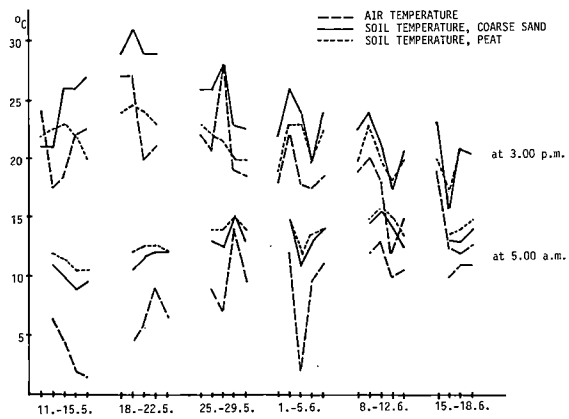

Fig. 3. Soil temperature in the coarse sand and peat (3 cm deep) and the air temperature in the plastic house.

Table 8. Total and marketable yield in the planting time trial in 1981—82.

Planting time	Total yield, kg/m^2			Marketable yield, kg/m^2		
	1981	1982	average 1981—82	1981	1982	average 1981—82
Planting May 11	9,70	7,87	8,79	9,54	7,69	8,62
Planting May 25	10,06	8,83	9,45	9,91	9,66	9,29
Planting June 8	6,58	8,15	7,37	6,46	8,02	7,24
LSD/Tukey	0,24			0,23		

Table 9. Total and marketable yield in the culture medium trial in 1981—82.

Culture medium	Total yield, kg/m²			Marketable yield, kg/m²		
	1981	1982	average 1981—82	1981	1982	average 1981—82
Coarse sand	9,09	7,59	8,34	8,94	7,47	8,21
Peat	8,63	7,42	8,03	8,42	7,34	7,88

culture media either year (Table 9, Fig. 2). Neither did the variety and the culture medium have a significant combined effect either year. In earlier investigations (VIROLAINEN and PESSALA 1978) a better crop with pickling cucumbers has also obtained in mineral soil than in peat with planting in mid-May in the plastic house.

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SELOSTUS

Partenokarppiset avomaankurkkulajikkeet muovihuoneviljelyssä

RAILI PESSALA

Maatalouden tutkimuskeskus

Maatalouden tutkimuskeskuksen puutarhaosastolla Piikkiössä tehtiin vuosina 1981—82 kokeita, joiden tarkoituksena oli selvittää partenokarppisten avomaankurkkulajikkeiden soveltumista kasvukauden aikaiseen muovihuoneviljelyyn Suomen oloissa. Kokeissa oli kolme geneettisesti partenokarppista avomaankurkkulajiketta, 'Andrea' (Nunhems Zaden), 'Marbel' (Royal Sluis) ja 'Paragon' (Sluis en Groot). Nämä lajikkeet ovat riippumattomia pölytyksestä, sillä hedelmä syntyy niillä ilman siemenaiheiden hedelmöittymistä. Täten muovihuoneviljelyssä säästytään mehiläispölytyksen järjestämisestä.

Kokeissa pyrittiin määrittämään, onko lajikkeille parhaiten soveltuva istutusaika toukokuun alku, toukokuun loppu vaiko kesäkuun alku. Lisäksi verrattiin kahta eri kasvualustaa, kivennäismaata ja turvetta. Kokeissa selvitettiin myös kukkien pölyttymisen vaikutusta partenokarppisten avomaankurkkulajikkeiden sadonmuodostukseen.

Kurkun taimet esikasvatettiin kasvihuoneessa 25 vrk:n

ajan. Taimet viljeltiin muovihuoneessa pystyasentoon tuettuina. Satoa korjattiin kaksi kertaa viikossa kesä—elokuussa.

Partenokarppiset avomaankurkkulajikkeet soveltuivat hyvin muovihuoneviljelyyn ja jatkuvaan sadonkorjuuseen. Ne osoittautuivat kohtalaisen satoisiksi ja sato oli laadultaan hyvää. Lajikkeista 'Marbel' oli muita parempi. Sopivimmaksi istutusajankohdaksi osoittautui toukokuun loppupuoli. Verratuilla kasvualustoilla, karkeassa hiedassa ja turpeessa kasvaneiden avomaankurkkujen sadossa ei ilmennyt merkitseviä eroja. Pölyttymisestä ei näiden kokeiden perusteella tuntunut olevan haittaa sadonmuodostukselle.

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SERIA HORTICULTURA N. 63 — Sarja PUUTARHAVILJELY n:o 63

EFFECT OF BENCH WIDTH, PLANT DENSITY AND THINNING OF SHOOTS ON FLOWERING IN SPRAY CARNATION

TAPANI PESSALA

PESSALA, T. 1987. **Effect of bench width, plant density and thinning of shoots on flowering in spray carnation.** Ann. Agric. Fenn. 26: 307—313. (Agric. Res. Centre, Dept. Hort., SF-21500 Piikkiö, Finland.)

The effects of the width of the culture bench in glasshouse were investigated with the widely grown 'Lilli Anne' variety. The highest yield with the best quality was obtained from the narrowest, 0,71 m wide benches, on an average 595 flowers per square metre of bench, whereas the yield from the widest, 1,14 m benches, was 18 % less. Of the yield from the narrowest benches 42 % was graded Extra and I class, from the widest benches only 35 %.

Using a planting density of 30 plants/m^2 the yield was 3,5 % higher than when the plant density was 25 plants/m^2. When a greater plant density was used a qualitywise better crop was obtained from the narrow, 0,71 and 0,87 m, benches.

By means of the thinning done after the first flowering a significant reduction of the amount of poor quality flowers was achieved. The effect of the thinning of the shoots did not extend to the last two flowerings but a new thinning would have been needed the next autumn.

Index words: spray carnation, under glass cultivation, bench width, plant density, thinning of shoots, flower yield, flower quality.

INTRODUCTION

Light is the environmental factor that has the greatest influence on the rate of growth and flowering of the carnation during the year. There are six months during autumn and winter when there are poor light conditions for a high-quality carnation production in southern Finland. The spacing of the plants affects the number of flowers obtained, the quality of the flowers and stems and the quantity of the yield (BOODLEY 1981). If the plants are grown too close together they compete for light, water and nutrients.

The actual planted area in most carnation glasshouses is about 70 % in Finland. The best width of the carnation bench is 1,00—1,20 m (RISTIMÄKI 1981). According to ESCHER (1983) 0,80 m wide benches are due to the ample light suitable for growing carnations, but then the culture area of the glasshouse is not effectively utilized.

According to KINGHAM (1967) increasing the planting density results in a much denser foliage mass within the bed, with a consequent reduction in air circulation and a greater sus-

ceptibility to diseases as well. In Finland the best planting density for growing spray carnations is between 25 and 30 plants per net m^2 (RISTIMÄKI 1981). Since each plant produces 4 to 6 flowering stems from a single pinch, the logical plant spacing is 35 to 45 plants per m^2 for a 2-years' culture. According to BESEMER (1980) this is the best, proved balance of plant costs, flower quality, and production. BOODLEY (1981) mentions that the normal spacing used to produce a pinched crop is 15 × 20 cm or 33 plants per m^2.

With the standard carnation many investigations have been made of the effects of the plant density on the quality and quantity of the yield (PESSALA 1972, JENSEN 1973, BUNT and POWELL 1982), but results of 2-years' trials with the spray carnation are hard to find.

Plants given a single pinch usually show heavy growth in two weeks. Removal of the main stem stimulates a rapid growth of side shoots. These shoots are allowed to go on and flower in May plantings during August and September. After this first crop too many side shoots develop for winter growing. Therefore thinning out the shoots can benefit the next flowering in April and May.

The trial was carried out in 1983—85, the purpose of which was to find out the best bench width and plant density for growing spray carnation in poor light conditions. Effect of thinning shoots was investigated in the same experiment as well.

MATERIAL AND METHODS

Carnation plants were precultivated since 17th May and pinched 24th May 1983. The plants were planted on 10th June in a 12 × 20 m glasshouse compartment provided with automatic heating, ventilation and a mist system. The benches were 9,3 m long, 1,14, 0,87 or 0,71 m wide and 0,24 m high. On the gravel floor was a plastic sheet so that the excess water could drain off from the sides and onto the gravel floor of the glasshouse, but diseases could not invade the substrate directly. The growing medium was light spaghnum peat.

Two planting densities were used, 25 and 30 plants per net m^2 (about 17,5 and 21 plants per m^2 of greenhouse area). There were mostly 3—4 replicas (Table 1) and the plot was 0,86 m^2. Thus the plot using different bench widths measured 0,75 × 1,14 m, 0,98 × 0,87 m or 1,20 × 0,71 m. Each plot contained either 22 or 26 plants according to the spacing. Spray carnation variety was 'Lilli Anne'.

The night and day minimum air temperature was in December and January 4—5 °C. During the best growing season from the end of March to the beginning of September the night temperature was usually 13—15 °C and the highest daytime temperature calibrated on the

Table 1. Bed width, planting density and thinning of shoots in experiment with spray carnation 'Lilli Anne'.

Symbol	Bed width m	Plant density per net m^2	Thinning of shoots Shoots removed Sept. 30, 1983 per net m^2	Shoots left per net m^2	No. of replicas
a	1,14	25	131	80—100	4
b			117	110—130	4
c			61	140—160	4
d			0	188	4
e		30	114	80—100	4
f			84	110—130	4
g			71	140—160	4
h			0	233	2
i	0,87	25	81	80—100	3
j			94	110—130	3
k			0	202	3
l		30	108	80—100	3
m			96	110—130	3
n			0	209	3
o	0,71	25	124	110—130	3
p			112	140—160	3
q			0	233	3
r		30	162	110—130	3
s			145	140—160	3
t			0	270	3

automatic ventilation equipment was 22—25 °C.

The thinning out of the shoots was done on 30 September after the first flowering of the carnation. Irrigation was carried out by pipes with TP-nozzles on both sides of the benches. Nutrients were given mainly in the irrigation water. Spraying for disease and insect control was normal practice.

The flowers were graded according to current quality requirements in four groups, E, I, II and "others". The last group mainly consisted of flowers that were marketable, but of poor quality, grading classes III and IV.

Table 2. Monthly sunshine hours on trial site at Piikkiö (60° 23′ N. lat.) in 1983—85.

Month	Sunshine hours 1981	1982	1983	Mean 1968—83 Monthly	Daily
January		42	32	32	1,0
February		62	111	66	2,3
March		120	117	127	4,1
April		197	89	167	5,6
May	331	219	172	253	8,2
June	186	244		289	9,6
July	213	324		247	8,0
August	157	273		234	7,6
September	140	138		134	4,5
October	61	87		81	2,6
November	29	48		37	1,2
December	13	16		22	0,7
Total		1770		1689	

RESULTS AND DISCUSSION

First yield

The light conditions after the planting were up to the end of the year mostly below average, then and until spring slightly better than the average. The flowering of the spray carnation 'Lilli Anne' started week 34 or on 22th August. The flowering continued abundant into week 38. The different treatments gave 101—129 flowers/m² (Fig. 1). The yield by the end of the year 1983 was 107 flowers/m² from the wide benches and 115 flowers/m² from the other benches. The quality of the flowers was poorest for the carnations grown in the widest benches even though the first yield developed under summer light conditions:

Bench width	No. of flowers/m² E	I	II	Others
1,14 m	5	34	40	28
0,87 m	8	43	37	27
0,71 m	9	46	37	23

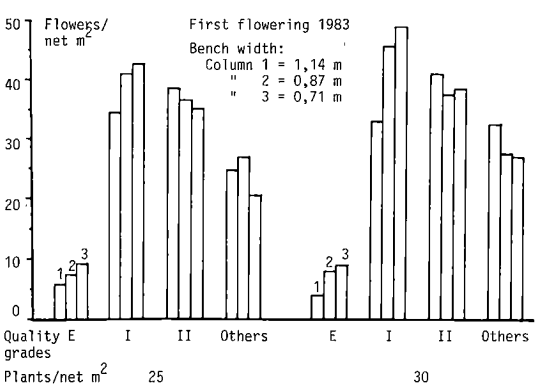

Fig. 1 Effect of bench width and plant density on the first flowering of spray carnation in Aug.—Dec. 1983.

When the plant density was 25 plants/m² the result was 107 flowers/m² and when the plant density was 30 plants/m² the yield was 9 % higher or 117 flowers/m².

Effect of thinning of shoots

At the end of the first flowering of the spray carnation the shoots were thinned out on 30 September in such a way that 80—100, 110—130 or 140—160 were left per bench square metre. In addition part of the plots were left as they were unthinned.

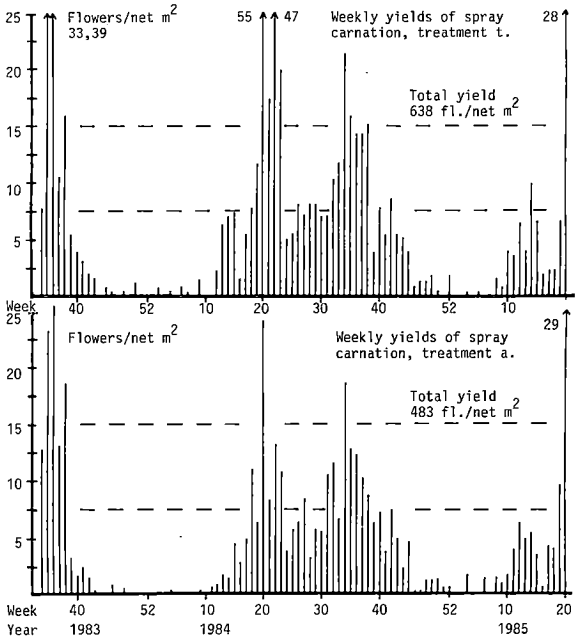

Fig. 2. Example of timing, weekly carnation yields in 1983—85. Treatment a: bench width 1,14 m, 25 plants/m², shoot thinning Sept. 30, 1983, left 80—100 shoots/m², treatment t: bench width 0,71 m, 30 plants/m², no thinning of shoots.

Table 3. Flower quality of spray carnation between Jan.—June 1984 after thinning of shoots 30. Sept. 1983. For symbols, see Table 1.

Symbol	Quality distribution of yield 1.1.—30.6.1984, fl. per net m²				
	E	I	II	Others	Total
a	6	36	45	21	108
b	4	31	49	35	119
c	4	32	52	29	117
d	5	33	58	35	131
e	6	27	45	34	112
f	6	27	55	37	125
g	4	34	56	40	134
h	2	26	62	73	163
i	7	38	38	33	116
j	6	39	45	39	129
k	3	26	63	71	162
l	7	39	42	33	121
m	7	35	44	35	121
n	5	38	69	73	185
o	11	40	58	44	153
p	8	44	64	53	169
q	6	32	73	76	187
r	12	42	52	38	144
s	7	39	59	55	160
t	3	41	80	88	212

The second flowering started at the end of March 1984 and week 20 gave the biggest crop. The total yield was the higher the more shoots had been left in the treatments. The quality-wise best flowers were harvested from the narrowest benches. The more the shoots were thinned out the better the quality of the crop (Table 3). Leaving a great number of shoots in the benches only increased the number of flowers of class II and of the still lower quality classes. By combining the treatments the following example can also be given of the second flowering:

	No. of flowers/m²				
	E	I	II	Others	Total
110—130 shoots/m²	8	36	50	38	132
Unthinned shoots	4	33	67	69	173

The thinning of shoots on 30 September no longer had any effect on the later crop of the spray carnation in the autumn 1984 and in the spring 1985. This can be seen as the result of the shoots becoming fully and densely set after the flowering following the thinning when the poor light conditions within the growth habit prevented an excessive development of shoots.

Effect of plant density

The increased density of planting from 25 plants to 30 plants/m² produced an improved total yield in most treatments during the 2-years' culture. In the trial the greatest differences between the various treatments became 9—10 % in favour of the greater plant density, the average showing a 3,5 % increase of the yield (Table 4). In an almost 3 years' experiment the total flower production has increased with increasing plant density from 14 to 64 plants per m² with standard carnation (JENSEN 1973), and PESSALA (1972) has got similar results in a two years' trial with 35 to 52 plants but the yield has not increased more if plant density has been 59 plants per m². In the quality of the yield there were no great differences between the plant densities:

	No. of flowers/m²				
	E	I	II	Others	Total
25 plants/m²	28	180	186	133	527
30 plants/m²	31	182	187	146	546

Table 4. Effect of various treatments on quality of the 'Lilli Anne' spray carnation flower yield in 1983—85. For symbols, see Table 1.

Symbol	Quality distribution of yield 22.8.1983 — 14.5.1985 Flowers per net m²					%			
	E	I	II	Others	Total	E	I	II	Others
a	19	167	188	109	483	4	34	39	23
b	21	152	179	122	474	4	32	38	26
c	18	157	180	119	474	4	33	38	25
d	20	154	185	135	494	4	31	38	27
e	22	135	170	133	460	5	29	37	29
f	22	132	198	153	505	5	26	39	30
g	15	155	185	146	501	3	31	37	29
h	17	152	198	170	537	3	28	37	32
i	32	191	165	122	510	6	38	32	24
j	35	199	171	121	526	7	38	32	23
k	27	175	185	155	542	5	32	34	29
l	40	193	173	120	526	8	36	33	23
m	36	203	166	124	529	7	38	31	24
n	29	202	201	164	596	5	34	34	27
o	37	204	202	142	585	6	35	34	25
p	38	217	193	137	585	7	37	33	23
q	35	183	215	165	598	6	30	36	28
r	48	220	200	127	595	8	37	34	21
s	42	214	173	142	571	7	38	30	25
t	41	210	211	176	638	6	33	33	28

However, when using the plant density of 30 plants/m² the amount of the poorer classes increased by about 10 %.

When each of the four flowerings of the spray carnation were examined separately it was seen that using a greater plant density for the first two flowerings gave a slightly higher yield. PESSALA (1972) has got similar results with spacing 35—52 plants per m² in a standard carnation experiment and ANON. (1974) with spacing 33 and 46 plants per m² in trials of spray carnation. For the two later flowerings there were no significant differences between the plant densities in the quantity and quality of the yield. According to SPITHOST (1977) after first yield there was a tendency of equal rates of production with densities 24—64 plants/m².

Effect of bench width

The bench width had a distinct effect on the yield and on the flower quality of the spray carnation (Fig. 3 and 4, Table 4). The number of flowers was larger and the quality of the crop was better the narrower the bench was. The

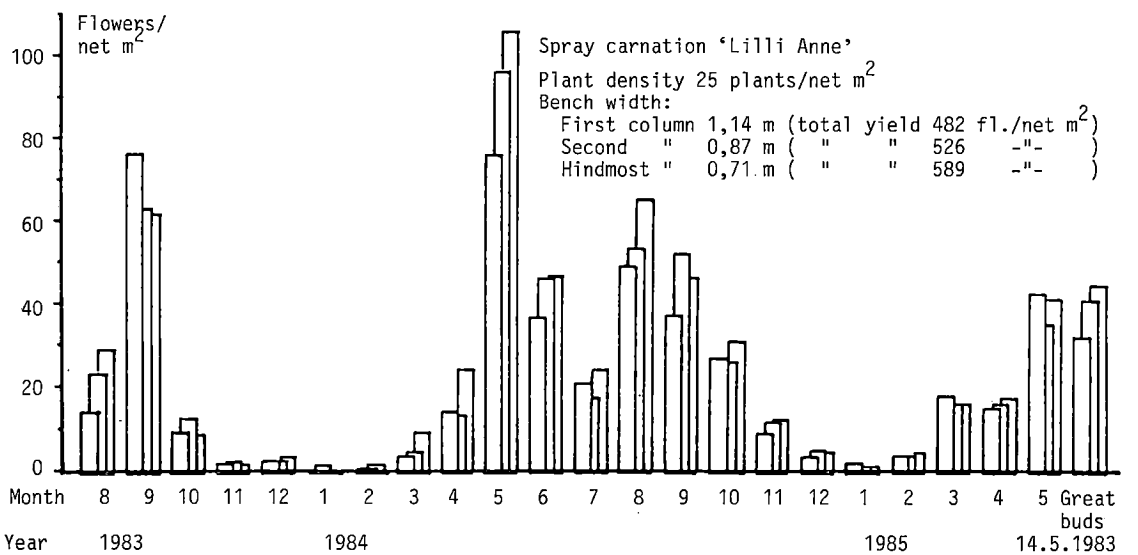

Fig. 3. Effect of bench width on the monthly yield of spray carnation 1983—85.

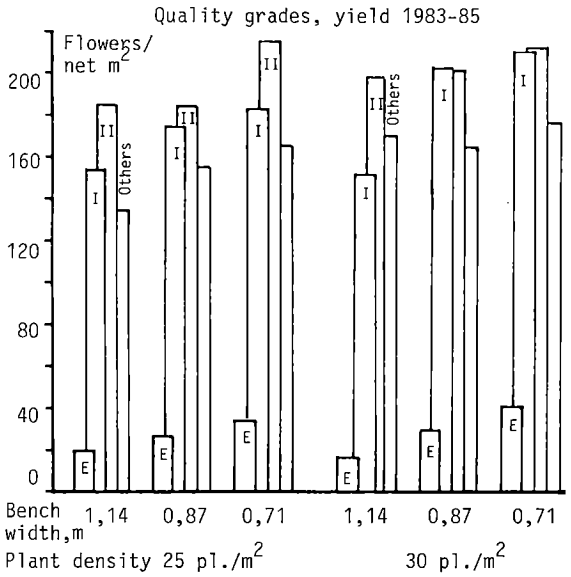

Fig. 4. Effect of bench width and plant density on the flower quality of spray carnation in 1983—85. No shoot thinning are made with these treatments.

difference in favour of the narrowest benches was smallest during the first flowering. Since the plants in the narrowest benches had the most natural light, the increase in the yield and the improvement of the flower quality can for the most essential part be attributed to the increase of light. During the two years of cultivation the widest benches gave a quality-wise better crop when the plant density was 25 plants/m^2 instead of 30 plants/m^2. When the bench width was 0,87 and 0,71 m the amount of the E—II classes increased as the planting density was changed from 25 plants to 30 plants/m^2. The plant mortality in this 2-years' trial was 3 % and thus the mortality had no impact from the point of view of interpreting the results of the investigation.

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SELOSTUS

Viljelypenkin leveyden, taimitiheyden ja versoharvennuksen vaikutus terttuneilikan kukintaan

TAPANI PESSALA

Maatalouden tutkimuskeskus

Viljelypenkin leveyden ja taimitiheyden vaikutuksia terttuneilikan sadon määrään ja kukkien laatuun tutkittiin 'Lilli Anne' (alkuperä Shemi, Israel) lajikkeella. Penkkien leveydet olivat 1,14, 0,87 ja 0,71 m ja taimien istutustiheys 25 ja 30 kpl/m^2. Taimet esikasvatettiin 17.5.1983 alkaen ja latvottiin 24.5. Istutus tehtiin 0,86 m^2:n kokoisiin ruutuihin turvealustalle 10.6. Viljelyn kesto oli 24 kuukautta ja tänä aikana terttuneilikalta kerättiin neljä pääsatoa.

Suurin ja hyvälaatuisin sato saatiin kapeimmasta, 0,71 m levyisestä penkistä, keskimäärin 595 kukkaa/m^2, leveimmissä penkeissä sato oli 18 % pienempi. Kapeimmista penkeistä saadusta sadosta lajiteltiin 42 % kukista ekstra ja I-luokkaan, leveimmissä penkeissä vastaava osuus kokonaissadosta oli 35 %.

Istutustiheyttä 30 kpl/m^2 käytettäessä kukkien luku oli 3,5 % suurempi kuin jos taimitiheys oli 25 kpl/m^2. Suurempaa, 30 kpl/m^2 taimitiheyttä käytettäessä saatiin laadullisesti paras sato, kun terttuneilikan viljelyyn käytettiin kapeita, 0,71 ja 0,87 m, penkkejä. Tuloksen perusteella 1,14 m leveisiin penkkeihin sopiva taimitiheys on 25 kpl/m^2, kapeammissa penkeissä vastaavasti 30 kpl/m^2 silloin kun neilikan viljely kestää kaksi vuotta.

Ensimmäisen kukinnan jälkeen 30.9. suoritettiin osalla koejäsenistä versojen harvennus siten, että versoja jätettiin taimiin 80—100, 110—130 tai 140—160 m^2. Harventamattoman versoston kasvuston versoluku oli yleensä noin 200 kpl/m^2. Ensimmäisen kukinnan jälkeen tehdyn harvennuksen avulla saatiin vähennettyä huonolaatuisten kukkien osuutta merkittävästi. Versoharvennuksen vaikutus ei ulottunut enää kahteen viimeiseen kukintaan, vaan niitä varten olisi tarvittu uusi harvennus seuraavana syksynä.

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CULTIVATION OF THE STRAWBERRY IN PLASTIC HOUSE AND UNDER FIBRE-CLOTH COVER

EEVA LAURINEN and JAAKKO SÄKÖ

LAURINEN, E. & SÄKÖ, J. 1987. **Cultivation of the strawberry in plastic house and under fibre-cloth cover.** Ann. Agric. Fenn. 26: 315—322. (Agric. Res. Centre, Dept. Hort., SF-21500 Piikkiö, Finland.)

The early production of the strawberry was investigated by using an unheated plastic house and a fibre-cloth cover as covering for the plant stand. The temperatures of the air and the soil were higher in the plastic house and under the fibre-cloth cover than out in the open. On an average the plastic house was warmer than the fibre-cloth cover. The soil became nearly as warm under the fibre-cloth cover as in the plastic house. The average soil temperature at the beginning of May in 1986 was both in the plastic house and under the fibre-cloth cover 3—4 °C higher than the outdoors temperature, in 1987 the corresponding difference was 1—2 °C.

The plastic house made the crop 10—12 days earlier as compared to the outdoors. The crop of the fibre-cloth covered plant stand started to ripen 3—5 days earlier than was the case in the open. When harvesting in the open began on the average 77 % of the crop in the plastic house had been harvested, and of the crop from the fibre-cloth cover on an average 38 %.

The plant stand in the plastic house and under the fibre-cloth cover gave a lower yield than the outdoor plant stand. The amount of marketable yield was decreased by the quantity of small berries in the crop from the plastic house and the fibre-cloth cover. In the plastic house and under the fibre-cloth cover the average fruit weight was smaller than out in the open.

The trial included the varieties 'Zefyr', 'Karina', 'Riva' and 'Solgry'. Of the varieties 'Zefyr' did best under all growth conditions.

Index words: strawberry, plastic house cultivation, fibre-gloth cover, Agryl-cover, early production.

INTRODUCTION

The thermal growth period, when the average twenty-four-hour temperature exceeds +5 °C, begins late in April in southern Finland, in 1987 on 28 April. Even after this there may be cold spells and night frosts. Out of doors the flowering of the strawberry starts at the end of May or at the latest in the beginning of June, and the harvesting can begin about a month later. For earlier harvest protective structures — a plastic house and polythene tunnels or a

fibre-cloth cover — can be placed over the plant stand after the snow has melted away, usually in mid-April. However, the weather conditions in the beginning of the growing season vary from year to year and using an unheated protective structure does not always produce a good enough result.

In the Department of Horticulture at the Agricultural Research Centre the early culture of strawberries has been investigated since 1965. The results of the trials have been consistent with results reported in other countries (among others VIK 1965, JORDAN and HUNTER 1972, NESTBY 1979, SEIPP 1983). Cultivation in a plastic house and in polythene tunnels causes the strawberry to flower and crop earlier, the achieved advantage is greater in a plastic house. Depending on the weather conditions of the year the harvesting (control cultivar Zefyr) in a plastic house can begin 9—16 days earlier and in polythene tunnels 5—10 days earlier than out of doors. Under the protective cover the twenty-four-hour average temperature of the air and the soil are already at the end of April and beginning of May higher than in the open. The risk factor in early flowering is frost nights, against which the plastic house and polythene tunnels do not offer sufficient protection (SÄKÖ 1971, 1975, LAURINEN and SÄKÖ 1982).

A fairly new method for early production of strawberry is the fibre-cloth cover spread over the plant stand. According to SEIPP (1983) and SEITZ (1985) the fibre-cloth cover does not advance the ripening as much as a plastic house, but offers a better protection against the frost. In the following a report is given on the early culture project carried out in the Department of Horticulture over the years 1984—87. In this project the cultivation of strawberry in the plastic house, under the fibre-cloth cover (Agryl-cover) and in the open was investigated.

MATERIAL AND METHODS

The 1984—87 strawberry trial was done in coarser fine sand on a gently southwards sloping hill. The fibre-cloth cover and outdoor part of the trial was located on the south side of the plastic house. Before planting a 5 cm layer of peat was added to the soil. The soil was not given any fertilizers before planting. During the cultivation the plant stands were given a compound fertilizer (N-P-K % 7-11-12), of which was administered on an average 2,5 kg/100 m^2 a year. All treatments were given fertilizers in the same manner.

For plant protection general plant protection programs were applied. Only the outdoor part was treated with herbizides. The plant stand in the plastic house was watered once a week, the outdoor and fibre-cloth cover part as needed.

The plastic house was erected (the polythene covering put in) after the snow had melted away and the surface of the ground thawed (7 May 1985, 21 April 1986 and 16 April 1987). The plastic house measured 9 × 14 m (126 m^2) and the height in the centre was 3 m. The polythene covering (EVA) was 0,20 mm thick. The plastic house was removed when the harvesting was over. The fibre-cloth cover (AGRYL P 17) was spread over the plant stand at the same time the plastic house was erected. The cover was removed when the flowering had started.

The planting was done in the spring 1984. Neither the plastic house nor the fibre-cloth cover were used the year of planting. The planting density was 0,33 × 0,7 m and thus there were 428 plants in 100 m^2. The treatment measured 4 × 3,5 m^2 in the plastic house, and under the fibre-cloth cover as well as out of doors it measured 2 × 3,5 m^2.

Thermographs were used to record soil and air temperatures and the measurements were started after the plastic house was erected. The air temperature was measured at plant stand height and the soil temperature at a depth of 10 cm. The crop was weighed and graded marketable, small and mouldy berries. The berry size was determined in a sample of 200 berries from the initial, middle and final crop. Harvesting was done in three years of the trial.

During the cultivation years the monthly mean temperatures °C at Piikkiö (60° 23′ N. lat.) in April—July were as follows:

	1985	1986	1987	1931—60 (mean temperature)
April	0,8	2,4	1,9	2,6
May	8,9	10,2	7,5	9,2
June	13,8	16,5	11,9	14,0
July	15,8	16,4	15,7	17,3

RESULTS AND DISCUSSION

Temperature in plastic house and under fibre-cloth cover

In the plastic house and under the fibre-cloth cover (Agryl-cover) the temperature both of the air and the soil rose quite rapidly higher than the corresponding temperatures in the open (Table 1, Fig. 1). In the plastic house the temperature difference in the air as compared to the outdoors was greater than for the fibre-cloth cover. Under the fibre-cloth cover the air cooled off more during the cold hours of the night, and the minimum temperatures (in May 1987 — 4 °C) at times matched the corresponding outdoor temperatures.

The cooling of the air around the fibre-cloth cover did not, however, affect significantly the temperature of the soil since the temperature difference in the soil as compared to the outdoor was nearly the same in the plastic house and under the fibre-cloth cover. The unusually cold spring 1987 the soil temperature in the plastic house in May rose on an average only 1,7 °C and under the fibre-cloth cover 1,2 °C higher than the soil temperature out in the open. The soil became warmer at a slow rate and only reached a temperature suitable for growth in the middle of May. This delayed the flowering. The importance of the substrate warming up is illustrated by the fact that under outdoor conditions the growth and flowering of the strawberry can be made earlier by few days by heating the soil (SONDERN 1975, LAURINEN and SÄKÖ 1980, HÅKANSSON et al. 1984).

Inducement of early flowering and crop

The earlier the heat-collecting structure can be erected over the strawberry plant stand the greater the benefit that can be expected from its use (VIK 1965). The weather conditions in the spring also have a decisive effect on the result. In 1987 the plastic house was put up and the fibre-cloth cover spread shortly after the snow had melted away late in April. However, the chilly spring slowed down the development of the strawberry, and the flowering of the earliest cultivars ('Karina', 'Solgry') did not begin until on 25 May in the plastic house and three days later under the fibre-cloth cover (Table 2). Previous trial years with normal weather conditions the flowering in the plastic house could start as much as ten days earlier (SÄKÖ 1975, LAURINEN and SÄKÖ 1982).

On the average the flowering under the fibre-cloth cover began only a few days later

Table 1. Average weekly air and soil temperature in plastic house and under Agryl-cover as compared to outdoor temperature in 1986—87. Measured at 8 a.m.

Calendar weeks	1986 Air temperature in the open C°	1986 Temp. diff. In plastic house	1986 Temp. diff. Under Agryl-cover	1987 Air temperature in the open C°	1987 Temp. diff. In plastic house	1987 Temp. diff. Under Agryl-cover
17 April	+ 4,5	+ 5,1		+ 5,0	+5,8	+0,9
18	12,3	1,1	+2,3	6,4	4,1	3,4
19 May	8,6	4,9	0,9	6,0	5,4	−3,6
20	10,1	4,6	−1,8	4,7	4,4	2,9
21	10,4	7,1	3,0	9,1	6,8	4,0
22	10,1	4,2	3,3	9,6	3,5	2,9
23 June	14,5	3,9		8,7	3,9	
24	15,4	11,5		11,8	3,8	
25	10,9	11,6		11,8	−0,2	
26	16,3	4,8		13,4	2,5	
27 July	17,3	5,6		15,9	3,8	
28	11,7	7,4		15,5	5,1	
	Soil temperature in the open C°	Temp. diff. In plastic house	Temp. diff. Under Agryl-cover	Soil temperature in the open C°	Temp. diff. In plastic house	Temp. diff. Under Agryl-cover
16 April				− 0,8	+0,5	−
17	+ 2,3	+ 2,9	+5,0	+ 0,5	0,6	0
18	6,0	3,4	3,5	1,2	1,1	+0,5
19 May	8,0	4,3	4,8	5,2	2,1	1,2
20	7,5	3,9	3,5	5,3	1,4	1,0
21	7,8	3,3	3,1	6,5	1,8	1,2
22	8,1	2,7	2,9	7,0	2,2	1,9
23 June				9,0	0,9	
24				10,9	1,2	
25				10,5	1,1	
26				12,1	1,1	
27 July				12,1	1,1	
28				12,8	1,2	

than in the plastic house. The fibre-cloth cover had better be taken off the plant stand after the flowering has started for a better pollination of the flowers (SEIPP 1983, SEITZ 1985). In the trial in the Department of Horticulture the introduction of the plant stand to outdoor conditions slowed the opening of the flowers. The plant stand that had been covered by fibre-cloth attained the full flower stage more slowly than the plant stand in the plastic house. According to DIJKSTRA and OOSTEN (1981) it is better to delay the removal of the cover with bad weather for better fruit setting.

The years now in question the plastic house gave an earlier crop by 10—11 days as compared to the outdoors, for the fibre-cloth cover plant stand the corresponding difference was 3—5 days the first two years (Table 3). In 1987 harvesting from the fibre-cloth cover plant stand could start only three days earlier than from the outdoor plant stand. When harvesting out of doors started 54—96 % of the plastic house crop, depending on the cultivar and the year, had been harvested, and from the fibre-cloth cover plant stand correspondingly 22—56 %. The use of the fibre-cloth cover did not advance ripening as much as did the plastic house or the polythene tunnel in previous trials (SÄKÖ 1971, 1975). In Norwegian trials the advance in the crop ripening by using the fibre-cloth cover (Agryl P 17) was 5—6 days (MELAND 1986).

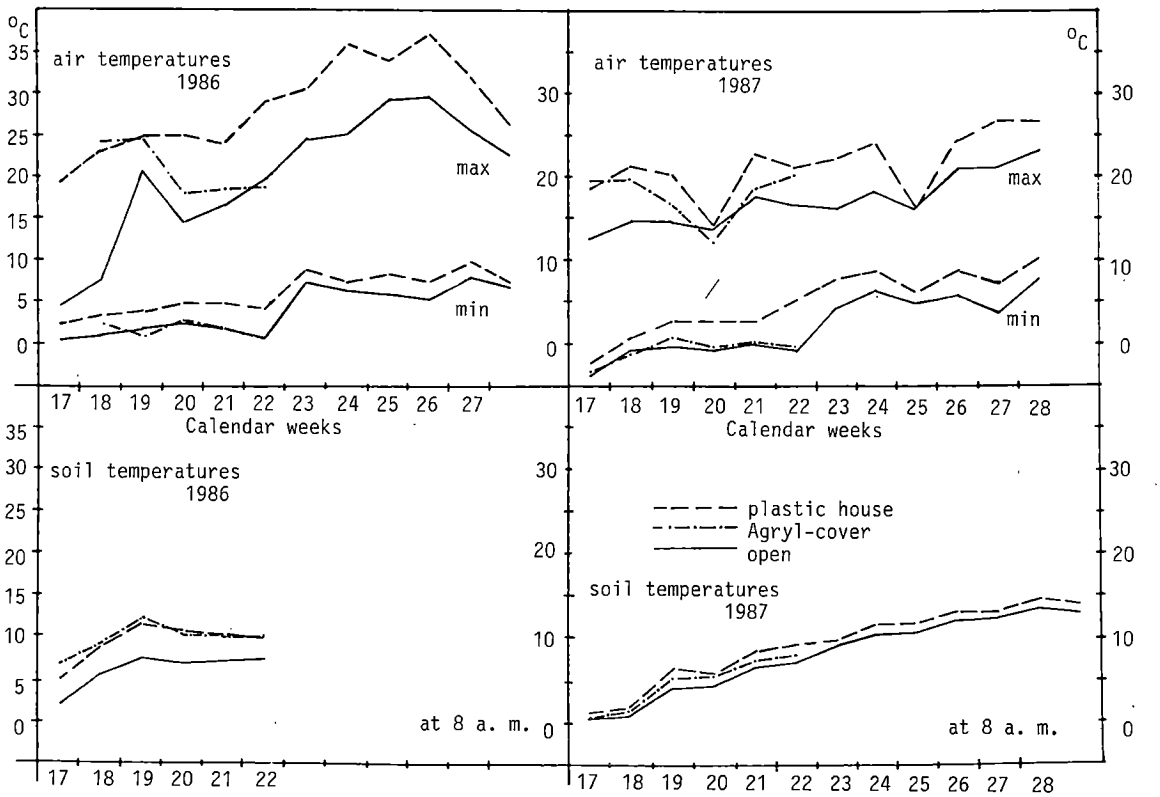

Fig. 1. The weekly minimum and maximum temperatures °C of air at plant stand height and the temperature of soil at a depth of 10 cm in plastic house, under fibre-cloth cover (Agryl-cover) and in the open in 1986 and 1987. Agryl-cover removed week 22.

Table 2. The effect of plastic house and Agryl-cover on the flowering time of the strawberry cultivars at Piikkiö in 1985—87.

	Start of flowering			Days from flowering to harvesting		
	1985	1986	1987	1985	1986	1987
Plastic house						
Zefyr	31/5	24/5	1/6	27	28	35
Karina	29/5	16/5	25/5	29	32	35
Riva	31/5	22/5	29/5	27	28	34
Solgry	29/5	15/5	27/5	29	33	36
Agryl-cover						
Zefyr	31/5	30/5	6/6	30	29	37
Karina	31/5	22/5	28/5	30	32	41
Riva	2/6	27/5	3/6	29	27	40
Solgry	31/5	22/5	30/5	30	32	38
Open						
Zefyr	3/6	4/6	8/6	35	26	38
Karina	3/6	1/6	3/6	32	24	40
Riva	7/6	1/6	10/6	31	26	36
Solgry	3/6	30/5	3/6	30	26	40

Table 3. The effect of plastic house and Agryl-cover on the crop ripening of the strawberry cultivars at Piikkiö in 1985—87.

	Advance of ripening in days compared to the open			Total yield in % harvested before harvesting in the open		
Plastic house	1985	1986	1987	1985	1986	1987
Zefyr	11	11	10	77	88	73
Karina	8	8	14	67	82	96
Riva	11	10	14	76	77	81
Solgry	6	8	—	54	75	—
Agryl cover						
Zefyr	7	4	3	31	34	8
Karina	4	2	5	26	56	22
Riva	7	4	3	54	47	53
Solgry	2	2	5	37	33	54

Yield and quality of yield

The plant stands were harvested for three years. Every year the plastic house gave a smaller total and marketable yield than the plant stand of the fibre-cloth cover or the outdoors plant stand (Table 4, Fig. 2). The fibre-cloth cover crop was only slightly poorer than the outdoor crop. The third year the crop level dropped in all plant stands. In a previous trial with early cultivars ('Zefyr', 'Kristina') the plastic house crop was lower as the crop in the open the third year of culture (LAURINEN and SÄKÖ 1982). Since the crop level in 1987 also decreased in the open the reason can be a poor pollination and fertilization with the temperatures during the flowering time as THOMPSON (1971) has reported. The cultivar 'Solgry', for instance, flowered abundantly in the plastic house, but only a small part of the flowers developed into berries. Pollination ensured by insects in considered to be one prerequisite for a satisfactory crop in the cultivation in plastic houses, in polythene tunnels and under fibre-cloth covers (VIK 1965, LEHMUSHOVI and SÄKÖ 1982, SEIPP 1983, SEITZ 1985).

The number of mouldy berries remained small with these early cultivars. On the other hand the large share of small berries (less than 1,5 cm in diameter) reduced the quantity of the marketable yield from the plastic house and fibre-cloth cover plant stands. The average fruit weight in the plastic house and under the fibre-cloth cover was lower than in the open. Since the fruit size generally remains smaller in a plastic house and in polythene tunnels than in the open (SEIPP 1983), the berry size of the cultivars with small berries ('Karina', 'Solgry') is reduced quite rapidly after the initial crop.

Cultivars

The trial contained current early cultivars, which in spring respond most readily to a raised air and soil temperature (Tables 2 and 3). The earliest cultivars in flowering and ripening of the crop were 'Karina' and 'Solgry'. Of the cultivars 'Zefyr' did the best both in the plastic house and under the fibre-cloth cover (Table 4, Fig. 2). Its total and marketable yield was each year the largest. Being a cultivar with moderately large berries its berry size was retained the best even in the final crop.

The strawberry mildew (*Sphaerotheca macularis*) is found to be common in plastic houses and in polythene tunnels (JORDAN and HUNTER 1972, HÅKANSSON et al. 1984). In the plastic house the plant stands of 'Zefyr' and 'Karina' were severely attacked by mildew. The second cultivation year the disease had contaminated the plant stands of both varieties.

Table 4. Cropping of strawberry cultivars in the open, under Agryl-cover and in plastic house in 1985—87. Plant density 428 ps/100^2. Planting on 1/6 1984.

	Total yield kg/100 m^2			marketable yield		Average small -sized berries	moulded berries	Weight of berries	1st 2 wks' harvest	Harvested before harvesting in the open
	1985	1986	1987	kg/ 100 m^2	%	%	%	g	%	%
Plastic house										
Zefyr	114	108	82	76	74	24	2	8,8	95	79
Karina	76	96	42	50	69	30	1	6,6	93	82
Riva	77	107	67	65	75	23	2	8,0	90	78
Solgry	91	95	(19)	52	56	43	1	6,2	90	65
Agryl-cover										
Zefyr	130	172	127	111	77	21	2	10,0	75	24
Karina	95	106	73	65	71	29	0	7,4	96	35
Riva	73	141	78	76	76	23	1	8,3	91	51
Solgry	87	172	59	67	60	39	1	6,0	87	41
Open										
Zefyr	168	195	109	132	84	14	2	13,2	97	
Karina	99	100	44	61	75	24	1	8,0	99	
Riva	116	147	60	91	83	15	2	10,5	99	
Solgry	126	177	121	106	75	24	1	11,2	94	
Average										
Plastic house	90	102	64	61	68	30	2	7,4	92	77
Agryl-cover	96	148	84	80	71	28	1	7,9	87	38
Open	127	155	84	98	79	19	2	10,7	97	

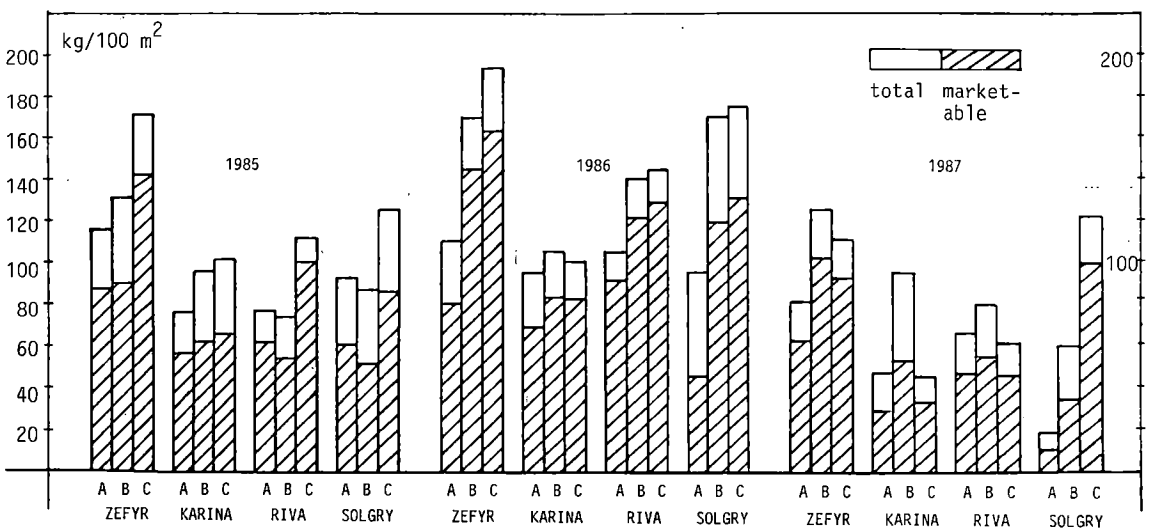

Fig. 2. The total and marketable yield in kg/100 m^2 of strawberry cultivars in plastic house (A), under Agryl-cover (B) and in the open (C). Plant density 428 ps/100 m^2.

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SELOSTUS

Mansikan viljely muovihuoneessa ja harsokatteessa

EEVA LAURINEN ja JAAKKO SÄKÖ

Maatalouden tutkimuskeskus

Maatalouden tutkimuskeskuksen puutarhaosastolla Piikkiössä selvitettiin vuosina 1984—87 mansikan varhaistuotantoa käyttämällä kasvuston yllä lämmittämätöntä muovihuonetta ja harsokatetta (Agryl P 17). Muovihuone pystytettiin ja harsokate levitettiin kasvuston päälle huhtikuun lopulla lumen ja pintaroudan sulamisen jälkeen. Muovihuone purettiin sadonkorjuun päätyttyä, harsokate poistettiin kukinnan alkaessa. Viljelyn aikana oli kasvukausi 1987 epätavallisen kylmä, ja harsokate levitettiin kukinnan alkuvaiheessa yön ajaksi kasvuston ylle.

Ilman ja kasvualustan lämpötilat olivat muovihuoneessa ja harsokatteen alla korkeammat kuin avomaalla. Keskimäärin oli muovihuone hieman harsokatetta lämpimämpi. Harsokatteessa alimmat lämpötilat vastasivat avomaan minimilämpötiloja. Maa sen sijaan lämpeni ja säilytti lämpöä lähes yhtä hyvin kuin muovihuoneessakin. Maan keskilämpötila (aamulla) oli vuonna 1986 toukokuun alussa sekä muovihuoneessa että harsokatteessa 3—4 °C korkeampi kuin avomaalla, vuonna 1987 oli vastaava ero 1—2 °C.

Muovihuone aikaisti satoa keskimäärin 10—12 päivää avomaahan verrattuna. Vastaavasti harsolla katetun kasvuston sato alkoi valmistua 3—5 päivää aikaisemmin kuin avomaalla. Sadonkorjuun alkaessa avomaalla oli muovihuoneen sadosta korjattu keskimäärin 77 % ja harsokatteen sadosta keskimäärin 38 %.

Muovihuoneesta ja harsokatteen alla olleesta kasvustosta saatiin vähemmän satoa kuin avomaalta. Myyntikelpoisen sadon määrään vaikutti pienten (halkaisija alle 1,5 cm) marjojen suuri osuus muovihuoneen ja harsokatteen sadossa. Muovihuoneessa ja harsokatteessa marjojen keskikoko jäi pienemmäksi kuin avomaalla.

Kokeessa olivat mukana lajikkeet 'Zefyr', 'Karina', 'Riva' ja 'Solgry'. Lajikkeista menestyi 'Zefyr' parhaiten kaikissa kasvuolosuhteissa. Koevuosina esiintyi muovihuoneessa mansikkahärmää.

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SISÄLLYS—CONTENTS

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